WHERE NATURE AND ART ADJOIN: INVESTIGATIONS INTO THE ZARLINO-GALILEI DISPUTE, INCLUDING AN ANNOTATED TRANSLATION OF VINCENZO GALILEI'S *DISCORSO INTORNO ALL'OPERE DI MESSER GIOSEFFO ZARLINO*

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Dedication

For encouraging me to follow my dreams and
helping me “be the ball,”
this dissertation is dedicated with love to my parents
Barry and Sherry Goldberg

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The late sixteenth century was a remarkable era for Western music history. Contentious arguments over the relative merits of sacred vocal and secular instrumental music, the interpretation of ancient Greek and Latin writings about music, and the rise of experimentation as an alternative to scholasticism fueled lively debates among music theorists and performers. The most noteworthy of these quarrels involved Gioseffo Zarlino (1517-1590), a Franciscan priest and chapel master of St. Mark's Basilica in Venice, and Vincenzo Galilei (1520 -1591), a Florentine lutenist and father to the mathematician Galileo Galilei.

Many facets of the debate between Zarlino and Galilei remain unexplored. For example, each theorist wrote in distinct intellectual climates and catered to unique audiences: Zarlino collaborated with other intellects in the *Accademia Venetiana della Fama* and dedicated his treatises to powerful political figures. Galilei, on the other hand, sought patronage with noblemen in Florence, many of whom were anti-authoritarian and also interested in instrumental music and experimentation.

Galilei's *Discorso intorno all'opere di Messer Gioseffo Zarlino* (Florence, 1589) contains his most virulent and original attack on Zarlino's great synthesis of music theory, mathematics, Neoplatonic philosophy, and Aristotelian metaphysics. This dissertation includes the first English translation of the *Discorso*, complete with annotations and corrections of the original printed text.

CONTENTS

Introduction

Music theory purports to define and explain the principles of its subject, but this activity is not hermetically sealed from the cultural context of the writers who produced treatises, discourses, and dialogues on music in the *cinquecento*. On the contrary, late Renaissance writers were influenced by a number of oppositions—ancient authority versus contemporary experimentation, sacred versus secular, theory versus practice—and these tensions are reflected in the musical polemics of the era. The dispute between Gioseffo Zarlino (1517-1590) and Vincenzo Galilei (1520?-1591), which took place in a series of publications and epistles, was fueled by these dichotomies, and the confrontation set the agenda for the most important musical controversies of the early Baroque.[1] Nevertheless, the Zarlino-Galilei controversy has never received a thorough study.

To understand the texts of Zarlino and Galilei we must examine the larger contexts in which they were produced. Sixteenth-century music books, as in the present day, were intended to serve a variety of functions and audiences. Paradoxically, the *cinquecento* treatises that have attracted the most attention over the years are also the

[1] The principal texts are Gioseffo Zarlino's, *Le istitutioni harmoniche* (Venice: [by the author], 1558; reprint in Monuments of Music and Music Literature in Facsimile, II/1, New York: Broude Brothers, 1965), *Dimostrationi harmoniche* (Venice: Francesco de' Franceschi Senese, 1571; reprint in Monuments of Music and Music Literature in Facsimile, II/2, New York: Broude Brothers, 1965); *Sopplimenti musicali* (Venice: Francesco de' Franceschi Senese, 1588; reprint in Monuments of Music and Music Literature in Facsimile, II/15, New York: Broude Brothers, 1979); and Vincenzo Galilei's *Dialogo della musica antica, et della moderna* (Florence: Marescotti, 1582; reprint in Monuments of Music and Music Literature in Facsimile, II/20, New York: Broude Brothers, 1967) and *Discorso intorno all'opere di Messer Gioseffo Zarlino di Chioggia* (Florence: Marescotti, 1589; reprint in Collezione di trattati e musiche antiche edite in facsimile, Milan: Bollettino bibliografico musicale, 1933). Galilei furthered his arguments in three late, unpublished essays, which treat ancient musical history and musical intervals, and a final, unpublished critique of Zarlino (preserved in Florence, Biblioteca Nazionale Centrale [**I**-Fn], Gal. 5). That their dispute was still noteworthy in the seventeenth century is indicated by the reprinting of both Zarlino's *Istitutioni* and *Dimostrationi* (Venice: Franceschi) and Galilei's *Dialogo* (Florence: Giunti) in 1602. The Florentine printer, Modesto Giunti, was probably trying to exploit the notoriety of the Zarlino-Galilei debate by adding the phrase "In his defense against Gioseffo Zarlino [In sua difesa contro Ioseffo Zarlino]" to the original title of the *Dialogo*.

most difficult to assess in terms of their various functions. This dissertation proposes that the content and tenor of the Zarlino-Galilei debate is connected to the social milieu of its protagonists and can only be fully understood in this context. Underlying their quarrels about tuning systems, counterpoint, and the interpretation of ancient Greek sources are debates about the relative merits of sacred polyphony and secular instrumental music, the rise of experimental science as an alternative to scholastic authority, and fundamental arguments over the relationship between natural philosophy and artistic practice.

Historical Background

In the latter half of the sixteenth century, following the success of his compendious *Le istitutioni harmoniche* (Venice, 1558), Gioseffo Zarlino was considered the most important music theorist in Italy. Zarlino's greatest achievement lay in his ability to create ideal theoretical systems that were grounded in ancient philosophy, and his treatises were the most influential of the sixteenth century. Although Martha Feldman in her *City Culture and the Madrigal at Venice* asserts that his ideas were "abandoned by his successors,"[2] Zarlino was esteemed as an authority of Boethian status by *cinquecento* and *seicento* musicians. In Italy, he was praised in many treatises, and his *bone regole* of counterpoint were considered to be law.[3] Outside the peninsula, Zarlino's influence was clearly acknowledged in the *Compendium musicae* of the French philosopher René Descartes, Jan Pieterszoon Sweelinck translated portions of the *Istitutioni* for his German

[2] Martha Feldman, *City Culture and the Madrigal at Venice* (Berkeley: University of California Press, 1995), xxviii.

[3] Even in Naples, where Franchino Gaffurio continued to exert a wide influence on theorists, Zarlino was given a place of honor in treatises. See, for example, Scipione Cerreto, *Della prattica musica vocale, et della strumentale* (Naples: Carlino, 1601; reprint in Bibliotheca musica bononiensis, II/30, Bologna: Forni, 1969), 6.

students, and scholars have noted an important historical link between Zarlino's interval theories and the first explanation of the harmonic triad offered by Johannes Lippius in his *Synopsis musicae novae*.[4] Furthermore, Zarlino's posthumous reputation reached mythic proportions when biographer Francesco Caffi claimed that Zarlino invented the *stile rappresentativo* and composed the first opera, *Orfeo*![5]

The central tenet of Zarlino's theoretical work is the *musico perfetto*. He claimed the "perfect musician" was one who not only composed, sang, or played with the proper rules but also understood the scientific foundations of music.[6] To this end, Zarlino tried to establish musical truths that synthesized elements of musical theory and practice. Foremost among these truths is Zarlino's assertion that modern singers intone their pitches and instrumentalists tune their instruments according to the Syntonic tetrachord, which was formulated by the ancient scientist and philosopher Claudius Ptolemy.[7] In the *Istitutioni*, Zarlino also offered an extensive compendium of Greek musical history and ideas, a codification of the rules for contrapuntal composition, and guidelines for proper text underlay in polyphonic music. Zarlino's synthesis of materials was astounding, including the work of the literary theorist Pietro Bembo and contemporary music

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[4] René Descartes, *Compendium of Music*, translated by Walter Robert, introduction and notes by Charles Kent, Musicological Studies and Documents, vol. 8 (n.p.: American Institute of Musicology, 1961). Although Descartes's debt to Zarlino is quite obvious, Kent notes that Descartes cites Zarlino only once, in order to criticize him; for a discussion of Sweelinck's teaching, see David Gaynor Yearsley, "Ideologies of Learned Counterpoint in the North German Baroque" (Ph.D. dissertation, Stanford University, 1995); on the theoretical links between Zarlino and Lippius, see Benito Rivera, *German Music Theory in the Early 17th Century: The Treatises of Johannes Lippius*, Studies in Musicology, ed. George Buelow, no. 17 (Ann Arbor, MI: UMI Research Press, 1980), 95-102.

[5] Francesco Caffi, *Delle vita e delle opere del prete Gioseffo Zarlino: Maestro celeberrimo nella capella ducale di Venezia* (Venice: Giuseppe Orlandelli, 1836), 16-18. One can infer from Caffi's narrative that he is not describing only Zarlino's *Orfeo* but both the 1607 setting by Claudio Monteverdi *and* Luigi Rossi's 1647 opera of the same title.

[6] Zarlino, *Istitutioni* I.11, 20-21.

[7] The tetrachord, a central aspect of ancient Greek music theory, is a scale of four notes that covers the span of a diatessaron—or perfect fourth. The Greek theorists proposed many species of tetrachords, but Zarlino focused on Ptolemy's *syntonic* species because it facilitated consonant thirds and sixths.

theorists Lodovico Fogliano and Heinrich Glarean, as well as the tradition of ancient music theory as handed down by Boethius. While he served as *maestro di cappella* of St. Mark's Basilica in Venice, many musicians sought out Zarlino as a teacher and transmitted his ideas throughout Italy and abroad.

The validity of Zarlino's tidy systems was questioned by his former student, Vincenzo Galilei, first in an anonymous discourse in 1578 (now lost) and then more fully in his *Dialogo della musica antica, et della moderna* (Florence: Marescotti, 1581). In the *Dialogo*, interlocutors Count Giovanni Bardi (Galilei's dedicatee and patron) and Piero Strozzi point out many errors in Zarlino's work. Influenced by the Florentine humanist Girolamo Mei, Galilei also condemned sixteenth-century contrapuntal practice.[8]

Zarlino responded to Galilei in his *Sopplimenti musicali* (Venice: Francesco de' Franceschi Senese, 1588), in which he set out to expand the philosophical and scientific foundations of his theories. Although Zarlino never referred directly to Galilei, many references to an unnamed "disciple" create the illusion of a dialogue between the combatants. In publishing the *Sopplimenti*, Zarlino showed himself to be unmoved by Galilei's criticisms while subtly applying Galilei's ideas to his own theories.[9] Zarlino's entrenched attitude towards his former student led Galilei to devote almost all of his later writings to exposing Zarlino's "errors" and "abuses."

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[8] For information on Girolamo Mei, see Donatella Restani, *L'Itinerario di Girolamo Mei dalla "poetica" alla musica: Con un'appendice di testi,* Studi e testi per la storia della musica, vol. 7 (Florence: L. S. Olschki, 1990).

[9] Don Harrán considers Galilei's ideas an important source for Zarlino's *Sopplimenti*. See Harrán, "Sulla genesi della famosa disputa fra Gioseffo Zarlino e Vincenzo Galilei," *Nuova rivista musicale italiana* 21 (August-September 1987): 468.

Galilei's 1589 *Discorso*

One year after Zarlino published his *Sopplimenti musicali*, Galilei responded with a *Discorso intorno all'opere di Messer Gioseffo Zarlino* (Florence: Marescotti, 1589). Unlike Zarlino's major treatises and Galilei's *Dialogo*, all of which are large, folio volumes, the *Discorso* is a small octavo. It contains no elaborate diagrams or visual examples. The text is composed in a single paragraph of 134 pages, with no headings, divisions, or marginalia. There is, however, an underlying form that supports the aims of the book; Galilei initially indicates that he will discuss the inpracticality of the Syntonic tetrachord, temperament, mathematics, and the extent to which his *Dialogo* influenced Zarlino's *Sopplimenti*, although he does not adhere to his original synopsis.[10]

Galilei unifies these four topics under a forceful discussion of what constitutes "natural" and "artificial" in music. His argument for a reconsideration of man, as artificer, in the creation of musical systems is the most important contribution of the *Discorso*, while it ties his work to the late-sixteenth-century flowering of experimental science.[11] Specifically, Galilei demands that we question the assumed "naturalness" of musical scales or tuning systems. In his view, there was no justification to conclude that Ptolemy's Syntonic tetrachord was any more natural than those attributed to Pythagoras, Archytas, or Didymus: all were human constructions and thus were "artificial." In

[10] Galilei, *Discorso*, 8-9.

[11] Stillman Drake suggests that the new trends in sixteenth-century musical practice specifically led to the rise of experimental physics and that Galilei's *Discorso* is a significant document in this regard. See his "Renaissance Music and Experimental Science," in *Essays on Galileo and the History and Philosophy of Science*, 3 vols., selected and introduced by Noel Swerdlow and T. H. Levere (Toronto: University of Toronto Press, 1999), 3:195-96, 202-3.

addition to his discussion of ancient tetrachords, Galilei refuses to acknowledge that all consonant intervals are more natural than dissonant intervals.[12]

An angry rhetoric pervades the 1589 *Discorso*. Aside from charging Zarlino with plagiarism and blind ambition,[13] Galilei also accuses his former teacher of holding up the publication of the *Dialogo* through underhanded means while Zarlino contemplated printing it under his own name. Furthermore, Galilei's derisive tone is a reaction to Zarlino's refusal to acknowledge logical flaws in his teachings. Throughout the text, Galilei also ridicules Zarlino's associates, referring to them as *chriocanti* (members of a clique).

After Zarlino and Galilei died (1590 and 1591 respectively), their debates were continued by two Bolognese writers: the canon Giovanni Maria Artusi (ca. 1540-1613) and the Cavalier Ercole Bottrigari (1531-1612). Although Artusi agreed with many of Galilei's ideas, he lashed out at the Florentine's disrespect towards Zarlino, while also defending Zarlino's speculative approach to musical science.[14] Artusi later redirected his attacks toward Bottrigari after the latter published *Il Patricio, overo de' tetracordi armonici di Aristosseno* (Bologna: Benacci, 1593), a discourse directed at the Ferrarese philosopher Francesco Patrizi's inaccurate descriptions of the ancient tetrachords. Artusi had again taken offense at a minor noble's disrespect towards speculative philosophy. He

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[12] On this point, Galilei is arguing with the Pythagorean/Boethian musical tradition that gives precedence to musical intervals with simple ratios.

[13] Centuries later, Cristle Collins Judd wrote that Zarlino's *Istitutioni* was inspired by his ambition to gain acceptance to the Accademia Veneziana and succeed his teacher Adrian Willaert as *maestro di cappella* of St. Mark's basilica. Galilei would have emphatically agreed. See Cristle Collins Judd, *Reading Renaissance Music Theory: Hearing with the Eyes*, Cambridge Studies in Music Theory and Analysis, vol. 14 (Cambridge: Cambridge University Press, 2000), 192-98.

[14] Artusi published a directed critique of Galilei under the pseudonym *Burla academico*. The work is mentioned in Bottrigari's "Aletologia di Leonardo Gallucio" (Bologna, Civico Museo Bibliografico Musicale [**I**-Bc], B.43), yet Artusi's text appears to be lost. Artusi refused to credit Galilei with any contributions to music theory. In his *L'Arte de contraponto* (Venice: Vincenti, 1598), he refers to Galilei only as "Scritti sotto il nome Vincenzo Galilei" (writings under the name Vincenzo Galilei).

went so far as to accuse Bottrigari of plagiarizing the treatise *Il desiderio, overo de' concerti di varii strumenti musicali* (first published in Venice by Ricciardo Amadino in 1594) from the Cavalier's own student Annibale Melone. In his invective, Artusi extolled Zarlino's codifying systems while lamenting the errors of unlearned musicians. Bottrigari, like Galilei, tended towards a historical approach to music theory. In his unpublished dialogue, "Il trimerone de' fondamenti armonici," Bottrigari attempted a comprehensive history of music theory, showing the artificiality and mutability of theoretical systems.

Perspectives on the Debate

The theoretical details of these debates have been discussed by Claude Palisca, Daniel Pickering Walker, Karol Berger, Maria Rika Maniates, and others, but many issues remain unresolved.[15] Of primary importance are the social contexts in which these writers worked. Both Zarlino and Artusi were clerics who dedicated many of their writings to religious figures and, especially in Zarlino's case, supported their ideas with scripture and patristic writings.[16] Galilei, on the other hand, was patronized by Florentine *cavalieri*, and his publications were directed towards non-clerical, amateur musicians.[17]

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[15] See for example Claude V. Palisca, *Humanism in Italian Renaissance Musical Thought* (New Haven, CT: Yale University Press, 1985); D[aniel] P[ickering] Walker, *Studies in Musical Science in the Late Renaissance*, Studies of the Warburg Institute, ed. J. B. Trapp, vol. 37 (London: Warburg Institute, 1978), 14-26; Karol Berger, *Theories of Chromatic and Enharmonic Music in Late Sixteenth Century Italy*, Studies in Musicology, no. 10 (Ann Arbor, MI: UMI Research Press, 1980); and Maria Rika Maniates, "Bottrigari Versus Sigonio: On Vicentino and His Ancient Music Adapted to Modern Practice," in *Musical Humanism and Its Legacy: Essays in Honor of Claude V. Palisca*, ed. Nancy Kovaleff Baker and Barbara Russano Hanning, Festschrift Series, no. 11 (Stuyvesant, NY: Pendragon, 1992), 195-212.

[16] For example, in his *Sopplimenti musicali*, Zarlino compares himself to St. Ambrose of Milan, levying justice against heresy. See chapter 2, pp. 94-95 *infra*.

[17] For information on Florentine patronage, see Tim Carter, "Music and Patronage in Late Sixteenth-Century Florence: The Case of Jacopo Corsi (1561-1602)," *I Tatti Studies: Essays in the Renaissance* 1 (1985): 57-104; and idem, "*Non occorre nominare tanti musici*: Private Patronage and

The sacred-versus-secular dynamic of these theoretical debates is important to recognize because it helps us understand the larger, foundational principles upon which the detailed arguments about tuning systems and dissonance treatment stand. Zarlino's belief in the superiority of vocal music over instrumental music is certainly influenced by his intellectual and religious background. Likewise, Galilei's attempt to place instrumental music on an equal footing with vocal styles is consistent with his background as a lutenist and the interests of his patrons.

A central issue in the debate is the definition and role of authority, in its broadest terms; both writers are transparent in their viewpoints on the subject. Zarlino cloaks his works with a mantle of political and religious authority. For example, each of his three principal treatises is dedicated to a powerful political figure: Vincenzo Diedo, Patriarch of Venice (1555-1559), Alvise Mocenigo, Doge of Venice (1570-1577), and Pope Sixtus V (reigned 1585-1590). This regard for authority governs many of the theoretical topics in his treatises, such as the relative merits of harmonically divided proportions and adherence to the *bone regole* of counterpoint.

Galilei, by contrast, defies authority. Early in the *Dialogo*, his interlocutor Piero Strozzi criticizes those who simply bow to authority.[18] Galilei's challenging tone may have been influenced by his association with several members of the Florentine *Accademia degli Alterati*. Although debates over literary theory were more common than musical polemics in the academy, Galilei's mentor Girolamo Mei and Mei's teacher Piero Vettori had participated in quarrels over Aristotle's *Poetics*. Just as Galilei argued

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Public Ceremony in Late Sixteenth-Century Italy," *I Tatti Studies*: *Essays in the Renaissance* 4 (1991): 89-104.

[18] Galilei, *Dialogo*, 2; translated in Vincenzo Galilei, *Dialogue on Ancient and Modern Music*, trans. with introduction and notes by Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 2003), 12.

against Zarlino's Ptolemaic systems, Mei and Vettori matched words with the Sienese Archbishop and prolific writer, Alessandro Piccolomini (1508-1579), who was also influenced by Ptolemy's neat systems.[19] Furthermore, seventeenth-century theorists sometimes explicitly equated challenges to musical-theoretical authority (e.g., Zarlino's rules for counterpoint) with political rebellion.[20]

More than fifty years ago, Claude Palisca examined these polemics in his own dissertation.[21] In doing so, he clarified the essential musical topics, theoretical arguments, and important personages. Supported by a thorough knowledge of Galilei's later writings and the intellectual climate of the late Renaissance, Palisca elevated Galilei's stature above that of a mere transmitter of others' ideas.[22] A central tenet in Palisca's work was his insistence that music treatises must be considered in their entirety. Whereas many scholars tended to browse primary sources for tidbits about performance practice or compositional process, he treated these documents as true literary works, worthy of objective study. In his view, only through studying these works as complete documents could scholars answer more sophisticated questions about the role of music theory in the culture of the late Renaissance. It is in this spirit that the first full translation of Galilei's 1589 *Discorso* is included as part of this dissertation.

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[19] Gaspare De Caro, *Euridice: Momenti dell' umanesimo civile fiorentino* (Bologna: Ut Orpheus Edizioni, 2006), 82-83.

[20] For example, see Giovanni Maria Bononcini, *Musico prattico* (Bologna: Giacomo Monti, 1673; reprint in Monuments of Music in Facsimile, II/78, New York: Broude Brothers, 1969). This popular treatise offers a brief compendium of theory, musical notation, composition, and the modes, all based on Zarlino's *Istitutioni*. Bononcini warns the reader against those ignorant of the *bone regole*, and the elaborate frontispiece includes a symbolic representation of "Piety" casting away an allegorical image of "Rebellion."

[21] Claude V. Palisca. "The Beginnings of Baroque Music: Its Roots in Sixteenth-Century Theory and Polemics" (Ph.D. dissertation, Harvard University, 1954).

[22] Earlier scholarship on Galilei focused on his role in the Florentine Camerata and some writers denied the importance of his theoretical works. For example, Nino Pirrotta claimed that Galilei "cuts a poor figure as a theorist, and has nothing, or next to nothing, original to say." See Nino Pirrotta, "Temperaments and Tendencies in the Florentine Camerata," trans. by Nigel Fortune, *Musical Quarterly* 40 (April 1954): 172.

Because Palisca was so thorough in his treatment of this period, it might be asked if all these sources need to be reviewed. There are two significant ways in which this dissertation will update our understanding of these theoretical debates. First of all, Palisca adopted a dynamic, almost progressivist view towards his subjects. For example, he claims Galilei "helped liberate musical thinking from the prejudices that had long reigned among musicians and bound them to an obsolete theoretical system."[23] That Zarlino's system was obsolete is surely contradicted by its continued esteem in Italian music theory long after the sixteenth century.[24] Palisca also assumes that the music preferred by Galilei and his colleagues, whether interpreted as monody or the *seconda prattica* in general, soon became the dominant compositional style in Italy. In fact, strict contrapuntal writing was still quite prominent in the seventeenth century; a contextual reading of Zarlino's works and a study of their reception will shed light on the persistence of polyphonic composition. That Galilei "liberated" musical thinking is also a commonplace among some post-World War II music historiography that views historical change as a dynamic cycle of enslavement and freedom.[25] It assumes that theorists were oppressed by Neoplatonic or Pythagorean worldviews, whereas in fact many musicians of the sixteenth and seventeenth centuries were quite enamored with Zarlino's writings and the world view they represent.

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[23] Palisca, "The Beginnings of Baroque Music," 58.

[24] For one example among many, I would cite the nineteenth-century composer and theorist Luigi Picchianti. In his *Principj generali e ragionati della musica teorico-pratica* (Florence: Tipografia della speranza, 1834), Picchianti proposes a harmonic system that still adheres to Zarlinian ideals of modal unity.

[25] Edward Lowinsky, in the same year Palisca completed his dissertation, used a similar construction in discussing fifteenth-century music: "One can view the evolution of vocal music in the Renaissance as one great process of emancipation: emancipation from the Gregorian chant, from the *cantus firmus*, from the technique of successive composition, from preëxistent patterns of form and rhythm. Similarly, one can interpret the evolution of instrumental music in the Renaissance as a slow process of emancipation from the domination of vocal music." Edward E. Lowinsky, "Music in the Culture of the Renaissance," *Journal of the History of Ideas* 15 (October 1954): 541.

To fully understand the Zarlino-Galilei controversy, we must grasp the intended audience and function of the texts that carried the debate. Most music treatises composed in the sixteenth century had a clear didactic purpose. For example, Orazio Scaletta's *Scala di musica* (first printed in 1585 with many later editions) is a simple primer for singers.[26] Its seventeen chapters teach rudiments of sight reading, hexachordal mutation, and performance decorum. There are no speculative discussions about music's role in society, the harmony of the spheres, or the mathematical foundations of music. Instrumental primers, too, such as Galilei's treatise on lute playing and intabulation, *Il Fronimo* (Venice: Scotto, 1568–69 and 1584), focused on purely practical issues. Many of these texts were composed as dialogues, simulating the interaction between master and student. The enthusiastic Florentine nobles who serve as interlocutors in Galilei's *Fronimo* and *Dialogo* tell us as much about the author's context and readership as the circle of elite musicians and philosophers featured in Zarlino's dialogue *Dimostrationi harmoniche*.

Zarlino's *Sopplimenti* and Galilei's 1589 *Discorso* do not show any of the affable traits of a typical *cinquecento* dialogue. There are no pastoral settings, encomiums of civic pride, or catechistic discussions. Both texts, however, do suggest dialogue through their incessant use of quotation. In the *Sopplimenti*, Zarlino cites many passages from Galilei's *Dialogo* (referring to the author as "my disciple" or "my student"). Galilei accepts Zarlino's challenge and in turn dissects the *Sopplimenti* at length. In one case, he

[26] Orazio Scaletta, *Scala di musica* (Venice: Alessandro Vincenti, 1626; reprint in Bibliotheca musica bononiensis, II/33, Bologna: Forni, [1976]).

treats the entirety of book I, chapter 6 of the *Sopplimenti*, reprinting and arguing with each clause.[27]

To place these works in a broader literary context, it may be useful to trace the important scientific and literary debates of the era. John Emil Kelleher's dissertation has already observed strong affinities between Zarlino's *Dimostrationi harmoniche* and the quarrel over *certitudo mathematicarum* (mathematical certainty) that began in the middle of the sixteenth century.[28] The debate was provoked by Alessandro Piccolomini's *Commentarium de certitudine mathematicarum disciplinarum* (Rome: Antonius Bladus Asulanus, 1547), in which he argued that physics allowed for more certainty than abstract mathematics. That Zarlino may have been cognizant of Piccolomini's ideas is indicated by his continuing examination of the *corpo sonoro* (sounding body), the physical embodiment of musical sound.

Daniel Pickering Walker has suggested that the Zarlino-Galilei dispute was fueled more by personal dislike than by any true disagreement over the principles of musical science.[29] In any case, both men participated in the flowering of empirical science that would revolutionize European culture in the seventeenth century, not to mention its effect on the influence of Pythagorean or Neoplatonic philosophy in music theory. Nevertheless, as Walker points out, by the end of the seventeenth century, Europe's greatest scientist, Isaac Newton, captivated by new research into *prisci theologi*, had

[27] Galilei, *Discorso*, 72-99.

[28] John Emil Kelleher, "Zarlino's *Dimostrationi* and Demonstrative Methodologies in the Sixteenth Century" (Ph.D. dissertation, Columbia University, 1993), 10.

[29] Walker, "Vincenzo Galilei and Zarlino," 14.

turned back to the mysteries of Pythagorean science as an inspiration for his universal law of gravitation.[30]

It is difficult to ascertain how a "sacred" or "secular" worldview may affect one's inquiries into scientific or musical phenomena. The present examination of the Zarlino-Galilei debate, however, shows that a complex of factors—including religion, patronage, authority, and ambition—contributes to any inquiry that seeks to define the nature of music.

Chapter Synopses

Chapter 1. A Context for the Dispute

The initial chapter will provide a new history of the Zarlino-Galilei controversy. Although Galilei provides a narration of events in the opening pages of the 1589 *Discorso*, further evidence can be gleaned from Zarlino's later biographers, Francesco Caffi and Girolamo Ravagnan, as well as references in the treatises of Giovanni Maria Artusi and Giovanni Battista Doni. In an effort to uncover the cultural origins of the debate, the chapter draws on relevant research on the Florentine and Venetian academies by Paul Rose, Gaspare de Caro, Paolo Sanvito, and others.[31] The aim of this chapter is to situate the debate in a larger context than simple "musical polemics." For example, Zarlino and his colleagues in Venice studied the relationships between geometry and mathematics, using the *Mesolabio* and the geometric square.[32] Galilei, on the other hand,

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[30] Ibid., 25-26.

[31] See Paul Rose, *The Italian Renaissance of Mathematics: Studies on Humanists and Mathematicians from Petrarch to Galilei*, Travaux d'humanisme et Renaissance, vol. 145 (Geneva: Droz, 1975); De Caro, *Euridice*; and Paolo Sanvito, "Le sperimentazione nelle scienze quadrivali in alcuni epistolari zarliniani inediti," *Studi musicali* 19 (1990): 305-18.

[32] Unpublished documents regarding these activities are found in Sanvito, "Le sperimentazione."

was influenced by Girolamo Mei, who played a prominent role in the turbulent literary debates of the sixteenth century.[33]

Chapter 2. Heretics and Music Theory in the *Sopplimenti musicali*

This chapter presents Zarlino's *Sopplimenti musicali* as a combination of literary genres. The *Sopplimenti* was published in 1588 together with a reprint of his first two major theoretical works. As in the *Dimostrationi harmoniche* of 1571,[34] Zarlino uses the *Sopplimenti* to re-assert his principal theories, while offering a grand synthesis of ancient knowledge and analytical methods derived from Euclidian geometry, all centered around the physical properties of the *corpo sonoro* (sounding body). Although the overall form of the treatise follows the Aristoxenian "Seven Parts of Harmonics," Zarlino reproves his unnamed "disciple" (Galilei) throughout the text, quoting many passages from the *Dialogo*.[35] The *Sopplimenti* is dedicated to Pope Sixtus V, and Zarlino uses his introductory letter to introduce a Counter-Reformation rhetoric that runs throughout the work.

The second part of the chapter focuses on Book IV, by far the largest section of the *Sopplimenti*, in which Zarlino defends his Syntonic tuning system. Although he begins with a traditional presentation of ancient genera, found in many earlier treatises, Zarlino branches out from the traditional discussion of the tetrachords. To defend his

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[33] See De Caro, *Euridice*, especially chapter 4.

[34] In the *Dimostrationi*, Zarlino synthesizes the demonstrative methods of Aristotle (syllogistic) and Euclid (axiomatic) in an effort to establish the certitude of his theories. For a detailed analysis of the *Dimonstrationi harmoniche*, see Kelleher, "Demonstrative Methodologies."

[35] Bernardino Baldi, a contemporary of Zarlino, suggests that the unnamed "disciple" is the Spaniard Francisco de Salinas. See Bernardino Baldi, *Vite inedite di matematici italiani*, ed. Enrico Narducci (Rome: Tip. delle scienze matematiche e fisiche, 1887), 170. If Baldi had a copy of Galilei's *Dialogo*, he would perhaps have seen that the "disciple" could have been no one other than Vincenzo Galilei.

Syntonic tuning system, he devises a "natural" Syntonic scale that may be used only by voices and a few select instruments. Galilei's criticisms, Zarlino asserts, are based on an "artificial" Syntonic scale that is limited to Ptolemy's tetrachord and not used in practical music. Furthermore, Zarlino sets out to destroy Galilei's credibility by pointing out many errors in the *Dialogo*.

Chapter 3. Modality in Sixteenth-Century Music Theory

Sixteenth-century theorists discussed modal systems for a variety of reasons. The humanist and mathematician Herinrich Glarean developed the 12-mode system in his *Dodecachordon* to emphasize the relationship between Catholic service music and ancient Greek and Roman music theory. In Glarean's system, each mode was distinguinshed by its unique combination of species of fourths and fifths. For Glarean, the modes provided an analytical tool for understanding the ethical properties of contemporary polyphony. Zarlino later adapted Glarean's system for his *Istitutioni* even though he saw little concordance between the ancient and modern use of musical modes. In addition to its analytical properties, Zarlino considered the 12-mode system to be a useful pre-compositional tool; he would write later that the mode (or tone) of a composition was synonymous with its form.[36]

Galilei criticized both Glarean and Zarlino in the *Dialogo*, arguing that they misrepresented ancient writers. In particular, he claimed that modes were distinguished by their relative height of pitch and not by unique sequences of intervals. Galilei's descriptions of ancient modal systems were designed to show the extent to which they differed from the scale systems used in contemporary polyphony; literal interpretations of

[36] Zarlino, *Sopplimenti* VI.1, 240.

the diagrams he presented reveal scale systems that do not resemble those used in sixteenth-century music.

In response, Zarlino re-envisioned the 12-mode system in Books V and VI of the *Sopplimenti*, showing that even if it did not conform to ancient practice, it was still based on natural properties. Zarlino's new conception of the modal system betrays the extent to which he was influenced by discussions of scales in Ptolemy's *Harmonics*. Like his defense of Syntonic tuning in the Book IV, Zarlino's "naturalization" of modal systems forced Galilei to argue in broader terms in his 1589 *Discorso*.

Chapter 4. Introduction to Galilei's *Discorso intorno all'opere di Messer Gioseffo Zarlino*

Galilei was angered yet unconvinced by Zarlino's *Sopplimenti*, and he devoted his final years to writing lengthy criticisms of Zarlino's theories. While searching for new patrons, he composed many discourses and essays on counterpoint, ancient music theory, and other topics, but the *Discorso intorno all'opere di Messer Gioseffo Zarlino* was the only treatise to be published before his death. Shunning music's place in the quadrivial studies, the *Discorso* sought to realign music with the rhetorical and mechanical arts, and Galilei supports this idea with many analogies to medicine, painting, and sculpture. In addition, the form and style of the unpublished "Intavolatura di liuto" (ca. 1584) demonstrates that Galilei was interested in showing the practical use of the theoretical ideas he had developed in the *Dialogo*.

Galilei describes the contents of the *Discorso* in the opening pages, but he breaks with his original synopsis after the third chapter. It appears he realized that a discussion of the role of nature and art in music and his own solution to describing modern tuning

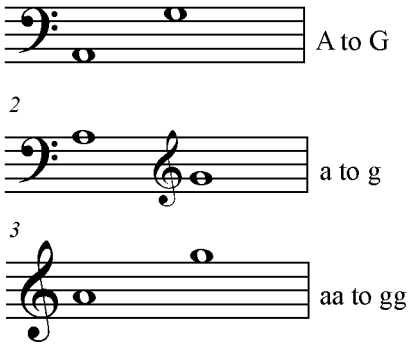
systems would be more useful than a recounting of ideas that Zarlino took from the *Dialogo* and recast as his own.

Chapter 5. Annotated translation of Galilei's *Discorso intorno all'opere di Messer Gioseffo Zarlino di Chioggia*

Chapter 6. Conclusion

Nomenclature of Pitch

Sixteenth-century theorists typically discussed pitch within a three-octave range beginning on the *proslambanomenos* of the Greater Perfect System. The nomenclature used in this dissertation follows the system found in most treatises, although solmization syllables will not be used unless necessary:



Chapter 1

A Context for the Dispute

Prelude: Theoretical Disputes from Antiquity to 1600

The late Renaissance was an era of conflicting forces.[1] In the literary academies, humanists with an eye to the distant past argued over the relative merits of Aristotle's *Poetics* and modern poets such as Torquato Tasso and Lodovico Ariosto; in universities, the long-accepted Ptolemaic universe slowly crumbled and was replaced by the new physics and Copernicanism.[2] Within these larger trends, the most minute details of intellectual inquiry were contested in printed treatises, public lectures, and unpublished epistles. Although the specifics of these discussions could be understood only by those familiar with the subtleties of any given scientific or literary discipline, scholars and polemicists used these various branches of learning to argue about universal principles and methodological problems.

Music theory served as a fertile battleground for quarrels over epistemology and methodology. Fueled by a growing awareness of discrepancies between musical practice and the theoretical tradition, scholars argued with acknowledged ancient authorities and sought new ways to synthesize theory and practice. Medieval universities adhered to ancient notions of the liberal arts that considered music as one of the quadrivial studies

[1] For a broad introduction to cultural and intellectual thought in the Italian Renaissance, see Eugenio Garin, *Science and Civic Life in the Italian Renaissance*, trans. Peter Munz (Garden City, NY: Anchor Books, 1969); and William J. Bouwsma, *The Waning of the Renaissance, 1550–1640* (New Haven, CT: Yale University Press, 2000). Bouwsma views the late sixteenth century (the era in which the Galilei-Zarlino dispute took place) as a time when Europeans were quite anxious over rapid changes in technology, communication, and society in general. For another discussion of late-Renaissance dichotomies in a musicological context, see Gary Tomlinson, *Monteverdi and the End of the Renaissance* (Berkeley, CA: University of California Press, 1987), 3-30.

[2] Garin, *Science and Civic Life*, 14-15.

(along with arithmetic, geometry, and astronomy), and this curriculum was still followed for most of the Renaissance. Music theory was therefore seen as subject to the same laws that governed mathematics and geometry. Nevertheless, as theorists tried to reconcile quadrivial principles of musical science with contemporary polyphonic music, the writings of long-accepted musical authorities were questioned or reinterpreted. Because ancient Greek and Latin music theory played a dominant role in musical polemics, especially in the writings of Zarlino and Galilei, it is necessary to begin with an overview of the relationship between ancient music theory and contemporary musical practice in the Renaissance.

Musical Authority in Antiquity

The central text for university study of music in the fifteenth and sixteenth century was Boethius's *De institutione musica*, an incomplete treatise dating from late antiquity. A full millennium before the Renaissance, Boethius (ca. 480 – ca. 524 C.E.) had deplored the ignorance of classical studies in his own time and intended his treatises on the quadrivial studies to aid in the resurgence of Platonic and Aristotelian thought in the sixth-century remains of the Roman empire.[3] The unfinished *De institutione musica* provided a compendium of Greek music theory while focusing on the mathematical basis of musical science. Not professing original concepts, the text is primarily a translation of earlier treatises and offers no commentary on contemporary musical practice.

[3] Anicius Manlius Severinus Boethius, *Fundamentals of Music*, translated with introduction and annotations by Calvin M. Bower, edited by Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 1989), xix. For a Latin edition of the text, see Anicius Manlius Severinus Boethius, *De institutione musica libri quinque*, ed. Godofredus Friedlein (Leipzig: B. G. Teubner, 1867).

Boethius's sources for *De institutione musica* suggest he was trying to reconcile two methodological approaches to musical science. Books I-IV are derived from writings of the Pythagorean Nicomachus of Gerasa (fl. late first – early second century C.E.).[4] Stressing reason as the ultimate judge of music, these books contain a thorough mathematical treatment of musical intervals and explore other basic topics: note names, modes, notation, tuning the monochord, etc. The *Harmonics* of Claudius Ptolemy (second century C.E.) is paraphrased throughout Book V. In contrast to the abstract nature of Nicomachus's material, Ptolemy's approach is more firmly rooted in experimentation and empirical evidence. As in his astronomical works, Ptolemy preferred to design reasonable musical systems that were derived from observed phenomena. Unlike the Pythagoreans, he encouraged the participation of the senses in scientific discourse. Boethius was certainly aware that he was creating contradictions within the *De institutione musica* by introducing some Ptolemaic ideas; he writes at the beginning of Book V, chapter 8: "Ptolemy reproves the Pythagoreans and rejects the proof that we have expounded in previous books."[5] Incongruities aside, the Pythagorean concepts take precedence in *De institutione musica*, and Calvin Bower notes that Boethius's carefully worded paraphrases in Book V were seemingly intended to turn Ptolemy into a Pythagorean.[6]

There was much common ground between Ptolemy and the Pythagorean tradition, including their shared criticisms of the philosopher and music theorist Aristoxenus of Tarentum (fourth century B.C.E.). According to the *Suda*, Aristoxenus was one of

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[4] Other scholars have suggested a variety of sources for the fourth Book, but Calvin Bower asserts that Nicomachus is the principal source because the content of Book IV is so consistent with that of Books I-III and because Boethius himself referred to Books I-IV as "setting out basic fundamentals." See Boethius, *Fundamentals*, xxiv-xxix.

[5] Boethius, *Fundamentals*, 168.

[6] Ibid., xxix.

Aristotle's most gifted pupils and wrote 453 books on various topics.[7] Eschewing Pythagorean methods of musical science, Aristoxenus sought to describe musical phenomena through empirical observation. Writing centuries before Nicomachus or Ptolemy, Aristoxenus is responsible for establishing the seven principal topics of music theory: notes, intervals, genera, scales, tonoi, modulation, and composition. Many later writers would adapt his organization in their treatises, including Zarlino in his *Sopplimenti musicali* (Venice, 1588).[8]

In Boethius's *De institutione musica* and Ptolemy's *Harmonics*, Aristoxenus is specifically attacked for his method of describing intervals. The criticisms leveled against him will seem more justifiable once we discuss the mathematical basis on which the Pythagoreans defined the consonances.

The Pythagorean tradition asserted that intervals were understood as aural manifestations of simple mathematical ratios.[9] With the diapason, or octave, defined by 2:1, the simplest ratio of inequality, smaller intervals were determined only as divisions of the octave. For example, by expanding the 2:1 or *dupla* ratio into the proportion 4:3:2 (in which the outer terms preserve the 2:1 ratio), we find the diatessaron or perfect fourth

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[7] Sophie Gibson, *Aristoxenus of Tarentum and the Birth of Musicology*, Studies in Classics, ed. Dirk Obbink and Andrew Dyck (New York: Routledge, 2005), 2.

[8] Gioseffo Zarlino, *Sopplimenti musicali* (Venice: Francesco de' Franceschi Senese, 1588; reprint in Monuments of Music and Music Literature in Facsimile, II/15, New York: Broude Brothers, 1979).

[9] Pythagoras was said to have discovered the mathematical basis of consonant intervals after hearing the sounds of workmen in a blacksmith shop. Upon weighing the various hammers used by the workmen, he found that consonant intervals were produced by hammers with simple ratios of weight. For example, two hammers with a 2:1 ratio of weight (i.e., 12 pounds and 6 pounds) produced the diapason (octave); 3:2 produced the diapente (perfect fifth); and 4:3 produced the diatessaron (perfect fourth). In his 1589 *Discorso*, Vincenzo Galilei showed that the analogy of the blacksmith's hammers does not work: Galilei found that to obtain the octave ratio, one would need a hammer that was four times as heavy as another to sound the diapason. See Vincenzo Galilei, *Discorso intorno all'opere di Messer Gioseffo Zarlino di Chioggia* (Florence: Marescotti, 1589; reprint in Collezione di trattati e musiche antiche edite in facsimile, Milan: Bollettino bibliografico musicale, 1933), 103-4.

(4:3) and the diapente or perfect fifth (3:2).[10] Furthermore, all the proportions of the Pythagorean consonances could be defined by the quaternary of the first four numbers (1, 2, 3, 4). Theon of Smyrna (second century C.E.) elucidates their significance in his treatise *Mathematics Useful for Understanding Plato*:

> The importance of the quaternary obtained by addition (that is 1, + 2, + 3, + 4) is great in music because all the consonances are found in it. But it is not only for this reason that all Pythagoreans hold it in highest esteem: it is also because it seems to outline the entire nature of the universe. It is for this reason that the formula of their oath was: "I swear by the one who has bestowed the tetraktys to the coming generations, source of eternal nature, into our souls." The one who bestowed it was Pythagoras, and it has been said that the tetraktys appears indeed to have been discovered by him.[11]

That is, the Pythagoreans found affinities among the simple consonances, the movement of the planets, and the nature of the human soul.[12] Boethius himself discusses these similitudes in defining three types of music (Book I, chapter 2): *musica mundana* (music of the universe), which creates order in the universe; *musica humana*, which unites the corporeal body with incorporeal reason; and *musica instrumentalis*, which resides in sounding instruments.[13] Because the consonances signified more than just musical properties, intervals were deemed dissonant not by virtue of their sound but rather by the nature of the mathematical ratios that defined them. For example, although the perfect

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[10] In converting these ratios into sound, the reader should note that the ratios refer to string lengths. The 2:1 or *dupla* proportion indicates that with a string's length divided in half, plucking one portion of the string will produce a pitch exactly one octave higher than would be heard if the entire length of the string was plucked. Likewise, the 3:2 or *sesquialtera* proportion indicates that if the string is divided into three parts, when two parts of the string are plucked, a perfect fifth higher will sound in respect to the sound of the full length of the string.

[11] Theon of Smyrna, *Mathematics Useful for Understanding Plato*, translated from the 1892 Greek/French edition of J. Dupuis by Robert and Deborah Lawlor, edited and annotated by Christos Toulis and others (San Diego: Wizards Bookshelf, 1979), 62.

[12] To the Pythagoreans and Platonists, "simplicity" was an essential trait of higher intellectual forms, i.e., eternal and incorporeal objects. In contrast, "complexity," such as is found in complicated ratios, was demonstrative of corporeality and corruptibility. See Proclus, *A Commentary on the First Book of Euclid's* Elements, trans. with introduction and notes by Glenn R. Morrow (Princeton, NJ: Princeton University Press, 1970), 3-4.

[13] Boethius, *De institutione music*, 187-89; trans. in *Fundamentals*, 9-10.

fourth (4:3) was considered consonant, the octave plus perfect fourth (8:3) was ruled dissonant because it was defined by a superpartient ratio.[14] In the Pythagorean tuning system, all major and minor thirds and sixths were defined by superpartient ratios, and all were therefore considered to be dissonant.[15]

Plato embraced this doctrine and elaborated upon the quaternary to describe divine creation. In the *Timaeus* (35B–36), he recounts how the Demiurge (divine mind) organized the World-Soul through numerical proportions:

> And he began the division in this way. First he took one portion (1) from the whole, and next a portion (2) double of this; the third (3) half as much again as the second, and three times the first; the fourth (4) double of the second; the fifth (9) three times the third; the sixth (8) eight times the first; and the seventh (27) twenty-seven times the first. . . . These links gave rise to intervals of 3/2 and 4/3 and 9/8 within the original intervals.[16]

Figuratively, Plato's Demiurge designed the soul by laying out varying lengths of "soul" material, just as we might compare intervals on a monochord or segments of a line. Plato also confirms that the numerical values are considered in proportion with each other, producing the abovementioned ratios 3:2 and 4:3, as well as 9:8, which defines the tone or major second.

For clerically minded scholars of the Renaissance such as Gioseffo Zarlino, numerical proportions were still considered essential to understanding scientific phenomena, especially as they pertained to musical intervals. The simple ratios offered insight into God's creation, observed as nature. In addition, the many similitudes that

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[14] The ratio for the octave plus perfect fourth is found by adding the ratios of the octave and fourth. 2:1+4:3 = (2x4):(1x3) = 8:3. "Superpartient" refers to any ratio in which the larger term exceeds the lesser term by more than one factor of the lesser term.

[15] The Pythagorean major third (ditone) is comprised of two 9:8 tones, i.e., 9:8+9:8 = (9x9):(8x8) = 81:64. The minor third (semiditone) equals a tone plus a 256:243 semitone, which is 32:27. The major and minor sixths (major and minor hexachords) are represented by 27:16 and 128:81, respectively.

[16] Francis MacDonald Cornford, trans., *Plato's Cosmology: The* Timaeus *of Plato Translated with a Running Commentary* (London: Routledge & Kegan Paul, 1937; reprint, Indianapolis, IN: Bobbs Merrill, 1966), 66, 71.

could be drawn from small integers (e.g., the relationship between the four elements [earth, water, air, fire] and the four bodily fluids [humours]) were evidence of an ordered universe.

In composing the *Harmonics*, Ptolemy drew on the Pythagorean tradition, yet his penchant for idealized systems often takes precedence over dogmatic notions of reason or sense. Taking the Pythagorean ratios as a starting point, he favors the superparticular "for the simplicity of its ratios, for the excess in the superparticular ratio is the simple part in it, while in the multiple it is the smaller part of the greater number."[17] But Ptolemy breaks from the Pythagoreans in noting that a theoretical view of intervals has its limitations:

> . . . reason universally discovers by theorizing what is well, presents the result in operation and assimilates the basic subject matter by becoming accustomed to it. The result is naturally that the common, rational understanding of the species of proportion, characteristically called the mathematical, is not encompassed within the contemplation of the beautiful alone, as some would profess, but also by the simultaneous demonstration and practice of what is subsequently created by it.[18]

That Ptolemy stressed the practical application of his theories sets him apart from other writers of late antiquity.[19] Paradoxically, because he favored simplicity and order over empirical observation, his theoretical systems probably have little to do with the actual musical practice of his time. Nevertheless, the revival and popularity of his astronomical and geographical works as well as the *Harmonics* in the sixteenth century added to Ptolemy's status as an established authority in *cinquecento* musical polemics.[20]

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[17] Ptolemy, *Harmonics*, translation and commentary by Jon Solomon, Mnemosyne Supplementa, vol. 203 (Leiden: Brill, 2000), 17. "Superparticular" refers to any ratio in which the larger term exceeds the smaller term plus one whole-number factor of the smaller term, e.g., 3:2, 4:3, 5:4, etc. In a multiple ratio, the larger term is a multiple of the smaller term, e.g., 3:1, 4:1, 5:1, etc.

[18] Ptolemy, *Harmonics*, 140.

[19] Thomas J. Mathiesen, *Apollo's Lyre: Greek Music and Music Theory in Antiquity and the Middle Ages*, Publications of the Center for the History of Music Theory and Literature, vol. 2 (Lincoln: University of Nebraska Press, 1999), 429-30.

[20] Galilei's mentor, Girolamo Mei, praised Ptolemy above all others: "Now among all these [theorists], I am resolved to choose, as a foundation, Ptolemy, as the one I judge the most complete and

Aristoxenus discussed practical aspects of music centuries before Ptolemy, but his description of intervals is much less restricted by Pythagorean mathematics. Whereas in the Pythagorean system smaller intervals could only be derived from larger intervals, Aristoxenus measured smaller intervals in discrete quantities, basing their size on an estimation of contemporary practice. Using the tetrachord as a constant, Aristoxenus discussed smaller intervals as divisions of the fourth.[21] For example, the *meson* tetrachord, bounded by the notes *hypate meson* and *mese*, contains two internal pitches—*parhypate* and *lichanos*—that were found in various configurations depending on the genus and species of a given tetrachord.[22] Aristoxenus does not give exact measurements for the smallest intervals of the tetrachords, but he does note that the whole tone (which he defines as the difference between the fifth and the fourth) can be split into half-tones, third-tones, and quarter-tones for use in the diatonic, chromatic, and enharmonic tetrachords.[23]

Aristoxenus's division of the tone into three and four parts suggests that any of the smaller intervals can be measured as so many parts of a tone. A numerical description of several Aristoxenian tetrachords is found in Cleonides' *Harmonic Introduction*

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resolute of all [Ora io tra tutti questi mi son risoluto a pigliar per fondamento Tolomeo, come quello che io giudico il più compiuto e più risoluto di tutti]." Translation mine. Letter to Piero Vettori, dated 21 February 1562. Edited and published in Donatella Restani, *L'itinerario di Girolamo Mei dalla "poetica" alla musica: Con un'appendice di testi*, Studi e testi per la storia della musica, vol. 7 (Florence: Leo S. Olschki, 1990), 180.

[21] In ancient Greek music, the Greater Perfect System was derived from combinations of four-note scales called tetrachords, and each tetrachord outlined a perfect fourth. There were three types of tetrachords: diatonic, chromatic, and enharmonic. A diatonic tetrachord was roughly comprised of a sequence of two tones and one semitone; the chromatic, roughly two semitones and a minor third; the enharmonic, roughly two quarter-tones and a major third. The genera are essentially tuning systems, which were varied by the musicians for stylistic and affective purposes. Within these three genera, there were many species with varying sizes of intervals. A basic explanation of the *genera* can also be found in Boethius, *Fundamentals*, 39-40.

[22] For a more detailed discussion of Aristoxenus's interval theory, see Mathiesen, *Apollo's Lyre*, 310-14.

[23] Ibid., 311.

(second century C.E.), which is a brief epitome of Aristoxenian thought. In Cleonides' discussion, the perfect fourth is divided into thirty equal parts:

> The tone is assumed to be divided into twelve least parts, of which each one is called a twelfth-tone. The remaining intervals are also assumed analogous to the tone: the semitone into six twelfths, the quarter-tone diesis into three twelfths, the third-tone diesis into four twelfths, and the whole diatessaron into thirty twelfths. The harmonia [enharmonic tetrachord] will be sung by a magnitude of 3, 3, and 24 twelfths, the soft color [chromatic] tetrachord by 4, 4, and 22, . . . and the intense diatonic [tetrachord] by 6, 12, and 12.[24]

In the enharmonic species, each of the first two intervals fills three parts of the tetrachord, while the interval between *lichanos meson* and *mese* is much larger, filling twenty-four parts. The soft color (chromatic) species also contains two small intervals, although they are larger than those in the enharmonic, filling four parts each. The intense diatonic is the most noteworthy of these tetrachords: in its distribution the smaller interval (6 parts) is exactly half of the two larger intervals (12 parts), that is, exactly one semitone and two whole tones.

Aristoxenus's simple division of the whole tone into two equal semitones was his most serious crime in the eyes of the Pythagoreans. Both the Pythagoreans and Aristoxenus defined the whole tone as the difference between the fifth and the fourth; using ratios, the interval is found by subtracting the *sesquitertia* (4:3) from the *sesquialtera* (3:2), resulting in the *sesquioctave* (9:8).[25] As is true of all superparticular ratios, the sesquioctave cannot be divided into equal halves by any integer, and therefore Pythagorean mathematics did not allow for equal semitones. The proportion 9:8 can be expanded into 18:17:16, but this produces two unequal semitones: 18:17 and 17:16.

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[24] Cleonides, "Harmonic Introduction," trans. Oliver Strunk and Thomas J. Mathiesen, in *Source Readings in Music History*, ed. Oliver Strunk, rev. ed., ed. Leo Treitler (New York: Norton, 1988), 40-41.

[25] To find the difference between two ratios, the larger ratio is multiplied by the inverse of the smaller ratio. In this case, the sesquialtera is multiplied by the inverse of the sesquitertia, i.e., 3:2-4:3 = (3x3):(2x4) = 9:8.

Aware that his equally divided tones would provoke the Pythagoreans, Aristoxenus describes another method to prove that the perfect fourth can be constructed of two whole tones and a semitone that is exactly half of a tone in measurement (Da Rios 56–57):

> Let us take [a Fourth], and let us find the discord of two tones above its lower note, and the same discord below its higher note. Evidently the complements will be equal, since they are remainders obtained by subtracting equals from equals. Next let us take the Fourth above the lower note of the higher ditone, and the Fourth below the higher note of the lower ditone. It will be seen that adjacent to each of the extreme notes of the scale thus obtained there will be two complements in juxtaposition, which must be equal for the reasons already given. This construction completed, we must refer the extreme notes thus determined to the judgement of the ear.[26]

Aristoxenus's proof is more easily understood with a visual demonstration. An illustration of the process from Giovanni Maria Artusi's dialogue *L'Artusi, overo Delle imperfettioni della moderna musica* is found below (figure 1).[27]

[26] Aristoxenus, *The Harmonics of Aristoxenus*, edited with translation, notes, introduction, and index of words by Henry S. Macran (Oxford: Clarendon, 1902), 207. A Greek edition of the text can be found in Rosetta da Rios, ed., *Aristoxeni elementa harmonica*, Scriptores Graeci et Latini (Rome: Typis publicae officinae polygraphicae, 1954), 69-70.

[27] Giovanni Maria Artusi, *L'Artusi, overo Delle imperfettioni della moderna musica ragionamenti dui* (Venice: Giacomo Vincenti, 1600; reprint in Bibliotheca musica bononiensis, II/36, Bologna: Forni, 2000), f. 32r.

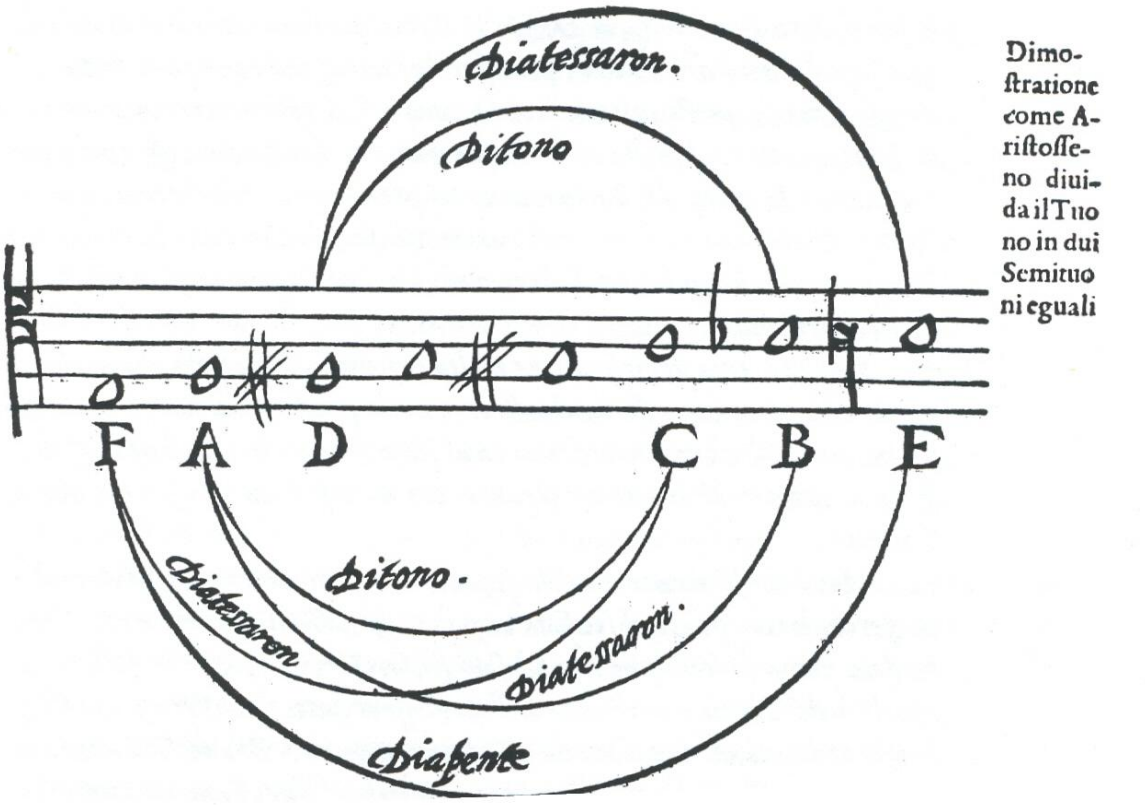

Figure 1. Aristoxenus's method for deriving equal semitones, from Giovanni Maria Artusi, *L'Artusi* (Venice, 1600), f. 32r.

In the diagram, Artusi notates a series of semitones on a musical staff, filling the range of a perfect fifth. The letters underneath the notes do not refer to musical pitches; they signify geometric points, as on a line. According to Artusi, if we measure an equal distance from the bottom and top of diatessaron AB (ditones AC and BD), it follows that the excesses AD and CB will also be equal and that they are semitones. Then, by measuring two diatessarons (FC and DE), we prove that the excesses FA and BE are likewise equal semitones. If the entire distance (FE) sounds the diapente, by subtracting the diatessaron AB from the diapente FE, we will be left with a 9:8 whole tone constructed of two equal semitones, FA and BE.

Although Aristoxenus logically demonstrated how two equal semitones could fill the musical space of a whole tone, Pythagorean critics were unimpressed and took issue with his statement that the final judgment is made through the senses. Boethius dismissed Aristoxenus's division and castigated his dependence on human hearing as a judge of consonance:

> Just because something seems to sound consonant to the ears when some vague pitch is compared to another pitch at a distance of two tones and an integral semitone does not mean that it is actually consonant; inasmuch as each sense is unable to grasp things that are very small, so the sense of hearing cannot distinguish this difference that progresses beyond consonance.[28]

To the Pythagoreans, admitting that the hearing could accurately determine the size of intervals was the same as measuring distances by eyesight alone. These criticisms were passed on for centuries, while Aristoxenus's writings were not readily available to readers in the West until the *cinquecento*.[29] As a result, his reputation suffered from the anathema of later theorists.

Claude Palisca notes that in the late Middle Ages Boethius's *De institutione musica* was "copied and recopied, but musicians did not read it with attention" because its contents did not relate to the needs of musical practitioners.[30] Indeed, practical texts, following Guido of Arezzo's *Micrologus* (written ca.1025), taught notation, solmization, and basic composition; these skills were far more useful to church musicians and young singers. Nonetheless, a surge in Neoplatonic studies in fifteenth-century Italy, in the

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[28] Boethius, *De institutione musica*, 269: "Quodsi videtur auribus consonum aliquid canere, cum cuilibet voci duos tonos ac semitonium integrum distans vocula comparetur, id non esse consonum natura monstratur; sed quoniam sensus omnis, quae minima sunt, conprehendere nequeat, idcirco hanc differentiam, quae ultra consonum procedit, sensum aurium non posse distinguere, . . ."; trans. in Boethius, *Fundamentals*, 89.

[29] Claude V. Palisca, "Aristoxenus Redeemed in the Renaissance," in *Studies in the History of Italian Music and Music Theory* (Oxford: Clarendon, 1994), 189.

[30] Claude V. Palisca, "Boethius in the Renaissance," in *Music Theory and Its Sources: Antiquity and the Middle Ages*, ed. André Barbera (Notre Dame, IN: University of Notre Dame Press, 1990), 259.

universities and in local academies, led to renewed interest in Boethius's *De institutione musica* and Pythagorean musical science. By the end of the fifteenth century, however, new compositional techniques again revealed a conspicuous gap between the teachings of Boethius and the actual musical practice of the era.

Describing Consonant Polyphony

The rise of tertial sonorities in the early Renaissance created a significant problem for theorists. If the authority of Boethius and Pythagoras instructed that thirds and sixths were dissonant, how then could tertial music be sonorous? Because choirs were producing sonorities that sounded consonant regardless of theoretical considerations, theorists needed to find new tuning systems that could describe imperfect consonances while staying true to ancient authority. The quest to accurately describe, in music-theoretical terms, the sizes of intervals used in vocal polyphony became a matter of contention among theorists and played a primary role in musical polemics of the late-fifteenth and sixteenth centuries, including the writings of Zarlino and Galilei.

The first published attempt to describe consonant polyphony is found in Bartolomeo Ramis de Pareia's *Musica practica* (Bologna, 1482).[31] Educated in Spain, Ramis spent the greater part of his career in Italy; he perhaps taught in Bologna and later resided in Rome. As a result of his overt suspicion of ancient authority, Ramis was never able to gain official employment in an academic setting, although it appears he lectured at

[31] Earlier attempts at a monochord division with pure triads can be found in manuscript, including one example that is more suited to the keyboard than vocal music. See Christian Meyer, *Mensura monochordi*: *La division du monocorde (IX^e^-XV^e^ siècles)*, Publications de la Société Française de Musicologie, 2d ser., no. 15 (Paris: Klincksieck, 1996), cxvii, 228; quoted in Jan Herlinger, "Medieval Canonics," in *The Cambridge History of Western Music Theory*, ed. Thomas Christensen (Cambridge: Cambridge University Press, 2002), 182.

universities in Salamanca and Bologna. At Salamanca he debated with the theologian Pedro de Osma about the nature of the Greek genera,[32] and in Italy he angered theorists with his criticisms of Guido of Arezzo.[33]

Ramis was particularly ambivalent about the Pythagorean theory of intervals as transmitted by Boethius in the *De institutione musica*; in the *Practica*, he cites Boethius as an authority yet envisions a tuning system that would be more useful to performers:

> A standard monochord has been subtly divided by Boethius in numbers and measurement. But still, although it is useful and pleasing to theorists, it is laborious and difficult for singers to understand. But since we promised to satisfy everyone, we will present a very easy division of the standard monochord, which let no one believe we discovered without great labor, for we found it with toil by reading in many nightly vigils the precepts of early writers, and by avoiding the errors of modern writers.[34]

Like most Renaissance theorists, Ramis describes his tuning system as a division of a double-octave, measured out on a monochord.[35] Although he does not offer exact sizes for the intervals, they were calculated by his contemporary John Hothby, and Palisca

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[32] Ramis writes in the *Musica practica* that Pedro conceded victory to him. Bartolomeus Ramis de Pareia, *Musica practica*, ed. Johannes Wolf, Publikationen der Internationalen Musikgesellschaft, vol. 2 (Leipzig: Breitkopf & Härtel, 1901), 42-43**;** translated in Bartolomeo Ramis de Pareia, *Musica practica*, commentary and translation by Clement A. Miller, Musicological Studies and Documents, no. 44 (Neuhausen-Stuttgart: American Institute of Musicology, 1993), 92.

[33] For example, see Nicolò Burzio's *Musices opusculum* (Bologna: Ugo Ruggeri, 1487), which was composed specifically to defend the writings of Guido against Ramis's *Musica practica*. Burzio was later supported in his attacks by Franchino Gaffurio, and both were criticized by Ramis's student Giovanni Spataro. For a discussion of Burzio's *Opusculum*, see Ann E. Moyer, *Musica scientia: Musical Scholarship in the Italian Renaissance* (Ithaca, NY: Cornell University Press, 1992), 39-52.

[34] Bartolomeus Ramis de Pareia, *Musica practica*, 4-5: "REGULARE monochordum numeris et mensura subtiliter a Boetio dividitur. Sed illud, sicut theoricis utile iocundumque est, ita cantoribus laboriosum intellectuque difficile. Verum quia utrisque satisfacere polliciti sumus, facillimam regularis monochordi divisionem reddemus, quam non modico labore nemo nos arbitretur invenisse, quippe qui illam multis vigiliis antiquorum praecepta lectitantes et neotericorum vitantes errorem cum sudore repperimus"; trans. in *Musica practica*, commentary and translation by Clement A. Miller, 46-47.

[35] The practice of examining an array of intervals that have been measured out on a monochord stems from the medieval dissemination of Boethius. For a general history of monochord divisions, see Herlinger, "Medieval Canonics," 169-92.

provides an illustration of Ramis's octave in *Humanism in Italian Renaissance Musical Thought* (figure 2).[36]

Figure 2. Interval sizes in the monochord division of Bartolomeo Ramis de Pareia, *Musica practica*, I, i, 2.

In Ramis's octave, consonant major and minor thirds are envisioned through superparticular intervals. The major third (5:4) is considered as the sum of two unequal whole tones (9:8 and 10:9); the semitone is the remainder of the perfect fourth (4:3) minus the major third (5:4), or 16:15;[37] the minor third (6:5) is calculated by adding the semitone (16:15) to the larger tone (9:8).[38] According to figure 2, all of the thirds in this octave will be superparticular except for the minor third b–d (32:27), which is dissonant.[39]

Ramis's critics noted that the system created two dissonant intervals that should be perfect: the D–G fourth (27:20) and the G–d fifth (40:27): the fourth is too large by a Syntonic comma (81:80) and the fifth is too small by the same amount.[40] More damning was the opinion of Franchino Gaffurio, the most renowned proponent of Pythagorean music theory in the late *quattrocento* and early *cinquecento*.[41] Even though Gaffurio

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[36] John Hothby, "Excitatio quaedam musicae artis per refutationem," in Johannes Octobi, *Tres tractatuli contra Bartholomeum Ramum*, ed. Albert Seay, Corpus scriptorum de musica, vol. 10 ([Rome]: American Institute of Musicology, 1964), 25; quoted in Claude V. Palisca, *Humanism in Italian Renaissance Musical Thought* (New Haven, CT: Yale University Press, 1985), 233.

[37] 4:3-5:4 = (4x4):(3x5) = 16:15.

[38] 9:8+16:15 = (9x16):(8x15) = 144:120 = 6:5.

[39] The b-d minor third is equal to 16:15+10:9. I.e., (16x10):(15x9) = 160:135 = 32:27.

[40] Hothby, "Excitatio," 25.

[41] Franchino Gaffurio (1451-1522) sought to reconcile Boethius's *De institutione musica* with many other ancient sources that were just becoming available in Latin translations. Gaffurio's popularity continued in some areas (especially Naples) even after Zarlino's writings were disseminated throughout Italy. His late writings express a strong faith in the Pythagorean tradition, an interest in Ptolemy's idealism,

recognized the superparticular ratios as stemming from Ptolemy's *Harmonics*, he refused to recognize Ramis's system because it broke with the authority of Boethius and Pythagoras.[42]

Ramis's monochord division, along with his repudiation of Guido's hexachordal system and an antagonistic attitude towards his colleagues, set off a series of musical polemics that, after nearly a century, would culminate in the writings of Zarlino and Galilei. In these disputes, interval theory and tuning would remain in the forefront. Although the correct intonation of vocal music was emphasized, theorists were also concerned with the intonation of "artificial" instruments, used in performance with voices, and the increasing use of chromatic pitches that challenged the theories of numerically based intervals.

Letters in the Spataro Collection

The subject of musical polemics may appear arcane and academic to modern readers, but there was certainly an interest in music theory among the educated public in the sixteenth century. The notoriety of these quarrels was acknowledged by Knud Jeppesen, who observed that in the sixteenth century, "one discussed music theory as one does sport or the theater today."[43]

Earlier in the sixteenth century, Italian musical polemics were often conducted through private letters, such as those in the "Spataro Collection," named for the

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and a distrust of the writings of Aristoxenus. For a discussion of Gaffurio's role in early sixteenth-century music theory, see Moyer, *Musica scientia*, 67-92.

[42] Palisca, *Humanism*, 233-34.

[43] Knud Jeppesen, "Eine musiktheoretische Korrespondenz des früheren Cinquecento," *Acta musicologica* 13 (1941): 36; quoted in Bonnie J. Blackburn, Edward E. Lowinsky, and Clement A. Miller, eds., *A Correspondence of Renaissance Musicians* (Oxford: Clarendon Press, 1991), 5.

Bolognese music theorist Giovanni Spataro (1458–1541). Most of these letters were not composed for publication, although Spataro had planned to print at least twenty-three of his own epistles.[44] In 1991, however, a modern edition of the Collection was published as *A Correspondence of Renaissance Musicians*, which contains the epistles of Spataro and other principal theorists of the era.

The letters in the *Correspondence* tell us much about intellectual discourse outside the printed treatises. In private correspondence, theorists often eschewed the typical decorum and didactic approaches found in published treatises, habitually denouncing their colleagues and zealously guarding their own intellectual ideas. For example, in this August 1529 letter to Giovanni Del Lago (1490–1544), Spataro asks his colleague to comment on a new treatise he has composed. In making this request, Spataro praises Del Lago while criticizing fellow theorist Pietro Aaron (1480–1545):

> But I have placed my trust in you; your experience and learning will take care of everything. However, I should like to know what your doubts are. Although I stand with both feet in the grave, I still wish to learn, and I want to avoid [Pietro] Aaron's mistake of being too self-confident; his three treatises have brought him little honour among the intelligent.[45]

Del Lago replied to Spataro in October, offering numerous critiques of the treatise. Spataro responded in late November:

> . . . I find in you more prattle than action: you wait two, three, and four months, then you write to me with your infantile doubts and you argue in a way that reveals not only your small knowledge, but your intention to learn under the veil of 'disputation,' just to drag things out. So do me a favour and return my treatises; my works are too humble for your exalted mediation and would bring you little

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[44] Blackburn et al., *Correspondence*, 3.

[45] Ibid., 373: "Ma me sono confidato in Vostra Eccellenza, la quale (per essere perito et docto in tale facultà) satisfarà al tuto. Pure harò apiacere intendere dove dubitati, perché ancora che io sia con ambedui li pedi in la fossa, ancora desidero imparare, et etiam per non incorrere in lo errore nel quale (come scriveti) è caduto el nostro excellente et venerabile Frate Petro Aron, el quale (fidandosi tropo in sé stesso) ha producto in luce tri musici tractati de li quali lui n'ha havuto asai poco honore apresso a li intelligenti"; trans. in ibid., 375.

> honour. . . . Don't expect any more letters from me on your puerile arguments; there is no profit in corresponding with you, who are ignorance personified.[46]

Spataro's malice towards his colleagues is reminiscent of the more famous literary invectives found in epistles by such classic humanists as Lorenzo Valla and Poggio Bracciolini.[47] That Spataro elsewhere indicts Del Lago for surreptitiously stealing his ideas is also commonplace among humanist scholars who tended to exaggerate the originality of their works.

The Vicentino–Lusitano Debate

Controversies over tuning systems intensified in the sixteenth century. At the same time, the increasing use of chromatic pitches in polyphonic music strained the theorists' ability to describe these systems through simple ratios. Public observation of such musical controversies is exhibited in the 1551 debate between Nicola Vicentino (1511–1576) and Vicente Lusitano (d. after 1561).

Vicentino claimed the ability to revive the miraculous powers of ancient Greek music. While studying composition with Adrian Willaert in the 1530s, he resided in Venice, the center of humanistic publishing in the sixteenth century. Vicentino probably had access to the many new editions of Greek and Latin texts and modern commentaries

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[46] Ibid., 408-9: "cioè che in vui io trovaria più zance che facti, perché vui stati dui, trei, et quattro mixi [= mesi], et da poi me scrivete con qualche vostre puerile dubitatione et fati argumenti de tale sorte che non solo monstrati el vostro poco sapere, ma cercati de imparare soto umbre de disputatione, et questo è usitato da vui per meglio conducere l'opera in longo. Pertanto ve prego, se me voleti fare apiacere, che me mandati li mei tractati, perché non curo che siano impressi per vostra mezanità, perché vui ve existimati tropo docto, et le opere mie sono humile et basse. . . . Pertanto non aspectati più littere da me circa la declaratione de le vostre puerile dubietà et argumenti, perché con vui (che seti la propria ignorantia) cosa alcuna non posso guadagnare"; trans. in ibid., 412.

[47] Poggio Bracciolini and Lorenzo Valla argued over the proper use of Latin in modern prose. On one occasion, Poggio found criticisms of his Latin style scrawled in the margins of copies of his letters. In response, he tried to have Valla murdered. See Rudoph Pfeiffer, *History of Classical Scholarship* (Oxford: Clarendon Press, 1976), 34.

on ancient music theory that were printed in Venice, but his principal concern was the composition of music, and he rarely looked beyond Boethius for ancient musical knowledge. Although the feasibility of reviving ancient music was questioned by many theorists, including Gioseffo Zarlino, Vicentino's experiments were supported by humanistically minded nobles and clergy who shared his hope of reviving the past. The novelty of his "chromatic" style gained him employment in the retinue of Ippolito II, Cardinal of Ferrara. Furthermore, during the Counter-Reformation, Cardinal Carlo Borromeo of Milan, while seeking new music that would fit the ideals of the Council of Trent, ordered "don Nicola who favors chromatic music," among other composers, to provide a Mass to be considered as a solution to perceived problems in contemporary sacred polyphony.[48] In order to validate his chromatic method, Vicentino sought to challenge contemporary notions that modern music was composed entirely in the diatonic tetrachord. Although his efforts were endorsed by his patrons, many musicians were quick to dispute Vicentino's controversial claims.

Vicentino's 1551 debate with the Portuguese composer Vicente Lusitano was sparked by an argument between the two combatants at a private concert in Rome.[49] Upon hearing a polyphonic setting of the chant *Regina coeli*, Lusitano insisted that the work was composed in the diatonic genus, while Vicentino asserted that the chromatic genus was also utilized in the composition and that all modern music contained a mixture

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[48] Lewis Lockwood, *The Counter-Reformation and the Masses of Vincenzo Ruffo*, Studi di musica veneta, vol. 2 ([Wien]: Universal Edition, 1970), 94.

[49] A thorough description of the history and context of the debate can be found in Nicola Vicentino, *Ancient Music Adapted to Modern Practice*, translated, with introduction and notes, by Maria Rika Maniates, Music Theory Translation Series, ed. Claude V. Palisca (New Haven, CT: Yale University Press, 1996), xi-xxiv; and Henry William Kaufmann, *The Life and Works of Nicola Vicentino*, Musicological Studies and Documents, no. 11 (n. p.: American Institute of Musicology, 1966), 22-31. For an account of how Vicentino used contrapuntal examples in *Ancient Music* to convince his readers that the diatonic genus was actually harsh to the ears, see Timothy R. McKinney, "Point/Counterpoint: Vicentino's Musical Rebuttal to Lusitano," *Early Music* 33 (August 2005): 393-411.

of the diatonic and chromatic genera.[50] It was agreed that two gold scudi would be wagered by both men and that the issue would be judged by Ghiselin Danckerts (ca. 1510–1565) and Bartolomé de Escobedo (ca. 1505–1563), two singers in the papal choir. A warrant on the debate, signed by Vicentino, Lusitano, and four witnesses, attests that the contest was attended by the "Very Reverend Cardinal [Ippolito II] . . . and many other learned and noble persons."[51]

Because Ghiselin Danckerts was unable to attend the debate, both Vicentino and Lusitano expressed their opinions to him in written documents. Although copies of these documents contain many variants, we can use them to see how each presented his argument.[52]

Vicentino simply states that for a piece to be "purely diatonic" (*diatonica semplice*), the melodic line must move in sequences of tone, tone, and semitone. Any use of an "incomposite trihemitone or semiditone, or step of a minor third" would be evidence of the chromatic genus; likewise, the "incomposite ditone" would demonstrate the enharmonic genus.[53] Vicentino closes his argument by noting that the proof may be found in Boethius's *De institutione musica*.[54]

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[50] See fn. 21 *supra*. Because the chromatic tetrachord contains two consecutive semitones, most sixteenth-century musicians denied the possibility of its use in contemporary music.

[51] Nicola Vicentino, *L'antica musica ridotta alla moderna prattica* (Rome, 1555; reprint in Documenta musicologica, I/17, Kassel: Bärenreiter, 1959), f. 95r: "Reuerendissimo signor Hyppolito II. . . . con audientia di molti Dotti"; trans. in *Ancient Music*, 448.

[52] Both Vicentino and Ghiselin Danckerts reprinted their arguments in published treatises. Maria Rika Maniates traces the variants in these publications and suggests that Vicentino made slight alterations in the original document to bolster his claims. See Vicentino, *Ancient Music*, 305-7.

[53] Vicentino, *L'antica musica*, f. 95v: "Io gli hò dichiarato le Regole de i tre Generi, e che il Diatonico uà cantato, per i gradi di Tono, e Tono, e Semitono, e mai hà da essere ne suoi gradi, altro che tono, e semitono, come lui istesso hà confessato esser il uero: ma nel nostro cantare, et procedere con le uoci, questa è cosa publica al Mondo, che si procede ne i canti, con i Dittoni incomposti, come saria, da ut. à mi. et anchora con il Triemitono incomposto, come da re. a fa. e da mi. à sol. senza alcuna cosa di mezzo, di Tono, ne di Semitono, come saria, re.mi.fa. che è nel Genere Diatonico. si che questo re.fa. et mi.sol. è il Triemitono, ò Semitdittono, o passo di terza minore, che è nel Genere Cromatico, et il Dittono imcomposto, che in prattica dicemo, ut.mi. e fa.la. è del Genere Enarmonico"; trans. in *Ancient Music*, 305. In this case,

Like Vicentino, Lusitano bases his entire argument on Boethius, referring to chapters from Books I and IV of *De institutione musica.* Whereas Vicentino cited the presence of major and minor thirds as evidence of the chromatic and enharmonic tetrachord, Lusitano applies the reverse argument. Following Boethius's description of the three tetrachords, he disregards the existence of thirds and instead cites the lack of consecutive semitones or quarter-tones to prove that modern music is composed exclusively in the diatonic system. To explain the presence of major and minor thirds (ditones and semiditones), he posits that they "existed in the diatonic genus before any of the others, for the diatonic was the primary and most natural [genus] according to what Boethius said."[55] The judges sided with Lusitano and ordered Vicentino to pay him the two scudi.

On the authority of Boethius's *De institutione musica*, which was composed approximately one thousand years before the Vicentino-Lusitano debate, the judges ruled that modern musicians composed exclusively in the diatonic system. The decision was not based on contemporary musical practice, and in fact, neither Vicentino nor Lusitano even cite the passages in the setting of *Regina coeli* that inspired the debate. For Vicentino (and his patron Ippolito II), it may have been important to prove that modern composers mixed the *genera* because Vicentino was trying to promote his own chromatic compositions. Lusitano, on the other hand, was not alone in being averse to the use of chromatic and enharmonic systems, for they introduced many dissonances into

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an "incomposite ditone" signifies a melodic leap of a major third. A "composite ditone" would signify a melodic passage in which the seconds C to D and D to E would be sung as separate notes.

[54] Vicentino, *L'antica musica*, f. 95v: "per detta mia dichiaratione che uedrette in Boetio"; trans. in *Ancient Music*, 305.

[55] Vicentino, *L'antica musica*, f. 96r: "prima stanno nel Genere Diatonico, che in nissuno de gli altri, come primo, & piu naturale, secondo che dice Boetio"; trans. in *Ancient Music*, 307.

polyphony. Nevertheless, both theorists relied purely on ancient authority to prove their side.

In conclusion, we can note two subsequent opinions of Vicentino's chromaticism, written by Gioseffo Zarlino and the Bolognese Cavalier Ercole Bottrigari. Zarlino, for one, asserted that it was impossible to use the chromatic and enharmonic *genera* in modern music. More important, however, is his repudiation of Vicentino, expressed as a function of his two primary intellectual foundations: natural philosophy and Ptolemaic idealism. Zarlino does not mention Vicentino by name (perhaps out of deference for a fellow student of Adrian Willaert) but refers to the *chromatisti* (composers of chromatic music), among which Vicentino, as well as other experimental composers of the day, would be grouped.[56] Zarlino rejected the chromatic genus because it forced musicians to sing intervals that were not included among the harmonic numbers. Tacitly comparing the *chromatisti* to the "harmonicist" predecessors of Aristoxenus, Zarlino notes that the *chromatisti* assume that any interval that can be formed by voices is legitimate and they defend their chromaticisms as "being necessary to imitate ordinary speech, in representing the words as orators do and ought."[57] Furthermore, Zarlino rested his

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[56] See Part III, chapter 80: "The Opinions of the *Chromatisti* Rejected," in Gioseffo Zarlino, *Le istitutioni harmoniche* (Venice: [by the author], 1558; reprint in Monuments of Music and Music Literature in Facsimile, II/1, New York: Broude Brothers, 1965), 290-92; trans. in Gioseffo Zarlino, *The Art of Counterpoint: Part Three of* Le istitutioni harmoniche, *1558*, trans. Guy A. Marco, ed. with an introduction by Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 1968), 288-90.

[57] Zarlino, *Istitutioni* III.80, 290: "essendo necessario di imitare il parlar famigliare nel proferir le parole, come vsano gli Oratori, & vuole anco il douere"; trans. in Zarlino, *Art of Counterpoint*, 288. In his *Elementa harmonica*, Aristoxenus criticized the Harmonicists for describing the notes used in musical practice without explaining the relationships among these notes or the scale that was formed by those intervals. See Mathiesen, *Apollo's Lyre*, 301-2. Because of his empirical approach to musical science, Aristoxenus was later but wrongly associated with the Harmonicists. In his *Harmonics* (Book I, chapter 9), for example, Ptolemy accuses the Aristoxenians (not the Harmonicists) of discussing the aural relationships among notes in the scale but not inquiring into how "notes relate to each other in a species," i.e., in terms of number and ratio. Jon Solomon suggests that Ptolemy's knowledge of Aristoxenus was drawn from the latter's successors and not from Aristoxenus himself. See Ptolemy, *Harmonics*, 28-29.

argument on Ptolemy's criticism of Aristoxenus, Didymus, and Eratosthenes for suggesting tetrachord divisions that did not include superparticular intervals.[58]

Many theorists repeated Zarlino's criticisms, sometimes applying them to Vicentino by name. After reading one such critique by the music teacher Gandolfo Sigonio, the Cavalier Bottrigari composed a defense of Vicentino in the early 1590s; it was finally published in 1602 as part of the discourse *Il melone . . . et il melone secondo*.[59] Although Bottrigari does not appreciate the arguments put forth by Vicentino or Lusitano, he views Vicentino as just one example of a group of composers who were well versed in the rules of counterpoint and speculative theory yet sought to go beyond the harmonic conventions of the day.[60] To Sigonio's complaint that the use of chromatic and enharmonic tetrachords created "irrational and disproportionate movements" and were "outside of reason and rule," Bottrigari countered that the fault did not come from the chromatic and enharmonic intervals, "but from the singer who is not well exercised in intoning every sort of interval."[61] Bottrigari's conclusions suggest that the skill of the performer is just as important as the authoritative rules of musical science.

No definitive conclusions on the validity of chromatic music could be reached. Contemporary literature on the Lusitano-Vicentino debate, including the solutions offered

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[58] Zarlino, *Istitutioni* III.80, 291: "Per la qual cosa quanto fusse lodeuole appresso di loro cotali licenze, si può comprendere da quello, che scrisse il prencipe delli Musici Antichi Tolomeo contra Aristosseno, Didimo, et Eratosthene; che non volse lodare, anzi biasimò alcune loro Diuisioni di Tetrachordi, fatte di maniera, che i loro interualli non erano contenuti dalle proportioni, che sono del genere Superparticolare"; trans. in Zarlino, *Art of Counterpoint*, 289.

[59] Ercole Bottrigari, *Il melone discorso armonico et il melone secondo* (Ferrara: Vittorio Baldini, 1602; reprint in Bibliotheca musica bononiensis, II/29, Bologna: Forni, 1969). For a history of Bottrigari's quarrel with Sigonio and commentary on *Il melone*, see Maria Rika Maniates, "The Cavalier Ercole Bottrigari and His Brickbats: Prolegomena to the Defense of Don Nicola Vicentino against Messer Gandolfo Sigonio," in *Music Theory and the Exploration of the Past*, ed. Christopher Hatch and David W. Bernstein (Chicago: University of Chicago Press, 1993), 154-74.

[60] Bottrigari, *Il melone secondo*, 9.

[61] Ibid: "ma del Cantore; il qual non è bene essercitato nell'intonare ogni sorte d'interuallo."

by the combatants themselves, suggests that the various writers' opinions stemmed from broader notions of musical taste and the relationship between contemporary practice and ancient music theory. Although the "sound" of chromatic music was certainly important to listeners, there was no concrete language for the theorists to use in discussing it. Instead, arguments were based on the words of accepted authorities and philosophical proofs, on the one hand, and general notions of musical progress and text expression, on the other.

Zarlino, Venice, and the Perfect Synthesis

The bitter dispute between Zarlino and the Florentine lutenist Vincenzo Galilei draws upon the many themes introduced earlier in this chapter. It mirrors the intellectual controversies that took place in antiquity: their debate reflects a conflict between Ptolemaic idealism and Aristoxenian pragmatism. Zarlino purported to describe contemporary musical practice as a manifestation of musical truths that were grounded in reason and logic. Galilei, on the other hand, maintained that his theories were derived from experimentation and actual musical practice. Boethius's *De institutione musica* is not the principal source for their arguments, but both writers still rely on the authority of ancient theorists to support their claims, even though both Zarlino and Galilei acknowledge great differences between ancient and modern practice. The acerbic tone of Galilei's late writings is reminiscent of the letters collected in *A Correspondence of Renaissance Musicians*, though *both* theorists continually accuse their foes of plagiarism and malicious intentions.

Zarlino and Galilei, whose disputations were communicated through printed treatises and discourses, argued on two planes of inquiry.[62] On the surface, they discussed ancient music theory and music history, tuning systems, counterpoint, and the qualitative relationship between vocal and instrumental music. Their texts demonstrate that Zarlino and Galilei were arguing over very slight minutiae of musical practice. On the other hand, it is the broader plane of inquiry that distinguishes the writers. Underlying their lengthy explanations and demonstrations are debates about the relative merits of sacred polyphony and secular instrumental music, the rise of experimentation as an alternative to scholastic authority, and fundamental arguments about the relationship between natural philosophy and artistic practice. These issues were important to the theorists and their intended audiences. Furthermore, both writers tailored their methodology to suit their colleagues and patrons. For example, in defending his explanation of keyboard temperament to Zarlino, Galilei claims that his methodology was suitable because he only sought "to show some gentlemen with whom I found myself at that time the difference between one and the other system, without the use of the *Mesolabio* or of the harmonic rule."[63] To fully understand these texts, then, we must consider the readers as well as the authors.

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[62] The principal Italian texts are Zarlino's *Le istitutioni harmoniche*, *Dimostrationi harmoniche* (Venice: Francesco de' Franceschi Senese, 1571; reprint in Monuments of Music and Music Literature in Facsimile, II/2, New York: Broude Brothers, 1965), and *Sopplimenti musicali*; and Vincenzo Galilei's *Dialogo della musica antica, et della moderna* (Florence: Marescotti, 1582; reprint in Monuments of Music and Music Literature in Facsimile, II/20, New York: Broude Brothers, 1967) and 1589 *Discorso*. Galilei furthered his arguments in unpublished treatises on counterpoint and dissonance, shorter unpublished essays that treat ancient musical history and musical intervals, and a final unpublished critique of Zarlino's *Sopplimenti* (**I**-Fn Gal. 5).

[63] Galilei, *Discorso,* 51-52: "ma per solo mostrare ad alcuni Gentil'huomini con i quali mi trouauo all'hora, la differenza che è dall'vno all'altro Sistema, senza l'vso del Mesolabio, o della Regola harmonica."

Gioseffo Zarlino and Venice

Known as the "restorer" (*ristauratore*) of music, Zarlino was an active member of the intellectual community in sixteenth-century Venice.[64] Because biographical information about Zarlino is limited, most writers have focused on his intellectual pedigree. For example, in the *Unpublished Lives of Italian Mathematicians* (*Vite inedite di matematici italiani*), Bernardino Baldi (1533–1617) states that the young Zarlino studied grammar with Giacobo Eterbo, arithmetic and geometry with Giorgio Atanagi, music with the monk Francesco Maria Delfico, and organ with Marco Antonio Cavazzoni. Baldi notes that these studies were undertaken "with miraculous profit, but above all in geometry and music."[65] Having completed his religious education at the age of 22, Zarlino relocated from Chioggia to Venice, where he continued his studies in philosophy, Greek, and Hebrew, and furthered his musical training at St. Mark's Basilica with Adrian Willaert.[66]

Biographical writings on Zarlino, including the earliest elegies and recent encyclopedia articles, repeat his educational background as if it carried prophetic weight. Zarlino seems to have been destined from birth to synthesize the contemporary musical practice of sixteenth-century Venice with the rich philosophical and scientific traditions that flourished in the Italian Renaissance. Baldi also notes that Zarlino moved to Venice

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[64] Girolamo Ravagnan praised Zarlino as the most important Italian theorist since Guido of Arezzo (early eleventh century), noting that as Guido is the "father of modern music, so the illustrious Zarlino is universally proclaimed its 'restorer'" [Guidon Aretino: e come questi il Padre della moderna Musica, così l'illustre Zarlino il Ristauratore universalmente si proclama della medesima]." See Girolamo Ravagnan, *Elogio di Giuseppe Zarlino di Chioggia* (Venice: Zerletti, 1819), 8.

[65] Bernardino Baldi, *Vite inedite di matematici italiani*, ed. Enrico Narducci (Rome: Tip. delle scienze matematiche e fisiche, 1887), 167-68: "con profitto mirabile, ma sopra tutto ne gli studii Geometrici e de la Musica." Cristle Collins Judd suggests that Zarlino himself selectively provided biographical information to Baldi. Thus, the information that comes down to us is a result of the theorist's own self-fashioning. See Cristle Collins Judd, *Reading Renaissance Music Theory: Hearing with the Eyes*, Cambridge Studies in Music Theory and Analysis, vol. 14 (Cambridge: Cambridge University Press, 2000), 185.

[66] Baldi, *Vite inedite*, 168.

to avoid the "persecution of some malefactors," but it was all for the best.[67] Baldi, who probably knew Zarlino, does not provide any information about the controversy in Chioggia; he only wants to show Zarlino's relocation to Venice as an important step in fulfilling his destiny.

In 1565, Zarlino succeeded fellow Willaert student Cipriano de Rore as *maestro di cappella* of St. Mark's Basilica, rising to the most prestigious musical position in the city. The *procuratori* at St. Mark's were certainly impressed with his pedigree, and Zarlino helped his own cause by publishing his compendious treatise *Le istitutioni harmoniche*.[68] The initial printing and subsequent reprintings of the *Istitutioni* were strategically timed to draw the greatest attention to his learning and scholarship.[69] Ellen Rosand remarks in her "Music and the Myth of Venice" that when the *procuratori* were choosing a new *maestro di cappella*, they inclined towards students of Willaert, as opposed to accomplished singers, because of their scholarly backgrounds and professionalism.[70] Because the *procuratori* worked for the Doge of Venice, the esteem in which Zarlino was held suggests that they viewed his theoretical works as drawing positive attention to Venetian institutions. One of the men who hired Zarlino, Alvise

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[67] Ibid.: "persecutioni de'maleuoli."

[68] Scholars have suggested that Zarlino wrote *Le istitutioni harmoniche* in response to Vicentino's *L'antica musica ridotta alla moderna prattica*. Enrico Fubini, in particular, notes that both Willaert students endorse a distinct view of music's purpose in their respective treatises. Whereas Vicentino saw the expression of text as the most important function of music, Zarlino emphasized music's self-sufficient properties. Fubini argues that Zarlino's radical slant towards the autonomy of musical expression was an important factor in the development of instrumental music, especially with regard to the Venetian tradition. See Enrico Fubini, "Zarlino, Venezia e la musica strumentale," in *Convegno internazionale su "Andrea Gabrieli e il suo tempo" (1985: Venice, Italy)*, ed. Francesco Degrada (Florence: Leo S. Olschki, 1987), 388-92.

[69] Judd, *Reading Renaissance Music Theory*, 192-98.

[70] Ellen Rosand, "Music in the Myth of Venice," *Renaissance Quarterly* 30 (Winter 1977): 519-20.

Mocenigo, was chosen to be Doge in 1570, and Zarlino may have been returning an old favor when he dedicated his *Dimostrationi harmoniche* to Mocenigo in 1571.[71]

Outside of St. Mark's, Zarlino was also active in the *Accademia Venetiana della Fama*, which was established in 1560. According to its founder, Federigo Badoer, the academy would give its members an education in all of the "virtues," particularly the sciences and arts, as well as lessons on the political makeup of all provinces, "Christian and infidel."[72] One endeavor of the Academy was to publish Italian translations of many Greek and Latin treatises on music, an activity inspired by the linguistic theories of Pietro Bembo (1470–1547).[73] Providing vernacular editions of these works placed the academy in opposition to the classicist Aldine Academy, founded by the publisher Aldus Manutius, which preferred Greek and Latin, the languages of the universities.[74] On the other hand, a vernacular scholarly tradition had already been cultivated in nearby Padua under the auspices of the *Accademia degli Infiammati*. This academy was founded by Bembo's colleague Sperone Speroni (1500–1588) and the Sienese humanist Alessandro Piccolomini (1508–1579), among others.[75] Both were active as well in the Venetian

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[71] Zarlino apparently also had close ties with the dedicatee of *Le istitutioni harmoniche*, Vincenzo Diedo, Patriarch of Venice (1556-1559). One year after the first printing of *Istitutioni*, Zarlino served as witness for the signing of Diedo's last will and testament. The document can be viewed online, through the Moldenhauer Archives [database online], available at <http://memory.loc.gov/ammem/collections/moldenhauer/> (accessed 29 July 2010).

[72] Federigo Badoer, "The Venetian Academy and Its Progamme of Universal Knowledge," in *Venice: A Documentary History, 1450-1630*, ed. David Chambers, Brian S. Pullan, and Jennifer Fletcher (Oxford: B. Blackwell, 1992), 366.

[73] Martha Feldman has discussed Bembo's influence on Zarlino, especially as it relates to the *Istitutioni*. See Martha Feldman, *City Culture and the Madrigal at Venice* (Berkeley: University of California Press, 1995), 171-76, 184-86.

[74] For background on musical studies at the Venetian Academy, see Iain Fenlon, "Gioseffo Zarlino and the Accademia Venetiana della Fama," in *Music and Culture in Late Renaissance Italy* (Oxford: Oxford University Press, 2002), 118-37, especially 131-32.

[75] A history of the short-lived *Accademia degli Infiammati* is found in Richard S. Samuels, "Benedetto Varchi, the Accademia degli Infiamatti, and the Origins of the Italian Academic Movement," *Renaissance Quarterly* 29 (Winter 1976): 599-634. As *prencipe* of the academy in 1541-1542, Speroni demanded that all lectures be read in Italian, but his plan was thwarted by the many foreign students who spoke only Latin or their own native tongues. Zarlino initially intended to publish *Le istitutioni harmoniche*

Academy, and Piccolomini, in particular, may have had a profound influence on Zarlino.[76]

The *Accademia Venetiana della Fama* proposed several Greek and Latin music theory treatises for translation, and Zarlino certainly played a role in the selection process.[77] Among the works listed are Ptolemy's *Harmonics*, the most important source for Zarlino's *Istitutioni* and later *Sopplimenti musicali*; Lodovico Fogliano's *Musica theorica* (Venice, 1529), which Zarlino used as the basis of his new tuning system, elucidated in Part II of the *Istitutioni*; and Heinrich Glarean's *Dodecachordon* (Basle, 1549), which is Zarlino's principal source for the 12-mode system, discussed in Part IV of the *Istitutioni*. Although the academy did not produce translations of any of the cited works, Zarlino disseminated their contents in the vernacular through his own writings. Vincenzo Galilei would later ridicule Zarlino for plagiarizing these authors (especially Glarean and Fogliano), but Zarlino defended himself by noting that he was only introducing readers to the many aspects of musical science.[78]

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in both Italian and Latin. Paolo Da Col suggests that he was trying to market the work to a "European" audience, but perhaps Zarlino thought there were enough non-Italian speakers in Venice who might buy his treatise. See Paolo Da Col, "The Tradition in Science," trans. Hugh Ward-Perkins, in Gioseffo Zarlino, *Le istitutioni harmoniche* (Venice: Francesco de' Franceschi Senese, 1561; reprint in Bibliotheca musica bononiensis, II/39, Bologna: Forni, 1999), 35-36.

[76] Fenlon, "Gioseffo Zarlino," 132. John Kelleher notes similarities between Zarlino's *Dimostrationi harmoniche* and the sixteenth-century debate over *certitudo mathematicarum* (mathematical certitude), which was provoked by Alessandro Piccolomini. See John Kelleher, "Zarlino's *Dimostrationi harmoniche* and Demonstrative Methodologies in the Sixteenth Century" (Ph.D. dissertation, Columbia University, 1993), 10-12.

[77] Fenlon, "Gioseffo Zarlino," 128-29. Zarlino is listed in the Academy's *Instrumento di deputatione* as one of four members who oversaw the music "stanza" of the academy. The *Instrumento* is reprinted in the *Giornale dell'italiana letteratura* 23 (1808): 63; quoted in Fenlon, "Gioseffo Zarlino," 136. The list of music treatises that were marked for translation is found in a printed catalog called the *Summa librorum*, quoted in ibid., 128.

[78] Galilei's accusations are discussed by Don Harrán. He suggests that in Zarlino's academic climate it was not at all inappropriate for him to use uncited material from other treatises. See Don Harrán, "Sulla genesi della famosa disputa fra Gioseffo Zarlino e Vincenzo Galilei," *Nuova rivista musicale italiane* 21 (August-September 1987): 474.

Details from academy-related writings provide information on Zarlino's intellectual circle and their activities. Zarlino's three principal treatises, the *Istitutioni*, *Dimostrationi*, and *Sopplimenti musicali*, exhibit an encyclopedic grasp of ancient and modern scientific literature. His aptitude for synthesizing information is apparent, yet he was not alone in his research. On the contrary, unpublished letters from Venetian and Paduan scholars show that the Venetian Academy was a hub for scientists interested in bridging the quadrivial sciences.[79] Documents in the Biblioteca Ambrosiana show that Zarlino was in contact with many of the important scientists in the region, including Gian Vincenzo Pinelli (1535–1601), who also exchanged letters with Galilei's mentor Girolamo Mei, and Giuseppe Moletti (1531–1588), professor of mathematics at the University of Padua. Among Moletti's writings on mechanics and geometry is an essay on proportions that exists in the hand of Vincenzo Galilei.[80] Paolo Sanvito lists many other important personages associated with the Academy in his study of Zarlino's letters, but in regard to the letters directed at Pinelli, he describes the tenor of the academic circle in which Zarlino participated: "From these pages are clearly shown a fervent intellectual environment, lively with exchanges, often even with violent polemics, but always permeated by a spirit of collaboration and participation in the same practical or theoretical applications."[81]

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[79] For a review of the related documents, see Paolo Sanvito, "Le sperimentazioni nelle scienze quadriviali in alcuni epistolari zarlinioni inediti," *Studi musicali* 19 (1990): 305-18.

[80] Ibid., 305-6. The final page of the article includes a transcription of a letter from Mei to Pinelli in which Mei discusses his relationship with Galilei and announces that he has not yet received Galilei's *Dialogo*. Perhaps Pinelli was making inquiries about Galilei on behalf of Zarlino.

[81] Ibid., 306: "Da queste pagine ci si mostra chiaramente un fervido ambiente intellettuale, vivo di scambi, spesso anche di violente polemiche, ma sempre permeato di uno spirito di collaborazione e di partecipazione alle stesse istanze pratiche o teoriche."

Zarlino's *Dimostrationi* and the "Myth of Venice"

The *Istitutioni* cemented Zarlino's position as the foremost Italian music theorist of his era and aided him in eventually winning the position as *maestro di cappella* at St. Mark's Basilica in 1565. Cristle Collins Judd notes that Zarlino printed his last musical composition in 1570, after which he focused primarily on the dissemination of his theoretical works.[82] The publication of the *Dimostrationi harmoniche* (1571) marks this new emphasis in theory, and it was followed two years later by a revised edition of the *Istitutioni*. The *Dimostrationi* consists of five Discussions (*ragionamenti*) in which Zarlino teaches the scientific foundations of music to several practitioners, including his former teacher Adrian Willaert; Claudio Merulo, an organist at St. Mark's; and Francesco Viola, another Willaert protégé and court musician in Ferrara. The literary style and contents of the *Dimostrationi* suggest that its author was enjoying his new prestigious position and wanted to present himself as an important personage of the "Serene Republic of Venice."

St. Mark's served as the private chapel of the Doge of Venice. All matters regarding the administration of the chapel, including hiring, finance, and discipline, were decided by a group of *procuratori*, although the Doge had final say on most issues.[83] The *maestro di cappella* of St. Mark's, then, was not just an employee of the chapel but also a component of the government. Zarlino certainly accepted responsibility for sustaining the

[82] Judd, *Reading Renaissance Music Theory*, 250.

[83] For information on the administrative organization of the chapel at St. Mark's, see Giulio Ongaro, "The Chapel of St. Mark's at the Time of Adrian Willaert (1527-1562): A Documentary Study" (Ph.D. dissertation, The University of North Carolina at Chapel Hill, 1986), 18-21.

"myth of Venice," as is shown in the deference he exhibits toward Venetian authority in his treatises and particularly in the literary conceit of his *Dimostrationi*.[84]

Zarlino's ties to persons of authority in Venice, as exhibited by the dedications of the *Istitutioni* and *Dimostrationi*, were noted above.[85] Throughout the *Dimostrationi*, Zarlino emphasizes his regard for authority. In the dedication to the Doge Alvise Mocenigo, he tells how the ancient writers Valerius Maximus, Pliny the Elder, and Vitruvius composed treatises to honor their emperors.[86] In presenting the *Dimostrationi* to the Doge, Zarlino associates himself with these ancient scientists and the Doge with the emperor: "I wanted to offer and dedicate [this work] to Your Sublimity, as to a High Prince and my Lord. And I hope it will be no less pleasing to you than were the works of those excellent writers to those grand emperors."[87] This regard for authority governs many of the theoretical topics in his treatises, such as the relative merits of harmonically divided proportions and adherence to the *bone regole* of counterpoint.[88]

In addition to praising the Doge, Zarlino also celebrates Venice itself and the *Signoria* (governing senate). The first discussion of the *Dimostrationi* opens with a paean to the Serene Republic:

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[84] Although Renaissance Venice was officially considered a republic, the city was actually ruled by an oligarchy of the wealthy elite. David Rosand's definition of the "myth" suggests that public works of art, architecture, and even the musical chapel at St. Mark's could promote "the self-proclaimed Most Serene Republic as an ideal political entity whose ruling patriciate were selflessly devoted to the commonweal." See David Rosand, *Myths of Venice: The Figuration of a State* (Chapel Hill: The University of North Carolina Press, 2001), 2.

[85] See pp. 7-8 *supra.*

[86] Zarlino, *Dimostrationi*, [iv].

[87] Ibid.: "hò uoluto offerirle e dedicarle a Vostra Sublimità, come ad un'Ottimo Prencipe e mio Signore. Et spero, che non minormente le saranno grate, di quello, che furono grate à quei grandi Imperatori le fatiche di quelli eccellenti Scrittori."

[88] Some seventeenth-century treatises, especially those that extol the *bone regole* of counterpoint, include the same associations among musical authority and political authority that are found in Zarlino's works. For an example, see Giovanni Maria Bononcini, *Musico prattico* (Bologna: Giacomo Monti, 1673; reprint in Monuments of Music in Facsimile, II/78, New York: Broude Brothers, 1969). The frontispiece to the first edition of Bononcini's treatise features an allegorical figure of piety admonishing an allegorical figure of rebellion.

> The years of our savior had just reached the number 1562, and it was the month of April when the Illustrious Signor Don Alfonso d'Este, Duke of Ferrara, came to Venice in order to see a beautiful, noble, and rich city, not only the glory, splendor, and esteem of beautiful Italy, but also of all Christendom, and perhaps for his other important business. On which account, he was received by our Illustrious Venetian *Signoria* with most solemn pomp and royal preparations, as is their custom to receive all those persons who are of high affairs.[89]

After introducing the Duke and his *maestro di cappella* Francesco Viola to the reader, Zarlino leads them across the "most beautiful plaza of St. Mark's" and into its "famous and rich temple."[90] Upon entering the basilica, Zarlino and his Ferrarese friends meet up with the organist Claudio Merulo, and the quartet continues on to the house of Adrian Willaert, at whose residence the remainder of the dialogue will take place. Zarlino's inclusion of Willaert, his famous teacher and former *maestro di cappella* of St. Mark's, in the *Dimostrationi* is one more example of the way in which Zarlino draws attention to the great institutes of Venice. Zarlino also uses this revered interlocutor as a mouthpiece to praise the contents of the book and voice some of his more controversial opinions.

Renaissance dialogues typically included pictorial descriptions of locations, yet Zarlino's introduction to the *Dimostrationi* suggests a propagandistic tone. The "myth of Venice" that opens the *Dimostrationi* set a precedent for music theorists who wanted their publications to be associated with the Republic. Zarlino's own student, Girolamo Diruta, wrote a similar introduction for his treatise on keyboard playing, *Il transilvano*. In

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[89] Zarlino, *Dimostrationi*, 1: "GLI ANNI di nostra salute erano gia peruenuti al numero di M D LXII. et era il mese di Aprile: quando l'Illustrissimo Signor Donno Alfonso d'Este Duca di Ferrara: per cagione di vedere vna bella, nobile e ricca città: non solamente gloria, splendore e riputatione della bella Italia: ma anco di tutto'l Christianesimo: & forse per altri suoi negotij d'importanza, vene à Vinegia. Onde dalli nostri Signoria Illustrissimi Venetiani con solennissima pompa, e regali apparati: si come è loro costume di riceuere tutte quelle persone, che sono di alto affare: fù riceuuto."

[90] Ibid.: "si auiassimo verso la bellissima piazza di San Marco. La onde vedendo aperto il suo famoso e ricco tempio."

the opening of the first dialogue, the "Transylvanian" Stephen Jósika celebrates his arrival in Venice, giving praise to its governing institutions:

> *Transylvanian*: At last, after the tedious hardships of a long and fatiguing journey, thanks to the goodness of God, I have arrived safe and sound in this most illustrious city of Venice. I am overcome with joy to have arrived on such a day as this one, when the Ascension of Our Lord into heaven is being celebrated with so much festivity. I will do nothing else so that I can satisfy my desire to see and pay homage to His Excellency the Most Serene Prince, along with all the rest of the very illustrious Senate, and I can enjoy hearing with them the delightful concerts and harmonious songs with which, if I am not mistaken, such a ceremony is observed.[91]

Diruta goes one step beyond Zarlino's introduction by setting his dialogue on the Feast of the Ascension. This holy festival was a significant day in the Venetian calendar: it coincided with the celebration of the "Marriage of the Sea" in which Venetians commemorated the supremacy of Venice's naval power.

With the *Dimostrationi*, Zarlino sought to do for music theory what Euclid had done for geometry in his *Elements* almost two millennia earlier. Each of the five Discussions includes sets of definitions (*definitioni*), postulates (*dimande*), and propositions (*proposte*) that seek to *demonstrate* the mathematical basis for musical practice.[92] While the first discussion focuses on proportions, each subsequent discussion progresses toward more practical aspects of music. Throughout the text, Zarlino trains his

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[91] Girolamo Diruta, *Il transilvano*, 2 vols. (Venice: Alessandro and Giacomo Vincenti, 1593, 1609; reprint with an introduction by Edward J. Soehnlen and Murray C. Bradshaw in Bibliotheca Organologica, vol. 44, Buren: Knuf, 1983), 1: "ECCO che pur'alla fine dopò i grauosi stenti del lungo, e faticoso viaggio, mercè della bontà di Dio; son gionto sano, e saluo in questa Illustrissima Città di Vinegia, e sento allegrezza sì inestimabile l'esser arriuato in tal giorno quale è questo d'hoggi, in cui si celebra con tanto aplauso l'ascendimento di nostro Signore in Cielo, che niente piu, poi che potrò à pieno sodisfare al desiderio mio, e di vedere, et inchinare il Serenissimo Prencipe, con tutto il resto del Illustrissimo Senato, et insieme gioire vdendo i dolcissimi concerti, et armonici canti, con quali s'io non m'inganno è per honorarsi tal solennità"; trans. in Girolamo Diruta, *The Transylvanian,* 2 vols., ed. Murray C. Bradshaw & Edward J. Soehnlen, Musicological Studies, vol. 38 (Ottawa: Institute of Mediaeval Music, 1984), 1:41.

[92] The first discussion also includes a set of *dignità* or axiomatic statements. See Zarlino, *Dimostrationi*, I.dig.1-17, 28-34.

enthusiastic audience in musical science. The dialogic nature of the text allows Zarlino to integrate his scientific basis for music as his interlocutors support his more controversial ideas. For example, after defining the diatonic genus (Discussion IV, definition 3), Adrian Willaert, a mentor to Zarlino *and* Vicentino, mentions the modern chromaticists who "do not wish one to be able to sing in this [diatonic] genus, from the first string to the third by leap, because that makes the interval of a semiditone or trihemitone."[93] Willaert is clearly making reference to the Vicentino-Lusitano debate,[94] and by placing the words in Willaert's mouth, Zarlino suggests that someone other than he is offering an opinion on chromaticism. After Zarlino explains the manner in which the diatonic genus is used in actual practice, Willaert offers his judgment: "It seems to me that [the chromaticists] do not know what they say and that they move against every reason."[95]

Because of its emphasis on theoretical topics, the *Dimostrationi* was not read as widely as the *Istitutioni* and is not cited nearly as often by other theorists. Zarlino would later use the text to defend his theories, noting that anything "demonstrated" in the *Dimostrationi* should be considered fact by virtue of the demonstration. On the other hand, Zarlino's rival Galilei would criticize many topics in the *Dimostrationi* in an effort to tear down Zarlino's elegant synthesis of mathematics and natural science.

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[93] Ibid. IV.def.3, 213: "non uogliono, che in questo Genere si possa passare cantando dalla Prima chorda alla Terza per salto. percioche si fa l'interuallo del Semiditono, o Trihemituono." The semiditone is equal to a tone plus a semitone, while the trihemitone is composed of three semitones. Because musicians in the sixteenth century used tones and semitones of varying sizes, semiditones and trihemitones were usually considered as two different intervals.

[94] See pp. 35-41 *supra*.

[95] Zarlino IV.def.3, *Dimostrationi*, 214: "Parmiche non sanno quello che si dicano: e che si muouino contra ogni ragione." With regard to Willaert's role in the dialogue, Frans Wiering suggests that Zarlino is imitating a common practice in ancient dialogues, such as Cicero's *De oratore* and Plato's Socratic dialogues, in which the last words of a revered man are revealed. In this instance, Willaert's "last words" are in complete support of Zarlino. See Frans Wiering, *The Language of the Modes: Studies in the History of Polyphonic Modality*, Criticism and Analysis of Early Music, ed. Jessie Ann Owens, vol. 3 (New York: Routledge, 2001), 35.

Furthermore, he ridiculed the dialogic conceit of the dialogue. Galilei found it hard to believe that Zarlino could really captivate an audience of talented practitioners:

> The most refined Mr. Claudio [Merulo] of Coreggio now occurs to me, and although he is modesty itself, I cannot believe that he would have heard some of these simplicities without laughing together with the others whom Zarlino introduces in his discussions, to whom he has done the greatest wrong by placing them in the predicament of men who have need of learning through demonstration the best-known things.[96]

Galilei's criticisms aside, the *Dimostrationi* provided Zarlino with a firm base upon which he could later defend his ideas. Although he features himself as the principal interlocutor of the dialogue, the figurative "community of scholars" who interact in the treatise adds authority to his proofs, while centering the content of the text in layers of decorum and entertaining prose.[97]

Zarlino's Approach to Proportions and Tuning

Zarlino's demonstrative method was influenced by sixteenth-century notions of certainty. Scholars of the era argued fiercely over which kinds of scientific methodology could actually provide "certitudinous knowledge";[98] perhaps the most famous example of this method was Nicolaus Copernicus's heliocentric model for the solar system, which "resulted out of an intense awareness of the need to restore certainty to astronomy."[99] The

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[96] Galilei, *Discorso*, 61: "Mi souuien'hora del gentilissimo Messer Claudio da Coreggio, e quantunque egli sia l'istessa modestia, non posso credere ch'egli habbia vdito alcune di queste semplicità senza ridersene insieme con gl'altri che introduce il Zarlino ne suoi ragionamenti; a i quali ha fatto vn grandissimo torto, con mettergli in predicamento di huomini c'habbino bisogno d'imparare per dimostratione le cose notissime."

[97] In this regard, the dialogic nature of the *Dimostrationi* is similar to Castiglione's *Il corteggiano* (*The Courtier*, published in Venice in 1527), a popular dialogue that extolled the moral attributes of educated aristocrats. For an English translation of *The Courtier*, see Baldassare Castiglione, *The Book of the Courtier*, trans. Sir Thomas Hoby, Tudor Translation Series, no. 23 ([London]: E. Arnold, 1900; reprint, New York: AMS Books, 1967).

[98] Kelleher, "Demonstrative Methodologies," 10.

[99] Paul Rose, *The Italian Renaissance of Mathematics: Studies on Humanists and Mathematicians from Petrarch to Galilei*, Travaux d' humanisme et Renaissance, vol. 145 (Geneva: Droz, 1975), 127.

controversy over *certitudo mathematicarum* (certitude of mathematics) was provoked by Alessandro Piccolomini, the aforementioned Sienese scholar who noted that mathematics "does not acquire its certainty from proof, but rather from the nature of its objects."[100] Drawing from Proclus's *Commentary on the First Book of Euclid's Elements* (fifth century C.E.), Piccolomini placed mathematical objects within a broader classification of knowledge, derived from a Neoplatonic distinction between the corporeal and incorporeal.[101]

Neoplatonic ideas were common in sixteenth-century science, especially in the writings of theologically minded scholars such as Piccolomini and Zarlino, and the similarities between both scholars are striking.[102] Seeking to bring certainty to music theory, Zarlino emphasized the role of geometry and arithmetic in formulating musical systems, although his proofs were bound by first principles and theological concerns. In his final Italian treatise, the *Sopplimenti musicali*, Zarlino, too, invoked Proclus's *Commentary on Euclid*, noting that mathematics is a "middle place" (*mezano luogo*) between the "things of nature" (*cose della Natura*) and the "divine things" (*cose diuine*); mathematics, therefore, can be said to be the "the first step of certainty."[103]

Zarlino further emphasizes the role of certainty in his treatises through the synthesis of seemingly contrasting methodologies. In the *Istitutioni*, synthesis is apparent at the highest levels of organization. The treatise is divided into four parts. Parts I and II treat theoretical aspects of music (*musica speculativa*), while Parts III and IV are concerned with practice (*musica prattica*). Zarlino defines the *musico perfetto*, or perfect

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[100] Daniele Cozzoli, "Alessandro Piccolomini and the Certitude of Mathematics," *History and Philosophy of Logic* 28, no. 2 (2007): 167.
[101] Ibid., 165-67.
[102] See fn. 76 *supra*.
[103] Zarlino, *Sopplimenti* I.8, 27. "il primo grado di certezza."

musician, as one who can claim expertise in both theory and practice.[104] Certainty is also apparent in the *Istitutioni* through a hierarchal preference for the mathematical basis of music (proportions), which is deemed superior to the natural aspects of music (sounds and tones).[105]

In the *Istitutioni* and *Dimostrationi*, Zarlino employed logical formulations, geometric proofs, and visual representations of mechanical processes to explain the basic principles of musical science. In pursuing this type of research, Zarlino collaborated with Giuseppe Moletti, one of his colleagues from the *Accademia Venetiana della Fama*, on the reconstruction of the *Mesolabio*.[106] Charles Hutton, in his *Philosophical and Mathematical Dictionary*, defines this as a "mathematical instrument invented by the ancients, for finding two mean proportions mechanically, which they could not perform

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[104] Zarlino, *Istitutioni* I.11, 21. The concept of a *musico perfetto* may have originated in the polemical debates over the use of polyphony in the fifteenth century. Responding to charges that the singing of polyphony in churches would lead to bad morals, defenders of contrapuntal music argued that poorly trained musicians, who did not have a full understanding of theory and practice, were the problem, and not polyphony itself. Johannes Versoris, in his commentary on Aristotle's *Politics*, particularly noted that an ignorant musician will choose the wrong mode and that musical "abusers" are responsible for the improper use of music in churches. See Rob C. Wegman, *The Crisis of Music in Early Modern Europe, 1470-1530* (New York: Routledge, 2005), 70-71.

[105] Zarlino, *Istitutioni* I.20, 31: "But having to name all things from the thing that is more noble, we say more reasonably that music is a mathematical rather than a natural science, knowing that form is more noble than matter [però douendosi denominare tutte le cose dalla cosa più nobile, più ragioneuolmente diciamo la Musica essere scienza mathematica, che naturale: conciosia che la forma sia più nobile della materia]." This passage is discussed by John Kelleher ("Demonstrative Methodologies," 67), who notes that Zarlino favors the "mathematical" over the "natural" through Aristotle's "notion of causality." Mathematics is the formal cause of music and, therefore, more noble than sound, which is the material cause of music. An explanation of causality is found in Aristotle's *Physics* 2.3. For an English translation, see *The Complete Works of Aristotle: The Revised Oxford Translation*, 2 vols., ed. Jonathan Barnes, Bollingen Series, LXXI/2 (Princeton, NJ: Princeton University Press, 1984), I:332-34. In the *Istitutioni* I.41, 54, Zarlino defines the four causes of music as follows:

formal cause:	proportion [*proportione*]
material cause:	strings [*chorde*]
efficient cause:	musician [*musico*]
final cause:	sound with harmony, or to please and delight [*Sonare con harmonia; ouero il giouare, et dilettare*].

[106] Sanvito, "Le sperimentazioni," 307.

geometrically."[107] Its use in antiquity is verified in the writings of Pappus, Eudoxus, Aristides Quintilianus, and Ptolemy. For Zarlino, the instrument was useful because it allowed him to demonstrate tuning systems with purely logical illustrations. Figure 3 shows the example of the *Mesolabio* presented in the *Dimostrationi*.[108]

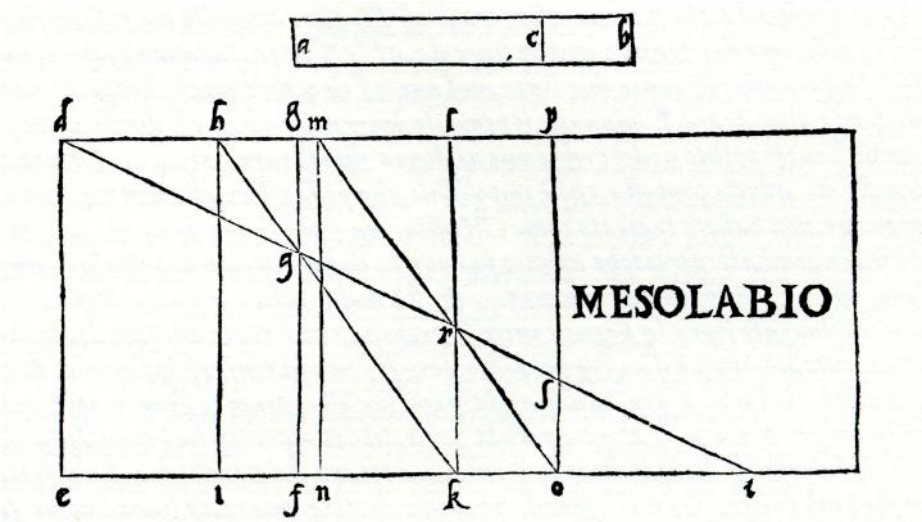

Figure 3. Example of a *Mesolabio* in Zarlino, *Dimostrationi harmoniche* III.p.11, 163.

In the third Discussion of the *Dimostrationi*, Zarlino's audience is reluctant to hear a demonstration of the *Mesolabio*, but Zarlino convinces them that "without its means one cannot demonstrate anything."[109] The tableau suggests that Zarlino is relaying the type of discussion that might occur at an academy to professional musicians who desire to learn musical science but are not as informed or enthusiastic about the type of theoretical discussions pursued by intellectuals.

In this instance, Zarlino is trying to show the division of intervals through mechanical means rather than through mathematics or by relying on the sense of hearing.

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[107] Charles Hutton, *A Philosophical and Mathematical Dictionary*, 2 vols. (London: by the author, 1815), 2:47.

[108] Zarlino, *Dimostrationi* III.prop.11, 163. Zarlino makes a similar demonstration of the instrument in the *Istitutioni* II.25, 94-96.

[109] Zarlino, *Dimostrationi* III.prop.11, 163. "senza il suo mezo non ui potrei dimostrar cosa alcuna."

First, he describes a proportion, represented by the line *acb.* Zarlino then presents three parallelograms: *defg*, *hikl*, and *mnop* in which the sides *de*, *hi*, *gf*, *mn*, *lk*, and *po* are each equal to *ab.* The side *po* of the third parallelogram is divided so that *ps* is equal to *ac*. To find the middle proportions, diagonal lines *om* and *kh* are drawn to intersect lines *lk* and *gf*, respectively, at points *r* and *q*. The resulting lines, *rk* and *qf*, are proportional to *so* and *de*. Through this process, Zarlino has shown how the interval *ab*:*ca* can be divided into three equal intervals.[110] Having explained the diagram, Zarlino checks his theory with a detailed description of similar angles and parallel constructions, all drawn from various parts of Euclid's *Elements*.[111] The use of the *Mesolabio* in the *Dimostrationi* is important because it shows the way in which Zarlino formulates his theories and sheds light on the way he communicates with his readership. The *Mesolabio* and other mechanical tools, such as Ptolemy's *Helicon*, were so important to Zarlino that he featured them as the centerpiece of his personal device.[112] Nevertheless, Zarlino's adherence to the *Mesolabio* and other logical formulations left him vulnerable to Galilei's attacks on his purely rational explanations of musical intervals.

Zarlino's Syntonic Diatonic Tuning

As discussed above, the problem of describing consonant polyphony preoccupied many music theorists in Italy from the late fifteenth century onward. Ramis de Pareia

[110] This type of division could not be reproduced by adding or subtracting the ratios of superparticular intervals.

[111] Zarlino, *Dimostrationi* III.prop.11, 163-64.

[112] An image of the device was printed in Giovanni Maria Artusi's *Impresa del molto R. M. Gioseffo Zarlino* (Bologna: G. B. Bellagamba, 1604). For a reproduction of that image, see Claude V. Palisca, "Scientific Empiricism in Musical Thought," in *Studies in the History of Italian Music and Music Theory* (Oxford: Clarendon, 1984), 212.

offered the first published explanation in his *Musica practica* of 1482.[113] His monochord, which implied superparticular intervals, suggested that consonant thirds and sixths could be substituted for the dissonant thirds and sixths of the Pythagorean system. Ramis's system was condemned by Pythagoreans such as Franchino Gaffurio, but it elicited many alternative proposals. Although not without its flaws, Zarlino's monochord description, which he presented as a true precept of natural philosophy, came to be considered as law by its supporters.[114]

Zarlino's solution, first published in the *Istitutioni*, is more remarkable than that of his predecessors, not because of its originality but because of the manner in which he presents it.[115] Following his usual method of operation, Zarlino takes a previously published solution from a Latin treatise. In this case, it is the monochord division offered by Lodovico Fogliano in his *Musica theorica* of 1529.[116] Zarlino makes no mention of its recent origins and instead appropriates it as his own and drapes it in authoritative

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[113] See pp. 30-33 *supra*.

[114] Many later writers did not provide their own analysis of tuning systems. For example, Cesare Crivellati, a strong proponent of monody and Baroque vocal idioms, notes that the Syntonic tetrachord is "that which is in use today" (*che al presente è in vso*) without any reference to Zarlino or the controversy surrounding tuning systems in the sixteenth century. See Cesare Crivellati, *Discorsi musicali* (Viterbo: Agostino Discepoli, 1624), 55-56.

[115] Another aspect of Zarlino's "certainty," the detailed explanation of imperfect consonances found in the *Istitutioni* surely surprised other writers who viewed them as indefinable. In his first letter to Vincenzo Galilei (8 May 1572, f. 20r), Girolamo Mei writes that ancient scientists did not study the imperfect consonances because they "were altogether impossible to grasp in a determinate and certain way by the intellect, since they were born and originated without any more certain and determinate rule than the mere imperfection of the sense of hearing . . ."; quoted in Claude V. Palisca, *The Florentine Camerata: Documentary Studies and Translations*, Music Theory Translation Series (New Haven, CT: Yale University Press, 1989), 66. A transcription of the letter is found in Girolamo Mei, *Letters on Ancient and Modern Music to Vincenzo Galilei and Giovanni Bardi: A Study with Annotated Texts by Claude Palisca*, 2d ed., Musicological Studies and Documents, vol. 3 (Neuhausen-Stuttgart: American Institute of Musicology, 1977), 104: "erano al tutto impossibili à possedersi determinatamente et certamente dal'intelletto, havendo esse per suo nascimento e quasi fonte senza altra certa et determinata regola la sola imperfezzione de l'udito. . . ." The letters are transcribed from the codex Bibliotheca Apostolica Vaticana, Reg. lat. 2021, on which, see Mei, *Letters*, 82-85.

[116] Lodovico Fogliano, *Musica theorica* (Venice: G. A. e fratelli di Sabio, 1529; reprint in Monuments of Music and Music Literature in Facsimile, II/43, New York: Broude Brothers, 1969), ff. 32v-35r. An analysis of Fogliano's monochord division is found in Palisca, *Humanism*, 240-42.

rhetoric. Like Ptolemy before him, Zarlino exhibits the theory as an idealized system, based in nature and true to Pythagorean precepts.

Sixteenth-century theorists described their tuning systems as monochord divisions, measured out in octaves, but in ancient sources tuning is explained in tetrachords. In order to present his system as true to ancient authority and modern practice, Zarlino needed to combine the most natural or harmonious tetrachord with an octave that would show the same qualities. Ptolemy himself singled out his own Syntonic (or intense) diatonic tetrachord as the most natural, for it is composed entirely out of superparticular intervals. Figure 4 shows Zarlino's diagram of the Syntonic diatonic tetrachord, as it is presented in Part II, chapter 16 of the *Istitutioni*.

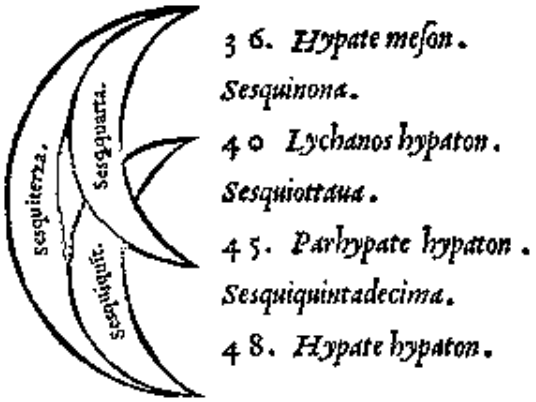

Figure 4. Ptolemy's Syntonic tetrachord in Zarlino, *Istitutioni* II.16, 84.

The lowest interval (on the bottom) is a semitone (48:45 = 16:15), and the two following whole tones are of different sizes (45:40 = 9:8; 40:36 = 10:9). Adopting the Syntonic as the foundation of modern tuning, Zarlino then sets out to provide the most harmonious division of the monochord.

In chapter 39 of Part II, Zarlino describes a harmonically divided octave. To divide a ratio harmonically, a proportion is created in which the ratio of the extreme terms, in this case 2:1, is equal to the ratio of the differences between the harmonic mean

and the extremes, for example, 6:4:3. 6:3 equals 2:1. If the mean is subtracted from the larger extreme (6 – 4 =2) and the smaller extreme from the mean (4 – 3 =1), the ratio 2:1 is preserved in the differences. The harmonic division results in 6:4, that is, 3:2, a perfect fifth (*diapente*) and 4:3, a perfect fourth (*diatessaron*), as can be seen in figure 5.

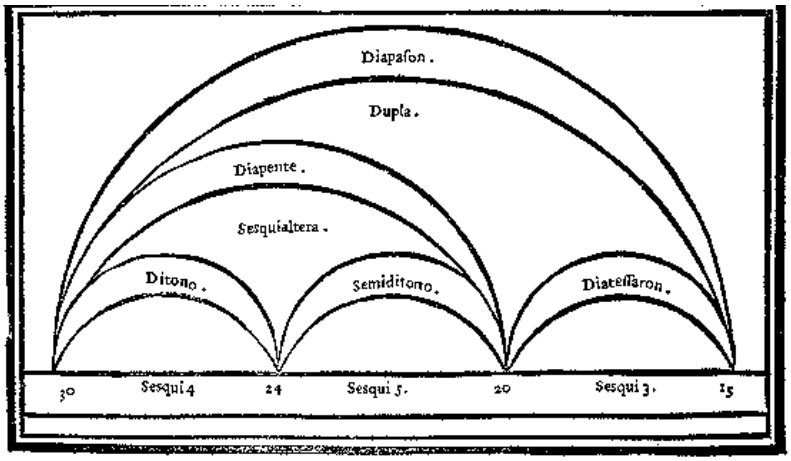

Figure 5. The harmonically divided octave in Zarlino, *Istitutioni* II.39, 121.

Thus, like the Pythagoreans, Zarlino derives the smaller intervals from the larger intervals, and he always works from the simplest forms of inequality to more complex ratios.

Zarlino then harmonically divides the fifth, the ratio 3:2. Once again, he finds a proportion in which the ratio of the extremes is equal to the ratio of the differences between the harmonic mean and the extremes. The smallest integers that reflect this proportion are 30:24:20. These particular terms can be reduced to 5:4 and 6:5, and those become the ratios for the consonant major third (*ditono*) and minor third (*semiditono*). Figure 6 shows Zarlino's diagram of a completely divided octave:

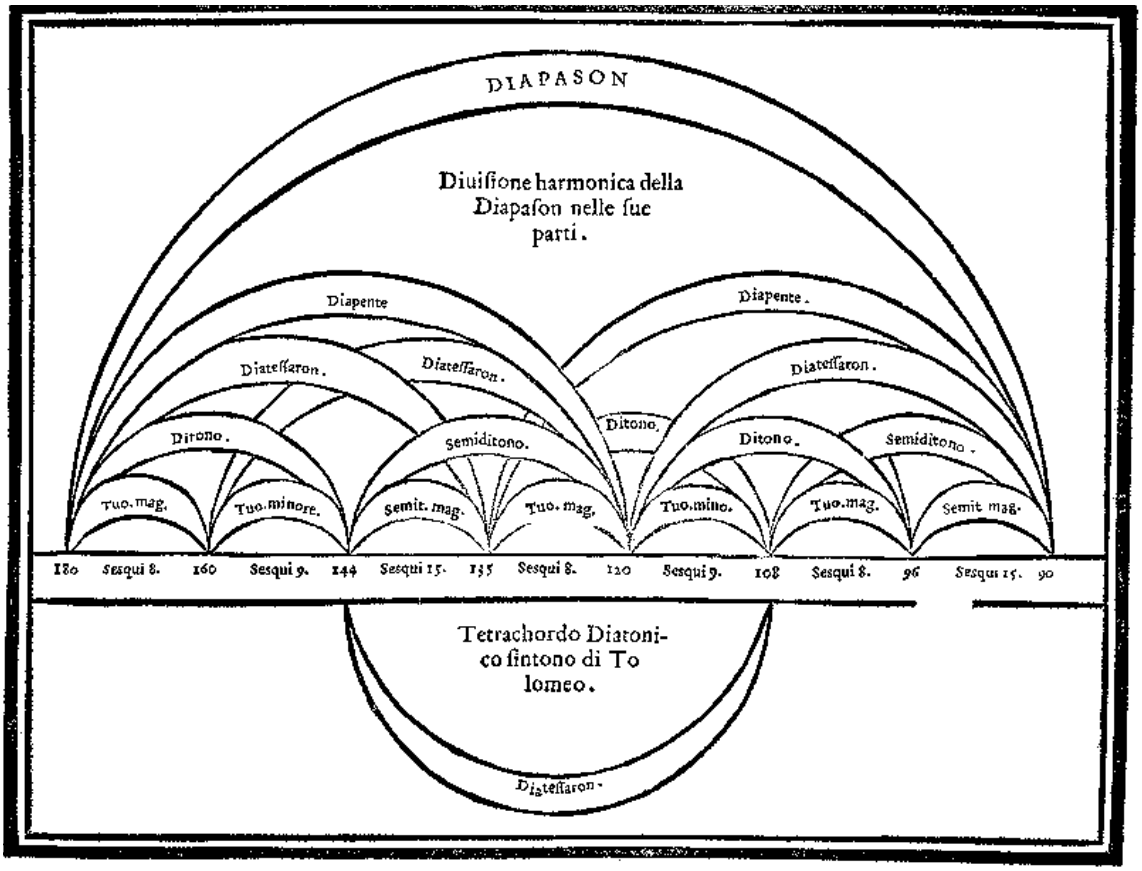

Figure 6. "Harmonic Division of the Octave in its Parts" from Zarlino, *Istitutioni* II.39, 122.

If pitches were to be applied to this octave, it would represent a scale from C to c with no sharps or flats. After determining the sizes for all of the intervals in the octave, Zarlino then adds Ptolemy's Syntonic diatonic tetrachord: it sits right in the middle of the diagram, seemingly holding the octave together. Zarlino's harmonically divided octave represents the perfect synthesis of ancient authority and modern practical concerns. On the one hand, it is derived from Ptolemy, whose geocentric model of the universe was still revered in university and theological contexts. For practitioners, on the other hand, Zarlino's system purportedly described the intervals used in polyphonic vocal music, without the obvious contradictions that were found in Ramis's and others' monochord

divisions. Furthermore, because the *Istitutioni* was written in Italian, it was more easily comprehended by those without an academic background.

The harmonically divided octave also gave Zarlino the impetus to reorder the common modal system. Theorists had traditionally described a modal order that began with a scale that outlined the D-to-d octave species. Zarlino himself had referred to the D–d scale as mode 1 in the first printing of the *Istitutioni*.[117] In the fifth Discussion of the *Dimostrationi*, however, Zarlino reordered his twelve modes and defended his innovation: "having shown in the *Istitutioni*, that from the harmonic division of the octave in its parts—insofar as the nature of the thing behaves—is born an order of intervals . . . clearly comprised so that the octave, divided according the nature of the harmonic number, is collocated among the modern strings: C. D. E. F. G. a. b. and c."[118] Not satisfied with a purely theoretical view of modal order, Zarlino also noted that by starting the modal sequence on C, or the solmization syllable *ut*, the basic order of pitches, C, D, E, F, etc. was in line with the order of solmization syllables, *ut, re, mi*, *fa*, etc., formulated five hundred years earlier by Guido of Arezzo.[119]

Following Ptolemy's preference for simplicity and Fogliano's monochord division, Zarlino's Syntonic tuning system consists almost entirely of intervals that can

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[117] Zarlino, *Istitutioni* IV.18, 320. Although most sixteenth-century theorists listed the modes by traditional Greek names, Dorian, Phrygian, Lydian, etc., Zarlino, aware that modern scales were quite different from those of the ancients, referred to each mode only by number.

[118] Zarlino, *Dimostrationi* V.def.8, 270-71: "hauendo dimostrato nelle Istitutioni: che dalla Diuisione harmonicamente fatta della Diapason nelle sue parti: per quanto comporta la natura della cosa; nasce uno ordine de interualli: . . . chiaramente compresi, che tale Diapason: diuisa secondo la natura del Numero harmonico: è collocata tra le nostre moderne chorde C. D. E. F. G. a. [b natural]. c." For a discussion of Zarlino's reordering of the modes, see Richard Crocker, "Why Did Zarlino Re-number the Modes?" *Rivista italiana di musicologia* 3 (1968): 48-58; reprinted in *Studies in Medieval Music Theory and the Medieval Sequence* (Aldershot: Ashgate, 1997), XI. Crocker wisely confutes scholars who seek the origins of tonality in sixteenth-century music theory. Edward Lowinsky, in particular, saw Zarlino's reordering as a significant sign that modal theory was getting closer to tonality. See Edward Lowinsky, *Tonality and Atonality in Sixteenth Century Music* (Berkeley: University of California Press, 1961), 35.

[119] Zarlino V.def.8, *Dimostrationi*, 271.

be represented by superparticular ratios. Table 1 compares the Syntonic intervals with the Pythagorean tuning system.

Table 1. Comparison of Syntonic and Pythagorean Intervals.

Syntonic			Pythagorean		
Interval	Ratio	Cents	Interval	Ratio	Cents
Octave	2:1	1200.0	Octave	2:1	1200.0
Major sixth	5:3	884.4	Major hexachord	27:16	905.9
Minor sixth	8:5	813.7	Minor hexachord	128:81	792.2
Fifth	3:2	701.9	Fifth	3:2	701.9
Fourth	4:3	498.0	Fourth	4:3	498.0
Major third	5:4	386.3	Ditone	81:64	407.8
Minor third	6:5	315.6	Semiditone	32:27	294.1
Major tone	9:8	203.9	Tone	9:8	203.9
Minor tone	10:9	182.4			
Major semitone	16:15	111.7	Semitone	256:243	90.2
Minor semitone	25:24	70.7			
Comma	81:80	21.5	Comma	531441:524288	23.5

In each system, the perfect consonances are identical, but in the Syntonic system, the major thirds and sixths are smaller than the ditone and major hexachord, while the minor thirds and sixths are somewhat larger than their counterparts in the Pythagorean system. In both cases, the Syntonic thirds and sixths will sound more consonant in vocal polyphony.

Zarlino's inclusion of thirds and sixths as imperfect consonances was certainly acceptable to contemporary practitioners, but the ratios that represented these intervals did not fit into the Pythagorean quaternary.[120] Zarlino was a secular priest and certainly did not place his spiritual faith in the number 4. But unlike his predecessors, such as Ramis de Pareia, he was diligent enough to defend his new theory of consonances from the attacks of Pythagoreans. Because the larger term of the ratio of the minor third was 6, he needed to establish the number 6 and the *senario* as equally fundamental to existence as the number 4 and the *quaternario* had been to the Pythagoreans. He does this in Part I,

[120] See pp. 21-23 *supra*.

chapter 14 of the *Istitutioni*, noting six errant bodies in the heavens, Plato's six directions, Aristotle's six types of motion, God's six days of creation, and many other similitudes.[121] The minor sixth, with its 8:5 ratio, does not fit into Zarlino's *senario*, but he justifies its place as a consonance through division of the minor sixth into its parts: 8:5 can be divided into 24:18:15, and the inner terms form a perfect fourth (4:3) and a minor third (6:5), both of which are contained within the *senario.* Zarlino's Syntonic tuning, as well as his reworking of the modal system and thorough explanation of counterpoint, led to a reputation that rivaled Boethius in late-sixteenth- and seventeenth-century music theory.

Thus, Zarlino's greatest achievement lay in his ability to appropriate existing musical systems—from ancient and modern writers—and present them in a broader philosophical context. By communicating theoretical ideas such as tuning systems and the laws of counterpoint in layers of authoritative prose and Neoplatonic notions of certainty, he reinforced his readers' worldviews. The great renown of his treatises was no doubt partially dependent upon these traits.

Vincenzo Galilei and the Florentine Tradition

Vincenzo Galilei came from a noble Florentine family whose economic fortunes had declined before the sixteenth century. Chiara Orsini notes that Vincenzo's grandfather Giovanni had relocated from Florence to the small Pisano community S. Maria a Monte because he could not cover all of his debts.[122] After the Galilei family had

[121] Zarlino, *Istitutioni* I.14, 23-24.

[122] Chiara Orsini, "Vincenzo Galilei (1520? – 1591): La professione di un 'musico pratico e teorico, tra aspirazioni e realtà," in *Vincenzo Galilei: Atti del convegno di studi svoltosi nell'Aprile 1987 presso la Biblioteca Comunale*, ed. Donata Bertoldi and Renzo Cresti (Pontedera: Bandecchi & Vivaldi, 1988), 91. In addition to this article, biographical information on Galilei can be found in idem, "Vincenzo Galilei," *Il Fronimo* 16 (January 1988): 7-28. Further material is found in Fabio Fano, *La camerata fiorentina*: *Vincenzo Galilei (1520?-1591); La sua opera d'artista e di teorico come espressione di nuove*

given up their lands in Florence, Vincenzo's father helped stabilize the family's finances by marrying the daughter of a wealthy landowner in S. Maria a Monte.[123] The loss of prestige, however, seemed to affect Vincenzo's outlook, and after a lifetime of working on and off as wool merchant while trying to further his music career, he expressed some bitterness over his financial situation. Responding to epithets that were directed at him by Zarlino, Galilei complained:

> Among all the others, the one naming me "fortunate" suits me least, considering that except for nobility, I was born without any other chance for good things of Fortune herself. In addition, until now, the labors done by me in regard to music to show that I am not useless to the world have been done more often to begrudge than to bring me some profit. And because of the expenses that happened in printing it, instead of some comfort, they have continuously brought me greater discomfort.[124]

Galilei certainly maintained a lifelong grievance, and it may have influenced his polemical stance against his successful adversary Gioseffo Zarlino as well as authority in general.

Scholars agree that Galilei was born in S. Maria a Monte, but no one has been able to verify the year. Fabio Fano suggested that he was born around 1520, but Palisca and more recently Philippe Canguilhem have placed the date closer to 1530.[125] At some

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idealità musicali (Milano: Edizioni Ricordi, 1934), xxii-xxxiii. The most substantial account of Galilei's life can be read in Philippe Canguilhem, *Fronimo de Vincenzo Galilei*, Collection "Épitome musical," no. [9] (Paris: Minerve, 2001), 17-44.

[123] Orsini, "Vincenzo Galilei (1520?-1591)," 8.

[124] Galilei, *Discorso,* 17-18: "e di tutti gli altri meno a me conuien quello del nominarmi fortunato. atteso che dalla nobiltà impoi, io nacqui senz'altra sorte di beni di essa fortuna. le fatiche in oltre fin ad hora da me fatte intorno alla Musica per mostrarmi non inutile al mondo mi hanno fatto più tosto inuidiare che portomi alcuna vtilità. e mediante le spese occorse nello stamparle, hannomi in vece di alcun comodo, portomi del continouo incomodo maggiore." Galilei also mentions his poor financial situation in the prefatory material of his *Intavolature de lauto . . . libro primo* (Rome: Valerio Dorico, 1563), dedicated to Alessandro de' Medici. See Canguilhem, *Fronimo*, 20.

[125] Canguilhem suggests three reasons for the later date: (1) Galilei was married in 1562, and it is more likely that he married around age 30 than age 40; (2) a letter from Guidobaldi del Monte to Galileo Galilei (dated 22 February 1592) after the death of his father notes that "he did not appear so old to me";

point in the 1540s, Vincenzo moved to Florence to continue his musical studies. Though he was not financially independent, young Galilei benefitted from the patronage of an old family friend, Giovanni de' Bardi, Count of Vernio. Bardi descended from one of the most prominent families in Florence. In fact, one of his ancestors, Simone dei Bardi, was the husband of Bice Portinari, later immortalized as Dante's "Beatrice."[126] A true Renaissance man, Bardi excelled in classical Greek and Latin, was an accomplished military commander, and even composed a treatise on soccer.[127] Bardi encouraged and funded Vincenzo's music training and also introduced him to the intellectual elites of Florence. Galilei acknowledged his debt in the dedication to Bardi that precedes the *Dialogo della musica antica, et della moderna*:

> Therefore, how could I minimally recompense you for the means you provided me to pursue with tranquility those studies to which from my first years I dedicated myself and which, without your help, I could not have brought to the present conclusion? To this, I must add your readiness in bringing from the most remote parts of Europe at my request various books and instruments, without which it would have been impossible to have the knowledge of music that we have by their means, so that this science has become, through me, much clearer to the world than perhaps it has been since its loss.[128]

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and (3) Vincenzo himself said that when he composed his dialogue *Il Fronimo* (1586), he was still a young man. See Canguilhem, *Fronimo*, 18.

[126] Dante Alighieri, *The Divine Comedy*, 3 vols., trans. Mark Musa (New York: Penguin Classics, 2002), 1:16, 19.

[127] Claude V. Palisca, "Bardi, Giovanni de', Count of Vernio," in *The New Grove Dictionary of Music and Musicians*, ed. Stanley Sadie and John Tyrrell, 2d ed., 29 vols. (London: Macmillan, 2001), 2:719. Bardi's treatise on soccer was dedicated to Ferdinand I de' Medici, Grand Duke of Tuscany. See Giovanni de' Bardi, *Sopra il givoco del calcio fiorentino. Del Puro Accademico Alterato* (Florence: Giunti, 1580).

[128] Galilei, *Dialogo*, 2r: "percioche come potrei io pure in minima parte ricompensare le comodità che ella mi ha date di potere con quieto animo attendere à quelli studij a'quali da primi anni mi diedi, et che senza l'aiuto suo non hauerei condotti in quel termine nel quale hora si ritrouano? à che si aggiugne la prontezza dell'animo suo in far venire ad instanza mia, dalle piu lontane parti d'Europa varij libri et instrumenti, senza i quali impossibile era potere della Musica quella notizia hauere che mediante quelli habbiamo; et acciò questa scienza si mostrasse per me al monda assai piu chiara di quello che forse dopo la sua perdita." Unless noted otherwise, all translations of Galilei's *Dialogo* are from Vincenzo Galilei, *Dialogue on Ancient and Modern Music*, trans. with introduction and notes by Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 2003), in the present case, from p. 3.

As he praises Bardi, Galilei also expresses a common cliché of Renaissance writers. Noting the "loss" of musical science suggests that the true knowledge of the ancient Greeks was obscured for centuries during the "barbaric" Middle Ages. The "myth of the golden age" is a commonplace in the writings of Francesco Petrarch, Desiderius Erasmus, and particularly among Florentine humanists. In Galilei's treatises, the "golden age" theory is particularly interesting because he proposes that Renaissance polyphony is just a continuation of medieval compositional practices.[129] Thus, Northern European polyphonic music as perfected by Adrian Willaert and championed by Zarlino certainly did not represent for Galilei a historical peak of musical practice.[130]

With Bardi's assistance, Galilei traveled to Venice around 1563. Little is known about his sojourn except that a principal reason for his visit was to continue his musical studies with Zarlino at St. Mark's. After returning to Tuscany, Galilei established his residence in S. Maria a Monte where it is believed that he ran a small school for lute students.[131] There is almost no information as to the nature of Galilei's lessons with Zarlino, yet in 1572, while living under Bardi's patronage again in Florence, Vincenzo began work on a *Compendio di tehorica* [*sic*] (Compendium of Theory) based entirely on Zarlino's *Istitutioni*.[132] It seems Galilei's intention was to compose a brief epitome of the *Istitutioni*, inasmuch as most of the material is directly copied from Zarlino's treatise, although many words are respelled in Florentine dialect. Galilei may have planned to publish the *Compendio* for Bardi and his associates, but whether he was trying to pay

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[129] See chapter 3, 173-76 *infra*.

[130] Galilei, *Dialogo*, 37; *Dialogue*, 95. Galilei credits Guido of Arezzo with the invention of counterpoint and pejoratively compares polyphonic composition to the manner in which medieval geomancers divined their prophesies.

[131] Canguilhem suggests that Galilei's clientele came primarily from the University of Pisa, noting that Gasparo Torello, author of a dedicatory poem that appears in the first edition of the *Fronimo* (Venice, 1568) taught law at the University. See Canguilhem, *Fronimo*, 20-21.

[132] Vincenzo Galilei, "Compendio di Tehorica [*sic*] della musica," **I**-Fn, Gal. 4.

homage to Zarlino or simply print this material under his own name is unclear. He never mentions Zarlino in the text and even recasts statements in the first person as if they were his own words. For example, figure 7 shows parallel passages from Zarlino's printed *Istitutioni* and the manuscript of Galilei's "Compendio." The words are drawn from Zarlino's discussion of the modes and refer to local musical practices in ancient Greece. The underlined text in both examples reads: "It seems to me that such variety could be born from the variety of customs in a region."

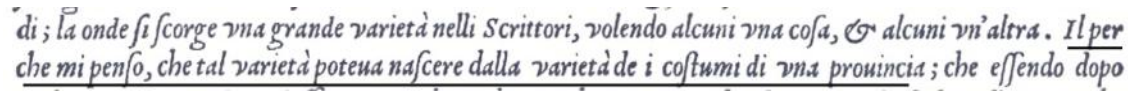
di; la onde ſi ſcorge vna grande varietà nelli Scrittori, volendo alcuni vna coſa, & alcuni vn'altra. Il per
che mi penſo, che tal varietà poteua naſcere dalla varietà de i coſtumi di vna prouincia; che eſſendo dopo

Figure 7a. Passage from Zarlino, *Istitutioni* IV.5, 304.

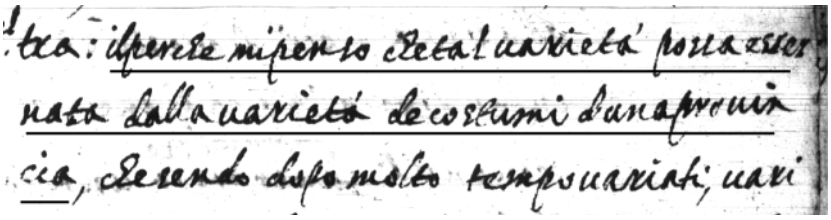
tra: ilperche mi penso che tal varietà possa esser
nata dalla varietà de costumi d'una prouin
cia, essendo dopo molto tempo variati, vari

Figure 7b. Same passage from Galilei, "Compendio di Tehorica," f. 36r.

Palisca notes that the compendium breaks off during a discussion of the modes, for it seems that Galilei was unable to reconcile Zarlino's ideas with those he was finding in other writers.[133] The manuscript shows that Galilei tried to complete the *Compendio* by integrating the ideas of other authors but eventually gave up. In time, the prose is replaced with a variety of study notes, mathematical equations, and many doubts. Some of these notes must have been composed several years after Galilei first began the *Compendio*, for he mentions a discourse he has already written. We must assume that Galilei is referring to the anonymous discourse that he sent to Zarlino in 1578.[134] Except

[133] A description of the manuscript is found in Palisca's introduction to his translation of the *Dialogo*. See Galilei, *Dialogue*, xxiii-xxv.

[134] Galilei, *Compendio*, f. 41r-v: "One should note that the semitone one finds in the Syntonic diatonic monochord is contained among these numbers: 135:128. That comes to be the minor semitone of

for a few fragments that appear in Zarlino's *Sopplimenti musicali*, the contents of the 1578 discourse are unknown.

Galilei was wise to not publish the *Compendio*. Throughout his debate with Zarlino, he continually blames his former teacher for stealing his own ideas, accusations he could never have justified if this *Compendio* had been printed. From the text of the *Compendio*, we also learn that in 1570 Galilei was not yet the expert in music theory he claimed to be in the *Dialogo* of 1581. He had already published *Il Fronimo*, a dialogue that taught the principles of intabulation of vocal music for the lute in 1568. But the acumen he showed in arranging music for the lute is nowhere to be found in his first attempt at a music theory treatise. Nor do we find the antagonistic tone of his later writings.[135] Considered in hindsight, the drafting of the *Compendio* was an intellectual exercise for Galilei. The attempt to reconcile Zarlino's teachings with other sources led him to study ancient music theory more deeply, setting him on a path to his radical stance against polyphonic music.

Galilei and the Florentine Academies

Through Bardi and his associates, Galilei made the acquaintance of members of Florence's intellectual elite, and although he was never a member of the local academies, Galilei was certainly influenced by their politics. In Galilei's Florence, the prominent

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the major tone following what I said in my *Discorso* [È da notare che'l semituono che si troua nel monocordo diatonico sintono è contenuto tra questi numeri 135.128. che viene a essere il minor semituono del Tuon'maggiore secondo ch io ho detto nel mio discorso]."

[135] Howard Mayer Brown, in assessing Galilei's *Intavolature di lauto* (1563), his first printed collection of lute music, suggests that it was produced "before [Galilei] had begun to think about the aesthetic and historical problems that later became the focal point of the Camerata's attention." See Howard Mayer Brown, "Vincenzo Galilei in Rome: His First Book of Lute Music (1563) and Its Cultural Context," in *Music and Science in the Age of Galileo*, ed. Victor Coehlo, The University of Western Ontario Series in Philosophy of Science, no. 51 (Dordrecht: Kluwer Academic Publishers, 1992), 153.

literary academy was the *Accademia degli Umidi* (Academy of the Moist), which formed in 1540. As the epithet "Umidi" suggests, it was created as a response to the Paduan *Accademia degli Infiammati* (Academy of the Enflamed).[136] Like the *Infiammati* and the *Accademia Venetiana della Fama*, members of the *Umidi* intended to produce translations of Greek and Latin texts in the vernacular. Paduan and Venetian scholars, however, were influenced by Pietro Bembo, who advocated the adoption of Francesco Petrarch's prose and the poetry of Boccaccio as models for a unified Italian language. Although the Florentines appreciated Bembo's preference for Tuscan literature, many felt that spoken and written Italian should reflect the language used in contemporary Tuscany and not a historicized dialect from the past.

Within a few months of the founding of the *Accademia degli Umidi*, Cosimo I, Grand Duke of Tuscany, took control of it and changed the name to the *Accademia Fiorentina*.[137] Cosimo was particularly concerned with expanding Medici control over Tuscan lands, and he knew that promotion of a unified Tuscan dialect would facilitate his political goals. In addition to changing the name, he moved the Academy into a public location and added many members who were sympathetic to the Medici.

The academic competition over Italian dialects played a role in late Renaissance musical polemics. Zarlino's *Sopplimenti* and Galilei's *Discorso* are filled with quotations from each other's writings, yet neither ever reprints text in the original dialect. In adapting prose to a new dialect, both writers occasionally change the syntax of a phrase. Some of these alterations are immaterial, but others create suspicious changes of mood or

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[136] For information on the origins of the *Accademia Fiorentina*, see Michael Sherberg, "The Accademia Fiorentina and the Question of the Language: The Politics of Theory in Ducal Florence," *Renaissance Quarterly* 56 (Spring 2003): 26-30.

[137] Ibid., 27.

meaning. Galilei takes special offense at seeing his prose modified, noting that Zarlino "translates my mother tongue, Florentine, into Bergamasque."[138] In his study of polemics about language in the *Accademia Fiorentina*, Michael Sherberg notes that Bergamasque was "often invoked as a stereotype for rustic, illiterate speech." Galilei may also be alluding to Carlo Lenzoni's *In difesa della lingua fiorentina*. Lenzoni was admitted to the *Accademia Fiorentina* during Cosimo's reform of the organization. In the *Difesa*, he warns that the Florentines must codify their language and be watchful over any attempts to change it: "And if we Florentines sleep on it in the future, as was done in the past, it will become ruined in such a way that it will no longer be able justly to be called Florentine, but . . . Bergamasque."[139]

In turning the *Accademia Fiorentina* into a political institution, Cosimo marginalized many original members of the *Umidi* who eventually created a new academy in 1569. The *Accademia degli Alterati* sought a private environment that was divorced from "power politics."[140] Among the *Alterati*, the most venerable scholar was Piero Vettori (1499–1585), a rigorous humanist and staunch foe of the Medici. Vettori did not actually attend meetings of the academy. Nevertheless, he served as an honorary member and is listed in the register with the nickname *L'assicurato* (the assured).[141] His

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[138] Galiei, *Discorso*, 63: "la lingua materna mia fiorentina, la traduce in Bergamasca."

[139] Carlo Lenzoni, *In difesa della lingua fiorentina* (Florence: Lorenzo Torrentino, 1556), 8: "E se noi Fiorentini ce la dormiamo per l'avvernire, come si è fatto per il passato, ella si andrà guastando in maniera che giustamente non potrà dirsi poi Fiorentina ma . . . Bergamasca."; quoted and translated in Sherberg, "The Accademia Fiorentina," 37. Lenzoni's attack was directed at northern reformers, such as Pietro Bembo, whose ideas influenced Zarlino's views on dialects. In *The Book of the Courtier*, Castiglione's interlocutor, Federico Fregoso, also refers to Bergamasque as a faulty antithesis to the Florentine dialect. See Castiglione, *The Book of the Courtier*, 52.

[140] Gaspare De Caro, *Euridice: Momenti dell'umanesimo civile fiorentino* (Bologna: Ut Orpheus Edizioni, 2006), 78: "Un connotato sicuramente distintivo dell'Accademia degli Alterati rispetto all'Accademia Fiorentina fu il suo carattere privato, la sua formale indipendenza dal potere politico."

[141] Domenico Maria Manni, *Memorie della fiorentina famosa Accademia degli Alterati* (Florence: Giovanni Battista Stecchi, 1748), 17. On Vettori's association with the *Alterati*, see De Caro, *Euridice*, 81-93.

reputation as an ardent proponent of republican values legitimized the anti-authoritarian stance of the Academy, while his educational pedigree suggested that the Academy was part of a distinctly Florentine, intellectual tradition.[142] Several of his students were also members of the Academy, including Galilei's mentor Girolamo Mei. When Vettori's interpretation of Aristotle's *Poetics* was attacked by the Archbishop Alessandro Piccolomini, the same scholar who was associated with the *Accademia della Fama* and the crisis over mathematical certitude, Mei and other members of the Academy rose up in his support. [143]

Although removed from Medicean politics, the *Alterati* continued the literary debates begun by the *Umidi*: they focused on poetics (especially as they relate to Aristotle's treatment of the subject), theoretical matters, and the judgment of specific authors and works.[144] In addition to literary topics, the *Alterati* distinguished itself from other Florentine academies of the time through its interest in all the arts and sciences. Lectures on music took place at the Academy, and Galilei's patron Giovanni de' Bardi and Ottavio Rinuccini, librettist of *Dafne*, the first opera, were members.[145]

Galilei benefitted from his association with members of the *Alterati* when he needed help resolving the doubts that arose while attempting to reconcile his *Compendio*

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[142] Claude Palisca notes that Vettori frequented the early *cinquecento* academy of Francesco di Zanobi Cattani da Diacceto, who claimed to be the intellectual successor to Marsilio Ficino. See Claude V. Palisca, "Girolamo Mei: Mentor to the Florentine Camerata," *Musical Quarterly* 40 (January 1954): 7.

[143] De Caro, *Euridice*, 82. The extent to which the polemics between Piccolomini and Vettori may have influenced later acrimony between Zarlino and Galilei is unclear.

[144] Bernard Weinberg, "The Accademia degli Alterati and Literary Taste from 1570-1600," *Italica* 31 (December 1954): 208.

[145] Claude V. Palisca, "The Alterati of Florence, Pioneers in the Theory of Dramatic Music," in *New Looks at Italian Opera: Essays in Honor of Donald J. Grout*, ed. William W. Austin (Ithaca, NY: Cornell University Press, 1968; reprint, Westport, CT: Greenwood Press, 1976), 12, 14. Palisca notes that music became a more acceptable topic for the *Alterati* after one member, Giulio del Bene, suggested that music be included among the trivial arts: rhetoric, logic, and grammar, and removed from its traditional place in the quadrivium.

with other sources. He probably made contact with Girolamo Mei through Bardi.[146] In 1572, when Galilei was working on the *Compendio*, Mei was working in Rome under the patronage of the Cardinal Giovanni Ricci da Montepulciano and had access to more or less the entire corpus of ancient music theory, including the codices of Greek authors owned by Fulvio Orsini and Alberto Pio di Carpi.[147] In addition, Mei had access to multiple copies of Ptolemy's *Harmonics* and Aristoxenus's *Elementa Rhythmica.*

Mei offered Galilei more than a thorough knowledge of ancient music theory. Zarlino's use of the ancients was tied to contemporary polyphonic music and structured to co-exist with his theological beliefs. Even Zarlino's contemporary sources, such as Heinrich Glarean's *Dodecachordon* (Basle, 1547), interpret ancient sources in an effort to defend contemporary musical and liturgical practices.[148] Mei, on the other hand, admitted a poor knowledge of contemporary music, and he approached the ancient sources as a pure classicist, primarily with the desire to understand ancient Greek theater and to revive Aristotle's *Poetics*.[149]

In 1566, Mei began writing a treatise on the modes (*De modis musicis*) in which he planned to explain the various different ancient modal systems and the extent to which

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[146] According to Mei's first letter to Galilei, Vincenzo was also recommended by Pirro del Bene, another member of the *Alterati*, and "Messer Damiano." See Palisca, *Florentine Camerata*, 56.

[147] Restani, *L'itinerario,* 40-41. Orsini's collection included writings by Bryennius, Aristides Quintilianus, "Bellerman's Anonymous," Pseudo-Bacchus, and the three Hymns of Mesomedes, among others. A brief history of the Pio codex (Modena, Biblioteca Estense e Universitaria, gr. 173 [α.V.7.1]) is found in Mei, *Letters,* 61.

[148] Glarean's treatise, from which Zarlino appropriated his 12-mode system, defends the traditional, liturgical practice of the Catholic religion. Glarean was writing as a northern Catholic humanist in the wake of the Protestant Reformation. Although Zarlino does not acknowledge Glarean as the author of his modal system, he tacitly accepts Glarean's interpretation of the sources. For an examination of Glarean and the cultural context of the *Dodecachordon*, see Sarah Fuller, "Defending the *Dodecachordon*: Ideological Currents in Glarean's Modal Theory," *Journal of the American Musicological Society* 49 (Summer 1996): 191-224.

[149] Palisca, "Girolamo Mei," 8-9, 19. Palisca notes that Mei's approach to music theory stems from his mentor Piero Vettori, who wanted to revive Aristotle's *Poetics* as a "living document of criticism."

they had become deformed by modern musicians. Mei concluded, moreover, that modern musicians could not produce any of the effects allegedly achieved by ancient musicians.[150] Mei was free from any need to justify a particular musical practice or theory and was able to provide Galilei with the information to attack Zarlino's systems as artificial or at least not true to antiquity.

Galilei's letters to Mei are not extant, but in Mei's first letter to Galilei (8 May 1572), many of the questions he answered correspond to those written down by Galilei in the first few folios of the manuscript that contains the *Compendio*.[151] Mei's research led Galilei to oppose Zarlino's most basic teachings. In his first letter, Mei discussed at length that ancient compositions were monophonic and that the legendary affective power of ancient music was produced through the contrasts of high-, intermediate-, and low-pitched melodies or fast and slow rhythms. In modern polyphony, on the other hand, the joining of different melodies at various pitch levels negated any potential for powerful effects. Mei called polyphony a "supreme hindrance in moving the soul to any affection" and questioned Galilei's assumption that the purpose of music is to delight the ears.[152] The latter complaint is an indirect criticism of Zarlino's definition of music, which Galilei probably paraphrased in his letter to Mei. At the conclusion of the letter, Mei lists Zarlino's *Istitutioni* among his vernacular sources. His reference to the

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[150] Girolamo Mei, letter to Piero Vettori dated 2 August 1566; quoted in Restani, *L'itinerario*, 47-48.

[151] Palisca, *Florentine Camerata*, 51-55. Palisca provides a concordance between the questions notated by Galilei in the *Compendio* manuscript and Mei's response in his letter dated 8 May 1572.

[152] Ibid., 62, 73; Girolamo Mei, "Letter to Vincenzo Galilei," Rome, Biblioteca Apostolica Vaticana, Regina lat. 2021, ff. 18r, 23r; transcribed in *Letters*, 97, 115: "sommo impedimento à commovere l'animo ad affezzione alcuna."

"modern" practice of numbering the modes instead of calling them by their ancient names (Dorian, Phrygian, etc.) also indicates that he was familiar with Zarlino's work.[153]

The most important facet of Mei's communication with Galilei was his suspicion that modern musicians did not sing the Syntonic tetrachord as described by Ptolemy in his *Harmonics*. In Mei's first letter, he does not seem to be aware of Zarlino's illustration of the Syntonic tetrachord because he mentions only the monochord divisions of Guido of Arezzo, Franchino Gaffurio, and Heinrich Glarean.[154] In a later epistle (22 November 1577), Mei helps Galilei distinguish between the Syntonic tetrachords of Didymus and Ptolemy, while noting that he has not read Zarlino's writings on the Syntonic.[155] Finally, in a letter dated 17 January 1578, Mei suggests that if Galilei should stretch two strings on a lute and tune the frets of one string to the Syntonic and the other to the Diatonic, whichever corresponds to actual musical practice would have to be the tetrachord that is sung.[156]

Whether or not the experiment worked, we must recognize Mei's recommendation as a unique approach to solving problems in sixteenth-century music theory. Empirical observation was rejected outright by Boethius and treated with suspicion by Ptolemy. Zarlino had already solved the "tuning problem" through natural philosophy and mathematics. Whether or not Galilei tried out Mei's experiment, he did

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[153] Palisca, *Florentine Camerata*, 66, 77. Mei, "Letter to Vincenzo Galilei," Rome, Biblioteca Apostolica Vaticana, Regina lat. 2021, ff. 20v, 24v, transcribed in *Letters*, 105, 122.

[154] Palisca, *Florentine Camerata*, 68; Mei, "Letter to Vincenzo Galilei," Rome, Biblioteca Apostolica Vaticana, Regina lat. 2021, f. 21r; transcribed in *Letters*, 107. For Zarlino's demonstration of the Syntonic tetrachord, see pp. 57-64 *supra*.

[155] Mei, "Letter to Vincenzo Galilei," Rome, Biblioteca Apostolica Vaticana, Regina lat. 2021, f. 43r-v; transcribed in *Letters*, 122-25.

[156] Mei, "Letter to Vincenzo Galilei," Rome, Biblioteca Apostolica Vaticana, Regina lat. 2021, f. 48v; transcribed in *Letters*, 140.

integrate empirical evidence into his writings.[157] Furthermore, Galilei's "experimental" methods are more significant in his debate with Zarlino than the actual results of the experiment.

Mei claimed to have written "more than thirty lengthy letters" to Galilei, but only six are extant.[158] Galilei relayed the information to the members of Bardi's famous *Camerata*, while formulating his own arguments against Zarlino. Because Mei provided much of the research for Galilei's polemical writings, scholars have challenged the worth of Galilei's writings. Nino Pirrotta, for one, noted that Galilei "cuts a poor figure as a theorist, and has nothing, or next to nothing, original to say."[159] Galilei's originality, however, lay not in his theoretical ideas but in the manner that he taught them to his audience. He recognized that his patrons and readers were not university scholars or scientists but musical amateurs and participants in the Florentine salons.

We can ascertain the interests of Galilei's readership with evidence from his treatises. Aside from Bardi's *Camerata*, he was patronized by Jacopo Corsi, another wealthy amateur musician who hosted informal music academies and sought out Galilei

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[157] Scholars have argued over whether or not Galilei actually performed any of the experiments he describes in the *Dialogo*, *Discorso*, or other unpublished essays. D. P. Walker finds that Galilei's own writings contradict the evidence that he would have produced if he had done the experiments. See D[aniel] P[ickering] Walker, "Vincenzo Galilei and Zarlino," in *Studies in Musical Science in the Late Renaissance*, Studies of the Warburg Institute, ed. J. B. Trapp, vol. 37 (London: Warburg Institute, 1978), 24. Stillman Drake, on the other hand, finds Galilei's *Discorso* to be of the "greatest interest with respect to the beginning of experimental science" and speculates that the young Galileo was probably with his father in Florence, witnessing these experiments. See Stillman Drake, "Renaissance Music and Experimental Science," in *Essays on Galileo and the History and Philosophy of Science*, 3 vols., selected and introduced by Noel Swerdlow and T. H. Levere (Toronto: University of Toronto Press, 1999), 3:202, 204.

[158] Girolamo Mei, "Letter to Gian Vincenzo Pinelli," Milan, Biblioteca Ambrosiana, S. 105. sup., f. 74r; transcribed in Sanvito, "Le sperimentazioni," 318.

[159] Nino Pirrotta, "Temperaments and Tendencies in the Florentine Camerata," trans. Nigel Fortune, *Musical Quarterly* 40 (April 1954): 172.

for lute lessons.[160] Galilei acknowledges his patron's interest in theory and practice in his dedicatory letter to Corsi, published in the 1584 edition of the dialogue *Fronimo*:

> Wishing to publish it for the above reason, it seemed to me suitable to dedicate it to Your Excellency, not only to show you how fresh is my memory of the many courtesies you have shown me on divers occasions and the desire I have to serve you, but to agree perfectly with that part of your studies concerned with the science and practice of music. In this Dialogue are many of the things which you, by your own request, have heard from me, and many others which you wanted to hear and study, as you will clearly see in reading it.[161]

In Galilei's dialogues, the personages express their interest in also discussing instrumental music. In the *Dialogo*, the interlocutor Piero Strozzi (1550–1609) is pleased to learn about the different sizes of intervals: "This struck me as a new and grateful speculation, one that I have wanted many times to hear, not only on account of counterpoint, but of keyboard instruments."[162] Just as the personages in Zarlino's *Dimostrationi* enthusiastically discussed geometric proofs and the *Mesolabio*, the characters in Galilei's *Dialogo* want to hear about "artificial" instruments and musical practice.

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[160] For information on the patron Jacopo Corsi, see Tim Carter, "Music and Patronage in the Late Sixteenth-Century: The Case of Jacopo Corsi (1561-1602)," *I Tatti Studies: Essays in the Renaissance* 1 (1985): 57-104. Carter suggests that Corsi participated in Bardi's *Camerata* and later hosted concerts of new music.

[161] Vincenzo Galilei, *Fronimo: 1584,* trans. and ed. by Carol MacClintock, Musicological Studies and Documents, vol. 39 (Neuhausen-Stuttgart: American Institute of Musicology, 1985), 15. A transcription of the dedication appears on p. 14: "volendo per il detto et altri rispetti darlo alla Stampa, m'è paruto conueniente il dedicarlo A Vostra Sublimità non solo per mostrarle la memoria ch'io tengo delle molte cortesie che in diuersi tempi ho da lei riceuute, et il desiderio che ho di seruirla, ma per confarsi grandemente con quella parte de suoi studij, che tendono alla Scienza, e Prattica della Musica, nel qual Dialogo, sono molte delle cose che lei ha da me (a sua richiesta) vdite, et molte altre di quelle ch'ella desidera a vdire et intendere, come in leggendolo potrà sensatamente vedere."

[162] Galilei, *Dialogo*, 9: "Questa mi è bene stata vna nuova et grata speculatione, la quale ho piu volte desiderata intendere, non tanto per la cosa del Contrapunto, quanto per lo strumento di tasti"; trans. in *Dialogue*, 30.

Galilei's "Practical" Demonstration of 4/7 Comma Temperament

In her study of the Renaissance dialogue, Virginia Cox notes that a *cinquecento* dialogue on any subject might tell us "what kind of people possess this information and what kind might want to acquire it."[163] Considering the interlocutors of Galilei's *Dialogo*, Count Bardi and Piero Strozzi, we can assume that wealthy amateur musicians possess or are desirous of possessing the knowledge the publication imparts. Bardi and Strozzi are more concerned with solving theoretical problems through practical means than with the philosophical proofs provided by Zarlino in the *Istitutioni* and *Dimostrationi*. For example, when Strozzi inquires about tuning keyboard instruments, Bardi suggests they step over to a keyboard and work directly on the instrument.[164] He first asks Strozzi to tune the keys to the Pythagorean intervals so that they may hear all of the dissonant imperfect consonances. When Strozzi admits that the tuning sounds horrible, Bardi insists that the dissonances are caused simply because the whole tones are too large and the semitones are too small. In order to create consonant thirds and sixths, he suggests the individual tones and semitones be tempered.[165]

Galilei then suggests a system of temperament that adheres closely to the 2/7 comma temperament described by Zarlino in the *Istitutioni*.[166] The principal difference

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[163] Virginia Cox, *The Renaissance Dialogue: Literary Dialogue in Its Social and Political Contexts, Castiglione to Galileo*, Cambridge Studies in Renaissance Literature and Culture, ed. Stephen Orgel, no. 2 (Cambridge: Cambridge University Press, 1992), 6.

[164] The following is paraphrased from the *Dialogo*, 32-33; *Dialogue*, 82-87.

[165] Galilei was not the first theorist to describe a "practical approach to temperament." As Mark Lindley has shown, Arnolt Schlick (1511), Pietro Aaron (1523), and Giovanni Maria Lanfranco (1533) presented temperament systems in vernacular treatises. Galilei's explanation of the 4/7 comma temperament is unique in that, following Zarlino, he implies a precise measurement to the practical demonstration. See Mark Lindley, "Early 16th-Century Keyboard Temperaments," *Musica disciplina* 28 (1974): 129-51.

[166] Zarlino, *Istitutioni* II.43, 128-29. Rudolph Rasch notes that Zarlino was the first to describe temperament in systematic terms, yet he claims Zarlino's system had no "practical significance." See

between the two systems is the order in which intervals are tempered. Both Zarlino and Galilei start from an unchanging octave, but whereas Zarlino first shortens each fifth by 2/7 of a comma, Galilei begins by modifying each of the smaller intervals (tones and semitones), which results in alterations to the larger intervals.

In a manner similar to his explanation of the Syntonic tuning system, Zarlino illustrates his method of temperament on a monochord, rather than demonstrating it on an actual keyboard instrument. Acknowledging that all of the intervals, save for the octave and the semitone between B-flat and B-natural, need to be adjusted by divisions of the comma, Zarlino claims that because of these alterations, all of the changed intervals are now numerically irrational.[167] These irrational intervals are allowed in Zarlino's system because they were produced in an effort to adapt "artificial" instruments to the tuning system used by "natural" voices. Zarlino emphasizes the fundamental differences between notes made by voices (*voci*) and instruments (*suoni*) in his later writings. In fact, one of Galilei's important contributions to music theory is his rebuttal that there is no real distinction between the sounds made by voices and those made by "artificial" instruments.[168]

In observing Galilei's explanation of temperament, we can also note how he and Zarlino are influenced by different ancient sources. Just as Zarlino defended his tuning system as based on Ptolemy's "natural" Syntonic tetrachord, Galilei justified his temperament system by attributing its origin to an ancient writer, in this case

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Rudolph Rasch, "Tuning and Temperament," in *The Cambridge History of Western Music Theory*, ed. Thomas Christensen (Cambridge: Cambridge University Press), 202.

[167] Zarlino, *Istitutioni* II.43, 128. Zarlino notes that the semitone between B-flat and B-natural is found in the ratio 135:128. This admission is significant only because in the 1589 *Discorso* Galilei insists that Zarlino never mentions the existence of the 135:128 semitone in the *Istitutioni* or *Dimostrationi*. See Galilei, *Discorso*, 47.

[168] Walker, "Vincenzo Galilei and Zarlino," 19-20.

Aristoxenus.[169] Galilei was not the first theorist to turn to Aristoxenus in seeking a simpler method for understanding intervals, but he was the first to benefit from a modern, if faulty, translation of Aristoxenus by Antonio Gogava.[170] In his *Discorso*, Galilei suggests that Aristoxenus had many adherents and claims that he writes favorably about the maligned philosopher at the behest of his "Aristoxenian friends."[171]

In antiquity, Aristoxenus was vilified by the Pythagoreans and admonished by Ptolemy for his emphasis on empirical observation and, more specifically, for measuring musical intervals as discrete quantities. Unlike the Pythagoreans, who derived smaller intervals only from divisions of larger intervals, Aristoxenus was seen as positing that each semitone could be measured as a distinct number of particles.[172] Using this as a model, Galilei tempered his keyboard intervals by diminishing the whole tones and augmenting the semitones.

Using an F–f octave, Galilei subtracts 4/7 of the Syntonic comma from each tone and lengthens each semitone by 10/7 comma.[173] The tempering of the complete octave is illustrated in table 2.

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[169] Galilei (*Dialogue*, 86) begins his method of temperament by noting: "In order to do this, at present we principally follow the method of Aristoxenus"; *Dialogo,* 33: "per il che fare noi al presente, torremo principalmente secondo il modo d'Aristosseno."

[170] Palisca, "Aristoxenus Redeemed," 191-93. In the first half of the sixteenth century, theorists were dependent on secondary accounts of Aristoxenus in Ptolemy's *Harmonics* or other sources derived from Ptolemy.

[171] Galilei, *Discorso*, 109: "e diró in favor suo (poi che tale è il desiderio di alcuni Aristossenici amici miei) quanto mi sarà conceduto dalla capacità del mio intelletto."

[172] See pp. 25-28 *supra*.

[173] Refer to the table of Syntonic intervals on p. 63 *supra***.** The syntonic comma (81:80) is 21.5 cents; thus, 4/7 comma is equal to about 12.3 cents.

Table 2. Galilei's 4/7 comma temperament, as described in the *Dialogo della musica antica, et della moderna*, 33.[174]

Interval altered	Pitches[175]	Amt. of Comma	Total octave differential
Tone	F-G	- 4/7	- 4/7
Tone	G-a	- 4/7	- 8/7
Tone	a-b	- 4/7	- 12/7
Semitone	b-c	+ 10/7	- 2/7
Tone	c-d[176]	- 4/7	- 6/7
Tone	d-e	- 4/7	- 10/7
Semitone	e-f	+10/7	-0-

As the table illustrates, the deficit created by subtracting from the tones is added to the semitones. The octave itself remains unchanged, but after adjusting the first four intervals, the perfect fifth F–c is shortened by 2/7 comma, and that small remainder is carried over to the perfect fourth c–f. Thus, the diapente and diatessaron are adjusted by the same amount as in Zarlino's 2/7 temperament. In addition, because each semitone is lengthened by more than twice the amount subtracted from each tone, the major thirds and sixths are smaller, and the minor thirds and sixths are somewhat larger than their counterparts in the untempered scale.

Galilei's demonstration of keyboard temperament appears to be a practical demonstration. But was it really possible for even an expert keyboardist to flatten a string by 4/7ths of a comma? Or did musicians simply use their ears to judge the correct size of intervals? Galilei would later defend his explanation of temperament by noting that he was only trying to show some gentlemen the difference between one and the other system (the Pythagorean and the 4/7 comma temperament) without the use of a geometrical

[174] Galilei, *Dialogue*, 86.

[175] Galilei specifies the octave by using solmization syllables.

[176] At this point in the explanation, Palisca misreads Galilei, translating it as "it will be useful to lower this c sol fa ut six-sevenths [4/7 for the tone C-D plus 2/7 remainder from the fifth F-C] of a comma." The original text reads "abbassarlo sei Settime parti d'vn Comma." The pronoun "-lo" must refer to d la sol. See Galilei, *Dialogue*, 86.

diagram or a monochord.[177] Certainly his method would have appealed to his patrons who were more interested in playing instruments than drawing diagrams.

In comparing Zarlino's explanation of Syntonic tuning with Galilei's demonstration of temperament, significant similarities and differences in their methods become evident (table 3).

Table 3. Competing Methodologies in Zarlino's *Le istitutioni harmoniche* and Galilei's *Dialogo della musica moderna, et della antica.*

	Zarlino (Syntonic tuning)	Galilei (keyboard temperament)
Modern source:	L. Fogliano, *Musica theorica*	G. Zarlino *Le istitutioni harmoniche*
Ancient authority:	Claudius Ptolemy	Aristoxenus
Methodology:	Natural philosophy	Practical demonstration

Zarlino took Fogliano's monochord division, justified its preeminence through Ptolemy's Syntonic diatonic tetrachord, and explained its derivation through natural philosophy. Galilei, in explaining keyboard temperament, reworked a system first described by Zarlino himself in the *Istitutioni*.[178] Galilei then justified the tempering of individual tones and semitones through the authority of Aristoxenus and explained its application through a practical demonstration on the keyboard. This simple comparison emphasizes the notion that although there are fundamental differences between the theories of Zarlino and Galilei, in some instances, each theorist is more distinct in his proposed methodology than in the content of his message.[179]

[177] See fn. 63 *supra*.

[178] Zarlino did not invent temperament, but he was the first to quantify it through divisions of the Syntonic comma. See Zarlino, *Istitutioni* II.43, 128-30.

[179] D. P. Walker notes that Zarlino and Galilei "on the one hand, genuinely hated each other, and, on the other, may in fact agree on the main subject under discussion." See Walker, "Vincenzo Galilei and Zarlino," 14.

Galilei and Authority

Galilei incorporates an anti-authoritarian tone in the *Dialogo* that must have resonated with his audience. The interlocutor Piero Strozzi establishes this sentiment at the beginning of the *Dialogo*, demanding that Giovanni Bardi, the other interlocutor, allow him to speak freely:

> For it seems to me that those who, for the sake of proving some conclusion, want us to believe simply on the basis of authority without adducing valid arguments for it are doing something laughable, not to say (with the Philosopher) acting like silly fools. . . . I wish, further, that you agree to let me freely ask questions and to answer you without any sort of adulation, as suits those who search for the truth of things.[180]

That Galilei chose Piero Strozzi as one of his interlocutors may be read as an attempt to provoke controversy. Like Bardi, Strozzi was a wealthy, amateur musician. He participated in Bardi's *Camerata*, was close friend of Giulio Caccini, and even composed some music for Medici wedding festivities.[181] But the Strozzi family had quarreled with the Medici throughout the Renaissance. In the early fifteenth century, Piero's ancestor Palla di Nofri Strozzi was the leading banker in Florence. As Medici fortunes rose, Palla joined with anti-Medici families and was banished from the city in 1434.[182] One century later, Filippo Strozzi (born Giovan Battista, 1489–1538) also battled against the Medici. He was married to Clarice de' Medici, granddaughter of Lorenzo the Magnificent, and

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[180] Galilei, *Dialogo*, 2: "perche mi pare che faccino cosa ridicola (per non dire insieme col Filosofo, da stolti) quelli che per proua di qual si sia conclusione loro, vogliono, che si creda senz'altro alla semplice autorità; senza addurre di esse ragioni che valide siano . . . Voglio in oltre, che mi concediate, essermi lecito alla libera interrogarui, et risponderui senz'alcuna sorte d'adulatione, come veramente conuiene tra quelli che cercano la verità delle cose"; trans. in *Dialogue*, 12.

[181] Galilei, *Dialogue*, xxii.

[182] Lauro Martines, *April Blood: Florence and the Plot against the Medici* (Oxford: Oxford University Press, 2003), 39-40.

had accumulated great power and wealth through his ties with the Medici.[183] After sparring with Leopoldo and Alessandro de' Medici, Filippo and his son Piero (1510–1558) escaped to France. In 1537, Filippo formed an army with other Florentine exiles and marched against the Medici. Filippo was captured and committed suicide in prison, while Piero later defended Siena against Medici aggression before being mortally wounded in battle in 1558. Although the Piero Strozzi (1550–1609) of Bardi's *Camerata* is somewhat removed from these power struggles, his notorious family history resonates with his iconoclastic role in the *Dialogue*.

In addition to lending their names to the *Dialogo*, Bardi and Strozzi protected the contents of the treatise with their family coats of arms. The elaborate frontispiece of the *Dialogo* is not unique to this treatise, and we can note the importance of Galilei's patrons to the work by comparing earlier uses of the same image. Figure 8 shows the frontispiece of Cosimo Bartoli's Italian translation of Leon Battista Alberti's *L'Architettvra* (Venice, 1565). In the upper corners of the page are two goats holding Medici coats of arms. Two other family emblems are found on the bottom of the pillars.

[183] Filippo is remembered as both a staunch supporter of the Medici and one of their greatest foes. His rocky relationship with the ruling wing of the Medici, under Duke Alessandro de' Medici, ended after the death of Pope Clement VII (Giulio de' Medici) in 1534. For a book-length discussion on this topic, see Melissa Meriam Bullard, *Filippo Strozzi and the Medici: Favor and Finance in Sixteenth-Century Florence and Rome* (Cambridge: Cambridge University Press, 1980).

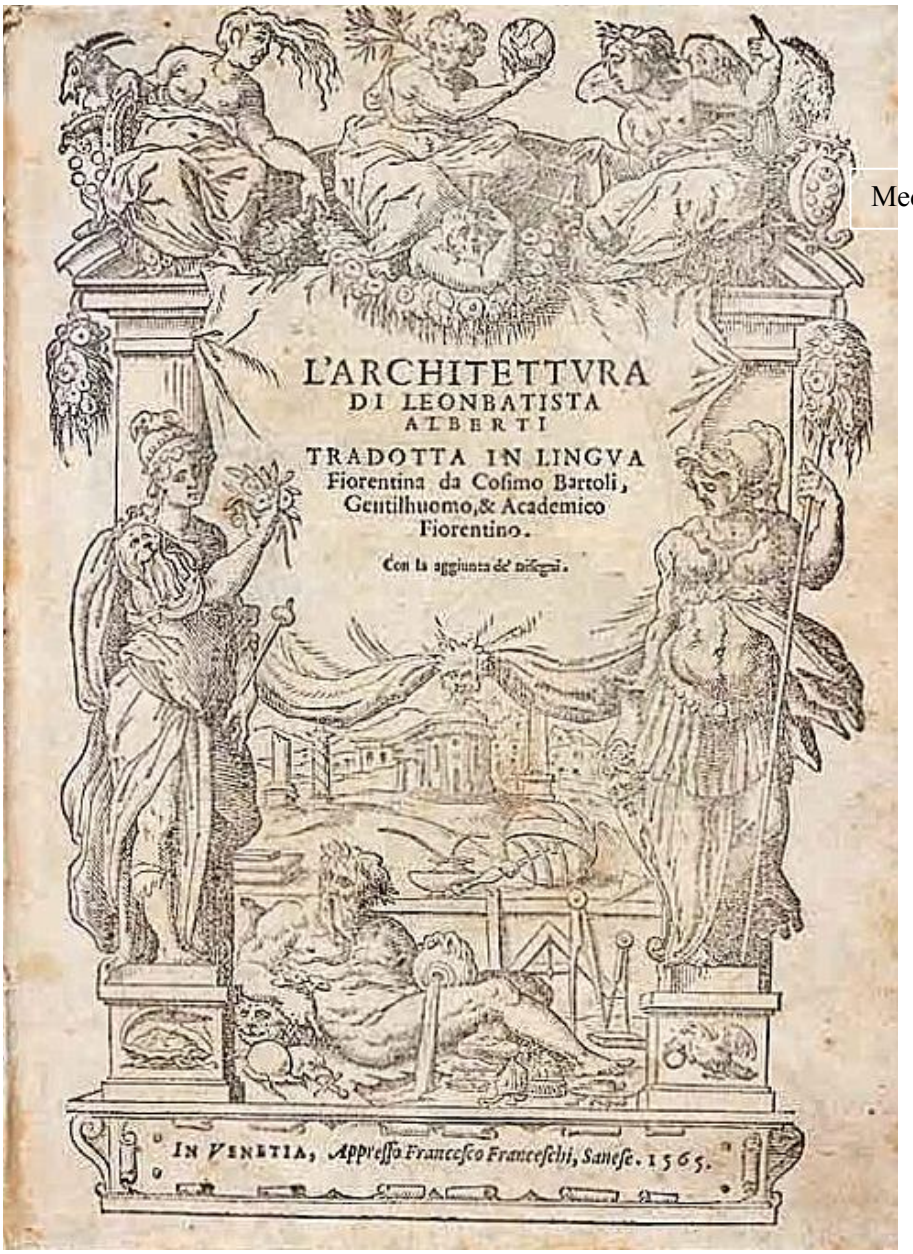

Figure 8. Frontispiece from Leon Battista Alberi, *L'Architettvra*, trans. Cosimo Bartoli (Venice: Francesco Franceschi, Sanese, 1565).

Figure 9 shows the frontispiece to Galilei's *Dialogo* printed seventeen years later.

Figure 9. Frontispiece from Galilei, *Dialogo*.

Thre are several differences between the two images: the allegorical figures are shown in reverse, the curtain is higher and the foliage is more pronounced in the later exemplar, and there are various smaller items not found in both images. Most notable,

however, is the disappearance of the Medici coats of arms at the top of the page and the addition of the Bardi and Strozzi arms at the bottom of the two pillars.

The anti-authoritarian nature of the *Dialogo* is reflected in Galilei's often abrasive style of discourse. Speaking of Galilei, Palisca suggests that the *Dialogo* "reveals a courteous and important corrector of Zarlino's theory."[184] Galilei does complement Zarlino on occasion: in the introduction to the *Dialogo*, he names Zarlino, Franchino Gaffurio, and Heinrich Glarean as "truly princes in this modern practice," although in this case he is only paraphrasing a quotation from Girolamo Mei's letter of 8 May 1572.[185] Throughout the *Dialogo*, however, Galilei ridicules his former teacher. The most audacious example of this lack of respect is found in the index. Galilei rarely includes more than one or two references for any item in the index. For this reason, the entry for "Zarlino's errors" (*Errori del Zarlino*) is quite conspicuous (figure 10).[186]

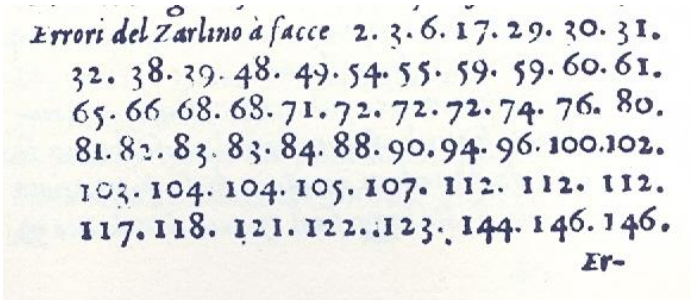
Errori del Zarlino à facce 2. 3. 6. 17. 29. 30. 31.
32. 38. 39. 48. 49. 54. 55. 59. 59. 60. 61.
65. 66 68. 68. 71. 72. 72. 72. 74. 76. 80.
81. 82. 83. 83. 84. 88. 90. 94. 96. 100. 102.
103. 104. 104. 105. 107. 112. 112. 112.
117. 118. 121. 122. 123. 144. 146. 146.
Er-

Figure 10. "Zarlino's Errors." Galilei, *Dialogo*, f. N5r.

The *Dialogo* contains many tacit references to Zarlino and his ideas. From the onset of theoretical discussions, Galilei's interlocutors refer to anonymous "modern

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[184] Galilei, *Dialogue*, xvii.

[185] Galilei, *Dialogo*, 1: "fin'à che il Gafurio prima, et appresso Glareano, et poscia il Zarlino (Principi veramente in questa moderna prattica)"; trans. in *Dialogue*, 7: "first Gaffurio, then Glarean, and finally Zarlino—truly princes in this modern practice." Compare to Mei's letter (*Letters*, 107): "Franchino et Glareano hanno come ogniuno sa in questa professione principi"; translated in Palisca, ed., *Florentine Camerata*, 68: "Franchino and Glarean—men who, as everyone knows, are princes in this profession."

[186] Because the *Dialogo* was printed in a large folio format with no table of contents or chapter divisions of any kind, we might assume that readers would often consult the index for various topics.

practitioners" who "make a profession of knowing" or sometimes just an indeterminate "they." Although the interlocutors do not always name the culprit, it may be inferred that Bardi and Strozzi are accusing Zarlino and his *Istitutioni* and *Dimostrationi* by the topics that are discussed. In the first section of the *Dialogo*, Galilei is committed to disproving Zarlino's notion that the Syntonic tetrachord is the tuning system used by modern singers. Later, he challenges the historical validity of the 12-mode system, also endorsed by Zarlino. Other subjects in the treatise are often drawn from passages in the *Istitutioni* that Galilei wants to disprove.

Zarlino and his allies took great offense at Galilei's arrogance and responded by never acknowledging that he was even capable of writing such a treatise. One particular theorist, the Bolognese canon Giovanni Maria Artusi, who actually agreed with Galilei on many points, refused to credit him in the index to his 1598 *Art of Counterpoint*. Figure 11 shows part of the index from Artusi's treatise. On this page, he lists all of his sources for the treatise; between Giovanni del Lago and Ptolemy, Artusi includes "Scritti sotto nome di Vincentio Galilei" or "writings under the name Vincenzo Galilei" (figure 11).[187]

[187] It is surprising that Zarlino is not mentioned in the index. Giovanni Battista Doni joined Artusi in questioning Galilei's authorship. In his third discourse to Francesco Nigetti, he referred to the "celebrated dispute that reigned in the past era between Vincenzo Galilei, or rather those gentlemen who used his name, and Gioseffo Zarlino [celebre disputa, che regnò nell'età passata tra Vincenzio Galilei, o piuttosto tra quei Gentilhuomini, che si servirono del suo nome, e Gioseffo Zarlino]." See Giovanni Battista Doni, "Quale specie di diatonico si usasse dagli antichi, e quale oggi si pratichi, Discorso terzo al Signor Francesco Nigetti," in *Lyra Barberina*, ed. Antonio Francesco Gori and Giovanni Battista Passeri, 2 vols. (Florence: Typis Caesareis, 1763; reprint in Bibliotheca musica bononiensis, II/151, Bologna: Forni, 1974), 1:365. In a second anonymous letter to Zarlino, Galilei included an anonymous discourse by a "very learned gentleman [Gentil'huomo assai ben dotto]," which argued against any ancient basis for Zarlino's interpretation of the Syntonic. The discourse was probably drawn from Mei's letters and certainly did not help Galilei's cause in proving his authorship of the *Dialogo*. A portion of the letter is quoted in Zarlino, *Sopplimenti* III.3, 93.

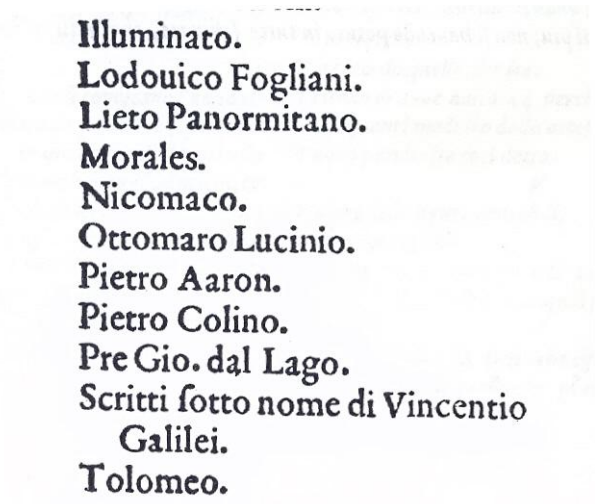
Illuminato.
Lodouico Fogliani.
Lieto Panormitano.
Morales.
Nicomaco.
Ottomaro Lucinio.
Pietro Aaron.
Pietro Colino.
Pre Gio. dal Lago.
Scritti ſotto nome di Vincentio
Galilei.
Tolomeo.

Figure 11. Excerpt from the index of Giovanni Maria Artusi, *Art of Counterpoint* (1598).

Whether or not Galilei is acknowledged as the author of the *Dialogo*, its effect on Italian music theory in the late *cinquecento* and beyond was quite substantial. The *Dialogo* revealed a formidable obstacle to the tidy synthesis of theory and practice advocated by Zarlino and his followers. In addition to the authors who actively participated in the debate (Giovanni Maria Artusi, Ercole Bottrigari, etc.), many later theorists took a side in the matter, supporting Zarlino or Galilei. Zarlino himself was certainly taken aback by the *Dialogo* and possibly tried to delay or permanently obstruct its publication. Unable to do so, he sought to purge Galilei's musical "heresies" with a third, compendious publication.

Chapter 2

Heretics and Music Theory in the *Sopplimenti musicali*

Purpose and Design

The *Sopplimenti musicali* (or Musical Supplements) was published in 1588, as the third part of a multi-volume collection of Zarlino's writings. The set included reprints of the *Istitutioni* and *Dimostrationi harmoniche*, as well as several moral and scientific writings: the *Treatise on Patience*, a *Discourse on the True Year and the True Day in Which Our Lord Jesus Christ Was Crucified,* essays on the *Origin of the Capuchin Order of Friars*, and calendar reform. The religious nature of these non-musical writings mirrors a pious, counter-reformation aesthetic that can also be traced in the *Sopplimenti*. The *Sopplimenti* itself encompasses more than the debate with Galilei, although the dispute is featured in several parts of the treatise, and many of Zarlino's points are centered on reactions to Galilei's *Dialogo*.

Zarlino briefly describes the contents of the *Sopplimenti* on its title page: "Musical Supplements in which many things contained in the first two volumes [that is, the *Istitutioni* and *Dimostrationi*] are explained for being poorly understood by many, and a response is made to their lies."[1] Although Zarlino suggests he is defending himself against many detractors, in the preface to Book I he quotes a letter that he received from a single, dissatisfied student. Zarlino never acknowledges that it was Galilei who wrote the

[1] Gioseffo Zarlino, *Sopplimenti musicali*, (Venice: Francesco de' Franceschi Senese, 1588; reprint in Monuments of Music and Music Literature in Facsimile, II/15, New York: Broude Brothers, 1979), f. a1r: "Sopplimenti mvsicali . . . Ne i quali si dichiarano molte cose contenute nei Due primi Volumi, delle Istitutioni e Dimostrationi; per essere state mal'intese da molti; e si risponde insieme alle loro Calonnie."

letter, but in the 1589 *Discorso*, Galilei acknowledges that the epistle came from him.[2] Most of Zarlino's defense applies to the *Dialogo*, yet Zarlino also reacts to the *De musica* (Salamanca, 1577) of Francisco de Salinas and other unnamed critics. Like Galilei, Salinas sought to understand Greek music theory on its own terms, without having to defend modern practice. Zarlino took note of Salinas's many objections to his own work and includes an entry in his index that cites the many places where "Francisco de Salinas disparages the author beside the point."[3]

The form of the *Sopplimenti* is similar to that of the *Istitutioni*: the treatise is divided into a series of parts or Books, which are subdivided into chapters. This generic arrangement is typical of academic treatises, but the overall content of the *Sopplimenti*, that is, Zarlino's defense of the material already published in the *Istitutioni* and *Dimostrationi*, suggests that the work may also be viewed as an apology. Apologetic writings were common in Greek antiquity and in the early Christian church, but in this case Zarlino may be emulating the scholastic St. Thomas Aquinas,[4] who sought to prove God's existence through a synthesis of theology and Aristotelian philosophy.[5] Zarlino, likewise, defends his theoretical systems as a fact of nature and, furthermore, a gift from God. To this end, he counters Galilei's arguments with a broader explanation of his first

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[2] Vincenzo Galilei, *Discorso intorno all'opere di Messer Gioseffo Zarlino di Chioggia* (Florence: Marescotti, 1589; reprint in Collezione di trattati e musiche antiche edite in facsimile, Milan: Bollettino bibliografico musicale, 1933), 14.

[3] Zarlino, *Sopplimenti* index*,* f. Ff4v: "Francesco Salines [*sic*] tassa l'Autore fuori di proposito." Bernadino Baldi, who supposedly knew Zarlino, claims that Salinas and not Galilei is Zarlino's principal target in the *Sopplimenti*. The many quotations from the *Dialogo* that fill the pages of the *Sopplimenti* suggest otherwise. See Bernardino Baldi, *Vite inedite di matematici italiani*, ed. Enrico Narducci (Rome: Tip. delle scienze matimatiche e fisiche, 1887), 170.

[4] Although Zarlino does not cite Aquinas in the *Istitutioni* or *Dimostrationi*, a disctinct Thomist influence is apparent throughout his musical writings. For a comprehensive account of Zarlino's indebtedness to Aquinas, see Chadwick Jenkins, "*Ridotta alla perfettione*: Metaphysics and History in the Music-Theoretical Writings of Giovanni Maria Artusi" (Ph.D. dissertation, Columbia University, 2007).

[5] For a summary of Aquinas's views on music, see Herbert M. Schueller, *The Idea of Music: An Introduction to Musical Aesthetics in Antiquity and the Middle Ages*, Early Drama, Art, and Music Monograph Series, vol. 9 (Kalamazoo, MI: Medieval Institute Publications, 1988), 382-88.

principles (Book I) and detailed discussions of specific topics in which he reconciles material from the *Istitutioni* and *Dimostrationi* with ancient texts that have recently become available and with modern sources, including Galilei's *Dialogo*.[6] The influence of Aquinas's ideas are also evident in Zarlino's general distaste for musical innovation and his emphasis on vision and hearing as the most important of the five senses.[7]

The authorial tone of the *Sopplimenti* is far removed from that of the *Dimostrationi*. Whereas in the earlier work Zarlino cast himself as the great humanist-scholar and an important figure in the Serene Republic of Venice, in the *Sopplimenti* he appears as a religious reformer, aiming to stamp out rising heresy in musical science. Zarlino's common use of third person plural when speaking of Galilei also intimates that he is speaking of a multitude of detractors.[8] Recognizing Zarlino's defensive stance, Don Harrán suggests that he comes off as a "somewhat tragic figure" (*figura alquanto tragica*) combating Galilei and a changing musical environment in which his teachings are losing their authority.[9]

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[6] Don Harrán proposes that we consider the *Dialogo* as an important source for the *Sopplimenti*. See Don Harrán, "Sulla genesi della famosa disputa fra Gioseffo Zarlino e Vincenzo Galilei," *Nuova rivista musicale italiana*, 21 (1987): 468, 470.

[7] Schueller, *The Idea of Music*, 382-83. Zarlino avers that music, in his time, is in a state of perfection, and that nothing new can be added to it. See Zarlino, *Sopplimenti* I.3, 16. Zarlino's student Giovanni Maria Artusi would later use the same argument in contesting the contrapuntal innovations of Claudio Monterverdi. See Giovani Maria Artusi, *Seconda parte dell'Artvsi* (Venice: Giacomo Vincenti, 1603; reprint in Bibliotheca musica bononiensis, II/36, Bologna: Forni, 2000). Zarlino discusses hearing and vision as the "highest senses" in the *Sopplimenti* I.12, 35, but the passage is drawn completely from Ptolemy's *Harmonics* (III.3).

[8] Zarlino also speaks of Galilei in the third person as a way of not crediting his rival with writing the *Dialogo* on his own. The "plural" references to Galilei also intensify Zarlino's rhetoric; see pp. 99-101 *infra*. In the *Discorso* (p. 14), Galilei responds that the *Dialogo* is "my labor, my work, my invention without any other man than I having any part of it. . . . whoever says otherwise says a lie [mia fatica, mia opera, mia inuenzione, senz' hauerui parte alcuna altr' huomo di me. . . . e quello che altramente dice, dice la bugia]." Galilei's and Zarlino's incessant defense of their orginality is disingenuous in that both borrow freely from other writers.

[9] Harrán, "Sulla genesi della famosa disputa," 468, 470.

The Dedication

The *Sopplimenti* is dedicated to Pope Sixtus V (reigned 1585-1590), and just as Zarlino had compared the Doge Mocenigo to the great emperors of Rome in the dedicatory letter of his *Dimostrationi*, Sixtus is associated with a counterpart from the ancient past, Pope Leo I. Leo the Great, who served the Holy See from 440-461 C.E., ardently condemned the Christian sects of Nestorius and Eutychus as heretics.[10] Zarlino draws several parallels between the ancient Leo I and the modern Sixtus V, noting that the latter is the "great defender and solicitous avenger against the unjust and like a sun that at its appearance expels the wicked darkness of the unjust, he purges the clouds of the depraved heretics who fight against the light of the Holy Spirit."[11] He also praises Pope Sixtus for his authority, given by Christ, and for his charitable and civic acts.

In the *Sopplimenti*, it seems that heresy is also responsible for the opposition shown towards Zarlino's theoretical systems. A discussion of the *Mesolabio*, which Zarlino had already introduced in the *Istitutioni* and *Dimostrationi*, prompts an explanation as to why this device is so essential to understanding music: "I am inclined to believe that perhaps the Lord God desired that I give perfection to this thing, since [my ideas] should have aroused certain heretics (so to speak) in this profession who would have denied that one could find such true and natural forms through a series."[12] Later, in the sixth book (on the modes), Zarlino again accuses Galilei of heresy for misinterpreting

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[10] *Liber pontificales*, translated and edited by Louise Ropes Roomis, Records of Civilization: Sources and Studies, vol. 1 (New York: Columbia University Press, 1916), 97-99.

[11] Zarlino, *Sopplimenti* ded., f. a2v. "Massimo difensore, e solecito uendicatore contra l'Ingiusto; e come un Sole, ch'al suo apparir scaccia le inique tenebre dell'Ingiusto; purga le nebbie delle Heretiche prauità, che si contrapongono al lume dello Spirito santo."

[12] Ibid. III.3, 88: "e crederó, che forse Iddio Nostro Signor habbia uoluto ch'io dessi perfettione à questa cosa; poscia che doueano suscitare in questa professione alcuni (diró cosi) Heretici, c'haurebbono [ne]gato il potersi ritrouar cotali Forme per ordine, che fussero uere & naturali"; translation in Jane Piper Clendinning, "Zarlino and the Helicon of Ptolemy: A Translation with Commentary of Book III, Chapter III of Gioseffo Zarlino's *Sopplimenti Musicali*," *Theoria: Historical Aspects of Music Theory* 2 (1987): 45.

the holy scriptures when arguing about the number of modes used in music: "Now in respect to this, they do like the heretics, who, when speaking of anything, take the authority of the holy scriptures and the most holy Catholic doctors (truncated and imperfect) to conclude in their favor."[13]

On other occasions, Zarlino refrains from accusations of heresy and only invites Galilei to recognize his sinful ways. In the *Dialogo*, Galilei ridicules Zarlino's explanation of the use of the compass in measuring circles.[14] Zarlino argues that Galilei has completely misunderstood the process by which circles are measured and notes that Galilei needs to "have patience and do penance at times for his sins and other displays of ignorance."[15]

Having established the importance of fighting heresy, Zarlino continues his dedication by noting that justice must be tempered with prudence. For an example, he cites St. Ambrose's excommunication of the Roman emperor Theodosius I (reigned 378-395) in 390 C.E. "for having cut the Thessalonians to pieces."[16] Like Leo I, Theodosius was also a staunch foe of heresy, and under the influence of Ambrose he sought to rid the Roman Empire of all forms of paganism.[17] After the massacre at Thessalonica, which was ordered when one of Theodosius's Governors was murdered, Ambrose barred the

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[13] Zarlino, *Sopplimenti* VI.1, 243: "Hora in questo proposito fanno costoro, come fanno gli Heretici, che quando parlano d'alcuna cosa, pigliano, per concludere in lor fauore, l'autorità della Santa Scrittura, e de Santissimi Dottori Catholici tronche et imperfette."

[14] Vincenzo Galilei, *Dialogo della musica antica, et della moderna* (Florence: Marescotti, 1582; reprint in Monuments of Music and Music Literature in Facsimile, II/20, New York: Broude Brothers, 1967), 49. Galilei is referring to a passage in Zarlino's *Istitutioni*. See Gioseffo Zarlino, *Le istitutioni harmoniche* I.14 (Venice: [by the author], 1558; reprint in Monuments of Music and Music Literature in Facsimile, II/1, New York: Broude Brothers, 1965), 24.

[15] Zarlino, *Sopplimenti* IV.29, 206: "hauer patienza, e far la penitenza alle fiate de i peccati e delle ignoranze altrui."

[16] Ibid., f. a3r: "per hauer fatto tagliar à pezzi quelli di Tessalonica."

[17] In 380 C.E., Theodosius decreed "We command that persons who follow this rule [i.e. the nature of the Holy Trinity] shall embrace the name of Catholic Christians. The rest, however, whom We judge demented and insane, shall carry the infamy of heretical dogmas." See Stephen Williams and Gerard Friell, *Theodosius: The Empire at Bay* (New Haven, CT: Yale University Press, 1994), 53.

Emperor from the church and enforced months of penance. Theodosius's zealous defense of Christianity ultimately saved him from Ambrose's ire, although Ambrose wanted the emperor to learn that "justice is that which embraces all and cannot be distant from prudence."[18] This lesson may have been edifying to the Pope, but the rhetoric was aimed at Galilei. In the *Dialogo*, Galilei mentions Zarlino by name on many occasions, accusing him of many errors and abuses. Even if his criticisms were justified, it is probable that Zarlino was hurt by the lack of respect shown from a former student. Throughout the *Sopplimenti*, Zarlino criticizes Galilei for his arrogance. By relating the story of Theodosius and Ambrose's appeal to prudence, he is warning Galilei that his invective is not acceptable and that it is especially inappropriate for a student to act in such a manner towards a former teacher.

An Ancient Model for the *Sopplimenti*

If the tone of the *Sopplimenti* is far removed from that of the *Dimostrationi*, Zarlino is consistent in his practice of modeling his modern literary works on the formal structures of ancient writers. The *Dimostrationi*, with its sets of definitions, postulates, and theorems, is certainly inspired by Euclid's *Elements*. Zarlino may have intended the *Sopplimenti* to be modeled on Euclid as well, although he was actually emulating another source. After the first Book regarding first principles, Books II-VIII follow Aristoxenus's seven parts of harmonics in the same order found in Cleonides' *Harmonic Introduction*

[18] Ambrose of Milan, *De Abraham patriarchis*, Book II, chapter 10; quoted in Zarlino, *Sopplimenti* ded., f. a3v. "Giustitia è quella, che le abbraccia tutte; e non può star lontana dalla Prudenza."

(table 4). Zarlino quotes his source, in Greek and Italian, at the beginning of six Books but names Euclid as the author.[19]

Table 4. Gioseffo Zarlino, *Sopplimenti musicali*, content of Books I-VIII.

I.	First Principles	pp. 1-42
II.	Notes	43-81
III.	Intervals	81-110
IV.	Genera	111-229
V.	Scales	230-239
VI.	Tonoi	240-268
VII.	Mutation	269-275
VIII.	Melopoeia	276-330

The true author of the *Introduction* is one of the many peripheral arguments that fill the *Sopplimenti*, and Zarlino takes Galilei to task for questioning Euclid's authorship.[20] Galilei was uncertain about the matter, for on p. 35 of the *Dialogo* he refers to Euclid as the author but later questions the attribution.[21] This was not a debate of

[19] The seven parts of harmonics originated in Aristoxenus's *Elementa harmonica*. The organization of Aristoxenus's treatise may be found, with commentary, in Thomas J. Mathiesen, *Apollo's Lyre: Greek Music and Music Theory in Antiquity and the Middle Ages*, Publications of the Center for the History of Music Theory and Literature, vol. 2 (Lincoln: University of Nebraska Press, 1999), 319-34. Zarlino copied the order of topics as they appear in the treatise now commonly attributed to Cleonides. See Cleonides, "Harmonic Introduction," trans. Oliver Strunk and Thomas J. Mathiesen, in *Source Readings in Music History*, ed. Oliver Strunk, rev. ed., ed. Leo Treitler (New York: Norton, 1988), 36. In the first chapter of Books III-VIII, Zarlino states the definition of each topic exactly as it appears in Cleonides' *Harmonic Introduction*. In Books IV-VIII, Zarlino credits Euclid with the definition because he thought the treatise was by Euclid.

[20] Zarlino, *Sopplimenti* VI.5, 256-57. Scholars debated the authorship of the *Harmonic Introduction* in the Renaissance. Mathiesen (*Apollo's Lyre*, 367) supports Cleonides' authorship, citing the methodology of the treatise, which "does not seem especially 'Euclidean,'" and the fact that Cleonides is noted as the author in one of the earliest copies of the the work. To defend Euclid as the author, Zarlino cites the scholarship of Ioannes Pena, who published a Greek edition of the *Harmonic Introduction* and the *Division of a Canon* under Euclid's name in 1557. In addition, Zarlino notes that both Porphyry in his *Commentary on the* Harmonics *of Ptolemy* and Proclus in his *A Commentary on the First Book of Euclid's* Elements mention a work on music by Euclid. Inasmuch as Porphyry attributes the *Division of a Canon* to Euclid and Proclus does note a Euclidian work titled *Elements of Music*, it was reasonable for Zarlino to conclude in favor of Euclid's authorship of the *Introduction*. For the relevant passages in Porphyry and Proclus, see Ingemar Düring, *Porphyrios Kommentar zur Harmonielehre des Ptolemaios*, Göteborgs Högskolas Årsskrift, vol. 38, no. 2 (Göteborg: Elanders, 1932; reprint, New York: Garland, 1980), 92, 98; and *Proclus*, *A Commentary on the First Book of Euclid's* Elements, trans. with introduction and notes by Glenn R. Morrow (Princeton, NJ: Princeton University Press, 1970), 57.

[21] Galilei, *Dialogo*, 51: "et Euclide nell'Introduttorio che fa di Musica, dato però che egli sia suo"; trans. in Vincenzo Galilei, *Dialogue on Ancient and Modern Music*, trans. with introduction and notes by

significant importance, but it should be noted that Zarlino's affirmation of Euclid as the author of the *Introduction* would have placed it—in his view—in a Pythagorean context. Galilei, for his part, does not mention Cleonides in the *Dialogo*, although he may have known the work through Giorgio Valla's Latin translation, which gives Cleonides as the author; Girolamo Mei had also noted the alternate attribution in one of his letters to Galilei.[22] Galilei's inconsistency must have inspired Zarlino's discussion of the *Introduction*'s authorship in the *Sopplimenti*.

Whether or not Euclid was the author of the *Introduction* on which Zarlino based his treatment, the topical arrangement of Books II-VIII suggests that he is teaching the fundamentals of ancient music theory. In fact, though, each Book shows Zarlino entrenched in his own theories of modern musical performance. For example, in Cleonides' *Introduction* the entire discussion of the genera fills a mere few paragraphs. Book IV of Zarlino's *Sopplimenti*, on the other hand, is by far the longest section of the treatise. Zarlino does offer an overview of the different types of tetrachords described by Ptolemy, Didymus and others, but almost 100 pages of Book IV are dedicated to the defense of Syntonic tuning and a comprehensive attack on the temperament systems discussed in Galilei's *Dialogo.*

Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 2003), 124: "and Euclid—if the *Introduction on Music* is by him."

[22] *Cleonidae harmonicum introductorium, interprete Georgio Valla Placentino* (Venice: Simon Papiensis dictus Bevilaqua, 1497). On Mei's attribution, see Girolamo Mei, "Letter to Vincenzo Galilei," Rome, Biblioteca Apostolica Vaticana, Regina lat. 2021, f. 24v; transcribed in Claude V. Palisca, *Letters on Ancient and Modern Music to Vincenzo Galilei and Giovanni Bardi: A Study with Annotated Texts*, 2d ed., Musicological Studies and Documents, vol. 3 (Neuhausen-Stuttgart: American Institute of Musicology, 1977), 118; translated in Claude V. Palisca, *The Florentine Camerata: Documentary Studies and Translations*, Music Theory Translation Series (New Haven, CT: Yale University Press, 1989), 76.

Book I: First Principles

In the preface to Book I, Zarlino reminds us that no man can find perfection in either the operative or speculative arts "if not with the help of one or of many that were before him."[23] He mentions Aristotle, for example, who wrote that "one ought to render much thanks to the first inventors of things," and the ancient musician Timotheus of Miletus, who owed much to his predecessor Phrynis of Mitylene.[24] Of all the ancient musicians Zarlino could have cited, Timotheus is a provocative choice, for Zarlino certainly knew that Timotheus's brash innovations led to his expulsion from Sparta. In the *Cheiron* of Pherecrates (fifth century B.C.E.), a female allegorical representation of Music is asked by Justice to explain how she has been treated by modern composers. Using violent imagery, Music denotes the vicious treatment she has received from Melanippides and even Phrynis. But all were tolerable except for one musician:

> Music: But Oh, my dear! Timotheus buried and crushed me most shamefully!
> Justice: And who is this Timotheus?
> Music: A redhead from Miletus. I say he's caused me more woes than all the others put together, doing those perverted ant-crawlings. And when he finds me on a walk alone, he undoes me and pays me off with his twelve strings.[25]

For all his faults, Timotheus was still indebted to Phrynis, and Zarlino suggests that modern theorists should likewise show gratitude to him for his *Istitutioni* and *Dimostrationi*.

An ethical tone permeates the preface to Book I. Zarlino feels slighted by those, filled with "envy and ambition" (*Inuidia & Ambitione*), who show "little gratitude for the

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[23] Zarlino, *Sopplimenti* I.pref., 2: "se non con l'aiuto d'uno ò di molti, che siano stati prima di lui."

[24] See Aristotle, *Metaphysics* 2.1 (993b14-16). For information on Timotheus and Phrynis, see Mathiesen, *Apollo's Lyre*, 61, 65-71.

[25] Passage is quoted in the Plutarchan *De Musica* (1141d-1142a). See *Plutarchi Moralia VI 3*, ed. Konrat Ziegler (Leipzig: B. G. Teubner, 1966), 25.11-26.9; translated in *Apollo's Lyre*, 66-67.

work that I have done for public benefit."[26] Returning to ancient culture, he recalls the envy of Zoilus who slandered the legendary poet Homer, Didymus of Alexandria's and Gaius Asinius Pollio's great jealousy of the orator Cicero, and the Roman Emperor Hadrian, who destroyed bridges and gave away provinces that were acquired by his predecessor Trajan. Zarlino includes all of these examples of the destruction caused by envy in order to introduce the letter (mentioned above) by an unnamed disciple. A portion of this otherwise lost document is included in the *Sopplimenti*:

> Most great and reverend Lord, after the most excellent Cipriano de Rore departed from the service of this most Serene Republic, and you, reverend Lord, meritably succeeded in his place, I have never paid a visit, nor (for it truly did not occur to me) have I written to you, as behooves my obligation, not only for having been, a little before that time, your most obedient student both of counterpoint and also of many things pertaining to theory, even if in this and that, thanks to my neglect, I profited little.[27]

Zarlino claims to have been saddened by the remarks: after reading and re-reading the anonymous treatise that accompanied the letter, he agreed that Galilei had received little benefit from his studies in Venice.[28]

Zarlino laments the poor teachings found in the anonymous treatise and the insults that have been leveled against him in the *Dialogo*. Wanting to lead by example, he never mentions Galilei by name in the *Sopplimenti*, citing his rationale in the preface:

> But I did not want to make manifest the name of this author, for which no one should be surprised, for two reasons: first, because my intention has always been

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[26] Zarlino, *Sopplimenti* I.pref., 3: "poco grati delle fatiche ch'io ho fatto à publico beneficio."

[27] Ibid., 5-6: "Molto Magnifico e Reuerendo Signor mio; Dopoi che l'eccellentissimo Cipriano Rore partì del seruitio di cotesta Serenissima Repubblica e Vostro Signor Reuerendo meritamente successe in suo luogo, non l'hò mai presentialmente veduta, ne anco (per non mi essere veramente occorso) gli hò scritto, come conueniua all'obligo mio, non tanto per essere stato poco auanti al sudetto tempo, suo domestichissimo Scolare e di Contrapunto, et ancora di molte cose attenenti alla Theorica; se bene in questa, et in quella, mercè della mia trascuratezza, haueuo profitato poco."

[28] Ibid.: "Et veramente mi duole, ch'ei dica il uero, d'hauer fatto poco profitto; percioche hauendo letto & riletto il detto Trattato . . . egli si dichiara ueramente non essere stato mio Scolare." The anonymous treatise that accompanied Zarlino's letter was probably based on Girolamo Mei's letters to Galilei. See Galilei, *Dialogue*, xxvi.

> very far from what I am now forced to do, for the reason I have given. Second, so that no one should think that I have taken this burden because of a grudge I bear him or as a vendetta I have taken against him for all that he has spoken and written arrogantly against me by name.[29]

This show of pious decorum drew glowing praise from Zarlino's posthumous biographers.[30] Zarlino, however, was not above the use of insulting language, and his many references to "my loving disciple" (*il mio amoreuole discepolo*) were certainly intended to belittle Galilei. Because Zarlino refused to acknowledge that Galilei could even have written the *Dialogo* on his own, the omission of his name in the *Sopplimenti* adds to the lack of respect Galilei received from his rival. It was surely an odd predicament for an iconoclastic writer such as Galilei to be denied credit for his scabrous statements. By contrast, Zarlino does criticize Francisco de Salinas by name, but his attitude towards this fellow priest and organist is much less hostile than his demeanor towards Galilei.

The exclusion of Galilei's name from the *Sopplimenti* also underscores the reformist nature of the treatise. Zarlino had noted on the title page that he was writing the book to respond to many people who had misunderstood his earlier writings. By introducing more than one hundred quotations from Galilei's *Dialogo* with so many different epithets, Zarlino gives the illusion that he is besieged by not only his "loving

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[29] Zarlino, *Sopplimenti* I.pref., 6: "Non ho però uoluto manifestare il nome del sudetto Autore; delche niuno dee prender marauiglia, per due cagioni; prima, perche sempre hò hauuto intentione molto lontana da quello, che per la ragione c'ho detto, son'hora sforzato di fare; dopoi accioche alcuno non si pensasse, ch'io hauessi pigliato questo carico, per odio ch'io gli porti, ne per uendetta ch'io hauessi pigliare contra di lui di quanto egli habbia detto e scritto nominatamente et arrogantemente contra di me." Like Zarlino, Galilei often contends that he is "forced" to write new music-theoretical works in order to correct his opponent's publications.

[30] See Francesco Caffi, *Delle vita et delle opere del prete Gioseffo Zarlino: Maestro celeberrimo nella capella ducale di Venezia* (Venice: Giuseppe Orlandelli, 1836), 26: "one perceives the religious piety in him . . . [in] his delicacy in not wanting to ever reveal the name of that ungrateful student who worked so hard to dishonor him [Si scorge in essi la religiosa pietà . . . la sua dilicatezza nel non voler mai palesar il nome di quell'ingrato discepolo che tanto lavorava per disonorarlo]."

disciple" but also some "gentlemen," the "new censors," the "modern speculators," the "modern Aristoxenians," the "modern Aristarchians," the "Abachisti," and so forth.[31] The plural references are especially effective because they further deny a single author for the *Dialogo* while simultaneously implying that Zarlino is faced with an outbreak of musical heterodoxy. Just as the severe Pope Sixtus V cleansed Rome of brigands and street gangs, Zarlino sought to purify musical science from its many detractors. The reference to the Aristarchians is especially noteworthy because the astronomer Aristarchus of Samos (third century B.C.E.) had proposed a heliocentric model for the universe that was rejected in favor of the Ptolemaic model. It is ironic that Zarlino intends this as a critical reference to Galilei, considering the contemporaneous rise of the Copernican system and the astronomical breakthroughs to be achieved by Vincenzo's son Galileo.[32]

Zarlino himself was certainly frustrated at not being credited with the discovery of Syntonic tuning. In Book III of the *Sopplimenti* (on intervals), he digresses from the principal subject to discuss why he was moved to write that the Syntonic tetrachord of Ptolemy was sung and played in modern music rather than the Diatonic tetrachord attributed to the Pythagoreans. He recounts the manner in which he proved the validity of the Syntonic and the fear he experienced in presenting a new concept that was not previously explained by any ancient or modern writer.[33] That his contribution was significant, Zarlino claims, is confirmed even by his aforementioned disciple. After quoting a passage from the *Dialogo* in which Galilei names Zarlino among the great

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[31] Zarlino, *Sopplimenti*, passim: "gentilhuomini"; "nuoui Censori"; "speculatiui moderni"; "moderni Aristosseni"; "nuoui Aristarchi."

[32] Zarlino's reference to Aristarchus was probably inspired by the latter's contentious personality more than by his views on cosmology.

[33] Zarlino, *Sopplimenti* III.2, 85.

music theorists of the sixteenth century, he continues with this excerpt, in which Galilei begins his discussion of intervals:

> The first species [of tuning] we will examine—it being the newest and principal and one that all practitioners of our time generally agree upon, persuaded by the authority of Reverend Mister Gioseffo Zarlino—is, according to him, the tense syntonic of Ptolemy. After we have examined this, we will see in due time with the same diligence that which is FOLLOWED BY ALL THE OTHERS BESIDE HIM, such as Guido of Arezzo, Glarean, Gaffurio, Faber [Lefèvre d'Etaples], Valgulio, and other serious writers.[34]

Having established that Galilei himself acknowledged the originality of the ideas in the *Istitutioni*, Zarlino quotes the *Dialogo* again, this time referring to the use of imperfect consonances:

> This opinion—that they were the same as the ancient—lasted a long time in people's minds until Reverend Mr. Gioseffo Zarlino sought with a variety of arguments to demonstrate to the sense and reason that these imperfect consonances are not in any way those that are found distributed according to the ditonic diatonic . . . . THE WORLD OWES perpetual debt to Zarlino, a man of exemplary habits, life, and doctrine, for the many beautiful works he has written concerning music, from which one can draw knowledge of an infinity of things and WITHOUT WHICH THE MAJORITY OF PEOPLE WOULD SURELY BE IN THE DARK.[35]

This quotation is particularly interesting in that Zarlino presents it as if it immediately followed the passage from page 2 of the *Dialogo*, but these excerpts are actually

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[34] Ibid., 85-86: "*di uoler prima di ciaschecun'altra Specie essaminare, come più noua e principale quella, doue concorrono uniuersalmente tutti i Prattici de i nostri tempi; mossi dall'autorità del Reuerendo Messer Gioseffo Zarlino; laquale secondo ch'à lui piace; è il Syntono incitato da Tolomeo;* dopo laquale essamina, dice, *di uedere quando gli occorrerà con l'istessa diligentia quello, c'HANNO TENVTO, DALVI IN FVORI; come Guido Aretino, il Glareano, il Gaffurio, il Fabro, il Valgulio, et altri graui Scrittori*" (italics and capitalization here and in the following quotation have been preserved to show Zarlino's interjections and emphases in the quotation); trans. in *Dialogue*, 11. Palisca's translation of the passage has been revised to fit Zarlino's text.

[35] Zarlino, *Sopplimenti* III.2, 86: "*Et tale, opinione, ch'elle fussero l istesse dell'Antiche, durò nelle menti de gli Huomini, fin che uenne il Reuerendo Messer Gioseffo Zarlino: ilquale con diuerse ragioni hà cercato di dimostrare al Senso et all'Intelletto, che TALI IMPERFETTE CONSONANZE NON SONO IN MODO ALCVNO QVELLE*, *che si trouano tra le chorde distribuite secondo il Diatono diatonico. . . . A quest'Huomo essemplare di costumi, di uita, e di dottrina DEVE IL MONDO*, per le molte belle fatiche, ch'egli hà fatto; particolarmente intorno la Musica, perpetuo obligo; dalle quali si trae cognitione d'infinite cose; e SENZA NE SAREBBONO FACILMENTE LA MAGGIOR PARTE DE GLI HVOMINI AL BVIO"; trans. in *Dialogue*, 100, with revisions.

separated by almost forty pages in the *Dialogo*'s large, folio format. By juxtaposing them, Zarlino essentially ignores Galilei's lengthy discussion of intervals in which the practicality of Syntonic tuning was thoroughly examined and criticized. Furthermore, the text that was omitted (the ellipsis in the second quotation) shows that Galilei did not intend this statement to be taken at face value. In fact, Galilei specifically writes:

> Reverend Mr. Gioseffo Zarlino sought with a variety of arguments to demonstrate to the sense and reason that these imperfect consonances are not in any way those that are found distributed according to the ditonic diatonic but rather those of the syntonic of Ptolemy. He allowed himself to be induced by the novelty of this idea to believe and to say that the diatonic species that we sing and play today is entirely the syntonic of Ptolemy, which, as you have seen, is not true.[36]

Zarlino omits part of Galilei's statement because he wants to set up his rival for the more serious accusation of treachery. Following the altered quotation, Zarlino intensifies his rhetorical tone and laments Galilei's behavior: "But the point quickly changed; Oh what great inconstancy, oh what great malignity."[37]

Zarlino's tone may be hyperbolic, but it continues as he accuses Galilei of ingratitude and carelessness.[38] The cause for Zarlino's anger is finally made clear in a third excerpt from the *Dialogo*. Although Zarlino noted that Galilei's point had "quickly" changed, the next excerpt he presents is drawn from p. 112 of Galilei's text, more than seventy pages later:

> If the diatonic that is sung today is truly the one that Zarlino maintains, we should not thank him for this discovery, because that opinion—though impertinent and not approved—was conscientiously written by Lodovico Fogliano sixty or

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[36] Galilei, *Dialogo*, 39: "Reuerendo Messer Gioseffo Zarlino; il quale con diuerse ragioni ha cerco di dimostrare al senso et all'intelletto, che tali imperfette consonaze [*sic*] non sono in modo alcuno quelle che si trouano tra le corde distribuite secondo il Diatono Ditonieo, ne à si bene quelle istesse del Syntono di Tolomeo. per la nouità della qual cosa, si lasciò indurre à credere et dire, che la spezie Diatonica che si suona e canta hoggi, è tutta Syntona di Tolomeo; la quale come hauete veduto non è vera"; trans. in *Dialogue*, 100.

[37] Zarlino, *Sopplimenti* III.2, 86: "Ma presto mutò proposito, Ò che gran leggierezza, ò che gran malignità."

[38] Ibid: "ò grande ingratitudine; . . . ò gran trascuraggine."

> seventy years ago in the second section of his *Musica theorica*. The only difference between them is in the quantity and size of the semitones.[39]

Zarlino defends himself from Galilei's veiled charge of plagiarism. Preserving his ethical tone, he supposes that if he had studied Fogliano's treatise and if it was of great help, then "what great sin would it have been, when he not only does not mention the Syntonic even a single time but also does not once mention Ptolemy, even if not in this place."[40] Zarlino claims in addition that he does not cite Fogliano because he does not agree with him, although he does give the elder theorist an "honored mention" (*honorata mentione*) in another chapter of the *Istitutioni*.

Sixteenth-century theorists often attacked their rivals with charges of plagiarism (in the particular) or general ambitiousness, but Galilei seems to have particularly enraged Zarlino by naming Fogliano as the discoverer of the Syntonic tetrachord. In Zarlino's academic environment, typical decorum would not demand that he name all of his sources. In fact, throughout Zarlino's career he reprinted swaths of material from other authors without acknowledgment. The intensity with which Zarlino and Galilei argue over who rightly invented tuning systems is indicative of how seriously authors and readers considered this topic in the sixteenth century.

In chapter 1, Zarlino commences the *Sopplimenti* with a brief defense of Syntonic tuning and the *senario*, as well as the 12-mode system first discussed in Book IV of the

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[39] Ibid: "Quando il Diatonico che si canta hoggi, fusse ueramente quello, che tiene il Zarlino; non perciò gli se ne deue; come di cosa da lui ritrouata, render gratie: auenga che quella tale opinione (ancora che come impertinente, non è approuata) fù con diligentia scritta da Lodouico Fogliano, già sessanta ò settant'anni, nella Seconda settione della Musica theorica; ne altra differentia è fra loro che nella quantità e misura de Semituoni"; trans. in *Dialogue*, 277-78. In Section II, chapter 1, Fogliano discusses the consonant thrids and sixths among other intervallic ratios. See Lodovico Fogliano, *Musica theorica* (Venice: G. A. e fratelli di Sabio, 1529; reprint in Monuments of Music and Music Literature in Facsimile, II/43, New York: Broude Brothers, 1969), f. 12r.

[40] Zarlino, *Sopplimenti* III.2, 86: "che gran peccato sarebbe stato? quando ei, non solamente non nomina pure una sola fiata il sudetto Syntono; ma etiandio non nomina anche Tolomeo se non nel luogo sudetto una sola uolta."

Istitutioni. Zarlino began with these subjects for two reasons. First, although Zarlino's discussion of these systems brought him great renown, both ideas were ridiculed in Galilei's *Dialogo*. By mentioning them in the first chapter, Zarlino is telling his readership that he is not backing down from his prior assertions. Furthermore, each system represents one side of the dual nature of Zarlinian theory: the synthesis of *musica speculativa* and *musica prattica*. Syntonic tuning was discussed in Book II of the *Istitutioni* as a component of speculative music, while the modes are related more to practice. Zarlino notes that he found the Syntonic and *senario* through his study of the great authors, ancient and modern, after his long and diligent search for truth. The natural intervals derived from the Syntonic are "not a thing of art, nor the invention of man, but were first produced by nature itself."[41] Throughout the *Sopplimenti*, Zarlino will insist that minute details of musical practice cannot disprove the ideal nature of the Syntonic: it is a proven entity of nature regardless of mankind's adaptations.

Zarlino's defense of the Syntonic tetrachord as a true component of natural science, independent from practical considerations, is meant to deflect Galilei's arguments that it is not used in actual musical practice. On the contrary, Zarlino justifies his adherence to the 12-mode system because it fits modern practice, especially the compositions of his mentor Adrian Willaert.[42] In the *Dialogo*, Galilei attempted a short history of ancient modal systems in an effort to cast doubt on the historical authenticity of

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[41] Ibid. I.1, 8: "non sono cosa dell'Arte, ne inuentione dell'Huomo, ma della istessa Natura primeramente prodotte."

[42] Zarlino's reference to Willaert may offer more than just a vague definition of "modern practice." Although Willaert's music was steeped in the Franco-Flemish polyphonic tradition, Zarlino also interpreted Willaert's style as exhibiting a musical manifestation of the Ciceronian ideals taught by Pietro Bembo in the literary academies of Venice. For a discussion of Zarlino, Willaert, and Cicero, see Martha Feldman, *City Culture and the Madrigal at Venice* (Berkeley: University of California Press, 1995), 176-93.

the 12-mode system.[43] Zarlino, however, openly acknowledged the differences between ancient theory and modern practice, especially with regard to the modes, and although he followed Heinrich Glarean's method of deriving the twelve modes from harmonically and arithmetically divided octaves, Zarlino's decision to refer to each mode by a number—rather than the ancient Greek names Dorian, Phrygian, Lydian, etc.—highlights the extent to which he viewed the modern tonal system as distinct from that of the ancients.[44] The distinctions he draws between the Syntonic tetrachord and the 12-mode system exemplify his divisions of the arts and sciences into two types, the speculative and the productive. The speculative (or contemplative) arts and sciences seek to find the truth of their subjects; the productive (or active) arts and sciences undertake the completion of a work.[45] In this paradigm, the 12-mode system is an appropriate component of musical production, which is composition.[46] Later, in chapter 7, Zarlino claims that the sciences and arts are differentiated in that their subjects are either immutable or mutable.

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[43] See, Galilei, *Dialogo*, 56-79; *Dialogue*, 135-96. Galilei's presentation of tonal systems is affected by Mei's critique of modern polyphony and his enthusiastic, if not accurate, reading of Aristoxenus. Ironically, Zarlino goes to some length in Book VI of the *Sopplimenti* to prove that the ancients would have known at least twelve different modes.

[44] Zarlino cites the varying and often contrasting descriptions of modal systems in antiquity as the primary reason for not using the ancient Greek names when discussing the modern modes. See Zarlino, *Istitutioni* IV.8*,* 308. Zarlino's modal theories are discussed in greater detail in chapter 3 *infra*.

[45] Zarlino, *Sopplimenti* I.pref., 1: "diuerse sono l'operationi che à cotal Fine ci conducono; e ritrouandosi l'Arti e le Scientie di due sorti; l'una il cui fine consiste nella Verità della cosa cercata, e l'altra nel fine dell'opera; di qui nasce, che quella è detta Speculatiua ò Contemplatiua, e questa Fattiua ouero Attiua."

[46] There has been much scholarly debate over the pre- and post-compositional use of the modes in sixteenth-century polyphony. Heinrich Glarean first derived the 12-mode system as a tool for musical analysis. Writing as a Catholic humanist in the wake of the Lutheran Reformation, it was his intention to show that Gregorian chant and the music of the great polyphonic composers was connected to the music of antiquity through a modal system that could be traced from Josquin back to antiquity. Glarean was not writing for musical practitioners and was not concerned with the process of musical composition. Zarlino appropriated the 12-mode system from Glarean but, observing its incompatibility with ancient theory, placed it within a practical/compositional context. For a summary of Glarean's and Zarlino's modal systems, see Cristle Collins Judd, "Renaissance Modal Theory," in *The Cambridge History of Western Music Theory*, ed. Thomas Christensen (Cambridge: Cambridge University Press, 2002), 383-98.

Other sixteenth-century scholars, such as Galilei's mentor Girolamo Mei, saw the distinction between "speculative" and "productive" as the principal difference between the sciences and the arts, rather than considering both the arts and the sciences as carrying speculative and practical components. Mei explains this dichotomy in his 5 May 1572 letter to Galilei:

> the true end of the sciences is altogether different from that of the arts, since the end and proper aim of science is to consider every contingency of its subject and the causes and properties of these purely for the sake of knowing truth from falsehood, without caring further how the arts will use this knowledge, whether as an instrument, as material, or otherwise for the pursuit of their ends.[47]

Far from a subtle distinction, the disparity between Mei's and Zarlino's definitions of the arts and sciences has great consequences for the way in which a theorist might treat various musical topics and, in addition, opens the broader plane upon which we might view Zarlino's quarrel with Galilei. For example, if one believes that music is purely a productive art, then his judgment of a musical system would be dependent on its accuracy in describing musical practice. Galilei, in this view, would be justified in criticizing Zarlino's tuning system if he could show that it does not describe the actual intervals that are sung in performance. Zarlino, on the other hand, believes that his Syntonic tuning is a scientific fact of nature; the truth of the Syntonic tetrachord cannot be disproved regardless of its relevance to practice. Read through this lens, the Zarlino –

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[47] Palisca, *Florentine Camerata*, 65; Girolamo Mei, "Letter to Vincenzo Galilei," Rome, Biblioteca Apostolica Vaticana, Regina lat. 2021, ff. 19v-20r; transcribed in *Letters*, 103: "l'essere il real fine de le scienzie in tutto differente da quel de le arti conciosiache fine e mira propria de la scienzia è considerare ogni accidente del suo subbjetto et le cagioni et le proprietà di quelli per la sola cognizione del vero e del falso senza altro pju rispetto de l'uso à che sene servino le arti le quali sene vaglino ò per instrumento ò per materia, ò altramente nel condurre il fine loro." Mei's definition appears to have been more universally accepted in the Renaissance. In his study of ancient and Renaissance conceptions of art and nature, A. J. Close defines art (per mainstream Renaissance thought) as "any rationally organized activity which has a practical rather than a speculative end." See A. J. Close, "Commonplace Theories of Art and Nature in Classical Antiquity and in the Renaissance," *Journal of the History of Ideas* 30 (Oct.-Dec. 1969): 467.

Galilei debate is analogous to many of the great scientific disputes of the sixteenth century in which a perceived scientific fact is challenged by an opposing methodology or new empirical evidence.[48] In confronting challenges to their theories, both writers could retreat to broader philosophical foundations regardless of the principal subject of the dispute.

Expanding on Zarlino's discussion of speculative and active arts, the entirety of Book I is filled with dichotomies and classifications of knowledge. Most important to his debate with Galilei is the distinction between nature and art, which is the subject of chapters 4-6. Nature takes precedence in music, Zarlino says, because sound itself is natural and all the consonances and intervals are derived from sound.[49] Zarlino then defines nature as a "thing that naturally has being or whichever quality that is naturally found in it."[50] This tautological definition emphasizes the ancient Greek origins of Zarlino's concept of nature. According to Arthur Lovejoy and George Boas, the earliest Greek writers used nature to connote "the visible characteristics of the person or object under consideration."[51] Later writers, such as Anaxagoras and Democritus, who needed to prove the objective features of their scientific ideas, used the term "nature" in

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[48] For example, see Charles B. Schmitt, "Experience and Experiment: A Comparison of Zabarella's View with Galileo's in *De motu*," in *Studies in the Renaissance* 16 (1969): 104; reprinted in *Studies in Renaissance Philosophy and Science* (London: Variorum Reprints, 1981): VIII. Schmitt discusses Zabarella's arguments against medieval writers who attacked Aristotle's *Physics*. He concludes: "the important point here with regard to our present discussion is that in certain instances *experimenta* are to be rejected when they give results in opposition to our world-picture as a whole."

[49] Zarlino, *Sopplimenti* I.4, 18: "Musica depende prima dalla Natura che dall'Arte; percioche da quella habbiamo prima il suono, che (come ho detto altroue) è cosa naturale, senza il quale non si farebbe la Consonanza; oltra di questo habbiamo l'Acuto et il Graue, et anco l'Intervallo."

[50] Ibid., 19: "Natura esser cosa, che naturalmente ha l'essere; ouer che sia quella proprietà, che naturalmente in essa si troua."

[51] Arthur O. Lovejoy and George Boas, *Primitivism and Related Ideas in Antiquity*, with supplementary essays by W. F. Albright and P. E. Dumont (New York: Octagon Books, 1965), 104. Lovejoy and Boas ascribe this definition of nature to Homer, Pindar, and Aeschylus.

opposition to conventions or prejudiced opinions.[52] From this usage, "nature" was bound with moral implications. The "natural" aspects of any object or phenomenon were considered to be true, innate, and unalterable. Although Zarlino's definition only hints at these moral implications, he insists throughout the *Sopplimenti* that musical science is based on a set of natural principles that cannot be improved or replaced by art or artificial means.[53]

Zarlino contrasts the qualities of natural and artificial things using his customary synthesis of natural and ancient philosophy.[54] He first notes that all sensible things are produced by nature or art, including on the one hand the four elements (air, water, earth, fire), plants, animals, and so on; and on the other hand a house, knife, bed, stool, etc.[55] Both sets of objects differ primarily in that the first group is subject to Aristotle's six laws of motion, as described in the *Physics*.[56] Artificial items are only subject to the six motions insofar as the materials of these items may be natural. "Nature," furthermore, is the beginning (*principio*) of these motions, which do not occur by chance or by necessity. For an example, he cites the weather: rain, hail, thunder, lightning, etc.—things that are not eternal yet are born by nature, as distinct from human activity or necessity. On the contrary, art is the source of operation (*operare*) in things. The "artificial," Zarlino implies, is the attribute of things that have been reasoned or deliberately undertaken.

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[52] Ibid., 110.

[53] For recent discussions about the meaning of "artificial" and "natural" in various disciplines, see Bernadette Bensaude-Vincent and William R. Newman, eds. *The Artificial and the Natural: An Evolving Polarity*, Dibner Institute Studies in the History of Science and Technology (Cambridge: The MIT Press, 2007).

[54] Zarlino's discussion of nature is essentially drawn from Aristotle's *Physics*, Book 2.

[55] Zarlino, *Sopplimenti* I.4, 19: "tutte le cose, che cadono sotto'l Senso; alcune sono dalla Natura & alcune dall'Arte prodotte; Le prime sono i quattro Elementi; le Piante, gli Animali brutti, et altre simili; Le seconde sono la Casa, il Coltello, il Letto, lo Scagno e simili."

[56] The six motions are generation, corruption, increase, decrease, alteration, and mutation.

Having defined nature and art, Zarlino turns back to musical issues. He immediately addresses the harmonic numbers, which are the foundation of his musical science:

> Therefore, by applying this discourse to musical matters, we will first call the consonance "natural" that will be contained in its natural form by one of those forms or proportions—or the ratios of numbers—that will have been assigned by nature. These are contained between the proportions that are found collocated in order (as I have said many times) between the parts of the *senario*. [57]

Any intervals tuned outside these true forms, like some of those found on instruments (such as a keyboard or flute), are considered to be produced by art or artificial. By extension, an instrument that can produce consonances in their "true" forms (namely the human voice) is deemed natural, while all other instruments are called artificial. Zarlino insists, furthermore, that we must admit that there are two distinct genres of music, natural and artificial, of which the former is superior to the latter.

In the *Discorso*, Galilei charges Zarlino with misinterpreting Aristotle. Passages such as the preceding, in which Zarlino jumps from a paraphrase of Aristotle's *Physics* to a discussion of musical science, provoked Galilei's ridicule:

> It is manifestly seen that on account of this, he has labored over some Philosopher, for the beginnings of quite a few chapters where he casts his hasty fundamentals by means of the Peripatetic doctrine conclude their work quite well, but when Zarlino then wishes to apply them to conceptions of nature contrary to his points, he speaks with such a deformity that among them are found the major impertinences in the world. From these, it is manifestly recognized that the

[57] Zarlino, *Sopplimenti* I.4, 19: "Noi dunque, per applicar questo discorso alle cose della Musica, chiamaremo primieramente la Consonanza naturale, che sarà contenuta nella sua natural forma, da una di quelle forme ò proportioni, ò ragioni de numeri, che le sarà stato assegnato dalla Natura, lequali sono contenute tra le proportioni, che si trouano collocate per ordine (come hò detto più uolte) tra le parti del numero Senario." Zarlino's method, in which he discusses a principle in broad philosophical terms and then applies it to music, is found in many treatises of the late sixteenth and early seventeenth century. See for example, Lodovico Zacconi, *Prattica di musica* (Venice: Bartolomeo Carampello, 1596; reprint, Hildesheim: Georg Olms, 1982); and, to some extent, Agostino Pisa, *Battuta della musica* (Rome: Bartolomeo Zannetti, 1608; reprint in Bibliotheca musica bononiensis, II/32, Milan: Forni, 1969).

> philosophy of Aristotle was not of his time, because one who should have had a capacity for it would not have added the blunders that I will show that he added.[58]

Nevertheless, Zarlino's discussion of nature and art is derived from a theological worldview that favors the natural over the artificial. Proclaiming the superiority of nature over art, Zarlino remarks: "But the forms of artificial things are pure accidents, and those of natural things are genera of substance. The operation of art is founded upon the operation of nature, and this (as St. Thomas [Aquinas] instructs) is founded upon the Creation."[59] From these premises, it is understood that artificial things cannot be similar to those of nature. Furthermore, because art can only operate with the "power of nature" (*virtù della Natura*), art cannot be used to correct the things of nature, which are founded upon God's creation itself.[60] Zarlino's hierarchic conception of nature and art is reflected in his discussions of vocal and instrumental music as well as his preference for the human voice over artificial instruments. As a corollary to this formulation, Zarlino criticizes any attacks on the validity of his Syntonic tuning that involve discussions of artificial instruments. For example, Galilei's explanation of the 4/7 comma temperament in the *Dialogo* (discussed in chapter 1 of this dissertation) is considered to be unsound because, Zarlino contends, it is an attempt to correct nature by artificial means.

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[58] Galilei, *Discorso*, 10-11: "doue si vede manifestamente, ch'egli ha per ciò affaticato alcuno Filosofo; imperoche ne i principij di alquanti capitoli doue lui getta i precipitosi suoi fondamenti con il mezzo della dottrina Peripatetica, concludano molto bene il fatto loro: ma quando poi il Zarlino vuole applicare à quei concetti di natura contraria de suoi propositi, dice per la disformità che tra essi si trouano le maggiori impertinenze del mondo. dalle quali si conosce manifestamente che la filosofia d'Aristotile non era a suo tempo: imperoche quello che di essa fusse stato capace non hauerebbe soggiunto gli spropositi ch'io mostrerò che lui soggiugne."

[59] Zarlino, *Sopplimenti* I.4, 20: "Ma le forme delle cose Arteficiali sono puri accidenti, & quelle delle naturali sono Generi della Sostantia, e la operatione dell'Arte è fondata sopra l'operatione della Natura, e questa (come ne insegna S. Thomaso) è fondata sopra la Creatione." Zarlino's citation of Thomas Aquinas is in reference to Book I, q. 45, a. 8 of the *Summa theologica*, in which Aquinas discusses the relationship between creation and nature. For an English translation, see St. Thomas Aquinas, *Summa theologiae*. *Latin text and English translation, Introductions, Notes, Appendices and Glosseries*, 61 vols. (New York & London: Blackfriars; McGraw Hill, 1964-), 8:59-63.

[60] This topic, in particular, is treated in Book I, chapter 6 of the *Sopplimenti*. Galilei provides a line-by-line rebuttal of the chapter in the *Discorso*, 69-99.

Having criticized Galilei's reliance on artificial instruments, Zarlino later sets out to discredit any experimental approach to music theory. In chapter 7 of Book I, he discusses cognition from two perspectives: particular vs. universal; and with reason vs. without reason. He illustrates this dynamic in the following diagram (figure 12).

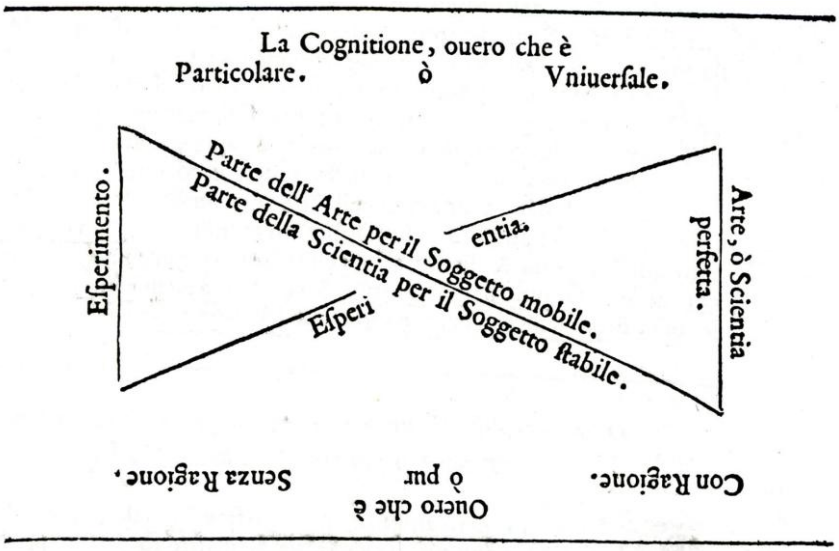

Figure 12. Cognition illustrated, from Zarlino, *Sopplimenti* I.7, 25.

In the diagram, Zarlino considers "experiment" as the antithesis of the "perfect art or science." He posits that cognition of the particular without reason (e.g., "when one recognizes a single remedy and knows a single aid for something without knowing the cause from which it came") is the lowest form of cognition.[61] This type of knowledge creates a single experience and cannot be applied to any other problems outside of its specific usefulness. Cognition that is universal but still without reason may lead to a more advanced experience, as when a doctor may have knowledge of many remedies but lacks awareness of their causes.[62] Zarlino then states that universal cognition without reason in

[61] Zarlino, *Sopplimenti* I.7, 25: "quando si conosce un solo Rimedio e si sà un solo aiuto d'una cosa; della quale non si sà la cagione di donde uenga."

[62] Zarlino's use of the terms "experience" and "experiment" may seem vague, but it is consistent with other scientific writers of the period. Charles Schmitt's article on the two terms shows that in the sixteenth century, scholars understood "experience" to connote the general observance of empirical data.

a doctor is a form of memory and observance of those things that work and do not work in improving a malady without knowing the cause or reason.[63] In other words, with enough observance of causes and effects, intelligence can apply experience to new phenomena. Higher forms of cognition, those that consist of universal knowledge and reason, are not cultivated through experiment or experience but by gaining knowledge that is "received from others, holding for certain that it is true."[64]

Zarlino concludes his discussion of cognition by noting the difference between the arts and the sciences. His distinction is important because it adds further support to his belief that musical systems, because of their scientific nature, cannot be derived through experimentation. Practical arts, on the contrary, involve the application of knowledge to a mutable body or *soggetto mobile*. In medicine, for example, the subject of the doctor is the human body, which is susceptible to the aforementioned six motions: generation, corruption, increase, decrease, alteration, and mutation. The trained doctor, then, through his understanding of universals and reason can work towards useful ends in administering the human body.[65] For scientists, however, the subject is immutable or stable. The geometer, for example, works from established premises that cannot be demonstrated: the point is indivisible; any magnitude can be divided infinitely; a line has

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For example, one might gain experience of physics by watching carpenters construct a wall. The distinction is noteworthy in that the observed phenomenon is not planned. Experiment, on the other hand, signifies a "specific experimental or observational situation by which to resolve a particular difficulty." Whereas sixteenth-century scientists supported the use of "experience," as is prominent in Aristotle's teaching, "experiment" was viewed as being more indicative of magical or alchemical practice. Schmitt notes that in Galileo Galilei's early treatise, *De motu*, Vincenzo's son does apply "experimental" procedures to problems of the motion of bodies with mixed results. See Schmitt, "Experience and Experiment,"106-23.

[63] Zarlino, *Sopplimenti* I.7, 25: "Il Medico ò Esperimentatore conosce molte cose, che giovano ad alcune infirmità, non sapendo la cagione d'alcun giovamento." Jenkins notes that in thise case, the connection between experience and memory is derived from Aristotle, *Metaphysics* 1.1 (980b28-981a2) but the translation is filtered through Aquinas's *Commentary on Aristotle's Metaphysics*. See Jenkins, "*Ridotta alla perfettione*," 172.

[64] Zarlino, *Sopplimenti* I.7, 25: "riceuuto d'altrui, tenendo per certo che sia uero."

[65] Both Zarlino and Galilei often use analogies from medicine. In the *Discorso*, Galilei cites the ability of the medical "arts" to repair what is made defective by nature. See Galilei, *Discorso*, 70-77.

no breadth; etc. Whereas knowledge of the arts is formulated by a combination "of opinion and of intelligence with reason," scientific knowledge is derived only from "intelligence and the intellect."[66]

Following Aquinas, Zarlino posits that all things can be found in one of three groups (see table 5).

Table 5. Three sorts of things, following St. Thomas Aquinas and Zarlino, *Sopplimenti* I.7, 26.[67]

Types of things	Examples	Scientific study	Classification
1.Dependent on matter	wood, stone, man	Physics	Natural (*Naturali*)
2. Exist in matter but defined[68] without matter	numbers, magnitudes, figures	Mathematics	Middle (*Matematiche e Mezzane*)
3. Independent of matter	God, substance, act, potency,	Metaphysics	Divine (*Divine ò Theologiche*)

According to Aquinas, each group listed in table 5 is the subject of a particular science. Things that are dependent on matter are the subject of physics; things that exist in matter but can be defined without it are the subject of mathematics; and so on. Zarlino ignores this classification, choosing instead to note that the ancient philosophers divided their speculations into three things, "calling the first natural, the second divine or theological, taking the former and latter as two extremes; and they named the third mathematical or

[66] Zarlino, *Sopplimenti* I.7, 26: "che quella [Arte] si genera d'opinioni e d'Intelligentia con ragione, e questa [Scientia] d'intelligentia e d'intelletto."

[67] Ibid.: "Imperoche alcune sono materiali, tanto nella sostantia, quanto nella opinione; come è il legno, la pietra, la carne, et altre simili cose; et alcune sono al tutto senza materia, cosi nell'esser proprio, come nella opinione; come è Iddio benedetto, l'Angiolo, l'Anima rationale e cose simili. Ma tra queste se ne trouano alcune, che nella sostantia sono materiali, e nella opinione sono fuori di essa sostantia; come ogni Figura mathematica, sia poi circolo ò Triangolo ò Quadrato, ò qual si uoglia altra cosa simile." Zarlino is paraphrasing from the first lecture of Aquinas's *Commentary on Aristotle's Physics* (184a9–b14). For an English translation of the passage, see St. Thomas Aquinas, *Commentary on Aristotle's Physics*, trans. Richard J. Blackwell, Richard J. Spath, and W. Edmund Thirkel, Rare Masterpieces of Philosophy and Science, ed. W. Stark (New Haven, CT: Yale University Press, 1963), 3.

[68] Zarlino translates Aquinas's Latin "definitione" into "opinione" in Italian.

middle, between the natural and divine, as that (so to speak) which partakes from the nature of one and the other, between which is placed music."[69]

Although Zarlino appears to misread Aquinas, his reference to mathematical figures and shapes as a "middle" category is an attempt to synthesize Thomist conceptions of knowledge with other Neoplatonic ideas that permeate his treatises. Aquinas does not refer to the second category as a "middle" classification of things. In Neoplatonic thought, on the other hand, mathematics is often viewed as an intellectual gateway for man to approach divine knowledge. In this instance, Zarlino may be alluding to Proclus's *Commentary on the First Book of Euclid's* Elements.[70]

In short, chapter 7 serves a two-fold purpose in the *Sopplimenti*. First of all, by considering experimentation as the lowest form of cognition, Zarlino denies the validity of Galilei's seemingly experimental approach to music theory. Having illustrated the process by which true cognition is acquired (universal knowledge with reason), Zarlino differentiates the arts and sciences by their respective mutable and immutable subjects. Through a synthesis of Aquinas's categorization of things and Neoplatonic views on mathematics, he concludes that music is still a quadrivial science of which its subject is immutable and its object is the study of God's creation.

Chapter 8 then offers a short encomium on the study of mathematics, derived mostly from Proclus's *Commentary*.[71] Zarlino begins by noting that Pythagoras promoted

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[69] Zarlino, *Sopplimenti* I.7, 26: "chiamando le prime Naturali, le seconde Diuine ò Theologiche; pigliando queste e quelle per due estremi; e le terze nominarono Mathematiche e Mezane, tra le Naturali e le Diuine, come quelle (dirò cosi) che partecipano della natura dell'una e dell'altra; tra lequali è posta la Musica."

[70] In chapter 8 of the prologue, Proclus writes: "For theology, first of all, mathematics prepares our intellectual apprehension. Those truths about the gods that are difficult for imperfect minds to discover and understand, these the science of mathematics, with the help of likenesses, shows to be trustworthy, evident, and irrefutable." See Proclus, *A Commentary on the First Book of Euclid's* Elements, 18.

[71] Ibid., 37-38.

the study of arithmetic and geometry because they were essential for the study of "eternal and unmovable things."[72] Mathematics is unique among the sciences, Zarlino claims, because it is the only scientific discipline that must be undertaken with the aid of a master who can teach it. Furthermore, the Greeks considered learning (*Imparare* or *μάθησις*) to be the act of reminiscence or permanent recollection in the soul of the eternal reasons. The study of mathematics, then, is the process through which man recalls the eternal knowledge he has forgotten since becoming human. Although these concepts were first taught by pre-Christian philosophers, such as Plato in the *Timaeus*, Zarlino transforms the study of mathematics into a Christian theology. In the *Commentary on Euclid*, Proclus writes of mathematics:

> It arouses our innate knowledge, awakens our intellect, purges our understanding, brings to light the concepts that belong essentially to us, takes away the forgetfulness and ignorance that we have from birth, sets us free from the bonds of unreason; and all this by the favor of the god who is truly the patron of this science.[73]

Zarlino includes this passage almost verbatim in the *Sopplimenti* but without attribution (figure 13). The only significant alteration occurs in the phrase "and all this by the favor of the god," which he replaces with "to the likeness of God," a concept central to Judeo-Christian belief but unrelated to Greek mythology.[74]

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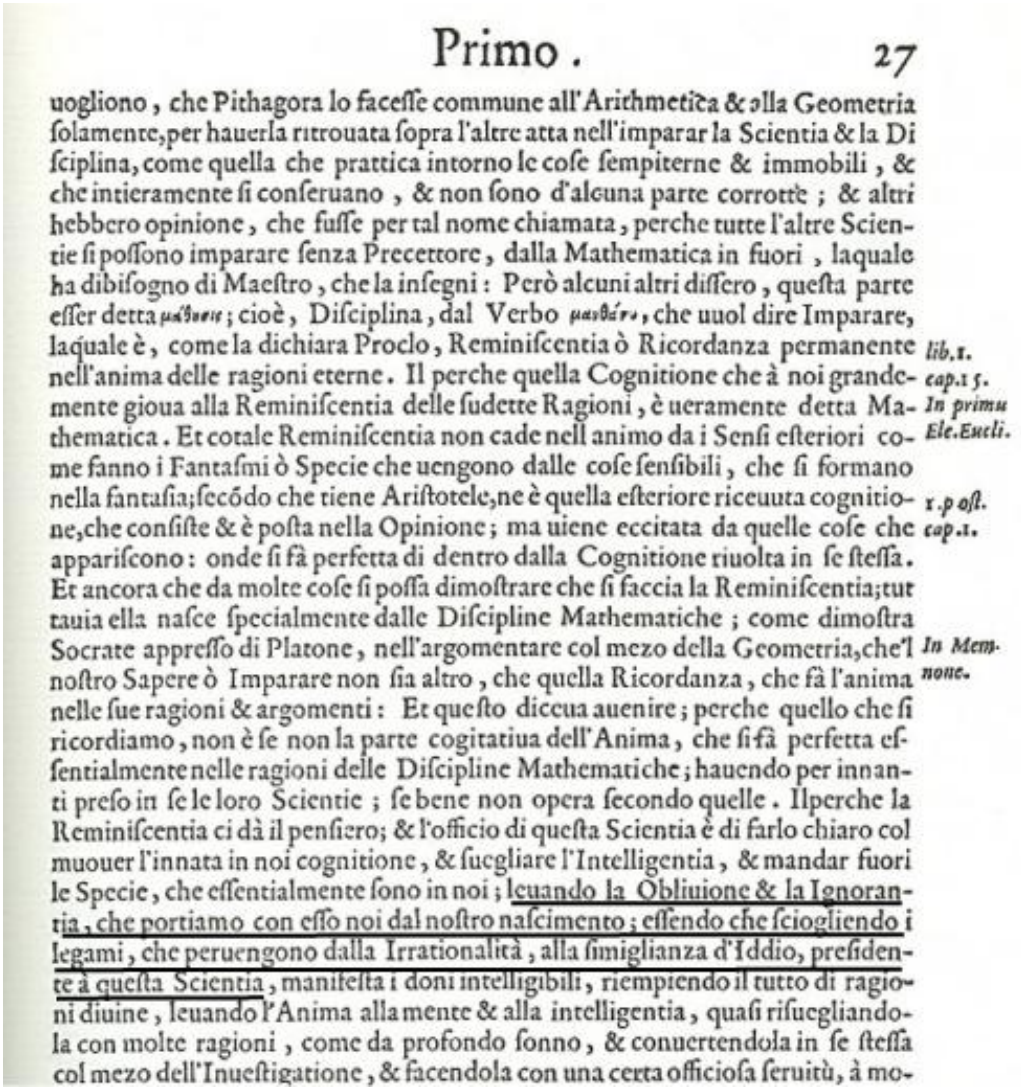
[72] Zarlino, *Sopplimenti* I.8, 27: "cose sempiterne et immobili."

[73] Proclus, *A Commentary on the First Book of Euclid's* Elements, 38. Glen Morrow suggests that the "god" mentioned by Proclus is Hermes. Alistair C. Crombie sees Proclus's conception of mathematics as an intermediary discipline as "probably the most influential program for the mathematical sciences and arts in the sixteenth century." See Alistair C. Crombie, "Science and the Arts in the Renaissance: The Search for Truth and Certainty, Old and New," in *Science and the Arts in the Renaissance*, ed. John W. Shirley and F. David Hoeniger (Washington D.C.: Folger Shakespeare Library; London: Associated University Presses, 1985), 19.

[74] Zarlino, *Sopplimenti* I.8, 27: "col muouer l'innata in noi cognitione, e suegliare l'Intelligentia, e mandar fuori le Specie, che essentialmente sono in noi; leuando la Obliuione e la Ignorantia, che portiamo con esso noi dal nostro nascimento; essendo che sciogliendo i legami, che peruengono dalla Irrationalità, alla simiglianza d'Iddio, presidente à questa Scientia." Zarlino's Christianizing of Proclus, who defended the worship of pagan gods against the rise of Christianity, is characteristic of the ways in which ancient pagan writings were adapted by later Christian writers.



Primo. 27

uogliono, che Pithagora lo faceſſe commune all'Arithmetica & alla Geometria ſolamente, per hauerla ritrouata ſopra l'altre atta nell'imparar la Scientia & la Diſciplina, come quella che prattica intorno le coſe ſempiterne & immobili, & che intieramente ſi conſeruano, & non ſono d'alcuna parte corrotte; & altri hebbero opinione, che fuſſe per tal nome chiamata, perche tutte l'altre Scientie ſi poſſono imparare ſenza Precettore, dalla Mathematica in fuori, laquale ha dibiſogno di Maeſtro, che la inſegni: Però alcuni altri diſſero, queſta parte eſſer detta μαθησις; cioè, Diſciplina, dal Verbo μανθάνω, che uuol dire Imparare, laquale è, come la dichiara Proclo, Reminiſcentia ò Ricordanza permanente nell'anima delle ragioni eterne. Il perche quella Cognitione che à noi grandemente gioua alla Reminiſcentia delle ſudette Ragioni, è ueramente detta Mathematica. Et cotale Reminiſcentia non cade nell animo da i Senſi eſteriori come fanno i Fantaſmi ò Specie che uengono dalle coſe ſenſibili, che ſi formano nella fantaſia; ſecõdo che tiene Ariſtotele, ne è quella eſteriore riceuuta cognitione, che conſiſte & è poſta nella Opinione; ma uiene eccitata da quelle coſe che appariſcono: onde ſi fà perfetta di dentro dalla Cognitione riuolta in ſe ſteſſa. Et ancora che da molte coſe ſi poſſa dimoſtrare che ſi faccia la Reminiſcentia; tuttauia ella naſce ſpecialmente dalle Diſcipline Mathematiche; come dimoſtra Socrate appreſſo di Platone, nell'argomentare col mezo della Geometria, che'l noſtro Sapere ò Imparare non ſia altro, che quella Ricordanza, che fà l'anima nelle ſue ragioni & argomenti: Et queſto diceua auenire; perche quello che ſi ricordiamo, non è ſe non la parte cogitatiua dell'Anima, che ſi fà perfetta eſſentialmente nelle ragioni delle Diſcipline Mathematiche; hauendo per innanti preſo in ſe le loro Scientie; ſe bene non opera ſecondo quelle. Ilperche la Reminiſcentia ci dà il penſiero; & l'officio di queſta Scientia è di farlo chiaro col muouer l'innata in noi cognitione, & ſuegliare l'Intelligentia, & mandar fuori le Specie, che eſſentialmente ſono in noi; leuando la Obliuione & la Ignorantia, che portiamo con eſſo noi dal noſtro naſcimento; eſſendo che ſciogliendo i legami, che peruengono dalla Irrationalità, alla ſimiglianza d'Iddio, preſidente à queſta Scientia, manifeſta i doni intelligibili, riempiendo il tutto di ragioni diuine, leuando l'Anima alla mente & alla intelligentia, quaſi riſuegliandola con molte ragioni, come da profondo ſonno, & conuertendola in ſe ſteſſa col mezo dell'Inueſtigatione, & facendola con una certa officioſa ſeruitù, à mo-

lib. 1. cap. 15. In primu Ele. Euclı.

1. p oſt. cap. 1.

In Menone.

Figure 13. Uncited quotation from Proclus's *Commentary* in Zarlino, *Sopplimenti* I.8, 27 (underscoring added).

Zarlino then adds that "no one without a perfect possession of mathematics was ever held to be a man of worth."[75] To conclude his panegyric on mathematics, Zarlino reiterates the importance of contemplating the *middle* category of things because it is a gateway from the contemplation of natural things, which are known through sensory perception, to the divine things, which can be understood only through the reminiscence and recollection that takes place in mathematical study. In this regard, examination of the "middle" category is the "first step of certainty."[76] Having stated his principles in Book I, Zarlino works through many aspects of his musical systems in Books II-VIII of the *Sopplimenti*. The most substantial of these discussions is his defense of Syntonic tuning, which will be covered in the remainder of this chapter.

Book IV: On the Genera

Chapter 1 discussed the importance of the genera in ancient and early modern theoretical writings. In the *Harmonic Elements*, Aristoxenus used the genera as a foundation from which he derived his empirically based interval theories. The typical classification of the genera into the diatonic, chromatic, and enharmonic species was standardized in Boethius's *De institutione musica* (on the authority of Nicomachus and Ptolemy) and disseminated throughout Europe in the Middle Ages. In the sixteenth century, the importance of the genera increased as composer/theorists such as Nicola Vicentino attempted to revive the chromatic and enharmonic music of the ancient Greeks,

[75] Ibid.: "giamai non fu tenuto alcuno per huomo di ualore, che non possedesse la Mathematica perfettamente." Galilei noted this claim and repeats it ironically when discussing Zarlino's errors in the *Dimostrationi*. See Galilei, *Discorso*, 57.

[76] Zarlino, *Sopplimenti* I.8, 27. See also pp. 53-55 *supra*.

and, more important for this study, when Zarlino justified his Syntonic tuning system through the Syntonic diatonic tetrachord of Ptolemy.[77]

Book IV is far and away the longest section of the *Sopplimenti*, and although Zarlino does discuss the ancient genera within this Book, he branches out from treatments of ancient music theory to argue about many issues of tuning and temperament in contemporary music. Zarlino attacks Galilei's interval and tuning theories from every angle. It will be shown in this section that Zarlino is guided by a music-theoretical tradition of favoring vocal performance as "natural" music in contrast to artificial music, which in Zarlino's opinion, is dependent upon the instrument maker's and the performer's ability to imitate what is sung by voices. Although Carolingian music theorists such as Regino of Prüm (ca. 840 – 915) articulated this idea in the ninth and tenth centuries, Zarlino expanded the definition of natural music by asserting a theoretical basis for vocal intervals in the guise of the Syntonic tuning system.

Zarlino takes advantage of several opportunities to disagree with Galilei in Book IV, even while presenting basic concepts about the different genera that were invented in antiquity. Zarlino's arguments highlight the apologetic nature of the *Sopplimenti*, yet his many quotations from Galilei's *Dialogo* suggest a more casual literary genre, such as the discourse.[78] That Zarlino constantly mixes didactic presentations with aggressive charges against Galilei is a remarkable trait of the *Sopplimenti*, for the reader is essentially confronted with two books at the same time.

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[77] Vicentino's debate with Lusitano was discussed on pp. 35-41, while Zarlino's proof of Syntonic tuning is covered on pp. 57-62 *supra*.

[78] For example, Galilei's 1589 *Discorso* is filled with quotations from Zarlino's *Dimostrationi* and *Sopplimenti*.

Zarlino's polemical attacks in the *Sopplimenti* are especially problematic because the document against which he is arguing is a dialogue. The difference between literary styles often provoked Zarlino to cite Galilei's words out of context or with substantial alterations. While discussing the chromatic tetrachord in chapter 3, for example, Zarlino argues with Galilei's historical account of the development of the chromatic genus. In Galilei's *Dialogo*, Bardi says:

> The lyricist Timotheus used the chromatic frequently among the Spartans, with the result that they, lovers of a severe music, chased him outside their boundaries. This is not surprising, since Timotheus's motherland was the Greek island of Milo, whose men, according to what the histories tell us, were exceedingly lascivious and effeminate, and, from what I hear, they are still like that today.[79]

Galilei's statement about the present state of the people of Milo was probably intended as a joke. Impolite humor was fairly common in dialogue treatises, as it magnified the casual nature of these documents. Although it is difficult to appreciate the tone of the remarks, it was probably not meant to be understood with the severity with which Zarlino presents it in the *Sopplimenti*. Zarlino includes the quotation, changing only the phrase "from what I hear" (*per quell che io intendo*) to the impersonal "from what one hears" (*per quello s'intende*) and sarcastically noting that they "do not wrong their good nature of speaking poorly of everyone."[80] Besides using the third person to refer to Galilei (another refusal to admit that he wrote the *Dialogo*), Zarlino takes Galilei's humor out of its colloquial context and places it within his ethical appeal to Pope Sixtus.

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[79] Galilei, *Dialogo*, 102: "l'vso del quale sendo assai frequentato dal Lirico Timoteo tra gli Spartani, fu cagione che essi come amatori della seuera musica, lo cacciarono da lor confini. ne di cio è punto da marauigliarsi di Timoteo, auuenga che la sua patria fu vn'isola della Grecia detta Millo; gli habitatori della quale erano (per quanto cene dicono l'historie) huomini lasciuissimi et effeminati, e tali (per quello che io intendo) sono ancora hoggi"; trans. in *Dialogue*, 253.

[80] Zarlino, *Sopplimenti* IV.3, 124: "non far torto alla lor buona natura nel dir mal d'ogn'uno."

Zarlino also alters the content of certain statements when he divorces them from their origins in Galilei's text. In the *Dialogo*, the following exchange takes place as Bardi and Strozzi discuss the relationship between modern singing and interval theory:

> Bardi: How do you think that the consonant intervals are sung today—I mean by the most excellent singers with the keenest hearing you can find?
> Strozzi: I believe that they sing the consonances in their true ratios, even though artificial instruments, as you have made me see by sense experience, play them more or less far from these.[81]

This exchange is merely part of a discussion in which Bardi leads Strozzi to believe the opposite of what he just said: that modern singers do not sing intervals in their true ratios. In this excerpt, Bardi plays the role of Socrates in the Platonic dialogues, forcing Strozzi to see the error of his opinions. Nevertheless, Zarlino paraphrases the quotation out of its original context to suggest that Galilei is only repeating ideas that he has learned from the *Istitutioni*.[82] Removing the dialogic nature of the text, he presents the quotation in this manner:

> . . . and to establish their strange opinion anew, when they say that *they believe that consonant intervals are sung today by the most excellent singers with the keenest hearing*, *which can be found within their true ratios*. And so they truly speak well, for in fact it is so, but not understanding what they say, as when they add fickle things that discord with what they have said in many places: that *artificial instruments play* [intervals] *more or less far from these.*[83]

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[81] Galilei, *Dialogo*, 54: "Bardi. Come credete voi che si cantino hoggi gli interualli consonanti? dico da piu eccellenti cantori e di purgato vdito che si trouino? Strozzi. Credo che si cantino drento le vere proporzioni loro, ancora che gli artifitiali strumenti, come mi hauete sensatamente fatto vedere, gli suonino chi piu, e chi meno da esse lontane"; trans. in Galilei, *Dialogue*, 131.

[82] In fact, Galilei actually cites Part II, chapter 45 of the *Istituitoni* in the margins of the *Dialogo*, drawing attention to the origins of an idea that he intends to disprove.

[83] Zarlino, *Sopplimenti* IV.4, 133: "e di nuouo stabilire cotale opinione loro strana; quando dicono, che *Credono che si cantino hoggi gli Interualli consonanti da i più eccellenti Cantori di purgato Vdito, che si trouino dentro le uere proportioni loro* Et ciò dicono ueramante bene; percioche in fatto è cosi: ma non intendendo quello che dicono; come instabili soggiungono quello, che discorda da quello c'hanno detto in molti luoghi; cioè, che *Gli arteficiali istrumenti si suonano, chi più e chi meno da esse lontane*." Zarlino's awkward transcription has been preserved in the translation to highlight the liberties he takes in presenting quotations from the *Dialogo*. Based on the placement of commas, it seems he intended the object to which "can be found" refers to be "intervals" and not "excellent singers."

In the first quotation, Zarlino conflates Bardi's question with the first part of Strozzi's answer, presenting the entirety of the excerpt as Galilei's indicative statement. In the following passages (including quotations from p. 55 of the *Dialogo*), Zarlino presents the conclusion of this discussion between Bardi and Strozzi. Citing Galilei's opinion that modern performers customarily sing slightly diminished fifths and slightly augmented fourths (as are also used in tempered instruments), Zarlino again claims that the *Dialogo* is filled with contradictions.[84] These exchanges highlight the complexities faced by theorists and their readers in presenting or understanding polemical arguments that range across literary genres. Without clear citations or precise transcriptions, authors could easily recontextualize the writings of their opponents, while making it difficult for their readers to verify their claims.

Presentation of the Genera

Zarlino devotes the opening chapters of Book IV to the presentation of the three melodic genera: diatonic, chromatic and enharmonic. Although Aristoxenus established the six shades or species of each genus, he did not necessarily specify the exact sizes of intervals in each species. On the contrary, he only intended that each shading produce a different color, while in actuality he allows that an infinite number of species was possible.[85] Later scholars codified the shadings offered by ancient theorists, and a tradition of presenting specific intervallic sizes for the various shades in comparative

[84] Ibid., 133-34.
[85] Mathiesen, *Apollo's Lyre*, 313.

tables was developed in the later manuscript history of Ptolemy's *Harmonics*.[86] These tables were in turn reproduced by other scholars, such as Manuel Bryennius in his own *Harmonics*, composed around 1300 C. E.[87] Although *quattrocento* theorists may not have been interested in the precise details of the ancient genera, the tables of Bryennius and their Ptolemaic origins were transmitted to *cinquecento* readers through Giorgio Valla's *De expetendis et fugiendus rebus opus* (Venice, 1501) and Gaffurio's *De harmonia musicorum instrumentorum opus* (Venice, 1518).[88]

For Zarlino and Galilei, the precise intervals and historical origins of each species were significant because of their argument about the legitimacy of Ptolemy's Syntonic tetrachord. The presentations of genera in Ptolemy's *Harmonics*, Galilei's *Dialogo*, and Zarlino's *Sopplimenti* are compared in table 6a-c.[89]

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[86] Ibid., 466. Ptolemy discusses these divisions in I.12-15 and II.13-15 of the *Harmonics*. See Ptolemy, *Harmonics*, translation and commentary by Jon Solomon, Mnemosyne Supplementa, vol. 203 (Leiden: Brill, 2000), 39-53; 94-123.

[87] See Manuel Bryennius, *The Harmonics of Bryennius*, ed. with trans., notes, introduction, and index of words by G. H. Jonker (Groningen: Wolters-Noordhoff, 1970), 189-281.

[88] Claude V. Palisca, *Humanism in Italian Renaissance Musical Thought* (New Haven, CT: Yale University Press, 1985), 82-87. Valla relied on Bryennius's presentation of the genera, whereas Gaffurio compared Valla's tables to those he found in Ptolemy's *Harmonics.*

[89] The rendering of Ptolemy's ordering of the genera in table 6a-c is drawn from Solomon's translation of the *Harmonics*, 99-103. Both Zarlino and Galilei may have used Antonio Gogava's translation of Ptolemy, which displays the same ordering of the genera as is found in the above tables. See Antonio Gogava, *Aristoxeni mvsici antiqviss. Harmonicorvm elementorvm libri III. Cl Ptolemaei Harmonicorum, seu de musica lib. III. Aristotelis de obiecto auditus fragmentum ex Porphyrij commentarijs* (Venice: Vincenzo Valgrisi, 1562), 112-14.

Table 6a. Presentation of the diatonic genera

Ptolemy (*Harmonics* II.14)	**V. Galilei (*Dialogo* pp. 107-8)**	**Zarlino (*Sopplimenti* IV.1)**
	1. Pythagorean (from Boethius)	1. Pythagorean [same as Galilei 1]
1. Archytas	2. Archytas	2. Archytas
2. Aristoxenus-Soft	3. Aristoxenus-Syntonic	3. Aristoxenus-Syntonic
3. Aristoxenus-Syntonic	4. Aristoxenus-Soft	4. Aristoxenus-Soft
4. Eratosthenes		
5. Didymus	5. Didymus	5. Didymus
6. Ptolemy-Soft	6. Ptolemy-Even	
7. Ptolemy-Tonic	7. Ptolemy-Syntonic	6. Ptolemy-Syntonic
8. Ptolemy-Diatonic	8. Ptolemy-Soft	7. Ptolemy-Even
9. Ptolemy-Syntonic	9. Ptolemy-Diatonic	8. Ptolemy-Soft
10. Ptolemy-Even		

Table 6b. Presentation of the chromatic genera

Ptolemy (*Harmonics* II.14)	**V. Galilei (*Dialogo* pp. 109-10)**	**Zarlino (*Sopplimenti* IV.2)**
	1. Unknown (from Boethius)	1. Unknown (same as Galilei 1)
1. Archytas	2. Archytas	2. Archytas
2. Aristoxenus-Soft	3. Aristoxenus-Soft	3. Aristoxenus-Soft
3. Aristoxenus-Hemiolic	4. Aristoxenus-Tonic	4. Aristoxenus-Tonic
4. Aristoxenus-Tonic	5. Aristoxenus-Hemiolic	5. Aristoxenus-Hemiolic
5. Eratosthenes	6. Eratosthenes	[om. as the same as Aristoxenus-Tonic]
6. Didymus	7. Didymus	6. Didymus
7. Ptolemy-Soft	8. Ptolemy-Syntonic	7. Ptolemy-Syntonic
8. Ptolemy-Syntonic	9. Ptolemy-Soft	8. Ptolemy-Soft

Table 6c. Presentation of the enharmonic genera

Ptolemy (*Harmonics* II.14)	**V. Galilei (*Dialogo* pp. 110-11)**	**Zarlino (*Sopplimenti* IV.3)**
	1. Olympus (from Boethius)	1. Olympus (same as Galilei 1)
1. Archytas	2. Archytas	2. Archytas
2. Aristoxenus	3. Aristoxenus	3. Aristoxenus
3. Eratosthenes	4. Eratosthenes	[om. as the same as Aristoxenus]
4. Didymus	5. Didymus	4. Didymus
5. Ptolemy	6. Ptolemy	5. Ptolemy
	7. Unknown	6. Unknown
		7. Zarlino from the *Istitutioni* (II.45)

Table 6 shows that Zarlino was clearly modeling his presentation of the genera on the tables found in Galilei's *Dialogo*. Galilei appears to have started with Ptolemy's ordering and then attempted to complete it by adding three species that he found in

Boethius's *De institutione musica* and one enharmonic species of unknown origin.[90] In Book IV of the *Sopplimenti*, Zarlino appears to have copied Galilei's order: the species attributed to Pythagoras and Olympus (taken from Boethius's *De musica*) are presented earlier than those found in Ptolemy, and where one inventor has multiple species within a given genus, the order conforms to the *Dialogo*. Zarlino omits the three species by Eratosthenes because they are repetitions of species attributed to Aristoxenus, a fact that is acknowledged by both Ptolemy and Galilei.

Zarlino's ordering highlights the extent to which Galilei's *Dialogo* influenced the writing of the *Sopplimenti*, while it is also related to the true purpose of these opening chapters: to argue with Galilei's assumptions about the genera and further legitimize the role of Ptolemy's Syntonic diatonic tetrachord in contemporary musical performance. The importance of the latter is noted in the one species Zarlino reproduces that is not found in the orderings of Ptolemy or Galilei. Save for the omission of Eratosthenes' species, Zarlino's enharmonic ordering is identical to Galilei's except for his final example, which he reproduces from the *Istitutioni* (II.47). Zarlino claimed that because it was derived from Ptolemy's Syntonic diatonic tetrachord, this particular array of intervals was also the only enharmonic tetrachord that could actually be used in musical practice.[91]

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[90] Galilei could have taken his numerical descriptions of the genera from Ptolemy, Boethius, or Franchino Gaffurio's *De harmonia instrumentorum opus* (Milan, 1518). It appears that he used all three sources. Palisca clarifies Galilei's method for deriving the numerical values for each species. See the footnotes in Galilei, *Dialogue*, 267-74.

[91] Zarlino's preferred enharmonic tetrachord is made up of a 5:4 major third and a two dieses that combine to form the major semitone, 16:15. This is the only acceptable species, according to Zarlino, because the major third is made up of two unequal tones (9:8 and 10:9), and, combined with the 16:15 semitone, it outlines the Syntonic diatonic tetrachord. To complete the enharmonic species, the 16:15 semitone is divided into a 25:24 semitone (here serving as one diesis) and a 128:125 diesis. It should be noted that 128:125 can be written as "super 3 partiente 125." Zarlino erroneously refers to this ratio as "super 13. partiente." See Zarlino, *Sopplimenti* IV.3, 130. Zarlino's description of the tetrachord is found in the *Istitutioni* II.47, 139-40.

Zarlino uses each of the three chapters on the ancient genera to argue with Galilei's own presentation of the tetrachords in the *Dialogo*. Zarlino primarily wants to argue with Galilei's conclusion that the Syntonic tetrachord of Ptolemy is not significantly different from Didymus's single diatonic species. Both tetrachords are comprised of the same intervals, but Didymus places the smaller 10:9 tone between the 9:8 tone and the 16:15 semitone (table 7).

Table 7. Comparison of three diatonic tetrachords from Zarlino, *Sopplimenti* IV.1.

Pythagoras	Didymus	Ptolemy (Syntonic)
192	24	36
9:8 (maj. tone)	9:8 (maj. tone)	10:9 (min. tone)
216	27	40
9:8 (maj. tone)	10:9 (min. tone)	9:8 (maj. tone)
243	30	45
256:243 (min. semitone)	16:15 (maj. semitone)	16:15 (maj. semitone)
256	32	48

The table shows that the tetrachords of Didymus and Ptolemy included a semitone larger than that of Pythagoras; a smaller 10:9 tone balances out the perfect fourth. In combinations of intervals, the uneven tones allowed for consonant thirds and sixths.[92] Although the argument is somewhat unclear in the *Dialogo*, Galilei later explained that Didymus's Diatonic tetrachord was but one step in a historical process that culminated in Aristoxenus's tetrachord made up of equal semitones and, therefore, two equal tones. Galilei notes in the *Discorso*:

> . . . among the different species of melody that were distributed and ordered by the aforesaid musicians and philosophers, three have been the most famous. First was that of Pythagoras or, to say it better, what he believed was sung in his times. This species, copious in tones, acquired the name Ditonic Diatonic. Second was that of Didymus, and he named it Syntonic Diatonic. After many years, Ptolemy

[92] See pp. 57-62 *supra* for a discussion of the Syntonic tetrachord.

> attributed it to himself—or it was attributed to him by others. Third and final was that of Aristoxenus, called by him Intense Diatonic.[93]

Galilei's historical theory is quite problematic. First of all, Didymus lived in the first century C.E., about 400 years after the death of Aristoxenus. Galilei does not offer specific dates for Didymus in the *Dialogo* or *Discorso*, but his prose suggests that he is offering a chronological assessment of historical tuning systems. Second, no writer before Galilei refers to Didymus's tetrachord as the "Syntonic" Diatonic, a name that Ptolemy used for his own species. Because Galilei probably learned of Didymus's tetrachord from Ptolemy's *Harmonics* (II.14), we might assume that he added the epithet to suit his purposes. By placing Didymus's species after Pythagoras's and before Aristoxenus's in the chronology, Galilei intended to emphasize the benefits of a tetrachord made entirely of superparticular intervals as well as showing the improvements apparent in Aristoxenus's Intense Diatonic.

It can be noted from table 6 that Zarlino's presentation of the genera differs most from Galilei in the diatonic genus. Zarlino places Ptolemy's Even Diatonic tetrachord after the Syntonic so that Didymus's Diatonic tetrachord would be directly followed by the Syntonic.[94] After the presentation of the Syntonic tetrachord, a long digression follows in which Zarlino shows that the order of tones in Didymus's tetrachord will create many more dissonances in contemporary polyphony; he even notes that Ptolemy

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[93] Galilei, *Discorso*, 100: "tra le diuerse spetie d'armonia che furon distribuite et ordinate dai sopradetti Musici e Filosofi, tre sono state le più famose. fu la prima quella di Pitagora, o per meglio dire quella che lui credette che si cantasse ne suoi tempi; laquale come copiosa di Tuoni si acquistò nome di Diatona Ditoniea. fu la seconda quella di Didimo, e la nominò Diatonico Sintono: ilquale dopò molt'anni si attribuì Tolomeo, o gli fu da altri attribuito per suo. la terza et vltima fu quella d'Aristosseno, detta da lui Diatonico Incitato."

[94] Zarlino, *Sopplimenti* IV.1, 115-16.

himself raised doubts in the *Harmonics* (II.13) about Didymus's tetrachord.[95] Galilei actually anticipated Zarlino's arguments in the *Dialogo*, noting that both tetrachords would cause dissonances in tertial harmony; thus, it did not matter that Ptolemy's species created fewer problems. Furthermore, Galilei tacitly accused Zarlino of preferring Ptolemy to Didymus because the alternative would have "jeopardized perhaps the designs of the authors of these things."[96] Galilei assumed that Zarlino was staking his "Syntonic" tuning theory on the importance and influence Ptolemy asserted in other scientific disciplines. If Galilei could prove that Didymus was the inventor of the modern tuning system (even though he did not agree with the idea), Zarlino's system would seem less remarkable.

The dispute over the invention of the Syntonic highlights an important facet of the debate between Zarlino and Galilei. Although both were accomplished musicians, Zarlino treats the Syntonic tetrachord as a theoretical matter. It is a scientific truth of nature, given to man by God. The slight dissonances that arise in its practical use are more than ameliorated by the elegance of its design and its proximity to perfection. Because Didymus's tetrachord would produce so many more dissonances, it cannot be taken as exhibiting the same qualities. Galilei, on the other hand, is interested only in the practical use of the Syntonic. Because choirs sing in consonance, the Syntonic cannot be the correct tuning system because it would create dissonances. Didymus's Diatonic and Ptolemy's Syntonic tetrachord are comprised of the same intervals (albeit in a different order), and either would lead to dissonance in contemporary polyphony.

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[95] Ibid., 115. Although Ptolemy does criticize Didymus for not understanding the practical application of his diatonic tetrachord, Ptolemy was not concerned about its use in polyphony.

[96] Galilei, *Dialogo*, 35: "pregiudicaua forse à disegni degli autori di queste cose"; trans. in *Dialogue*, 90.

Zarlino's Syntonic Tuning and the Tripartite Scale

After presenting the ancient genera in chapters 1-3, Zarlino commits the remaining thirty-four chapters to issues that pertain to modern tuning. Although he remains silent about the name of his adversary, Zarlino clearly wrote Book IV "with the explicit desire of demolishing Galilei."[97] Going far beyond mere presentation of the genera, Zarlino attacks Galilei for his interval theory, use of mathematics, and interpretation of Aristoxenus, and he even presents his own solutions for splitting the tone into equal parts. Furthermore, the role of nature and art and natural and artificial instruments in the formation of music theory and practice dominates all discussions. Zarlino establishes his case in the beginning of chapter 4:

> One sees that because they have not recognized in music the difference that is found among natural and artificial instruments and have never had true recognition of their properties, many have let themselves be induced to believe a thousand errors and, in addition, have forced themselves to believe true many other things that are not true in this science and say a thousand foolish things that are outside every reason.[98]

Zarlino's insistence on the importance of natural instruments is certainly influenced by his background in Aristotelian metaphysics, but it is also rooted in musical performance. Natural instruments, that is, unaccompanied voices, can always produce consonances because their intervals are not limited by string lengths, finger holes, or frets, as are found

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[97] Don Harrán, "Sulla genesi della famosa disputa, 470: "Benché i *Sopplimenti* fossero scritti col desiderio esplicito di demolire il Galilei."

[98] Zarlino, *Sopplimenti* IV.4, 130: "Il perche si uede, che molti, per non hauer conosciuto nella Musica la differentia, che si troua tra gli Istrumenti naturali e gli arteficiali, e per non hauer hauuto giamai la uera cognitione delle loro proprietà, s'hanno lasciato indurre à credere mille errori: e più oltra si hanno sforzati di far credere ad altri molte cose non uere in questa Scientia per uere; e dire mille sciocchezze fuori d'ogni ragione." After this statement, Zarlino quickly notes that the principal error of those who do not understand the difference between natural and artificial instruments is to believe that the Syntonic Diatonic tetrachord is not sung or played by modern musicians.

in artificial instruments. Acknowledging that some instruments share these properties, Zarlino admits in the *Sopplimenti* that trombones, violins, and other such instruments are able to play natural intervals to some extent.[99]

In addition to not understanding the difference between natural and artificial instruments, Zarlino also accuses Galilei of not recognizing the broader separation between natural and artificial music, especially as it relates to the Syntonic tetrachord. Throughout the *Istitutioni*, Zarlino had relied on Neoplatonic conceptions of natural philosophy and similitudes to explain "natural" properties of musical science. Zarlino's Syntonic tuning, combined with his *senario* number, is an exemplar of this method, for with the Syntonic tetrachord, polyphonic vocal music could now be firmly incorporated into the Platonic universe.

After Galilei attempted to destroy Zarlino's elegant synthesis of music theory and practice in the *Dialogo* by pointing out all of the dissonances that would be created if singers and instrumentalists actually used the Syntonic tetrachord in performance, Zarlino again turned to natural philosophy to defend his territory. To this end, he conceived of a tripartite scale system that contained two artificial scales and one natural scale. The three scales are described in Book IV, chapter 6 of the *Sopplimenti*:

> Inasmuch as the [one] is the simple system that is ordered among the strings or sounds according to the model or form of the natural species or simple Syntonic diatonic and the other is what comes naturally made and ordered among the

[99] Zarlino, *Sopplimenti* IV.11, 152: "The natural instrument is that of the voice with which (as has been said many times) one can form whatsoever interval. Nor will one ever find in whatsoever other instrument (apart from the violin, trombone, and other similar instruments that do not have their places or limits for intervals prefixed) that it possesses such privilege [L'Istrumento naturale è quel della Voce, col quale (come si è detto più uolte) si può formar qual si uoglia Interuallo. Nè si trouerà mai in qual si uoglia altro Istrumento; dal Violino, e dal Trombone et altri simili impoi, che non habbiano i luoghi ò termini prefissi de gli Interualli, che goda di tal priuilegio]."

> voices by nature, the third is very different from these two kinds: it is what is tempered in the artificial instruments.[100]

The first, "simple system" is a two-octave scale based entirely on intervals from Ptolemy's Syntonic tetrachord. Although it is constructed from a "natural" species, it is an artificial scale because the intervals in the scale that may be employed are limited by the ratios formed from the Syntonic tetrachord.[101] Zarlino confirms its artificiality later in the chapter: "just as in the artificial order of the true Syntonic, so in that of whatsoever stable instrument: one cannot pass outside of the order."[102] The second scale, on the contrary, is purely natural. Although it is based on the same Syntonic tetrachord, this scale is used by natural instruments (voices) that can adapt their pitch to form any consonant interval. The third scale is also artificial because it is limited by the holes and frets of instruments.

Zarlino's tripartite scale system was a clever response to the *Dialogo* because it negated Galilei's specific arguments as well as his methodology. In Zarlino's view, any mathematical demonstrations that pointed out dissonances that would be caused by the Syntonic tetrachord were now irrelevant because they were applicable only to the "artificial" scale. Experiments performed on artificial instruments were equally useless

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[100] Zarlino, *Sopplimenti* IV.6, 141: "Essendoche altro è il Semplice systema, che si ordina tra le chorde ò suoni secondo il modello ò forma della Specie Naturale ò Syntona semplice diatonica; et altro è quello, che naturalmente uien fatto et ordinato tra le Voci dalla Natura; dalle quali due sorti è molto differente il terzo, ch'è quello, ch'è temperato ne gli Istrumenti Arteficiali."

[101] Zarlino defines this scale as "artificial" for the same reason that he would consider the flute to be an "artificial" instrument. Just as the flute can only play those intervals that are formed by fingering the holes in its body, any performer using the "artificial" scale can avail himself only of those intervals that arise from the ratios found in Ptolemy's Syntonic tetrachord. The "natural" scale, on the other hand, incorporates the slight adjustments natural instruments such as voices will make to avoid dissonances that would be caused by strict adherence to the Syntonic ratios.

[102] Zarlino, *Sopplimenti* IV.6, 143: "Ilche tanto nell'ordine arteficiale del uero Syntono, quanto in quello di qual si uoglia Istrumento stabile; non si può passar fuori dell'ordine."

because the ratios that were created in tempering intervals were not exactly the same as those that were found in the "natural" Syntonic scale.

Zarlino's *Disputatio* against Galilei

In Book IV, chapter 4 of the *Sopplimenti*, Zarlino presents a "foolish statement" from Galilei that he considers to be the "principal and foundation of the whole fabric of music."[103] Galilei is alleged to have written "that the species of melody we use to sing at present is not the natural or Syntonic diatonic of Ptolemy, but what is used in the artificial tempered instruments, especially the organs, harpsichords, and other similar instruments."[104] In fact, Galilei never wrote these words, although he does insist in the 1589 *Discorso* that singers may learn how to sing from hearing consonant intervals played on an instrument. Nevertheless, this false quotation allows Zarlino to focus the reader's attention on his principal argument against Galilei's interval theories. Galilei, in Zarlino's words, does not give primacy either to the scales used by voices, which have been characterized as "natural music," or to the authoritative harmonic theory of the ancients, handed down from Ptolemy and Boethius. Instead, Galilei gives preference to the tempered intervals of an artificial instrument. Temperament had received some attention in sixteenth-century theoretical literature—by 1588, Zarlino had presented numerous processes for tempering keyboard instruments—but the idea that natural instruments would rely on tempered intervals to create consonant polyphony was anathema to Zarlino.

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[103] Zarlino, *Sopplimenti* IV.4, 131: "la principale et il fondamanto [*sic*] di tutta la fabrica della Musica."

[104] Ibid.: "che La Specie d'harmonia, che noi usiamo cantare al presente, non sia la Naturale o Syntona diatonica di Tolomeo; ma quella che si usa ne gli Istrumenti arteficiali temperati, massimamente ne gli Organi, Grauecembali et altri simili."

Having cited Galilei's principal crime against music theory, Zarlino devotes the next several chapters in Book IV to refuting the many criticisms of the Syntonic found in Galilei's *Dialogo*. In view of Zarlino's background in scholastic thought, it is not farfetched to consider chapters 5-9 as a *disputatio*.[105] The thesis to which Zarlino responds is Galilei's assertion that the Syntonic tetrachord is not sung or played on instruments. Using the tripartite scale system and broader notions of nature and art, Zarlino exposes five major "errors" in Galilei's thesis.[106]

Error no. 1 (Book IV. chapter 5): They take the intervals that are found in the Greatest System or artificial constitution of the said Syntonic in the first species of the diapason, contained between C and c (which is found to be without the synemmenon tetrachord), and combine it together with the fourth species, contained between F and f (which does contain such tetrachord).[107]

Galilei's first order of business in the *Dialogo* was to show that if the Syntonic tetrachord were actually adopted in performance, it would create dissonances.[108] To this end, he devised a series of examples that show many hidden dissonances in Zarlino's system. Two of these examples are mentioned in Error 1: the use of the artificial Syntonic scale and the combination of intervals in the first and fourth species of the octave.

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[105] John Haines and Patricia DeWitt have discussed two disputations in Johannes de Grocheio's treatise *De musica* (Paris, ca. 1300). Having participated in Parisian university culture in the late twelfth and early thirteenth centuries, Johannes was certainly much closer than Zarlino to the academic context in which the *disputatio* was quite common as both an oral and written exercise. Zarlino may not have intended such a strict generic classification for this portion of the *Sopplimenti*, but because of his close readings of Thomas Aquinas and other Aristotelian literature, it is safe to assume that he understood the parameters of the *disputatio*. See John Haines and Patricia DeWitt, "Johannes de Grocheio and Aristotelian Natural Philosophy," *Early Music History* 27 (2008): 53-69.

[106] Throughout the *Sopplimenti*, Zarlino casually cites many errors in Galilei's *Dialogo*. By way of example, this section concentrates on the problems discussed in chapters 5-9 of Book IV.

[107] Zarlino, *Sopplimenti* IV.5, 135: "pigliano da gli Interualli, che si trouano nel Systema massimo ò Costitutione arteficiale del sudetto Syntono; nella prima specie della Diapason, contenuta tra C. e c. che si troua esser senza il Tetrachordo Synemennon; e nella Quarta, contenuta tra F. e f. che contiene cotale Tetrachordo; insieme congiunte." For our purposes, it should be noted that the inclusion of the "synemmenon tetrachord" in the fourth species of the octave refers only to the Bb found on the fourth degree of the scale. Zarlino's description is indicative of his attempt to synthesize ancient Greek theory and modern practice.

[108] Galilei, *Dialogo*, 2-28; *Dialogue*, 11-74.

To begin his attack on Syntonic tuning, Galilei produces the sixteen different intervals that would exist in Syntonic tuning. The intervals are listed in table 7 below:

Table 7. "The Ratios of the Intervals of the Syntonic Diatonic," from Galilei, *Dialogo*, 3.[109]

Comma	81:80
Minor semitone	25:24
Major semitone	16:15
Minor tone	10:9
Major tone	9:8
Minor third	6:5
Major third	5:4
Fourth	4:3
tritone	45:32
Semidiapente	64:45
Fifth	3:2
Minor sixth	8:5
Major sixth	5:3
Minor seventh	9:5
Major seventh	15:8
Queen of consonances, today called octave	2:1

Galilei then demonstrates that combinations of these intervals, as defined by their respective ratios, would create dissonances. For example, whereas Zarlino divides the perfect fifth (3:2) into the consonant major third (5:4) and minor third (6:5), Galilei claims that a fifth is also composed of a fourth plus a tone and, therefore, a fifth constructed from a perfect fourth (4:3) and the minor tone (10:9) is a possible interval in the Syntonic system.[110] Although the fourth plus a major tone creates a consonant fifth,[111] the fourth plus a minor tone produces the dissonant ratio 40:27, which is a slightly smaller interval.[112] Because Galilei found that many more dissonant intervals could be created with combinations of the Syntonic intervals cited above, he concluded that if

[109] *Dialogue*, 13.

[110] Galilei, *Dialogo*, 17-18; *Dialogue,* 48-50. For Zarlino's division of the perfect fifth, see p. 60 *supra*.

[111] 4:3+9:8 = (4x9):(3x8) = 36:24 = 3:2.

[112] 4:3+10:9 = (4x10):(3x9) = 40:27. The interval would be smaller than the 3:2 fifth by a Syntonic comma (81:80).

Syntonic tuning were actually used by singers, we would hear many more dissonances in performances of polyphonic music than we do.

Zarlino does not deny Galilei's arithmetic but instead asserts that the information is irrelevant with regard to vocal performance. Zarlino claims that Galilei is working with intervals that may be defined in an "artificial" Syntonic rather than in the "natural" Syntonic. Although Zarlino has not offered at this point in the *Sopplimenti* a full explanation of the difference between the "artificial" and "natural" scale, it is clear that he disregards all the dissonances Galilei cites because they do not occur in vocal performance.

Galilei also suggests that the order of major and minor tones, so important in Syntonic tuning, would be altered if one were to compose or sing a scale with a single flat in the key signature. For example, he claims: "in the Syntonic of Ptolemy the step d la sol re with hard b is sharper than that in the soft hexachord."[113] Although Galilei does not initially demonstrate this paradox, he later shows that the difference in pitch comes about because of the differences in the sequence of major and minor tones.[114] A simple diagram of the C-c and F-f octaves in Syntonic tuning shows the variance in the sequence of tones and semitones (see figure 14).[115]

[113] Galilei, *Dialogo*, 4: "nel Syntono di Tolomeo, la corda di d la sol re per h duro, sia piu acuta di quella per b molle"; trans. in *Dialogue*, 16.

[114] Galilei's explanation is found on p. 27 of the *Dialogo*; *Dialogue*, 72-74.

[115] In presenting these scales, Galilei conflates the c-cc and f-ff octaves with the order of intervals in the Greater Perfect System. He notes that the first scale contains the meson tetrachord of Ptolemy's Syntonic while the F scale includes the synemmenon tetrachord.

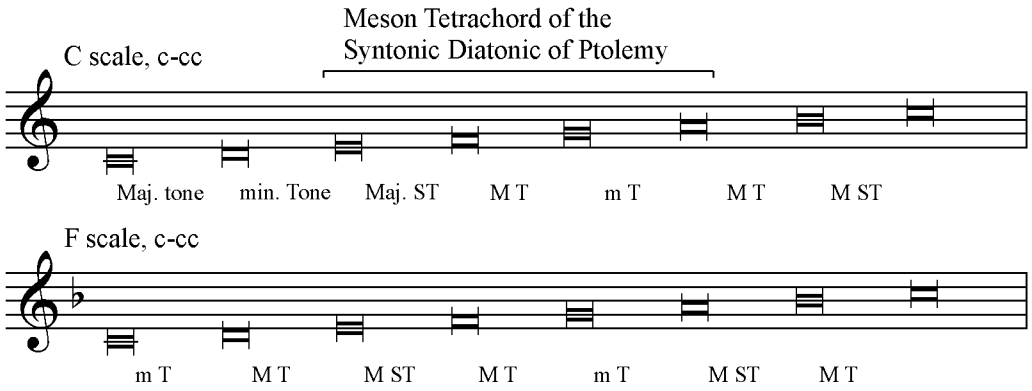

Figure 14. Comparison of intervals in the C and F scale in Syntonic tuning.

Figure 14 shows that the intervals between c-d and d-e are reversed in the two scales. As a result, if one were to extend either octave as necessary and ascend by step from aa to dd in the C scale, the total interval would be larger than a 4:3 fourth.[116] On the other hand, ascending from aa to dd by way of bb^b and cc, the total interval would be exactly a 4:3 fourth.[117] The relative pitch of the note dd in the extended C and F scales is just one of two dozen examples Galilei provides to show that many seemingly identical intervals are not the same size in Syntonic tuning.[118] Two of Galilei's examples are shown below (see figures 15a-b).[119]

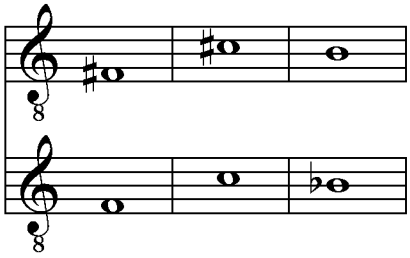

Figure 15a. Galilei, *Dialogo*, 5 (example 1b).

[116] To calculate the total melodic distance between aa and dd, the individual intervals are added together. In the C scale, one would ascend by 9:8, 16:15, and 9:8. The resulting interval would be (9x16x9):(8x15x8) = 1296:960 = 81:60, larger than the perfect fourth by a Syntonic comma (81:80).

[117] In Syntonic tuning, aa-bb^b is a major semitone (16:15). The distance from aa to dd, then, may be calculated as (16:15)+(9:8)+(10:9) or (16x9x10):(15x8x9) = 1440:1080 = 4:3.

[118] Galilei, *Dialogo*, 4-5; *Dialogue*, 19-20.

[119] It should be noted that Galilei does not explain the problems in these examples.

Figure 15a displays three semitones; all the intervals are the minor semitones (135:128) used within major tones (F-G, c-d, a-b).[120] Galilei claims that these semitones are different in size from those in figure 15b.

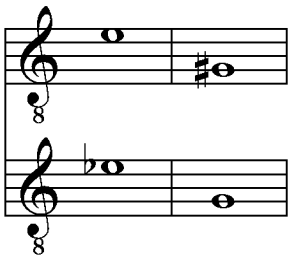

Figure 15b. Galilei, *Dialogo*, 5 (example 1c).

Figure 15b shows two semitones, both of which are the minor semitones (25:24) used within minor tones (d-e and G-a).[121] Galilei continues with many more examples that demonstrate the variety of interval sizes that would actually occur in Syntonic tuning. All of these discrepancies create the problem that in polyphony the vertical sonorities of many chords will differ, depending on the location of the major and minor tones. On pages 7-29 of the *Dialogo*, Galilei calculates the possible sizes for every interval within the octave. He shows a 40:27 fifth produced by combining the 4:3 fourth with 10:9 tone, and a 128:81 minor sixth, which is comprised of a 64:45 semidiapente and the 10:9 tone.[122]

Galilei's interlocutor Piero Strozzi summarizes the entirety of these tuning exercises with the following problem:

> If all modern practicing contrapuntists use in their compositions tones and semitones in any ratio whatever willy-nilly on any step without being able to demonstrate any of the concerns you showed, I cannot imagine how this can happen without the hearing being aware of the many discrepancies that you proved with efficacious reasons should continually come up. And if they do not

[120] I.e., (9x15):(8x16) = 135:128.
[121] I.e., (10x15):(9x16) = 150:144 = 25:24.
[122] Galilei, *Dialogo*, 17-19; *Dialogue*, 50-54.

> occur, a major obstacle intrudes: many maxims proposed by the theorist are totally useless, impertinent, and false. Among these are two already mentioned: the position and difference in the site and value of the tone, and the major, minor, and intermediate semitones. All that you have discussed with me so far may be put under these two headings, if I understood rightly.[123]

Strozzi's speech describes a riddle that Zarlino must solve. If singers and instrumentalists really use the Syntonic, why do we not hear all of the dissonances that should be produced by it? It should also be noted that Strozzi, as a cavalier musical amateur, aims his attack on the "theorist" who does not seem to understand how musical systems work in reality.

Zarlino's simple defense against this exercise demonstrates the extent to which he and Galilei are actually discussing two different styles of composition and performance. Zarlino claims that these dissonances are irrelevant "because such intervals are not (as I have said) of the Syntonic species; nor do they enter into any composition."[124] When he says that the intervals are not of the Syntonic species, Zarlino is speaking of the natural species of the Syntonic in which voices will never sing a 128:81 minor sixth or a 40:27 fifth.[125] Consequently, the many dissonances that are caused by the Syntonic would only

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[123] Galilei, *Dialogo*, 29: "Se ciascuno de moderni prattici Contrapuntisti, vsa in qual si voglia sua Cantilena, il Tuono, et Semituono di qualunque proporzione, in qual si voglino corde, à caso, et senza essere non che altro capaci di alcuna delle mostrate considerationi; non mi sò imaginare da quello possa nascere, che non si manifestino al purgato vdito tante discrepanze, che realmente mi hauete prouato con efficaci ragioni douerci del continouo interuenire. et non nascendoui, ne seguirà vno inconueniente di questo maggiore; il quale sarà, che molte delle cose proposteci dal Teorico per massime, saranno totalmente inutili, impertinenti, et non punto vere: tra le quali saranno le due già dette circa la positione et differenza del sito et valore del Tuono, et Semituono maggiore, minore, et medio. ne quali due capi (per quanto però ho compreso) è principalmente fondato tutto quello che sin quì meco hauete ragionato"; trans. in *Dialogue*, 76.

[124] Zarlino, *Sopplimenti* IV.5, 138: "poiche cotali Interualli non sono (come hò detto) della specie Syntona; ne entrano in alcuna compositione."

[125] In addition to claiming that these intervals are not in the Syntonic, Zarlino cites his own *Dimostrationi harmoniche* (II. prop. 30) in which he proved that the fifth can be constructed only with a 4:3 fourth and a 9:8 tone. See Zarlino, *Dimostrationi harmoniche* (Venice: Francesco de' Franceschi Senese, 1571; reprint in Monuments of Music and Music Literature in Facsimile, II/2, New York: Broude Brothers, 1965), 132-33.

occur on untempered instruments. For proof, Zarlino needed only cite the experience of hearing modern performances in which the aforementioned dissonances are absent. Having disputed Galilei's interval theory, Zarlino turns to a terminological defense of the Syntonic.

Error no. 2 (IV.6): They also wish to prove their opinion to be true with reasons that are apparently persuasive and sophisticated (and not with those that they make by chance) and that may be demonstrative. From this, therefore, they come to commit many errors. First they say that the sixteen intervals shown above are principles, and I do not see by what reason they should be simply called principles, inasmuch as (speaking universally and absolutely) that which is first in order—before which no other is found, after which follow those that are "principled"—is called "principle."[126]

To expose Galilei's second error, Zarlino turns to an obscure passage from the *Dialogo* and uses it as a springboard to continue his defense of the Syntonic. His primary goal in this discussion is to further prove that dissonances do not occur in his tuning system. In the *Dialogo*, Galilei asserts that contemporary audiences have become so accustomed to diminished fifths and augmented fourths that the true ratios of the intervals, 3:2 and 4:3, almost sound harsh to the ears:

> Consider just from this single abuse the imperfection of the music of our times, how much the general public is deceived, and how little understanding it has of the true music, not having known until today either the size or the quality and nature of singable and audible intervals, which are its simple elements and principles.[127]

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[126] Zarlino, *Sopplimenti*, IV.6, 140: "VOGLIONO anco prouar questa loro opinione esser uera, con ragioni apparenti persuasiue e soffistiche, e non con quelle che fanno al caso, che siano demostratiue: onde da questo uengono à commetter molti errori. Prima dicono, che i sumostrati Sedeci interualli sono Principij; e non sò uedere, per qual cagione si possino cosi semplicemente chiamar Principii; essendoche (parlando uniuersalmente et assolutamente) quello che è Primo in un'ordine, auanti il quale non se ne troua un'altro; alquale seguitino quelli, che sono principiati, è detto Principio."

[127] Galilei, *Dialogo*, 55: "Hora considerate da questo solo abuso, l'imperfettione della Musica de nostri tempi; et di quanto l'vniuersale s'inganni, et quanto male ageuolmente possa la verità delle cose conoscere, et quanta poca cognitione habbia della vera musica; non hauendo sin al dì d'hoggi conosciuto ne anco la grandezza, non che la qualità et natura degl'interualli cantabili et vdibili, che sono i semplici suoi elementi et principij"; trans. in *Dialogue*, 133. Palisca elides Galilei's use of "principij"; the passage has been amended to reflect Zarlino's reference to that specific term.

Galilei certainly did not intend his use of "principij" to be regarded with the philosophical rigor Zarlino applies to it. Strozzi and Bardi are much more concerned with the practical aims of their discussion. Nevertheless, in an earlier chapter of the *Sopplimenti* (II.3), Zarlino contrasts the terms "principle" and "element," noting that while an element must have matter and form, the principle has neither because it cannot be made or composed.[128] Musical intervals, such as the "singable and audible intervals" mentioned by Galilei cannot be considered as principles because an interval is composed of a form (ratio) and matter (sound). Nor, according to Zarlino, can all of the intervals be considered as elements; the only intervals that share the proper qualities of elements are the three components of the Syntonic tetrachord: the 9:8 and 10:9 tones and the 16:15 semitone.[129]

Zarlino's attack on Galilei's "principij" has a larger purpose in the *Sopplimenti* than wrangling over terminology. As noted in the discussion of Error 1, it was important for Zarlino to show that the many dissonances discussed by Galilei were not relevant to the use of Syntonic tuning. Galilei's casual use of the terms *principij* and *elementi* may seem a minor issue, but by focusing on this aspect, Zarlino shifts the tuning question away from its practical concerns to the realm of natural philosophy. It is at this point in the *Sopplimenti* that Zarlino introduces the aforementioned tripartite scale system. He notes that the smaller semitones and the Syntonic comma, which cause many of the dissonances shown by Galilei, are smaller than the elements of the Syntonic tetrachord but are only accidents that appear in the artificial scales of the Syntonic. Zarlino explains the difference in practical terms:

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[128] Zarlino, *Sopplimenti* II.3, 48: "ogno Elemento è composto almeno di materia e di forma, e lo Principio non è, ne si può dire fatto, ne composto."

[129] Ibid., 49.

> But the Greatest System that one makes naturally with voices was not limited by some number of strings or by other intervals or limits, so that it would not be free and restricted between some limits or spaces. For in leaping or descending, voices can, as we have said many times, make themselves high or low, insofar as the reason of the intervals that are adopted in the species will allow without some contradictions, inasmuch as after the song is finished, no interval is seen that remains in action among those they sing. Rather, they remain in pure potentiality in the artificial instruments among their strings and holes, for they have the intervals and their forms made according to the model to which they are tuned and tempered, even if they are outside of their true and natural forms or proportions.[130]

Although Zarlino only mentions the artificial scale for tempered instruments, the same is true for the other artificial scale based entirely on mathematical ratios. Both scales are restricted either by the limits of the instruments or by the ratios. Having demonstrated that the only elements relevant to the natural scale are the 9:8 and 10:9 tones and the 16:15 semitone, Zarlino rests on his claim from Book I, chapter 6 in which he notes that if "anyone shall wish to argue and conclude from a thing of art, as I have said, or from the artificial about a thing of nature or about the natural, he will turn out (so to speak) to wish to conclude from the things contained in one genus about those that are contained in another."[131] Zarlino's assertion, drawn from Aristotle's *Posterior Analytics* (1.7), is the foundation of his defense of Syntonic tuning, although it also left him vulnerable to Galilei's ridicule in the 1589 *Discorso*.

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[130] Ibid. IV.6, 141-43: "Ma il Systemo massimo; che si fà naturalmente con le Voci, non è terminato d'alcun numero di chorde; ò d'altri interualli ò altri termini, di modo che non sia libero, & non ristretto tra alcuni termini ò spacii; percioche le Voci possono nel salire & nel discendere; come molte fiate habbiamo detto; farsi acute ò graui, quanto porta la ragione de gli Interualli, che s'adoperano nella Specie, senz'alcuna contradittione; essendoche dopo che la Cantilena è finita, non si uede alcun'Interuallo, che resti in atto tra coloro che cantano; ma si bene in potentia restano ne gli Istrumenti arteficiali tra le chorde ò fori loro; percioche hanno gli Interualli e forme loro, fatte secondo'l modello, alquale sono accordati e temperati; se ben sono fuori delle lor uere e naturali Forme ò Proportioni."

[131] Ibid. I.6, 24: "alcuno da una cosa dell'Arte, come hò detto ouer dall'Arteficiale uorrà argomentare e concludere in una cosa della Natura ò nella Naturale, uerrà (per modo di dire) à uoler concludere dalle cose contenute in un Genere à quelle che sono contenute in un'altro."

Error no. 3 (IV.7). These things that have been narrated [in Errors 1 and 2] were the causes or reasons that gave spirit to these new contemplators to add another not very real [reason] in order to show that we sing tuned or tempered intervals contained in their accidental forms and not the true intervals contained in their natural forms.[132]

The third error is really a continuation of Error 1. In this case, Galilei claims that assemblages of perfect consonances will not be equal to groupings of perfect and imperfect consonances. In the *Dialogo*, Bardi describes the problem to Strozzi:

> To make you know even better the variability of the intervals of this [Syntonic] distribution, ask those who insist that it is the one we sing today to divide however they like the major thirteenth [octave plus major sixth], which in the Syntonic has the ratio 10:3, into three 3:2 fifths that they say it contains. Then ask them to divide the minor tenth in the ratio 12:5 into three 4:3 fourths. Then ask them by how much the latter interval [triple fourth] is surpassed by the former [minor tenth].[133]

Indeed, three consecutive 3:2 fifths would produce the ratio 27:8, which is larger than 10:3 by the Syntonic comma (81:80).[134] Likewise, three 4:3 intervals will produce the ratio 64:27, which is smaller than 12:5 by one Syntonic comma.[135] Zarlino responds that it is quite obvious to anyone that the groups of fifths and fourths will be unequal to the 10:3 and 12:5 intervals, but that it is only a concern in tempered instruments that would be limited by their tunings.

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[132] Ibid. IV.7, 143: QVESTE cose, che si sono narrate, furono le cagione ò ragioni lequali diedero animo à questi Noui contemplatiui, d'aggiungeruene un'altra non molto reale, per mostrar che cantiamo gli Interualli partecipati ò temperati, contenuti nelle lor forme accidentali, e non i ueri, contenuti nelle lor forme naturali."

[133] Galilei, *Dialogo*, 30: "Et per maggiormente farui conoscere la variabilità degli interualli di questa Distribuitione, dite vn poco à coloro, che vogliano che ella sia quella, che si canta hoggi; che vi diuidino in qual si voglia maniera, la Terzadecima maggiore contenuta secondo il Syntono da questi numeri 10.3. in tre Sesquialtere come essi dicono che ella contiene? ditegli ancora secondo l'essempio che segue appresso, che vi diuidino in tre Sesquiterze, la dupla Superbipartientequinta, forma della Decima minore? e domandategli appresso, di quanto questo interuallo sia da quello superato?"; trans. in *Dialogue*, 79.

[134] To add three consecutive intervals of the same size, one can simply cube each term in the interval. E.g., $3:2+3:2+3:2 = 3^3:2^3 = 27:8$; $27:8-10:3 = (27x3):(8x10) = 81:80$.

[135] To add consecutive fourths, the same continuous proportion is set up: $4:3+4:3+4:3 = 4^3:3^3 = 64:27$; $12:5-64:27 = (12x27):(5x64) = 325:320 = 81:80$.

Zarlino continues the discussion in a manner that suggests a new tack in his dispute with Galilei. He refers to the "new contemplators" at the opening of the chapter and later calls his opponents "modern speculators."[136] Having asserted that natural voices will sing consonant intervals regardless of the ratios produced in the artificial scale, Zarlino attempts to characterize Galilei's attack on the Syntonic as a speculative rather than practical matter. For example, after demonstrating that these problems occur only in artificial instruments, Zarlino further suggests that if artificial instruments were used to determine the perfection and imperfection of tuning systems, we should consider adding together the fifths and fourths used in systems of keyboard temperament. As has been discussed above in chapter 1, Galilei adapted Zarlino's own system of temperament in the *Dialogo*. Zarlino now supposes that if one were to combine three of the tempered fifths together, they would be smaller than 27:8 by 6/7 of the Syntonic comma.[137] Likewise, three tempered fourths would be larger than 64:27 by the same amount. Zarlino, then, is not so much disputing Galilei's claims as he is noting that an overly speculative analysis of any tuning system will reveal many problems. Later in the chapter, he further challenges Galilei to calculate the size of three combined fifths in a scale of equal-tempered semitones. Assuming that Galilei cannot solve the equation, for these ratios will be "not only irrational, but also indeterminately irrational," Zarlino repeats that one cannot conclude anything about the natural Syntonic by comparing intervals in the artificial scale.[138]

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[136] Zarlino, *Sopplimenti* IV.7, 145: "Speculatiui moderni."

[137] In Galilei's 4/7 comma keyboard temperament, the perfect fifth is tempered by 2/7 comma, therefore, three combined tempered fifths would be smaller than three 3:2 fifths by at least 6/7 comma.

[138] Zarlino, *Sopplimenti* IV.7, 145-46: "Non dirò solamente irrationali; ma etiandio irrationali indeterminate."

Error no. 4 (IV.8). The fourth reason or fourth manner they adduce to prove their opinion true is no less fallacious than are the others, inasmuch as this is the foundation of the following, as we shall see. With a very long and fastidious speech, by means of numbers or proportions of the intervals contained in the just shown Greatest System, they wish, like good *abachisti*, to confirm as true what they have forced themselves to show with those reasons and examples we have produced in the three preceding chapters. And they do so either by subtracting, in vain, the proportions of said smaller intervals from the larger intervals of the Syntonic, either natural or artificial (these make their point: the one from the other, showing the sums or remainders and the excesses with the defects, by how much the one surpasses or is surpassed by the other), or by adding two or more proportions together, demonstrating by what quantity the intervals so added come to be larger or smaller than what they propose.[139]

In composing this chapter, Zarlino may have noticed that mathematics were not really the problem, for near the conclusion he claims that the mathematical demonstrations are not to be blamed. Furthermore, he later rephrases the fourth error in this generic manner: "And this is the fourth manner: by seeking to stabilize the other [errors] they have fallen into a trap from which they can never regain their footing after being entangled."[140] Ambiguity aside, it is not the accuracy of Galilei's equations that is problematic but the terms that are being added and subtracted. Among the examples cited in the chapter, Zarlino focuses on Galilei's assertion that a combined 6:5 minor third and a 9:8 tone will produce a dissonant 27:20 fourth.[141] In this case, Galilei points out one of

[139] Ibid. IV.7, 146: "LA Quarta ragione, ò Quarto modo ch'adducono à prouar questa loro opinione esser uera; non è di minor fallacia di quello che siano l'altre; essendo questa il Fondamento della seguente, che uederemo: imperoche con una lunghissima e fastidiosissima diceria, col mezo de i Numeri ò Proportioni de gli Interualli contenuti nel già mostrato Systema massimo; uogliono, come buoni Abachisti, confermar esser uero quello, che s'hanno sforzato di mostrar con quelle ragioni et essempii, c'habbiamo addotto ne i tre Capitoli precedenti; et ciò fanno, ò col sottraher uanamente le proportioni de i sudetti Interualli minori da i maggiori del Syntono ò Naturale arteficiale, lequali fanno al proposito loro, l'una dall'altra; mostrando gli auanzi ò residui, e gli eccessi con i difetti, di quanto l'uno superi, ò sia superato dall'altro; ò co'l sommare due ò più proportioni insieme; dimostrando di quanta quantità uengono gli Interualli cosi sommati, tanto i maggiori, quanto i minori, di quelli che propongono."

[140] Ibid., 149: "Et questo è il Quarto modo, co'l quale cercando di stabilire gli altri, uanno à cadere in un laccio; dal quale mai non potranno ritrarre i piedi, dopo l essersi auiluppati."

[141] I.e., 6:5+9:8 = (6x9):(5x8) = 54:40 = 27:20.

the principal deficiencies in the Syntonic tuning system, the A-d fourth.[142] Zarlino must have been well aware of this problem, and his impatience in defending the Syntonic against it is obvious in his response: "Who (please) is so foolish and so ignorant of proportions that without even subtracting the form of the major tone from that of the minor third, he would not know . . . this thing to be more than manifest?"[143] His exasperated reply is followed by further insistence that this dissonant interval is only relevant to the artificial scale and would never be heard in the natural scale used by voices.

The issues in Book IV, chapter 8 center on Galilei's interval theory, but the chapter is most remarkable because of the degree of interconnectedness between its text and corresponding passages in Zarlino's *Istitutioni* and Galilei's *Dialogo* and *Discorso*.[144] In particular, the exchanges between Zarlino and Galilei show that both combatants have a penchant for combining unrelated passages in the opponent's writings to give the appearance that the opponent is contradicting himself. The following passage from Part III, chapter 13 of Zarlino's *Istitutioni* provides an example:

> To return, then, to the diapente, I say that when it is considered in its simple form, in which the extremes are unmediated by any intervening tone, it may be said to have only one species, since no diapente is larger or smaller in proportion than another; nor are the extremes in one more distant from each other or closer than in another.[145]

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[142] Zarlino's harmonically divided octave spans from C to c. In this configuration, the dissonant A-d fourth is obscured because the reader does not see the sequence of intervals A-B, B-c, and c-d in succession..

[143] Zarlino, *Sopplimenti* IV.8, 148: "Chi è colui (di gratia) tanto goffo e tanto ignorante delle Proportioni, che senza tanto sottraere la forma del Tuono maggiore da quella della Terza minore, non sappia . . . questa cosa esser più che manifesta?"

[144] Galilei also devotes two folios to this chapter in his final critique of the *Sopplimenti*. See Galilei, "Supplimenti musicali," **I**-Fn, Gal. 5, ff. 34r-36r.

[145] Zarlino, *Istitutioni* III.13, 159: "Ritornando adunque alla Diapente dico, che quando ella è considerata semplicemente, nel modo che è contenuta nelli suoi estremi termini, senza alcun mezo, si può dire, che tal consonanza sia di vna sola specie: percioche non si ritroua alcuna Diapente, che sia maggior di

This excerpt assumes that all fifths sung in performance will be of the same size. In its context (a discussion of the intervals used in counterpoint), Zarlino was not considering all of the various species of fifths created by combinations of intervals in the Syntonic. On the contrary, he was concerned only with its use in composing polyphony and does not address the tuning issue in any fashion. Nevertheless, in the *Dialogo*, Galilei's interlocutor Piero Strozzi takes the passage out of its original context and applies it to the tuning question:

> Strozzi: Mr. Gioseffo Zarlino specifically maintains that half a comma added or taken away from any consonant interval is enough to make it dissonant. But then he adds, for fun I think, that one should put aside considering the difference between the major and minor tones, which, when you take away the comma, erases the difference between the various species of semitones. Remove this single issue, and the diatonic that is sung today, if it is the syntonic of Ptolemy, becomes something else.[146]

Although Strozzi does not directly cite the *Istitutioni*, references to Book II, chapter 43 and Book III, chapter 13 in marginal postils clearly assign the sources of Strozzi's comments. The first statement, in which Zarlino says that the application or removal of a half comma may change a consonance to a dissonance, comes from a chapter in the *Istitutioni* that relates to tuning. The second claim, that Zarlino does not think that a comma has any consequence, is an interpretation of the preceding quotation about the species of perfect fifth. Galilei, therefore, has taken two passages from very different

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vn'altra, o minore di proportione; ne meno che gli estremi dell' vna siano più distanti, o più ristretti di proportione, di quelli di vn'altra"; trans. in Gioseffo Zarlino, *The Art of Counterpoint: Part Three of* Le istitutioni harmoniche, *1558*, trans. Guy A. Marco and Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 1968), 28.

[146] Galilei, *Dialogo*, 29: "volendo particolarmente Messer Gioseffo Zarlino che la metà habbia facultà aggiunta, ò tolta da qual si voglia interuallo consonante, di farlo dissonante: quantunque egli dipoi soggiunga (per ischerzo credo) che si debba lasciare da parte la consideratione della differenza de tuoni maggiori et minori; la quale tolta via ne porta seco quel la delle varie spezie de Semetuoni, et così al Diatonico che si canta hoggi (quando egli fusse il Syntono di Tolomeo) tolto gli questa sola consideratione (per il che è forse tale) viene à essere altro"; trans. in *Dialogue*, 76.

contexts and juxtaposed them to make broad claims about the nature of theory and practice. In fact, Strozzi's passage occurs in the *Dialogo* just after he suggests that "many maxims proposed by the theorist are totally useless, impertinent, and false.[147]

In the *Sopplimenti*, Zarlino does not refer to this passage from the *Dialogo* to deny Galilei's claims but to turn the argument back on his rival. If theory is not useful, why then is Galilei attempting to write about theoretical systems? After claiming that Galilei has either not read or perhaps not understood the chapters that contain the claims about the importance of the comma, Zarlino notes how the "speculators" who composed the *Dialogo* often say that "the practitioner, so ignorant, does not understand such things" even though Galilei (a practitioner himself) tries to prove his ideas "like a theorist, by means of the arithmetic faculty."

A recurring theme in the Zarlino-Galilei dispute is the ability of theoretical systems to explain what happens in a musical performance, and both writers tend to choose whichever side of the argument supports their opinion on any given subject. Zarlino's "natural scale" is a buffer that protects his Syntonic tuning from any attempts to disprove it on theoretical grounds. When it comes time to attack Galilei's 4/7 comma temperament, however, Zarlino applies the same kind of speculative analysis that Galilei used to disprove the Syntonic.

Error no. 5 (IV.9): They have finally, with another fallacy (no less than the others narrated), introduced a fifth manner by which they firmly believe they have concluded their thought to be true: i.e., the means of artificial instruments tempered according to their nature.[148]

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[147] Ibid.

[148] Zarlino, *Sopplimenti* IV.9, 149: HANNO questi ultimamente con un'altra fallacia, non minore dell'altre narrate, introdotto un Quinto modo, del quale si credono per fermo d'hauer concluso il pensiero loro esser uero; e questo è il mezo de gli Istrumenti arteficiali temperati descondo la loro natura."

The opening of Book IV, chapter 9 suggests that Zarlino now wants to discuss temperament, but this chapter is actually an introduction to the remaining eighty pages of Book IV. Stepping beyond discussions of Syntonic tuning, Zarlino now accuses Galilei of misappropriating the 2/7 comma temperament that Zarlino first discussed in Part II of the *Istitutioni*. He charges Galilei with explaining equal temperament in an erroneous fashion and falsely assuming that nature will sometimes imitate art.

After citing these errors, Zarlino focuses on one particular transgression in the *Dialogo*: Galilei's opinion that the ears of modern audiences have grown accustomed to fifths that are flatter than the 3:2 ratio and fourths that are sharper than 4:3. Galilei makes this claim on more than one occasion in the *Dialogo* and derives this opinion from his experience as a professional lutenist and his assumptions about the role of Aristoxenian tuning in modern music. He suggests that Aristoxenus's method for dividing intervals was similar to the manner in which frets are placed on a lute, that is, each semitone is treated qualitatively, as a discrete number of parts.[149]

The arguments offered in explaining the "fifth error" may be clarified if we consider a basic feature of these treatises. Both Zarlino and Galilei considered the tastes, preferences, and musical knowledge of their readership when they composed their writings. As noted in chapter 1, Galilei's habit of explaining theoretical processes through practical demonstrations does not communicate much about the theories, but it does reveal the method by which he conveyed ideas to his readers. In explaining 4/7 comma temperament, Galilei offered a practical experiment. He took Zarlino's idealized explanation of redistributing fractions of a comma among intervals to create consonant thirds and sixths and translated it into a practical activity in which musicians sitting at a

[149] Galilei, *Dialogo*, 53; *Dialogue*, 128.

keyboard could quickly sharpen and flatten notes by very small amounts, using their ears to discern the correct intervals.[150] Neither Zarlino nor Galilei ever discussed how their temperament systems could actually be put into practice, but their methods rang true among their supporters. Impressing one's audience, however, is not the same as applying rigorous standards to one's theories, and both authors often left themselves open to repudiation. Considering Zarlino's reaction to the *Dialogo* and Galilei's retaliation in the 1589 *Discorso*, it appears that neither writer ever felt it necessary to accept defeat. They might not have admitted it, but musical science benefitted from both authors, who were ruthless in finding inconsistencies in each other's works.

Conclusion

In the *New Grove Dictionary* entry on "Just Intonation," Mark Lindley notes that Zarlino's "metaphysically inspired nonsense was to prove a stimulating irritant in the early development of experimental physics."[151] The defense of Syntonic tuning in the *Sopplimenti* certainly had its critics; Galilei was especially hostile towards the *Sopplimenti* in his 1589 *Discorso* and unfinished "Critique."

Other writers found value in both theorists' views on tuning. In his *Speculationi di musica*, the mathematician Pietro Mengoli suggested that one should look to Galilei for information about tuning lutes for use in chamber music and use Zarlino's methods when tuning the organ in church.[152] Mengoli's treatise includes many speculative ideas about intervals and music in general, but his reference to Zarlino and Galilei highlights a crucial

[150] See pp. 78-82 *supra*.

[151] Mark Lindley, "Just Intonation," in *The New Grove Dictionary of Music and Musicians*, ed. Stanley Sadie and John Tyrrell, 2d ed., 29 vols. (London: Macmillan, 2001), 13:291.

[152] Pietro Mengoli, *Specvlationi di mvsica* (Bologna: L'herede del Benace, 1670), 265.

aspect of their dispute: each writer was defending a tuning system applicable to the type of music in which he and his patrons were most interested.

In the *Sopplimenti musicali*, Zarlino appealed to the notion of music as a timeless set of laws and regulations. He claimed to have elucidated these rules in the *Istitutioni*, proved them in the *Dimostrationi*, and defended them against progressive detractors such as his former student Vincenzo Galilei. The *Sopplimenti* was Zarlino's final attempt to codify the musical foundations that governed the polyphonic idiom he and his colleagues considered to be the perfection of musical science.[153]

If we continue to view Zarlino's arguments as outdated or unscientific, we will fail to understand why writers still championed his works for generations after they were published. Artists who believed that music stemmed from timeless, universal rules continued to find value in Zarlino's writings. Even as late as the nineteenth century, the music historian François-Joseph Fétis (1784-1871), writing on the Zarlino-Galilei debate, was certain that "all the advantage of this discussion rests with Zarlino."[154]

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[153] Zarlino does present many new ideas in the *Sopplimenti*, but they are not the focus of this dissertation. For example, Don Harrán has remarked that Book VIII, chapter 13 contains the first substantial discussion of Hebrew music by a European music theorist. See Don Harrán, *In Search of Harmony: Hebrew and Humanist Elements in Sixteenth-Century Musical Thought*, Musicological Studies and Documents, no. 42 (Neuhausen-Stuttgart: American Institute of Musicology, 1988), 1-23.

[154] François-Joseph Fétis, *Biographie universelle des musiciens et bibliographie générale de la musique*, 2d ed., 8 vols. (Paris: Firmin Didot Frères, 1865), 8:511: "Tout l'avantage de cette discussion resta à Zarlino."

Chapter 3

Modality in Sixteenth-Century Music Theory

Introduction

The amount of quotation and criticism of the *Dialogo* in Book IV of Zarlino's *Sopplimenti* is indicative of the extent to which Galilei influenced his former teacher. The Venetian *maestro di capella* was clearly angered by the overtly harsh reception his work received from his erstwhile student, and even though he claims that he bears no grudge against his rival, Zarlino certainly intended Book IV of the *Sopplimenti* to destroy Galilei's credibility. Zarlino's defense of Syntonic tuning may represent his most impassioned rebuttal to Galilei, but his writings on scales and modes in Books V and VI are equally important because they were undertaken to protect his legacy as a scholar of practical music and to show his readers that the 12-mode system was just as natural as Syntonic tuning.

In Book I, chapter 1 of the *Sopplimenti*, Zarlino cites the Syntonic tuning as a component of speculative music and an inherent truth of musical science. The 12-mode system, on the other hand, he characterizes as an attempt to describe contemporary music, especially polyphonic songs.[1] Zarlino writes specifically about the practice in this first chapter:

> It never was nor is it now my intention to write about the usage of [musical] practice according to the fashion of the ancients, Greek or Latin (even if at times I have concealed it),[2] but only the fashion of those who have found this new manner of singing together many parts with different modulations and different airs, and especially according to the way and fashion held by Adrian Willaert, the

[1] Zarlino, *Sopplimenti musicali* I.1 (Venice: Francesco de' Franceschi Senese, 1588; reprint in Monuments of Music and Music Literature in Facsimile, II/15, New York: Broude Brothers, [1979]), 9.

[2] I.e., concealed his intentions by writing about ancient theory.

> most excellent practitioner of great judgment, of the happiest and most prolific memory, of great experience in music, and my teacher in matters of musical practice.[3]

Zarlino's desire to be remembered as the true musical heir of Adrian Willaert has been discussed above with regard to the *Dimostrationi harmoniche*,[4] and in the *Sopplimenti*, Zarlino evokes his master's name with a new purpose. After mentioning Willaert, he immediately turns to his 12-mode system, thereby tacitly promoting the modal system as an outgrowth of Willaert's teachings. In Zarlino's writings, Willaert represents an authority of musical practice parallel to Ptolemy as an authority of theory. Because Ptolemy's *Harmonics* was considered by many sixteenth-century theorists to be the finest ancient treatise on music, it served as an appropriate authority upon which Zarlino could model his Syntonic tuning. Likewise, the contrapuntal style of Willaert, which was still practiced by many composers of the day, was a suitable practice to which Zarlino could anchor his modal system.

Zarlino's evocation of his former teacher may also be an attempt to divert attention from the origins of the 12-mode system. Although Zarlino's explanation of counterpoint in Part III of the *Istitutioni* is certainly based on Willaert's compositional

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[3] Zarlino, *Sopplimenti* I.1, 9: "Ne fu mai ne anco è mia intentione di scriuer l'uso della Prattica secondo'l modo de gli Antichi, ò Greci, ò Latini, se bene alle fiate la uò adombrando; ma solamente il modo di quelli, c'hanno ritrouato questa nostra maniera, nel far cantar insieme molte parti, con diuerse Modulatione, e diuerse Aria, e specialmente secondo la uia et il modo tenuto d'Adriano Vuillaert, prattico eccellentissimo, di giudicio grande, di felicissima e fecondissima memoria, e di grande, isperientia nella Musica, e nelle cose della Prattica mio Precettore." Giulio Cesare Monteverdi noticed Zarlino's reference to the "practice" of Adrian Willaert and commented on this quotation in his "Dichiaratione [Explanation]" of his brother's *seconda prattica*. Although Giovanni Maria Artusi denied that Zarlino was advocating that there was more than one practice, Monteverdi's comment suggests that some musicians of the time saw Zarlino's theoretical systems as relevant only for particular styles of composition. For an English translation of Giulio Cesare's "Explanation," see *Source Readings in Music History*, ed. Oliver Strunk, rev. ed., ed. Leo Treitler (New York: Norton, 1998), 535-44. Artusi's response is found in a short discourse he composed under a pseudonym. See Antonio Braccino da Todi, *Discorso secondo musicale* (Venice: Giacomo Vincenti, 1608; reprint in Collezione di trattati e musiche antiche edite in facsimile, Milan: Bollettino bibliografico musicale, 1934), 15.

[4] See pp. 51-52 *supra*.

style, Claude V. Palisca notes in his introduction to Vered Cohen's translation of Part IV, where the 12-mode system is first described, that the system grew out of Zarlino's personal research into music theory.[5] In particular, Zarlino relied on Heinrich Glarean's *Dodecachordon* (Basle, 1547), which—like Ptolemy's *Harmonics* and Lodovico Fogliano's *Musica theorica*—was on the list of treatises Zarlino was planning to translate into Italian for the *Accademia della Fama*.[6] Zarlino does not acknowledge the *Dodecachordon* anywhere in the *Istitutioni*, but it is obvious that he appropriated Glarean's ideas.

Like Zarlino, Glarean sought to articulate a modal system that could describe contemporary polyphonic compositions. Writing in northern Europe, however, Glarean was also concerned with defending the music of the Catholic Church against Lutheran reformers. To this end, the theoretical systems he created and his many appeals to ancient authority are intended to show that the musical practices of Catholicism, and in particular Gregorian chant and polyphonic service music, are justified in ancient music theory.[7] Glarean did not write the *Dodecachordon* for practicing musicians, and his readers were not expected to learn how to compose or perform music. On the contrary, the 12-mode system in Glarean's treatise is used solely as an analytical tool for understanding sacred music. It is therefore ironic that Zarlino would adapt the 12-mode system for the

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[5] Gioseffo Zarlino, *On the Modes: Part Four of* Le istitutioni harmoniche, *1558*, trans. Vered Cohen, ed. with an introduction by Claude V. Palisca, Music Theory Translation Series (New Haven, CT.: Yale University Press, 1983), vii.

[6] Iain Fenlon, "Gioseffo Zarlino and the Accademia Venetiana della Fama," in *Music and Culture in Late Renaissance Italy* (Oxford: Oxford University Press, 2002), 128. For a discussion of Zarlino's role in the *Accademia della Fama*, see pp. 45-47 *supra*.

[7] Glarean was a friend of the most prominent proponent of northern humanism, Desiderius Erasmus. Although Erasmus did not show much interest in music, he praised Glarean's erudition in a 1517 letter to Wolfgang Capito (EE 541). See Hans J. Hillebrand, ed., *Erasmus and His Age: Selected Letters of Desiderius Erasmus* (New York: Harper & Row, 1970), 109. For more information about the humanistic elements in the *Dodecachordon*, see Sarah Fuller, "Defending the *Dodecachordon*: Ideological Currents in Glarean's Modal Theory," *Journal of the American Musicological Society* 49 (Summer 1996): 191-224.

Istitutioni, for he views modality as an important pre-compositional tool in the creation of polyphonic music.[8] Furthermore, although Zarlino saw little congruence between ancient and modern music or between ancient and modern modes, Glarean insisted that his system was just as applicable to ancient music as it was to the polyphony of the early sixteenth century, especially that of Josquin des Prez.[9]

Zarlino surely took notice of the combination of medieval theory and ancient authority Glarean espoused in presenting the 12-mode system. In a manner anticipating Zarlino's proof of Syntonic tuning in the *Istitutioni*,[10] Glarean drew on basic Pythagorean concepts to form the modes, such as harmonically divided octaves and simple ratios. Glarean approached the construction of his modal system with the same idealism Zarlino would later apply to the Syntonic tuning, as will be demonstrated below.

Constructing the Renaissance Octave in Glarean's *Dodecachordon*

In the *Dodecachordon*, Heinrich Glarean states categorically: "Musical modes are nothing other than the consonant species of the octave; they are produced from the different species of fourths and fifths."[11] In a lengthy description of his modal system in

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[8] Scholars have debated the use of modes in sixteenth-century music, often drawing the line between considering mode as, on the one hand, a pre-compositional tool and, on the other, a significant trait for analysis and classification. For information on the use of mode as a pre-compositional tool, see Bernhard Meier, *The Modes of Classical Vocal Polyphony, Described According to the Sources*, trans. Ellen S. Beebe with revisions by the author (New York: Broude Brothers, 1988). Harold Powers, on the other hand, views mode as a post-compositional device. See Harold Powers, "Tonal Types and Modal Categories in Renaissance Polyphony," *Journal of the American Musicological Society* 34 (Fall 1981): 428-70.

[9] Because Josquin was admired by both Catholic and Lutheran scholars, he was an appropriate choice to be singled out as a model composer in the *Dodecachordon*.

[10] See pp. 57-62 *supra*.

[11] Heinrich Glarean, *Dodekachordon* I.11 (Basle: Heinrich Petri, 1547; reprint in Monuments of Music and Music Literature in Facsimile, II/65, New York: Broude Brothers, 1967), 29: "Modi musici nihil aliud sunt quam ipsius Diapason consonantiae species quae et ipsae ex uarijs diapente ac diatessaron speciebus conflantur." Unless noted otherwise, all translations are from Heinrich Glarean, *Dodecachordon*,

Book II, Glarean explains the derivation of twelve modes from these octave species and argues that they are consistent with ancient and modern musical practice.

The *Dodecachordon* relies heavily on Boethius's *De institutione musica* while also drawing on the medieval tradition. In expanding the common 8-mode system, Glarean cites Bern of Reichenau, a tenth-century composer and theorist, as having mentioned "four other modes, so that there were twelve in all, so far has the truth about the twelve modes left some trace even among the men of so barbarous an age."[12] Not concerned with distinguishing between ancient and medieval theory, Glarean creates an "extraordinary synthesis of medieval tradition" in a humanistic attempt to unify contemporary modal usage with past theoretical traditions. [13]

Octaves, fourths, and fifths can be constructed in many different ways, but in Glarean's system (*Dodecachordon* I.8), fourths are clearly defined as containing two tones and a minor semitone, fifths as having three whole tones and a minor semitone; octaves are then formed solely by combining species of fourths and fifths so that the resulting octave can be viewed as divided by a harmonic mean or an arithmetic mean. As a result of this arrangement of intervals, there are only three species of fourth and four species of fifth. When combined, they produce twelve possible octaves for each type of division (harmonic or arithmetic), or twenty-four altogether. Only some of these, however, will be accepted by Glarean as modes.

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2 vols., translation, transcription and commentary by Clement Miller, Musicological Studies and Documents, no. 6 (n.p.: American Institute of Musicology, 1965), in the present case from p. 68.

[12] Glarean, *Dodekachordon* II.37, 165: "Quod Berno in Isagoge etiam longius tractat, sed eo deuenit, ut quosdam suisse dicat, qui IIII. alios Modos excogitarint, ut omnino duodecim essent Modi, adeo ueritas de XII Modis aliquid uistigij etiam apud tam barbari seculi homines habuit"; trans. in *Dodecachordon*, 197.

[13] Harold S. Powers and Frans Wiering, "Mode," in *The New Grove Dictionary of Music and Musicians*, ed. Stanley Sadie and John Tyrrell, 2d ed., 29 vols. (London: Macmillan, 2001), 16:807.

The rationale may require a brief reminder of the procedure explained in chapter 1.[14] To divide a ratio harmonically, a proportion is created in which the ratio of the extreme terms, in this case 2:1, is equal to the ratio of the differences between the harmonic mean and the extremes. For example, the octave ratio 2:1 can be harmonically divided by the proportion 12:8:6.[15] In terms of musical intervals, if the numbers are associated with string lengths (the larger numbers thus representing lower pitches), this arrangement places the fourth above the fifth.[16] In an arithmetic division, the difference between the terms is equal, as in 12:9:6.[17] In this proportion, the fourth falls below the fifth. By combining each species of fourth and fifth so that the octave is divided harmonically or arithmetically, Glarean determines which octave species can be properly considered as modes. He does not discuss string lengths or ratios when describing each interval in Book I, chapter 8, but in his discussion of consonances in chapter 9, he defers to the Pythagorean ratios by citing Book II, chapter 16 of Boethius's *De institutione musica*.

In Book II, chapter 3 of the *Dodecachordon*, Glarean exhibits each combination by aligning the solmization syllables of the species of fourth and fifth. He also comments on each ordering, applying a modal number or offering a reason for rejecting the octave.

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[14] See pp. 59-60 *supra*.

[15] The ratio of the extremes is 12:6, which can be reduced to 2:1. The differences of the inner ratios are 12-8 = 4 and 8-6 = 2; 4:2 = 2:1. The inner ratios are 12:8 = 3:2 and 8:6 = 4:3, which represent the perfect fifth and the perfect fourth.

[16] Glarean notes that if three strings are arranged so that the fifth is placed below the fourth, it is called "harmonic" because the sound is agreeable to the ears. If the fourth is placed below the fifth, however, the arrangement is called an "arithmetic" division because it agrees with numbers rather than the harmony (*Dodekachordon* II.3).

[17] That is: 12-9 = 3 and 9-6 = 3.

Figure 17 displays Glarean's visual demonstration of the combinations of fifths and fourths, and tables 8a-b show the results in terms of tones and semitones.[18]

[18] These interval species may be considered segments of the common solmization of the C or natural hexachord (*ut re mi fa sol la*). For example, the first species of fifth *re-la* is equivalent to the sequence of notes from d to a, or d e f g a, and the semitone occurs between e and f. The second fifth *mi-mi* and third fifth *fa-fa* contain repeated solmization symbols because these segments cross the boundaries of the traditional hexachordal arrangement of notes. Thus, *mi-mi* is equivalent to the fifth e-b, or e f g a b, and the semitone also occurs between e and f in this species. The third species *fa-fa* is equivalent to the scalar segment f to c, or f g a b c. Here the semitone occurs between b and c.

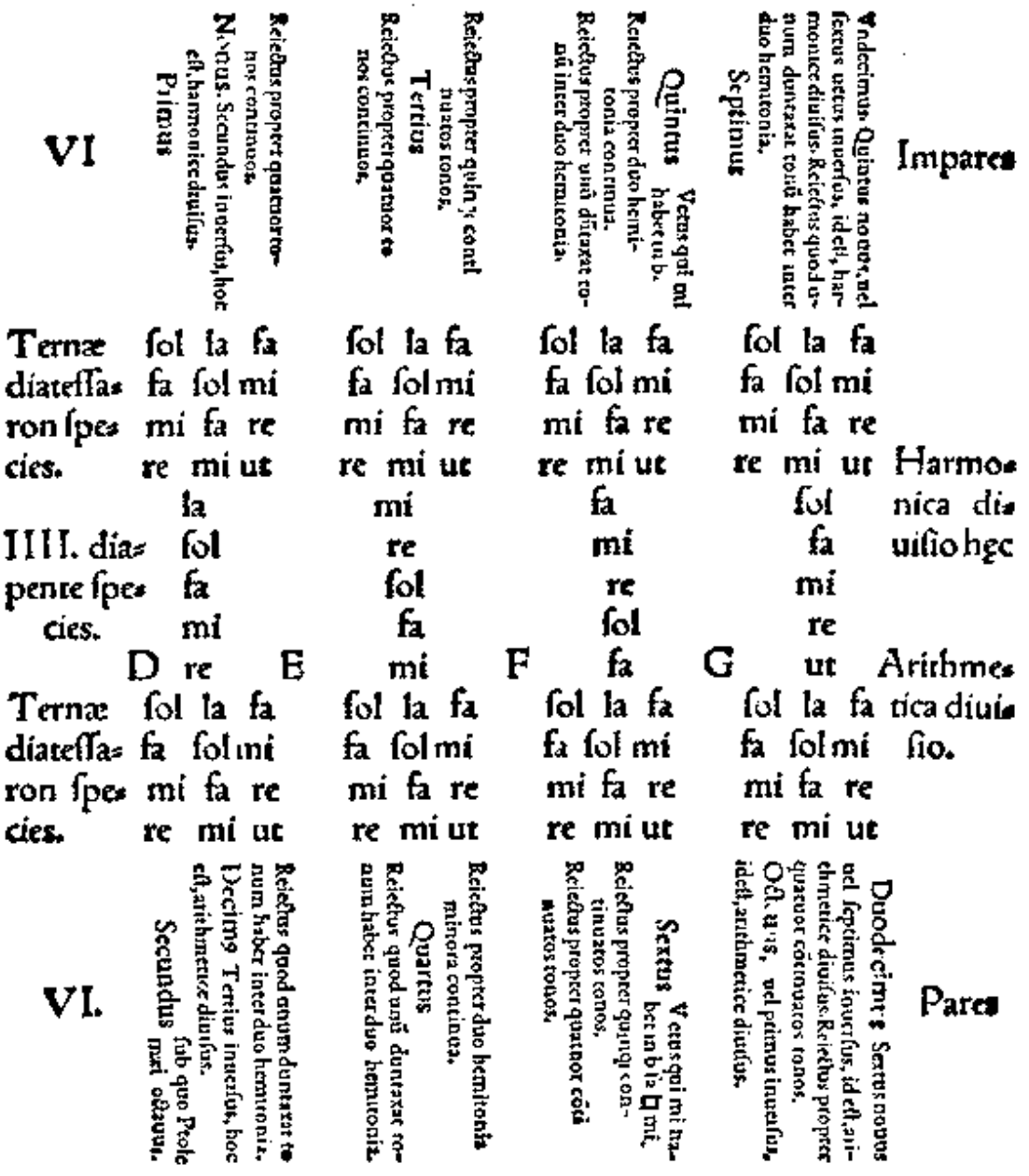

Figure 17. Combinations of species of fifths and fourths in Glarean, *Dodekachordon* II.3, 69.

Table 8a. Harmonic combinations of fourths and fifths in Glarean, *Dodekachordon* II.3, 69.

species of fifth	species of fourth	octave species	commentary
1.t-s-t-t (*re-la*)	1.t-s-t (*re-sol*)	t-s-t-t-t-s-t	Mode 1
1.t-s-t-t (*re-la*)	2.s-t-t (*mi-la*)	t-s-t-t-s-t-t	Mode 9, equivalent to mode 2 divided harmonically
1.t-s-t-t (*re-la*)	3.t-t-s (*ut-fa*)	t-s-t-t-t-t-s	Rejected—4 consecutive tones
2.s-t-t-t (*mi-mi*)	1.t-s-t (*re-sol*)	s-t-t-t-t-s-t	Rejected—4 consecutive tones
2.s-t-t-t (*mi-mi*)	2.s-t-t (*mi-la*)	s-t-t-t-s-t-t	Mode 3
2.s-t-t-t (*mi-mi*)	3.t-t-s (*ut-fa*)	s-t-t-t-t-t-s	Rejected—5 consecutive tones
3.t-t-t-s (*fa-fa*)	1.t-s-t (*re-sol*)	t-t-t-s-t-s-t	Rejected—1 tone between 2 semitones
3.t-t-t-s (*fa-fa*)	2.s-t-t (*mi-la*)	t-t-t-s-s-t-t	Rejected—2 consecutive semitones
3.t-t-t-s (*fa-fa*)	3.t-t-s (*ut-fa*)	t-t-t-s-t-t-s	Mode 5 (the old mode 5, which preserves bmi)
4.t-t-s-t (*ut-sol*)	1.t-s-t (*re-sol*)	t-t-s-t-t-s-t	Mode 7
4.t-t-s-t (*ut-sol*)	2.s-t-t (*mi-la*)	t-t-s-t-s-t-t	Rejected—1 tone between 2 semitones
4.t-t-s-t (*ut-sol*)	3.t-t-s (*ut-fa*)	t-t-s-t-t-t-s	Mode 11, also known as new mode 5 (which employs *bfa*) or old mode 6 divided harmonically

Table 8b. Arithmetic combinations of fourths and fifths in Glarean, *Dodekachordon* II.3, 69.

species of fourth	species of fifth	octave species	commentary
1.t-s-t (*re-sol*)	1.t-s-t-t (*re-la*)	t-s-t-t-s-t-t	Mode 2, from Ptolemy's octave
2.s-t-t (*mi-la*)	1.t-s-t-t (*re-la*)	s-t-t-t-s-t-t	Mode 10, equivalent to mode 3 divided arithmetically
3.t-t-s (*ut-fa*)	1.t-s-t-t (*re-la*)	t-t-s-t-s-t-t	Rejected—1 tone between 2 semitones
1.t-s-t (*re-sol*)	2.s-t-t-t (*mi-mi*)	t-s-t-s-t-t-t	Rejected—1 tone between 2 semitones
2.s-t-t (*mi-la*)	2.s-t-t-t (*mi-mi*)	s-t-t-s-t-t-t	Mode 4
3.t-t-s (*ut-fa*)	2.s-t-t-t (*mi-mi*)	t-t-s-s-t-t-t	Rejected—2 consecutive minor semitones
1.t-s-t (*re-sol*)	3.t-t-t-s (*fa-fa*)	t-s-t-t-t-t-s	Rejected—4 consecutive tones
2.s-t-t (*mi-la*)	3.t-t-t-s (*fa-fa*)	s-t-t-t-t-t-s	Rejected—5 consecutive tones
3.t-t-s (*ut-fa*)	3.t-t-t-s (*fa-fa*)	t-t-s-t-t-t-s	Mode 6, old mode 6, which preserves *bmi*
1.t-s-t (*re-sol*)	4.t-t-s-t (*ut-sol*)	t-s-t-t-t-s-t	Mode 8, equivalent to mode 1 divided arithmetically

2.s-t-t (*mi-la*)	4.t-t-s-t (*ut-sol*)	s-t-t-t-t-s-t	Rejected—4 consecutive tones
3.t-t-s (*ut-fa*)	4.t-t-s-t (*ut-sol*)	t-t-s-t-t-s-t	Mode 12, also known as new mode 6 (with *bfa*) or mode 7 divided arithmetically

In table 8, we can see the importance Glarean places on the position of tones and semitones in determining mode. The relative pitch of each octave is ignored in favor of a series of static octaves, centered around species of fifths. Four distinct orderings are grounds for the rejection of an octave species: 1) four successive whole tones; 2) five successive whole tones; 3) a single whole tone between two semitones; and 4) two successive semitones.[19] Glarean never explicitly explains why these combinations are inadequate, but they are rejected if they involve sequences of tones and semitones that would hinder the formation of perfect fourths and fifths, a rejection suggested by Aristoxenus in Book III of his *Harmonic Elements*.[20] Glarean's arrangement also leads him to identify "new fifth" and "new sixth" modes, which refer to the contemporary tendency of employing b fa in the Lydian and Hypolydian modes. He abhorred this practice because it changed the sequence of tones and semitones in the mode, obscuring its identity and lessening the potential for ethical effect. Thus, he was concerned more about singing the correct form of the mode than the proper notes of any given chant.[21]

[19] Glarean, *Dodekachordon* II.2, 68-69: "Porro quatuor de causis bis totidem abijcit, vel quod quatuor tonos habeant continuos, ut si quis primae speciei diapente re, la connectat, superne tertiam diatessaron speciem ut, fa. Vel quod quinque etiam tonos continuos, ut si quis secundae diapente speciei mi mi superne eandem diatessaron speciem ut, fa annectat. Vel quod unum duntaxat tonum inter duo hemitonia minora habeant, ut si tertiae speciei diapente fa fa, superne adijcias primam diatessaron speciem re, sol. Vel postremo quod duo habeant hemitonia minora continua. Vt si eidem tertiae diapente speciei, fa fa, connectemus superne secundam diatessaron speciem, mi, la."

[20] Thomas Mathiesen explains Aristoxenus's principle of fourth and fifths: "on this principle, either the fourth note in sequence should form the consonance of a fourth, the fifth note should form the consonance of a fifth, or both the fourth and fifth notes should form their respective consonances." See Thomas J. Mathiesen, *Apollo's Lyre: Greek Music and Music Theory in Antiquity and the Middle Ages*, Publications of the Center for the History of Music Theory and Literature, vol. 2 (Lincoln: University of Nebraska Press, 1999), 317.

[21] With respect to modal purity, Glarean follows the attitudes of the authors of his medieval sources. In *The Critical Nexus,* Charles Atkinson describes how Bern of Richenau and Johannes Affligemensis, among others, instructed their readers to alter chants when they did not perfectly fit a given

Upon determining an abstract set of octaves, Glarean puts them in modal space by combining them with a set of seven octave species derived from Book IV, chapter 15 of Boethius's *De institutione musica*,[22] along with the eighth, Hypermixolydian species, which he erroneously adds on Ptolemy's authority.[23] Glarean's octaves are listed in table 9.

Table 9. Octave species mapped onto the Greater Perfect System, from Glarean, *Dodekachordon* II.2, 66.

Pitches	Octave	Name
proslambanomenos – mese	A-a	Hypodorian
hypate hypaton – paramese	B-b	Hypophrygian
parhypate hypaton – trite diezeugmenon	C-c	Hypolydian
lichanos hypaton – paranete diezeugmenon	D-d	Dorian
hypate meson – nete diezeugmenon	E-e	Phrygian
parhypate meson –trite hyperbolaion	F-f	Lydian
lichanos meson – paranete hyperbolaion	G-g	Mixolydian
mese – nete hyperbolaion	a-aa	Hypermixolydian

Glarean claims that Ptolemy added the eighth octave, a-aa, so that the modes would fill out the Greater Perfect System from *proslambanomenos* to *nete hyperbolaion*.[24] The

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mode. See Charles M. Atkinson, *The Critical Nexus: Tone-System, Mode, and Notation in Early Medieval Music*, AMS Studies in Music, gen. ed. Mary Hunter (Oxford: Oxford University Press, 2009), 234-44.

[22] See Anicius Manlius Severinus Boethius, *De institutione musica libri quinque*, ed. Godofredus Friedlein (Leipzig: B. G. Teubner, 1867), 341-43.

[23] In the *Harmonics* (II.10), Ptolemy explicitly refers to an eighth tonos as superfluous. See Ptolemy, *Harmonics*, translation and commentary by Jon Solomon, Mnemosyne Supplementa, vol. 203 (Leiden: Brill, 2000), 88. Glarean may have copied this error from Boethius. See Boethius, *De institutione libri quinque*, 348; trans. in Anicius Manlius Severinus Boethius, *Fundamentals of Music*, translated with introduction and annotations by Calvin M. Bower, edited by Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 1989), 160.

[24] Glarean, *Dodekachordon* II.2, 66-67: "Hae sunt, quae totum negotium versant, septem illae diapason species, quae tamen disdiapason, maximum in musicis systema, non implent, sed tono deficiunt. Quod Ptolemaeus videns, a mese in neten hyperbolaeon, hoc est, ab a, ad Aa, geminatum, systema, natura

authority of Ptolemy (actually Boethius) is significant because it supports Glarean's expansion of the modal system. Although Boethius added an eighth mode to fill up the space in the Greater Perfect System, Glarean includes an eighth octave species in the *Dodecachordon* because it helps him demonstrate that there is an essential difference between octaves divided harmonically or arithmetically. By allowing the eighth species, he tacitly suggests that there is a difference between mode 2, Hypodorian, which is based on an arithmetic division, and the Hypermixolydian mode, which consists of the same octave species divided harmonically. To Glarean, the division of the octave is a clearer determinant of a specific mode than the final. The acceptance of the eighth mode, therefore, validates the addition of four modes to the eight-mode system:

> Thus, if the common eighth mode is different from the other seven true and incontestable modes only on account of the inversion of a system, it is necessary that the four remaining modes, the ninth, tenth, eleventh and twelfth, as we call them, also be admitted into the list of modes.[25]

Because the Hypermixolydian octave is identical to Hypodorian, both octaves are occupied by modes 2 (Hypodorian) and 9 (Aeolian). As he subsequently refers to the harmonically divided octave A-a as Aeolian, it would have been confusing for him to refer to the Hypermixolydian scale as one of the "incontestable" modes.

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cum primo, quod hypodorij est, prorsus idem, adiecit, constituitque octavum Modum, ab Hypodorio nihil differentem, eum autem Hypermixolydium vocauit, atque totum systema disdiapason hoc pacto completum est"; trans. in Glarean, *Dodecachordon*, 104-5: "These are the very seven octave-species about which the entire matter revolves, which however, do not fill out the double octave, the largest system in music, but are deficient by a whole tone. Ptolemy saw this and added from *mese* to *nete hyperbolaion*, that is from *a* to *aa*, a system which is identical in nature with the first or Hypodorian system, and he constructed the eighth mode, not different than the Hypodorian, but which he called Hypermixolydian, and in this way the entire double octave system was completed." Glarean's source for this error is probably Boethius's *De institutione musica* (IV.17).

[25] Glarean, *Dodekachordon* II.6, 75: "Quare si octavus vulgo alius est Modus ab septem illis veris atque indubitatis, idque ob unicum systematis inversionem, necesse est quatuor reliquos Modos, nonum, decimum, undecimum, ac duodecimum, quod nos ita nominamus, etiam in Modorum numerum admittere, . . . "; trans. in *Dodecachordon*, 114.

Through an analysis of the arithmetic and harmonic divisions of the octave, Glarean is able to justify adding four modes to the eight that were commonly accepted prior to his time. In Book I, chapter 11, he shows how most contemporaries assume an eight-mode system based on the four finals D, E, F and G.[26] The ambitus of the four authentic modes reaches about an octave above each final, and the range of plagals stretches from a fourth below to a fifth above the final. As these ranges correspond exactly to the harmonic and arithmetic divisions, Glarean proposes that any harmonic division of the octave that contains a perfect fifth below a perfect fourth is an acceptable mode. Likewise, any arithmetic division that contains a perfect fifth above a perfect fourth will also be valid. For example, because the final of Dorian is D, we know that the Hypodorian mode—based on the A-a octave—contains the fourth A-D below the fifth D-a; thus it exhibits an arithmetic division of the octave. By contrast, if we divide the octave harmonically, the fifth A-E falls under the fourth E-a. Glarean names this mode Aeolian on Aristoxenus's authority and even cites a polyphonic work by his near-contemporary Adam von Fulda to show that it is used in actual practice.[27] The plagal form of Aeolian is found by arithmetically dividing the Phrygian mode, E-e. Glarean uses the same process to explain the Ionian (or Iastian) mode, which is gleaned from the harmonic division of Hypolydian, C-c, while its plagal is the arithmetic division of Mixolydian, G-g. Table 10 shows the harmonic and arithmetic division of each octave species, as well as the resulting mode.

[26] Glarean, *Dodekachordon* I.11, 29-30.
[27] Ibid. II.4, 70.

Table 10. Twelve modes derived from harmonic and arithmetic divisions of the octave species in Glarean, *Dodekachordon* II.5, 72-74.

Octave Species	Arith. Div.	Mode	Harmonic Div.	Mode
Hypodorian: A-a	A-D; D-a	2. Hypodorian	A-E; E-a	9. Aeolian
Hypophrygian: B-b	B-E; E-b	4. Hypophrygian	B-F; F-b	Not harm. divisible due to tritone
Hypolydian: C-c	C-F; F-c	6. Hypolydian	C-G; G-c	11. Ionian
Dorian: D-d	D-G; G-d	8. Hypomixolydian	D-A; A-d	1. Dorian
Phrygian: E-e	E-a; a-e	10. Hypoaeolian	E-B; B-e	3. Phrygian
Lydian: F-f	F-b; b-f	Not arith. divisible due to aug. fourth.	F-c; c-f	5. Lydian
Mixolydian: G-g	G-c; c-g	12. Hypoionian	G-d; d-g	7. Mixolydian
Hypermixolydian: a-aa	a-d; d-aa	2. Hypodorian	a-e; e-a	9. Aeolian

Table 10 shows that out of fourteen possible divisions of the seven octave species, two modes are rejected because they cannot be divided harmonically or arithmetically. These exceptions would have formed an authentic/plagal pair on the final B. In Book II, chapter 7, Glarean offers a visual representation of this system to illustrate his Aristoxenian nomenclature of the modes (figure 18).

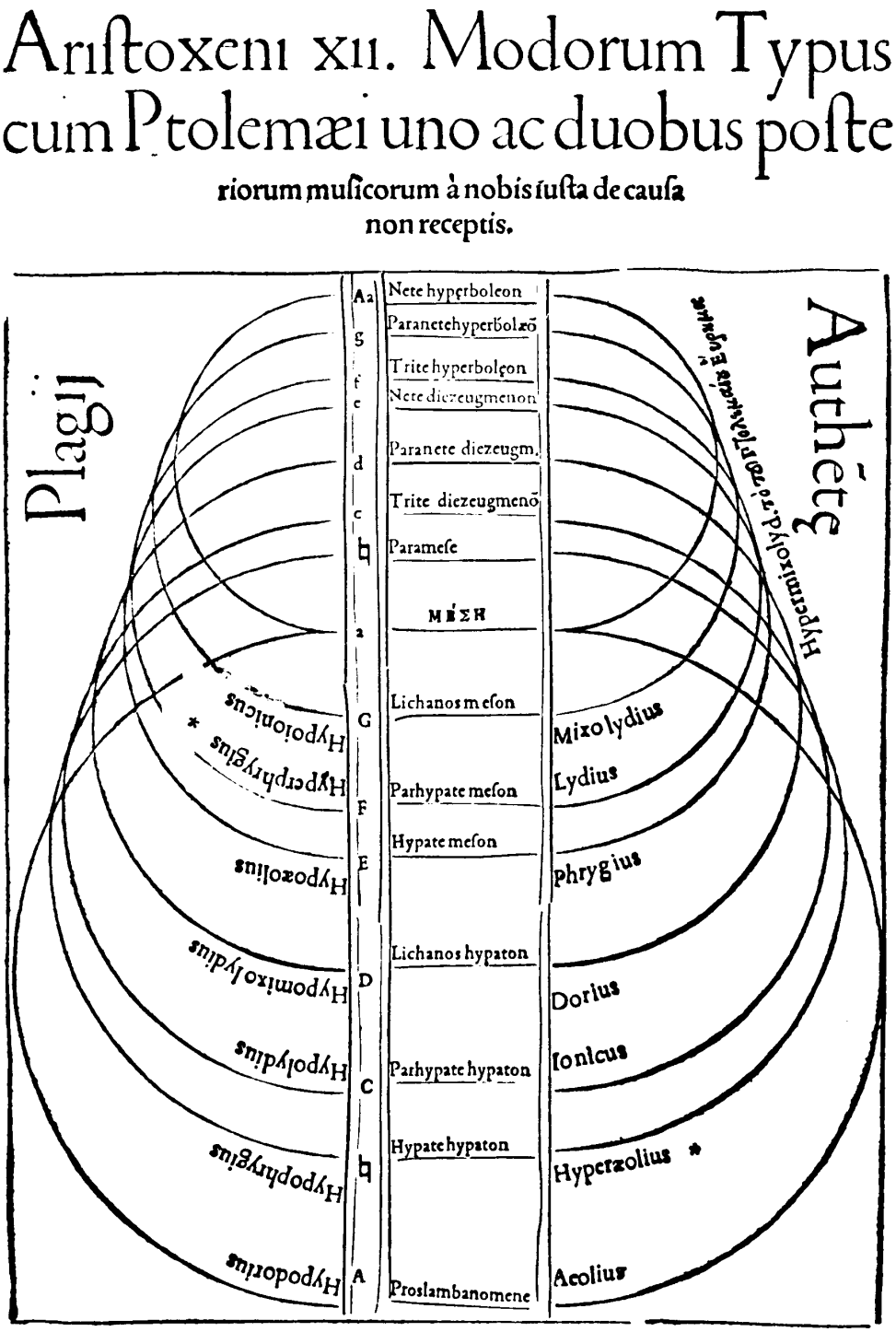

Figure 18. "The Twelve Modal Types of Aristoxenus with Those of Ptolemy," from Glarean, *Dodekachordon* II.7, 81.

In figure 18 we find fourteen labeled arcs that represent twelve accepted and two rejected modes mapped onto the Greater Perfect System. The seven plagal modes are set against the authentic modes in a ribcage-like structure. Thus, the arc representing Hypomixolydian, which fills the octave D-d, is set symmetrically against the arc for Dorian. Likewise, Hypolydian (C-c) is set against Ionian (C-c), and the same follows for the remaining modes. The diagram is an apt depiction of Glarean's system because it shows that two distinct modes may fill the same musical space, although it does not offer a just account of Aristoxenus's modal system. As we shall see, Vincenzo Galilei illustrates the Aristoxenian system in a wholly different manner and takes offense at Glarean's misleading illustration.

That Glarean's Hypermixolydian octave species holds the same mode as the Hypodorian species is further proof of his disregard for relative pitch, which is also expressed in his dismissal of the final as a modal determinant. Furthermore, Glarean claims that the nations for whom the modes were named "delighted" in their particular mode, suggesting that even in antiquity it was the octave species that defined the music-making of the Dorian, Phrygian, and Lydian peoples.[28] In modern practice, according to Glarean, the numbering of the modes is once again governed by the octave species. Dorian is called mode 1 because it represents the first octave species.

Having explained the twelve modes along with other basic theoretical concepts, Glarean fills part of Book III with copious examples of each mode as it is found in contemporary polyphonic compositions. Although he is concerned with the particular ethical quality of each mode, Glarean's analyses show that, in polyphony, different

[28] Glarean, *Dodekachordon* II.7, 76: "Sed mihi videtur appellatio haec Modorum primum a gentibus nata, postquam quarta diapason specie Dores oblectati sunt, Phryges quinta, Lydij sexta."

modes may operate simultaneously. For example, Glarean describes the modality of Josquin des Prez's motets *Domine non secundum* and *Adjuva nos*:

> In the first example of Josquin, the cantus belongs to the Hypodorian, lacking the octave note by whole tone. The other voice, however, full of sweetness and everything agreeable, is in the Dorian, with a minor third added above, which we have often mentioned as occurring in the Dorian, Hypodorian, and Aeolian. But in the following example, the tenor belongs to the Hypodorian without the descent of the fourth, while the bass expresses the Dorian, and so also remains there while other voices are added.[29]

Glarean's allowance for more than one mode to be heard simultaneously in a polyphonic work insured that his theory of modality could be applied to a musical composition with two or more melodic lines. Glarean's analysis also reveals his 12-mode theory as primarily post-compositional.

The Nexus of Theory and Practice: Gioseffo Zarlino's *Le istitutioni harmoniche*

Although later writers such as Vincenzo Galilei would contest Glarean's reductive attempt to unify ancient and modern musical practice, the *Dodecachordon* was sufficiently persuasive to convince Gioseffo Zarlino to adopt the 12-mode system for his *Istitutioni*. Even though Zarlino perceives much less congruence between ancient and modern practice, he finds Glarean's system suitable for his own general assumptions regarding contemporary musical practice. Zarlino relies heavily on the 12-mode system formulated by Glarean, but he recognizes that modern music is far removed from ancient

[29] Glarean, *Dodekachordon* III.13, 243: "In Iodoci uero priore exemplo Cantus Hypodorium refert, defectum superne tono. Altera autem uox suauitatis et omnis iucunditatis plenissima Dorium, cum adiecto superne Semiditono, quod in Dorio, Hypodorio atque AEolio frequentissimum esse saepe admonuimus. In sequenti uero exemplo Tenor Hypodorium absque descensu diatessaron, refert: Basis uero Dorium exprimit, atque ita quoque deinde se habet, ubi aliae accedunt uoces"; trans. in *Dodecachordon*, 250.

practice and frequently acknowledges that contemporary modes have little to do with those of the Greeks. For this reason, Zarlino removed the Greek names from his 12-mode system and emphasized the importance of modal finals.

For Zarlino, the relationship between mode and compositional procedure is more than a pure theoretical abstraction. To clearly distinguish one mode from another, he emphasizes modal finals and cadential patterns, although he also attaches great significance to the harmonic and arithmetic divisions of the octave. Despite his qualms about the affinities between modern and ancient music, Zarlino ties his theoretical systems to ancient concepts of nature and metaphysics, and as was discussed in chapter 1 above, one of his principal goals in the *Istitutioni* is to show the relationship between nature and modern musical practice. For example, Zarlino's explanation of the harmonically divided octave and accompanying diagram shows the sequence of tones in a C-c scale (Zarlino's Mode 11) with the Syntonic Diatonic tetrachord sitting right along the center of the scale (see figure 6, p. 61 *supra*). Although the relationship between mode and tuning is not entirely clear in Zarlino's description of the Syntonic tetrachord, he does employ the distinction between harmonic and arithmetic divisions, so important in Glarean's conception of mode, to bridge two distinct theoretical topics.

In Part IV of the *Istitutioni*, Zarlino vaguely defines mode as "that measure or form which prevents us from going too far in anything we do, making us act in all things with a certain temperateness and moderation."[30] The definition lacks any concrete musical information, and it is sufficiently broad to encompass any usage of "mode,"

[30] Gioseffo Zarlino, *Le istitutioni harmoniche* IV.1 (Venice: [by the author], 1588; reprint in Monuments of Music and Music Literature in Facsimile, II/1, New York: Broude Brothers, 1965), 293: "quella misura, o forma, che adoperiamo nel fare alcuna cosa, laqual ne astrenge poi a non passar più oltra; facendone operare tutte le cose con una certa mediocrità, o moderatione"; trans. in *On the Modes*, 1.

whether or not it relates to music. Zarlino's definition goes hand in hand with his basic view of the history of music. The ancients used their modes as a way of structuring their music, and the moderns use their own different set of modes for the same purpose. He follows his definition with an essay that shows the ways in which musical practices, like their literary counterparts, are historically and geographically determined. Of course, Zarlino is not completely consistent in this regard, as we have seen in the area of tuning systems. Nevertheless, he seems well aware of the discontinuities, whereas Glarean was anxious to show the unity of modern and ancient music. Zarlino's skepticism about a wholesale synthesis of ancient theory and modern practice is adopted by later writers, including Galilei, Artusi, and Bottrigari.

Table 11 shows the twelve modes as they are presented in Part IV, chapter 10 of the *Istitutioni*. Zarlino, following Glarean, builds his twelve modes out of combinations of fifths and fourths. He seems to be most concerned with convincing his readers that there are indeed twelve modes and therefore does not give an explanation of which fourths and fifths are to be excluded from consideration. Instead, Zarlino notes only that "these [rejected combinations of fourth and fifth] cannot be matched with each other in any other way, except with great drawbacks, as is clear to anyone who has good judgment."[31]

[31] Zarlino, *Istitutioni* IV.10, 310: "Et per tal maniera haueremo ne più, ne meno di Dodici Modi: imperoche cotali specie non si possono accompagnare in altra maniera l'vna con l'altra, se non con grande incommodo; come è manifesto a ciascuno, che habbia giuditio"; trans. in *On the Modes*, 39.

Table 11. Combinations of species of fourth and fifth in Zarlino, *Istitutioni* IV.10, 309-10.

Species of Fifth	Species of Fourth	Octave Species	Commentary
1.t-s-t-t (D-a)	1.t-s-t (a-d)	4.(D-d) t-s-t-t-t-s-t	Mode 1
1.t-s-t-t (D-a)	1.t-s-t (A-D)	1.(A-a) t-s-t-t-s-t-t	Mode 2
2.s-t-t-t (E-b)	2.s-t-t (b-e)	5.(E-e) s-t-t-t-s-t-t	Mode 3
2.s-t-t-t (E-b)	2.s-t-t (B-E)	2.(B-b) t-s-t-s-t-t-t	Mode 4
3.t-t-t-s (F-c)	3.t-t-s (c-f)	6.(F-f) t-t-t-s-t-t-s	Mode 5
3.t-t-t-s (F-c)	3.t-t-s (C-F)	3.(C-c) t-t-s-t-t-t-s	Mode 6
4.t-t-s-t (G-d)	1.t-s-t (d-g)	7.(G-g) t-t-s-t-t-s-t	Mode 7
4.t-t-s-t (G-d)	1.t-s-t (D-G)	4.(D-d) t-s-t-t-t-s-t	Mode 8
1.t-s-t-t (a-e)	2.s-t-t (e-aa)	1.(a-aa)t-s-t-t-s-t-t	Mode 9
1.t-s-t-t (a-e)	2.s-t-t (E-a)	5.(E-e) s-t-t-t-s-t-t	Mode 10
4.t-t-s-t (c-g)	3.t-t-s (g-cc)	3.(c-cc)t-t-s-t-t-t-s	Mode 11
4.t-t-s-t (c-g)	3.t-t-s (G-c)	7.(G-g) t-t-s-t-t-s-t	Mode 12

Zarlino anticipates criticism of a 12-mode system, possibly from other humanists. In response, he shows in Part IV, chapters 10-11 of the *Istitutioni* that the twelve modes are derived either from combinations of fourths and fifths or the harmonic and arithmetic division of the octave. Unlike Glarean, he is not concerned with proving his case by demonstrating parallels with ancient theorists and asserts that the twelve modes "cannot be less, no matter how many ancient modes there were, because the ancient modes have little or nothing to do with our purpose."[32]

Differences between Glarean's and Zarlino's description of the 12-mode system help reveal the intended readers of their treatises. Glarean first constructed his octaves

[32] Zarlino, *Istitutioni* IV.10, 309: "ne possono esser meno, siano poi stati quanti si voglino li Modi antichi: percioche nulla, o poco fanno più al nostro proposito"; trans. in *On the Modes*, 37.

from species of fourths and fifths represented by solmization syllables. Zarlino skipped this step and introduced the modes using note names. This is significant because Zarlino immediately places the modes in relative pitch space, whereas Glarean's modes are abstractions that can be found at any pitch.

The contrast between Glarean's solmization syllables and Zarlino's note names may also be considered in terms of the literary traditions of music theory. Although the *Dodecachordon* includes many examples of contemporary polyphony and older plainchant, Glarean was not a practicing musician and his principal intention in writing the *Dodecachordon* was to defend the music of the Catholic church. Therefore, his readers only needed a sufficient understanding of the 12-mode system to use it as an analytical tool. Furthermore, Glarean provided ancient justification for the modes and, in addition, revealed the connections between the traditions of plainchant and an idealized antiquity. Zarlino, on the other hand, was an aspiring music director and composer, and the *Istitutioni* is an attempt to reconcile theoretical concepts with the practical skills needed by a contemporary musician. Zarlino intentionally composed the first two parts of the *Istitutioni* in the theoretical tradition, while leaning toward practical knowledge in parts III and IV, which treat counterpoint and the modes. If his modes were to be practical, Zarlino had to place them in actual pitch space.

Interlude: Nicola Vicentino's *L'antica musica ridotta alla moderna prattica*

Nicola Vicentino's *L'antica musica ridotta alla moderna prattica* (Rome, 1555) is another treatise illustrating the difference between mode as a theoretical concept and as a practical tool. Vicentino's text, which is as progressive as Zarlino's *Istitutioni* is

traditional, is arranged with one book on music theory and five books on practice. A comparison of two short passages from Vicentino's treatise will demonstrate that his discussion of mode in the "Book on Theory" is closer to Glarean's explanation while his treatment of the same topic in "Book III on Music Practice" is similar to Zarlino's. In the "Book on Music Theory," Vicentino writes:

> The first mode, called Dorian, is formed by the first [species of] diapente below and the first [species of] diatessaron above. The second, Hypodorian, is formed by the first diatessaron and the first diapente placed above it because the diatessaron must be underneath.[33]

In this statement, modes are discussed only in terms of species of fourth and fifth, as we saw in Book II, chapter 3 of the *Dodecachordon*. In "Book III on Music Practice," Vicentino discusses the modes again, now placing the seven octave species in relative pitch space:

> The fourth octave begins on D sol re and ascends stepwise through the pitches up to D la sol re. The fifth octave is formed by the second [species of] fifth with the second [species of] fourth placed over it, beginning on the low E la mi and ascending through eight pitches up to the high E la mi.[34]

For his practical explanation of the modes, Vicentino not only included the pitches for each octave but changed the terminology as well. The Greek terms diatessaron

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[33] Nicola Vicentino, *L'antica musica ridotta alla moderna prattica* (Rome: Antonio Barre, 1555; reprint in Documenta musicological, I/17, Kassel: Bärenreiter, 1959), f. 5v: "il primo adunque detto Dorio, sarà formato della prima diapente sotto, e della prima diatessaron sopra. Il secondo detto Ipodorio, per essere la diatessaron sottoposta, è formato della prima diatessaron, & della prima diapente sopra posta"; translation from Nicola Vicentino, *Ancient Music Adapted to Modern Practice*, trans. with introduction and notes by Maria Rika Maniates, ed. Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 1996), 15.

[34] Ibid., 44: "si fomerà la Quarta ottava, incominciando da D sol re. ascendenti per gradi, di voci fin à D la sol re. la quinta Ottava sarà formata della seconda quinta, & della seconda quarta, posta sopra la quinta, incominciando da E la mi. grave ascendente per otto voci, fin à E la mi. acuto"; trans. in *Ancient Music*, 139. Vicentino may have confused even himself in the process of explaining the modes. The species of diatessaron that he provides in "Music Theory," chapters 9 and 10, do not match his explanation of the octaves in chapter 12 or "Book III on Music Practice," chapter 4. The species given in Book III, chapters 2 and 3 are correct. Maniates notes that Vicentino appears to have copied Boethius's interval species backwards (*Ancient Music*, 14, fn. 23).

and diapente have been replaced by *quarta* (fourth) and *quinta* (fifth). The use of vernacular vocabulary in the practical texts may indicate the author's intention of producing a treatise accessible to professional musicians who might not have been able to read Greek or Latin.[35]

Expanding the Middle Ages: Mode in Galilei's *Dialogo*

In the preface to his 1581 *Dialogo*, Vincenzo Galilei includes a common humanistic trope concerning the Middle Ages: "Meanwhile, Italy for a long time suffered great floods of barbarians. Every spark of science was extinguished, and as if everyone were overwhelmed by a heavy lethargy of ignorance, people lived without any desire for knowledge."[36] Galilei then cites those responsible for rediscovering the musical knowledge that lay dormant for centuries:

> Gaffurio, then Glarean, and finally Zarlino—truly princes in this modern practice—began to investigate what it had been and sought to rescue it from the darkness in which it was buried . . . . these writers deserve the highest praise, and the world owes them perpetual obligation, if for nothing else, at least for having given many others the opportunity to work more intensely to try to bring [music] to perfection.[37]

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[35] In some cases, humanistic writers composed treatises in Latin for their educated colleagues and provided separate Italian translations for professionals to use. Leon Battista Alberti's *De pictura* (Florence, 1435) is one example. See Anthony Grafton, *Leon Battista Alberti: Master Builder of the Renaissance* (Cambridge: Harvard University Press, 2000), 71.

[36] Vincenzo Galilei, *Dialogo della musica antica*, *et della moderna* (Florence: Giorgio Marescotti, 1581; reprint in Monuments of Music and Music Theory in Facsimile, II/20, New York: Broude Brothers, 1967), 1: "Hauendo poi la Italia per lungo spatio di tempo patite grandi inondationi de Barbari, s'era spento ogni lume di scienza; & come se tutti gli huomini fussero stati soprapresi da graue letargo d'ignoranza"; trans. in Vincenzo Galilei, *Dialogue on Ancient and Modern Music*, trans. with introduction and notes by Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 2003), 6.

[37] Galilei, *Dialogo*, 1: "Gafurio prima, & appresso il Glareano, & poscia il Zarlino (Principi veramente in questa moderna prattica) cominciarono ad inuestigare quello che ella fusse, & à cercare di trarla dalle tenebre oue era stata sepolta . . . . questi scrittori meritano somma lode, & il mondo deue loro perpetua obligatione; se non per altro, almeno per hauer dato occasione à molti di maggiormente affaticarsi in essa, per vedere per ridurla nella sua perfettione"; trans. in *Dialogue*, 7.

In fact, Galilei uses the *Dialogo* more as an "opportunity" to reproach his predecessors than to praise them, and he often insists that all their theories, as well as the polyphonic music they praise, stem from medieval musical traditions. In fact, his "high praise" of Glarean and Zarlino in this opening statement is more than contradicted throughout the *Dialogo* by a number of criticisms expressed by the dialogue's two interlocutors, Giovanni Bardi and Piero Strozzi.

In this regard, one of Galilei's favorite rhetorical tactics is to connect Zarlino's and occasionally Glarean's theoretical premises to the barbaric Middle Ages, viewing them as part of the ignorant past and not as an emblem of the rebirth of ancient knowledge. If this were not enough, Galilei occasionally tries to brand the entire tradition of Renaissance polyphony as an extension of medieval musical aesthetics. For example, in a discussion of vocal practices in the Middle Ages, Galilei's interlocutor Giovanni Bardi describes Guido of Arezzo's era as a time when "every spark of virtue, so to speak, was extinguished in Italy and particularly in regulated music."[38] Shortly thereafter, Bardi introduces one of Guido's notational innovations, drawing a comparison between compositional style and fortune telling:

> Guido placed the points in the space between the lines as composers do today. From the use of these points composers acquired the label "contrapuntists." This name was very apropos, because they composed their songs of points, which have no existence in nature, only in the human imagination. Superstitious geomancers compose their figures out of random points in this way in response to judgments and questions made to them. With these they judge what caused a particular case, basing this on their few principles and terms, without knowing in advance the effects that could arise from operating more in one manner than in another. Ten or more geomancers, or even one, forming on the dots ten or more figures, may give as many different opinions about the same question. Similarly, if you offered ten

[38] Galilei, *Dialogo*, 36: "era spento ancora (per modo di dire) nell'Italia qual si voglia lume di virtù, & particolarmente della Musica regolata"; trans. in *Dialogue*, 93.

> contrapuntists the task of expressing a particular affection of the soul by means of music according to the usage of that century, they would express it in as many ways and different manners and variety of tones.[39]

A more substantial critique of counterpoint occurs later in the *Dialogo*, but here Galilei devises a brief history of the most prominent compositional technique of the Renaissance. Counterpoint, to Galilei, was an invention of medieval composers and is completely foreign to the music of ancient Greece. Whereas Glarean in particular tries to show the connections between the Greeks and the music of his day, Galilei seeks to create a chasm between ancient music and the polyphonic tradition.

In bolstering his argument against modern music, Galilei also wants to show the medieval origins of Zarlino's and Glarean's theoretical approach. To do this, he discusses their misrepresentations of ancient theorists, accusing his predecessors of purposely confusing the authorities in order to fit their own agendas. Galilei, first of all, suggests that many of the modern modal determinants, including the modal final, were inventions of polyphonic composers, not the ancients. In considering whether ancient musicians had any concept of a modal final, Galilei (speaking as Bardi) opines:

> The difference that existed between one tonos and mode and another consisted principally in the tension and relaxation of the constitutions' strings and the diversity, so to speak, of the longer and shorter distance between frets, placed differently in each system, and not as with modern practicing contrapuntists,

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[39] Galilei, *Dialogo*, 37: "ponendogli esso Guido dentro ancora allo spatio che si trouaua tra questa & quella linea come ancora hoggi costumano i Compositori; dall'vso de quali, si acquistarono nome di Contrapuntisti, il quale fu molto à proposito. imperoche componendo le Cantilene loro di punti, che nulla altro essere hanno nella Natura, che nella sola imaginatione degli huomini, à caso non altramente che si componghino hoggi i superstitiosi Geomanti le figure intorno à giu ditij de quesiti fattigli; delle quali ne giudicano poi quello che l'istesso caso (secondo però alcuni pochi principij e termini loro) ha cagionato; senz'altramente sapere auanti gli effetti che poteuano nascere più in questa che in vn'altra maniera operando. & si come da dieci ò piu Geomanti, anzi da vn solo, si haverà altretanti diuersi pareri sopra il medesimo dubbio, formando sopra esso diece ò piu figure; cosi parimente, dando cura à diece ò piu Contrapuntisti; di esprimere vn'istesso & particolare affetto d'animo con la musica loro secondo l'vso di questo secolo; l'esprimeranno in altrettante ò in piu differenti maniere & variati Tuoni"; trans. in *Dialogue*, 95.

> where the difference is determined by the final. Some, however, to show themselves wiser and more learned, add the arithmetic and harmonic division of the diapason to make the modes different in harmony and affection. This has less to do with these [modern modes] than you have with the kingdom of Peru. According to them, there are twelve different tones and modes. . . .[40]

Many theorists discussed the arithmetic and harmonic division of the diapason, but the statement regarding twelve modes points specifically to Zarlino and Glarean. Furthermore, the beginning of this passage points to one of Galilei's principal opinions of the ancient modes: they are distinct from one another by their relative highness or lowness. His position devalues the importance of the characteristic intervallic patterns or cadential structures emphasized by Glarean and Zarlino.[41]

Galilei will occasionally critique specific interpretations of ancient theorists found in the *Dodecachordon* and the *Istitutioni*. In one instance, he takes Glarean to task for his erroneous description of Aristoxenus's octave species:[42]

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[40] Galilei, *Dialogo*, 71: "la differenza che era tra l'vno & l'altro Tuono & modo loro, consisteua principalmente nell'intensezza & lentezza delle corde delle constitutioni; & nella diversità per così dirgli, de tasti lunghi & breui, per diuerso ordine posti in ciascun Systema; & non come quella de moderni prattici Contrapuntisti; la quale hanno tutta riposta nella corda finale. ancora che alcuni per mostrarsi piu degli altri saputi & dotti, ci aggiungano la diuisione Aritmetica, & Armonica del Diapason; la qual diuisione, circa il fargli differenti d'harmonia, di affetto, o di Tuono; ci ha meno parte che non hauete voi nel regno del Perú; & à detto loro hanno dodici Tuoni & modi diuersi"; trans. in *Dialogue*, 172.

[41] Galilei mocked the importance of the modal final in his unfinished "Il primo libro della prattica de contraponto [First Book on the practice of Counterpoint]" (f. 99r) by alluding to one of the popular legends regarding Pythagoras. Pythagoras is said to have spotted an angry and inebriated youth who was planning to set fire to the house of his rival. Noting that an aulete nearby was playing in the affective, Phrygian mode, Pythagoras asked the musician to change the mode to something that would project a milder ethos. When the character of the music changed, the youth's anger subsided. In considering Zarlino's emphasis on modal finals, Galilei asks: "When Pythagoras said 'change mode' to that tibia player . . . do we believe that Pythagoras wished to infer 'change the final note of the cantilena' or that the expert tibia player understood such a vapid statement [Quando Pitagora disse Muta Modo, a quel Tibicine . . . , crediamo noi che Pitagora volesse inferire, muta la corda finale della Cantilena; o che quel perito Tibicine intendesse una cotale leggierezza]." Two versions of the legend are recounted in Boethius's *De institutione musica* (I.1). See Boethius, *Fundamentals*, 5-6. Galilei's treatise on counterpoint is transcribed in Frieder Rempp, *Die Kontrapunkttraktate Vincenzo Galileis*, Veröffentlichungen des Staatlichen Instituts für Musikforschung preussischer Kulturbesitz, ed. Hans-Pieter Reinecke and Dagmar Droysen, vol. 9 (Cologne: Arno Volk, 1980), 7-76.

[42] See figure 18 *supra*.

> Glarean says also that the Lydian is under the Aeolian by a third, while Aristoxenus places the former above the latter by a semitone. Glarean further maintains that the Dorian is lower than the Hypoionian by a fourth, while Aristoxenus says it is a third. Finally, Glarean, from the Dorian and Phrygian and their plagals on, distorts all the others from what Aristoxenus had thought. He does all this to make them agree with those of today, which is about as possible as to make an Ethiopian white.[43]

Perhaps because of these errors and misreadings, Galilei purports to present his discussion of the modes as an objective explanation of ancient conceptions of the tonoi. He appears content with "discussing only the most famous points of view: first, that of the Aristoxenians; second, the Ptolemaics; and third, the Boethians."[44] Furthermore, his descriptions of these systems are intended to show that modern scalar systems are derived in part from Boethius and that there is little concordance between the scales of the modern polyphonic composers and those of the ancient theorists.

Galilei initially offers thirteen tonoi, "following the mind of Aristoxenus."[45] The explanation of this system, however, is interrupted as the interlocutors in his *Dialogo*

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[43] Galilei, *Dialogo*, 72: "[Glareano] dice ancora che il Lydio è sotto l'Eolio vna Terza & Aristosseno pon[e] questo sopra quello vn Semituono. vuole in oltre il Glareano, che il Dorio sia sotto l'Hypoionico vna Quarta, quando Aristosseno dice esserui vna Terza: ma diciamo questo per vltimo, che il Glareano dal Dorio e'l Frygio & i loro Plagij in poi, storce tutti gli altri dalla mente d'Aristosseno: è tutto questo fa, per volere accordare quelli con questi d'hoggi; la qual cosa è tanto possibile come fare vn'Ethiope bianco"; trans. in *Dialogue*, 175-76.

[44] Galilei, *Dialogo*, 50-51: "vi ragionerò solo intorno alle tre piu famose. la prima delle quali sarà degli Aristossenici, de Tolomaici la seconda, e per terza torremo quella de Boehiti [*sic*]"; trans. in *Dialogue*, 124. Galilei actually describes the Boethian system second and the Ptolemaic third. Nevertheless, his chronological listing of the authors suggests an awareness of the historical development of scale systems. He is not concerned with describing an ideal system as much as wanting to show the variety of systems that have existed.

[45] Galilei*, Dialogo*, 52: "Dimostratione de'tredici Tuoni, secondo la mente d'Aristosseno." Palisca notes that Galilei's knowledge of Aristoxenus's tonoi may have come from Cleonides' *Harmonic Introduction* (*Dialogue*, 125, fn. 127). While giving four definitions for tonos, Cleonides remarks: "We use [tonos] as a position of the voice whenever we say Dorian, Phrygian, Lydian, or any of the other tonoi. According to Aristoxenus, there are thirteen tonoi." See Cleonides, "Harmonic Introduction," trans. Oliver Strunk and Thomas J. Mathiesen, in *Source Readings in Music History*, ed. Oliver Strunk, rev. ed., ed. Leo Treitler (New York: Norton, 1988), 44.

work through a series of digressions. When he finally returns to the tonoi (p. 56), he speaks of “the thirteen tonoi of Aristoxenus with two added by his followers” (figure 19).

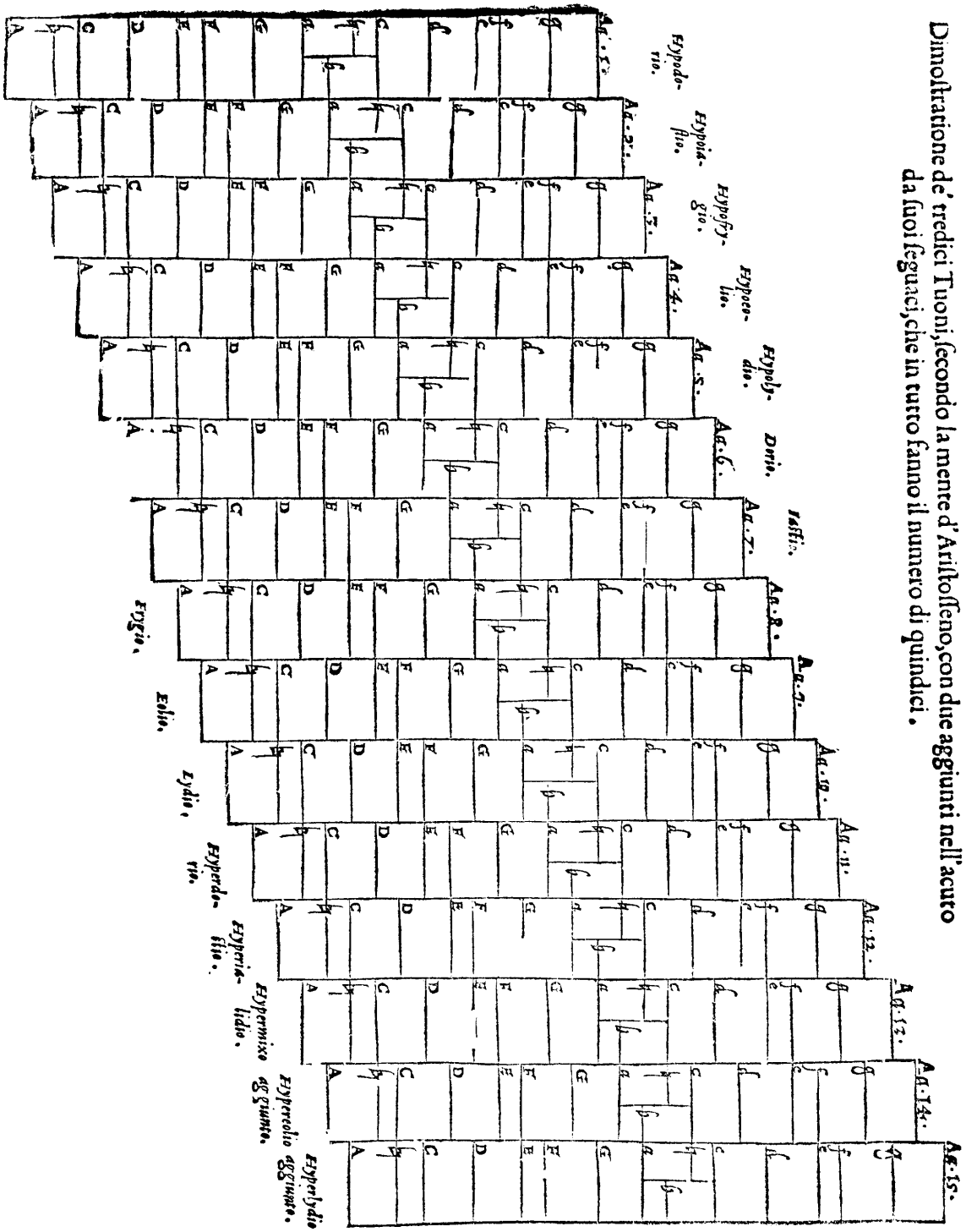

Figure 19. "Demonstration of Thirteen Tonoi According to Aristoxenus, with Two Added above by His Followers, Which Makes Fifteen in All," from Galilei, *Dialogo*, 57.

Galilei assumes that two extra tonoi were added so that the total number would be divisible by three. In this way, Aristoxenus's tonoi can be assigned to the three ranges of the human voice: low, middle, and high. Here, we see another reference to relative pitch and its significance in ancient musical practice. Because the mode is determined by the lowness and highness of pitch, the duplication of an octave species is not problematic. Galilei even suggests that the followers of Aristoxenus were able to add the fourteenth and fifteenth tonoi by following Aristoxenus's duplication of the A-a octave with the thirteenth tonos:

> Their project was very much favored by their discovery that the extremes of the thirteen [tonoi] that [Aristoxenus] proposed corresponded at the octave and not at the seventh, like those of Ptolemy. His highest was the Hypermixolydian, which was nothing but a replica of the Hypodorian.[46]

The tripartite division of Aristoxenus's tonoi further distinguishes them from any medieval or Renaissance classification in that the common arrangement of authentic and plagal modes is now split into authentic, plagal, and principal. The fifteen Aristoxenian modes, according to Galilei, are summarized as such:

Table 13. Tripartite division of the fifteen Aristoxenian tonoi.

Low (Plagal)	Intermediate (Principal)	High (Authentic)
Hypodorian	Dorian	Hyperdorian
Hypoiastian	Iastian	Hyperiastian
Hypophrygian	Phrygian	Hyperphrygian
Hypoaeolian	Aeolian	Hyperaeolian
Hyperlydian	Lydian	Hyperlydian[47]

[46] Galilei, *Dialogo*, 56: "fauorendo molto questa loro intentione, l'hauer trouato gli estremi de tredici che lui fece, rispondersi per ottava, & non per Settima con quelli di Tolomeo; il piu acuto de quali detto Hypermixolydio, non era altro che il replicato dell'Hypodorio"; trans. in *Dialogue*, 136.

[47] Galilei, *Dialogue*, 136, fn. 222. Galilei lists Hyperphrygian as the middle mode of the "High" range in the text, yet it is labeled as "Hypermixolidio" on the chart (fig. VII, *Dialogue*, 137). This confusion may have also come from Cleonides' claim that Hyperphrygian and Hypermixolydian are one and the same. See Cleonides, "Harmonic Introduction," 44.

Galilei's representation of the tonoi (figure 19) shows that each contains the same sequence of intervals. The actual note names for each octave are the same; thus, the notes are distinguished from one another only by their relative height. Each tonos fills the double-octave space of the Greater Perfect System, and the distance between any adjacent pairs of tonoi is a semitone. Table 15 shows the pitch equivalents for the five principal tonoi:

Table 15. Principal tonoi in the Aristoxenian system.[48]

Dorian:	A	B	C	D	E	F	G	a	b	c	d	e	f	g	aa
Iastian:	B♭	C	D♭	E♭	F	G♭	a♭	b♭	c	d♭	e♭	f	g♭	aa♭	bb♭
Phrygian:	B	C#	D	E	F#	G	a	b	c#	d	e	f#	g	aa	bb
Aeolian:	C	D	E♭	F	G	a♭	b♭	c	d	e♭	f	g	aa♭	bb♭	cc
Lydian:	C#	D#	E	F#	G#	a	b	c#	d#	e	f#	g#	aa	bb	cc#

Inasmuch as the number of flat and sharp notes would have seemed ludicrous to sixteenth-century musicians, Galilei wisely did not attempt to add specific pitches in his table. Nevertheless, this interpretation is very different from Glarean's treatment of the Aristoxenian tonoi. Upon concluding his discussion of the Aristoxenian tonoi, Galilei decides to delay an explanation of Ptolemy's system, as his "order and views are very artful and difficult to understand."[49] Galilei instead turns his attention to Boethius. Because Boethius's system is partially based on that of Ptolemy, however, we should continue by examining Galilei's explanation of the Ptolemaic system.

Galilei's reading of the Ptolemaic tonoi is somewhat mistaken, and it may therefore be useful to begin with a consideration of Ptolemy's actual arrangement of his scale system. Like those of Aristoxenus, Ptolemy's scales are based on the double octave of the Greater Perfect System, but he strays from the Aristoxenian tradition in significant

[48] This chart excludes the *trite synemenon*.
[49] Galilei, *Dialogo*, 56: "molto artificioso & difficile à bene intendersi"; trans. in *Dialogue*, 136.

ways.[50] For example, we recall that each Aristoxenian tonos includes the same sequence of intervals; the only difference among the tonoi, then, is the relative height of the pitch. Ptolemy, however, denies the importance of relative height:

> It is not by means of higher or lower voices that we would find constituted a modulation by tonos. The raising or again the lowering of whole instruments produces this difference, and no change of melody occurs as long as the lower-voiced and higher-voiced singers continue the melody without changing it. It is rather by means of one voice that modulation by tonos exists.[51]

Instead, Ptolemy considers three determinants in constructing his system.[52] The first and principal determinant is the "ratio formed by the extremes" of the tonos. Here, he is referring to the diapason, or octave, which is the interval that spans the length of the tonos. With this limiting factor, Ptolemy rejects any tonoi repeated a diapason above or below the central octave, such as tonoi 13-15 of the pseudo-Aristoxenian system.[53]

The second determinant pertains to "the number of those between the extremes," or simply, the seven notes that make up the octave.[54] For his part, Ptolemy posits a characteristic octave, establishing a consistent sequence of notes derived from the Greater Perfect System: *hypate meson* to *nete diezeugmenon*.[55] This sequence determines each note's position and name in the series: Ptolemy refers to this sequence as "thetic" nomenclature. The full sequence of notes in descending order is provided in table 16.

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[50] Thomas Mathiesen has shown that Ptolemy definitely takes the Aristoxenian tradition as a starting point, borrowing several concepts from Cleonides' *Harmonic Introduction*. See Mathiesen, *Apollo's Lyre*, 459-66. The following discussion of Ptolemy is based on Mathiesen's explanation.

[51] Ptolemy, *Harmonics*, 82. Mathiesen notes that Ptolemy's own conception of the tonoi, and its relation to that of the Aristoxenians, is similar to our modern notions of modulation and transposition. A tonal modulation in the Aristoxenian system is similar to transposition in that it involves the same sequence of intervals being played or sung at a different pitch level. Ptolemy's system, on the other hand, is close to modulation in that each tonos is determined by the sequence of intervals within the same octave.

[52] Ptolemy, *Harmonics*, 81.

[53] Ibid., 84.

[54] Ibid., 81.

[55] Ptolemy's characteristic octave can be considered as the E-e scale with no sharps or flats.

Table 16. Ptolemy's thetic nomenclature.[56]

Note name	Distance to next pitch	Modern equivalent
nete diezeugmenon		e
	tone	
paranete diezeugmenon		d
	tone	
trite diezeugmenon		c
	semitone	
paramese		b
	tone	
mese		a
	tone	
lichanos meson		G
	tone	
parhypate meson		F
	semitone	
hypate meson		E

Paralleling this "thetic" sequence, Ptolemy devises a "dynamic" nomenclature that refers to the function of each note within a particular tonos, that is to say, the name of the note in a given tonos as it is transposed to the characteristic octave. As each tonos begins on a different step of the thetic nomenclature, the dynamic nomenclature defines the specific segment of notes and intervals for each tonos that will appear within the "thetic" octave. Using the dynamic nomenclature, a series of unique scalar patterns is established. Because each tonos is restricted to a characteristic octave, it turns out that there can only be seven unique tonoi, paralleling the seven possible octave species. The Dorian tonos falls in the central octave, and it is equivalent to the characteristic octave, or E-e. Because all the traditional tonoi employ the same dynamic octave structure, Ptolemy proposes that all of them can be represented within a single octave. Thus, a modern representation of the tonoi would appear as in table 17.

[56] Mathiesen, *Apollo's Lyre*, 461. This representation of the octave is specific to the Dorian tonos.

Table 17. Ptolemy's seven tonoi.[57]

Tonoi	Octave Species	Modern Equivalent
Mixolydian	s-t-t-s-t-t-t	E F G a b♭ c **d** e
Lydian	t-t-s-t-t-t-s	E F# G# a b **c#** d# e
Phrygian	t-s-t-t-t-s-t	E F# G a **b** c# d e
Dorian	s-t-t-t-s-t-t	E F G **a** b c d e
Hypolydian	t-t-t-s-t-t-s	E F# **G#** a# b c# d# e
Hypophrygian	t-t-s-t-t-s-t	E **F#** G# a b c# d e
Hypodorian	t-s-t-t-s-t-t	**E** F# G a b c d e

Table 17 reveals that the pattern of intervals effectively rotates, with the upper interval of each pattern moving to the bottom of the subsequent pattern as the tonoi ascend from Hypodorian to Mixolydian. In addition, it is clear that the sequence of intervals for each tonos is essential in distinguishing one from the other.

The third determinant considers "the measure of difference between each consecutive tonos,"[58] and in Book II, chapter 10 of the *Harmonics*, Ptolemy does establish the relative height of each tonos.[59] Criticizing "those advancing the notion of the eight tonoi,"[60] Ptolemy insists that the differences between each tonos must be measured by consonances, in particular, perfect consonances. Thus, starting with Mixolydian, Ptolemy locates Dorian one diatessaron, or fourth, below. The Hypodorian is then found a diatessaron below the Dorian. Any further descent would break the octave range, and Ptolemy accordingly locates the Phrygian one diapente above the Hypodorian, and so forth. The intervals that separate consecutive tonoi are assigned from the position of the *mese* in each tonos. Thus, the space between each tonos is clear if one follows the

[57] Ibid., 465. The *mese* is indicated in boldface to emphasize the rotation of the dynamic nomenclature in each tonos.

[58] Ptolemy, *Harmonics*, 81.

[59] Ibid., 88-90.

[60] Ibid. As it happens, Ptolemy's arrangement of the modes into relative pitch space is identical to those who did not "use the required method" of locating each tonos through leaps of fourths and fifths.

position of the dynamic *mese* in each consecutive tonos (table 17, in boldface). Table 18 shows the intervals between each tonos.

Table 18. Intervallic differences between Ptolemy's Tonoi.

Mixolydian	
	semitone
Lydian	
	tone
Phrygian	
	tone
Dorian	
	semitone
Hypolydian	
	tone
Hypophrygian	
	tone
Hypodorian	

With this background, it should now be easier to understand Galilei's interpretation of Ptolemy's tonoi.[61] Galilei's diagram of Ptolemy's system appears in figure 20.

[61] Galilei's explanation is somewhat vague. Palisca clarifies Galilei's presentation of Ptolemy's tonoi in the introduction to his translation (*Dialogue*, xlix-liii).

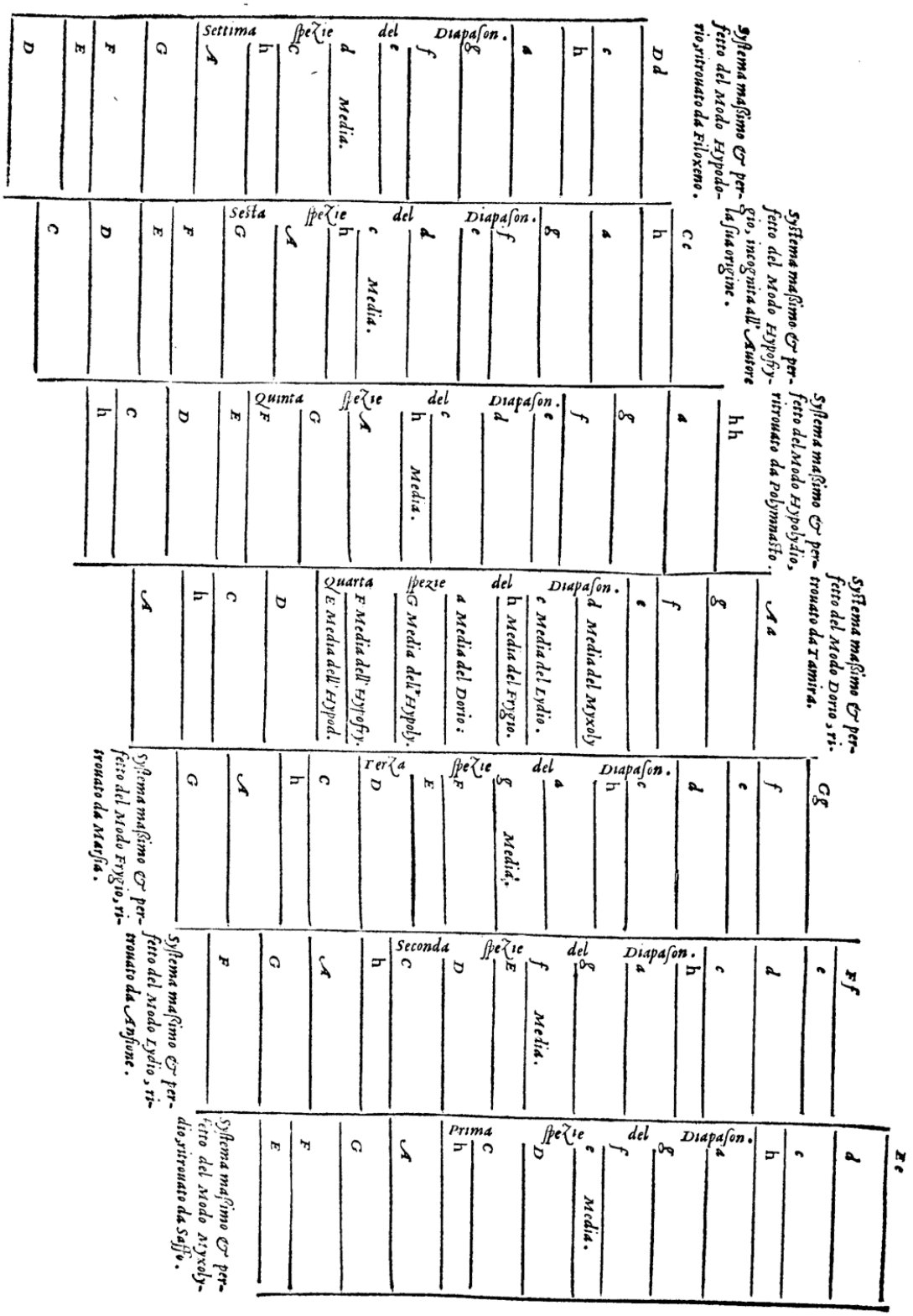


Figure 20. "Demonstration of the Seven Tonoi, According to Ptolemy," from Galilei, *Dialogo*, 64.

Figure 20 displays the seven tonoi "according to Ptolemy." Each column shows a double octave scale filled with letters, but these letters do not refer to pitches. Rather, they represent Ptolemy's thetic nomenclature, which is assigned various pitches depending on the tonos. For example, the *mese*, or *media*, for the Hypodorian mode (leftmost column) is marked "d." In the Hypophrygian column, one step to the right, "d" is now one step above the *mese*. If "d" were considered as a pitch, it would appear that the relative height of each tonos descends as one moves to the right of the chart. But Ptolemy explicitly says that Mixolydian is the highest of the tonoi and Hypodorian is the lowest; thus, the pitch must ascend as the tonoi move from Hypodorian to Hypophrygian.[62] It is only in the middle octave of the Dorian tonos that the letters can actually be equated with pitches. Here, Galilei notes that the letters signify the actual *mese* of each tonos, descending d c b [h] a G F E. These letters do not exactly represent the pitch of the true *mese* of each tonos: Ptolemy's own writings indicate that the tonoi are differentiated in the descending intervallic sequence s-t-t-s-t-t. Applying this sequence to the generic pitches offered by Galilei results in the combination seen in table 19:

Table 19. Tonos-to-mese relationship in Galilei's interpretation of Ptolemy's tonoi, *Dialogo*, 64.

Mixolydian	d
Lydian	c#
Phrygian	b
Dorian	a
Hypolydian	G#
Hypophrygian	F#
Hypodorian	E

[62] Ibid.

Now that the *mese* is known, the rest of the pitches may be determined by counting out the tones and semitones as indicated by the letters in the chart. For example, in the Mixolydian tonos, the tetrachord underneath the *mese* d (marked *e Media* in Galilei's diagram) has the ascending sequence s-t-t (h, c, d, e), or a-b♭-c-d. The tetrachord above, starting at the *mese*, is s-t-t (e, f, g, a), or d-e♭-f-g. The intervals can be expanded to fit the two-octave column; the end result is a B-flat major scale that starts and ends on d. Applying the same method to the other tonoi reveals that each resembles a modern major scale, although there is no corresponding modern tonic. The seven tonoi are summarized in table 20.

Table 20. Galilei's presentation of Ptolemy's seven tonoi, from Galilei, *Dialogo*, 64.

Tonos	8ve Species	Modern Equivalent								Range	[Key][63]
Mixolydian	1.s-t-t-s-t-t-t	a	b♭	c	d	e♭	f	g	aa	d-ddd	B♭ major
Lydian	2.t-t-s-t-t-t-s	G#	a#	b#	c#	d#	e#	f##	g#	c#-ccc#	G# major
Phrygian	3.t-s-t-t-t-s-t	F#	G#	a	b	c#	d#	e	f#	b-bbb	E major
Dorian	4.s-t-t-t-s-t-t	E	F	G	a	b	c	d	e	a-aaa	C major
Hypolydian	5.t-t-t-s-t-t-s	D	E	F#	G#	a	b	c#	d	G#-gg#	A major
Hypophrygian	6.t-t-s-t-t-s-t	C#	D#	E#	F#	G#	a#	b	c#	F#-ff#	F# major
Hypodorian	7.t-s-t-t-s-t-t	B	C#	D	E	F#	G	a	b	E-ee	D major

Galilei most likely realized that presenting scales with four or more altered notes would seem absurd to his readers, but it is more significant that in describing the tonoi of Aristoxenus and Ptolemy, he does not attribute any aspect of their systems to the harmonically or arithmetically divided octaves Glarean had emphasized. Although Ptolemy's system is far removed from Aristoxenus's model in that each tonos has a unique octave species, Galilei emphasizes the relative height of each tonos more than any mathematical or harmonic definition of scales. Furthermore, any modern (or sixteenth-

[63] The modern keys are added for clarification. Galilei was certainly not aware of any burgeoning tonal system.

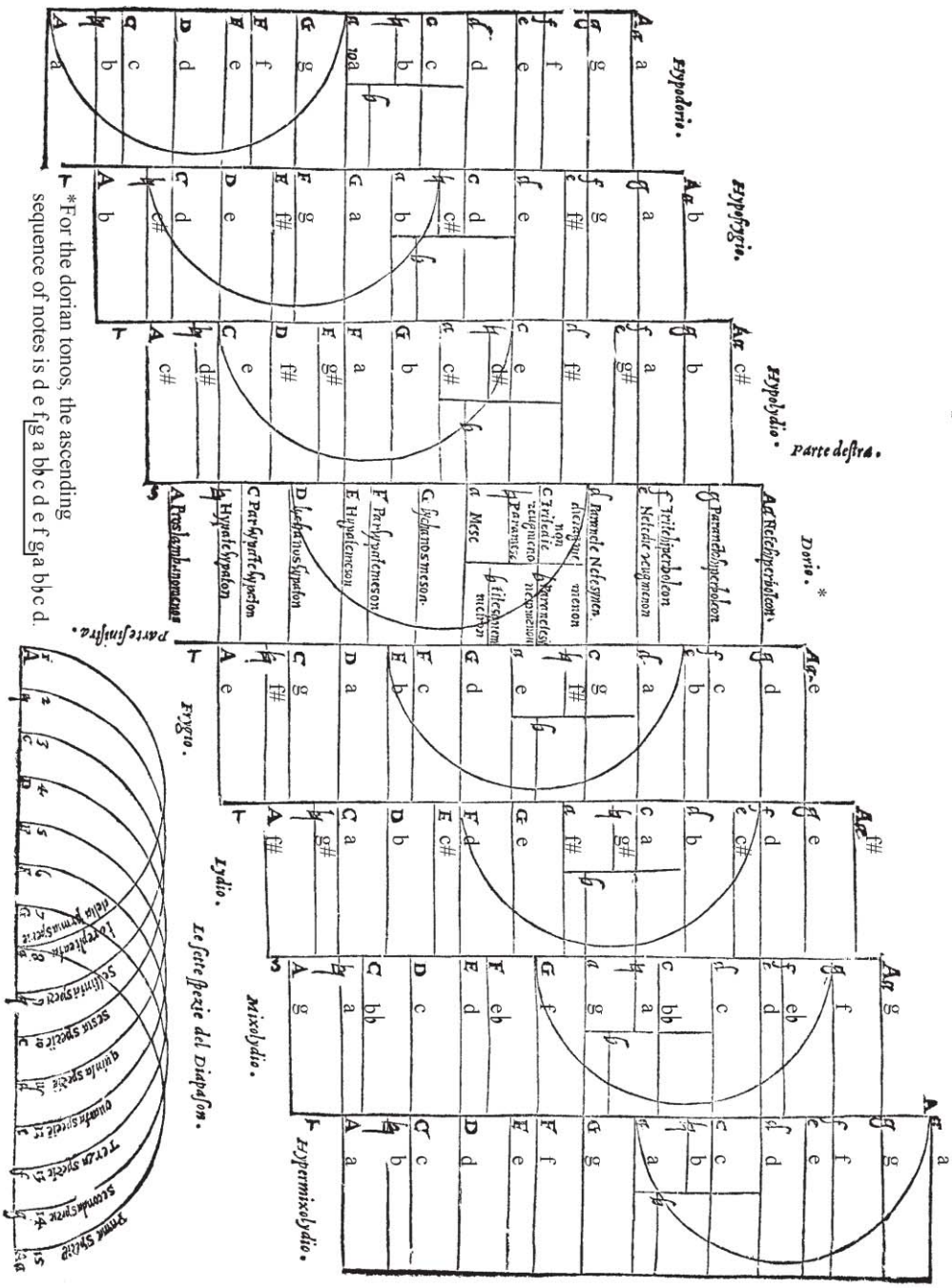
century) analysis of Ptolemy's modes that places them in actual pitch-space will not exhibit the complete diatonicism found in Glarean's and Zarlino's modal systems.

Galilei breaks his chronological treatment of tonoi and explains those of Boethius before those of Ptolemy because they are "less difficult."[64] Although Boethius's system is indeed more straightforward than that of Ptolemy, Galilei may have considered the Boethian tonoi easier to discuss because in his view they foreshadow the Renaissance conception of mode. Principal among these correspondences is the number of tonoi in Boethius's system.

Breaking with Ptolemy, Boethius presents eight tonoi, including the Hypermixolydian one tone above the Mixolydian.[65] Galilei's visual representation (figure 21) displays each tonos as a double-octave species of the Greater Perfect System.

[64] *Dialogo*, 55-59; *Dialogue*, 138-41.

[65] Boethius (IV.17) reasons that an eighth mode is necessary to fill out an entire sequence of notes in a double octave. He does not specifically refer to the Greater Perfect System, but it seems apparent that he envisions the seventh mode spanning from *lichanos meson* to *paranete hyperbolaion*. Without an eighth mode the highest pitch, *nete hyperbolaion*, would be excluded from the modal system. See Boethius, *Fundamentals*, 159-60.



*For the dorian tonos, the ascending sequence of notes is d e f g a b♭ c d e f g a b♭ c d.

Figure 21. "Demonstration of the Eight Tonoi, According to Boethius," from Galilei, *Dialogo*, 58 (pitch names have been added to Galilei's diagram on the model of Palisca's additions to Galilei's diagram of the Ptolemaic modes in the *Dialogo*; see Galilei, *Dialogue*, l).

Galilei places over each column octave-spanning arches that map out the intervallic arrangement of Boethius's seven octave species. In Book IV, chapters 14-16 of *De institutione musica*, Boethius discusses the octave species and the eight modes, just as Galilei presents them in the *Dialogo*, but Galilei's chart unites these distinct concepts in a manner that is not evident in Boethius's text. One reason for this anomaly may lie in Galilei's source of Boethius's *De institutione musica*. Having no ecclesiastical duties, Galilei probably did not use Latin on a daily basis, and Palisca posits that he was not at all fluent in reading Latin treatises.[66] He could turn to Girolamo Mei for translations of the Greek authors but may have needed an Italian translation of *De institutione musica* to study Boethius on his own. Coincidentally, in 1579 the Florentine Giorgio Bartoli completed the first vernacular translation of *De institutione musica*.[67] Bartoli's diagram of the Boethian tonoi, which also superimposes the octave species over the eight modes, is shown in figure 22. It seems likely that Galilei modeled his chart of Boethius's tonoi on Bartoli's transcription. Both diagrams include arcs to point out the placement of the octave species in each tonos and the labels on the seven arcs found on the bottom–right of Galilei's chart match those of Bartoli, although they are printed in the reverse order.

[66] *Dialogue*, xli.

[67] **I**-Fn, Magliabechianus XIX.75. See Claude V. Palisca, "Boethius in the Renaissance," in *Music Theory and Its Sources: Antiquity and the Middle Ages*, ed. André Barbera (Notre Dame, IN: Notre Dame University Press, 1990), 266. Palisca suggests that the Bartoli translation was prepared, in part, for Galilei's use (ibid., 280). Bartoli seems to have been involved in activities of the Florentine Camerata and also produced copies of some of Mei's letters to Galilei.

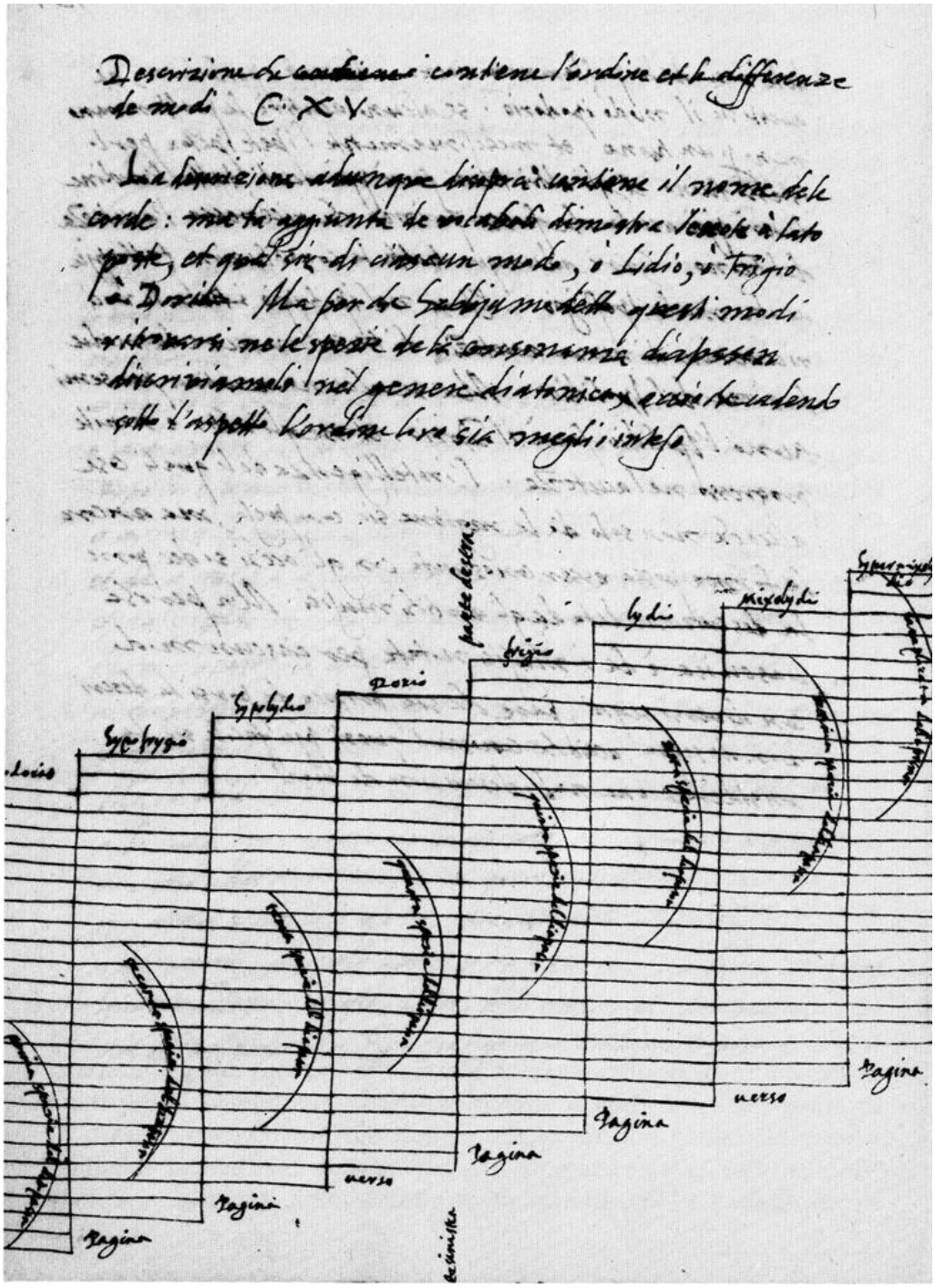


Figure 22. Demonstration of the Boethian tonoi, as translated by Giorgio Bartoli. **I**-Fn, Magliabechianus XIX.75, f. 134v.[68]

[68] This image is published in Palisca, "Boethius in the Renaissance," 277.

Galilei's terse explanation and diagram of Boethius's system illuminates the extent to which Boethian modal theory had been misunderstood by Renaissance and medieval theorists. In Book IV, chapter 15 of *De institutione musica*, each of the eight modes contains the same two-octave series of notes. As with Aristoxenus, the modes are distinct from one another by relative height. In this case, the eight modes are separated by the ascending series t-t-s-t-t-s-t. But Boethius only notes that the modes "arise" out of the octave species. His own description of each mode is very similar to the Aristoxenian arrangement:

> The arrangement of the modes proceeds in the following manner. Set out the succession of pitches in the diatonic genus from the *proslambanomenos* to the *nete hyperbolaion*. Let this be the Hypodorian mode. If one were to raise the *proslambanomenos* by one tone, and further raise the hypate hypaton by the same tone, thereby making the whole disposition higher by a tone, then the higher succession would turn out higher than it was before it was raised by a tone. Thus this whole system, having been made higher, forms the Hypophrygian mode.[69]

Thus, the eight church modes, long considered to be derived from Boethius's authoritative modal system, are really derived from a later misunderstanding of Boethius's octave species.[70] The distinction may appear superficial, but it is important if one considers the ethical properties of modes that were emphasized by sixteenth-century theorists. Although Zarlino expressed doubts with regard to the correspondence between modern and ancient modes, Glarean's thesis is predicated on a strong link between the

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[69] Boethius, *De institutione musica*, 343: "Horum vero sic ordo procedit. Sit in diatonico genere vocum ordo dispositus a proslambanomeno in neten hyperboleon atque hic sit hypodorius modus. Si quis igitur proslambanomenon in acumen intendat tono hypatenque hypaton eodem tono adtenuet ceterasque omnes tono faciat acutiores, acutior totus ordo proveniet, quam fuit priusquam toni susciperet intentionem. Erit igitur tota constitutio acutior effecta hypophrygius modus"; trans. in Boethius, *Fundamentals*, 148.

[70] The most influential misinterpretation of Boethius's modal system was written by the second author of the Carolingian *Alia musica*, which consists of a treatise and layers of commentary. For an explanation of the description of Boethius's modes in the *Alia musica*, see David Cohen, "Notes, Scales, and Modes in the Earlier Middle Ages," in *The Cambridge History of Western Music Theory*, ed. Thomas Christensen (Cambridge: Cambridge University Press, 2002), 331-35.

plainchant and polyphonic modality of the Catholic church and the ancient doctrines of musical ethos.

Galilei's chart of the Boethian tonoi (figure 21) shows that a literal interpretation of Boethius's modal system would produce modes that do not conform to sixteenth-century practice. At first glance, Galilei seems to be outlining the eight church modes. The first arc, over the Hypodorian mode, spans from A to a with no sharps or flats. The Hypophrygian arc covers B to b and so forth. The eight arcs appear to be identical to Glarean's first eight modes (see table 21), but Boethius claims that each individual mode is separated from the next by the ascending sequence t-t-s-t-t-s-t. Thus, the proslambanomenos of each mode in ascending order would correspond to the pitches A B C# D E F# G a. If the octave species of each mode is reconfigured to correspond to the relative height of each scale, the following modal octaves emerge:

Table 21. Boethius's eight octave species, as presented in Galilei, *Dialogo*, 58.

Tonos	Dbl-8ve	8ve Species	Modern Equivalent							
Hypodorian	A-aa	7.t-s-t-t-s-t-t	A	B	C	D	E	F	G	a
Hypophrygian	B-bb	1.s-t-t-s-t-t-t	C#	D	E	F#	G	a	b	c#
Hypolydian	C#-cc#	2.t-t-s-t-t-t-s	E	F#	G#	a	b	c#	d#	e
Dorian	D-dd	3.t-s-t-t-t-s-t	G	a	b♭	c	d	e	f	g
Phrygian	E-ee	4.s-t-t-t-s-t-t	b	c	d	e	f#	g	aa	bb
Lydian	F#-ff#	5.t-t-t-s-t-t-s	d	e	f#	g#	aa	bb	cc#	dd
Mixolydian	G-gg	6.t-t-s-t-t-s-t	f	g	aa	bb♭	cc	dd	ee♭	ff
Hypermixolydian	a-aaa	7.t-s-t-t-s-t-t	aa	bb	cc	dd	ee	ff	gg	aaa

The sequence of intervals in these octave species is identical to that in Glarean's and Zarlino's modes 1-8, but according to Galilei's interpretive diagram, the pitches

cannot be the same.[71] In other words, Galilei suggests that Glarean's modes and, in addition, the entire modal tradition of the Middle Ages and the Renaissance do not have a real affinity with the modes of Boethius. Although the sequences of tones and semitones follow the ancient octave species, the actual pitches are incongruent with Boethius's, as well as Ptolemy's and Aristoxenus's systems. The extent to which Galilei was concerned with a literal interpretation of his diagrams is unclear, yet his explanation of the Boethian tonoi demonstrates, again, the gulf between the systems of ancient music theorists and sixteenth-century musical practice.

Boethius's justification of an eighth mode in Book IV, chapter 17 of *De institutione musica* further confirms his role as a conduit of ancient music theory and not as the true source of medieval or Renaissance practice. In contrast to Glarean's justification of an eighth mode, which was based on a distinction between a harmonic and an arithmetic division of the octave, Boethius differentiates between Hypodorian and Hypermixolydian in that Hypodorian fills the octave A-a while Hypermixolydian is located in the octave a-aa (or Aa). The two tonoi are exactly an octave apart as they also appeared in the diagram of Aristoxenus's ordering. Galilei suggested that medieval theorists derived the concept of arithmetically and harmonically divided octaves from Boethius, but in fact Boethius is more closely connected to the ancient tradition.[72] Furthermore, Galilei's inclusion of the *synemmenon* tetrachord (included in Boethius's

[71] Zarlino noticed the incongruities between the notes Galilei labeled on the Dorian tonos of the diagram and the order of sequence of intervals that separated each tonos. He concluded that Galilei had demonstrated Boethius's modes "with little intelligence [con poca intelligentia]." See Zarlino, *Sopplimenti* VI.4, 252.

[72] For a brief explanation of the literary sources for Boethius's *De institutione musica*, see chapter 1 *supra*. Most of its content was composed centuries before Boethius wrote his treatise in the sixth century C.E. For a concise comparison of Boethius's modal system with those of his sources, see Calvin Bower, "The Modes of Boethius," *Journal of Musicology* 3 (Summer 1984): 252-63.

own diagrams but not in Bartoli's visual example) emphasizes the difference between Boethius's tonoi and the church modes.

In describing the tonoi of Aristoxenus, Ptolemy, and Boethius, Galilei intended to show his readers the tradition of ancient Greek music. There was no attempt to show a correspondence between modern music and ancient theory. In fact, Galilei insists that the concepts most essential to the theories of Glarean and Zarlino (i.e., the harmonic and arithmetic division of the octave and the modal final) obscured the power of the ancient tonoi. Speaking as Strozzi, Galilei compared the modern modes to the androgynous paintings of Ermippus:

> In truth, the way these [modern] modes are set up reminds me of the paintings of the singular Ermippus the Athenian, who in painting males and females—whether because of the hostility he naturally felt toward the beards and clothes or for some other particular bias—made them always so alike that it was impossible to tell females from males unless by their sex, as if diligent nature had not deliberately formed them differently in a thousand other and evident ways. So with the modes of modern contrapuntists—when you hear them sung it is truly impossible to distinguish by their height of pitch the first from the second, the third from the fourth, and so the others from these, and only by the final note can you tell them apart.[73]

Galilei's criticism of Glarean's and Zarlino's modal systems is certainly tied to his polemical stance against polyphonic music. Just as Glarean and Zarlino used their analyses of modern and ancient modes to defend the musical repertoires they preferred, Galilei's attack on the sixteenth-century modal system was influenced by his and his

[73] Galilei, *Dialogo*, 77: "In vero che questi Modi loro si fattamente accomodati, mi fanno sovvenire delle pitture del singulare Ermippo Atheniese; il quale nel dipignere i maschi, & le femmine; ò fusse per la inimicitia, che naturalmente haveva con le barbe, & con li habiti, ò per altro suo particolare interesse; le faceva del continovo tanto simili, che non era possibile conoscere queste da quelli se non al sesso: come se l'industriosa Natura non gli hauesse formati differenti in mille altri & sensati accidenti. così parimente i Tuoni de'Moderni Contrapuntisti; è impossibile veramente nell'udirgli cantare, conoscere circa l'acutezza, & gravità, il primo dal secondo, e'l terzo dal quarto, & così gli altri da questi; ma si bene alla corda finale; se bene nel vedergli scritti si mostrano molte piu acuti, ò piu gravi questi di quelli"; trans. in *Dialogue*, 188-89.

colleagues' attempts to revive ancient Greek music through monodic composition.[74] Although we may compare Galilei's modal theories to the monodic works of Giulio Caccini, Emilio Cavalieri, and others, it would be most beneficial to see if the theorist's own monodic settings of Dante and Holy scripture, now lost, might elucidate his opinions.[75]

Galilei's critique of polyphony is quite prophetic with regard to early opera and the rise of instrumental music in the early seventeenth century.[76] Indeed, much new music in the decades after the publication of Galilei's *Dialogo* emphasized single melodic lines and expressive text declamation more than the complex polyphony and seemingly polymodal music that Glarean and Zarlino had praised. In the theoretical tradition, on the other hand, Zarlino's *Istitutioni* remained the most influential treatise on music throughout the seventeenth century.[77] The survival of these theoretical ideas, nevertheless, does not necessarily reflect the important circumstances from which they arose. Glarean's twelve-mode system and its transmission through Zarlino are important because they demonstrate a growing desire among music theorists to validate the authority of ancient knowledge in contemporary musical practice. Zarlino's skepticism

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[74] Even before the *Dialogo* was published, Galilei's patron Giovanni Bardi, who had also studied Mei's letters on Greek music theory, dedicated a discourse to Giulio Caccini. In this document, Bardi urges Caccini to avoid contrapuntal music because it mixes modes. He also promotes a Ptolemaic system of tonoi in which each octave species is tied to a specific harmonic area, i.e., the Hypodorian is a low mode, while the Mixolydian is the highest. See Giovanni Bardi, "The Discourse Addressed to Giulio Caccini, Called the Roman, on Ancient Music and Good Singing," in *The Florentine Camerata: Documentary Studies and Translations*, edited and translated by Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 1989), 101, 109.

[75] Musicians have searched for Galilei's monodic compositions for well over a century. None other than Giuseppe Verdi, Italy's foremost opera composer of the nineteenth century, made inquiries into their location. See Gaetano Cesari and Alessandro Luzio, eds., *I copialettere di Giuseppe Verdi* (Milan: S. Ceretti, 1913; reprint in Bibliotheca musica bononiensis, V/23, Bologna: Forni, 1968), 634.

[76] Galilei himself put his modal theories to practical use in his unpublished "Libro d'intravolatura di liuto." The project is discussed in chapter 4 of this dissertation.

[77] Gregory Barnett, "Tonal Organization in Seventeenth-Century Music Theory," in *The Cambridge History of Western Music Theory*, ed. Thomas Christensen (Cambridge: Cambridge University Press, 2002), 414-15.

led the way for his student Galilei to present a marked criticism of an apparently naive attitude towards Greek music theory.

Ptolemy Reclaimed in the *Sopplimenti*

Sixteenth-century music theorists were the first to truly contemplate the historical contexts of ancient sources. Although Boethius's *De institutione musica* was considered to be the absolute authority on musical science until the end of the fifteenth century, modern editions and translations of Ptolemy, Aristoxenus, and other writers led to a greater awareness of the variety of musical systems in antiquity. Rather than simply applying Boethius's ideas to modern music, scholars of music in the later sixteenth century began to pick and choose ideas from Ptolemy, Aristoxenus, and Boethius depending on their intellectual milieu.

Many *cinquecento* writers were impressed with Ptolemy's idealized systems, which incorporated reason and the senses. Ptolemy's scientific writings were also the model for those authors who were more interested in certainty than in the authority offered by Boethius.[78] Zarlino championed Ptolemy and the Syntonic Diatonic tetrachord in the *Istitutioni*, and Ptolemy continued to serve as Zarlino's model in the *Sopplimenti*. Whereas Galilei presented Ptolemy's modal system as just one ancient formulation, Zarlino incorporated Ptolemy in the *Sopplimenti* as a final authority.[79]

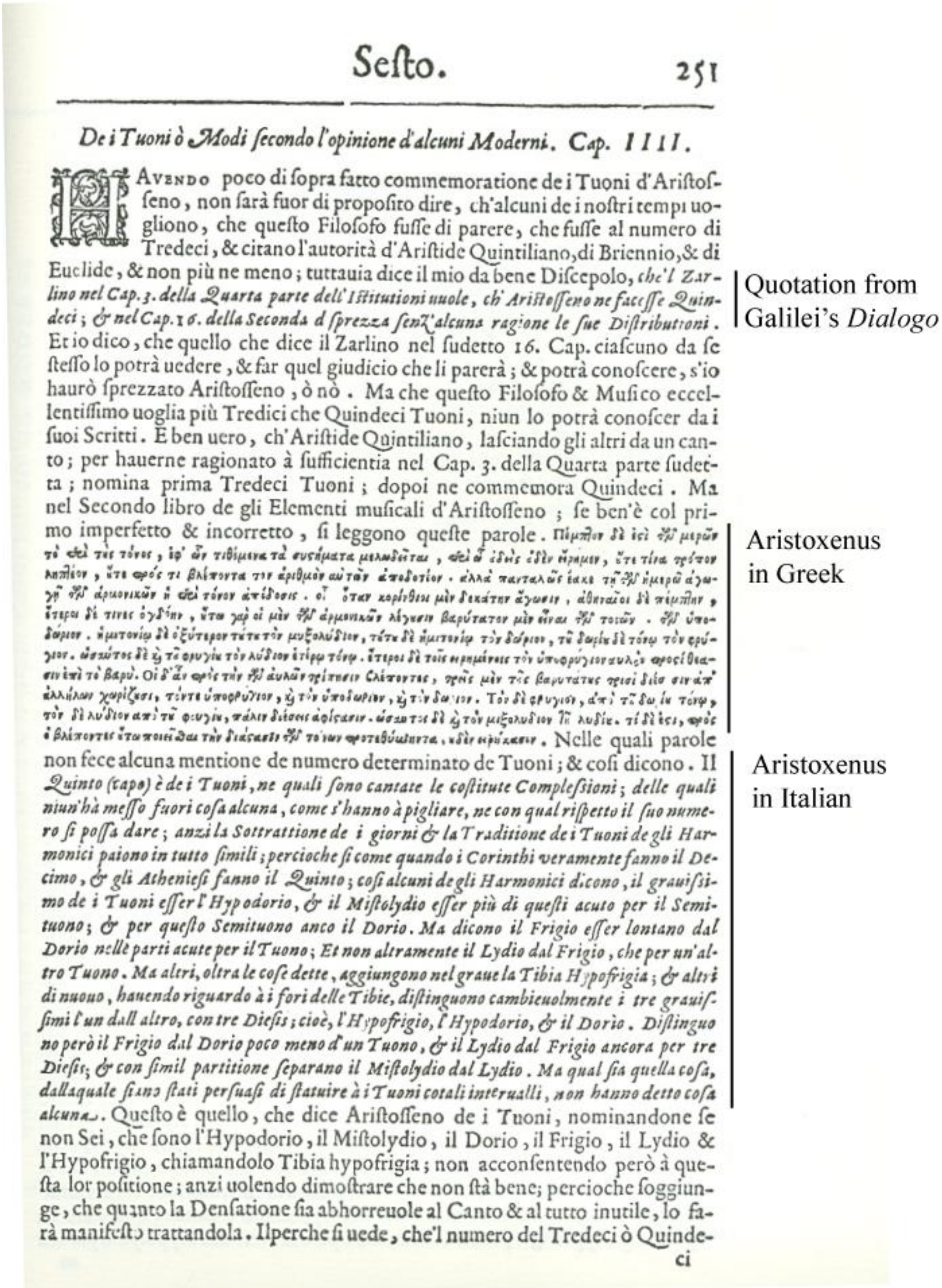
Zarlino intermixes many Ptolemaic ideas in the *Sopplimenti*; in fact, he sometimes paraphrases entire chapters from the *Harmonics*. Although Zarlino typically acknowledges most quotations and paraphrases by using an italic font or placing postils

[78] The search for certainty is discussed on pp. 53-57 *supra*.

[79] Although Girolamo Mei cited Ptolemy's *Harmonics* as the finest musical treatise in antiquity, Galilei understates Ptolemy's accomplishments, perhaps in part to ruffle Zarlino's feathers.

in the margins, some texts are integrated into the *Sopplimenti* without acknowledgement or with vague attributions.[80] As an example of quotations acknowledged within the text and set in italics, figure 22 displays a single page from the *Sopplimenti* that contains passages from Aristoxenus (in Greek and translated into Italian) and Galilei's *Dialogo*. Some pages exhibit numerous postils, but even so, there are many places in the *Sopplimenti* where borrowed texts are hidden (figure 23). For example, on page 31 of the *Sopplimenti*, Zarlino defines the science of harmonics. It is clear from the text that Zarlino is drawing on ancient sources, but he does not acknowledge that the entire chapter is paraphrased from Ptolemy's *Harmonics*. One quotation from the chapter is included below.

[80] It would be anachronistic to consider Zarlino's methods as plagiarism, but it is important to recognize that some parts of the *Sopplimenti* are more like a compendium of ancient writers than modern readers may suspect.


Seſto. 251

De i Tuoni ò Modi ſecondo l'opinione d'alcuni Moderni. Cap. IIII.

HAVENDO poco di ſopra fatto commemoratione de i Tuoni d'Ariſtoſſeno, non ſarà fuor di propoſito dire, ch'alcuni de i noſtri tempi uogliono, che queſto Filoſofo fuſſe di parere, che fuſſe al numero di Tredeci, & citano l'autorità d'Ariſtide Quintiliano, di Briennio, & di Euclide, & non più ne meno; tuttauia dice il mio da bene Diſcepolo, *che'l Zarlino nel Cap. 3. della Quarta parte dell'Iſtitutioni uuole, ch'Ariſtoſſeno ne faceſſe Quindeci; & nel Cap. 16. della Seconda dſprezza ſenz'alcuna ragione le ſue Diſtributtioni.* Et io dico, che quello che dice il Zarlino nel ſudetto 16. Cap. ciaſcuno da ſe ſteſſo lo potrà uedere, & far quel giudicio che li parerà; & potrà conoſcere, s'io haurò ſprezzato Ariſtoſſeno, ò nò. Ma che queſto Filoſofo & Muſico eccellentiſſimo uoglia più Tredici che Quindeci Tuoni, niun lo potrà conoſcer da i ſuoi Scritti. È ben uero, ch'Ariſtide Quintiliano, laſciando gli altri da un canto; per hauerne ragionato à ſufficientia nel Cap. 3. della Quarta parte ſudetta; nomina prima Tredeci Tuoni; dopoi ne commemora Quindeci. Ma nel Secondo libro de gli Elementi muſicali d'Ariſtoſſeno; ſe ben'è col primo imperfetto & incorretto, ſi leggono queſte parole. Πέμπτον δὲ ἐστὶ τῶν μερῶν τὸ περὶ τοὺς τόνους, ἐφ' ὧν τιθέμενα τὰ συστήματα μελῳδεῖται, περὶ ὧν οὐδεὶς οὐδὲν εἴρηκεν, οὔτε τίνα τρόπον ληπτέον, οὔτε πρός τι βλέποντα τὸν ἀριθμὸν αὐτῶν ἀποδοτέον. ἀλλὰ παντελῶς ἔοικε τῇ τῶν ἡμερῶν ἀγωγῇ τῶν ἁρμονικῶν ἡ περὶ τόνων ἀπόδοσις. οἷ ὅταν Κορίνθιοι μὲν δεκάτην ἄγωσιν, Ἀθηναῖοι δὲ πέμπτην, ἕτεροι δέ τινες ὀγδόην, οὕτω γὰρ οἱ μὲν τῶν ἁρμονικῶν λέγουσιν βαρύτατον μὲν εἶναι τῶν τόνων τὸν ὑποδώριον. ἡμιτονίῳ δὲ ὀξύτερον τούτου τὸν μιξολύδιον, τούτου δὲ ἡμιτονίῳ τὸν δώριον, τοῦ δωρίου δὲ τόνῳ τὸν φρύγιον. ὡσαύτως δὲ καὶ τοῦ φρυγίου τὸν λύδιον ἑτέρῳ τόνῳ. ἕτεροι δὲ τοῖς εἰρημένοις τὸν ὑποφρύγιον αὐλὸν προστιθέασιν ἐπὶ τὸ βαρύ. Οἱ δ' αὖ πρὸς τὴν τῶν αὐλῶν τρύπησιν βλέποντες, τρεῖς μὲν τοὺς βαρυτάτους τρισὶ διέσεσιν ἀπ' ἀλλήλων χωρίζουσι, τόν τε ὑποφρύγιον, καὶ τὸν ὑποδώριον, καὶ τὸν δώριον. Τὸν δὲ φρύγιον, ἀπὸ τοῦ δωρίου τόνῳ, τὸν δὲ λύδιον ἀπὸ τοῦ φρυγίου, πάλιν διέσεις ἀφιστᾶσιν. ὡσαύτως δὲ καὶ τὸν μιξολύδιον τοῦ λυδίου. τί δὲ ἐστι, πρὸς ὃ βλέποντες οὕτω ποιεῖσθαι τὴν διάστασιν τῶν τόνων προτεθύμηνται, οὐδὲν εἰρήκασιν. Nelle quali parole non fece alcuna mentione de numero determinato de Tuoni; & coſi dicono. *Il Quinto (capo) è de i Tuoni, ne quali ſono cantate le coſtitute Compleſsioni; delle quali niun'hà meſſo fuori coſa alcuna, come s'hanno à pigliare, ne con qual riſpetto il ſuo numero ſi poſſa dare; anzi la Sottrattione de i giorni & la Traditione de i Tuoni de gli Harmonici paiono in tutto ſimili; percioche ſi come quando i Corinthi ueramente fanno il Decimo, & gli Athenieſi fanno il Quinto; coſi alcuni de gli Harmonici dicono, il grauiſsimo de i Tuoni eſſer l'Hypodorio, & il Miſtolydio eſſer più di queſti acuto per il Semituono; & per queſto Semituono anco il Dorio. Ma dicono il Frigio eſſer lontano dal Dorio nelle parti acute per il Tuono; Et non altramente il Lydio dal Frigio, che per un'altro Tuono. Ma altri, oltra le coſe dette, aggiungono nel graue la Tibia Hypofrigia; & altri di nuouo, hauendo riguardo à i fori delle Tibie, diſtinguono cambieuolmente i tre grauiſſimi l'un dall'altro, con tre Dieſis; cioè, l'Hypofrigio, l'Hypodorio, & il Dorio. Diſtinguono però il Frigio dal Dorio poco meno d'un Tuono, & il Lydio dal Frigio ancora per tre Dieſis; & con ſimil partitione ſeparano il Miſtolydio dal Lydio. Ma qual ſia quella coſa, dallaquale ſiano ſtati perſuaſi di ſtatuire à i Tuoni cotali interualli, non hanno detto coſa alcuna.* Queſto è quello, che dice Ariſtoſſeno de i Tuoni, nominandone ſe non Sei, che ſono l'Hypodorio, il Miſtolydio, il Dorio, il Frigio, il Lydio & l'Hypofrigio, chiamandolo Tibia hypofrigia; non acconſentendo però à queſta lor poſitione; anzi uolendo dimoſtrare che non ſtà bene; percioche ſoggiunge, che quanto la Denſatione ſia abhorreuole al Canto & al tutto inutile, lo farà manifeſto trattandola. Ilperche ſi uede, che'l numero del Tredeci ò Quinde-
ci

Figure 23. Zarlino, *Sopplimenti musicali* VI.4, 251.

Qual ſia l'Oggetto ò Propoſito della Muſica. Cap. X.

MA ueramente gli Antichi non poteano ritrouar coſa migliore, ne più al propoſito, del ſudetto Canone ò Regola per ſaper conoſcere & intendere eſſattamente le coſe della Muſica; il quale ſi può ben dire che ſia ueramente Iſtrumento di eruditione, col mezo del quale ſi conoſce, come i Suoni tra loro conuengono; percioche nel cercar la Verità delle coſe, ei dimoſtra quello, alquale non può arriuare il Senſo: Onde da quello che ſi è detto, potremo ſapere il fine, il propoſito, ouer'Oggetto di queſta Scientia Muſicale, chiamata (come habbiamo ueduto) Harmonica; che non è altro, che'l uoler diffendere, conſeruare, & dimoſtrar con ragione le Poſitioni ò Proportioni rationali del ſudetto Canone ò Regola, non ripugnanti da parte alcuna, ne per alcun modo al Senſo, ſecondo l'opinione di molti; come anco è l'oggetto ò propoſito dell'Aſtronomia di conſeruar le poſitioni conſonanti de i Moti celeſti; oſſeruando le Reuelationi pigliate dalle coſe euidenti & più uniuerſalmente apparenti, ritrouate però ſingolarmente più eſſattamente che far ſi poſſa; Eſſendo che il Proprio dello Speculatiuo ò Contemplatiuo è di dimoſtrar l'opere della natura eſſer fatte con ragione & ordinata cagione, & nulla eſſere ſtato fatto da lei pazzamente & à caſo; maſſimamente in quelle fabriche, che ſono dure le più belle, più degne, più honorate & più utili d'ogn'altra, che ſono i Senſi più ragioneuoli, il Vedere & l'Vdire; i quali ſenza dubio alcuno, per la Ragione di gran lunga uincono gli altri, ſe ben ſi uede, ch'alcuni (come gli Ariſtoſſenici ſecondo'l parere di Tolomeo) hanno fatto poco conto di queſta coſa; hauendo ſolamente operato con le mani, laſciando da un canto la Ragione, & pigliato per guida loro il Senſo in tutto nudo & priuo di Ragione. Dice però che i Pithagorici con maggior diligentia & inquiſitione hanno conſeguito il fine, i quali (come ſi dice) furono prima, & gli Ariſtoſſenici dopoi. E' ben uero, che gli uni & gli altri mancarono in qualche coſa; eſſendo che i Pithagorici non hauendo in tutte le coſe, nellequali facea dibiſogno, ſeguito l'aiuto & beneficio del Senſo, accommodarono proportioni alle Differentie de Suoni, che non corriſpondeuano; & ſpeſſe fiate à quelli ch'erano manifeſti à coloro che n'haueano fatto eſperientia; di doue auenne, che queſto lor giudicio, appreſſo quelli ch'erano d'altro parere, non fu ſenza riprenſione, & ſenza calunnia. Ma quelli che ſeguitarono Ariſtoſſeno, hauendo dato troppo credenza à quelle coſe, c'haueano compreſo col Senſo, uſarono malamente la Ragione, paſſando quaſi fuori de i termini; Ilche fecero, non ſolamente contra eſſa Ragione; ma contra l'euidente effetto & eſperientia; prima, perche fuori d'ogni

Quotation from Ptolemy, *Harmonics* I.10.

Figure 24. Uncited quotation from Ptolemy's *Harmonics* in Zarlino, *Sopplimenti* I.10, 31 (underscoring added).

Ptolemy, *Harmonics* I.10.[81]	Ptolemy, *Harmonics* I.10.[82] (Zarlino's Latin source)	Zarlino, *Sopplimenti* I.10, 31.
The purpose of the harmonicist would be then to preserve in every way the reasoned hypotheses of the canon which do not in any way at all conflict with the perceptions as most people interpret them, just as the purpose of the astrologer is to preserve the hypothese of the heavenly movements concordant with observable paths. . .	Est autem Harmonico propositum ubique conseruare rationales positiones canonis, nusquam nullo pacto repugnantes sensibus, iuxta plurium opinionem; ut Astrologo conseruare caelestium motuum positiones consonas . . .	Harmonics is nothing other than the wish to defend, conserve, and demonstrate with reason the positions or rational proportions of the canon or [harmonic] rule, not disagreeing in any part or in any fashion with the senses (according to the opinion of many), just as the object or point of astronomy is to conserve the consonant positions of the celestial motions . . .[83]

Among other changes, Zarlino alters Ptolemy's "astrology" to "astronomy." This is strange because Zarlino uses *astrologia* in other places in the *Sopplimenti* and the index even notes that the "object or point of astrology" is found on page 31, where Zarlino has written *astronomia* instead.[84] Zarlino's vacillation between the two terms may be indicative of late sixteenth-century views regarding the two sciences.

Zarlino included several passages from Ptolemy's *Harmonics* in which he either Christianized the language or altered the content to fit his discussions of modern music. In one example, Zarlino removed a pagan reference in the text in order to present the idea as his own. The passage occurs in Book I, chapter 12, titled: "In Which Genus One Should Put the Harmonic Faculty or Music and Its Science."[85] Although Zarlino notes that he is going to answer the question posed in the title of the chapter "according to the

[81] Ptolemy, *Harmonics*, 6-8.

[82] Zarlino used Antonio Gogava's translation of Ptolemy. See Antonio Gogava, *Aristoxeni mvsici antiqviss. Harmonicorvm elementorvm libri III. Cl Ptolemaei Harmonicorum, seu de musica lib. III. Aristotelis de obiecto auditus fragmentum ex Porphyrij commentarijs* (Venice: Vincenzo Valgrisi, 1562), 53.

[83] Zarlino, *Sopplimenti* I.10, 31: "Harmonica, che non è altro, che'l uoler diffendere, conseruare, & dimostrar con ragione le Positioni ò Proportioni rationali del sudetto Canone ò Regola, non ripugnanti da parte alcuna, ne per alcun modo al Senso, secondo l'opinione di molti; come anco è l'oggetto ò proposito dell'Astronomia di conseruar le positioni consonanti de i Moti celesti."

[84] Zarlino, *Sopplimenti* index, f. Ff2v.

[85] Ibid., 34: "In qual Genere si debba porre la facoltà Harmonica, ouer la Musica & la sua Scientia."

opinion of Ptolemy," he again does not make it clear that the entire chapter is merely a close paraphrase of the *Harmonics*, Book II, chapter 3 and a section from chapter 4. Zarlino hides Ptolemy's identity by altering pagan references:

Ptolemy, *Harmonics* III.3	Ptolemy, *Harmonics* III.3[86] (Zarlino's Latin source)	Zarlino, *Sopplimenti musicali* I.12[87]
. . . and in the sense of touch the soft, for instance, and the hard; and, **by Zeus**, each of the differences is suitable or it is not.	. . . in tangibilibus molle, uerbi gratia, et durum, ac **per Iouem**, quod in unaquaque differentia commodum aut incommodum.	. . . and in the sense of touch, what is hard and what is soft and what is suitable and unsuitable.

In addition to incorporating large swaths of the *Harmonics,* Zarlino occasionally inserts references to modern music within excerpts that are attributed to Ptolemy, tacitly recasting his ancient model as an expert on sixteenth-century theoretical issues. In the following example, Ptolemy's references to "sound" in general are expanded to encompass the *suoni* and *voci* of Italian music theory:

[86] Gogava, *Aristoxeni mvsici*, 135.

[87] Zarlino, *Sopplimenti*, 35: ". . . & nelle tangibili, quello, che è Duro & quello che è Molle, & quello che è Commodo & lo Incommodo."

Ptolemy, *Harmonics* I.1	Ptolemy, *Harmonics* I.1[88]	Zarlino, *Sopplimenti musicali* I.13, 36[89]
Harmonics is a perceptive function of the differences in sounds between high and low, and **sound** is a condition of beaten air—the first and most basic element of what is heard.	Harmonica quidem facultas in percipienda sonorum acuminis, e gravitatis differentia consistit. **Sonus** autem affectio est aeris pulsati, prima et generalissima earum quae audiuntur.	And from what has been said and what Ptolemy says in the beginning of the first chapter of his *Harmonics*, we can comprehend that the harmonic function, or music (as we might wish to call it) or science, consists in recognizing the differences placed among the high and the low, as much in the ***suoni*** as in the ***voci***; and sound is the first and most basic symptom of percussed air, of those things that can be heard. **Therefore, there is no doubt that the speculation of every musical composition that is made with the *voci* or the *suoni* of the artificial instruments**, and the full workings of the art and science are reduced under two headings, of which (as Aristoxenus wishes) the first is hearing and the other, reason (*Intelligentia*).
The criteria in harmonics are hearing and reason . . .	Atque arbitri sunt harmoniae, Auditus et Ratio:	

Ptolemy does not refer to musical compositions at all in the opening chapter of the *Harmonics*.

Ptolemaic ideas and texts inundate Books V (on scales) and VI (on modes) of the *Sopplimenti.* Paraphrases from the *Harmonics* fill almost half of Book V's ten pages, and a few chapters in Book VI are also adapted from that source. In Book V, chapter 2, for example, Zarlino writes: "we will now see, in the fashion the ancients considered them, how many and what were and still are the differences of the species of the first

[88] Gogava, *Aristoxeni mvsici*, 51.

[89] Zarlino, *Sopplimenti* I.13, 36: "Et perche da quello che si è detto, & da quello che dice Tolomeo nel principio del primo Capo de i suoi Harmonici; potiamo comprendere, che la facoltà harmonica ò la Musica, che dire la uogliamo, ò Scientia, che consiste nel conoscer le Differentie poste tra il graue & l'acuto; tanto ne i Suoni, quanto nelle Voci; & il Suono è la Prima & generalissima passione dell'Aria percossa, di quelle cose che si possono udire; però non è da dubitare, che la Speculatione d'ogni Compositione musicale, che si fà ò con le Voci, ò con i Suoni de gli Istrumenti arteficiali, e tutto'l negocio di questa Arte & Scientia, si riduca sotto due capi; de i quali come uuole Aristosseno, il primo è l'Vdito e l' altro la Intelligentia."

consonance."[90] The following discussion of the "ancients" is actually a close paraphrase of the *Harmonics*, Book II, chapter 3. Zarlino even retains Ptolemy's first-person plural, just as Galilei preserved Zarlino's first-person statements in the *Istitutioni* when he adapted that text for his unfinished "Compendio."[91]

Zarlino must have been aware that Ptolemy's explanations of musical systems could be confusing to his readers because he introduces slight modifications into the text. For example, in Book II, chapter 3 of the *Harmonics*, Ptolemy describes the manner in which diatessarons are mapped onto the Greater Perfect System. He begins with the highest note and works toward the bottom of the scale, adding a tone of disjunction between the second and third diatessaron. Figure 25 is an illustration of Ptolemy's placement of the tetrachords from Gogava's translation.

[90] Ibid. V.2, 233: "che uediamo hora, nel modo che le considerauano gli Antichi, quante & quali erano & anco siano le differentie delle Specie delle Prime consonanze."

[91] I.e., Zarlino writes "Diremo [we say]" where Gogava's Latin translation has "Dicimus." For a discussion of Galilei's "Compendio," see pp. 67-69 *supra*.

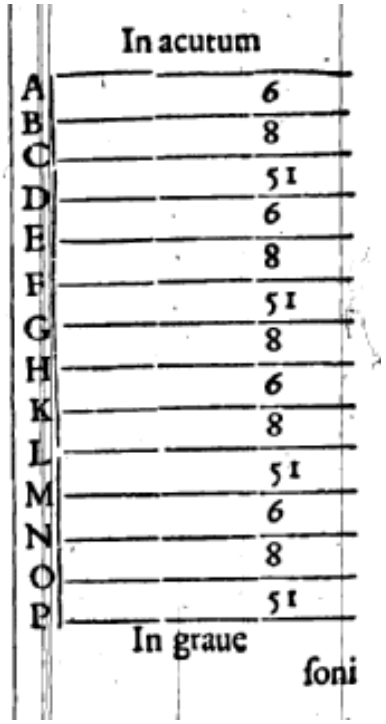


Figure 25. Antonio Gogava, *Aristoxeni mvsici,* 88.[92]

In figure 25, the diatessaron ABCD sits at the top of the scale.[93] The other diatessarons are represented by DEFG, HKLM, and MNOP, and the interval between notes G and H is the tone of disjunction. In Book V, chapter 2 ("On the Differences of the Constitutions or Species of the First Consonance"), Zarlino translates Ptolemy's description into Italian but turns the entire system upside down (figure 26).

[92] The exact meaning of the numbers on the right column of Gogava's diagram is unclear. Judging by their placement on the scale, "8" and "6" respectively refer to the major and minor tone while "51" must represent the semitone that completes the tetrachord. Many of Gogava's tables are incorrect or are difficult to follow because of errors that occurred in the printing of the translation. For a general discussion of the problems in Gogava's rendering of Ptolemy, see Claude Palisca, *Humanism in Italian Renaissance Musical Thought* (New Haven, CT: Yale University Press, 1985), 133-42.

[93] The letters ABCD do not represent musical pitches; they signify geometric points, such as one might find in a Euclidian diagram.

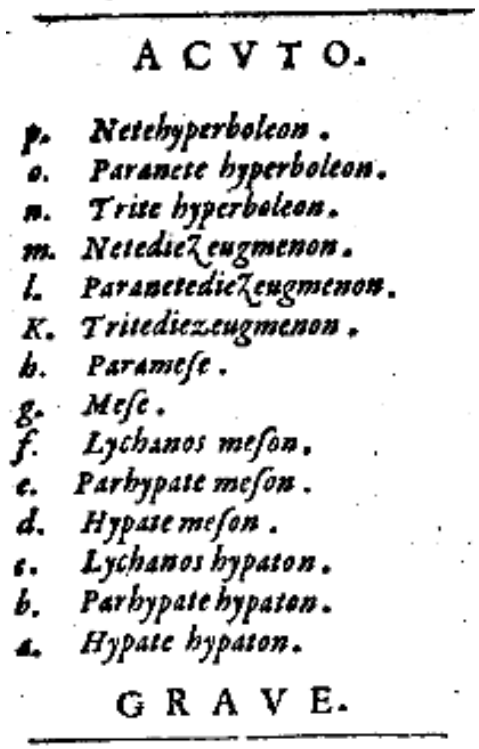


Figure 26. Zarlino, *Sopplimenti* V.2, 234.

In Zarlino's illustration, the first diatessaron is placed on the bottom of the Greater Perfect System and the notes ascend toward the top. Zarlino explains that Ptolemy describes his scale from top to bottom, and he probably turned it upside down so that the ordering would not confuse readers more familiar with the ancient scale through Boethius's *De institutione musica.*[94] It is also possible that Zarlino intentionally reversed Ptolemy's ordering because the octave species that arise from the reverse order of intervals is closer to those found in the modern 12-mode system. This possibility will be discussed below.

[94] Boethius's description of the species of consonance (IV.14) is similar to Ptolemy's, but Calvin Bower suggests that it is a translation from a lost work of Nicomachus. Among the differences is the placement of tetrachords,which are assigned from the bottom to the top of the scale in Boethius's species. In some copies of *De institutione musica*, the diagram that accompanies Boethius's description looks identical to Ptolemy's proposal, but Boethius's text clearly places the first tetrachord at the bottom of the Greater Perfect System. See Boethius, *Fundamentals*, 148-52.

On one occasion in Book V, a paraphrase from Ptolemy's *Harmonics* results in a confusing coincidence. Chapter 4 is titled: "That Only the Diapason Is a Perfect Complex or Constitution."[95] In this chapter, Zarlino purports to explain that the diapason is the only perfect consonance because it contains all of the other consonances within itself.[96] The entire text is paraphrased from Book II, chapter 4 of the *Harmonics*, and no postil or attribution to Ptolemy is included. Ptolemy himself titled the chapter: "On the Perfect System and That It Alone Contains the Double Diapason"; and after suggesting that the diapason could be considered the perfect consonance, he concludes that the double diapason is actually the only perfect system because it contains all of the different species of fourths and fifths. Because Zarlino does not stray far from Ptolemy's text, he too concludes that the double diapason is the only perfect system, contrary to the chapter's title. The error probably originated in Gogava's translation, which mentions only the diapason in his title.[97]

Zarlino's chapter 4 is also confusing because in his discussion of an "imperfect" configuration of tetrachords, Zarlino refers to a visual example placed in "chapter 4 of the second Book."[98] Knowing that Zarlino has based his chapter on Book II, chapter 4 of Ptolemy's *Harmonics*, we might assume that Zarlino is alluding to Ptolemy's *Harmonics*, but there is no such diagram in Gogava's translation of this chapter. In fact, Zarlino is referring to Book II, chapter 4 of the *Sopplimenti*, which does contain two diagrams of

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[95] Zarlino, *Sopplimenti* V.4, 237: "Che la Diapason solamente sia Complessione ò Costitutione perfetta."

[96] Solomon notes in his translation of the *Harmonics* that an English equivalent for the Greek word for perfect (τέλειον) would be closer to "complete" than "immaculate." See Solomon, *Harmonics*, 71. In this case, the diapason is perfect in the same sense that the number six is perfect. In other words, six is the sum of all of its divisors (1, 2, 3) and the diapason is the sum of the two other perfect consonances, the 3:2 fifth and 4:3 fourth, i.e., 3:2+4:3 = 12:6 = 2:1.

[97] Gogava, *Aristoxeni mvsici*, 89.

[98] Zarlino, *Sopplimenti* V.4, 238: "nel Capo 4. del 2 libro."

the Greater Perfect System that could be useful in piecing together Zarlino's description of the Greater Perfect and Imperfect systems.

The "Natural" Modal System

It has been argued in this dissertation that theorists will be most favorable towards musical systems that best describe the type of music in which they are most interested. For example, Zarlino promoted the "natural" order of the Syntonic scale in Book IV, chapter 6 of the *Sopplimenti* because it is the only system that could describe the tuning used by vocal choirs to sing the sonorities of polyphonic music without intolerable dissonances. Zarlino's idealized proofs of the system left him vulnerable to the mathematical rigor Galilei used to discredit its practicality. In discussing ancient scale systems, on the other hand, Galilei walked into a similar trap. His research on ancient Greek music and personal predilection for accompanied song led him to favor the Aristoxenian system of tonoi because unlike earlier configurations discussed by *cinquecento* writers, it placed more importance on the highness or lowness of pitch than on configurations of fourths and fifths.[99] Zarlino uses the majority of Book VI to show Galilei's misrepresentation of the ancient writers and especially the modal systems of Ptolemy and Aristoxenus. In spite of his claims that the modern modes have little to do

[99] Galilei conflates the notion that the Greek names for the modes (Dorian, Phrygian, Lydian, etc.) refer to the peoples of certain geographical locations with his own view that modes are distinguished by the relative height of pitch. While explaining how nature was the inventor of the tonoi, Bardi says in the *Dialogo*, 71: "la qual cosa vede & ode chi ben considera tutto il giorno accadere à molto altre prouincie, e particolarmente dell'Italia. imperoche con piu graue Tuono parlano & cantano generalmente i Lombardi, di quello ce fanno i Toscani; & con piu acuta voce di questi parlano i popoli della Liguria . . . . basta che l'istesso che occorre hoggi nell'Italia, occorse & deue occorrere giornalmente nell'Asia tra i popoli della Lydia, della Frygia, & della Doride"; trans. in *Dialogue*, 171: "You see and hear this happening every day to many other provinces, particularly in Italy, for the Lombards generally speak and sing with a lower pitch than the Tuscans, and the latter speak with a higher voice than the people of Liguria. . . . It is enough that what occurs today in Italy occurs and must occur every day in Asia and among the peoples of Lydia, Phrygia, and Doria."

with those of the ancients, Zarlino too sets out to show that his 12-mode system is quite similar to an idealized ancient system and that it is as natural as Syntonic tuning.

In Book VI of the *Sopplimenti*, Zarlino counters Galilei's diffuse explanation of ancient modal systems by illuminating the important principles that governed modal systems in antiquity. In chapter 1, through his customary analogies to Aristotelian philosophy, he defines the modes and their distinguishing set of intervals as the form and matter of a piece of music, adding: "just as all things in the world are reduced to ten headings, which we call subjects . . . , so every musical cantilena is comprised under one of the twelve ideas or forms, or (we might wish to say) headings."[100] After presenting such a broad definition of modality, Zarlino observes the various definitions of the word "tonos" that appear in Boethius's *De institutione musica* and Cleonides' *Harmonic Introduction* and justifies the many different systems that are described by ancient writers. Although he insists that contemporary musicians use twelve modes, he argues that it is not a serious problem to see so many different enumerations of the modes in ancient treatises. Some writers, according to Zarlino, were just noting the most famous modes, while a writer such as Pliny discussed only seven modes because he wanted to emphasize the relationship between musical science and the seven planets.[101]

As in Book V, Zarlino uses Ptolemy's *Harmonics* as the benchmark for ancient views on modality, For example, Zarlino discusses the names of the notes with regard to their position and function in Book VI, chapter 2. His exegesis, which explains Ptolemy's "thetic" and "dynamic" nomenclature, is an exact translation of the *Harmonics*, Book II,

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[100] Zarlino, *Sopplimenti* VI.1, 240: "Et si come tutte le cose, che sono nel mondo si riducono à Dieci capi, che chiamamo [*sic*] Predicamenti . . . cosi ogni Cantilena Musicale è compresa l'una de Dodici Idee ò Forme, ò uogliamo dir Capi."

[101] Ibid., 242.

chapter 5. Therefore, the material Galilei presented in the *Dialogo* as the "Tonoi According to Ptolemy" is presented by Zarlino in the *Sopplimenti* as *the* ancient view of modality. Zarlino again uses first-person speech so that Ptolemy's authorship is obscured.

Ptolemy's *Harmonics* is also useful for Zarlino because it provides an easy counter-argument to Galilei's "Aristoxenian" opinions of the ancient modes. Galilei explicitly preferred Aristoxenus's system of tonoi because it stressed the importance of relative height of pitch instead of characteristic sequences of intervals and modal finals. Ptolemy criticized the Aristoxenian view in Book II, chapter 11 of the *Harmonics*, and Zarlino includes a translation of it in Book VI, chapter 6 of the *Sopplimenti*.[102] Ptolemy's system allows for only seven distinct tonoi because there are only seven possible configurations of the octave within his characteristic set of intervals. To modulate from one tonos to another, a musician would need to cross over on one of the stationary pitches that connect the various tonoi. In Zarlino's view, if scales were added between any consecutive pair of the original seven, a modulation from one tonos to another would be impossible for two reasons. First of all, the connections among immutable pitches, which allow smooth transitions between two tonoi, would be broken because all of the pitches of the added tonoi would be a semitone away from the pitches in the tonoi on opposite sides of the added tonos. In addition, a modulation would alter the relative height of the intervals sung or played but not the characteristic sequence of intervals. Because Ptolemy does not accept relative height as a unique quality of a mode, a modulation from one

[102] Ibid. VI.6, 258-59. In this chapter, Zarlino mentions the *Harmonics* (II.2, 3) and draws correlations between Ptolemy's ideas and the pseudo-Aristotelian *Problems*, but he never acknowledges that the text is wholly derived from the *Harmonics*. Ptolemy's criticisms of the Aristoxenians have parallels to the polemics between Zarlino and Galilei. Andrew Barker (*Scientific Method in Ptolemy's* Harmonics [Cambridge: Cambridge University Press, 2000], 90) notes that the Aristoxenian method was the only distinct competition to Ptolemy's methodology. Ptolemy sought to discredit his principal rival just as Zarlino attempted to do in his *Sopplimenti*.

tonos to another in Galilei's Aristoxenian system would not actually constitute a change of tonos.

Zarlino often reminds the reader that his modal system is a reflection of contemporary musical practice and has little to do with ancient modal systems, but he is nonetheless eager to show his supporters and critics that the modern 12-mode system has close ties to ancient music theory. In Book VI, chapter 3 of the *Sopplimenti*, Zarlino describes the "Ancient order of the tones" along with the "new natural order of the twelve modes or tones placed in practice by our modern musicians." Zarlino specifically excluded use of the term "tone" (*tuono*) in the *Istitutioni* to avoid confusion with other definitions of the word.[103] In the *Sopplimenti*, however, he does not shy away from the term because it emphasizes the modern system's connections to ancient writers such as Ptolemy and Aristoxenus, both of whom use "tone." Zarlino also applies here the adjective "natural" in reference to his re-ordering of the system, an idea first articulated in the fifth Discussion of the *Dimostrationi harmoniche*.[104]

The description of the ancient order has concordances with Galilei's presentation of the Ptolemaic tonoi.[105] In Book VI, chapter 2 of the *Sopplimenti*, Zarlino listed a static order of notes following Ptolemy's *thetic* nomenclature and applied modern pitches to each note (table 22).

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[103] Zarlino explains his rationale in Book IV, chapter 1 of the *Istitutioni*, 297: "Et perche questo nome Tuono si estende in più cose, come hauemo veduto; però io per schiuare la Equiuocatione, più che hò potuto, hò voluto nominarli Modi, et non Tuoni"; trans. in *On the Modes*, 11: "Since the term 'tone' is extended to several things, as we have seen, I have chosen to use the term 'mode' and not 'tone,' in order to avoid ambiguity as much as possible."

[104] See p. 62 *supra*.

[105] See pp. 186-89 *supra*.

Table 22. Pitches added to Ptolemy's *thetic* nomenclature in Zarlino, *Sopplimenti* VI.2, 246.

Order	Pitch
Nete hyperbolaion	aa
Paranete hyperbolaion	g
Trite hyperbolaion	f
Nete diezeugmenon	e
Paranete diezeugmenon	d
Trite diezeugmenon	c
Paramese	b
Mese	a
Lychanos meson	G
Parhypate meson	F
Hypate meson	E
Lychanos hypaton	D
Parhypate hypaton	C
Hypate hypaton	B
Proslambanomenos	A[106]

Zarlino does not explicitly say why he attached this sequence of pitches, but his order (t-s-t-t-s-t-t) follows Ptolemy's description of the Hypodorian tonos and the order for the Hypodorian tonos in Galilei's descriptions of Ptolemy's and Boethius's systems (tables 20 and 21 *supra*).

As in Book V, chapter 2, Zarlino once again reverses the order of the notes in his table (Book VI, chapter 3) that presents the "Order of the Ancient Tonoi." In this schema, eight tonoi (sharing the same names and order as those discussed by Boethius in Book IV, chapter 16 of *De institutione musica*) are presented in a wing-like format, showing the characteristic interval sequence of each tonos (table 23).

[106] The printed text reads *a*.

Table 23. The "Order of the Ancient Tonoi," from Zarlino, *Sopplimenti* VI.3, 248.

Tonos	Dbl.-8ve	8ve Species	Modern Equivalent
Hypodorian	GG-g	t-t-s-t-t-s-t	GG A B C D E F G
Hypophrygian	A-aa	t-s-t-t-s-t-t	A B C D E F G a
Hypolydian	B-bb	s-t-t-s-t-t-t	B C D E F G a b
Dorian	C-cc	t-t-s-t-t-t-s	C D E F G a b c
Phrygian	D-dd	t-s-t-t-t-s-t	D E F G a b c d
Lydian	E-ee	s-t-t-t-s-t-t	E F G a b c d e
Mixolydian	F-ff	t-t-t-s-t-t-s	F G a b c d e f
Hypermixolydian	G-gg	t-t-s-t-t-s-t	G a b c d e f g

Zarlino does not explicitly add note names in his table, but we may infer these pitches from the manner in which he describes the ordering. In particular, Zarlino claims that each of the three plagal tonoi is lower than its corresponding authentic tonos by a fourth (*Tetrachordo*) and that the Dorian tonos is also a fourth lower than Mixolydian. Considering the specific interval sequence of each tonos, we can then add diatonic pitches to all of the tonoi.

In this ordering, the Dorian tonos follows the interval sequence t-t-s-t-t-t-s and is therefore comparable to the modern C-c scale. Although contemporary theorists considered the Dorian tonos with the octave species t-s-t-t-t-s-t as the first mode, Zarlino had already suggested in the *Istitutioni* that the C-c scale (or mode 11) should be called Dorian.[107] He reasoned further on the subject in the *Dimostrationi*, defining each octave species by the placement of the semitones. No doubt Zarlino also wanted to show that the

[107] Zarlino, *Istitutioni* IV.8, 308: "Imperoche quando si volessero nominare per tali nomi (quando li Modi moderni fussero simili in qualche parte a gli Antichi) più presto douerebbeno chiamare l'Vndecimo Dorio, il Primo Frigio, et Lidio il Terzo"; trans. in *On the modes*, 34: "If modern musicians want to call the modes by these [Greek] names (as if the modern modes were similar in some way to the ancient modes), they should call the eleventh mode Dorian, the first mode Phrygian and the third made [*sic*] Lydian."

harmonically divided octave with which he demonstrated Syntonic tuning was also the first tonos of the ancient system.[108]

Having established the ancient order of the tonoi, Zarlino then turns to his "modern" 12-mode system (table 24).

Table 24. The "New natural order of the twelve modes or tones put into practice by modern musicians," from Zarlino, *Sopplimenti* VI.3, 248.

Tonos no.	8ve	8ve Species
1	C-c	t-t-s-t-t-t-s
2	GG-G	t-t-s-t-t-s-t
3	D-d	t-s-t-t-t-s-t
4	A-a	t-s-t-t-s-t-t
5	E-e	s-t-t-t-s-t-t
6	B-b	s-t-t-s-t-t-t
7	F-f	t-t-t-s-t-t-s
8	C-c	t-t-s-t-t-t-s
9	G-g	t-t-s-t-t-s-t
10	D-d	t-s-t-t-t-s-t
11	a-aa	t-s-t-t-s-t-t
12	E-e	s-t-t-t-s-t-t

The octave species of each tonos is identical to those Zarlino presented in the *Istitutioni* (table 11 *supra*) but the new order, shown in comparison with that of the ancients, is now presented as not only an appropriate description of modern musical practice but also true to nature. The first tonos, C-c, is also identical to the ancient Dorian, which Zarlino

[108] Definition 8 of the fifth Discussion of the *Dimostrationi harmoniche* begins: "The first species of the diapson is that which contains the major semitone [16:15] between the third and fourth string and the seventh and eighth [La Prima specie della Diapason è quella, che tra la terza & la quarta chorda: & tra la settima & la ottaua contiene il Semituono maggiore]." When Claudio Merulo asks Zarlino why he considers this octave species to be first, Zarlino answers: "such diapason, divided according to the nature of the harmonic number, is collocated among our modern strings C, D, E, F, G, a, b, and C, and was also the first diapason that was naturally considered in music [tale Diapason, diuisa secondo la natura del Numero harmonico: è collocata tra le nostre moderne chorde C. D. E. F. G. a. ♮. & c: & anco era la prima Diapason, che naturalmente era considerata nella Musica]." See Gioseffo Zarlino, *Dimostrationi harmoniche* (Venice: Francesco de' Franceschi Senese, 1571; reprint in Monuments of Music and Music Literature in Facsimile, II/2, New York: Broude Brothers, 1965), 270-71. See pp. 59-62 *supra* for an explanation of the process by which Zarlino harmonically divides the C-c scale.

claimed was judged to be "the true Greek *harmonia*,"[109] although the *Sopplimenti* no longer employs the old modal names (Dorian, Phrygian, etc.). Furthermore, it is the same octave species Zarlino used to described Syntonic tuning.[110]

Conclusion

Scale systems play an essential role in theoretical discussions of music from antiquity to the present. They are a principal tool for analysis and a fundamental step in learning to sing or play any instrument. Furthermore, in antiquity and the Renaissance, the musical scale could often serve as an analogy for the structure of the solar system.[111] For the writers surveyed in this chapter, scale systems functioned as a medium through which each theorist could address broader concerns about music. Heinrich Glarean first developed the 12-mode system as an analytical tool to defend the music of the Catholic church—Gregorian chant and the polyphony of Josquin's generation. Although the foundations of his scale system are rooted in Boethius's *De institutione musica* and later medieval writers, Glarean's many references to ancient writers, however inaccurate, certainly appealed to his readers who were enamored with the "Golden Age" of Greece and Rome.

Zarlino and Galilei sought a greater concordance between their modal systems and contemporary music than Glarean, but both musicians ultimately defended their system through ancient music theory. Galilei favored the Aristoxenian system because it

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[109] Zarlino, *Istitutioni* IV.5, 302: "la vera Greca harmonia;" trans. in *On the Modes*, 20.

[110] It would have been impossible for Zarlino to present the Syntonic tetrachord as a result of the "harmonically divided" octave if he had used the D-d scale. For one, the lower diapente (D-a) would have to be arithmetically divided into a minor third placed below a major third.

[111] For one example, see the frontispiece to Franchino Gaffurio's *Practica musicae* in which the notes of the scale are compared to both the heavenly bodies and the nine muses. A discussion of this image is found in James Haar, "The Frontispiece of Gafori's *Practica Musicae* (1496)," in *The Science and Art of Renaissance Music*, ed. Paul Corneilson (Princeton, NJ: Princeton University Press, 1998), 79-92.

stressed relative height of pitch.[112] Zarlino initially tried to sever the ties between the 12-mode system and antiquity by defining the term "mode" as "that measure or form which prevents us from going too far in anything we do,"[113] instead of applying some ancient definition from Boethius or other writer. More important in this regard, Zarlino replaced the Greek names of the modes with numbers, thereby breaking any loose association with the ancient peoples of Ionia, Phrygia, or elsewhere.

In the *Dimostrationi* and *Sopplimenti*, however, Zarlino re-ordered the 12-mode system, placing the C-c scale first. He had already presented this octave species as the exemplar of the harmonically divided octave in Book II, chapter 39 of the *Istitutioni*. By labeling the "modes" with the more ancient term "tone" (*tonos*) and showing the similarities between his order and an idealized ancient configuration, Zarlino bestowed his "practical" modal system with the same "natural" characteristics with which he defended the Syntonic tuning. Even if the polyphonic idiom he cherished would lose ground to the chromaticists or to the monodists in Galilei's circle, in the *Sopplimenti*, Zarlino had provided a philosophical defense of tuning and scales that would be impregnable to attacks from musical heretics. Recognizing that their argument was now beyond the scope of humanistic antiquarianism, Galilei's next step was not to argue the details of theoretical systems as much as it was intended to destroy Zarlino's formulation of natural and artificial music.

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[112] Galilei provides a practical demonstration of his modal theories in his unpublished "Libro d'intavolatura di liuto" (1584). A discussion of the manuscript is found on pp. 228-32 *infra*.

[113] Zarlino, *Istitutioni* IV.1, 293: "quella misura, o forma, che adoperiamo nel fare alcuna cosa, laqual ne astrenge poi a non passar più oltra"; trans. in *On the Modes*, 1.

Chapter 4

Introduction to Galilei's *Discorso intorno all'opere di messer Gioseffo Zarlino*

Sixteenth-Century Culture Wars

Social conflict is common in any historical era, but the Venetian culture wars of the late sixteenth and early seventeenth century, as described by Renaissance historian Edward Muir in *The Culture Wars of the Late Renaissance*, offer a direct and contemporaneous parallel to the dispute between Zarlino and Galilei.[1] Drawing on a theory of late Renaissance anxiety expressed by William Bouwsma in *The Waning of the Renaissance*, Muir depicts a Venetian society in which "reason was dethroned" and God's role in human events was deemed by many as limited.[2]

Several facets of the culture wars are immediately (if not coincidentally) relevant to the Zarlino-Galilei dispute. For one, Muir speaks of the conspicuous rise of the Jesuit College in Venice in 1589, the same year in which Galilei published his *Discorso intorno all'opere di messer Gioseffo Zarlino*.[3] A fundamental aspect of the conflict between the Jesuit College and the University of Padua was the pedagogical method of each institution.[4] Whereas the Jesuits modeled their teachings on Aristotle and Thomist theology (as Zarlino did in the *Sopplimenti*), the University was influenced by the skeptic views of the philosopher Cesare Cremonini. In response to Jesuit opposition, Cremonini

[1] Edward Muir, *The Culture Wars of the Late Renaissance: Skeptics, Libertines, and Opera*, The Bernard Berenson Lectures of the Italian Renaissance (Cambridge: Harvard University Press, 2007).

[2] Bouwsma writes about the various manifestations of anxiety that afflicted Europeans in the late sixteenth century; he focuses on many famous thinkers of the era, including Robert Burton, Michel de Montaigne, and Galileo Galilei. See William J. Bouwsma, *The Waning of the Renaissance: 1550-1640* (New Haven, CT: Yale University Press, 2000), 112-28; Muir, *Culture Wars*, 6-7.

[3] Vincenzo Galilei, *Discorso intorno all'opere di messer Gioseffo Zarlino* (Florence: Marescotti, 1589; reprint in Collezione di trattati e musiche antiche edite in facsimile, Milan: Bollettino bibliographico musicale, 1933).

[4] Muir, *Culture Wars*, 30-35.

and a group of prominent Venetians and Paduans formed the *Accademia dei Ricoverati*, among whose co-founders was Vincenzo's son Galileo, a professor of mathematics at the University.

Zarlino did not have any ties to the Jesuit College, but he shared its pedagogical goals. As noted in chapter 1, Zarlino was influenced by notions of certainty, especially as they pertained to the works of Alessandro Piccolomini.[5] In the *Sopplimenti*, Zarlino provided an approach to musical science founded on Aristotle's metaphysics and first principles. In support of his theorems and arguments against Vincenzo Galilei, he cited parts of the *Dimostrationi harmoniche* as proof, creating a hermetic seal of validity around his musical systems. Muir notes that the Jesuits promoted a similar methodology, for which they were castigated by the Venetian patriot Paolo Sarpi, who viewed the Jesuit program as a threat to Venetian autonomy from Papal authority, and by Cremonini, whose own educational program focused on experience more than on reason.[6]

The influence of the Jesuit College in Venice was eventually suppressed by the Venetian senate, and the Jesuits were banned from Venice between 1606 and 1657. Although the Zarlino-Galilei dispute was essentially over by 1591, the culture wars provide a broader context within which to place the polemical treatises discussed in this dissertation. Because of their divergent worldviews and irreconcilable methodologies, both authors in their late writings sought to fully destroy the credibility of their foe.

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[5] See pp. 53-55 *supra*.

[6] On Sarpi's opposition to the Jesuits on patriotic grounds, see William J. Bouwsma, *Venice and the Defense of Republican Liberty: Renaissance Values in the Age of the Counter Reformation* (Berkeley: University of California Press, 1968), 524-25; quoted in Muir, *Culture Wars*, 34-35. On Cremonini and experience, see ibid., 48-50. Although Cremonini's arguments were often directed at Galileo Galilei's experimental approach to mathematics and astronomy, his opposition to mathematical certainty could also have been applied to Zarlino's writings.

Decades after Zarlino and Galilei had passed away, the classicist Giovanni Battista Doni summarized their "celebrated dispute" in this manner:

> when two contend upon some question with much animosity . . . they more often force themselves to vanquish their companion than discover the truth; they hear nothing other than sophistic arguments and useless nitpicking, which serve no other purpose than to confound the minds of those who read or listen and to make a show of affected subtlety rather than firm doctrine.[7]

"Late" Galilei

A conspicuous anger permeates Galilei's last theoretical writings, perhaps emerging from years of frustration over his career. Some writers suggest that he was bitter about his failure to gain employment in the Florentine court and held personal grudges against composers favored by the Medici.[8] Whatever the case, in the 1589 *Discorso*, Galilei expresses acrimony over his financial situation and the lack of success he has achieved since the publication of the *Dialogo*. In Galilei's view, Zarlino deserved part of the blame. In the dedicatory letter to Count Giovanni de' Bardi included in the

[7] Giovanni Battista Doni, "Quale specie di diatonico si usasse dagli antichi, e quale oggi si pratichi, Discorso terzo al Signor Francesco Nigetti," in *Lyra Barberina*, 2 vols., ed. Antonio Francesco Gori and Giovanni Battista Passeri (Florence: Typis Caesareis, 1763; reprint in Bibliotheca musica bononiensis, II/151, Bologna: Forni, 1974), 1:365: "quando due sopra qualche questione con molta animosità contendono . . . sforzandosi ciascuno piùttosto di superchiare il compagno, che di scuoprire la verità, non s'odono altro, che argomenti sofistichi, ed inutili cavillazioni, che per altro non servono, se non per confondere la mente a chi legge, o ascolta, e per far mostra anzi d'affetata sottigliezza, che di salda dottrina."

[8] Alfred Einstein, *The Italian Madrigal*, 3 vols., trans. Alexander H. Krappe, Roger H. Sessions, and Oliver Strunk (Princeton, NJ: Princeton University Press, 1964), 1:233-34. Einstein sees Galilei's attack on counterpoint in the *Dialogo* (pp. 80-90) as partially motivated by his jealousy. Galilei seems to have received some assistance from the Medici. In the dedication to his *Intavolature de lauto . . . libro primo*, he thanks Bernadetto de' Medici for favors received. The acknowledgment suggests that Galilei was looking for further financial help: he notes that due to his poverty, he can repay the favors only with the gift of music. See Howard Mayer Brown, "Vincenzo Galilei in Rome: His First Book of Lute Music (1563) and Its Cultural Context," in *Music and Science in the Age of Galileo*, ed. Victor Coelho, The University of Western Ontario Series in Philosophy of Science, no. 51 (Dordrecht: Kluwer Academic Publishers, 1992), 157.

Dialogo, Galilei had accused an unnamed person of holding up its printing;[9] in the *Discorso*, Galilei recalls the episode and names the culprit:

> . . . when my *Dialogo* was printed, I sent some of them to Venice and consigned them to a bookseller so that they might be read by the scholars of the field it treats. But not before they were seen by Zarlino, who immediately engaged with a gentleman of some authority **(**whose name I would know to say and would be able to produce letters from the same bookseller when it might be necessary), who went to him and showing him an angry face said these words: "take away these books on display, and if ever you dare to exhibit them again or show them to anyone, I will make you!"[10]

Galilei further suggests that Zarlino had missed the opportunity to print the *Dialogo* under his own name. Although there is no evidence Zarlino intended to steal the *Dialogo* for himself—after all, why would he want to claim authorship of a book that criticizes his work?—Galilei's accusation of obstruction fuels much of the anger towards Zarlino that he expresses in his last writings. In the *Discorso*, Galilei claims that "if anything is good or new in his *Sopplimenti*, [Zarlino] has learned it from me and from my *Dialogo*."[11]

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[9] Vincenzo Galilei, *Dialogo della mvsica antica, et della moderna* (Florence, Marescotti, 1581; reprint in Monuments of Music and Music Literature in Facsimile, II/20, New York: Broude Brothers, 1967), f. 2v: "e se non viene con quella purgata fauella che io doueua . . . accusine la poca fede d'alcuni Stampatori di Venezia: i quali non solo mi hanno (contro ogni douere) piu mesi intrattenuto, per compiacere ad alcuno il quale ò tratto da inuidia impediua che queste mie fatiche vscissero fuore, ò voleua egli delle molte vigilie mie se stesso horare"; trans. in Vincenzo Galilei, *Dialogue on Ancient and Modern Music*, trans. with introduction and notes by Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 2003), 4: "If [the *Dialogo*] does not reach you with the refined prose that it should . . . , certain barely reliable Venetian printers are to blame who not only held it up for many months—without any right—to please someone who prevented my efforts from seeing the light, led either by envy or the wish to honor himself with my many vigils."

[10] Galilei, *Discorso*, 12: ". . . quando fu stampato detto mio Dialogo, ne mandai alquanti a Venetia, e gli feci consegnare ad vn libraio perche fussero letti da gli studiosi della facultà di che egli tratta; ma non prima furono dal Zarlino veduti, che subito operò con vn Gentil'huomo di qualche autorità, del quale saperei dire il nome, e potrei produr lettere del medesimo libraio quando bisognasse; che andò da lui, e mostratogli il uiso dell'arme gli disse queste formate parole. To via questi libri di su la mostra e se mai più hai ardire di mettergli fuore, o di fargli vedere ad alcuno, io ti farò, è [*sic*] ti dirò."

[11] Galilei, *Discorso*, 8-9: "se nulla di buono, o di nuouo è ne'suoi supplimenti, l'ha apparato da me e dal mio Dialogo."

The Search for a New Patron

As noted above, Galilei was often patronized by nobles, particularly Count Giovanni de' Bardi.[12] After 1587, Bardi's Camerata ceased to meet at his villa, but a new group of artists with which Galilei was associated congregated at the household of Jacopo Corsi, the dedicatee of Galilei's 1584 edition of the *Fronimo* and patron of both Vincenzo and Galileo Galilei.[13] The extent to which Galilei benefitted from Corsi in the late 1580s is unknown, but it appears he was seeking further patronage.

Apart from his mock dedication to Zarlino in the 1589 *Discorso*, Galilei does not provide formal dedications in his late theoretical works. Nevertheless, a note in the manuscript of his unfinished critique of the *Sopplimenti* may refer to a new potential patron (figure 27).

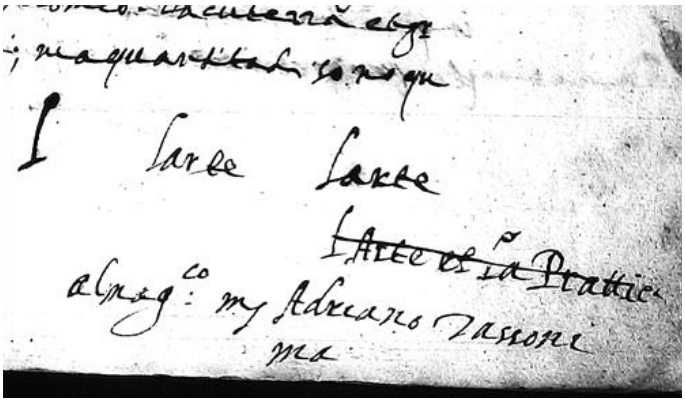

Figure 27. **I**-Fn, Gal. 5, f. 4r.

The note suggests that Galilei is testing a title. The cancelled material reads: "the Art and the Practice," the first five words of Galilei's unpublished "Il primo libro della prattica del contrapunto."[14] Underneath is the dedication: "to the magnificent Adriano Tassoni."

[12] See pp. 65-67 *supra*.

[13] Tim Carter, "Music and Patronage in Late Sixteenth-Century Florence: The Case of Jacopo Corsi (1561-1602)," *I Tatti: Essays in the Renaissance* 1 (1985): 70, 74.

[14] There are three copies of the treatise in manuscript. According to Frieder Rempp, the title is found only in version A. See Vincenzo Galilei, "Il primo libro della prattica del contrapunto intorno all'uso

Compared to Galilei's other benefactors, Adriano Tassoni (d. 1605) was the ideal patron. A Modenese nobleman, Tassoni appears to have been interested in the mechanical arts. He visited Florence as early as 1587 to represent the Duke of Urbino at the funeral rites for Grand Duke Francesco I de' Medici. In 1589 he moved permanently to Florence, where he served the Medici court and patented a triple plow that could be pulled by a single animal.[15] Tassoni is not mentioned by Galilei in any other writings, but it is possible that he was interested in Galilei's experimental approach to music theory and interest in tying music to the mechanical arts.

After publishing the *Discorso*, Galilei composed a series of short writings, all of which could have been used as gifts. Drawing on topics covered in the *Discorso*, these essays dealt with ancient music theory, the ratios of the diapason, the unison, and some doubts regarding the use of the enharmonic genus. They were little known until Frieder Rempp and Claude V. Palisca published them in the 1980s.[16]

Theoretical Goals

D. P. Walker notes that Galilei "had some interesting things to say; but his line of thought is constantly side-tracked and distorted by his obsessive need to contradict

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delle consonanze," **I**-Fn, Gal. 2, ff. 3r-54v; edited by Frieder Rempp in *Die Kontrapunkttraktate Vincenzo Galileis*, Veröffentlichungen des Staatlichen Instituts für Musikforschung preussischer Kulturbesitz, ed. Hans-Peter Reinecke and Dagmar Droysen, vol. 9 (Cologne: Arno Volk, 1980), 5-76. Galilei's second treatise on counterpoint focuses on the use of dissonance and is also transcribed in Rempp's *Die Kontrapunkttraktate Vincenzo Galileis*, 77-161.

[15] Luca Molà, "Il Mercato delle innovazioni nell'Italia del Rinascimento," in *Le tecnicien dans la cité en Europe occidentale, 1250-1650*, ed. Mathieu Arnoux and Pierre Monnet (Rome: Ecole française de Rome, 2004), 233.

[16] Rempp, *Die Kontrapunkttraktate Vincenzo Galileis*; Claude V. Palisca, *The Florentine Camerata: Documentary Studies and Translations*, Music Theory Translation Series (New Haven, CT: Yale University Press, 1989).

Zarlino and to adhere to [Girolamo] Mei's contempt for modern music."[17] Indeed, the 1589 *Discorso* and the unfinished critique of the *Sopplimenti* are obvious examples, but Galilei also blames Zarlino throughout his two treatises on counterpoint. It would be shortsighted, however, to consider Galilei's ideas as mere fodder for argument rather than true contributions to musical science. In fact, the projects Galilei undertook after the *Dialogo* was published show that he was trying to put his theories into practice. The structure of his unfinished "Libro d'intavolatura di liuto," for example, reveals Galilei's attempt to demonstrate the expressive possibilities of an "Aristoxenian" scale system in instrumental music. Throughout the last decade of his life, Galilei instituted a new program for musical science while consistently blaming Zarlino for the problems caused by the *bone regole* of counterpoint.[18]

In the introduction to his "Contrapunto," Galilei claims that Zarlino had not sufficiently attempted to fill the lacuna of musical scholarship on the subject:

> Up until the present, I had entertained the hope that this labor should be done by some excellent professor particular to the said field [of counterpoint], and having had notice many years ago in [the] *Sopplimenti musicali* that he was about to publish them [i.e., the rules for the use of consonance in counterpoint], I hoped it would be done by Mr. Gioseffo Zarlino rather than by any other, believing that in these, as was promised by the title and by the necessity of the matter, would be the entirety of what was lacking in his *Istitutioni harmoniche* and in particular in the third and fourth part, both written on the practice of counterpoint.[19]

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[17] D[aniel] P[ickering] Walker, "Vincenzo Galilei and Zarlino," in *Studies in Musical Science in the Late Renaissance*, Studies of the Warburg Institute, ed. J. B. Trapp, vol. 37 (London: Warburg Institute, 1978), 19.

[18] In 1584, Galilei published a revised edition of the *Fronimo dialogo* (2d ed. [Venice: L'herede di Girolamo Scotto, 1584]). Much of the treatise consists of rules for good counterpoint, for which Galilei cites Zarlino as an authority (as well as on modal theory). In fact, many of the rules Galilei ridicules in his unpublished "Contrapunto" are presented in the 1584 printing of the *Fronimo*. Perhaps it was the publication of the *Sopplimenti* that inspired an angrier stance against Zarlino's *Istitutioni*.

[19] Vincenzo Galilei, "Contrapunto," f. 55r-v; transcribed in Rempp, *Die Kontrapunkttraktate*, 7: "ne l'ho fatto prima che al presente trattenuto dalla speranza che questa tal fatica dovesse esser fatta da alcuno eccellente professore particolare della detta facultà; et piu da ogn'altro la speravo da ms. Gioseffo Zarlino, mediante l'havere havuto piu anni sono notitia de Supplementi [*sic*] Musicali ch'egli doveva

By the 1580s, Part III of Zarlino's *Istitutioni* had become a standard authority for the study of counterpoint. Zarlino did not establish the basic rules, but as Palisca notes in his translation, "he was their most lucid and perspicacious exponent in the sixteenth century, the golden age of vocal counterpoint."[20] The proponents of the so-called "golden-age" of counterpoint were not favorable to the greater amounts of dissonance and other expressive devices employed by later sixteenth-century madrigalists and instrumental composers. Galilei, for one, thought that the new experimental language used by composers needed to be addressed in a treatise on counterpoint.

Although the rules of counterpoint expressed in the *Istitutioni* were a perfect foil for Galilei's arguments in his own writings on counterpoint, it should be noted that even if Zarlino's discussion was not revolutionary, it was representative of important trends in musical composition from the first half of the *cinquecento*. Most notable is the lack of a discussion of proportional rhythm in polyphonic composition. Zarlino devotes only four out of eighty total chapters to this topic, which merited much more description in earlier, practical treatises by Franchino Gaffurio and Pietro Aaron.[21] After offering a basic

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mandare in luce; credendo che in essi si come mi promettevo dal Titolo, et dalla necessita della cosa, dovess'esser l'intero di quanto mancava alle sue Istitutioni Harmoniche, et imparticolare alla terza et alla quarta parte, scritte ambodue intorno la prattica del Contrapunto."

[20] Gioseffo Zarlino, *The Art of Counterpoint: Part Three of* Le istitutioni harmoniche, *1558*, trans. Guy A. Marco and Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 1968), xiii.

[21] The entirety of Book IV of Franchino Gaffurio's *Practica musice* (Milan: Ioannes Petrus de Lomatio, 1496; reprint in Monuments of Music and Music Literature in Facsimile, II/99, New York: Broude Brothers, 1979) is dedicated to proportional rhythm, as is Book I of Pietro Aaron's *Thoscanello de la musica* (Venice: Bernardino and Mattheo de Vitali, 1523; reprint in Monuments of Music and Music Literature in Facsimile, II/69, New York: Broude Brothers, 1969). See Franchinus Gafurius, *The Practica mvsicae*, trans. and ed. with musical transcriptions by Irwin Young (Madison: The University of Wisconsin Press, 1969), 165-266; Aaron, *Thoscanello*, [2-46]. Substantial explanations of mensural rhythm continued in some practical treatises. For example, theorists in Naples continued to follow the paradigms of Gaffurio long after Zarlino's *Istitutioni* was published. Scipione Cerreto's *Della prattica musica vocale, et della strumentale* (Naples: Carolino, 1601), in particular, contains a lengthy discussion of proportional rhythm in practical music.

description of the proportional rhythm, including perfection, imperfection, and the various signs used by "ancient" musicians, Zarlino concludes:

> Since such things are not in any way beneficial—and truly they are not—it seems to me very foolhardy to force a person with talent to arrest his studies and take time out to labor over similar irrelevancies. My advice is to ignore such ciphers and to concentrate on those matters that lead to the production of good sweet harmonies.[22]

Zarlino presents an impious attitude toward proportional rhythm because it is not essential material for students who want to compose and perform the polyphonic idioms that were popular in Venice at the time. Although he does not waste words on the topic or condemn the practice to the extent that Galilei denounces counterpoint in the *Dialogo*, Zarlino's criticism of "ancient" (fifteenth-century) music emphasizes the extent to which he is writing about a particular style of music rather than offering universal claims about the manner in which music should be practiced.

Thirty years after Zarlino first published the *Istitutioni*, Galilei tried to depict the monumental treatise as a work that was out-of-date and did not reflect current fashions. In the introductory pages of his "Contrapunto," Galilei specifically chooses topics on which he could argue with Zarlino. For example, Galilei disagrees with Zarlino's interpretation of the biblical account of music's origins. In the *Istitutioni* (I.1), Zarlino supposes Jubal was the discoverer of the musical science: "For (as Moses, Josephus, and Berossus the Chaldean said) before the universal flood [musical science] was found from

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[22] Zarlino, *Le istitutioni harmoniche* III.71 (Venice: [by the author], 1558; reprint in Monuments of Music and Music Literature in Facsimile, II/1, New York: Broude Brothers, 1965), 278: "Et se non danno vtile alcuno (come veramente non danno) parmi veramente gran pazzia, che alcuno di eleuato ingegno habbia da fermare il suo studio, & spendere il tempo, & affaticarsi intorno a simili cose impertinenti: Onde consiglierei ciascuno, che mandasse da vn canto queste cifere, & attendesse a quelle cose, col mezo delle quali si puo acquistare le buone, & soaui harmonie"; trans. in *The Art of Counterpoint*, 264. In this case, Zarlino uses "ancient" to refer to music that was composed in previous generations (i.e., the fifteenth century) and not to Greek or Roman antiquity.

the sound of hammers by Jubal of the lineage of Cain."[23] Zarlino actually conflates Jubal's achievements with those of Pythagoras because the Bible (Gen. 4:21) notes only that Jubal was "the father of them that play upon the psaltery and the kithara"; there is no reference to Jubal and the origins of musical science. Galilei argues that the origins of music did not come about as Zarlino found: Jubal merely reduced a musical practice to a musical science. The practice of instrumental music, Galilei claims, would have begun in the garden of Eden because Adam would have used clay pots and other items as drums.[24] In addition, the music theory developed by Jubal was not lost in the great flood, as many believe, but saved by Noah and his family. Whereas Zarlino and others merely mapped the achievements of Pythagoras onto the biblical Jubal, Galilei's speculative interpretation emphasizes the role that theorists play in musical discourse: they explain musical principles that have already been established by performers.

Throughout the treatises on counterpoint, Galilei attempts to dismantle the traditional rules, which were enumerated in the *Istitutioni*. The famous debate between Nicola Vicentino and Vicente Lusitano over the genera took place seven years before the *Istitutioni* was published, and by the time Galilei was drafting his two treatises on counterpoint (1588-91), chromatic passages and expressive dissonances were much more common in musical composition. Indeed, Cipriano de Rore, Zarlino's former colleague at St. Mark's, is cited as an authority in Galilei's "Discorso intorno all'uso delle

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[23] Ibid., 3: "percioche (come dicono Mose, Gioseffo, & Beroso Caldeo) auanti che fusse il diluuio vniuersale fu al suono de martelli trouata da Iubale della stirpe di Caino." Zarlino was not the first to attribute the discovery of musical science from the "sound of hammers" to Jubal. Although Boethius and other ancient writers credit Pythagoras for discovering musical science, a woodcut found in Franchino Gaffurio's *Theorica musice* (Milan: Ioannes Petrus de Lomatio, 1492; reprint in Monuments of Music and Music Literature in Facsimile, II/21, New York: Broude Brothers, 1967), f. bvir, depicts Jubal experimenting with musical consonance in the blacksmith's shop. Galilei discusses the experiment in the *Discorso* (pp. 102-4).

[24] Galilei, "Contrapunto," f. 56r-v; Rempp, *Die Kontrapunkttraktate Vincenzo Galileis*, 8-9.

dissonanze," even though he had passed away twenty-five years earlier.[25] Nevertheless, as Galilei explains the new contrapuntal resources cultivated by Rore and others, he maintains a running commentary on Zarlino's rules. He either claims that most of them are false or shows that they are valid in only some instances. Because these works were never published, they had no effect on the reception of the *Istituioni*, and Zarlino's rules continued to be esteemed as authoritative in *seicento* treatises. Galilei's process, however, illustrates the extent to which his theoretical goals were shaped by the need to contradict Zarlino.

Arguing with Zarlino appears to be the most important topic in Galilei's later theoretical works, yet his activities in the realm of practical music demonstrate positive solutions to the problems he introduced in the *Dialogo*. The unpublished "Libro d'intavolatura di liuto," composed in 1584, demonstrates that Galilei was actively trying to show the practical value of his ideas.[26]

The first part of the "Intavolatura" is a pragmatic application of the Aristoxenian modal system Galilei championed in the *Dialogo*. Galilei includes twelve sets of pieces, each containing various numbers of passamezzos, romanescas, and saltarellos; the groupings progress in order from the first to the twelfth position of the lute. In other words, Galilei offers sets of pieces that begin on each semitone of the chromatic scale.

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[25] Vincenzo Galilei, "Discorso intorno all'uso delle dissonanze," **I**-Fn, Gal. 1, f. 188r; transcribed in Frieder Rempp, *Die Kontrapunkttraktate Vincenzo Galileis*, 146.

[26] A facsimile of the "Intavolatura" is found in Vincenzo Galilei, "Libro d'intavolatura di liuto," **I**-Fn, Gal. 6; reprinted with commentary in Italian and English by Orlando Cristoforetti, Monumenta musicae revocata, ed. Laura Alvini, Marcello Castellani, and Paolo Paolini, vol. 2 (Florence: Studio per Edizioni Scelte, 1992). A critical edition and transcription of the third part of the "Intavolatura" may be found in Vincenzo Galilei, *Le gagliarde dal Libro d'intavolatura di liuto (Gal. 6): Edizione critica con intavolature per liuto e con trascrizione in notazione moderna*, ed. Giulia Perni, Studi musicali toscani, vol. 1 (Pisa: Edizioni ETS, 2000). For information on the collection itself, including discussions of the organization of the "Intavolatura," incipits for every composition, and transcriptions of several pieces, see Luis Gasser, "Vincenzo Galilei's Manuscript *Libro d'Intavolatura di Liuto 1584*: An Introductory Study" (D.M.A. dissertation, Stanford University, 1991).

Because the "Intavolatura" exists only in lute tablature, there is no fixed pitch for any of the compositions. If the first passamezzo in the collection is assumed to begin on a G minor triad,[27] then the second grouping begins on A♭, the third on A, the fourth on B♭, and so forth. If one were to transcribe the entire first part of the "Intavolatura," the finished product would be a group of pieces in twelve modes, each starting on a different pitch yet based on a scale that contains the same sequence of tones and semitones.[28] Galilei was not the first to compose a collection of lute music that used every position of the lute, but in this case he was offering a didactic demonstration of the expressive possibilities of that instrument.[29]

Orlando Cristoforetti, the editor of Galilei's "Intavolatura," sees the placement of the cycles itself as Galilei's alternative solution to the final and ambitus of the modal system he rejected in the *Dialogo*. A brief comparison of Zarlino's and Galilei's modal theory also highlights differences between each musicaian's views about musical expression. In the *Sopplimenti* (VI.1), Zarlino posits that all musical compositions are comprised under one of the twelve ideas or forms, which are the same as the twelve

[27] Sixteenth-century lutenists typically tuned their instruments in G or A. Galilei expresses his preference for G in both editions of his *Fronimo*. See Galilei, *Fronimo*, 2d ed., 8.

[28] For a discussion of Galilei's "Aristoxenian" modal system, see pp. 177-81 *supra*.

[29] Cristoforetti (Galilei, "Intavolatura," [viii]) notes that lute composers in the middle of the sixteenth century were aware that lute tuning approximated equal temperament and that Giacomo Gorzanis was the first to intabulate music in all twenty-four postures ("12 per b molle and "12 per b quadro"). Galilei uses only the twelve postures "per b molle" in the first part of the "Intavolatura"; the second part contains twelve passamezzos "per b quadro." Similar to Galilei's "Intavolatura," Gorzanis's collection contains pairs of passamezzos and saltarellos. Even though Gorzanis's collection, too, remains in manuscript (Munich, Bayerische Staatsbibliothek, Mus. Ms. 1511a), it is possible Galilei saw Gorzanis's format during his visit to Munich in 1578-79. Galilei also included twenty-four ricercares in the 1584 printing of the *Fronimo*. The purpose of these pieces was to demonstrate the use of the 12-mode system ("per b molle" and "b quadro"). In these short works, Galilei follows the octave species of Zarlino's system (as adapted form Glarean), but he does not always present each mode with the proper final. For example, the second ricercare has C instead of D as the final. See Galilei, *Fronimo*, 2d ed., 80-90.

modes.[30] Therefore, the form of a piece of music is understood by comprehending the modal final, ambitus. and sequence of tones and semitones in the scales that are used in the parts. The musical expression is established principally by the composer without regard to the voices or instruments that will perform the work. In the first part of the "Intavolatura," each piece is composed in a scale that has the same sequence of tones and semitones. In addition to highness and lowness of pitch, exploited by the use of twelve positions, each grouping of pieces requires a different combination of closed and open strings and various schemes for fingering the notes in the right and left hand. In addition, the quantity and types of ornaments used by the performer will vary in each mode. Thus, the weight of musical expression in each piece is shared by the composer and performer.

Two brief examples from the "Intavolatura" demonstrate the way in which Galilei's conception of scales is far removed from Zarlino's 12-mode system, which was more suitable for vocal polyphony. Figure 28 shows the tablature and transcription of the beginning of the first passamezzo.[31]

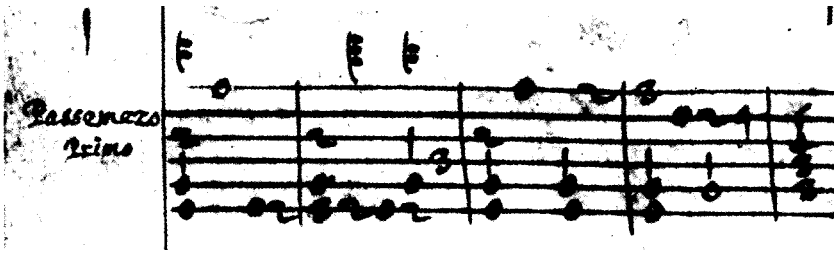

Figure 28a. *Passamezzo primo* from Galilei, "Intavolatura," f. 3v.[32]

[30] Gioseffo Zarlino, *Sopplimenti musicali* VI.1 (Venice: Francesco de' Franceschi Senese, 1588; reprint in Monuments of Music and Music Literature in Facsimile, II/15, New York: Broude Brothers, 1979), 240. Zarlino uses the term "tone" throughout Book VI of the *Sopplimenti* rather than "mode," which he used in Part IV of the *Istitutioni*.

[31] Passamezzos are dance pieces based on repeated chord progressions. They fall into two types: the *passamezzo antico* typically follows the progression i-VII-i-V-III-VII-i-V-I, while the *passamezzo moderno* uses I-IV-I-V-I-IV-I-V-I. Galilei uses the *passamezzo antico* throughout the first part of the "Intavolatura." For an introduction to the passamezzo, see Giuseppe Gerbino and Alexander Silbiger, "Passamezzo," in *The New Grove Dictionary of Music and Musicians*, ed. Stanley Sadie and John Tyrrell, 2d ed., 29 vols. (London: Macmillan, 2001), 19:194-96.

[32] The Italian tablature used by Galilei allowed amateur musicians to play the music even if they did not know how to read musical notation or if their lute was not tuned to whichever key Galilei conceived

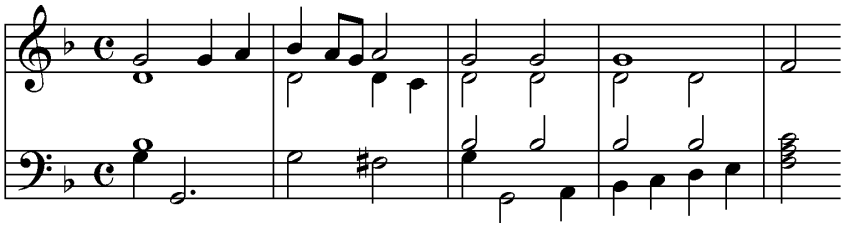

Figure 28b. *Passamezzo primo*, mm. 1-5.

In the common 8- or 12-mode systems used in the sixteenth century, this passamezzo could be analyzed as being composed in a Dorian mode transposed up a fourth (from D to G); the octave species of the composition is t-s-t-t-t-s-t. Although the f# in m. 2 is not part of the mode, f naturals are actually more common throughout the piece. Galilei then composes the second passamezzo-romanesca-saltarello set a semitone above the first (figure 29).

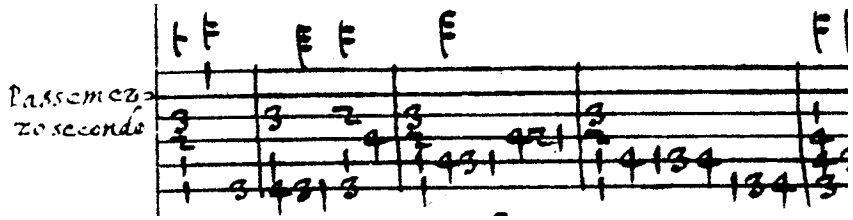

Figure 29a. *Passamezzo secondo* from Galilei, "Intavolatura," f. 8r.

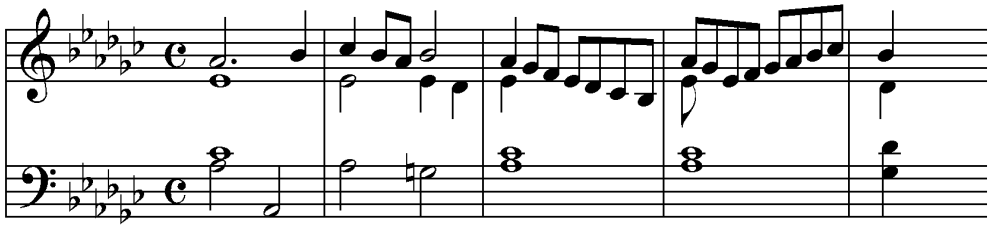

Figure 29b. Transcription of *Passamezzo secondo*, mm. 1-5.

Although the *Passamezzo secondo* is more florid than the first piece, the tune and bass line are quite similar. One obvious difference between the compositions is the resulting

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for the piece. The six horizontal lines in the example correspond to the six courses of the lute with the highest (pitched) string on the bottom and the lowest string on the top. The numbers represent either the fret on the lute (e.g., 1-3) or an open string (e.g., 0). Ciphers placed above the staff determine the rhythm of each note until the next cipher.

key signature of the second piece, which contains six flats. No vocal pieces in the sixteenth century approach such a signature and no theorist discusses a mode with so many altered notes.[33] If a single tuning system is assumed for both pieces, it would be a complicated task to quantify all of the intervals using the superparticular ratios found in Syntonic tuning. The difficulty in determining the intervals through mathematical means supports Galilei's claim that modern tuning cannot always be represented by ratios.[34]

Galilei and the Medicinal Arts

In his later writings, Galilei elevated the status of the arts, especially with regard to man's role in human activity. Zarlino and other sixteenth-century theorists had worked to emphasize the correlations between musical science and the literary and visual arts, and others questioned music's singular role among the quadrivial arts. Influenced by Aristotle's *Poetics*, Girolamo Mei classified music, along with poetry and drama, among the imitative arts.[35] Galilei, for his part, looked for correspondences between music and the other arts but with a special emphasis on medicine, which was typically counted among the mechanical arts.[36]

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[33] In the *Istitutioni* IV.17, 319, Zarlino discusses the manner in which musicians transpose modes by adding a flat (i.e., a round b) or one to two sharps (dieses) to the signature. He adds that some musicians may transpose further, but they do so only "as a joke and a caprice, or perhaps because they want, so to speak, to entangle the brains of singers [Ma perche alle volte li [*sic*] Musici, non gia per necessità: ma più presto per burla, & per capriccio; o forse per volere intricare il ceruello (dirò cosi) alli Cantanti]"; trans. in Gioseffo Zarlino, *On the Modes: Part Four of* Le istitutioni harmoniche, *1558*, trans. Vered Cohen, ed. with an introduction by Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 1983), 53.

[34] Galilei, *Discorso*, 118.

[35] Claude V. Palisca, *Humanism in Italian Renaissance Musical Thought* (New Haven, CT: Yale University Press, 1985), especially 333-38.

[36] For a more comprehensive discussion of classifications of the arts in the *cinquecento*, see chapter 1 of Bernard Weinberg, *A History of Literary Criticism in the Italian Renaissance*, 2 vols. (Chicago: The University of Chicago Press, 1963), 1-37. In the schemas presented by Weinberg, music is typically classified as a speculative art and medicine (when it appears) is viewed as a mechanical art.

The medical arts were a driving force in the development of scientific method in the sixteenth century. John Randall in *The School of Padua and the Emergence of Modern Science* has written that medical schools in the relatively progressive Italian universities of the *cinquecento* played a commanding role in a comprehensive critique of Aristotelian method that led to the revolutionary ideas of Galileo Galilei.[37] Randall traces the "gradual elaboration of the Aristotelian method, in the light of the medical tradition, from its first discussion in Pietro d'Abano (1250-1315) to its completed statement in the logical controversies of [Giacomo] Zabarella, in which it reaches the form familiar in Galileo and the seventeenth-century scientists."[38] His narrative shows the way in which scholars progressively clarified a scientific method in which experience and observation together formed the first step in determining principal causes. Randall finds the full flowering of this method in the work of Zabarella, who maintained "the independence and self-sufficiency of natural science, and indeed of each particular subject-matter, making the end of knowledge and inquiry a human thing, and directing the sciences toward human goals and aims."[39] Randall's work is particularly relevant to the study of Vincenzo Galilei because he concludes that the experimental scientists of the universities made a greater contribution to the rise of modern science than the humanists (such as Glarean and Zarlino), who in his view did not contribute much more than the rediscovery of ancient texts.

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[37] John Herman Randall, Jr., *The School of Padua and the Emergence of Modern Science* (Padua: Editrice Atenore, 1961), 25-26. For more recent studies on scientific thought in the Renaissance, see Charles B. Schmitt, ed. *The Cambridge History of Renaissance Philosophy* (Cambridge: Cambridge University Press, 1988).

[38] Ibid., 27. Pietro d'Abano's commentary on the Aristotelian *Problems* stands as one of the earliest works of Renaissance musical humanism. For a discussion of d'Abano's work, see Palisca, *Humanism*, 51-66.

[39] Ibid., 62.

The "human goals" of the medical arts may seem obvious due to the subject matter, and long before Zabarella and Galileo, medical humanists had sought to treat their profession as independent from philosophy and free from extraneous scholastic inquiry.[40] Many physicians were indeed writing treatises that intentionally avoided the philosophical rigor common in university texts on medicine. Katherine Park's study of writings on medicinal spas shows that the *trecento* witnessed "the appearance of a sustained tradition of inquiry and a coherent body of literature devoted to the causal analysis of individual phenomena based on meticulous and repeated sense experience."[41] Although Park describes the intellectual background that influenced experience-centered medical writing (Aristotle, Albertus Magnus, Aquinas, etc.), it appears that the physicians were also directing their writings towards municipalities and wealthy aristocrats who found spas on their landholdings and wanted to know if the medicinal properties of these baths could be harnessed for public or private use. Their goals are comparable Galilei's aims in the *Discorso*; the latter is explicit in his reasons for not using sophisticated demonstrations in his works:

> I have not wished to preach to myself what could be said with simple words, to adopt difficult instruments, or to make difficult demonstrations, first, because

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[40] Daniela Mugnai Carrara, "Epistemological Problems in Giovanni Mainardi's Commentary on Galen's *Ars parva*," in *Natural Particulars: Nature and the Disciplines in Renaissance Europe*, ed. Anthony Grafton and Nancy Siraisi, Dibner Institute Studies in the History of Science and Technology, gen. ed. Jed Buchwald (Cambridge: The MIT Press, 1999), 253. Carrara notes that readings in ancient medical sources inspired the medical humanists to break away from purely scholastic inquiry. Her account suggests a stronger overall influence of humanism in the development of scientific method than Randall allows.

[41] Katherine Park, "Natural Particulars: Medical Epistomology, Practice, and the Literature of Healing Springs," in *Natural Particulars: Nature and the Disciplines in Renaissance Europe*, ed. Anthony Grafton and Nancy Siraisi, Dibner Institute Studies in the History of Science and Technology, gen. ed. Jed Buchwald (Cambridge: The MIT Press, 1999), 347-49. For a detailed study of medical writings in the sixteenth century, see Nancy G. Siraisi, *History, Medicine, and the Traditions of Renaissance Learning*, Cultures of Knowledge in the Early Modern World, ed. Ann Blair, Anthony Grafton, and Jacob Soll (Ann Arbor: University of Michigan Press, 2007).

> these demonstrations are not understood by everyone, those instruments are not found in all places, and not everyone knows how to adopt them.[42]

Just as some physicians wrote for noble benefactors who were concerned more with the practical use of their hot springs than with the primary causes of herbal medicine, Galilei catered to patrons who preferred musical performance to philosophical rigor.

References to the medicinal arts also figure into Galilei's arguments in the debate over nature and art. In the *Sopplimenti*, Zarlino restates his position on the subject: "And just as it cannot be that operative nature imitate art in operating, so we cannot conclude from art anything in nature that is not beside the point."[43] Galilei responds:

> . . . it is true that operative nature does not ordinarily imitate art because she operates without cognition. But in the course of time, nature also accustoms herself to imitate art in its operation, as occurs with regard to the Macrocephali of whom Hippocrates speaks, and from this it does not follow that we cannot conclude from art some things about those of nature.[44]

In the treatise "On Airs, Waters, and Places," Hippocrates describes the ways in which various climates and natural conditions will affect the behavior of the people who inhabit any geographic region. The Macrocephali are a distinct case. Because they judged the nobility of a person by the length of the head, newly born babies were wrapped in various bandages and contrivances in order to reshape their skulls. Hippocrates tells us that although these long heads were produced artificially, nature soon imitated art and the

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[42] Galilei, *Discorso*, 56: "non ho voluto per predicar me stesso, adoperare difficili strumenti, o farne difficili dimostrationi: prima per non esser queste da ciascuno intese; e quelli per non trouarsene in tutti i luoghi e non saper ciascuno adoperargli."

[43] Zarlino, *Sopplimenti* I.6, 24: "Et si come non può esser, che la Natura operatrice imiti l'Arte nell'operare; cosi non si può dall'Arte concludere alcune cose nella Natura, che non sia fuor di proposito." In the *Discorso* (p. 94), Galilei reprints this statement and changes the final phrase to read "che non siano fuor di proposito."

[44] Galilei, *Discorso*, 94-95: "esser vero, che la natura operatrice non imita l'arte ordinariamente, perche ella opera senza cognitione; ma in processo di tempo la natura ancora s'auuezza ad imitare l'arte nel suo operare: come auuenne a'Macrocefali, de'quali parla Hippocrates: et non per questo ne segue, che non si possa concludere alcune cose dell'arte in quella della natura."

children of parents with long heads were often born with the same physiological condition.[45] Perhaps Galilei chose such a bizarre counterexample to make light of Zarlino's argument, but it is more probable that he was only trying to appear learned.

Other allusions to medical practice in the *Discorso* may also have been derived from Hippocrates, although Galilei does not mention him by name. For example, in demonstrating that art is occasionally superior to nature, Galilei writes:

> . . . art can correct many of the defects of nature, . . . For example, dislocated bones are returned to their natural place because thus they function properly and nature showed this. But the fashion of restoring them, by drawing and redirecting the limbs and making other necessary operations is done wholly by art. It is therefore not true, as [Zarlino] says, that art corrects the defects of nature according to the fashions shown to it by her, but according to the fashions of art itself.[46]

In the treatise "On Fractures," Hippocrates cites several errors that are committed by physicians in setting broken bones. In all cases, the offending physician had justified his setting as being "in accordance with Nature."[47] Hippocrates argues against their methods by describing what will happen to each arm if they are set in these allegedly "natural" positions. For his purposes, the "natural" position is a kind of sophistry upon which ignorant doctors will rely when pressed to explain procedures that they do not understand. The comparisons Galilei makes between music and medicine seem even more appropriate when one considers how often Galilei accuses Zarlino of relying on

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[45] Hippocrates, "On Airs, Waters, and Places," in *Hippocratic Writings*, trans. Francis Adams, Great Books of the Western World, vol. 10 (Chicago: Encyclopaedia Britannica, 1952), 15.

[46] Galilei, *Discorso*, 76: "L'arte può correggere molti de'difetti della natura, . . . come per essempio. L'ossa dislocate si rimettono al luogo loro naturale, perche cosi stanno bene, e questo mostrò la natura: ma il modo del ristituirle tirando le membra, e raddirizzandole; e facendo le altre operationi necessarie, è tutto fatto dall'arte. non è vero adunque come lui dice, che l'arte corregga i difetti della natura secondo i modi da lei mostratigli; ma secondo i modi di ess'arte."

[47] Hippocrates, "On Fractures", in *Hippocratic Writings*, translated by Francis Adams, Great Books of the Western World, vol. 10 (Chicago: Encyclopaedia Britannica, 1952), 75-76.

"nature" because he does not know how to explain musical phenomena as they actually occur.

Galilei also uses analogies to the medical arts to show that one can occasionally judge nature by a hypothetical perfection envisioned by an artist (or, in this case, a doctor):

> The doctor feigns in his fancy an idea and form of health so perfect and so stable that was never such in nature. From this artificial idea of health, it is most permissible, even necessary many times to argue about the natural health that is found in action in human bodies. For the health that is in this and that particular is better or worse insofar as it approaches or is distant from the aforesaid idea.[48]

Galilei's assumption might lead to thorny moral questions with regard to medical practice, but it throws into sharp relief his differences with Zarlino over musical practice. Zarlino prefers the Syntonic tuning system and his re-ordering of the 12-mode system because they represent "natural" solutions for the theoretical problems to which they are applied. That methodology does not necessarily consider the aims of the musician at any given time: it purports only to show fundamental truths of musical practice. For Zarlino, the "fancy" of the musician is irrelevant if it does not conform to the laws of nature as he defines them.[49]

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[48] Galilei, *Discorso*, 72: "il Medico si finge nella fantasia sua vna idea e forma di sanità tanto perfetta, è [*sic*] tanto stabile; che in natura non fu mai tale. da questa idea artifiziale di sanità, è lecitissimo, anzi necessario molte volte argomentare alla sanità naturale, che in atto si ritroua nè corpi humani. percioche la sanità che è in questo, et in quel particolare, è migliore o peggiore quanto più s'accosta o si discosta dall'idea sopradetta."

[49] Daniel Chua discusses Galilei's program to separate music from natural laws through the lens of Max Weber's theories of disenchantment. He avoids offering a conclusion about whether or not the Florentine Camerata created opera out of disenchantment, but he is sure that "they certainly produced, as their afterbirth, the modernity of instrumental music." Chua does not discuss the *Discorso* in any detail, but it is clear that Galilei was quite interested in elevating instrumental music to an equal status with vocal music. See Daniel K. L. Chua, "Vincenzo Galilei, Modernity and the Division of Nature," in *Music Theory and Natural Order from the Renaissance to the Early Twentieth Century*, ed. Suzannah Clark and Alexander Rehding (Cambridge: Cambridge University Press, 2001), 25-29.

Music, Art, and Theater

Galilei uses several analogies to the visual arts in the *Discorso*, again stressing music's ties to disciplines outside the quadrivium. As was noted in chapter 3, Zarlino (following Ptolemy) claimed that the object of music was to "conserve and demonstrate with reason the positions or rational proportions of the canon or [harmonic] rule."[50] This definition may be applicable to those who prefer to labor over the monochord, but Galilei's examples from painting and sculpture emphasize the expressive capabilities of the musical arts.[51] For example, Galilei compares the Syntonic tetrachord to a live model that is imitated by the expert painter. Zarlino notes that it is acceptable for voices to sing unequal tones in an order different from the specified order of the Syntonic because both the 9:8 and 10:9 tones are elements of that tetrachord; Galilei counters that the practice is artistically dishonest:

> This man does not notice that his reasons conclude the same as to say: when a painter happens to portray from nature a person who has, as sometimes happens, one eye larger than the other, of which the pupil of one was black and that of the other inclining to blue; a person who has, furthermore, a scab on the left cheek and a mole over the right eyebrow, greater excellence will be attributed to the painter whenever the portrait of this person is without any of those defects. This is arguing that if indeed the person has one eye larger than the other, it will be more becoming to make them one and the same breadth; and although he has a scab on the left cheek, he does not have one on the right, and it will therefore be well to

[50] Zarlino, *Sopplimenti* I.10, 31: "conseruare, & dimostrar con ragione le Positioni ò Proportioni rationali del sudetto Canone ò Regola."

[51] Leslie Korrick suggests that Galilei was specifically influenced by the writings of Giovanni Paolo Lomazzo. Although the connections Korrick draws between Lomazzo and Galilei may be tenuous, she does note the way in which both the painter and the lutenist use analogies between the visual arts and music to advance their opinions about the role of the senses in understanding art and music. See Leslie Korrick, "Lomazzo's *Trattato . . . della pittura* and Galilei's *Fronimo*: Picturing Music and Sounding Images in 1584," in *Art and Music in the Early Modern Period*, ed. Katherine A. McIver (Aldershot, UK and Burlington VT: Ashgate, 2003), 193-214. Zarlino, too, uses analogies to the visual arts in the *Sopplimenti*. For example, in explaining the superiority of nature over art, he recalls the ancient painter Parrhasius, who according to Pliny the elder, could paint such life-like grapes that birds would try to eat them. Zarlino notes that they may have looked like grapes and fooled animals without true reason, but they were not actual grapes. By analogy, artificially produced music could never be considered as equal to music that is created naturally. See Zarlino, *Sopplimenti* I.4, 21.

> make the former like the latter, and for the same reason, to depict him without that mole we said he has over the right eyebrow and make the pupils of one and the same color. Responding to which, I say that this portrait, because it lacks those accidents that were natural to him (which make him different from the others to a greater degree), will be remembered by everyone other than the one for whom it was made; moreover, that the painter will become reputed as ignorant or at least as a flatterer.[52]

Galilei claims that just as the portrait must show the flaws of its subject, voices tuned to a particular tetrachord must also imitate the imperfections created by that tuning system. To change dissonant intervals into consonances is merely an attempt (by analogy) to flatter the tetrachord or, in this case, the reputation of Claudius Ptolemy. Although Galilei's comparison may be an exaggeration, this discussion highlights his view of music's objectives, one of which is to imitate human expression. For Galilei, it is not as important to "conserve . . . the rational proportions of the canon" as it is to stir the emotions.[53]

Galilei's comparisons to the visual arts cover a wide spectrum of philosophical views of the arts in general. The previous excerpt is contrary to Platonic or Pythagorean views of art and imitation, and it is echoed elsewhere in the *Discorso*.[54] For example,

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[52] Galilei, *Discorso*, 40-41: "non si accorge quest'huomo che le sue ragioni concludano il medesimo che dire; Quando al pittore occorresse di ritrarre del naturale vno c'hauesse come alle fiate occorre, vn'occhio dell'altro maggiore; la pupilla d'vn'de quali fusse nera, e pendesse quella dell'altro nell'azzurro. hauesse inoltre vna volatica nella guancia sinistra, et vn neo sopra il ciglio destro; gli sarà attribuito a eccellenza maggiore tuttauolta che il ritratto di costui sia senza alcuno di quelli difetti: argomentando che se bene ha vn occhio dell'altro maggiore, più bello sarà facendoglieli d'vna medesima grandezza. e quantunque egli habbia vna volatica nella guancia sinistra, egli non l'ha perciò nella destra; bene adunque sarà fargli quella come questa: e per la medesima ragione dipignerlo senza quel neo che diceuamo hauere sopra il destro ciglio, e fargli le pupille d'vn'istesso colore. alche rispondendo dico, che questo tal ritratto mediante il mancare di quegli accidenti ch'erano in lui naturalmente, iquali dagli altri vi è più lo faceuano differente, sarà tenuto d'ogn'altro che di quello per il qual'fu fatto. oltre che'l Pittore ne verrà reputato ignorante, o almeno adulatore."

[53] In the *Dialogo* (88; trans. in *Dialogue*, 221), Galilei claims that the most important and principal part of music is "the imitation of the ideas that are in the words [l'imitatione de concetti che si trae dalle parole]."

[54] Galilei's views on the visual arts, as well as his opinions toward music, were influenced by Girolamo Mei, who was very interested in Aristotle's *Poetics*. Claude Palisca saw the rise of Aristotelian

Galilei notes that on occasion, painters and musicians have to abandon idealistic notions about beauty:

> [artists] are forced by the subject that they are seeking to imitate to represent it such as it is, with each one of those particular accidents that are naturally in it, leaving aside at the time proportion and beauty of the members when they are not found in the subject they have to imitate for us. Now, equally, so should voices . . . .[55]

Again, Galilei writes about music as if it were a productive art, the end result of which is an act of expression rather than the preservation of certain numerical ratios.

Galilei's views on tuning complement his ideas about performance practice. In the *Dialogo*, he encouraged singers to observe professional actors and note how they change the pitch of their speech and their inflection to capture the various personalities of the characters they play.[56] He reiterates the point in the *Discorso*: just as the actors are judged by how perfectly they imitate the various characters, so should those musicians who claim to use Syntonic tuning be judged by the accuracy of their rendition:

> Turning to my first aim, I say that the exemplar of this affair is (according to Zarlino) the Syntonic of Ptolemy, a thing wholly artificial, made by [Ptolemy's] artifice, and poorly understood by Zarlino. Art, and not nature, seeks to portray and imitate this exemplar with natural voices and with artificial instruments, and whoever will imitate it better and portray it correctly from the natural will merit the name of most excellent masters.[57]

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ideas in the late sixteenth century as a major influence on the rise of Baroque musical style. See Claude V. Palisca, "Girolamo Mei: Mentor to the Florentine Camerata," *Musical Quarterly* 40 (January 1954): 7-9.

[55] Galilei, *Discorso*, 25: "son forzati dal soggetto ch'ei cercono imitare, di rappresentarlo tale quale egl'è con ciascheduno di quei particolari accidenti che sono naturalmente in lui: lasciando all'hora da parte la proportione e bellezza delle membra, non trouandosi tali nel subbietto c'hanno da imitare. hora cosi parimente deuono le voci."

[56] Galilei, *Dialogo*, 89; *Dialogue*, 224-25.

[57] Galilei, *Discorso*, 32-33: "e tornando al primo mio intendimento, dico che l'esemplare di questo negotio è (secondo il Zarlino) il Sintono di Tolomeo, cosa tutta artifiziale, fatta dall' artifizio di lui, e mal inteso dal Zarlino. ilqual'esemplare, l'arte e non la natura cerca ritrare et imitare con le voci naturali, e con gl'artifiziali strumenti; e chi di questi meglio l'imiteranno, e puntalmente lo ritrarranno del naturale, meriteranno nome di più eccellenti maestri."

By interpreting the Syntonic tetrachord as a single paradigm among other ancient tetrachords that must be imitated perfectly in practice, Galilei further demonstrates his view that the objective of music is not to merely "preserve the harmonic ratios" but to use a set of intervals, such as those provided by the Syntonic tetrachord, for some expressive purpose.

The *Discorso* as Object

Galilei's *Discorso* is distinctly different from the other treatises discussed in this dissertation. Zarlino's three principal books and Galilei's *Dialogo* are luxurious volumes. They were printed in an upright folio format and include many illustrations, figures, and musical examples, as well as an index of important ideas and terms. The *Discorso* is an octavo, much smaller than the other books and containing no elaborate visual imagery or supplemental material. Although a book should not be judged by its size (or its frontispiece, which in the case of the *Discorso* is more modest than the others), the inexpensive format in which the *Discorso* was printed is worth noting. Niccolò Machiavelli (1469-1527), author of *The Prince*, discussed the contexts for books of varying formats. In a 1513 letter to his patron Francesco Vettori, he offered a description of his daily routine while exiled from Florence:

> Leaving the wood, I go to a spring, and from there to a bird snare. I have a book with me, either Dante or Petrarca, or one of the lesser poets like Tibullus, Ovid and the like: I read about their amorous passions, about their loves, and I remember my own, and I revel for a moment in this thought. . . . When evening comes, I return to my home, and I go into my study; and on the threshold, I take off my everyday clothes, which are covered with mud and mire, and I put on regal and curial robes; and dressed in a more appropriate manner I enter into ancient courts of ancient men and am welcomed by them kindly, . . . and for four hours I

> feel no boredom, and I dismiss affliction, I no longer fear poverty, nor do I tremble at the thought of death: I become completely part of them.[58]

Machiavelli's letter suggests two contexts for reading during the Renaissance. He does not specify the formats of the books he takes with him during his daily travels or those in his study, but Anthony Grafton in his "Humanist as Reader" claims that the former were probably octavo volumes, specifically editions of classical authors published by Aldo Manuzio; and the latter were large folio books, which were often exhibited on one's bookshelf. Galilei's *Discorso* may not have much in common with Dante or Petrarch, but the octavo format connotes a more casual reading experience, just as a paperback does today.[59] Zarlino's three volumes on music and Galilei's *Dialogo*, on the other hand, would most probably have been kept in a collector's study, proudly displayed on the shelf.

There are several possible explanations for the *Discorso* being printed as an octavo volume, and the lack of a prestigious dedicatee may be one of the principal causes. Zarlino's three music treatises and Galilei's *Dialogo* are dedicated to a wealthy or powerful patron who may have contributed to the costs of printing. Galilei was apparently seeking new patronage, but it is unclear if he found it in his last years, and he does not mention anyone in his final published book. Instead, the *Discorso* contains a mock dedication to Zarlino, in which Galilei accuses Zarlino of provoking him again to offer his help in correcting his former teacher's works.[60]

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[58] Niccolò Machiavelli, letter to Francesco Vettori dated 10 December 1513; translated in Anthony Grafton, "The Humanist as Reader," in *A History of Reading in the West*, ed. Guglielmo Cavallo and Roger Chartier (Amherst: University of Massachusetts Press, 1999), 180.

[59] Ibid., 180-81.

[60] Galilei, *Discorso*, f. A2v: "mi accorgo da gl'importuni modi che meco vsate, cercando di nuouo prouocarmi a porgerui il medesimo mio aiuto."

The genre of a work is also related to its format. The *Accademia della Crusca* defined a "discorso" as an "operation of the intellect with which one seeks to understand a thing perfectly by means of conjecture or its known principles."[61] In the case of Galilei's *Discorso*, the "thing" to be discussed is the erroneous teaching of his rival Gioseffo Zarlino. Even if Galilei thought the matter was of the utmost importance, it would not be fitting for such a topic to be presented in the same manner as large-scale, didactic treatises. Furthermore, the octavo format was used for other *discorsi* on musical subjects printed in the late sixteenth century: Giorgio Marescotti, for example, who printed Galilei's *Dialogo* and *Discorso*, also brought out Francesco Bocchi's skeptical *Discorso sopra la musica* in octavo format.[62]

The Structure of the *Discorso*

The form of the *Discorso* becomes apparent only after reading the entire text. It contains no table of contents or index, and there is only a single break in the body of the text for a visual example. A small but incomplete table of errata locates some errors that occurred in the printing. In addition, there are no chapter headings, postils, indentations for new paragraphs, or any other formal division. Although one could describe the book as a single, 130-page paragraph, Galilei provides an outline of the form in his synopsis of the text:

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[61] R. Accademia della Crusca, Florence, *Vocabolario degli accademici della Crvsca* (Venice: Iacopo Sarzina, 1623): "Operazione dell'intelletto, con la quale si cerca d'intendere una cosa perfettamente, per mezzo di conghietture. o di suoi principi noti."

[62] See Francesco Bocchi, *Discorso sopra la musica* (Florence: Marescotti, 1581; reprint in Antiquae musicae italicae studiosi, Bologna: Università degli studi, 1977). Florence did not have a successful music publishing industry in the sixteenth and seventeenth centuries because Marescotti and others could not compete with the cheaper prices offered by Venetian printers. For information on Marescotti's endeavors to sell music in Florence, see Tim Carter, "Music Printing in Late Sixteenth- and Early Seventeenth-Century Florence: Giorgio Marescotti, Cristofano Marescotti, and Zanobi Pignoni." *Early Music History* 9 (1990): 27-72.

> I will again make known to him and to whoever may not know it that the singer and performer of today on whatsoever instrument has no relationship to the Syntonic Diatonic of Ptolemy (according to the way in which he describes it). I will make them see how much better than he I have understood the temperament and the *participatione* of the keyboard instrument and that of the lute. I will acquit myself of the ignorance with which he charges me in regard to all the things of mathematics, and finally, I will make them accept that if anything is good or new in his *Sopplimenti*, he has learned it from me and from my *Dialogo*.[63]

The *Discorso* does have chapters, however, which are acknowledged in the body of the text. For example, on pp. 38-39, Galilei writes: "let this be a sufficient conclusion for this first chapter."[64] Galilei does not mark his chapters consistently, but by using his few references and the synopsis, a table of contents for the *Discorso* can be established as follows:

Table 25. Contents of Galilei's *Discorso*.

pp. [3] - [6]		Dedication to Zarlino
7 - 18	Introduction	
18 - 44	Chapter 1:	The Syntonic tetrachord[65]
44 - 56	Chapter 2:	The tuning and tempering of instruments
56 - 68	[Chapter 3:]	On mathematics[66]
68 - 99	Chapter 4:	Critique of *Sopplimenti musicali* I.6.
99 - 134	[Chapter 5:]	Tuning in antiquity and the present[67]

[63] Galilei, *Discorso*, 8-9: "farò di nuouo conoscere a lui et a chi non lo conoscesse, che il cantare et il sonare di hoggi qual si voglia strumento, non è appatto alcuno (secondo che lui ce lo descriue) il Diatonicon Sintono di Tolomeo. farò vedere quanto meglio di lui io habbia inteso il temperamento, e la participatione dello strumento di tasti, e quella del liuto. mi scolperò dell'ignoranza di che lui m'incolpa intorno alle cose di matematica, e farò vltimamente toccar con mano, che se nulla di buono, o di nuouo è ne'suoi supplimenti, l'ha apparato da me e dal mio Dialogo."

[64] Ibid., 38-39: "e ciò sia suffiziente conclusione di questo primo capo."

[65] Galilei marks the end of chapter 1 on p. 39 but does not explicitly begin chapter 2 until p. 44. Instead, he criticizes Zarlino's "natural" Syntonic scale.

[66] Galilei does not refer to a third chapter, but he does note the beginning of chapter 4 on p. 68. On p. 56, he refers back to his synopsis of the *Discorso*, quoted above: "According to the promised order, I shall respond with those few principles of mathematics that I learned as a boy to as much of this as Zarlino reprehends [Secondo l'ordine promesso, verrò con quei pochi principij di matematica che da fanciullo apparai, a rispondere a quanto di essa il Zarlino mi riprende]."

[67] Galilei does not note a new chapter at the beginning of this section, but his acknowledgement of the conclusion of the previous chapter may surely be taken as major structural break. Galilei, *Discorso*, 99: "Let as much as I have said in regard to his works be sufficient for now because at another time on a better occasion I have to treat them at greater length. Returning, therefore, to my discussion elsewhere, I say . . .

Galilei uses the introduction to establish his reasons for writing the *Discorso* and to accuse Zarlino of not only opposing the musical truths explicated by his former student but also attempting to suppress the publication of the *Dialogo*. Furthermore, the introduction makes it clear that the most important topic of the book is the validity of Zarlino's Syntonic diatonic tetrachord.

Chapters 1 and 2 focus on tuning issues discussed in Book IV of the *Sopplimenti*. In chapter 1, Galilei quotes copiously from various parts of Book IV, drawing attention to Zarlino's claim that voices will naturally create consonant intervals where strict adherence to the ratios of the "artificial" Syntonic scale would create dissonant intervals. Galilei insists that there cannot be a "natural" Syntonic and an "artificial" Syntonic because the Syntonic itself is an artificial system created by Ptolemy. The discussion includes analogies to the visual arts and a brief argument about God's role in the utilization of tuning systems.

Galilei claims that chapter 2 will pertain to the temperament of the keyboard instrument although he also reserves a few pages to discuss the distribution of frets on the lute.[68] In addition to defending himself against charges of stealing the temperament from Zarlino, Galilei embarks on a lengthy discussion of the sizes of tone and semitones used in counterpoint.

Chapter 3 is the most difficult section of the *Discorso*. Galilei discusses many places in the *Dimostrationi harmoniche* in order to prove that Zarlino does not understand mathematics or the proper method of demonstration. Topics in the chapter

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[e quant'ho detto intorno all'opere di esso, sia suffiziente per hora, perche altra volta con migliore occasione ne ho da trattare più allungo. Laonde riuolgendo altroue il mio ragionamento vengo à dire . . .]."

[68] See pp. 78-82 for an explanation of Galilei's 4/7 comma keyboard temperament.

include Zarlino's geometric proofs in the *Dimostrationi* and arguments over the interpretation of Euclid's *Elements.* Many of Galilei's criticisms are quite intelligent and show that he was adept at intellectual thought outside of music theory.[69] In some instances, however, argument for its own sake seems to drive his censure of the *Dimostrationi*.

Galilei breaks from his synopsis in the fourth chapter. He first claimed that this chapter would show Zarlino and the readers of the *Discorso* that "if anything is good or new in [Zarlino's] *Sopplimenti*, he has learned it from me and from my *Dialogo*."[70] That promise turns out to be misleading because in the beginning of the fourth chapter, Galilei changes his mind and says: "it would be impertinent of me to write everything here that can be clearly gathered from my *Dialogo*."[71] Urging any skeptics to read the *Dialogo* for themselves, he turns to a new topic. It appears that Galilei reconsidered the contents of the *Discorso* in the midst of writing it but did not bother to change the opening pages to fit his new concept for the book.

Even if unplanned, the next two chapters are the most important sections of the *Discorso*; Galilei probably departed from his initial synopsis because he conceived of an argument against Zarlino that would be stronger than mere accusations of plagiarism. Chapter 4 consists of a phrase-by-phrase analysis of Book I, chapter 6 of the *Sopplimenti*. Here, Galilei raises his debate with Zarlino to a higher plane: the role of nature and art in creating musical systems. Zarlino's chapter 6 is titled: "What is made according to nature

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[69] An explanation of Galilei's criticisms of the *Dimostrationi* is found in John Kelleher, "Zarlino's *Dimostrationi harmoniche* and Demonstrative Methodologies in the Sixteenth Century" (Ph.D. dissertation, Columbia University, 1993), 220-35.

[70] Galilei, *Discorso*, 8-9: "che se nulla di buono, o di nuouo è ne suoi supplimenti [*sic*], l'ha apparato da me e dal mio Dialogo."

[71] Ibid., 69: "sarebbe impertinenza la mia lo scriuer qui tutto quello, che da esso mio Dialogo si puo chiaramente raccorre."

cannot be properly corrected by means of those things that are made by art, and one cannot conclude properly from the things of art about those of nature."[72] Galilei claims that this opinion would be true only if it were reversed, i.e., what is made according to nature can be properly corrected by means of those things made by art. This chapter includes Galilei's most succinct prose in the *Discorso* and presents the fewest problems for translation.

Chapter 5: The Final Word on Tuning

To conclude the *Discorso*, Galilei promises to describe the tuning system that is actually in use. The first part of the final chapter consists of a survey of the three most important systems used in antiquity: Pythagoras's Ditonic Diatonic, Didymus's (Ptolemy is credited only with changing the order of the 9:8 and 10:9 tones) Syntonic Diatonic, and Aristoxenus's Intense Diatonic. The Syntonic and Intense tetrachords are both viewed as improvements over their predecessors, even though Aristoxenus lived centuries before Didymus and Ptolemy. Galilei uses this historical discussion of tuning systems to explain that the relationship between the numerical ratios and the physical properties of sounding bodies has been misunderstood for centuries. In particular, he notes that the octave, perfect fourth, and perfect fifth may be represented by ratios other than 2:1, 3:2, and 4:3. For example, Galilei shows that to produce the three principal intervals with suspended

[72] Zarlino, *Sopplimenti* I.6, 23: "Che quello ch'e fatto secondo la Natura, non si può ben correggere col mezo [*sic*] di quelle cose, che sono fatte dell'Arte, & che non si può concluder bene dalle cose dell'Arte in quelle della Natura."

weights, they would need to be in proportions of the squares of the Pythagorean ratios, or 4:1, 9:4, and 16:9 respectively.[73]

Galilei tells us that he is going to show the advantages of the Aristoxenian Intense Diatonic to please his "Aristoxenian friends," but after having explained the most prominent tuning systems in antiquity, he claims that none of them can accurately determine what is sung in modern practice because the tools we use to measure intervals (that is, artificial instruments) cannot account for the variable use of major and minor tones sung by voices and, therefore, do not have the capability to determine the exact system.[74] In other words, Galilei agrees that voices, as Zarlino said, change their intervals so that they will form consonances with other voices or instruments in the ensemble.

In noting that voices will variably sing major and minor tones depending on the context, Galilei appears to have finally accepted Zarlino's concept of a natural tuning system even if he does not agree that singers use the Syntonic tetrachord. This is, of course, surprising, as Galilei states many times in the *Discorso* that modern music has no relationship with the Syntonic. Galilei, however, was careful to always mention the Syntonic tetrachord with some variation of the disclaimer, "as Zarlino designs it for us."[75] It is possible that after he changed the formal structure of the *Discorso*, he also went back and added these disclaimers so that his conclusion would not appear contradictory. Galilei even offers a conditional acceptance of the Syntonic tuning if Zarlino were to give up his theory of the "natural" and "artificial" scale. Boasting that he had successfully

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[73] This information may also be found in the *Dialogo*, 134, although there it is applied to the areas of pipes rather than string tension.

[74] Galilei, *Discorso*, 109, 117-18.

[75] For one example, see p. 27: "It is therefore very appropriate to wish to conclude from this that the said Syntonic is not sung as Zarlino designs it for us [E [*sic*] adunque molto a proposito il voler concludere da questo, che non si canti il detto Sintono, come ce lo disegna il Zarlino]."

disproved the idea, Galilei writes: "Whenever he may wish to consent to what I have said and demonstratively proved (as I believe he will be able to do no less), I shall immediately confess that what we sing today agrees with the same Syntonic of Ptolemy more than with another distribution."[76]

D. P. Walker finds Galilei's conditional confession to be both "exasperating" and a "considerable annoyance" because it suggests that the entire controversy "has been a bogus one."[77] Perhaps Walker makes too much of Galilei's statement: even if both theorists agree on some of the specifics with regard to tuning, they are still far apart on other issues such as the manner in which tuning systems are explained and the role that nature and art play in the formation of musical systems. As was discussed in chapter 1, Zarlino was influenced by the notions of "certitudinous knowledge." Zarlino's promulgation of the Syntonic tetrachord evolved from his wider belief that musical practice could be explained through philosophical principles and Euclidian demonstrations. Galilei's description of modern tuning—even if the results are similar to Zarlino's conclusions—shows that neither the study of ancient music theory nor simple mathematical formulas can explain the modern tuning system. Noting evidence against certainty in other scientific fields, Galilei concludes:

> I say it is no less difficult to describe with words or really demonstrate by way of numbers or lines the system that we use in its exact form and proportion . . . than it is difficult to regulate and proportion among them the motions of the celestial bodies with limited periods and stable canons.[78]

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[76] Galilei, *Discorso*, 124-25: "e quand'ei voglia acconsentire a quello che io ho detto et demostratiuamente prouato, che credo non potrà far di meno, io subito confesserò che quello che noi hoggi cantiamo, conuenga più che con altra Distribuitione con il medesimo Sintono di Tolomeo."

[77] Walker, "Vincenzo Galilei and Zarlino," 17.

[78] Galilei, *Discorso*, 118: "per lo che vengo a dire, esser non men difficile a descriuer con parole, o dimostrare realmente per via di numeri, o di linee il Sistema che noi vsiamo nell'esatta sua forma e proportione . . . quanto è difficile con terminati periodi, è [*sic*] stabili canoni regolare e proportionare tra di loro i moti de corpi celesti."

Although Galilei never refers to any of the ancient skeptic writers, his opinion would have resonated among the rising number of contemporary scholars who were influenced by Pyrrhonian ideas.[79]

In discussing the ability of artificial instruments to correctly play the tuning system used by the voices, Galilei again agrees with Zarlino's statements in the *Sopplimenti*, although he makes no mention of it.[80] Among wind instruments, Galilei claims that only the trombone, because it is not limited by holes, can tune properly with the voices. Likewise, only fretless string instruments will form appropriate intervals because they—like the voice—can alter their pitch to form consonances.[81] Galilei differs with Zarlino, however, in that he does not attach any superiority to natural voices or those few artificial instruments. Instead, he merely notes that when voices sing with instruments restricted in one tuning system by holes or frets, it is the voices that will alter their pitches to make the music consonant.

The extent to which voices adapt their pitches to form consonances is explained in the final paragraph of the *Discorso*. Galilei asks himself to explain how five voices in a polyphonic texture could sing simultaneously three 3:2 fifths and a 5:4 third, a combination of intervals that adds up to a dissonant double octave.[82] He concludes that the voices would contract each of the fifths so that the entire interval would equal 4:1. In

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[79] Richard Popkin explains that a revival of Pyrrhonian skepticism arose along with the first modern editions of the writings of Sextus Empiricus (second century C.E.) in the late sixteenth century. Although Galilei does not refer to Sextus at any time, his arguments against Zarlino's metaphysical views on music approach the methodologies embraced by seventeenth-century scientists such as Petrus Gassendi and Marin Mersenne. See Richard H. Popkin, *The History of Scepticism from Erasmus to Spinoza* (Berkeley: University of California Press, 1979), 145-46.

[80] Zarlino, *Sopplimenti* IV.11, 152.

[81] Galilei, *Discorso*, 129-30.

[82] I.e., $(3:2)^3+5:4 = 27:8+5:4 = (27x5):(8x4) = 135:32$. 135:32 is slightly larger than 4:1, which is the ratio of a consonant double octave. Galilei demonstrates this problem on pp. 90-92 of the *Discorso*.

other words, whereas Zarlino thinks that natural voices will adapt their pitch to form pure intervals, Galilei expands on this idea to claim that they are equally able to change from pure consonances, such as a 3:2 fifth, to an interval that is demonstrable only through geometric means.

Conclusion

The aims of the *Discorso* appear to be in contradiction to its results. Just as Zarlino tried to show in the *Sopplimenti* that Galilei's *Dialogo* was filled with errors, Galilei set out to prove once again that he was the better scholar and that it was Zarlino who did not understand musical science. Their similar conclusions, especially with regard to tuning systems, may cast doubts upon the importance of studying these texts, but the importance of methodology in these writings should not be underestimated. For example, in criticizing the *Dimostrationi*, Galilei did not argue against Zarlino's propositions as much as he questioned the manner in which such demonstrations were conducted. Of greater importance, even though Galilei finally agreed that voices sing both the 9:8 and 10:9 tone in performance, he did not try to pin down this phenomenon to a single ancient tuning system or apply the universal dichotomies of "natural" and "artificial" to explain how intervals were formed.

The *Discorso* is also important because it shows Galilei expanding his musical thought beyond the classicism of his mentor Girolamo Mei. Galilei's *Dialogo* betrays a strong obsession with reclaiming the powers of ancient music; his critique of counterpoint in favor of the monodic texture practiced by the Greeks is not only taken wholesale from Mei's letters but is also reminiscent of other humanist writers of the

sixteenth century. In the *Discorso*, antiquity is historicized and the ancient theorists Pythagoras, Didymus, Ptolemy, and Aristoxenus are treated less like prophets. Eschewing the mysticism of Pythagorean thought or natural philosophy, Galilei rationalizes their tuning systems as the result of different methods for explaining musical phenomena.[83] In short, the Galilei who composed the *Dialogo* is easily cast as the mentor of the Florentine Camerata, but the author of the *Discorso* is more interested in explaining the music of the present day than in reclaiming an idealized past.

Galilei's arguments appear to be more progressive or enlightened than Zarlino's philosophical similitudes and demonstrations, but few seventeenth-century writers acknowledge the text in any fashion. The *Discorso* does not have a broad reception history, but there are some notable discussions of Galilei's work. Marin Mersenne (1588-1648) devotes a chapter to the Zarlino-Galilei debate in his *Harmonie universelle* and agrees with Galilei's assertion in the *Discorso* that art is sometimes superior to nature.[84] Writing at the end of the seventeenth century, Giovanni Andrea Bontempi (1625-1705) credits Vincenzo and Galileo Galilei with being the first to show the errors in the Pythagorean conception of musical intervals. Bontempi cites the *Discorso*, and his criticisms of Zarlino and Syntonic tuning were influenced by Galilei's book.[85]

The theorist who most shows the influence of Vincenzo Galilei is the Bolognese Cavalier Ercole Bottrigari. Like many of Galilei's patrons, Bottrigari was a minor nobleman greatly interested in Greek and Roman antiquity. He dabbled as a composer,

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[83] Galilei, *Discorso*, 99-117.

[84] Marin Mersenne, *Harmonie universelle, contenant la theorie et la pratique de la musique*, 3 vols. (Paris: Sebastien Cramoisy, 1636; reprint, Paris: Centre national de la recherche scientifique, 1965), 3:7-9.

[85] Giovanni Andrea Bontempi, *Historia mvsica* (Perugia: Costantini, 1695; reprint, Geneva: Minkoff, 1976), 54, 188.

printer, and poet, and he shared a common enemy with Galilei in Zarlino's loyal student Giovanni Maria Artusi.[86] Bottrigari owned copies of the *Dialogo* and *Discorso* and wrote copious commentary in the margins. Many scholars have noted that the title of Bottrigari's dialogue *Il Desiderio* is also the name of one of the interlocutors in Zarlino's *Dimostrationi*, but Bottrigari's notes in the *Dialogo* show that he was inspired by Galilei as well. Bottrigari may not have had the practical skills of Galilei or Nicola Vicentino, but he took it upon himself to defend their ideas in a series of discourses and dialogues.[87]

Bottrigari appears most like Galilei in his 1593 discourse *Il patricio*.[88] This short work on the Aristoxenian genera was written to correct an erroneous description of the tetrachords given by the Venetian philosopher Francesco Patrizi in his *Della poetica* (Ferrara: V. Baldini, 1586). Bottrigari's line-by-line criticism of Patrizi's writing is reminiscent of Galilei's critique of the *Sopplimenti* I.6 in the *Discorso*.[89] Bottrigari later noted that he had many friendly conversations with Patrizi during a period of exile in Ferrara,[90] but it is difficult to know if Bottrigari was trying to provoke a former associate, just as Galilei did with the anonymous discourse he sent to Zarlino in 1578. Still, the similarities between Bottrigari's debate with Patrizi and the Zarlino-Galilei dispute should not be overstated. In the first place, the former does not appear to be nearly as rancorous as the latter, although Bottrigari's *Patrici* inspired an angry response from

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[86] Bottrigari's musical work is limited to a few madrigals. For information on the printing press he created at age 15, see Albano Sorbelli, "Un grande musico e scienziato del sec. XVI tipografo," *Gutenburg-Jahrbuch* (1937): 168-73. In a dialogue that was composed in his honor, Bottrigari was credited with creating an enneasyllabic poetic style. See Ciro Spontone, *Bottrigaro, overo, del nuovo verso enneasillabo* (Verona: Girolamo Discepolo, 1589).

[87] On Bottrigari's response to the Vicentino/Lusitano debate, see pp. 39-41 *supra*.

[88] Ercole Bottrigari, *Il patricio, overo de'tetracordi armonici* (Bologna: Benacci, 1593; reprint in Bibliotheca musica bononiensis, II/27, Bologna: Forni, 1969).

[89] Galilei, *Discorso*, 69-99.

[90] Ercole Botttrigari, "Aletologia di Leonardo Gallucio," **I**-Bc, B.43, 277; quoted in Bottrigari, *Il patricio*, [ii].

Artusi, who attacked Bottrigari just as he had written against Galilei in defense of Zarlino.[91] Further research needs to be conducted in order to clarify the relationship between Galilei's writings and the theoretical polemics that took place in Bologna after his death.

Galilei and Bottrigari, as well as Zarlino and Artusi, wrote discourses and treatises that appealed to their patrons and colleagues. It is no coincidence that Zarlino and Artusi were connected to ecclesiastical circles or that Galilei and Bottrigari associated with cavaliers and held strong ties to literary academies and anti-authoritarian families. Their writings, taken as a whole, do not signify a broad shift from natural philosophy to experimental science in Italian intellectual culture or even the rise of secular, instrumental music amid a decline of sacred, vocal polyphony, even if these issues are the battleground upon which the disputes are fought. On the contrary, they represent the simultaneous existence of different attitudes toward the objectives of music and its place in society.

Ten years after his death, Galilei's pupils in the Florentine Camerata produced the first operas while publications of instrumental music began to fill the shelves at bookshops. Zarlino, however, retained his eminent reputation among musical scholars, including those who wrote treatises that were more practical than theoretical. For example, the violinist Giovanni Maria Bononcini's 1673 *Musico prattico* offers a compendium of Zarlinian rules and cites Zarlino as the highest authority. Although he

[91] Artusi's defense of Patrizi is found in the *Considerationi musicali*, which was printed with his *Seconda parte dell'Artusi* (Venice: Giacomo Vincenti, 1603). See Giovanni Maria Artusi, *L'Artusi, overo Delle imperfettioni della moderna musica ragionamenti dui* (Venice: Giacomo Vincenti, 1600; reprint in Bibliotheca musica bononiensis, II/36, Bologna: Forni, 2000). In addition to the work indicated in the title, the reprint edition includes the *Seconda parte* and the *Discorso secondo musicale* (Venice: Giacomo Vincenti, 1608).

mentions Galilei's *Dialogo*, it is clear that he did not read it carefully because he cites Galilei as one proponent of the 12-mode system.[92] Bononcini and other seventeenth-century authors, even those who made their career as instrumental composers, still followed the precepts of the *Istitutioni* even though they included very little discussion of the speculative topics covered in its first two parts. In other words, modal systems and the rules of counterpoint were still important, but the Syntonic tetrachord is rarely mentioned in practical treatises of the *seicento*.

If Galilei's *Discorso* is not a window to a musical revolution, it at least helps us understand the mental process Galilei and others must have followed in conceiving a new union of music, both vocal and instrumental, and the rhetorical arts.[93] Daniel Chua, in his article "Vincenzo Galilei, Modernity and the Division of Nature," accuses Galilei of being "confused" and contradictory in blaming instrumental music as the primary cause for modern counterpoint while promoting modern instrumental practice and equal temperament.[94] That view of Galilei may be tempered after reading the *Discorso*. Galilei explicitly notes that the Aristoxenian system (now considered to be a system of equal temperament, even though the modern concept is foreign to Aristoxenus) has its own faults and is poorly suited for keyboard instruments because the thirds sound intolerably sharp when heard on metal strings.[95] In addition, rather than serving purely as a promoter of instrumental music, Galilei recognizes that good voices will sing intervals better than instruments will sound them, although he claims that people prefer instrumental music to

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[92] Giovanni Maria Bononcini, *Musico prattico* (Bologna: Giacomo Monti, 1673; reprint in Monuments of Music and Music Literature in Facsimile, II/78, New York: Broude Brothers, 1969), 153.

[93] Galilei and Girolamo Mei were not alone in wanting to connect music to the trivium. Claude Palisca notes (*Humanism*, 337) that in 1586 Giulio del Bene proposed an educational program to the *Accademia degli Alterati* that placed music among grammar, rhetoric, poetics, and dialectic.

[94] Chua, "Vincenzo Galilei," 29.

[95] Galilei, *Discorso*, 127-28.

textless vocal music.[96] His opinions may be unscientific but they show an attempt to discuss musical practice in a manner that could be understood by the noble enthusiasts who patronized him and read his treatises. Galilei dispensed with Ptolemaic idealism and the Harmony of the Spheres and located the beautiful imperfections of music in the ear of the listener.

[96] Ibid., 130.

Chapter 5

Annotated Translation of Vincenzo Galilei's *Discorso intorno all'opere di messer Gioseffo Zarlino*

Notes on the Translation

Galilei's writing style does not lend itself easily to translation. In a didactic treatise with many separate chapters, it is generally easy for a reader or translator to follow the writer's argument. Even with dialogic works that contain only large structural divisions, the topic of any discussion is often clarified through the use of postils or questions offered by one of the interlocutors. Because the *Discorso* includes neither chapter headings nor even paragraph breaks, it is up to the translator to interpret each formal articulation in the prose. To facilitate reading, paragraphing has been added throughout this translation, even though the text thereby loses some of its meandering quality.

The *Discorso* is filled with lengthy sentences in which subjects and objects are obscured through the overuse or lack of pronouns and inconsistent punctuation. In addition, Galilei's striving for rhetorical power and Ciceronian elegance often results in many awkward constructions that are difficult to translate into English. Inconsistent use of periods, commas, semicolons, and colons is found throughout the *Discorso*, but it is not always clear whether they represent Galilei's rhetorical style or carelessness on the part of the printer. In the translation, the original punctuation has been emended to accord with current English usage, although the long-winded style is maintained insofar as possible.

The published *Discorso* contains many typographical errors.[1] Most of the mistakes consist of the incorrect usage of "è" (third person singular of "to be") and "e" ("and"). In most cases, the correct word is easy to determine. Some mistakes were caused by sloppy composition on the part of the printer. On p. 51, for example, instead of "la diapason ch'io tolsi, & l'ordine ch'io tenni, non fu punto a caso [the diapason that I took and the order that I held were not one whit haphazard]," the text reads: "la diapason ch'io tolsi, & l'ordine ch'io tenn,inon fu punto a caso." Typographical errors have been emended, and the translation reflects the emended text, with the uncorrected text given in a footnote.

Galilei makes frequent references to Zarlino's *Dimostrationi* and *Sopplimenti*. He usually cites the Book and chapter or, in the case of the *Dimostrationi*, a proposition or a definition, but that is not always the case. In fact, it is unlikely that even his contemporary readers could have followed the arguments in the *Discorso* without access to Zarlino's works. For example, during a discussion of keyboard temperament Galilei writes:

> For brevity, I leave aside consideration of many other matters of moment that could be considered in this place and come to the impertinent demand that Zarlino makes of me when he asks me what is the proportion of the fifth in the Ditonic Diatonic after two-seventh parts of a comma are taken from it and given to the fourth.[2]

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[1] This information is based on the published facsimile of the *Discorso* and the exemplar owned by the Newberry Library in Chicago. Outside of the initial printing of the book, there is one manuscript copy of the text, which is believed to be in the hand of Gioseffo's descendant, Natale Zarlino. See Vincenzo Galilei, "Discorso intorno all'opere di messer Gioseffo Zarlino da Chioggia," Chicago, Newberry Library, Vault case MS 5127.

[2] Galilei, *Discorso*, 50: "lascio per breuità di considerare molte altre cose di momento che si potrebbono considerare in questo luogo, e vengo all'impertinente domanda che mi fa il Zarlino col chiedermi di qual proportione sia la quinta nel Diatono Ditonieo dopo l'esserne tratto due settime parti del comma, e datole alla quarta."

Although it is clear from the topic that this passage comes from Book IV of the *Sopplimenti*, which is devoted to all aspects of tuning and temperament, Galilei seems to have expected his readers to work through the text to find the exact source of the reference or accept that Zarlino is not being cited out of context. For all practical purposes, it is therefore impossible to ascertain the accuracy of Galilei's conclusions without having copies of the *Sopplimenti* and *Dimostrationi* at hand and the time to find the reference. To assist the reader in tracing Galilei's points back to their sources, page numbers and, in some case, quotations from the *Dimostrationi* and *Sopplimenti* have accordingly been included in the annotations to this translation. A few of Galilei's discussions also refer to diagrams that appear in Zarlino's volumes, and all essential visual examples are included in annotations as well.

Discorso intorno all'opere di messer Gioseffo Zarlino

To the Very Magnificent

and Reverend

Mr. Gioseffo Zarlino

of Chioggia,

Most Excellent Musician of Practice and Theory and *Maestro di Cappella* of the most serene Dominion of Venice in San Marco.

When my *Dialogo dell'antica, et della moderna music* had made known the many important errors in your *Istitutioni* and *Dimostrationi harmoniche*,[3] as you and the world have seen, [-f.A2v-] I believed, after having emended them in addition, I had satisfied the courtesy that an affectionate and good student has held for his master.[4] But inasmuch as your *Sopplimenti musicali* has just now come into my hands, I notice from the importune fashions that you used with me, seeking anew to provoke me to proffer you my same aid, that you do not remain satisfied by as much as I have said in my *Dialogue*. Therefore, I have taken up the pen again to see about compensating for however much you especially desired from me in your first two works [-f.A3r-] and, later on, in the same *Sopplimenti*. I therefore send you, together with this letter of mine, as much as I have especially corrected until now, with the hope of having fully satisfied you, whenever you might not obstinately wish to oppose yourself to the truth. If you will set in press the book *De re musica* as you promise,[5] I will voluntarily look at it and will perform for it the pious duty

[3] The printed text reads *Aarmoniche*.

[4] Galilei's sarcasm in the dedication is clearly in response to Zarlino's many references to him as "my loving disciple" in the *Sopplimenti*.

[5] Zarlino promised to complete the *De re musica* in the *Sopplimenti* and, later, Giovanni Maria Artusi claims in the second part of *L'Artusi* that he is going to publish it. Unfortunately, the text has never

that the work and your courtesy will merit. Meanwhile, because it pleases you that I do so, I shall proceed emending the remainder of the errors that I have noted in your writings, and without further ceremony, I shall make you and the world aware of them in another book.

From Florence, the last day of August 1588

Always most ready to help and instruct you,

Vincenzo Galilei.

[7]

DISCORSO
OF VICENTIO
GALILEI
FLORENTINE NOBLE[6]

ON THE WORKS
of Mr. Gioseffo Zarlino of
Chioggia

AND OTHER IMPORTANT
details that pertain to music.

SEVEN years have passed since I printed my *Dialogo dell'antica, et della moderna musica*, in which I, desirous of finding the truth, made some objections to what Mr. Gioseffo Zarlino writes in his *Istitutioni* and his *Dimostrationi* [-8-] *harmoniche*. The content of this *Dialogo* (although I had not remembered[7]) I had previously communicated to him affectionately in letters in order to hear his opinion of it, so that he would not have

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come to light. See Giovanni Maria Artusi, *Seconda parte dell'Artusi overo delle imperfettioni della moderna musica* (Venice: Giacomo Vincenti, 1603; reprint in Bibliotheca musica bononiensis, II/36, Bologna: Forni, 2000), 24.

[6] For a brief discussion of Galilei's nobility, see pp. 64-65 *supra*.

[7] Later on (pp. 16-17), Galilei makes it clear that he did not remember sending an anonymous discourse to his former teacher until he read about it in Zarlino's preface to the *Sopplimenti*.

some occasion to be grieved with me. After seeing several replies[8] in which he stood obstinate in his first opinion without adducing reasons of importance, I resolved to print it. At that, with both his power and know-how, the same Zarlino sought to oppose it and attack me.[9] After the discourtesies I am about to recount (thanks to his importunity) so that the world may recognize that, as much as he is grieved with me (under the name of his "student") [10] in his *Sopplimenti musicali* (just now published in his defense), he is greatly wrong; he is, in addition, deceived, as I shall show in fact to whoever will take care to read this, my *Discorso*, in all that he has ever written about things that pertain to music and to mathematics.

And not to extend myself with idle words, I will again make him recognize and whoever may not recognize it that the singer and performer of today on whatsoever instrument[11] has no relationship to the Syntonic Diatonic of Ptolemy (according to the way in which he describes it). I will make them see how much better than he I have understood the temperament and the *participatione*[12] of the keyboard instrument and that of the lute. I will acquit myself of the ignorance with which he charges me in regard to all the things of mathematics, and finally, I will make them accept[13] that if anything is good or [-9-] new in his *Sopplimenti*, he has learned it from me and from my *Dialogo*.

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[8] The printed text reads *repliche*. Galilei typically uses the noun *replica* and the verb *replicare* to mean "repetition" or "to repeat." The above usage is one exception.

[9] The printed text reads *mi fece auanti*; there is no period following *auanti*.

[10] In the *Sopplimenti*, Zarlino never mentions Galilei by name. Instead, he makes many references to *mio Discepolo* (my student). See pp. 99-101 *supra*.

[11] In sixteenth-century musical parlance, a distinction is made between notes that are sung (*voci*) and notes that are played on an instrument (*suoni*). Throughout the *Discorso*, and most treatises of the era, theorists also refer to "singers and instrumentalists" as distinct from the general term "musicians."

[12] First discussed by Franchino Gaffurio, *participatione* refers to the process in which musicians will alter notes on an artificial instrument so that they may accord with voices. For one description of *participatione*, see Zarlino, *Le istitutioni harmoniche* (Venice: [by the author], 1558; reprint in Monuments of Music and Music Literature in Facsimile, II/1, New York: Broude Brothers, 1965), 125-31.

[13] Galilei writes: *toccar la mano*, an idiom that refers to the disciple Thomas's unwillingness to accept Christ's resurrection unless he could "touch with his hand" the wounds.

Commencing from this, I say that Mr. Gioseffo has believed what he may believe, and he always wishes to believe, as he says, that what is sung and played today is the Syntonic of Ptolemy (according to the way in which he designs it).[14] This will be granted to him by the court; but that it really is this, I am sure that no man so stupid (provided that he has the capacity for reason) could be found to believe it, because the certainty that we may have that the ancient Ditonic Diatonic had, has, and will always have all dissonant intervals that are comprised today under the name of imperfect consonances is born principally from our discovering, later on, the distribution of its strings[15] within the numbers and forms from which its author constituted it.[16] For the same reason, we may know how the Syntonic of Ptolemy was distributed.[17]

Now, the more vigorous and more lively reason[18] that persuades him that the species of the ancient Ditonic Diatonic is not what we sing today or even less what we play on some instrument is that the latter has dissonant thirds and sixths, as has been said,

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[14] In defending his Syntonic tuning in the *Sopplimenti*, Zarlino writes: "I have truly believed in this fashion, and in this fashion I believe, and will believe in the time to come [Hò creduto ueramente à questo modo, & à questo modo credo, & crederò per l'auenire]." *Sopplimenti musicali* IV.4 (Venice: Francesco de'Franceschi Senese, 1588; reprint in Monuments of Music and Music Literature in Facsimile, II/15, New York: Broude Brothers, 1979), 134. This direct paraphrase from the *Sopplimenti* is one of many instances where Galilei mocks Zarlino's claims with specific references to the text. Considering the sheer size of the *Sopplimenti*, it is difficult to know whether anyone other than Zarlino would have recognized Galilei's barbs.

[15] *Corde* literally means "strings." Sixteenth-century theorists often use the term more broadly, e.g., any steps on a musical scale may be referred to as *corde*. For this reason, Claude V. Palisca translated *corde* as "steps" throughout his rendering of Galilei's *Dialogo della musica antica, et della moderna* (Florence: Marescotti, 1582; reprint in Monuments of Music and Music Literature in Facsimile, II/20, New York: Broude Brothers, 1967). In the present translation of the *Discorso*, *corda*/*corde* will be translated literally as "string"/"strings" to emphasize the etymological origins.

[16] The Ditonic diatonic tetrachord, attributed to Pythagoras, is comprised of two major tones (each 9:8), and a small semitone (256:243). Consecutive 9:8 tones produce a large major third (9:8x9:8 = 81:64) that sounds dissonant in vertical sonorities. For this reason, tertial harmony was branded as dissonant by most theorists throughout the Middle Ages. Here, Galilei is just noting that the "imperfect consonances," common in the music of his time, were theoretically dissonant in Pythagorean tuning.

[17] In other words, if we know that the Pythagorean tetrachord cannot be the basis for modern tuning because it has dissonant thirds, then Ptolemy's tetrachord, too, cannot be correct because it would create dissonant intervals if it were used in polyphony.

[18] A reference to Zarlino's boast that he guided readers to the truth with "rigorous reasons and lively demonstrations." See Zarlino, *Sopplimenti* I.1, 9: "gagliarde ragioni & uiue dimostrationi."

and the former has consonant thirds and sixths. If this reason is able to persuade us of this truth—and it is furthermore true, even most true that in the Syntonic distribution made by Ptolemy some fifths, some fourths, some thirds, [-10-] and some sixths are dissonant, and all these are (as experience demonstrates) consonant in the species that is sung and played—, it will necessarily follow from this that the reason is not and can never be what Zarlino wishes to persuade us anew: that some such things occur in the Syntonic of Ptolemy, which we may see as he himself says and shows with the example of his monochord in chapter 40 of the second part of his *Istitutioni* and the first proposition from the fourth and fifth Discussion of his *Dimostrationi*, in which places his errors will not only be made clear to the senses but also the other absurdities that at the beginning of my *Dialogo* I said were found between the strings of the said Syntonic.[19]

And this is sufficient response to the disagreement made; and for what Zarlino has been able to do anew to this truth in the *Sopplimenti* by supplementing what was lacking according to him from his first two volumes, he has spent (not to say cast away) the greater part of the first four books[20] searching for an indirect path to hide this truth. It is manifestly seen that on account of this, he has labored over the Philosopher,[21] for the beginnings of quite a few chapters where he casts his hasty fundamentals by means of the Peripatetic doctrine conclude their work quite well, but when Zarlino then wishes to

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[19] These citations refer to places where Zarlino writes lengthy procedures for dividing the monochord. The *Istitutioni* II.40 and *Dimostrationi* IV.prop.1 include instructions for obtaining a diatonic scale on a monochord, while in the *Dimostrationi* V.prop.1, Zarlino discusses a method for tempering scales. In the *Dimostrationi* IV.prop.1, Zarlino demonstrates the division of the monochord for his interlocutors in a manner similar to Bardi's explanation of the 4/7 comma keyboard temperament in Galilei's *Dialogo.* See Zarlino, *Istitutioni* II.40, 123-24; *Dimostrationi harmoniche* IV.prop. 1 and V.prop.1 (Venice: Francesco de'Franceschi Senese, 1571; reprint in Monuments of Music and Music Literature in Facsimile, II/2, New York: Broude Brothers, 1965), 218-22, 283-87.

[20] Galilei is referring to the first four books of the *Sopplimenti* as distinct from the "first two volumes" mentioned above, which refer to the *Istitutioni* and *Dimostrationi*.

[21] The printed text reads *il Filosofo*. In Renaissance literature, *il Filosofo* (with an upper-case F) usually refers to Aristotle.

apply them to conceptions of nature contrary to his points, he speaks with such a [-11-] deformity that among them are found the major impertinences in the world. From these, it is manifestly recognized that the philosophy of Aristotle was not of his time, because one who should have had a capacity for it would not have added the blunders that I will show he added. And their final conclusion is that if indeed the imperfection shown by me is truly found in the distribution of the Syntonic that Ptolemy made, he wishes that when the voice meets in an imperfection, it runs immediately to the perfection of the consonance. Now, see in what vanity this man has cast away his labor and that of others. Not noticing that when the thing follows in the manner that he says, the same response as above should serve to convince him anew in judgment: that is, that the Syntonic of Ptolemy is not sung as he designed it; moreover, that with this same excuse, we can say that we sing the thirds and sixths of the ancient Diatonic, but that is not acceptable.

I am not saying these things to Zarlino as if they were new, but I am saying them to one who has obstinately repeated himself against the truth in his *Sopplimenti*, thanks first to the adulation and the ignorance of the men he has continuously around him and to the ruin he sees coming to him behind his back all the time should he ever consent, because this feeble prop would be taken away from him, in which case I do not know what would remain for him to do other than to obstinately malign. [-12-] All of his doctrine goes to perdition, as he himself affirms in the fourth chapter of the fourth book of his *Sopplimenti*.[22]

Now if against my belief, anyone of the clique of which he is the head, dissatisfied with as much as I have said, wished—not better, but more in his own

[22] This chapter (*Sopplimenti* IV.4, 130-35) includes a lengthy diatribe in which Zarlino mentions many of the errors in Galilei's *Dialogo*, but it is difficult to determine the exact statement to which Galilei is referring.

fashion—to clear up this business for himself, I refer him to read again Zarlino's same works because he has perhaps not read mine: considering that when my *Dialogo* was printed, I sent some of them to Venice and consigned them to a bookseller so that they might be read by the scholars of the field it treats. But not before they[23] were seen by Zarlino, [24] who immediately engaged with a gentleman of some authority (whose name I would know to say and would be able to produce letters from the same bookseller when it might be necessary), who went to him and showing him an angry face said these words: "take away these books on display, and if ever you dare to exhibit them again or show them to anyone, I will make you!"[25] Zarlino could say as his excuse for this that he engaged in wanting, before they were sold, to see what they were saying. On such a matter, I do not know what men of judgment will say about it.

I do know for certain that the year was 1581 when I was in Venice to give my *Dialogo* to the press and that I had entrusted it to a printer after agreeing between ourselves on a price and had paid him part of the money so that [-13-] he would print it. Zarlino was immediately informed about it, and through the intimate friendship between them, Zarlino extracted it from him and kept it for eight or nine continuous months, during which all the issues of the Vicarage of Naples could have been seen, read,

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[23] I.e., copies of the *Dialogo*.

[24] The printed text reads *ma non prima furono dal Zarlino veduti*. In other words, Zarlino got his hands on the *Dialogo* before other scholars could see it.

[25] The printed text reads *io ti faró*, é [*sic*] *ti diró*. The phrase appears to be idiomatic. Philippe Canguilhem translated it into the French idiom *tu auras de mes nouvelles!* which is equivalent to the English ultimatum: "or else!" See Philippe Canguilhem, *Fronimo de Vincenzo Galilei*, Collection "Épitome musical," no. [9] (Paris: Minerve, 2001), 25. The translation of the French idiom is found at *Larousse*, available from http://www.larousse.com/en/dictionnaires/francais-anglais/nouvelle/54747; Internet; accessed 30 June 2010.

answered, and defended (according, however, to reasons like the others he had had).[26] After which time, seeing that my book was not printed, I wrote to the one who had care of it asking him to return it to me, and after many lies from this printer, it was extracted from him by paying him, against any obligation apart from what he had previously had through my earnest money, twenty-five golden scudi. Finally recovered, it was printed here the following year 1582.

In this case, it seems to me that Zarlino failed himself as well as me. He failed himself by not knowing how to use the opportunity he was offered to be able to print my book under his own name, with the excuse of it being better advised anew by his own writings, as many men of worth have done through their own—and not through other's—labors. And if this did not strike his fancy through a fear of not knowing how to color such a fabrication or through recognizing, as he says, that my *Dialogo* was full of errors, he should not have impeded the bookseller who sold them: rather, he should have bought them and given them to his friends so that my insipidity and his wisdom would have been revealed as soon as possible. But fortune willed that it did not occur to Zarlino to take such an [-14-] expedient so that the world would recognize what was and is his nature, not previously recognized, and, later on, how much he stretched his knowledge, not previously recognized by everyone but only by those who know.

Zarlino could add to this that having recognized (according to what he says) the imperfections of my *Dialogo*, he would not have given it out as his for anything in the world. But from the effects, his stratagem manifested itself rather differently from that of

[26] Formerly the palace of the Viceroy of Naples. King Ferdinand I converted the palace into the central courts of Naples and an elaborate prison in 1540. See G. B. de Ferrari, *Nuova guida di Napoli, dei contorni di Procida, Ischia, e Capri*, 2d ed. (Naples: Tipografia de Porcelli, 1826), 313.

which he sought to persuade the world.[27] For if he had looked at it[28] with a steady eye, it would not have the imperfections he says in addition to what I have said he put in writing in the fourth chapter of the fourth book of his *Sopplimenti*: that some gentleman, friends of mine, made the *Dialogo* that was printed under my name.[29] To this, I respond, first, that there are, on the contrary, some gentleman who have learned from me many things from the *Dialogo*, which I say to be entirely my labor, my work, my invention, without any other man than I having any part in it. And whoever believes otherwise believes a falsehood. And whoever says otherwise says a lie. For the brief discourse likewise sent to Zarlino in 1578 under the name of another, I say the same as I have said of the *Dialogo*.[30] And who believes or says otherwise, I will prove to him in a fashion that will please him that he is in the greatest error.

[-15-] Secondarily, if there were the errors in my *Dialogo* that Zarlino says, he would not have forced himself with labor for so many years to defend himself. But with the example that he adduces in the preface to the *Sopplimenti* of Zoilus and Didymus of Alexandria, and like a fuming man, he would get mad responding to what had no need of it.[31] So, we can recognize if he is right or wrong from the quantity of years spent on

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[27] I.e., if Zarlino really thought that the *Dialogo* was full of imperfections, he would not have incorporated so many of its ideas into the *Sopplimenti*.

[28] I.e., the *Dialogo*.

[29] *Sopplimenti* IV.4, 130-35, includes many quotations from the *Dialogo*. Although Zarlino does not discuss authorship in this chapter, he always refers to the author(s) in the third-person plural, insinuating that the *Dialogo* was written by many authors. The authorship of the *Dialogo* is a common thread in both Zarlino's and his student Giovanni Maria Artusi's criticism of Galilei. Both contend that Galilei merely copied the ideas of Girolamo Mei and Giovanni Bardi and did not have any original ideas of his own. See pp. 88-89 and 99-100 *supra.* In practice, it was common for music theorists to "borrow" texts from other treatises without specific citation. Despite his claims of originality in the next sentence, Galilei freely printed material from letters he received from Girolamo Mei. See Claude V. Palisca, "Giorlamo Mei: Mentor to the Florentine Camerata," *Musical Quarterly* 40 (January 1954): 18.

[30] Perhaps Galilei realized that by not appending his name to the discourse he sent to Zarlino in 1578, he had made himself more vulnerable to the charge of plagarism.

[31] In the preface to the *Sopplimenti* (4-5), Zarlino recounts the envious criticisms made by Zoilus against Homer and Didymus against Cicero. For a discussion of the preface, see pp. 98-100 *supra*.

regard to searching to defend himself and from the quality of the processes. For defending the wrong, especially sensate things like these, neither all of the philosophy nor all the centuries of the world was sufficient. On the contrary, for defending the right, half a month was enough for him to keep my *Dialogo* in hand before it was printed. Even more, as Zarlino himself says in the preface and chapter 27 of the fourth book of the *Sopplimenti*,[32] he had come to the end of it and had nothing other than to set it under the press when my *Dialogo* came into his hands. I do not know how to see how this can be, since there is hardly a chapter in it that does not pertain to his defense or to my offense;[33] therefore, I would ask that he declare to me what his *Sopplimenti* was[34] before my *Dialogo* came into his hands.

But I recognize too well where Zarlino would want to strike with a poisoned arrow from his bow without taking aim. He would want to persuade the world that the things [-16-] learned from my *Dialogo* he had thought and written before he saw it but through another method. The matter, as it please God, will not come out in his fashion because apart from his his first two volumes bearing witness, however thoroughly he may search these parts for the place, he will not locate it for you because at the time he did not know them; instead of which he wrote a thousand vanities. But what is more important is that in many matters he deviates in the *Sopplimenti* from his first opinion, which he could

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[32] It is unclear to which passage in the Preface of the *Sopplimenti* Galilei refers. In the *Sopplimenti* IV.27, 197, however, Zarlino writes: "And when I was ready to publish my new inventions together with many other things that I had gathered in the present *Sopplimenti*, here comes into my hands the *Dialogo* on music by my disciple (who I mentioned many times), which overwhelmed me . . . [Et quando fui in procinto di mandar in luce queste mie inuentioni insieme con molte altre cose, che hauea raccolto nei presenti Sopplimenti, ecco che mi uiene alle mani il Dialogo di Musica del molte fiato da me nominato mio Discepolo, che mi fece soprastare]."

[33] Galilei is exaggerating, although he has a valid point. The *Sopplimenti* contains 103 quotations from the *Dialogo* and numerous other references to the text.

[34] The printed text reads: *quello che erano I suoi Supplementi*. Galilei speaks of the *Sopplimenti* literally, in the plural. This usage has been changed to the singular in the translation.

not salvage in some fashion, as I will make manifest in its place together with other treacheries that he is preparing for me.

Therefore, following what I have commenced above, I say that Zarlino failed me by not having any occasion to do me the wrongs he has done me, keeping my *Dialogo* from me by force for so many months, endeavoring that the printer would not print it, impeding the bookseller with threats so that he would not sell it after it was printed, and finally comporting so that his own familiar printer could rob me of so many scudi as he knows.[35]

And because I know how much Zarlino values calculations, so that he might not reprehend me anew for ignorance in this, I said above that in regard to the material that I am principally treating at present, he had time to think about it for seven years; however, I recant, nor do I wish to be, like him, obstinate against the truth, considering that actually ten years have passed. The matter [-17-] has awakened in my mind in reading the preface of his *Sopplimenti* because when I sent him my brief *Discorso* under the name of another (of which he makes mention in that place), the content of this affair was laid out. It was, as he says, on the 7th of June 1578.[36] So that what happened to my *Dialogo* may not have to happen to my *Discorso*, I have sent copies to Venice to be given to many of my friends and to the intelligentsia of this field in all the other cities of Italy, so that they may recognize the sufficiency and insufficiency of the one and of the other. And so that they more rightly be able to give judgment of it, it is well to draw to their attention that such a dispute is born (according to what Zarlino repeats in a thousand places in his

[35] Galilei implicates Francesco de' Franceschi, the printer of Zarlino's *Dimostrationi* and *Sopplimenti*.

[36] Zarlino, *Sopplimenti* preface, 5-6.

Sopplimenti) between him, learned with all the reason of the world, and me, ignorant with all the wrongs that the man is able to imagine.

We can therefore recognize from this that the epithets that Zarlino (thanks to his courtesy) so frequently gives to me in his *Sopplimenti* are more suited to the *Sopplimenti* than to me.[37] Among all the others, the one naming me "fortunate" suits me least, considering that except for nobility,[38] I was born without any other chance for the good things of Fortune herself. In addition, until now, the labors done by me in regard to music to show that I am not useless to the world have been done more often to begrudge than to bring me some profit. And because of the expenses that happened in printing it, instead of some comfort, [-18-] they have continuously brought me greater discomfort.

Now it remains for Mr. Gioseffo to break this ice by doing me some signal courtesy in recompense for my present labors done at his request and dedicated to him. When this also does not come out, I am not about to be amazed or be sorry for how much, until now, I have virtuously engaged myself; rather, with greater desire and more than usual vigor, I will proceed continuously reviewing the other works already done by me in order to publish them (there are many more than those I have published until now)[39] to attain even more what I promised myself in my heart at the beginning of my

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[37] Zarlino's "epithets" are usually aimed a group of rivals and include "modern speculators," "bean-counters" (*abachisti*), "modern Aristarchians" (after the outspoken astronomer Aristarchus [third century B.C.E.]), "modern Aristoxenians," etc.

[38] On the decline of the Galilei family's fortunes, see pp. 64-65 *supra*.

[39] When the *Discorso* was published, Galilei was working on two treatises on counterpoint and several short essays on music theory. Manuscript copies of these unpublished writings are housed in **I**-Fn, Gal. Transcriptions of the treatises on counterpoint may be found in Frieder Rempp, *Die Kontrapunkttraktate Vincenzo Galileis*, Veröffentlichungen des Staatlichen Instituts für Musikforschung preussischer Kulturbesitz, ed. Hans-Pieter Reinecke and Dagmar Droysen, vol. 9 (Cologne: Arno Volk, 1980). Transcriptions and English translations of the short, scientific essays, which are paraphrased in the *Discorso*, may be found in Claude V. Palisca, *The Florentine Camerata: Documentary Studies and Translations*, Music Theory Translation Series (New Haven, CT: Yale University Press, 1989), 152-207.

studies, and this was honor,[40] hoping despite fortune, the malignity of others, and ingratitude that continuously prevents me from overcoming envy.

What I have said up to this point (turning to my principal aim) in regard to proving that today the Syntonic of Ptolemy, as Zarlino designs it, is not sung or played in any fashion would be a sufficient response to as much as he says in his first two volumes because I have written my *Dialogo* against them, and I would truly not hold with proceeding further. But the desire I have to please the one who has forced me to take this labor also forces me to speak in further particulars than I have done in regard to his *Sopplimenti*. So, before extending myself even further, I will produce the more vigorous reasons [-19-] that Zarlino says anew in the *Sopplimenti*, with all his diversity of principles and alteration of terms in order to prove that his opinion is true. I will not draw heavy attention to this error (with a brevity greater than he will have conceded to me). First, in the fifth chapter of the fourth book of his *Sopplimenti*, Zarlino writes thus:

> *And if indeed in the order of the Syntonic we did not find that the major tone has a place after another major tone in its composition so that it would not be dissonant in its extremes, we could not then say that if one such interval is necessary in such an order, such consonance is not natural for such species. It is even more so when this precedes in natural instruments, that is, voices, because to nature is conceded the modulation of those intervals that turn to the point in forming consonances.*[41]

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[40] A period follows *honore* in the printed text.

[41] Zarlino, *Sopplimenti* IV.5, 139: "come sarebbe dire del Syntono, composto de i suoi Tetrachordi naturali, dirò cosi, non si ritrouasse, che[']l Tuono maggiore hauesse luogo dopo un'altro maggiore, nella sua compositione; acciò non fusse ne i suoi estremi dissonante; non si potrebbe però dire, che bisognando in cotal'ordine un tale Interuallo; che tale Consonanza non fusse natura le di tal specie: Et tanto più, quanto ciò procedesse da gli Istrumenti naturali; poiche alla Natura è concesso di modulare quelli Interualli, che tornano al proposito, nel formar le consonanze ne i loro estremi." Galilei often alters the spellings in

No one would deny that voices cannot form and modulate those intervals that are appropriate in the greater exactitude they can return through forming the consonances, just as there is also no one who would affirm that when voices or artificial instruments are assumed to play or sing in an order of intervals appointed and ordered by art in a system, as is for example the Syntonic of Ptolemy, they have to tear or corrupt it to their fashion, drawing it outside its being and from its first nature, because in doing so, we will never be able to say with truth that this is that or that is this. If the variety of nature and the affects [-20-] of the species of the diapason consist, in good part, in the diverse position of the semitones, how much greater this diversity will become if the breadth of the tones is varied in them once again.[42] Even if this follows, it does not pass as Zarlino understands it.

To add later on that voices are able to do this without any labor, it is necessary to see if doing so is in agreement at the time with the nature of the thing, because there are many things that can be but should not be. In addition, the interval that consists of two sesquioctaves [81:64],[43] as is the ditone of the ancient Diatonic, will be dissonant (I say) as much in voices as in strings, for the former are not more privileged than the latter. Nature, through having neither hands nor mouth, has not conceded to him[44] that she plays or that she sings, and our playing and singing is wholly art.

Zarlino's prose, occasionally omits or adds words, and changes the tense of some verbs. In this quotation, the words "that is, voices" were added by Galilei and the final phrase, "in their extremes," was omitted. It was common for writers to alter quotations to fit their own dialect. Competition over dialects in the Florentine and Venetian academies was quite common earlier in the sixteenth century. Zarlino and Galilei appear to be continuing that tradition. See pp. 69-71 *supra*.

[42] I.e., the species of the diapason. Galilei connects Zarlino's views on tuning to a princpal factor in Zarlino's modal system: that the modes are differentiated by the position of the tones and semitones. Zarlino could easily argue that the two ideas are not related in this context.

[43] I.e., 9:8+9:8 = (9x9):(8x8) = 81:64, which is larger than the 5:4 third by the Syntonic comma (81:80).

[44] I.e., Zarlino.

The second reason that he alleges is in the sixth chapter of the same fourth book, and he speaks in this manner:

> *But the Greatest System*[45] *that we make naturally with voices was not limited by some number of strings or by other intervals or limits so that it would not be free and restricted between some limits or spaces. For in leaping or descending, voices can, as we have said many times, make themselves high or low, insofar as the ratio*[46] *of the intervals that are adopted in the species will allow without some contradictions, inasmuch as after the cantilena has finished, no interval is seen that remains in action among those they sing, but rather in pure potentiality.*[47]

The Greatest System is sung by voices and not made by them [-21-] –because it is already made and ordered as art wishes it—and is limited by a particular number of strings, intervals, and spaces measured and defined by art. This, according to what pleases Zarlino, is the Syntonic of Ptolemy. If indeed the voices can leap and descend and make themselves low and high, they do not therefore have to do any of these operations (if, however, it is true that they sing the Syntonic as Zarlino says) nearer or farther than reason wishes them to be for the intervals that are constituted in the species one says or wishes to sing, nor may we proceed through any other intervals than its[48] own without

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[45] The two-octave scale, which formed the foundation of ancient Greek and Latin music theory, is commonly known as the Greater Perfect System. Both Galilei and Zarlino call it the *Systemo massimo* (Greatest System). A literal translation of the Italian will be used throughout this document.

[46] Both Zarlino and Galilei use *ragione* to mean either "reason" or "ratio."

[47] Zarlino, *Sopplimenti* IV.6, 141-42: "Ma il Systema massimo; che si fà naturalmente con le Voci, non è terminato d'alcun numero di chorde; ò d'altri interualli ò altri termini, di modo che non sia libero, & non ristretto tra alcuni termini ò spacii; percioche le Voci possono nel salire & nel discendere; come molte fiate habbiamo detto; farsi acute ò graui, quanto porta la ragione de gli Interualli, che s'adoperano nella Specie, senz'alcuna contradittione; essendoche dopo che la Cantilena è finita, non si uede alcun'Interuallo, che resti in atto tra coloro che cantano; ma si bene in potentia . . . ."

[48] I.e., the tuning system.

some contradiction.[49] It is indeed natural that the extreme sounds of the dupla and those of the sesquialtera [3:2] accord, but dividing the latter into four and the former into seven intervals by one or another measure and breadth is[50] wholly a thing of art, which divides them in such and so many[51] parts because by these it thought it could bring about greater accommodation for its goal, for the cause of which, art itself wished there to be five tones and two semitones in each octave. Its species, which are seven, vary the different positions of these because they can indeed be accommodated in seven different manners and no more. Long use is, then, the cause that posts—without due means—that we hear them with little satisfaction outside the places first determined by art.

Therefore, the art and practice of modulation in the alteration of the [-22-] ordinary and common diatonic strings uses certain means and considerations (as skilled contrapuntists know) and does not alter them haphazardly and extemporaneously. Because two contiguous major tones are not found one after the other in the Syntonic order,[52] according to the way in which Ptolemy distributed it, it will therefore not be permitted for the contrapuntist, regardless of the occasion, to modulate through two intervals so constructed (if what we sing is the Syntonic according to the way in which Zarlino designs it), not only because added together they would be dissonant but also because two tones of this breadth are not found successively in the said distribution of strings; rather, they are found in the distribution that Didymus[53] made prior to this.[54] Nor

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[49] In other words, if voices sing different intervals than those that would be created by strict use of Ptolemy's Syntonic tetrachord, or any other tuning system, they are not singing in that tuning system.

[50] The printed text reads *e*.

[51] The printed text reads *ètante*. The text has been emended to *e tante*.

[52] Meaning two tones of the same size. Ptolemy's distribution pairs a 9:8 tone with 10:9 tone so that they will create a consonant 5:4 major third. I.e., 9:8x10:9 = (9x10):(8x9) = 90:72 = 5:4.

[53] There were several musicians named Didymus in antiquity. The Didymus mentioned here, who also played a prominent role in Galilei and Zarlino's argument over the ancient tetrachords, lived in the time of the emperor Nero (37-68 C.E.). Thanks to the work of Nikolaos Aspiotes, we can now refer to

should any member of the clique believe that the alteration of the strings that are ordinarily made in the Diatonic by means of accidental signs called *chromatici*[55] (because from such alteration is born such a genus) is the same as mutating the major tone into the minor, or on the contrary, mutating the latter into the former, because he would be greatly deceived.[56]

With the variety of intervals and the diversity of their order and location, the good ancient musicians distinguished the diversity of the aforesaid species and the variety of genres of melodies.[57] These species, then, whether they were sung or played, were subject in each of their smallest parts to the conditions in which the authors have constituted the species from them. Whoever among them[58] [-23-] had[59] altered the species one whit came to be taken for ignorant or was severely punished as a despiser of musical laws.[60]

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ancient musicians by way of a numerical catalog (543 for this Didymus). See Nikolaos Aspiotes, *Prosopographia musica Graeca: Personenlexikon mit Daten zu 2350 (heidnischen) Musikern*, Kulturwissenschaft, vol. 3 (Berlin: Frank und Timme, 2006), 123.

[54] In Didymus's distribution, 9:8 tones would be found consecutively in the intervals between G-A and A-B. Galilei discusses the order of major and minor tones that would occur in a tuning system based on Didymus's tetrachord in the *Dialogo*, 35; trans. in Vincenzo Galilei, *Dialogue on Ancient and Modern Music*, trans. with introduction and notes by Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 2003), 91-92.

[55] The printed text reads *cromadici*. Galilei is probably referring to the *diesis* or # sign.

[56] Quite true, because the difference between the major and minor tone is only a Syntonic comma (81:80).

[57] The printed text reads *generi d'armonia*. Galilei is referring to different melodic tetrachords and not sonorities. The terms *harmonia* or *armonia* are often correctly translated as "melody," although they might refer to the harmony of the spheres or consonance in general. The issue is discussed in Claude V. Palisca, "Fidelities and Infidelities in Translating Early Music Theory," in *Music Discourse from Classical to Early Modern Times: Editing and Translating Texts*, ed. Maria Rika Maniates (Toronto: University of Toronto Press, 1997), 1-3.

[58] I.e., the ancient musicians.

[59] The printed text reads *heuesse*.

[60] Perhaps a reference to Timotheus of Miletus who was punished by the Spartans for introducing the chromatic genus into their austere music.

The Greatest System, therefore, that Zarlino describes for us is[61] absolutely limited by one determined quantity of strings, by one determined quantity of intervals and spaces, each of which comprises in itself one determined quantity of low and high sound, assigned to it by the art of Ptolemy.[62] Voices or instruments assumed to sing or play a particular system are not freer and cannot reasonably proceed through or form other intervals apart from those that were instituted in their particular places in it[63] by its author without altering any of its primary essence there, because from their alteration is born the diversity of melodies and affects.[64] Even if voices can, they should not want what ought not to be, or Zarlino should not say that they sing the Syntonic. I will not conceal the reason that he has for his song in this place, because it is most true, as he judiciously says, that "after the cantilena is finished, no interval is seen that remains in action [. . .], but rather in pure potentiality." Is it possible that this man does not blush in saying these vapidities? After it is sung, is it necessary that he see a swarm of bees or gnats in the air?

In the same chapter, he adds this other ingenious reason:

With wind and string instruments[65] [-24-] *one cannot pass outside their order, since the sounds are among the limited strings and holes. But this does not occur*

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[61] The printed text reads *e*.

[62] In this case, Galilei assumes a Greater Perfect System made up of intervals formed from Ptolemy's Syntonic tetrachord.

[63] I.e., the Greatest System.

[64] Galilei's criticism offers one example of ways in which the different musical genres favored by each theorist influenced their views on tuning systems. In this case, Galilei's conception of musical expression, influenced by Mei's research and the belief that monody is more affective than polyphony, is much closer than Zarlino's to the views of ancient writers. In Zarlinian theory, musical expression is born from the proper setting of the text in consonant polyphony and modal unity. Galilei, on the contrary, suggests that subtle changes in tuning will result in a distinctly different musical expression. For Zarlino, all contemporary music was sung using the Syntonic tetrachord (naturally or artificially). For his part, tuning does not affect the musical expression of a performance or composition because voices will alter their intervals, regardless of the tuning system, so that the same consonances are always heard.

[65] Zarlino writes: "whichever stable instrument [qual si uoglia Istrumento stabile]."

> *in the orders made by nature in voices,*[66] *the limits of which are not prescribed if not by the proportions and forms of the intervals that have to be sung: because of the good judgment and healthy hearing of the singers, without too much—or any—difficulty, they can extend the voice as far as the proportion of the intervals that they wish to form,*[67] *inasmuch as there is not on the instrument of the voice any string or hole that makes the sound determined as on the artificial instruments*.[68]

With the wind and string instruments, one cannot pass outside their order because with the order of sounds that is found among them, the player achieves his goal. Nor does anyone of judgment say that this instrument can or may do what it does not and cannot do. The orders of voices made by nature—it is true that among them there is not more or less tension or relaxation of these than of those intervals, the one to the other, through the ordinary and naturally prescribed limits of the forms and measure, and they[69] can form them[70] as is more pleasing to them. But they accept all these limitations from art every time they undertake to sing this or that system, which (inasmuch as it is true that today they have taken the Syntonic of Ptolemy to sing)[71] puts a bridle on the voices, so to

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[66] Zarlino writes: "in nature by the voices [nella Natura dalle Voci]." Galilei's alteration actually clarifies the meaning.

[67] Zarlino writes: "without obstacle or any difficulty [senza intoppo ò difficultà ueruna]."

[68] Zarlino, *Sopplimenti* IV.6, 143: "Ilche tanto nell'ordine arteficiale del uero Syntono, quanto in quello di qual si uoglia Istrumento stabile; non si può passar fuori dell'ordine, poiche i Suoni sono tra le lor chorde, ò fori terminati. Ma questo non auiene ne gli ordini fatti nella Natura dalle Voci, i cui termini non sono prescritti, se non dalle proportioni e forme de gli Interualli, che s'hanno da cantare; mediante il buon giudicio e sano Vdito de Cantori: percioche possono distender la Voce, quanto porta la proportione de gli Interualli che si uogliono formare senza intoppo ò difficultà ueruna; non essendo nell'Istrumento della Voce alcuna chorda ò foro, che faccia il suono determinato; come ne gli Istrumenti arteficiali." Galilei changes Zarlino's "intoppo" (impediment) to "troppo" (too much), which does not substantially alter the meaning of the sentence.

[69] I.e., singers.

[70] I.e., the orders of the intervals.

[71] Galilei's first suggestion that voices do actually sing in the Syntonic tuning. He admits this fact more fully near the end of the *Discorso*. See p. 383 *infra*.

speak, by assigning to them precise limits of whatever interval, not otherwise than the holes and frets of the artificial instruments—wind and string—do under the [-25-] fingers and hands of the player. And if they do otherwise, they will not sound the Syntonic as it has been designed for us.

Furthermore,[72] voices learn from art to carry and form whatever musical interval in an excellence greater than their truer proportions and forms contain, not otherwise than the principles of painting from design[73] teach us that it is first necessary to learn to design each part of whatever body in supreme excellence and in their exact proportion and beauty. For example, of the human body, one learns to design first the mouth, nose, eye, ear, hand, foot, and so on. And in having then to depict a man, a woman, or a horse in their fashion, excellent painters will always do it in total perfection whenever they wish, but when they have to portray some particular from the natural,[74] they are forced by the subject that they are seeking to imitate to represent it such as it is, with each one of those particular accidents that are naturally in it, leaving aside at the time the proportion and beauty of the members when they are not found in the subject they have to imitate for

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[72] A period follows *più oltre* in the printed text.

[73] Here, Galilei compares the art of the painter with that of the musician. Leslie Korrick suggests that Galilei was specifically influenced by the writings of Giovanni Paolo Lomazzo. Although the connections Korrick draws between Lomazzo and Galilei may be tenuous, she does note how both the painter and lutenist use analogies between the visual arts and music to advance their opinions about the role of the senses in understanding art and music. See Leslie Korrick, "Lomazzo's *Trattato . . . della pittura* and Galilei's *Fronimo*: Picturing Music and Sounding Images in 1584," in *Art and Music in the Early Modern Period*, ed. Katherine A. McIver (Aldershot, UK and Burlington, VT: Ashgate, 2003), 193-214. Zarlino, too, uses analogies to the visual arts in the *Sopplimenti*. For example, in explaining the superiority of nature over art, he recalls the ancient painter Parrhasius who, according to Pliny the elder, could paint such life-like grapes that birds would try to eat them. Zarlino notes that they may have looked like grapes and fooled animals without true reason, but they were not actual grapes. By analogy, artificially produced music could never be considered on the same level as music that is created naturally. See Zarlino, *Sopplimenti* I.4, 21.

[74] The printed text reads *del naturale hanno a ritrarre*. Keith Christiansen notes that the mannerist painter Michelangelo Merisi da Caravaggio's contemporaries described his naturalistic habit of painting directly from models as "ritratti dal naturale." See Keith Christiansen, "Caravaggio and 'L'esempio davanti dal naturale,'" *Art Bulletin* 68 (September 1968): 422.

us.[75] Now, equally, so should voices: although they might have the faculty (not naturally, as Zarlino wants, but after having learned, with long practice, the art of singing well) to form and modulate the intervals through whichever strings into the said excellence, when they then undertake [-26-] to sing a particular system, they have to sing it such as it has been distributed by the artifice of its author. Otherwise, by making a passage from one to another species of melody, they come to corrupt the orders and the musical laws. Now Zarlino notices that the strictness he earlier posed for the Syntonic cannot give him the perfection that he desires. For this, he needed to think ahead.

In chapter seven, he adduces this other reason:

Because even if in the artificial order of the said and natural Syntonic it will be true that the said imperfections are there, then such a consequence will be false in the natural order.[76] *It is therefore beside the point to wish to conclude that we may not use the said natural species and Syntonic of Ptolemy because many intervals are not comprised in the artificial system that are not found in our cantilenas that are played and sung. But indeed the conclusion would be turned true when on the natural instrument one used other intervals than those that in*

[75] Galilei supposes that universal conceptions about beauty must be cast aside in favor of depicting the unique characteristics of human figures. There is a clear parallel between his views on musical expression (made through the anology of the visual arts) and those of the composer Claudio Monteverdi. After Giovanni Maria Artusi criticized Monteverdi's madrigal *Cruda amarilli* for its licenses in part writing, Claudio's brother Giulio Cesare defended the work, noting that his brother was only doing what was necessary to express the affects in the text. Just as Claudio Monteverdi chose to ignore certain rules of counterpoint to better express a text with music, Galilei suggests that painters must not reduce their subjects to any pre-conceived notions of beauty.

[76] In the *Sopplimenti* (IV.6), Zarlino posits an artificial order of the Syntonic, built exactly on the intervals of Ptolemy's Syntonic Diatonic tetrachord, and a natural order, which voices actually sing in practice. The dissonances that would arise from a strict adherence to the Syntonic ratios are not heard in the natural order because voices immediately correct their intervals to form consonances. Zarlino claims that it is pointless to judge the practicality of Syntonic tuning on the basis of the artificial order because only the natural order is used by singers.

their proportions and proper forms are elemental in the artificial system of the natural or named Syntonic.[77]

If we wish to discuss like reasonable men, the consequence will not be otherwise than false. But if we wish to discuss anything without reason, it[78] and[79] all the others will be false. In the Syntonic of Ptolemy, Zarlino affirms such imperfection to be there. If it is there, therefore, whenever it will be sung as it stands, such imperfections will be heard among the voices. To say, then, that when the voices encounter it[80] while singing, they run to perfection [-27-] and on account of this we do not hear it, I respond that we do not hear it not because it is not there, but through having abandoned the dissonant intervals that the Syntonic has in those places and the voices having gone to those of another species that is consonant among the same strings. So, the consequence serves quite well. No longer is it permissible in the future—except among the members of his clique[81]—for him to use those epithets of "natural Syntonic" and "artificial Syntonic" as if Ptolemy had made two distributions of it. If it will please God, I will declare in the end of this, my *Discourse*, what is this "natural" and "artificial," poorly understood by Zarlino. I say

[77] Zarlino, *Sopplimenti* IV.7, 146: "percioche se ben nell'Ordine arteficiale della detta Specie Naturale & Syntona sarà uero; fallirà però cotale Consequentia nell'ordine Naturale. È adunque fuora di proposito, il uoler concludere che non si usi la sudetta Specie Naturale & Syntona di Tolomeo; perche nel Systema arteficiale non sono compresi molti Interualli, che nelle nostre Cantilene che si suonano & cantano, non si trouano: ma si bene tornarebbe uera la conclusione, quando nell'Istrumento naturale s'usasse altri Interualli di quelli, che nelle loro proportioni & forme proprie sono Elementali nel Systema arteficiale del Naturale ò Syntono nominato." According to Zarlino, the elements of Syntonic tuning are the 9:8 and 10:9 tones and the 16:15 semitone. Even when natural voices alter their intervals to form consonances, they will still use those three intervals; therefore, they are still using Syntonic tuning. An explanation of the difference between elements and principles as they relate to Syntonic tuning is found in the *Sopplimenti* II.3, 49.

[78] I.e., the consequence.

[79] The printed text reads *è*.

[80] I.e., imperfection.

[81] Galilei emphasizes that Zarlino is writing for a select group of readers who share his views. Both Galilei and Zarlino assume that they are offering universal truths while their rivals are only communicating with their closest allies.

again that Ptolemy made only a single distribution of it,[82] and he named it simply "Syntonic," without another epithet.

It is[83] therefore very appropriate to wish to conclude from this that the said Syntonic is not sung as Zarlino designs it for us, and those intervals of it that are not used according to him in our cantilenas and on our instruments—instead of which we adopt others of different measure and nature—conclude exactly the opposite of that of which he seeks to persuade us. For if in the Syntonic we have among the strings *D* and *a* a dissonant fifth (because it is diminished) and among *a* and *d* a dissonant fourth (because it is augmented),[84] the one and the other instituted there by the poor design of Zarlino, every time that between these strings, whether singing or playing, intervals of another [-28-] form and nature will be placed there, they will have no relationship to those that Ptolemy constituted there, and his order and his intention will necessarily become corrupted, perhaps from it having been poorly expressed by the latter and understood worse by the former[85] that—apart from many other places—there are the said dissonances in the Syntonic between the said strings.

The same Zarlino says in the eighth chapter that they[86] would be dissonant as such whenever they were set in action in such measure as a deaf man would hear them, a blind man would see them, and a mute would know how to say it.[87] Now, of this liberality, a

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[82] I.e., the Syntonic species.

[83] The printed text reads *E*.

[84] Zarlino acknowledges that a Syntonic scale will create a dissonant D-a fifth and a-d fourth. See Zarlino, *Sopplimenti* IV.1, 115-16.

[85] Galilei implicates Ptolemy, as well as Zarlino, for disseminating unclear information about tuning systems.

[86] I.e., intervals outside of the Syntonic.

[87] "A deaf man . . . would know how to say it." This quotation is drawn from the *Sopplimenti* IV.8, 147. Galilei is arguing with Zarlino's criticism of the *Dialogo*, 29, in which Galilei disputes the contents of Zarlino's *Istitutioni* II.43. In that chapter, Zarlino argues with his detractors and explains the nature of the comma and its place in his tuning system. The passage is one of several instances in which arguments in

half word that he might have posed about it[88] in his first works would not have come to these conflicts. But he adds, nearby, that to say this[89] is "beside the point," that is, his wish to infer it and allege his customary reason, saying that they[90] are not adopted in singing and when two parts encounter these dissonances they run (leaving aside that they are artificial) immediately to the perfection. Now, this is not the same thing as he himself said: that the voices abandon the Syntonic and go to another species of melody. But the "artificial" and the "natural" is his retreat, and he does not notice that just as it is natural for the octave to sound consonant, so it is for the seventh or whatever other interval to sound dissonant.[91]

Therefore, I say again that Ptolemy made only one Syntonic, to which he did not give the name "natural," nor "artificial" (as beside every point); and the intervals [-29-] that Zarlino says we do not use in singing and playing in the manner that they are comprised in the Syntonic occur through not being able to have from it our entire intent, and as a result, we pass from it to another species of melody, as has been said (if it be the case, however, that the Syntonic stands in the manner Zarlino has designed it for us). Nor does he wish us to believe that he has said as a joke that the half-comma taken from or

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Galilei's *Discorso* may be traced back through the *Sopplimenti* and Galilei's *Dialogo* to their origin in Zarlino's *Istitutioni*.

[88] The printed text reads *ch'egli ne.hauesse mosso*.

[89] I.e., to say that we do not use the Syntonic because it creates dissonant intervals.

[90] I.e., dissonant intervals.

[91] Galilei expanded on his theories of dissonance in his unfinished "Discorso intorno all'uso delle dissonanze," which was not published in his lifetime. The three manuscript copies of the treatise are housed in the Galilei papers at the Biblioteca Nazionale Centrale in Florence (**I**-Fn, Gal.), and a critical edition appears in Frieder Rempp, *Die Kontrapunkttraktate Vincenzo Galileis*, 77-161. Further commentary on the treatise and another transcription may be found in Annibale Gianuario, *Vincenzo Galilei, la dissonanza e la seconda pratica; Discorso di Vincentio Galilei intorno all'uso delle dissonanze (Ms. di Firenze),* 2d ed. (Sezze Romano: Fondazione centro studi rinascimento musicale, 2002). Both Gianuario and Palisca view Galilei's theories of dissonance as precursors to Monteverdi's *Seconda prattica*. See Claude V. Palisca, "Vincenzo Galilei's Counterpoint Treatise: A Code for the *Seconda prattica*," in *Studies in the History of Italian Music and Music Theory* (Oxford: Oxford University Press, 1994) 30-53.

added to whatsoever consonant interval acts to make it dissonant,[92] just as he has not said this as a joke: if the difference is of the entire comma, which is as much as the major tone exceeds the minor, he does not wish it to be of any importance. He adds, after many blunders, that I have said that the practitioner ignores and understands things very well; he says this fashion of speaking comes from my vapidity, and I confirm that so it would be, whenever judgment had simply to do with words of mine that he recites after having accommodated them to his fashion, as he has done many times in his *Sopplimenti*. But the words formed by me sound in this manner: the practitioner ignores the reason that the theorist understands[93]—without hearing the intervals, by seeing only that of which they are composed, he recognizes whether they are consonant or dissonant—; the practitioner recognizes them only by hearing them. It is therefore not vapidity to say this, but it is indeed pure malignity of the one who seeks to hide [-30-] the truth with fraud.

Later on, Zarlino adds that there is no man so foolish and so ignorant[94] who does not recognize that all those defects I demonstrate to be in the Syntonic are there. So,

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[92] See Zarlino, *Istitutioni* II.43. In the *Dialogo* (p. 29), Strozzi suggests that Zarlino must have been kidding when he claimed that "one should put aside considering the difference between the major and minor tones." Zarlino's original intention in the *Istitutioni* was to ennumerate the species of perfect fifth without, as Palisca points out (Galilei, *Dialogue*, 76, n. 112) confronting "the problem of the degree of consonance of the different species of fifth." Zarlino justifiably brings up the issue in the *Sopplimenti* IV.8, 147, to conclude that Galilei has not closely read or understood his writings. Never wanting to miss an opportunity to ridicule his rival, Galilei presses the issue in the *Discorso*. Perhaps he understood how difficult it would be for readers to trace the argument back to his own error.

[93] The printed text reads *il prattico ignora la ragione che intende il Teorico*. Galilei may have implied this idea in the *Dialogo*, but the actual quotation is not found anywhere in the text. In the *Sopplimenti* IV.8, 147, Zarlino writes: "Even if they have often said that the Practitioners, as ignoramuses, do not understand such things, in the example that follows, they wish to prove this, as Theorists, by means of the arithmetic faculty [se bene spesse fiate dicono, che i Prattici, come ignoranti, non intendono cotal cosa: onde nell'essempio che segue, uogliono prouar questo, come Theorici, col mezo della facoltà Arithmetica]." Zarlino implies that Galilei is playing both sides of the fence: considering himself a practitioner or a theorist whenever it suits his point.

[94] Zarlino applies the insult "so foolish and ignorant [tanto goffo e tanto ignorante]" to Galilei, suggesting that his rival is drawing great attention to something that is obvious to anyone else. See Zarlino, *Sopplimenti* IV.8, 148. To this, Galilei rejoins: if it is so obvious that these imperfections exist, why are they not heard in performance when using this tuning system? Galilei conveniently ignores Zarlino's theory that natural instruments will instantly adjust their intervals.

because I will have won the cause with only this, I seek nothing else from him, considering that in my *Dialogo*, I say only that between the strings of the Syntonic of Ptolemy, there are the said imperfections. Now Zarlino repeats again (and this is said with all due respect to those who will take care to read this, my *Discorso*) that these things are said "beside the point and without reason."[95] And thence he adduces, for example, that in singing and playing they[96] are not heard there because there would not be anyone, he says, so mad who would sing or play them.[97] And yet he only says that they are played and sung when we sing and play the Syntonic of Ptolemy as is pleasing to him. This reason, does it not fail to fit and militate against itself? If such defects that are found in the Syntonic are not heard in singing or in playing it, this occurs because the singers and players take, as he says, other intervals instead of the proper ones, and I would not know a reason or how to persuade the world better than this that what is sung and played today is not the Syntonic as Zarlino designs for us.

He responds to this with another most subtle and ingenious reason, and it is this: he says first that my argument does not conclude because it passes from one species to the other,[98] and this diversity of species is his "natural," [-31-] and "artificial." And I

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[95] Zarlino, *Sopplimenti* IV.8, 148.

[96] I.e., imperfections in the Syntonic.

[97] I.e., the imperfections. Zarlino was writing specifically about artificial instruments. His exact words (*Sopplimenti* IV.8, 148) are: "Because there would not be a player so mad who, when playing an instrument tuned according to the ratios of the numbers of the artificial system of the natural or Syntonic, would want to adopt these and other similar [intervals] that discord [Imperoche non sarebbe cosi pazzo un Sonatore, che sonando un'istrumento accordato secondo le ragioni de i numeri dell'Artificioso Systema del Naturale ò Syntono, uolesse adoperar questi & altri simili, che discordano]."

[98] Ibid. Zarlino is applying a universal dichotomy of nature and art to the focused topic at hand: the natural and artificial orders of Syntonic tuning. Earlier in the *Sopplimenti* (I.6, 24), Zarlino accuses Galilei of considering art to be superior to nature. He notes that these entities are separate and that one cannot "conclude from the things contained in one genus about those that are contained in another [concludere dalle cose contenute in un Genere à quelle che sono contenute in un'altro]." He now argues that Galilei cannot make any conclusions about the intervals contained in the natural species of the Syntonic tetrachord from the intervals found in the artificial species. Galilei denies that either species is natural. Zarlino's restrictions on drawing conclusions across genres are based on Aristotle's *Posterior*

repeat that the Syntonic is only a wholly artificial thing, so made by the artifice of Ptolemy.

I will not linger to repeat the other reason that he alleges in the end of this chapter because it is directly contrary to his goal.[99] His reasons neither can nor ever will be otherwise if he adduced thousands for us, with respect to their being based on falsehood through not understanding the principles. And I take this tediousness of producing them for his greater confusion.

Not content with this, he adds in chapter 9 that I adduce the example of the temperament of the keyboard instrument to prove that today we do not sing the Syntonic—which is detestable to me, as one reads in my *Dialogo*. Rather, by believing what he has attributed to me, nothing but ill has been caused. Later on, he says that I have written that augmented fourths and diminished fifths are sung today, which is and would have to be most true whenever the Syntonic is sung as he designs it for us. On this, I make a demonstration in that place that concludes necessarily; I do not repeat it in order not to be more tedious than I am because of his importunity.[100]

Analytics I.7. See *The Complete Works of Aristotle: The Revised Oxford Translation*, 2 vols., ed. Jonathan Barnes, Bollingen Series, LXXI/2 (Princeton: Princeton University Press), 1:122. Aristotle contends that one cannot solve a geometric problem by using arithmetic. Zarlino, on the other hand, avers that one cannot prove something about natural scales or natural instruments by using artificial scales or artificial instruments.

[99] At the end of *Sopplimenti* IV.8, 149, Zarlino mocks Galilei's proofs by comparing them to a bad geography lesson: "One might say: from Venice to Constantinople [modern-day Istanbul], there are (let us posit) 900 miles and from Venice to Ragusa [a city in Sicily], there are 400 miles; therefore, from Ragusa to Constantinople , there are 500 miles [dicesse alcuno; da Venetia à Costantinopoli sono, poniamo, miglia 900. & da Venetia à Ragusi sono 400. adunque da Ragusi à Costantinopoli sono miglia 500]."

[100] See Galilei, *Dialogo*, 33-34; *Dialogue*, 85-89. Zarlino accuses Galilei of merely copying his own 2/7 comma temperament, first explained in the *Istitutioni* II.43. Much of the novelty in Zarlino's system resides in his attempt to accurately quantify the amount each interval is tempered by dividing the comma into seven equal parts. Galilei's 4/7 comma temperament is certainly an adaptation of Zarlino's invention, but they differ in that Zarlino presents his temperament as a musical abstraction worked out on a monochord while Galilei describes 4/7 comma temperament as a practical exercise on the keyboard. For more on Galilei's temperament, see pp. 78-82 *supra*.

He adds in the same place and to the same point that I have said that men are content to hear imperfect fifths and fourths sung because they have not heard the true ones sung. Responding to this, I say that men are content insofar as he says with respect to the ordinary [-32-] keyboard instrument by comparing its intervals to those that are sung or to those of the keyboard instrument found by me in which all come in as great an excellence as one can desire.[101] And with respect to singing in his fashion, I do not say as he wishes. If in what I have written here, anyone finds the least thing that is not true, he may hold me as a man without honor.[102]

At the end of the chapter he writes this other argument:

> *Wishing that nature be corrected by art, that the latter be like an exemplar to the former, that it be imitated by the former, and not that art follow and imitate nature like a true exemplar–this will be contrary to what I have determined in chapter 4 of the first* [Book].[103]

What have we to do with what Zarlino has determined in that place? One may see if what I say is true and is then contrary to chapter 4—and to chapter 5—that this is of little importance.[104] Once again, as when I first put pen to paper, I will make us see more clearly than the sun that his principles are all directly contrary to the truth. Turning to my

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[101] In the *Dialogo*, Galilei describes a keyboard instrument owned by Albert of Bavaria that could be tuned in the same manner as a lute. See Galilei, *Dialogo*, 48; *Dialogue*, 116.

[102] Galilei claims that singers will produce sharp fourths and diminished fifths in the *Dialogo*, but not "with respect" to Zarlino's Syntonic tuning. Galilei discusses the mis-tuned fourths and fifths that occur in keyboard temperament as well as those that are created in Aristoxenian tuning. See Galilei, *Dialogo*, 33-34, 54-55; trans. in *Dialogue*, 86-87, 131-34.

[103] Zarlino, *Sopplimenti* IV.9, 150: "essendoche uogliono, che per tal modo sia corretta la Natura dall'Arte; & che questa sia come essemplare à quella; e che sia imitata da quella, & non che l'Arte segua & imiti la Natura, come uero essemplare; contra quello che si è determinato nel Capo 4. & ne i due seguenti del Primo libro." Galilei compresses the opening of the quotation and adds *sarà* before *contra*. He also leaves out the final phrase about the "next two chapters," mentioning only chapter 4. Zarlino is specifically referring to the the *Sopplimenti* I.4, 20.

[104] In the *Sopplimenti* I.4-5, 18-22, Zarlino presents a hierarchical function of nature and art in musical science. For Galilei, the Syntonic is purely artificial, and these chapters are therefore irrelevant in discussing it.

first aim, I say that the exemplar of this affair is (according to Zarlino) the Syntonic of Ptolemy, a thing wholly artificial, made by his[105] artifice, and poorly understood by Zarlino. Art, and not nature, seeks to portray and imitate this exemplar with natural voices and with artificial instruments, and whoever will imitate it[106] better and portray it correctly from the natural[107] will merit the name of most [-33-] excellent masters. To the blunder that he then adds,[108] I respond thus: whether the fashion that we use[109] in modern times to sing together this diverse quantity of parts[110] has had its origin in string instruments,[111] as I firmly hold,[112] or that playing many parts together on these was introduced by hearing them sung, as Zarlino says, I refer to the judgment of those who understand this field. I will believe, indeed, that at the first beginning of singing and playing in consonance, the thing may have passed from another manner that did not ultimately pass over.

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[105] I.e., Ptolemy's.

[106] I.e., the Syntonic.

[107] Galilei introduced the idea of painting "from the natural [del naturale]" on pp. 279-80. To follow Galilei's analogy, the Syntonic tetrachord is the model and musicians try to imitate its perfection, but they must contend with the unwanted dissonances that come about in actual practice.

[108] Zarlino accuses Galilei of concluding that singers learn their intervals by means of a fretted instrument. See Zarlino, *Supplimenti* IV.9, 150. He insists that Galilei's arguments are not valid because they cross from one genus to another.

[109] The printed text reads *si v sa*.

[110] The printed text reads *diuersa quantità d'arie*. Galilei uses this phrase several times in the *Discorso*. *Arie* is rendered as "parts" because Galilei is referring to the texture of a polyphonic composition.

[111] Although Zarlino only refers to "that fashion which we sing [quel modo che cantiamo]," Galilei includes the adverb *modernamente* to emphasize that "the fashion" is a recent phenomenon. It is possible that they are arguing over different topics. When Zarlino claims that singers do not learn the intervals from instruments, he is referring only to musical pedagogy. Galilei appears to have altered the discussion from pedagogy to music history. He suggests that polyphony was initially practiced on string instruments before it became common for vocalists. Unfortunately, Galilei does not follow through with his argument. In the *Dialogo*, he compares the earlierst polyphonic compositions to the work of fortune tellers. See Galilei, *Dialogo*, 37; *Dialogue*, 95.

[112] Galilei expresses this idea in the *Dialogo* (p. 55) after he explains why voices sing sharp fourths and flattened fifths: "cioè che si sia imparato di cantare questo modo da gli Strumenti di corde, & particolarmente da quelli che non hanno come il Liuto & la Viola I tasti"; trans. in *Dialogue*, 133: "we learned to sing this way from stringed instruments, and particularly those without the frets of the lute and viol."

He recounts his other deception in chapter 10 to prove that I am in error when I say that the Syntonic is not sung today, and it is this: he repeats anew that I argue on the basis of artificial instruments that the Syntonic is not sung today, and he says that I make my conclusion in this manner: "You wish to see that the Syntonic is not sung, you observe that neither is it played on instruments."[113] Where does Zarlino find that I use these terms? The reasons that I adduce that the Syntonic is neither sung nor played in the manner that he designs it for us I derive as is seen from nothing other than the same Syntonic. He adds later on that I say that the intervals that are sung today are not sung in their true natural forms. On the contrary: because the Syntonic, I say, has some consonant fifths and fourths and some dissonant and all those that are sung and[114] played today are all consonant, [-34-] therefore, the Syntonic is neither sung nor played. He says, furthermore, that the intervals that are sung must necessarily be contained in another genus and species than those that are played. That the matter (in the fashion that he says it) is so far away from the truth can be recognized from this. Sound as a continuous quantity can be divided, as much by voices as by strings, into whatever and as many parts as is wished. Therefore, whatever interval that the voices may sing can be played in the same measure and breadth by the strings. It is therefore not true that it is necessary that the intervals that are sung be contained in a genus and species diverse from those that are played.

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[113] The quotation is not found in the *Sopplimenti* IV.10, but it is a loose paraphrase of a passage in I.6, 24: "one could never say in music that this is proper: such a thing or such defect is always found among the sounds of the artificial instrument, therefore, they are always found among the voices. . . . Also, the natural or Syntonic species of Ptolemy is not found or played on the artificial instruments; therefore, the said species is not sung or composed [nella Musica non si potrà mai dire che stia bene; nell'Istrumento Arteficiale tra i Suoni sempre si troua cotal cosa ò cotal diffetto, adunque si troua anco sempre tra le Voci. . . . Ancora; Negli Istrumenti Arteficiali non si troua & non si sona la specie naturale ò Syntona di Tolomeo, adunque non si canta, ne si compone la detta Specie]." Inasmuch as Zarlino refers back to Book I in IV.10, it is possible that Galilei cited the wrong chapter.

[114] The printed text reads *è*.

He himself wishes to apply that diversity of genus and species to his "natural" and "artificial." What he says will also not be true because the "natural" of the Syntonic is, so to speak, the distribution that Ptolemy made of it; this can be sung and played correctly as it stands without lacking one least thing. Furthermore, he himself recognizes that this is impossible, as it truly is according to his limited explanation, because he says that all that is sung and played today is Syntonic. And there is only one Syntonic.

He adds this other discovery of his in the eleventh chapter:

> *And if indeed similar intervals necessarily come between the strings of the Syntonic*[115] *by accident and remain between them, this also intervenes in some*[116] *other artificial instrument*, [-35-] *arranged in five tetrachords*,[117] *in which art has limited itself in the instrument by imitating nature more than it has enabled what was granted to the instrument. Nevertheless, one cannot say that they are of the Syntonic species, born haphazardly between its strings, inasmuch as they are also not placed (because they are dissonant) in cantilenas*.[118]

When Ptolemy ordered the Syntonic, he did not make a distinction between natural intervals and artificial intervals. The Syntonic altogether and in each part of its division is artificial. Natural is the quality of the sound that contains in itself whatever its interval is. So, these are all Zarlinesque discoveries to befuddle simpletons. To say, then, that this

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[115] Zarlino writes "this system [questo Systema]."

[116] Zarlino writes "whatever [qualunque]."

[117] Instrumental scale-systems, such as those discussed by Carolingian authors, were typically organized in five tetrachords. Although the Greater Perfect System is also constructed out of five tetrachords, Zarlino is probably referring to theoretical literature known by his readers rather than to any actual instruments.

[118] Zarlino, *Sopplimenti* IV.11, 152-53: "Et se ben simili Intervalli uengono necessariamente tra le chorde di questo Systema per accidente, & restano tra esse; percioche questo anco intrauiene in qualunque altro Istrumento arteficiale, ordinato in cinque Tetrachordi; nelquale l'Arte hà in esso terminato, con l'imitar la Natura più c'hà potuto quello, che gli è stato pemesso; tuttauia non si può dire, che siano della Specie Syntona, nascendo à caso tra le sue chorde; essendoche ne anco si pongono (perche sono dissonanti) nelle Cantilene."

happens in some other instrument is beside the point, and to make mention in that place of five tetrachords does not serve otherwise than to cause wonder among the members of his clique. The artisan, then, in making his instruments at all times took care to imitate nature, but he only sought by means of it to obtain his proposed goals.

The dissonant intervals that the Syntonic has in itself are not born there more haphazardly or more deliberately than are born the consonant intervals. Therefore, one cannot truthfully say that they are not of the Syntonic species because whichever of them is a part and member necessary to it, all of them are placed there by Ptolemy with equal affection (with respect to the distribution; and by nature how much to accord or discord). To say, then, that today they are not adopted in cantilenas because they are dissonant and a change [-36-] is made to consonant intervals, this is exactly what I say in my *Dialogo*, that is, that we sing several species of melody together, and even if only one were demonstrable, it is not the Syntonic as Zarlino designs it for us.

He wishes in chapter 12 to prove anew with this nice example that the Syntonic is sung today:

> *And if it were true, as some hold, that intervals*[119] *limited by nature in their true and natural forms were never sung nor played, a major inconvenience would follow: that God—and nature as His instrument (who never do anything in vain)—would have given to mortals a thing that cannot be put in action, but which would always be in pure potentiality;*[120] *hence, it would be altogether vain and useless. This is altogether and thoroughly far from the truth.*[121]

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[119] The printed text reads *interuuli*.

[120] Act and potentiality are discussed by Aristotle in the *Physics* and *Metaphysics*. For an explanation of the terms with regard to Zarlino and the writings of his student Giovanni Maria Artusi, see

No one asserts that intervals in their true form are not sung and not played on some instruments, but rather that they are not sung nor can be sung or played in any fashion in their true form with the means of the Syntonic of Ptolemy poorly explained for us by Zarlino because they[122] are not there in the Syntonic, nor are its means (if its power is not extended even further than what Zarlino has until now told us) efficacious to make them so for us with whatever human knowledge because it is directly contrary to nature. This is what[123] I have said above to prove demonstrably in my *Dialogo* without any contradiction.

God and nature, therefore, have not given to mortals [-37-] what Zarlino says, without enabling them to set it in action, but indeed they have established that nothing can be set in action without the requisite means. Therefore, when he understands that if the Syntonic does not give such a means to us, nothing else can give us the means as he designs it for us, it happens from the excessive belief he has that the Syntonic may give to us what no relationship can give us without recognizing its power and adopting it, and he is greatly lacking in judgment on this matter. Therefore, inasmuch as he now finds himself clearly outside the direct path that can lead him in this truth, he should have to accommodate himself to what obligation wishes, at least until a better one is found. And what is better—rather, the true distribution that is sung and played today on some instruments—I will say before I rest the pen or at greater length in my *Discorso all'uso*

Chadwick Jenkins, "*Ridotta alla perfettione*: Metaphysics and History in the Music-Theoretical Writings of Giovanni Maria Artusi" (Ph.D. dissertation, Columbia University, 2007), 122-36.

[121] Zarlino, *Sopplimenti* IV.12, 160: "Et se fusse uero, come tengono alcuni, che non si cantassero mai, ne mai si sonassero gli Interualli terminati dalla Natura nelle loro uere & naturali forme; ne seguitarebbe un massimo inconueniente; Che Iddio et la Natura, come suo Istrumento, che non operano mai cosa alcuna in uano, hauesse dato à mortali una cosa, che non si potesse porre in atto, ma che fusse sempre in pura potentia; onde sarebbe in tutto uana & inutile; laqual cosa in tutto & per tutto è lontana dal uero." Galilei writes *cantasse* instead of *cantassero*.

[122] I.e., intervals in their true form.

[123] The printed text reads *questo e quello che*. *e* has been emended to *è*.

della dissonanze, already completed a few months ago, which ought soon to be published.[124]

I will now recount with respect to the final reasoning of Zarlino what he writes in the thirty-sixth chapter, leaving aside all the others because the same things have already been said. He writes thus:

> *Voices in singing the Syntonic do not do otherwise than is done by the player of the lute, on which, when he finds a string false in height or depth more than he ordinarily seeks from it*,[125] *he works with the fingers or with moving the frets from their ordinary place to compensate for such a defect*.[126]

Is this example not more amazing and surprising [-38-] than all the other examples? The false string on the lute or the frets outside their place—in order to obviate the inconvenience of the string—occur there by accident. And when the strings are just, as obligation requires, the frets stand firm in their places determined according to the way the player seeks the system that he has chosen to sound. And on the lute, it is the Intense

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[124] The "forthcoming treatise" is a common trope in the history of music theory. Unfortunately, most of these "forthcoming" documents either never appeared or have been lost.

[125] I.e. the string.

[126] The printed text reads: *Le voci nel cantare il Sintono fanno non altramente che si faccia il Sonatore di Liuto; nel quale trouandosi vna corda falsa nell' acuto o nel graue più di quello che per l' ordinario da essa si ricerca, va con le dita, o con il muouere i tasti dal luogo loro ordinario snpplendo a cotal difetto*. Galilei is paraphrasing the following passage from the *Sopplimenti* IV.36, 225: "And this is made manifest with the example: just as when the ear of one who plays the lute or fretted viol happens in some places upon a defect of the frets poorly placed on the instrument or some string tuned or stretched too high or made lower than it should be or another accident or some encounters among discordant parts, he immediately either alters with the finger the strings that he plays, which is an easy thing for him (if he is an expert of such an instrument), making it in one stroke a little lower or a little higher; or moves some fret from place to place, bringing it back toward the low or toward the high according to need; or stretches or slackens the string a little more, so that he might find the good and perfect accords [Et questo si fà manifesto con l'essempio; che si come l'Orecchia di colui che sona ò Liuto ò Viola da tasti, quando s'incontra in alcuni luoghi, che per difetto de i Tasti mal posti nell'Istrumento ò d[']alcuna chorda, per essere accordata ò tirata troppo acuta, ò fatta troppo graue del douere, ò per altro accidente, ò d'alcuni incontri tra le parti discordate; subito, ò che col dito uiene ad alterar le chorde, ch'ei tocca; il ch'è à lui (s'è perito di cotale Istrumento) cosa facile, facendola in un tratto un poco più graue ò un poco più acuta; ouer che muoue alcun Tasto da luogo à luogo, riportantdolo alquanto uerso il graue ò uerso l'acuto, secondo'l bisogno; ouer che tira un poco più, ò un poco meno allenta la chorda, accioche ritroui i buoni accordi e perfetti]."

Diatonic of Aristoxenus;[127] which sounds correctly without any sort of alteration. And all that Zarlino says the player does at the time, he does wishing to imitate, with both his power and know-how, the said Intense Diatonic, from which the falsity of the said string deviates him and the ordinary and true positioning of the frets. So, the example proves to us, as usual from his others, the opposite of what he seeks to persuade us. And it is true: singers, when singing the Syntonic species of Ptolemy,[128] leave aside its proper and particular intervals and go, not by any necessity but by choice, to those of another that has intervals diverse from the Syntonic between the same strings. What do they do? They do not sing at the time the Syntonic as Zarlino has designed it for us, but a species of melody of a nature diverse from the Syntonic. Therefore, the Syntonic of Ptolemy is not sung limited by the guise of the strings of an instrument as he designed it for us, but we sing some of its parts, as I have said many other times. Even at that, we have need of another explanation than what Zarlino gives us. And let this [-39-] be a sufficient conclusion for this first chapter.[129]

I sense from the following that Mister Gioseffo remains dissatisfied and seeks anew to malign me by producing for the members of his clique conclusions at the end of chapter 36 that specify in their diction a bit better his conception from which other conclusions are produced. Now, let them be bequeathed, please, and let it be finished:

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[127] The *Diatonico incitato* (tense diatonic) tetrachord, first discussed by Aristoxenus, contains two whole tones and a semitone that is exactly one half of a whole tone. Galilei discusses the pros and cons of this tuning system later in the *Discorso*. The printed text refers only to the *Incitato* throughout the *Discorso*. The genus "Diatonic" is appended to each appearance throughout the translation.

[128] The printed text reads *Tolom eo*.

[129] The printed text of the *Discorso* contains no formal breaks, and although Galilei appears to mark the end of chapter 1 in the prose, chapter 2 does not begin (according to Galilei) until p. 301.

> *And even if it seems (as at times should happen) that the major tone is sung in one place in place of the minor or the latter in place of the former, so that the encounters in the parts of the cantilena might not be heard to discord . . .*[130]

Sense that he turns anew to repeat that the cantilena would always be out of tune when it is sung according to the order of the strings designed for us in the Syntonic by Ptolemy. Later on follows:

> *and such an order might not be found in the Greatest System and that the pure natural Syntonic Diatonic might not be sung according to the order described for us by art . . .*[131]

That is, by Ptolemy. See if this man can speak more clearly to prove to us, as usual for him, the contrary of what he seeks to persuade us. Then he adds:

> *this would be of little importance*.[132]

Now see simplicity: he wishes that doing things in the reverse order of what they have to do is the same as doing them in their order. But listen to the pretty reason that he adduces:

> *nor could one ever argue from the impossible . . .*[133]

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[130] Zarlino, *Sopplimenti* IV.36, 226: "Et se ben paresse; com'alle fiate suole auenire; che cantandosi in alcun luogo, secondo il Syntono arteficiale un'altro Interuallo, come sarebbe il Tuono maggiore in luogo del minore; ò questo in luogo di quello, accioche gli Incontri nelle parti delle Cantilene non si udissero discordare." Galilei leaves out the phrase "secondo il Syntono arteficiale un'altro Intervallo."

[131] Ibid.: "non si trouasse tal ordine nel Systema massimo, & che non si cantasse la pura Naturale & Syntona diatonica, secondo l'ordine descritto dall'Arte."

[132] Ibid.: "questo sarebbe di poco rilieuo."

[133] Ibid.: "ne si potrebbe mai argomentare dall'impossibile."

As to the impossible, is it not possible, therefore, for the voices to sing whatever interval that two strings are able to play? Now, let us continue and you will see [-40-] in due course the pretty conclusion that I will draw from the "impossible:"

> *and make it so that there may not be sung according to need the intervals of one species and not of another*. . .[134]

Hear this other nice reason:

> *because the one and the other of these two elements* . . .[135]

that is, the major tone and the minor:

> *are proper to it* . . .[136]

Now, see the inconveniences that those incur who treat of the sciences and arts without having the principles sufficient for them and the damage and dishonor brought about by the excessive belief that someone else has that things may stand in the order that he would wish and not according to the order in which they do stand.

This man does not notice that his reasons conclude the same as to say: when a painter happens to portray from nature a person who has, as sometimes happens, one eye larger than the other, of which the pupil of one was black and that of the other inclining

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[134] Ibid.: "& fare che non si usasse, secondo[']l bisogno, gli Interualli di cotal Specie, & non d'altra"; Galilei replaces *usasse* with *cantasse*.

[135] Ibid.: "per esser l'uno & l'altro di questi due Elementi."

[136] Ibid.: "à lei proprii." The entire quotation reads: "And even if it it seems (as at times should happen) that when singing in any place (according to the artificial Syntonic) some other interval, as the major tone would be in place of the minor (or the latter in place of the former) so that the encounters in the parts of the cantilena might not be heard to discord, such an order might not be found in the Greatest System and that the pure and natural Syntonic diatonic might not be sung according to the order described by art, this would be of little importance. Nor could anyone ever argue from the impossible and make it so that there may not be used according to need the intervals of one species and not of another, because the one and the other of these two elements are proper to it [Et se ben paresse; com'alle fiate suole auenire; che cantandosi in alcun luogo, secondo il Syntono arteficiale un'altro Interuallo, come sarebbe il Tuono maggiore in luogo del minore; ò questo in luogo di quello, accioche gli Incontri nelle parti delle Cantilene non si udissero discordare. non si trouasse tal ordine nel Systema massimo, & che non si cantasse la pura Naturale & Syntona diatonica, secondo l'ordine descritto dall'Arte; questo sarebbe di poco rilieuo: ne si potrebbe mai argomentare dall'impossibile, & fare che non si usasse, secondo[']l bisogno, gli Interualli di cotal Specie, & non d'altra, per esser l'uno & l'altro di questi due Elementi à lei proprii]."

to blue; a person who has, furthermore, a scab on the left cheek and a mole over the right eyebrow, greater excellence will be attributed to him whenever the portrait of this person is without any of those defects. This is arguing that if indeed the person has one eye larger than the other, it will be more becoming to make them one and the same breadth; and although he has a scab on the left cheek, he does not have one on the right, and it will therefore be well to make the former like the latter, and for the same reason, to depict him without that mole we said he has over the right eyebrow and make [-41-] the pupils of one and the same color. Responding to which, I say that this portrait, because it lacks those accidents that were natural to him (which make him different from the others to a greater degree) will be remembered by everyone other than the one for whom it was made; moreover, that the painter will become reputed as ignorant or at least as a flatterer.

Even if Zarlino's reason might serve, it was less distant from the truth for having followed the opinion that was held earlier by Lodovico Fogliano (i.e., that the ancient Diatonic was sung and not the Syntonic of Ptolemy, as he had written many years before Zarlino) because the ancient Diatonic has a single difficulty with respect to ours, which is for thirds and sixths to sound dissonant because the latter are slightly sharp and the former too sharp by as much as the major tone exceeds the minor. Zarlino says this, following the opinion of Fogliano (because it has been poorly designed by them) *ad infinitum*, as has been demonstrated, but in the twenty-fifth chapter of the fourth book of his *Sopplimenti*, he perhaps recalled what the example that, before he was born, had thought to say, and it is this:

And if indeed the wolf resembles the dog, it is still not a dog, for that individual[137] *is truly the same as retains in itself those things that are found in the other.*[138]

And earlier in chapter 5 of the first book, he said:

For the similar is always made in imitation.[139]

So, the slight difference (turning to what I just said) that is between the Diatonic and that [-42-] which is sung today more easily hid the mask that Zarlino places on the Syntonic because the difference between this[140] and what is sung is fairly major. The difference is not so much concealed by this mask as by those who at least know how it is done without being recognized.

From his same course of words, you might draw this other conclusion: that if men do not know how to sing with the instruments given them by nature what the instruments made by art know how to play, art is more able than nature in this business. But neither is this true. Considering that the natural voice and the artificial sound are one and another material comprised under continuous quantity, nature and art are equally able;[141] for

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[137] I.e., the wolf.

[138] Galilei is paraphrasing again. Zarlino, *Sopplimenti* IV.25, 193: "Onde, si come non si può dire, che'l Lupo sia Cane, ne la Simia sia Huomo; se ben s'accosta & quasi tiene l'uno l'effigie del Cane, & l'altra l'effigie dell Huomo; percioche quello Indiuiduo è ueramente quello istesso, che ritiene in se quelle cose, che si ritrouano in altro." Zarlino makes the point that even if the intervals of an artificial tuning system are similar to the natural Syntonic, they are still different because one must consider other qualities when comparing objects, including (Aristotle's qualities) form, figure, lineage, place, time, country, and name. The problem of resemblance is derived from Plato's *Sophist* 231a (wolf/dog), but Zarlino's addition of the resemblance between an ape and man may derive from Politian *Epp.* 8.16 or possibly Erasmus's *Ciceronianus.*

[139] Zarlino, *Sopplimenti* I.5, 22: "Because in the imitation, one will make nothing other than the likeness [perche nella Imitatione altro non si fà, che il Simile]." Galilei's alterations do not help him make his point; Zarlino's original is clearer.

[140] I.e., the Syntonic. Galilei is saying that Zarlino's "mask" would fool more people if he was claiming that the Ditonic Diatonico was the proper species. But because he insists that the Syntonic is the correct tuning, the mask does not hide his errors.

[141] In the "Compendio della Tehorica," Galilei defines continuous quantity as "that which can be divided infinitely." Therefore, just as a string may be divided into infinite parts (i.e. 1/2, 1/4, 1/8, etc.), both voices and instruments should be able to sing or play any musical interval that can be expressed as a ratio. See Galilei, "Compendio della Tehorica della Musica," **I**-Fn, Gal. 4, 8: "Quantita contunoua è quella che si puo diuidere in infinito."

whatever the interval, it can be divided, increased, and diminished *ad infinitum* as much by the string as by the voice, although sense lacks capacity for some of the least differences or extreme distance in depth or extreme closeness in the height. On this first chapter, I have made a speech of so many words that a hundredth part (for those who understand this field)—even none—was enough because my *Dialogo* was sufficient, nor did it have some need for excuses, additions, or defenses. But the desire I have to be understood by those simpletons of Mr. Gioseffo's clique has led me to do this. I want especially [-43-] to draw to their attention that even if it were true that the Syntonic of Ptolemy is sung today (I speak of that which was designed for us by Zarlino),[142] they do not therefore have to render thanks to him for having discovered this truth for us, which is unjustly attributed in his *Istitutioni*, but rather, as I have noted above, to Lodovico Fogliano, as he demonstrates in the second section of his *Musica theorica*, printed before Zarlino was born.[143] I drew the matter to their attention in my *Dialogo*, and Zarlino, feigning not to have seen it, repeats in the final chapter of his *Sopplimenti* that he was the inventor of it,[144] adding there this ingenious parenthesis:

(*I know my diligent disciple will not deny me the matter*)[145]

He knew very well that his disciple (as it pleases him so to call me) had said in his *Dialogo* that Lodovico Fogliano was the inventor of it.[146] But Zarlino, as an ambitious

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[142] The close parenthesis is lacking in the printed text.

[143] Galilei is incorrect. Fogliano's *Musica theorica* was printed in 1529, eight years after Zarlino's birth. Fogliano offers a full demonstration of a monochord divided with the intervals of Ptolemy's Syntonic tetrachord in the *Musica theorica* III.1 (Venice: G. A. e fratelli di Sabio, 1529; reprint in Monuments of Music and Music Literature in Facsimile, II/43, New York: Broude Brothers, 1969), ff. 32v-35r.

[144] I.e., the Syntonic tuning system.

[145] Zarlino, *Sopplimenti* VIII.14, 329: "(ilche anco non potrà mai negare il mio diligente Discepolo)." Galilei changes the quotation from "cannot" to "will not." Just after this phrase, Zarlino claims that before he wrote on music, everyone believed that one used the numbers and proportions written by Boethius as the forms of the consonances.

[146] Galilei, *Dialogo*, 112; *Dialogue*, 277.

person, had no memory of it in his first two volumes, and he proceeded to attribute it to himself, just as was attributed the invention of the twelve modes taken from Glarean, about which he equally said not a word, and so on for a thousand other things self-attributed—not found—that he would never at the time have understood after having seen them. When he finally noticed that he was caught, he excuses himself in his *Sopplimenti* by saying that Fogliano had not done (after that long chatter) what [-44-] Zarlino does without ever touching a key that he tuned, and of Glarean, he says that he once saw him in a dream.[147] Of the square later usurped from Ptolemy,[148] he excuses himself by saying that it does not give us the imperfect consonances, as if he wishes that Ptolemy had treated a thing that was not in use at his time, and even if it was, it was beside his point to treat it. In chapter 40 of the second part of his *Istitutioni*, on the contrary, he attributes to Ptolemy the invention of the Syntonic, which was found by Didymus, before Ptolemy was born.[149]

Among the excuses of Zarlino, the one he makes in the first chapter of his *Sopplimenti* pleases me more than all the others—truly a most crafty excuse—and it is this: this man says that his having said these things, which were written by others many years before, did not occur from his having seen and read them in those books of theirs,

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[147] Galilei is possibly being cryptic. Zarlino never claims that he learned about Glarean's 12-mode system in a dream. In the *Sopplimenti* I.1, he does say that in discussing the modes he only wanted to follow the usage of modern composers, especially Adrian Willaert. Galilei is just noting Zarlino's continued reluctance to cite Glarean as the inventor of the 12-mode system.

[148] Here, Galilei is referring to the *Quadrato geometrico* (geometric square) demonstrated by Zarlino in the *Sopplimenti* (as well as in the *Istitutioni* and *Dimostrationi*). See Zarlino, *Sopplimenti musicali* III.3, 88. Ptolemy discusses this tool in *Harmonics* 2.2, but he refers to it as the helicon. See Ptolemy, *Harmonics*, translation and commentary by Jon Solomon, Mnemosyne Supplementa, vol. 203 (Leiden: Brill, 2000), 66-69.

[149] Didymus's Syntonic tetrachord does not contain the same order of intervals as Ptolemy's Syntonic, although Galilei claims they are similar because they would cause the same types of dissonances if used in polyphonic music. For a discussion of the differences between the tetrachords, see pp. 126-28 *supra.*

but from the force of truth that has compelled him to say so.[150] He would like to pull the same trick on me for what he has learned from my *Dialogo* and then written in his *Sopplimenti*. Things that apply on the one hand, Mister Gioseffo, are different from those that apply on the other hand, as those versed in the sciences know.

I come to the second chapter that pertains to the temperament and *participatione* of the keyboard instrument, which Zarlino says in chapter 9 and 25 of the fourth Book of the *Sopplimenti* that I attribute to myself as my invention, and he repeats this an infinite [-45-] number of times. Responding to this, I say that in my *Dialogo* one will never find words that communicate what, against every obligation, Zarlino writes so:

A distribution found anew by us.[151]

It is indeed true that in noting the invention of one of my instruments (because Zarlino has never seen or understood it, he cannot give judgment of it), I say the words that he applies to the ordinary and common instrument. It is not true, therefore, that I attribute to myself the invention of temperament or *participatione* of the ordinary keyboard instrument.

This man has a habit of never reciting the words he alleges to me in the order that they stand and of adducing the quantity that is pleasing to him, giving them in addition the sense that better suits him. In particular, when I say that in the Ditonic Diatonic

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[150] Indeed, Zarlino defends his writings in the *Sopplimenti* I.1, 9, by citing the famous proverb "Amicus Socrates et amicus Plato, magis est amica Veritas" or "Socrates is a friend and Plato is a friend, but truth is more of a friend."

[151] Zarlino, *Sopplimenti* IV.9, 150: "Ilche cosi accommodato, l'accordano & riducono dopoi: forse non s'accorgendo & fuori d'ogni loro opinione; secondo'l Temperamento ò Distributione fatta nel Capitolo 42. & 43. della Seconda parte delle Istitutioni; & dicono, tale Temperamento ò Distributione esser fatta secondo un Nouo modo ritrouato da loro." Zarlino contends that the temperament Galilei uses is borrowed from the *Istitutioni* (II.42-43). Galilei's use of "noi" (us) is in reference to himself. I.e., Zarlino originally wrote "loro" (them) and Galilei changed the pronoun.

species the intervals today called imperfect consonances come to be dissonant, not because of the perfection of the fifth (as endless numbers of people dare to say) but because of the breadth of the tones and the smallness of the semitones, Zarlino immediately adds that this occurs from the perfection of the fifth and not from the breadth of the tones.[152] Now, that he again deceives himself in this as in all of his other matters, we can recognize from the natural order of numbers, in which 3 is before 5. And even if the matter should stand otherwise, what is it that impedes me, after having drawn a perfect fifth on the instrument, so that [-46-] I may not divide it with an intermediate fret into two consonant thirds? The non-consonance of the thirds and sixths in the Ditonic Diatonic distribution, therefore, comes from the breadth of the tones and not from the perfection of the fifths. And even if this should occur from the perfection of the fifths, it would not follow that we could not hear between the voices or between the strings a perfect fifth divided into two consonant thirds. It is express madness to say this.

Later on, he adds that my reason is not good when I say it is not an inconvenience that the greater semitone of this distribution somewhat exceeds the 16:15 since it was taken from a whole, greater than 10:9.[153] To which I respond that I do not believe that any other man than he places himself in opposition to such truth by wishing that the same

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[152] In presenting his 4/7 comma keyboard temperament, Galilei instructs the performer to begin with an octave tuned to Pythagorean intervals and then subtract 4/7th comma from each of the five tones and give 1 3/7 comma to each of the two semitones. Therefore, the octave does not change, but all of the internal intervals are modified to sound more consonant. His method, although perhaps not as practical as he insists, is different from Zarlino's 2/7 comma temperament because in the latter system, one begins by tempering the larger intervals within the octave. Galilei is offended that Zarlino will not accept his verison as something distinct from Zarlino's system presented in Part II of the *Istitutioni*. For a more detailed description of Galilei's 4/7 comma keyboard temperament, see pp. 78-82 *supra.*

[153] Galilei makes this claim after explaining his 4/7 comma keyboard temperament. See Galilei, *Dialogo* 33; *Dialogue*, 86. Zarlino reprints most of Galilei's explanation in the *Sopplimenti* and refers to Galilei's claim about the size of the tempered semitone as one example that shows Galilei did not understand his own method of temperament. Considering that in the 4/7 comma temperament, 10/7 comma is added to each semitone in the scale, the point of Zarlino's argument is unclear. See Zarlino, *Sopplimenti* IV.24, 190.

semitones that fill out the 10:9 without augmenting it by anything should fill out equally the 9:8—and for all that, he professes to be a mathematician.

I do not want to pass over in silence (to the greater confusion of the members of his clique) this other consideration that occurs to me, and it is this: if in the Syntonic of Ptolemy are found the major tone and the minor tone—and it be true that the two semitones of which Zarlino makes mention in many places in his writings should fill out the minor tone without augmenting it by anything, as I have said—,[154] it will be clear that two of major breadth already named will be drawn from the major tone.[155] [-47-] But he would wish that the major tone should become minor and the minor major, according to the way that better accommodates him, without rendering any reason for it[156] and, in addition, so that we might not think one whit about the inconveniences that this inequality of tones, poorly designed by him, would cause if ever it were true that the said Syntonic, so poorly ordered, might be sung—which, in the manner that he demonstrates it to us, is impossible.

But tell me, in faith, what moved him to make mention in his first two volumes only of the two semitones that fill out the minor tone and not those that fill out the major?[157] May it come about that in the diapason there are three of the latter and two of the former;[158] in addition, that for the one time the minor tone happens to be divided in its two semitones, this occurs ten times for the major? If it was out of malice, the boldness

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[154] Zarlino describes a major semitone (16:15) and a minor semitone (25:24). Added together, these ratios equal the sesquinono (10:9) or minor tone. I.e., (16x25):(15x24) = 400:360 = 10:9.

[155] I.e., it should be obvious in Zarlino's writings which semitone would remain if the 16:15 semitone is drawn from the 9:8 tone.

[156] Galilei is referring to Zarlino's assertion that the voices will run to consonances before dissonances would be heard in performance.

[157] Galilei is incorrect. Zarlino does mention the 135:128 semitone in the *Istitutioni* (II.43) when discussing his method for *participatione.*

[158] A hypothetical C-c octave, tuned by the Syntonic tetrachord, would contain three major tones: C-D, F-G, and a-b; and two minor tones: D-E, and G-a.

taken from his *senario* number and his harmonic numbers caused it and, later on, the respect for as much as he said about his finding the consonant intervals in the multiple and superparticular genera and not in the others. In these places, not only the minor semitone of the major tone comes to be excluded; but also, what is more important, whenever the 6:5 form of the minor third is not augmented to make it become major, 81:64 would result, the form of the dissonant ditone, which is equally found outside of each of the said three places.[159] The same would occur for the semiditone, [-48-] which was always considered subtraction of a minor semitone of the major tone from the major third because at that time the semiditone of the said ancient Ditonic would remain within the numbers so constructed as 32:27.[160] But to this, he would respond with his customary retreat, that is, that the voice runs to the consonance, without having first demonstrated if this is or can really be.

If it comes about out of ignorance, it was crass ignorance of truth, since he still does not know among which numbers the minor semitone of the major tone is contained. This interval is more necessary to the Syntonic than any other, as I will demonstrate in its place. And what was born of this is bound to chapter 11 of the fourth book of his *Sopplimenti*, where he makes mention of five semitones of diverse breadth, causing them to be born in his fashion, without saying or knowing whence or how or why from these rather than other proportions or why this rather than another quantity.[161] Passing over

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[159] I.e., 6:5+135:128 = (6x135):(5x128) = 810:640 = 81:64. Using the C-c octave, major thirds may be found between C-E, F-a, and G-b.

[160] I.e., 5:4–135:128 = (5x128):(4x135) = 640:540 = 32:27.

[161] In the *Sopplimenti* IV.11, Zarlino demonstrates how one could temper the intervals of the keyboard instrument tuned to the artificial order of the Syntonic in order to create the consonances needed to play with voices that are also singing in Syntonic tuning. Because many notes would have to be added in the process, the complete list of intervals contains 27:25 and 256:243 semitones in addition to the three already enumerated by Galilei. Zarlino claimed to have designed a keyboard that included all of these intervals. A diagram of the instrument appears on p. 156 of the *Sopplimenti*. Galilei, in this instance, is

these matters without saying a word makes me believe as much as I have said: he could have spawned ten as well as five—and within those numbers that better suit him. In revealing the error in the manner that I am about to reveal it, I will come to note which, how many, whence, how, and why there are so many and such semitones in the Syntonic, therefore committing to memory that each fourth in the Syntonic of Ptolemy, except for the deficient (through having being poorly designed by Zarlino),[162] contains [-49-] a major tone, a minor tone, and a major semitone. The major semitone taken from the minor tone does not augment what is called the minor semitone (within these numbers 25:24), but taken from the major tone, there remains the minor semitone of this major tone (not earlier recognized by others as an element of modern counterpoint)[163] within these other numbers 135:128.[164] With these few words, I have demonstrated that there are three semitones (if, however, the description that Zarlino makes of the Syntonic is just) and not five, what breadths they are, whence, and how taken.

And if anyone demands of me the reason why I have taken the sesquiquindecima [16:15] and not the sesquiventiquatressima [25:24] semitone from the major tone, I will demonstrate for him with this other example that it is so of necessity, and nature so requires of the thing she makes. And this is true: we have already noted from the words of Ptolemy the terms of the major semitone, which is of the same breadth in whatever

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exaggerating his position by not accepting Zarlino's view that there is a difference between the natural and artificial orders of the Syntonic. Zarlino, for his part, would have never agreed that the natural order of the Syntonic would incorporate the 27:25 and 256:243 semitones. See Zarlino, *Sopplimenti* IV.11, 154-57.

[162] The "deficient" fourth between A and D contains two 9:8 tones and a 16:15 semitone. It is defined by the ratio 27:20.

[163] Galilei's point is unclear. Other theorists, including Zarlino, Fogliano, and Francisco de Salinas explicitly mention the 135:128 semitone.

[164] The passage describes a simple mathematical process. If we subtract a major semitone from the minor tone, we are left with a minor semitone. I.e., 10:9-16:15 = (10x15):(9x16) = 150:144 = 25:24. But if we subtract the major semitone from a major tone, we are left with a slightly larger minor semitone. I.e., 9:8-16:15 = (9x15):(8x16) = 135:128. The 135:128 semitone is larger than the 25:24 semitone by one Syntonic comma 81:80.

tone. With this interval, I depart from *c* and come thence to *b mi*; and after descending to *b fa* and because a sesquitertia has to remain between *b fa* and *F*, the excess by which the tritone surpasses it will be contained by the minor semitone of the major tone that is between *b fa* and *b mi*,[165] which by a comma [81:80] surpasses the sesquiventiquatressima [25:24], that is, the form of the minor semitone of the minor tone.[166] There are, therefore, three semitones and not five by which the Syntonic would be served [-50-] when one wished to sing or play[167] it correctly, according to the design it has. Of these, the greater, which is contained by the sesquiquindecima [16:15], is common to the one and other tone; the minor semitone of the minor tone—or we might wish to call it the least—is 25:24, and the middle—or we might wish to call it the minor of the major tone—is 135:128. Although the minor semitone of the sesquioctave [9:8] is augmented by a comma and the major remains as it is, nonetheless, it[168] remains inferior to this[169] by a little less than the augmentation gained.[170]

For brevity, I leave aside consideration of many other matters of moment that could be considered in this place and come to the impertinent demand that Zarlino makes of me when he asks me what is the proportion of the fifth in the Ditonic Diatonic after

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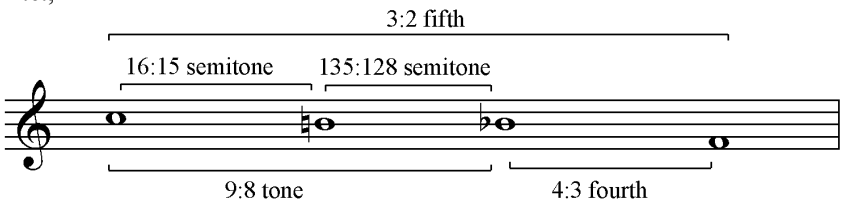
[165] This is proven by subtracting the perfect fourth from the tritone. I.e., 45:32-4:3 = (45x3):(32x4) = 135:128. The printed text reads *ch'tra b fa, & b mi*. It is emended to read *ch'è tra b fa, & b mi*.

[166] I.e.,



[167] The printed text reads *onare*.

[168] I.e., 135:128.

[169] I.e., 16:15.

[170] The comma can be measured as 21.5 cents. The difference between the 16:15 and the 135:128 is about 19.5 cents. 16:15-135:128 = (16x128):(15x135) = 2048:2025, or 19.5 cents. The expansion of the abbreviated *preso* in the original print is corroborated in the 1734 manuscript copy of the *Discorso*, allegedly in the hand of Natale Zarlino. See Vincenzo Galilei, "Discorso intorno all'opere di messer Gioseffo Zarlino da Chioggia," Chicago, Newberry Library, Vault case MS 5127.

two-seventh parts of a comma are taken from it and given to the fourth. But it would not now be impertinent with the same conditions to demand it of him in the case of the Syntonic of Ptolemy because they[171] are of many sorts thanks to his inadequate design. Before I proceed further, I want to say for my excuse that there is no one who should believe that I make blunders[172] by going—often jumping—from pillar to post (as is said in the proverb);[173] for I am forced to respond in that order and to those things that are demanded of me.

Mister Gioseffo, with his customary importunity, turns anew to repeat that I attribute to myself the invention of the aforesaid temperament. I say that I never [-51-] said or wrote such a thing. But I demand of Zarlino, who says in a thousand places it is his invention: before he found it,[174] how did one tune such an instrument that came into use so many hundreds of years before his great-great-grandfather was born? But perhaps he wished to say that he had been the first (nor is even this true) who considered how this *participatione* should stand[175] and by what quantity the intervals in it came to be increased or decreased from their true form, in the same manner that one reads of Pythagoras having been the first who considered within which numbers and proportions the consonances were found.

See now this other matter, about which I do not know what to say. He turns to reprehend me by saying that in showing such a temperament, I could have taken any other diapason than the one I took and commenced from the top or the bottom or

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[171] I.e., the fifths.
[172] The printed text reads *facci a gli sproposito*.
[173] An idiom meaning "jumping from one topic to another."
[174] I.e., temperament.
[175] Zarlino is credited with being the first music theorist to discuss *participatione* in numerical terms. Perhaps Galilei is referring to Pietro Aron or Giovanni Maria Lanfranco. Both discussed temperament but did not give precise measurements for the degree to which each interval is altered. See Mark Lindley, "Early 16th-Century Keyboard Temperaments," *Musica disciplina* 28 (1974): 129-51.

elsewhere, as if I had said that it was necessary to take the diapason that I took and that otherwise such a thing could not have been done in the order and fashion that I held.[176] I never said such a thing, but at present I do indeed say that the diapason that I took and the order that I held were not one whit haphazard[177] and were perhaps the best that could have been elected. My goal at the time was not one whit, as Zarlino says, wanting to instruct how to tune the instrument or to speak of *participatione* or anything else, as truly (by the testimony of my *Dialogo*) I do not speak,[178] but only to show to some gentlemen [-52-] with whom I found myself at the time the difference between one and the other system, without the use of the *Mesolabio* or of the harmonic rule.[179]

Although I had incidentally said in my *Dialogo* those few words about *participatione* of the keyboard instrument, I nonetheless have demonstrated with them that the fifths really are flat and the fourths sharp on it.[180] I have rendered the reason for the necessity that makes them such; I have shown by what quantity they are outside of their forms and that on the contrary the fifths may not be sharp and[181] the fourths flat. On these matters, like most of the other matters worthy to be known at that time, Zarlino moves nary a word, as perhaps neither understood nor considered by him.

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[176] Zarlino, *Sopplimenti* IV.26, 196. Zarlino claims that it does not matter which diapason is used as long as one commences from a stable note, i.e., the extreme note of a perfect fourth or fifth.

[177] The printed text reads *l'ordine ch'io tenn,inon fu punto a caso*.

[178] Galilei does not use the term *participatione* in the *Dialogo*, although he was probably aware that keyboardists tune their instruments using a series of perfect fifths and perfect fourths and not by tuning consecutive notes of a scale.

[179] Galilei makes reference to his community of readers, the noble music enthusiasts who are much more interested in practicing music on keyboard instruments than learning about theories on the monochord or other scientific tool.

[180] I.e., the keyboard instrument.

[181] The printed text reads *è*.

The instrument, therefore, that I said I found with perfect fifths and fourths has nothing in the world to do with the *participatione* of Zarlino or with any other.[182] With respect to this, I used the words that Zarlino malignantly cites as a blunder. But he is of such complexion that he despises things found by others, not touching them as if vulgar or not understanding them or not wishing to understand them or believing them only after having seen and understood them, when he sees them revealed in a manner that he may no longer usurp them for himself. But he exalts his things (or others' things made his) with such an apparatus of impertinent words that when others, after much patience, succeed at last in reading them, [-53-] most of the time he does not do what he may have wished us to infer, not through a defect of memory, as he says, but through his insipidity. And yet he says in a hundred places in his works that he, following the usage of the Greeks, has been stringent in his writing. I have observed this to be true in difficult places, and with such an excuse he passes over them with silence. But let us not lose time on this.

In chapter 25 of the same fourth book, he seeks with simple words as usual to discover new errors that occurred in my same distribution (as he wishes to call it) and concludes that in this, the tones come to be unequal.[183] This is truly so, for whenever equal parts are added to or taken from equal things, unequal parts remain among them.[184] He says, later on, that I am arrogant when I say that the superparticular interval cannot be divided in equal parts with numbers but only according to the fashion of Aristoxenus.[185]

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[182] Galilei first mentions this instrument on p. 32 of the *Discorso*.

[183] Zarlino lists seven errors in Galilei's description of a scale with equal tones and semitones. The fourth error accuses Galilei of not demonstrating how he is avoiding unequal tones. See Zarlino, *Sopplimenti* IV.25, 193.

[184] This statement is false. Whenever equal parts are added to or taken from equal things, equal parts will remain. Perhaps Galilei is being ironic.

[185] Zarlino, *Sopplimenti* IV.25, 192.

At the time, I understood the "fashion of Aristoxenus" to be "by means of lines," assigning to the parts the portion that we wish to give them with geometric means. To which, Zarlino adds that this can be done according to arithmetic. And when he comes to do it, he divides it equally without assigning with numbers the portion of these parts, in the manner that has been stated for the string or line. To wish to do this thing with numbers requires the same labor as to demonstrate that each number is at the same time equal and unequal. [-54-] But why am I wasting words on impossibilities, if in chapter 11 of his same Book, where numbers could and should necessarily be put to demonstrate with them that such a distribution is the Syntonic of Ptolemy, as he says (without which he could name them in his fashion), he did not put them there and so has not given an account of himself in that place.[186]

We come now to the distribution of the lute. Before Zarlino saw my *Dialogo*, he believed that it was the same as that of the keyboard instrument, as one reads in chapters 42 and 45 of the second book of his *Istitutioni*.[187] But then, perceiving himself to be in error and knowing by means of this that the most noble instrument the lute correctly sounds the Intense Diatonic of Aristoxenus together with his Chromatic, he was sorry he had confounded his[188] distribution in chapter 16 of the second part of his *Istitutioni*, without knowing why, as he did not understand it. Now, in his *Sopplimenti*, he says in many places that Aristoxenus was a most excellent musician.[189] Therefore, from what he

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[186] In the *Sopplimenti* IV.11 Zarlino shows how one may imitate the natural Syntonic system in artificial instruments by adding more notes to the scale.

[187] In a discussion of temperament in the *Istitutioni* (II.45, 136), Zarlino groups the lute with other keyboard instruments without noting any differences between the two families of instruments.

[188] I.e., Aristoxenus's

[189] In the *Istitutioni* , Zarlino cites Aristoxenus with regard to ancient modal systems and other historical information. He also discusses Ptolemy's crititicisms of Aristoxenus that were repeated by Boethius, Gaffurius, and many other authors. In particular, Zarlino claims (*Istitutioni* II.16, 82) that the genera attributed to Aristoxenus are not as important as those atributed to Ptolemy. Having studied

seeks to impute to me in this business, he could have disentangled himself with two words, but to show he understands the matter in reverse order, he further casts away the tedium of writing ten folios of paper and, especially, the labor of engraving so many of his lutes, little and big. I am sure that had he seen the writings of Albrecht [-55-] Dürer, he would not in any fashion have allowed to escape from hand the occasion of instructing us in the fashion of setting the lute in perspective because it fit perfectly.[190]

Now, all the racket that he makes is for the interpretation of these two words that, read in the sense as they stand written by me, are more clear than the sun, and they are this: "So, 18 is the more proper divisor than another greater or lesser number."[191] I add,

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Aristoxenus's works with the aid of Gogava's translation (Antonio Gogava, *Aristoxeni mvsici antiqviss. Harmonicorvm elementorvm libri III. Cl Ptolemaei Harmonicorum, seu de musica lib. III. Aristotelis de obiecto auditus fragmentum ex Porphyrij commentarijs* [Venice: Vincenzo Valgrisi, 1562],7-45), Zarlino appears to have a new appreciation of the much-maligned author. Galilei certainly takes note of his rival's change of heart.

[190] Galilei is referring to the diagrams of lutes that Zarlino inserted in the *Sopplimenti* IV.30-32, 209-15. The artist Albrecht Dürer (1471-1528) devised a method for creating two-dimensional drawings from three-dimensional objects in his *Underweysung der Messung* (Nuremburg: n. p., 1525), a text that teaches perspective and optics while drawing on Ptolemy and other ancient writers. In one particular example, Dürer shows how a lute might be translated into a drawing (see below). The image is reproduced in Francis Russell and the Editors of TIME-LIFE Books, eds., *The World of Dürer: 1471-1528* (New York: Time Incorporated, 1967), 160. A discussion of the image with regard to the organological aspects of Galilei's treatises may be found in Elena Ferrari Barassi, "Gli strumenti musicali nell'opera teorica di Vincenzo Galilei," in *Varietà d'harmonia et d'affetto: Studi in onore di Giovanni Marzi per il suo LXX compleanno*, ed. Antonio Delfino, Studi e Testi Musicali, no. 5 (Lucca: Libreria musicale italiana, 1995), 120-21.

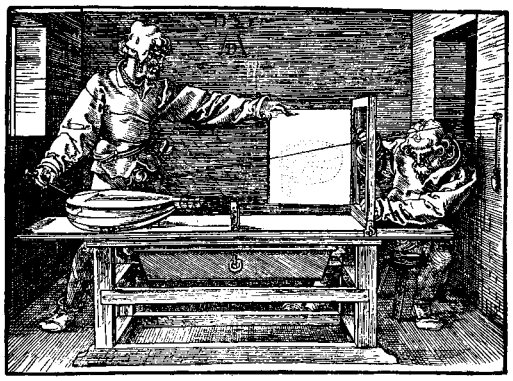

Figure 30. Albrecht Dürer's method for drawing images of lutes.

[191] Galilei, *Dialogo*, 49. To tune lutes with equal tones, following Aristoxenus's Intense Diatonic and Tonic Chromatic tetrachords, Bardi assumes a line divided into eighteen parts. Bardi places the first fret at the end of the first segment. The remainder of the line is then divided into eighteen parts and the

later on, that this does not give us the exact number of the matter, just as the opening of the compass, too, after having described a circle, does not measure the circumference of it in six times but rather that of the hexagon described for us within. Therefore, Zarlino, grasping the matter in reverse order, wishes to demonstrate, beside every point, that twelve sesquidiciasettesimi [18:17s] added together do not fill out the dupla [2:1].[192] Now see the pure malignity that is his. Who is it that has the capacity for my conception who has need of the things noted being demonstrated to him or who seek impossibilities, which on this point amounts to the same thing? Will he again not know that the dupla does not have the capacity of being divided in whatever equal parts? This matter, as manifest, does not have need of demonstration. But his normal procedure is always to want to demonstrate obvious things and to want the difficulties conceded to him, as I have demonstrated and will show a bit below with other than simple words, as he does. [-56-] I have said that to demonstrate at the time what I did out of necessity, 18 was more appropriate than whatever other number. Zarlino, wishing to prove that the matter stood otherwise, had to produce a number more appropriate than 18 and not a measure of a line. And so I came to be convinced in judgment. To him saying, then, that it does not give us the exact number of the affair, I say equally this: and neither did the example of the

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second fret is placed at the end of the first segment. The process is repeated until all of the frets have been measured.

[192] Zarlino, *Sopplimenti* IV.28-29, 201-7. Zarlino writes that Galilei's division of the octave in twelve semitones is as similar to Aristoxenus's Intense Diatonic as the ape is to the rooster (*come la Simia al Gallo*), yet he further claims that the errors in Galilei's demonstration are comparable to those that Ptolemy found in the Aristoxenians' derivation of equal tones (*Harmonics* I.9). As one of his principal arguments against Aristoxenian interval theory, Ptolemy observes that in describing intervals geometrically, the Aristoxenians do not actually define the ratios of the intervals. Because Galilei expresses each semitone on the lute as 1/18 of the remaining segment of a line (see previous footnote), he too does not quantify each interval as a ratio. To show that Galilei is mistaken, Zarlino computes the size of an interval that would be created by twelve 18:17 semitones. The ratio of such an interval is 1156831381426176:582622237229761 which is slightly smaller than *dupla* ratio. The actual ratio printed in the *Sopplimenti* IV.29, 205 (1156831381425976:582822237229761) contains a few errors, but it is still smaller than 2:1.

compass and the circle. A little above, on the contrary, he reprehended me in denying that I am able with numbers to divide the first multiple[193] and whatever superparticulars into equal parts. Now see what patience it is necessary to have with this man.

According to the promised order, I shall respond with those few principles of mathematics that I learned as a boy to as much as Zarlino reprehends. First, I say that in my *Dialogo*, all the calculations and computations that are there are most just and displayed with sufficient ease. Indeed, it is true that most of them are easy because the place did not seek greater difficulty (which I have avoided with every bit of my knowledge) and I have not wished to preach to myself what could be said with simple words, to adopt difficult instruments, or to make difficult demonstrations, first, because these demonstrations are not understood by everyone, those instruments are not found in all places, and not everyone knows how to adopt them. And coming to the case of Zarlino, I say that in his book that he titled *Dimostrationi harmoniche*, I do not know how to see [-57-] what it is that he wishes to say, nor even what the little stories—it is full of these—have to do with true demonstrations.[194] And coming to the particular (as he is pleased that I do so, against my will), he writes in the eighth chapter of his *Sopplimenti* this pretty sentence in his favor, saying that one cannot be a man of fame, reputation, or worth without being versed in mathematics.[195] Therefore, if by knowing mathematics,

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[193] I.e., 2:1.

[194] Galilei mocks the entertaining dialogue that frames the many demonstrations in Zarlino's treatise.

[195] In this chapter (I.8, 26-27), Zarlino is writing about mathematics with respect to Plato's theory of reminiscence and memory. Zarlino writes only that one cannot be a man of valor without mathematics: "che giamai non fu tenuto alcuno per Huomo di ualore, che non possedesse la Mathematiche perfettamente."

one has to make a judgment on the worth of men, I will demonstrate how much he knows of it.

Commencing from this, I say that in the first discussion, he places the fourth postulate as best known, (which has given the greatest men—such as Eudoxus, Pappus and Theon—occasion to labor over demonstrating it because of its obscurity), leaving aside that he placed it as a postulate while it has been placed as a definition by Euclid.[196] But he does this in all of the following that he calls *dignità*, which are Euclid's propositions and because of their difficulty, worthy to being demonstrated, such as the first, the fourth, the sixth, the seventh, and others. Now this is the procedure of commentators on easy places: these commentators pass the difficult matters in silence because they do not understand them, excusing themselves, then, as I have said, by being brief and[197] concise. Then, on those matters that are obvious, they make the longest discourses. I let [-58-] stand the poor order that he observes in them, when he places some physics, such as the second, among the others that are mathematics, indifferently

[196] The fourth postulate (*Dimostrationi* I.*dim*.4, 29) reads: "The proportion of the extremes is said to be composed of the mean proportionals, as by its parts [La Proportione de gli estremi si dice esser composta de i mezi Proportionali; come da sue parti]." Galilei is referring to Euclid's *Elements* 6.def.5, translated by Thomas Heath as: "A ratio is said to be compounded of ratios when the sizes of the ratios multiplied together make some (? ratio, or size)." Heath has difficulty translating the definition and claims that it has been interpolated into Euclid's text. He notes that it is not found at all in Johannes Campanus's Latin translation, an interesting fact considering that Zarlino refers to Campanus's translation in the *Sopplimenti* IV.27, 197, and possibly never saw the idea expressed as a Euclidian definition. Galilei does not clarify his references to Eudoxus, Pappus, and Theon, but Heath writes that the definition may be found in Eudoxus's commentary on Archimedes and Theon's commentary on Ptolemy's *Syntaxis*. Heath does not mention Pappus at all, and it is unclear which treatise Galilei has in mind. Heath's commentary may be found in *Euclid's* Elements, trans. with introduction and commentary by Sir Thomas L. Heath, 2d ed., 3 vols. (Cambridge: Cambridge University Press, 1926; reprint, New York: Dover, 1956), 2:189-90. John Kelleher provides a useful commentary on Galilei's critique of the *Dimostrationi,* and much of the information in this footnote can be found in his dissertation. See John Kelleher, "Zarlino's *Dimostrationi Harmoniche* and Demonstrative Methodologies in the Sixteenth Century" (Ph.D. dissertation, Columbia University, 1993), 220-35.

[197] The printed text reads *è*.

placing, furthermore, those taken from the definitions of the first and seventh Books of Euclid.[198]

As to the demonstrations, then, in addition to not being, for the most part, one whit in the fashion that is suitable to them, many of them are false, as is the eighth,[199] in which he instructs us that when we wish to place whatever number as the difference of whatever proportion, the terms of the proportion should be multiplied (whether or not they are root) by the given number, not noticing that this is not true, except when the said proportion is between not only its least terms, but also terms different by 1.[200] And it is true: wishing that 3 fall within the proportion 6:4, I shall multiply the terms 6 and 4 by 3; they will give me 18 and 12, between which 6 falls and not 3.[201] And when the proportion was again in its root terms, as is 5:2, it suffers from the same difficulty because if we wish to reduce it to terms different by 4, we will have 20 and 8, between which falls a difference of 12 and not 4. His rule, therefore, as universally as he places it, is not true except in one of five genera, that is, in the superparticular—and here again, only when the given proportion is in its least terms.

He uses a ridiculous fashion of arguing in the 36th of the same first discussion when considering the proportions as if they were quantity and not [-59-] relations of

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[198] The second axiom (*Dimostrationi* I.dig.2*,* 30) reads: "The compound is resolved into those simple things of which it is composed [Il Composto si risolue in quelle cose semplici, delle quali si compone]." This idea is found in Aristotle's *Physics* 3 (204b32-33) and other works. It may be out of place in the first Discussion, although Zarlino's interlocutor Desiderio notes that it is "taken from Aristotle in the *Physics*, *Metaphysics*, and in Book 3 *On the Heavens* [Questo è tolto d'Aristotele nella Fisica, & nella Metafisica, & anco nel Libro 3. del Cielo]."

[199] I.e., the eighth proposition of the first discussion. Zarlino, *Dimostrationi* I.prop.8, 43-44.

[200] I.e., the proportion must be in the superparticular genus. Galilei's criticism is misleading because Zarlino is explicit about this restriction in his proposition.

[201] In other words, the proposition would be true if 6:4 was in its root terms, 3:2. 3x3 = 9; 3x2 = 6; 9-6 = 3.

quantity,[202] attributing to them those passions that are suitable to the quantity, such as the whole being greater than its parts. From this, he argues that the proportion of the first to the third—because it is composed of the proportion of the first to the second and of that of the second to the third—is larger than both because the former[203] is as a whole composed of the latter[204] as parts. The extent to which this is true may be judged by this example, 6:8:4, in which it is most true that the proportion 6:4 is composed[205] of the two 6:8 and 8:4 (according to him) as its parts. Nevertheless, whether the proportion 6:4 is larger than 8:4 I shall leave to be judged by those that understand the 8th of the 5th of Euclid, which—insofar as I comprehend from this as from what he writes in the following proposition—has not been understood by him.[206] In the following proposition, based on the falsehood of the preceding proposition, he writes these words:

> *Therefore, from the preceding, the larger proportion will be 8 with the composite number 12 417/512, which it will not have with the simple number 12*.[207]

This is so contrary to the fashion of demonstration, he has the bad fortune to never demonstrate anything and always leaves in his pen all that is good in mathematics, which is necessarily to demonstrate its conclusions.[208]

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[202] I.e., the thirty-sixth proposition of the first Discussion. See Zarlino, *Dimostrationi* I.prop.36, 76.

[203] I.e., 1:3.

[204] I.e., 1:2 and 2:3.

[205] The printed text reads *6.4 et è composta*.

[206] The eighth proposition reads: "Of unequal magnitudes, the greater has to the same a greater ratio than the less has; and the same has to the less a greater ratio than it has to the greater." See *Euclid's* Elements, 2:149

[207] Zarlino, *Dimostrationi* I.prop.37, 77: "Onde, per la Precedente, haurà maggior proportione 8, con 12 & 417/512 numero composto: che non haurà con 12 numero semplice." Galilei writes *sarà* where Zarlino had written *haurà* in the first part of the sentence.

[208] The purpose of Zarlino's proposition is to show that four 9:8 tones added together are larger than the 3:2 fifth. To this end, he presents a diagram with two sets of five proportions (see figure 31). The first set (a-e) is a series of 9:8 ratios presented in whole numbers, while the second set uses fractions and is placed in reverse order. In other words, 12 417/512:11 25/64 = 6561:5832; both may be reduced to 9:8. Because 12 417/512:8 is a larger ratio then 12/8, four sesquioctaves [9:8] are larger then one sesquialtera

That this is again true: in the Square (taken wholesale from Ptolemy) in proposition 14 of the second Discussion,[209] from which he draws the forms of the consonances, [-60-] in order to demonstrate the extent to which these words are necessary, he writes:

and gh *is divided into* go *and* oh; *and* go *is the third part of* ac.[210]

O pretty conclusion! Later on, it continues:

[3:2]. This elaborate proof shows some creativity, but Zarlino could have proved his point just by noting that 6561:4096 is a larger ratio than 3:2.

a	b	c	d	e
6561	5832	5184	4608	4096
h	k	l	m	n
8	9	10 $\frac{1}{8}$	11 $\frac{25}{64}$	12 $\frac{417}{512}$
52488			52488	52488
8				21 $\frac{417}{512}$
				1 $\frac{417}{512}$

Figure 31. Zarlino, *Dimostrationi* 1.prop.37, 77.

[209] Zarlino, *Dimostrationi* II.prop.14, 116. The "square" is a demonstration of the *Mesolabio*. Zarlino's proof and Galilei's corrections follow figure 32, placed below.

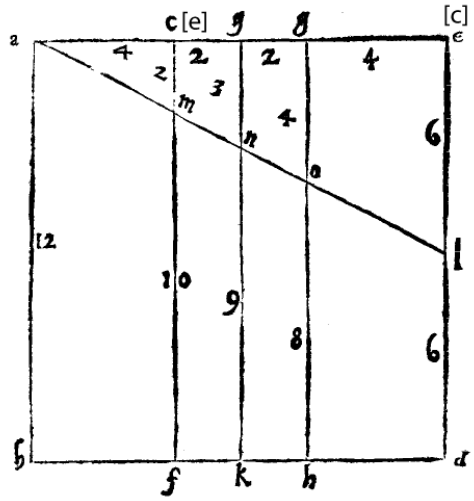

Figure 32. Zarlino, *Dimostrationi*, 116. Bracketed letters added for clearer correspondence with Galilei's proof.

[210] Ibid., 117: "Et la gh uenga diuisa in go & oh: Et go sia la Terza parte di ac."

again, qK *is divided into* qn *and* nK*, of which* qn *contains the fourth part of* ac.[211]

O how concise is this man in saying what he does not understand. It follows, in addition:

finally, ef *is divided into* em *and* mf*, so that* em *contains the sixth part of* ac.[212]

Similarly, this remains undemonstrated. Wherein every person of judgment will recognize that in this proposition—which is fairly extended—there is nothing that has need of being demonstrated except what he leaves without demonstration. This he will not do because he does not know how to do it. Consequently, he does not understand Ptolemy, from whom he lifts the demonstration wholesale. The same style holds for all the others that he claims as demonstrations. I, with those few principles I have, would have demonstrated it thus: inasmuch as *cal* and *gao* are similar triangles, *ca* to *ag* has the same proportion as *cl* to *go*; but *ca* is placed as the sesquialtera of *ag*, of which parts, therefore, *cl* will be 6 and the whole *cd* will be 12; *go* will be 4, on which account it will be the third part of *ac*; for the same reason, *ca* to *aq* has the same proportion as *cl* to *qn*. But *ca* by hypothesis is the double of *aq*; therefore, *cl* will be the double of *qn* and the whole *cd* will be the quadruple. Similarly, because *ca* to *ae* is as *cl* to *em* and *ca* is placed as the triple to *ae*, *cl* will be the triple *em* and *cd* will be the sextuple of the same. Q.E.D.[213]

[-61-] The most refined Mr. Claudio [Merulo] of Coreggio now occurs to me, and although he is modesty itself, I cannot believe that he would have heard some of these simplicities without laughing together with the others whom Zarlino introduces in his

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[211] Ibid.: "Cosi ancora qK sia diuisa in qn & nK: delle quali qn contenga la Quarta parte di ac."

[212] Ibid.: "Vltimamente sia diuisa ef in em: & mf: tanto che em contenga la Sesta parte, et mf Cinque seste parti di ac."

[213] Kellerher writes that Galilei is correct in accusing Zarlino of not really demonstrating anything with his proof of Ptolemy's square. Galilei is aware that Zarlino is more interested in showing that numerical ratios govern musical science than in providing a proof that demonstrates the relationship between a geometric figure and its parts. See Kelleher, "Demonstrative Methodologies," 230-32.

discussions, to whom he has done the greatest wrong by setting them in the predicament of men who have need of learning through demonstration the best-known things, such as: when drawing the fifth from the octave, the fourth remains—a conception truly given to hold in boredom whatever man who is idle or of obtuse intellect.[214] Perhaps if only one of some such things were read in his *Dimostrationi* . . . ; rather, the book is full of them from beginning to end.

Now, tell me please, Mister Gioseffo, from which mathematicians has it been learned that one may place definitions and at the same time seek to demonstrate? To do this is exactly to wish to litigate what has been conceded to us by agreement. In the eighth definition of the second Discussion, he says that the diapason is contained by the duple proportion; in the fifth demonstration,[215] then, he wishes to demonstrate that the interval of the diapason is multiple; in the ninth definition he says that the diapente is contained by the sesquialtera; and in the tenth, the diatessaron by the sesquitertia. Then, in the third proposition, he wishes to demonstrate that the diapente and the diatessaron are collocated between the larger superparticulars.[216] [-62-] In the eleventh and twelfth definitions, he says that the ditone is contained by sesquiquarta [5:4] and the semiditone by sesquiquinta [6:5]; in the seventh proposition, he demonstrates that the ditone and the semiditone are superparticular (which is not trivial[217]). Thus, in proposition 15 of the same Discussion, it follows: the interval of the major semitone is composed of the

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[214] Claudio Merulo is one of the interlocutors in the dialogue that runs throughout the *Dimostrationi*. For a discussion of the form and style of the *Dimsotrationi*, see pp. 48-53 *supra.*

[215] Galilei is probably referring to the fifth proposition of the second discussion. See, Zarlino, *Dimostrationi* II.prop.5, 102.

[216] The 8th *dignità* states that one can discern the relative size of superparticular ratios by comparing their denominators. Thus, 3:2 is a larger interval than 4:3 because 1 1/2 is a larger than 1 1/3. 3:2 and 4:3 are the largest superparticular ratios.

[217] Galilei ironically applauds Zarlino's definitions because the ditone [81:64] and semiditone [32:27] are not represented by superparticular ratios.

sesquidecima [16:15] proportion;[218] and then in the following proposition, he wishes to demonstrate that the interval of the major semitone is superparticular. O pretty acquisition! In the twenty-first of the third Discussion, he demonstrates that the major semitone consists of a major proportion that is not the sesquisestadecima [17:16], and in the following, he adds that the major semitone consists of a proportion larger than sesquidecimasettima [18:17]. O pretty novelty! He then adds in the following proposition that the proportion sesquiquartadecima [15:14] is larger than the major semitone, and later on in the following, he demonstrates that the proportion sesquisestadecima [17:16] is smaller than the major semitone.

The book of his *Dimostrationi* is filled with this subtlety, as I have said. It is no surprise, because in Venice, through the abundance of printers, books are sold by the yard.[219] This was the reason that induced him to expand his *Sopplimenti* by so many folios, filling them as he pleased with words of my *Dialogo*. He did what I have said not only because of this; in addition, he concealed my name not out of charity, as he says in the preface [-63-] of his *Sopplimenti*,[220] but because of what I am about to say at present. He concealed my name, first, because so many maledictions would have impeded the book, they were not printed; and finally, so that my *Dialogo* and I would not attain cognition among men, he sought to deceive the world anew with this treachery by persuading them that the words he alleges to me were sufficient to declare my intention.

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[218] Zarlino, *Dimostrationi*, II.prop.15, 118. Zarlino actually writes: "L'interuallo del Semituono maggiore è compreso dalla proportione Sesquiquintadecima."

[219] The breadth of the Venetian book trade was in part a result of the relative autonomy from Papal censorship that the Serene Republic enjoyed in the late-sixteenth and seventeenth centuries. Apart from music books and scientific treatises, Venetian bookmen disseminated the current news of all of Europe and the Middle East through local printers. See Edward Muir, *The Culture Wars of the Renaissance*, The Bernard Berenson Lectures (Cambridge: Harvard University Press, 2007), 4-5.

[220] See pp. 99-101 *supra*.

And so, without otherwise seeing my *Dialogo* with their own eyes, they might refer to these words as he himself said them, without seeking any further.

Therefore, whoever wishes to see with his senses how much more this man deceives himself than what I have said up to this point and how wrongly he complains of me should place himself before my *Dialogo*, without believing one whit what Zarlino writes in his *Sopplimenti* or elsewhere. He will see that in the *Sopplimenti* he places imperfect, truncated, and lacerated clauses, sentences, and paragraphs. To note one single instance, in the third chapter of the first of his so-called *Sopplimenti*, he recites some of my words thus:

> *Consider if an instrument made of a shin-bone of a crane, vulture, or eagle acts to strike men and take away their life.*[221]

In reciting these few words, he commits three sorts of errors. First, he translates my mother tongue, Florentine, into Bergamasque;[222] he shows that orthography was not born at his time; and third, which is more important, he defaces the sentence, in addition to interpreting [-64-] the thing in reverse and attributing my conception to himself and his blunder to me.

One would need to waste many words on a clarification of this. For brevity, therefore, I will leave aside the place that may be seen with one's own eyes and also that of "the quantity of the comma," which he writes in chapter 8 of the fourth Book.[223] He

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[221] Zarlino, *Sopplimenti* I.3, 14: "Considerate se un'Istrumento fatto d'un stinco di Grue, d'Auoltore, ò d'Aquila è, atto à percuotere gli Huomini, & torgli la vita." In the *Dialogo* (pp. 100-101), Galilei writes: "Considerate hora voi; se vno Strumento fatto d'vno stinco di Grue, d'Auoltore, ò d'Aquila, è atto col percuoter gli huomini à torgli la vita."

[222] In the debates over the true Italian language, one member of the Florentine Academy accused the Venetians of turning the Florentine dialect into "Bergamasque." See p. 71 *supra*.

[223] In the *Dialogo*, Bardi and Strozzi discuss the many dissonances that would occur if the Syntonic tuning were actually used in practice. To conclude this topic (p. 29), Strozzi paraphrases Zarlino himself as saying that when intervals are augmented or diminished by as little as 1/2 comma, they will be

adds, nearby, this one other instance of a different species, i.e., citing the chapters and the places in reverse; as when he says that I cite chapter 35 of his *Istitutioni* and in my *Dialogo*, the fourth is written.[224] These are some of the pleasing jests he so often makes for the reader.

But now is the time to disentangle myself from mathematics, and because it is less tedious, I will proceed by recounting only some among the more famous things that he writes, such as the seventh proposition of the third Discussion, where he makes a universal proposition and a particular demonstration:[225] he proposes to wish to demonstrate whatever space divided into many spaces, and in what he claims as a demonstration, he restricts himself to one particular space divided into nine spaces.[226]

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dissonant. Strozzi follows his conclusion by suggesting that Zarlino has also posited, in jest, that the consideration of the sizes of tones and semitones is not important. Galilei cites the *Istitutioni* III.13 as the source of this second idea. As Zarlino notes in the *Sopplimenti* IV.8, 147, anyone who goes back and reads the *Istitutioni* III.13 will quickly learn that he was referring only to the different species of the perfect fifth and not to degrees of consonance or dissonance.

[224] Galilei is referring to a passage on p. 15 of the *Sopplimenti* I.3. In this sentence, "nearby" refers to the quotation "Consider if an instrument made of a shin-bone . . ." found on p. 14. Here again, Zarlino is taking exception to p. 80 in the *Dialogo* where Galilei has cited the *Istitutioni* out of context: "The Greeks greatly loved music, although Zarlino is of contrary opinion at ch. 4 of the second part of the *Istitutioni*." In that chapter, Zarlino suggests that the Greeks were occupied with work, but he never suggests that they did not love music. Galilei is correct, however, in noting that he does not cite a chapter 35 of any part of the *Istitutioni* at this point in the *Dialogo*.

[225] In the 1571 printing of the *Dimostrationi*, there are two proposition 7s in the third Discussion. It appears that the printer mislabeled proposition 5 as proposition 7 (p. 154) and then continued with propositions 6-53. Galilei is referring to the first proposition 7. It does seem like a paradox because the title of the proposition says that the space is divided into a number of equal spaces, yet in the demonstration, Zarlino notes that the ratios that govern each division of the larger space are unequal. Galilei, on the other hand, wants to show that if the spaces are equal, each interval (distance between points) will be proportionately the same.

[226] Zarlino, *Dimostrationi* III.prop.7, 154-55. Zarlino includes the following diagram, which will be useful for following Galilei's proof:

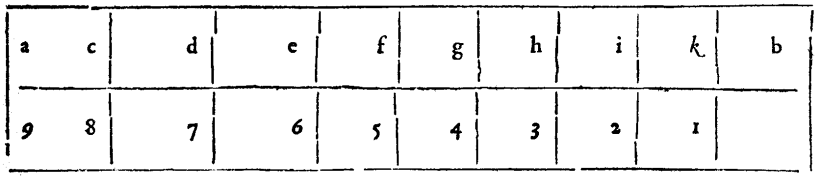

Figure 33. Zarlino, *Dimostrationi* III.prop.7, 155.

Then, what manner of demonstration is adopting numbers?[227] He has perhaps learned it from the eighth of the fifth Book of Euclid, where it speaks of having a larger or smaller proportion.[228] Now I wish to instruct him how to demonstrate it: inasmuch as *ac* is equal to *cd* (by the seventh of the fifth Book),[229] *ac* will have the same proportion to *cb* as *cd* has to *cb*; but by the eighth of the same Book, *cd* has a smaller portion to *cb*[230] [-65-] than *cd* has to *db*; in agreement with the twenty-eighth of the same Book,[231] *ab* will have a smaller proportion to *bc* than *cb* has to *bd*. Q.E.D. What is even better is that he goes about alleging to every word in his *Sopplimenti* these new and ingenious demonstrations, based on the evidence of the truth of what he says. And this is enough in regard to these things.

I shall now adduce one or two things I have read in a very quick survey of his *Sopplimenti* (as he is pleased that I do, against my will). In chapter 21 of the fourth Book, extending himself on the most vapid things of no moment, he leaves aside the demonstration of what he proposes to want to demonstrate, that is, to multiply by adding[232] whatsoever interval is proposed. Earlier, he says that he has comprehended it by the proof demonstrated in the preceding proposition of the same book, which has nothing to do with what he wants to say. Therefore, out of charity, I want to instruct him

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[227] Galilei rightfully questions Zarlino's use of numbers in an axiomatic demonstration. Euclidian demonstrations, such as those that pervade the *Dimostrationi*, were typically constructed without numerical analyses. Instead, scientists relied purely on geometric figures and established definitions and axioms.

[228] That is, Euclid *Elements* 5.8: "Of unequal magnitudes, the greater has to the same a greater ratio than the less has; and the same has to the less a greater ratio than it has to the greater"; trans. in *Euclid's* Elements, 2:149.

[229] "Equal magnitudes have to the same the same ratio, as also has the same to equal magnitudes"; trans. in *Euclid's* Elements, 2:148.

[230] The printed text reads *ch*.

[231] There is no 28th proposition in the fifth Book of the *Elements*. Galilei is most likely referring to proposition 10: "Of magnitudes which have a ratio to the same, that which has a greater ratio is greater; and that to which the same has a greater ratio is less"; trans. in *Euclid's* Elements, 2:155.

[232] Zarlino writes *soggiugnendo*. In the beginning of chapter 21, he mentions *soggiungere* as a specific process for multiplying intervals.

about it.[233] We should, however, refer beforehand to the figure constructed as it stands in the said place; and where he says *ae* is sesquialtera to *cf* by the "definition of the first of the demonstrations," he should say that it is true by the second of the third of Euclid.[234] Because he did not know what he should say, he proceeded with his bow without taking aim, drawing the bow back, as usual, without specifying which definition or which demonstration he is citing.[235]

He then places *cg* equal to *cf*, about which he composes a most tedious speech. [-66-] But in then demonstrating that *cb* is the sesquialtera of *bg*, because this is not meat for his teeth, he makes the most terrible hodgepodge of blunders in the world. When he says, first, that this is true by the second part of definition 15 of the first Book of Euclid,[236] this has as much to do with it as I have to do in Peru; and to fortify his reason,

[233] The following proof is in reference to the diagram placed below.

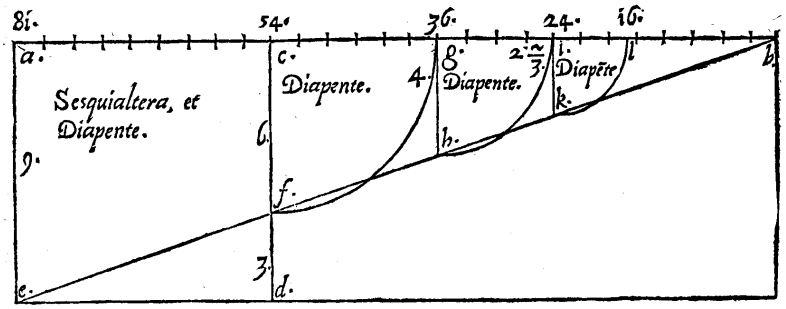

Figure 34. Zarlino, *Sopplimenti* IV.21, 183.

[234] Zarlino does not mention Euclid *Elements* 3 in this context. Because that particular book is primarily concerned with circles, it is difficult to see why Zarlino should have referred to it.

[235] In the *Sopplimenti* IV.21, 183, Zarlino makes a parenthetical reference to a definition in the first book of the *Dimostrationi harmoniche*, but he does not cite the number. The omission may be a printer's error; there are other places in the *Sopplimenti* where it appears that necessary words are missing from the text. Zarlino may have intended I.def.5, 22, which reads: "That in which the greater quantity contains the smaller one time and one of its aliquot parts is called superparticular, just as if the greater surpasses the smaller only one time and its half part is called sesquialter, and if it contains one time and its third part it is claimed sesquitertia, and the others so on in order [Quello, nel quale la maggior quantità contiene la minore una fiata & una sua parte Aliquota: si chiama Superparticolare: si come se la maggiore super la minore una sol uolta & una sua meza parte, è detto Sesquialtero: & se la contiene una fiata & la sua terza parte, è chiamato Sesquiterzo: & cosi gli altri per ordine]."

[236] It is difficult to determine the definition to which Zarlino refers because various translations of Euclid have different orderings in this part of the first Book. If Galilei was using Tartaglia's Italian translation, definition 15 reads: "The diameter of the circle is a straight line that passes over the center of it, applies its extremity to the circumference, and divides the circle in equal parts [Il diametro del cerchio è

he adds more: by the fourth part of the second definition of the same Book of Euclid, the two triangles *abe* and *cbf* are proportional.[237] Now from this alone, does not one notice that he does not understand the terms? How can he wish that Euclid should make a comparison of two triangles and claim them to be proportional if proportionality should fall among at least three terms?[238] He wished to say that they were equiangular and that their sides were proportional. Even if he had said so, it was still not apropos because the line *bg*, of which it is his intention to demonstrate that *bc* is the sesquialtera, is not any side of the two triangles named by him. But let us not waste time on this and instruct him in the fashion of demonstrating that *cb* is the sesquialtera of *bg*. Now he should say: because *cf* is parallel to *ae*, the two triangles *abe*, *cbf* are similar. And by the fourth of the sixth Book, as *ab* is to *bc*, so *ae* is to *cf* and *ac* to *cg*, inasmuch as *cg* is placed equal to *cf*.[239] Now, inasmuch as the whole *ab* is to the whole *bc*, when parts *ac* to *cg* are taken, the remainder *cb* will be to the remainder *bg*, as the whole *ab* was to the whole *bc*, by the

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una linea retta, laqual passa sopra il centro di quello, & applica le sue estremità alla circonferentia, & diuide il cerchio in parte equale].” Tartaglia was aware that other translations had different orderings, and he notes that his definition 14 may also be considered as definitions 15 and 16 combined. Definition 14 reads: “The circle is a plane figure contained by a single line that is called ‘circumference.’ In the middle of this figure is a point from which all the straight lines that extend and go to the circumference are equal. Such point is said to be the ‘center of the circle;’ [Il cerchio è una figura piana contenuta da una sola linea, laquale è chiamata circonferentia, in mezzo dellaqual figura è un ponto, dalqual tutte le linee rette, ch’escane, & uadano alla circonferentia sono fra loro equali: & quel tale ponto è detto centro del cerchio]”. See Nicolò Tartalea, *Evclide megarense philosopho solo introdvttore della scientie mathematice* (Venice: C. Trojano, 1565), 11-12.

[237] Galilei is incorrect. Zarlino writes (*Sopplimenti* IV.21, 184): “And, furthermore (by the second of the sixth book of Euclid), the two triangles *abe* and *cbf* are proportional among themselves; [Et di più (per la Seconda del Sesto d’Euclide) i due Triangoli abe. e cbf. uengono ad esser tra loro proportionali].” Euclid *Elements* 6.2 is applicable: “[Two] figures are *reciprocally related* when there are in each of the two figures antecedent and consequent ratios”; trans. in *Euclid’s* Elements, 2:189.

[238] Galilei evokes Euclid *Elements*, 5.8.

[239] Euclid *Elements* 6.4: “In equiangular triangles the sides about the equal angles are proportional, and those are corresponding sides which subtend the equal angles.” trans. in *Euclid’s* Elements, 2:200.

nineteenth of the fifth Book.[240] Therefore, *cb* is sesquialtera of *bg*. [-67-] Q.E.D. And all the others are demonstrated in the same fashion.

Because it will seem impossible to any of the members of his clique that having known how to demonstrate the preceding (rather more difficult than this), he would be so befuddled in the less difficult, I will tell them the cause in order to lift such doubt from them, and it is this: he has translated word-for-word from Eudoxus or Vitruvius the demonstration that he made to find two mean proportionals between two proposed lines.[241] In this translation once again, it is manifest how much he understands of this field, considering that he shows once again that he does not know the difference between the rectangle and the square when he claims the rectangle *bacg* is a square, even though the difference between them is learned in the definitions of the first Book of Euclid.

[240] Euclid *Elements* 5.19: "If a whole magnitude be to a whole as a magnitude taken from the first is to a magnitude taken from the other, the remainder shall be to the remainder as the whole is to the whole"; trans. in *Euclid's* Elements, 2:164

[241] In the *Sopplimenti* IV.20, 182, Zarlino shows his first of three methods for finding mean proportionals between two straight lines without the use of a *Mesolabio*. The first method involves combining the two straight lines to form a rectangular (see figure 35 below). Because Zarlino's intention is to find two mean proportionals between the lines *ab* and *bc*, it is impossible that these lines be of the same length. Therefore, it is also impossible, as Galilei says, that the rectangle *abcg* can also be a square.

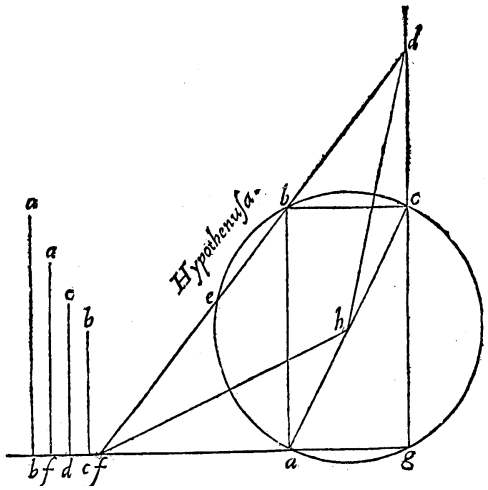

Figure 35. Zarlino, *Sopplimenti* IV.20, 182.

I let stand that in translating those words (but pedantry should not be attributed to me) "Quod autem continetur sub e cetera," which intervene many times in that demonstration, he writes "All that which is contained under," by which we can recognize that he does not understand the force of the words. They import "the rectangle contained under."[242] Now you learn how much better it was for him to conform to the counsel that he says (in the beginning of the fifth Discussion) his friend gave him in seeking to dissuade him from undertaking to publish (with a modesty greater than Zarlino was able to manage) his *Dimostrationi*.[243] One sees that his friend recognized much better than he what they were worth. But if he had conformed [-68-] to his counsel, he would not have learned as much as I have written up to now about his teaching (if, however, he had the capacity for it), and perhaps this man would not have gone about misusing poor Archimedes in his *Sopplimenti*, showing that he has him on the tips of his fingers no less than he has the Chaldean language.

Furthermore, if he had understood the stated proposition, he would not have mourned the duplication of the cube as if it were dead and so too the one from which he extracted the usage of the *Mesolabio*, which was by Philo Byzantius.[244] But if he had read

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[242] Galilei is referring to a passage at the end of the *Sopplimenti* IV.20, 182, in which Zarlino writes: "What, then, is contained under *bf* and *fe* is equal to what is contained under *gf* and *fa*. For the one and the other are likewise equal to the square of the line that touches the circle, stretched from point *f*. Therefore, what is contained under *gd* and *dc* is equal to what is contained under *gf* and *fa* [Quello però ch'è contenuto sotto la bf. & la fe. è equale al contenuto sotto la gf. & la fa. percioche l'uno & l'altro simigliantemente è equale al Quadrato della Linea, che tocca il Circolo, tirata dal punto f. però il contenuto sotto la gd. e la dc. è equale al contenuto sotto la gf. & la fa]." Zarlino is trying to establish concordances among segments of lines in a diagram.

[243] In the beginning of the Fifth Discussion of the *Dimostrationi*, Zarlino mentions that people tried to convince him to give up on it and instead turn to works that were pertinent to Holy Scripture. Zarlino concludes that his critics were just worried that his *Dimostrationi* would show them how ignorant they actually were with regard to musical science. See Zarlino, *Dimostrationi* V.intro., 263-64.

[244] Philo flourished in the third and second centuries B.C.E.; his writings contain a description of a water-powered organ or *hydraulis*. See Thomas J. Mathiesen, *Apollo's Lyre: Greek Music and Music Theory in Antiquity and the Middle Ages*, Publications of the Center for the History of Music Theory and Literature, vol. 2 (Lincoln: University of Nebraska Press, 1999), 225-28.

the demonstration of Archytas[245] with respect to the invention of the two means and had understood it, he would have recognized it to be pure and simple geometry and not mechanics, as these were found in different ways by many others. Because, as I believe he may know, the duplication of the cube is nothing other than the placement of two lines, the first of which is half the other, to find two mean proportionals between these, the cube of the second will be double the cube of the first, and the invention of the said means having been demonstrated, the duplication of the cube remains found.[246] I remain in awe that this man has had the courage to publish such vapidities, inasmuch as I am sure that in Venice this field, in particular, is not only appreciated among the nobility but there are many there who possess it in excellence.

The fourth and final chapter proposed in the beginning of my *Discorso* was to make the same Zarlino accept that everything [-69-] good or new that he says in his *Sopplimenti* he has learned from me and my *Dialogo*. It is not necessary to persuade him

[245] Archytas, a mathematician and musician, lived in the fourth century B.C.E and was an acquaintance of Plato. Ptolemy claims that he, "of all the Pythagoreans, was the most devoted to music." See Mathiesen, *Apollo's Lyre*, 445. For a full discussion of Archytas's proof, see Carl A. Huffman, *Archytas of Tarentum: Pythagorean, Philosopher, and Mathematician King* (Cambridge: Cambridge University Press, 2005), chapter 3.

[246] In the *Dialogo* (p. 135; trans. in *Dialogue*, 331, 333), Bardi presents some diagrams that show how one can discuss the area of cross-sections of pipes in geometric terms. He concludes the demonstration by noting: "this observation may be effective in opening the path to some beautiful intellect versed in mathematics to revive the already dead and mourned squaring of the circle [le quali considerationi potrebbono essere efficace mezzo d'aprir la strada à qualche bello intelletto versato nelle matemattiche, di trouare la già pianta per morta quadratura del circolo]." Zarlino makes reference to this passage in the *Sopplimenti* IV.29, 207. In response to Bardi's statement (*Dialogue*, 122): "I therefore warn the diligent operator that with discretion and care, he seek to avoid the not little incompatibility that is between the measurer and the measured" [written in regard to the compass and its six turns], Zarlino addresses Archimedes and sarcastically exclaims: "if only you had someone in your era that gave such advice"; and concludes, assuming that Archimedes would have "found the given-up-for-dead (as my disciple always speaks hyperbolically) squaring of the circle, still not found by anyone [se ne tuoi tempi hauesti hauuto uno che ti hauesse dato un tal consiglio, . . . ritrouar la già pianta per morta, come parla sempre Hiperbolicamente il mio Discepolo, Quadratura del Circolo, non ancora d'alcuno ritrouata]." So, neither have used the phrase "pianta per morta" ("mourned as if it were dead") with regard to the duplication of the cube. Galilei may just be confusing his points.

of this truth in order to know how many times he has confessed it to his conscience and concealed it from others for the sake of his honor. It would be impertinent of me to write everything here that can be clearly gathered from my *Dialogo*. Now if men of judgment and a capacity for as much as I have said in my *Discorso* will recognize it not to be true, they should not otherwise deign to see my *Dialogo dell'antica, et della moderna musica* but, without any chance of respect, should believe of it and declare of it what better suits them. But if on the contrary they will recognize it to be true, they should endeavor to get it because from it they will openly recognize how much reason I have had to say what I have said up to now against my will.

It was not my intention to pass beyond this limit, but reminded of the obligation that I have (because of the promise made) to demonstrate that Mr. Gioseffo Zarlino seldom says a thing that stands in his order, I wish to discuss the sixth chapter of the first Book of his *Sopplimenti* instead of what I have left to say (because one can read in my *Dialogo*).[247] Much profit will be drawn from this Book because in it are all the conclusions of his principles relevant to what he principally seeks to persuade and prove in the aforesaid work. If, however, of the twenty-eight or thirty conclusions [-70-] that are in this chapter, which he seeks to sustain as true, I will make him accept that they are all false, he will be able—in taking this as earnest money—to be content with the guarantor because from this he will recognize that he[248] acts to satisfy him with the entire sum and, in addition, to persuade the world that all that Zarlino will argue from these principles will be a chimera and a dream.

[247] Galilei's critique of the *Sopplimenti* I.6 is the most lucid discussion in the *Discorso*.
[248] I.e., the guarantor.

For the greater satisfaction of scholars and lovers of the true, I shall commence with the title of this chapter, and it is this:

> *What is made according to nature cannot be properly corrected by means of those things that are made by art*.[249]

These words concluded the truth every time if, on the contrary, he would have said this: "What is made according to nature can be very properly corrected by means of those things that are made by art." And he could adduce, among others, the examples given below. The arts are of many manners, and this is important for our point, for certain arts do not have any regard for the benefit of their subject but use and abuse it in whatever fashion serves them for doing the proposed work, as the cobbler would do with leather or the carpenter with wood. There are other arts that, contrary to these, have for a goal to benefit and make perfect—insofar as they can—their subject, as are agriculture, sheepherding, medicine for animals (called veterinary by the Latins), and medicine for the human body. Each one [-71-] of these is forced to reduce its subject to the perfection that is possible for it. Agriculture seeks this perfection in plants, sheepherding in flocks and herds, veterinary in its animals, and medicine in the human body. From this, it comes about that if nature, for whatever reason, commits some defect in one of these subjects, the artisan seeks to correct it. For example, nature makes wild fruit plants; agriculture grafts them with art and cultivates them by domesticating them. It happens that some are born without hair, with fingers not separated one from another, with the sex unpierced, with the belly loose (as occurs universally to everyone); the art of medicine corrects all of these errors made by nature, and so equally the other aforesaid arts correct the defects

[249] Zarlino, *Sopplimenti* I.6, 23: "Che quello ch'e [*sic*] fatto secondo la Natura, non si può ben correggere col mezo di quelle cose, che sono fatte dell'Arte."

that nature commits in their subjects. From this, it appears that what is made by nature, when it is made with some defect, can be corrected with art; and when it is made without some defect, many times art is content to let it stand so without doing anything about it. But if one would still wish to make some operation with regard to it, he is not denied, as is seen among women who, as beautiful as they have been made by nature, make themselves more beautiful still with art. It is therefore not true that what is made according to nature cannot be corrected by means of those things that are [-72-] made by art.

Later, the title continues in this manner:

And that one cannot conclude properly from the things of art about those of nature.[250]

This, on the contrary, should follow so: "And that one can conclude properly from the things of art about those of nature." It can be proven with this example. The doctor feigns in his fancy an idea and form of health so perfect and[251] so stable that was never such in nature. From this artificial idea of health, it is most permissible, even necessary many times to argue about the natural health that is found in action in human bodies. For the health that is in this and that particular is better or worse insofar as it approaches or is distant from the aforesaid idea. It is therefore most true that one can conclude properly from the things of art about those of nature.

I will now discuss the sixth chapter, and to declare myself with the greatest ease I can, I shall divide it into several parts or several clauses (as we may wish to call them). I

[250] Ibid.: "& che non si può concluder bene dalle cose dell'Arte in quelle della Natura."
[251] The printed text reads *è*.

shall go over each of these by discussing all that I judge to be appropriate. Therefore, the sixth chapter commences thus:

> *And to apply what we have discussed to what follows, we should know that inasmuch as artificial instruments are made in imitation of those that nature uses, every time their artisans or fabricators wish to correct or improve something that they see lacking in them, they seek to correct it with no other means than the example and model* [-73-] *made by nature herself*; *and when it is necessary for them to want to render some reason for their work, they never serve themselves if not by those principles they have derived from the things they wish to imitate.*[252]

In this first clause, Zarlino wants to persuade us that artificial instruments are made in imitation of those nature uses, that they cannot be corrected by other means than by her own, and especially that one cannot render a reason for this if not with her own principles. Therefore, in responding, I say it must first be known that no instrument was ever made by art for any other goal than for the use that it[253] ought to carry. For example, the saw was made to saw and the flute to play; however, the use that the instrument ought to carry is the principle from which the fabrication of it is extracted. So, each instrument functions properly at the time when it acts to carry the use that we seek from it. The flute, therefore, functions properly whenever it can be played as the musician wishes, and the saw functions properly every time wood can be sawn with it. Likewise, artificial instruments are never made in imitation of those that nature uses, for this similitude is not

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[252] Zarlino, *Sopplimenti* I.6, 23: "ET per applicare quello, c'habbiamo discorso à quello che segue, dobbiamo sapere; che essendo gli Istrumenti Arteficiali fatti ad imitatione di quelli, che usa la Natura; tutte le fiate che i loro Artefici & Fabricatori uogliono correggere ò migliorare alcuna cosa, laquale uedono mancare in essi, cercano di correggerla non con altro mezo, che con l'essemplare & modello fatto da essa Natura; & quando li fà dibisogno di uoler rendere alcuna ragione dell'opere loro, non si seruono mai se non di quei Principij, c'hanno cauato dalle cose che uogliono imitare."

[253] The printed text reads *che i*. Galilei probably intended *che si*.

important to the artisan. But it is indeed important to him to be able to attain with his instrument the proposed goal. When the fabricators of these instruments wish to correct or improve anything lacking in them, they cannot otherwise correct it with the example or model [-74-] made by nature, as Zarlino says, but rather with regard to the goal or true use that is expected of it. If, finally, they wish to render a reason for this, they do not take the reason from elsewhere than from the same use and goal of it, saying that they have made such an instrument because it had to be so in order to do such work. It is therefore not true that artificial instruments are made in imitation of those that nature uses or that they should be corrected by means of her, just as it is also not true that we render a reason for this with her principles.

Later on, these words follow:

> *For it would be total madness if they wished it to be possible, as has been said, that their art could reach where nature adjoins, and that the latter could be corrected by the former, although they could render a good account of such things by some convenient means taken from continuously working.*[254]

The final part of this second clause is to wish that there be total madness of those who say that it is possible that art may reach where nature adjoins and that the latter can be corrected by the former. Now, if I will show that neither the one nor the other thing that he says is true, it will be a manifest indication that the total madness is his because he never understands a thing he says except to the contrary of what it is. That the thing

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[254] Zarlino, *Sopplimenti* I.6, 23: "Percioche sarebbe somma pazzia, quando uolessero che fusse possibile, come si è detto, che l'Arte loro potesse arriuare doue la Natura aggiunge, & che questa da quella potesse esser corretta; quantunque di cotali cose potessero con alcuni mezi couenienti, tratti dal continuamente operare, renderne buon conto." On the following page, Galilei assumes that the final phrase ("although they could render a good account of such things by some convenient means taken from continuously working") does not refer to the "they" that is the subject of "uolessero," but to Zarlino himself.

follows by the opposite of what he says can be recognized by this: art and nature are operative causes, each of which is perfect in its genus. [-75-] When it occurs (which occurs in many arts) that they are about the same subject, it happens that nature can do many things in it that art cannot do, and on the contrary, art can do many things in it that nature cannot do. For example, in the human body, nature makes stews of crude humors that art cannot make, but on the same subject, art can reset a dislocated bone that nature cannot reset. Art, therefore, in many things surpasses nature and corrects it—and particularly in all those things that Zarlino seeks to persuade us to the contrary in order to sustain his false principles. In those things where nature is surpassed and corrected by art, they are—in all and through all—beside his point. At the end of the clause, he says that he has taken the certainty of his conclusions from the continuous labor he has done. This is credible: he has sought to persuade us of things to the contrary of what they are (to do this truly needs something other than words), but there is not any difficulty in persuading us of the true and real conclusions of sensate things such as these with true principles.

The chapter continues thus:

> *And even if the artisan ofttimes (as the Philosopher advises) compensated in many things for the defects of nature herself, nevertheless the imperfection and the defect that he supposes to be in the natural thing was neither learned nor derived simply from art but from nature.*[255] *Therefore, art simply corrects such defects,*

[255] In *Physics* 2 (192b8-193b22), Aristotle describes a fundamental difference between nature and art. Noting that things that exist by nature have within themselves an "innate impulse to change," which is lacking in the artificial, he concludes: "So it is with all other artificial products. None of them has in itself the principle of its own production." See *The Complete Works of Aristotle*, 1:329.

> [-76-] *aided by the fashions shown to it by its mistress, on whom art depends and is, as it were, her instrument.*[256]

To this third clause, I respond in such manner: art can correct many of the defects of nature, as has already been said. It is true, as the Philosopher says, that the goal of correction is learned from nature, but the fashion of correcting it is wholly learned from art. For example, dislocated bones are returned to their natural place because thus they function properly and nature showed this. But the fashion of restoring them by drawing and redirecting the limbs and making other necessary operations is done wholly by art. It is therefore not true, as he says, that art corrects the defects of nature according to the fashions shown to it by her but according to the fashions of art itself.

Later on, he adds:

> *However, just as one would be reputed foolish who believed that a human body, when it is defective or deformed in some part, could be made perfect and reduced to true symmetry and commensuration according to the model that it sees in a painting of a natural body—as the painting was made perfect and corrected by means of the model when the hand of a good painter and excellent master portrays it from life—and one would be reputed wise who believed the contrary, so one would be reputed mad and out of his senses who wished to think of correcting by means of instruments made by artisans the instrument of the voice, fabricated by amazing nature.*[257]

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[256] Zarlino, *Sopplimenti* I.6, 23: "Et se ben l'Artefice spesse fiate (come auisa il Filosofo) sopplisse in molte cose à i deffetti di essa Natura; tuttauia quella imperfettione e quel diffetto, ch'ei stima esser nella cosa Naturale, non lo imparò, ne cauò semplicemente dall'Arte, ma dalla Natura; onde corregge semplicemente cotali diffetti; aiutato da i modi mostratogli come da sua Maestra, dallaquale l'Arte dipende, & è quasi come suo Istrumento."

[257] Ibid.: "Però; si come sarebbe riputato stolto colui, che credesse, che un Corpo humano, essendo in qualche parte diffettiuo & difforme, si potesse far perfetto & ridurlo alla uera Simetria &

Because of his blunders in this fourth clause, there will be much to say. I see [-77-] that this man goes about paving a street along which he does not have to pass in order to join with his desired goal, and he may rack his brains as much as he likes. Now, let us first discuss what he says and then what he wishes to say. I say, first, that it is not a foolish thing to believe that a defective and deformed human body can be made perfect by art, for everyday experience demonstrates this to us in bodies where there are not uncorrectable flaws. But if the defects are emendable, the art of medicine (as has been said) instructs how to correct them, and one who believes otherwise will be reputed foolish. Artificial musical instruments are not made to correct instruments fabricated by nature that make the voice, but they are made so that the voice proceeding[258] from such natural instruments may learn to lower and raise itself and make itself high and low in the same fashion as we have made the sound on our artificial instruments and according to the way in which the intervals have been distributed and ordered by their author in this and that system, whether it be Syntonic or Diatonic. These systems and distributions are wholly artificial, and natural voices when singing are corrected and regulated by these artifices as much as are instruments made by art when playing. So, the example of the painting in this instance is exactly the opposite of what he says because the "model" and "natural" (so to speak) [-78-] that natural voices and artificial instruments seek to portray today, according to him, is the Syntonic of Ptolemy, and whichever of these is more similar to it and exact merits the name of the most excellent mistress. That this business

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commisuratione, secondo'l modello ch'ei uede i[n] una pittura d'un Corpo naturale, come si fà perfetta & si corregge questa col mezo di quello, ritraendolo dal uiuo la mano di buon Pittore & eccellente Maestro, & riputato sauio quello, che credesse il contrario; cosi sarebbe riputato pazzo & fuor di senno colui, che uolesse pensare col mezo de gli Istrumenti fatti da gli Artefici, di corregger l'Istrumento della Voce, fabricato dalla stupenda Natura."

[258] The printed text reads *precedente*.

does not turn out as Zarlino would wish comes from the poor design that he gave it, and it will always turn out excellently whenever it is designed in the order that I shall demonstrate.

With the example of the painting, he wishes to persuade us anew that nature surpasses art, and he makes the comparison from life to the depicted, which is taken wholesale from the conclusions of Doctor Gratiano.[259] Coming to my point, I say that if we wish to discuss art and the goal of painting in a sane manner, we shall say—after having properly considered and understood it—that in its genus, it can be and may be much more perfect than nature, as we may recognize from art and from its goal. The goal of painting, therefore, is[260] an imitation with features and colors of not only all natural and artificial things but also all those that are possible to imagine. Painting not only represents, with that excellence that nature uses, the part that our sight can desire from the stated features and colors in whatever body but greatly excels nature, both in the quality and diverse quantity of things. It does not serve, therefore, Mr. Gioseffo to say that nature makes live men and painting depicted ones; the live are more perfect [-79-] than the depicted: therefore, in making men, nature surpasses the art of painting. The goal of painting is not to make live men but only to imitate them as such with the proportion of the lines and the conformity of colors so that it will look to live eyes that the painter has depicted a beautiful woman in a manner the eyes have never seen (insofar as is expected of lines and colors, as I have said) a beautiful woman such as this in nature, and he will do the same for plants and animals. Where nature rarely makes that excessive

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[259] Dr. Gratiano is a stock character in the *commedia dell'arte* tradition. Winifred Smith describes him thus: "With spectacles on nose and pouch on side, and made up of long paragraphs of nonsensical, would-be-wise saws and 'counsels to youth' on the order of Polonius's farewell to Laertes." See Winifred Smith, *The Commedia dell'Arte* (New York: Benjamin Blom, 1964), 5.

[260] The printed text reads *e*.

beauty in an animate or inanimate body, rational or irrational, the excellent painter will always do this as he wishes in all things and in each of their parts, apart from what he can feign outside nature in his fashion.

It is therefore not true (turning to the two principal headings of the stated clause) that defective human bodies cannot be reduced to true symmetry by art, as Zarlino says, but it is indeed true that artificial musical instruments correct not only the natural of the voices (I am not saying this with respect to the material of the sound; I am saying it with respect to the form of the intervals) and especially that the voices learn from instruments the fashion of giving the forms that are desired in the intervals. If not from instruments, the voices learn the fashion at least from whoever has previously learned it from instruments. We could therefore truthfully speak of having from nature the material (which is sound, of voices as much as of strings) and from art the form of whatever interval [-80-] (consonant as much as dissonant). And let this be a sufficient response to the fourth clause.

Later on, his chapter continues in this manner:

> *For if it came about otherwise, we could say that it was a return anew to the principle, inasmuch as painting is an imitation solely of what has emerged from a natural thing, and it would be an attempt to wish to deviate it from its proper nature and proper goal.*[261]

To the repetition of his blunder, I respond that it is not true that painting is an imitation solely of natural things, for the painter is permitted to feign infinitely outside those things that are in nature, and just as this is not true, neither is it true (toward which his goal

[261] Zarlino, *Sopplimenti* I.6, 23: "percioche se altramente auenisse, si potrebbe dire, che fusse un di nuouo ritornarsi al principio; essendo la Pittura imitatione solamente di quello ch'è uscito da cosa [n]aturale; & sarebbe un tentar di uoler deuiarlo dalla propria natura & dal proprio fine."

aims) that natural voices are better able than artificial instruments to give us the exact form of whatever musical interval. Rather, the latter greatly surpass the former, as has already been said. Nor is saying that there is a fixed order of things a wish to deviate them from the proper nature: it is a wish to conserve them in their natural being. What he says above would come about whenever one wishes things to be outside the natural order in which they are—as he would wish them be, outside every reason.

He continues, so saying:

> *But again applying this discussion to our point, I say that it is not necessary for anyone to believe or imagine himself to be able in music to render simply an exact ratio for the certain and true form of the consonances that are born from the voices by applying them to the sounds that are born of artificial instruments as* [-81-] *some too-wise men have said, for these are not true and natural, but rather at the time when he will apply the sounds to the voices, that is, the artificial to the natural.*[262]

To this ingenious clause, I respond in this manner: the consonances that are born from the voices are not born from nature more than are born those that the strings give us, for nature makes the vocal instruments and, consequently, the voice, but raising and lowering the voice, according to the way that we wish, occurs by having learned it from art. We can therefore have learned punctiliously the same consonances that are in an instrument, and as we render the exact ratio of the form of the consonances of the instrument by their stability (whatever they be), the same precision will be that of the consonances that are in

[262] Ibid.: "Ma per applicare ancora questo ragionamento al nostro proposito, dico, che non bisogna ch'alcuno creda, ne s'imagini di poter nella Musica semplicemente render ragione essatta della certa & uera forma delle Consonanze, che nascono dalle Voci, applicandole à i Suoni che nascono da gli Istrumenti arteficiali, come hanno detto alcuni troppo sauii; percioche queste non son uere & naturali; ma si bene allora, quando egli applicherà i Suoni alle Voci; cioè l'Arteficiale al Naturale."

voices whenever I say they sing them in that measure by which they are contained in such an instrument. The consonances of the voices, therefore, can be claimed to be natural with respect to their material, that is, with respect to the voice, which is a natural thing, as are natural too the hands of a player of whatever instrument. But to raise or lower the voice by determined consonances by giving them one form more than another, or to touch or strike with the fingers that string or key more than another, are wholly artificial things.

In this same fashion we can say of speech that it is natural and artificial. It is natural [-82-] only with respect to the material, that is, the voice is made, as has been said, by the natural instruments acting to make the voice—and especially the articulate voice[263]—but all the rest are artificial, that is, "articulate" more in this than in that other fashion, and what is "articulate" in this or that fashion communicates this or that conception of the soul.

Furthermore, he says that one will not be able to render a ratio for the consonances that are born from the voices by applying the sounds to the voices, that is, the artificial to the natural. It is drawn to our attention in this statement that if we apply the artificial sounds of the instrument to the voices, if these voices will concord with those sounds, they will have the same ratios (as has been said above) as those sounds, and the voices will be artificial since they have learned from art to carry the likenesses to the said sounds. But if the voices will not be concordant with those sounds, these will not be the voices to which those sounds ought to be applied. Therefore, we will never be able to render for these voices the same precise ratio as for the sounds because they will be

[263] Galilei is referring to articulate sound, which presupposes some kind of organization into letters, words, etc. We can assume that Galilei considers all language to be artificially constructed, as well as tuning systems.

different from them. Again, it is drawn to our attention that if we cannot render (according to what he says) for the consonances that are born from the voices an exact and certain ratio for their form and can do so for those of the artificial instruments, whenever, therefore, voices will be applied to sounds, we will be able to render very properly a ratio and not on the contrary as some too-mad men[264] have said. [-83-] To render an exact ratio for the measure and form of whatever thing, it is not necessary that such measure and form be true and natural because I can very properly render an exact ratio for the form and measure of a monstrous man without also knowing what they would be for a well-proportioned man. If Zarlino finally recognized, as he says, that it is impossible to be able to render a ratio for the exact form of the consonances that are born from the voices, why has he said to us that the voices sing the Syntonic of Ptolemy, a thing so limited, determined, and certain?

All of this confusion is born from the false principle, as I am about to demonstrate at the end of this, my *Discorso*. It is therefore not true that one cannot render an exact ratio for the intervals of the sounds of artificial instruments without applying them to natural voices, but it is indeed true, on the contrary, that one cannot render an exact ratio[265] of the intervals of the voices without applying them to the sounds of the artificial instruments.

He adds later on:

Truly, it is indeed a laughable thing that they have wished and believed that the consonances produced naturally by the voices in their true forms be by their nature such that they recall among them the same forms and proportions as those

[264] Galilei parodies Zarlino's saracastic reference to "too-wise men" in the above quotation.
[265] The printed text reads *render ragione dell'esatto*.

> *produced by the sounds of some artificial instruments, tempered in their intervals outside the true and natural proportions, according to what nature—as I will say—seeks and allows and their disposition.*[266]

See [-84-] how Mister Gioseffo shows himself to be bold in this seventh clause (and he repeats this in chapter 10 of the fourth Book).[267] And whoever should see and hear him and did not understand him (as occurs to those of his clique) would believe that he has all the reasons in the world. Now, listen to me a bit, please, as by and by his pride will be lowered.

Consonances are not produced naturally by the voices in their true forms, but artificially through long practice taught from the art of singing properly, just as the hands of an excellent player have become such through long exercise taught by the art of playing properly; they are not naturally born such, as Zarlino wishes, but they are born acting properly to make themselves such by the means of art.

Just now, this man said that we cannot render an exact ratio for the form of the consonances the voices sing, and at present he adds that the consonances the voices sing are in their true form. But let us leave this aside and come to say that there is no one apart from him who has wished that the consonances produced by the voices should have by their nature the same proportions as have the consonances of instruments tempered

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[266] Zarlino, *Sopplimenti* I.6, 23: "Veramente è ben cosa da ridere, c'habbiano uoluto & creduto, che le Consonanze prodotte dalle Voci naturalmente nelle lor uere forme, siano per loro Natura tali, che ritengono tra loro quelle forme e proportioni istesse, c'hanno le prodotte da i Suoni d'alcuni Istrumenti Arteficiali, temperati ne i loro interualli fuori delle uere & naturali proportioni, secondo che ricerca & comporta la natura, dirò cosi, & dispositione loro." In the *Discorso*, the printed text reads *ritenghino* instead of *ritengono*.

[267] In the *Sopplimenti* IV.10, 151, Zarlino writes: "by this they wish to say and conclude that those intervals that we sing in our cantilenas are not sung in their natural forms or contained in the said artificial system of the natural and Syntonic, but that they are the same that are found in the said tempered artificial instruments. Truly they demonstrate that they are in great error . . . [da questo uogliono dire, & concludere, che quelli Interualli che cantiamo nelle nostre Cantilene, non siano cantati nelle lor Forme naturali, ne contenuti nel sudetto Systema arteficiale del naturale & Syntono; ma che siano gli istessi, che si trouano ne i detti Istrumenti arteficiali temperati, uengono ueramente à dimostrare d'essere in grande errore]."

according to their rules. We can recognize his vapidity from this. The Syntonic that Ptolemy made is a single Syntonic, nor can it ordinarily have in whole [-85-] or in part another form than what its author gave it, which is limited and determined by its art within those numbers and proportions in which it was constituted by him. This man has said in a thousand places that what is played and sung today is wholly the Syntonic of Ptolemy, which he affirms in this same chapter. At present, he says that it is a laughable thing to wish that the consonances produced by natural voices should have the same proportion as those of artificial instruments. Now, if there is one Syntonic and the voices sing it and the instruments play it correctly as it stands (which the one and the other can do very well), in singing and playing, the same intervals must necessarily be concordant between them, considering that whenever two things are, each of them, equal to a third, they are necessarily equal between them. But he, according to what he says, wishes that the voice fabricated by amazing nature should by the power of Morgan le Fay[268] naturally have (and not by having learned it from art) the faculty of forming whatever musical interval in such excellence that art cannot adjoin there.

Now, if the matter is as he says—whether he happens to say that the voices sing the Syntonic or the diatonic or another species of melody full of a thousand imperfections—it should be enough to say that the voices sing naturally the musical intervals [-86-] of the most excellent measure that man can ever imagine because nature infinitely surpasses art—leaving to one side the *senario* number, the harmonic numbers, and the genera of proportions—and to bother only with whoever may believe him in this,

[268] Morgan le Fay is the legendary half-sister of King Arthur and a powerful sorceress who could change her appearance at will. Because Zarlino claims that natural voices can alter the intervals of Syntonic tuning so that no unwanted dissonances are ever heard, Galilei jests that he must be using Morgan's magical power to make the trick work.

without seeking any further. The whole is then very well accommodated. But this, his *intemerata*,[269] is the most ridiculous thing a man ever imagined and not to be believed by him or even by those who have fear of Morgan le Fay. Anyone who has properly understood things has properly believed (turning to my principal aim) and wished that the consonances of voices should have the same proportions as the consonances of artificial instruments whenever the voices carry themselves according to the way in which the sounds are distributed on the instruments. But if the instrument will have the sounds distributed in one form and the voices tend towards another, the proportions will not be the same at the time, and consequently they do not tune together. To believe that things are far from being what they are and different from their nature and from the possible is a thing peculiar to his nature.

Now let us hear this other conclusion:

Because they have been deceived by this false principle, they are forced to demonstrate in many fashions that it is true.[270]

No one is forced to demonstrate that the proportions of the voices are always and naturally the same [-87-] as those of the instruments because on instruments the sounds are distributed at the pleasure of the musician forming and[271] tempering the instrument in his fashion, and the voices are carried high and low as the singer (after having learned it) wishes. Nor is the connection between the proportions of the instrumental and vocal

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[269] Galilei may be referring to "O Intemerata," a Marian prayer that was commonly found in Books of Hours. Due to the length of the prayer, the term "intemerata" was used to refer to a long and boring discourse. On the other hand, in his 1611 Italian-to-English dictionary, John Florio crosslists *intemerata* with *faggiolata*, which he defines as "a tittle tattle or flim flam tale without rime or reason, head or foot, as women tell when they shale peason." The latter meaning may be more appropriate in this case. See John Florio, *Queen Anna's New World of Words* (London: Edward Blount and William Barret, 1611), 177, 262.

[270] Zarlino, *Sopplimenti* I.6, 23: "Ilperche ingannati da questo falso Principio, si hanno sforzato di dimostrar in molti modi ciò esser uero;"

[271] The printed text reads *è*.

consonances anything natural but wholly artificial and voluntary. So, only Zarlino and his clique remain deceived in this business by his false principles.

There follow later on in the said chapter these words:

Therefore, they have firmly held that the natural[272] *Syntonic species of Ptolemy is neither sung nor played nor composed in any manner, believing that those intervals born from the voices as much as those that are made by sounds are contained in the ancient species of the Ditonic diatonic and in other species too, although I was forced in the* Istitutioni *and in the* Dimostrationi *with every manner of reason to make them recognize that this is not true.*[273]

That the Syntonic of Ptolemy is neither composed nor played nor sung is not inferred from the things said above by him, for they do not pertain one whit to this point, but from the other reasons as yet left out by him in his vigor. That what is played and sung today is not the ancient Ditonic diatonic—it is an impertinence to treat of this, for it has imperfect dissonant consonances where those that we use today, either among the voices or [-88-] among the strings, are consonant. Thus, all that he says of this business at present is only to befuddle simpletons.

Let us come now to the tenth clause devoid of sentence structure and full of idle words as any other; and it is this:

And as they remain greatly obstinate how in the artificial order of such species they have found many imperfections and many intervals that do not serve for the

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[272] The printed text reads *uaturale*.

[273] Zarlino, *Sopplimenti* I.6, 23-24: "onde hanno tenuto per fermo, che non si canti, ne si suoni, ne si compona per alcun modo la specie Naturale ò Syntona di Tolomeo; credendosi, che tanto quelli Interualli che nascono dalle Voci, quanto quelli che si fanno per i Suoni, siano contenuti nella Specie antica del Diatono diatonico, et anco in altre specie: quantunque nelle Istitutioni & nelle Dimostrationi mi sia sforzato con ogni maniera di ragione di fargli conoscere, ciò non esser uero."

> *Syntonic because they are contained by other forms, such as by those that are among the parts of the* senario, *therefore on this discourse they have a thousand ridiculous things and beside every point and concluded many, many vain things, as we see in their writings full of a thousand dreams, although they could have been clear on this by means of the tunings made by them on many instruments on which the thirds, the sixths, and their replicates*[274] *are recognized to be consonant; and they could learn this from the principles that they take in order to conclude and lead their demonstrations (which they say and affirm) to the goal that such intervals are dissonant; and they could know that this could not be a true relationship.*[275]

Now here is the response. In which artificial order are found those many imperfections that he says?[276] If in the Diatonic,[277] it is an impertinence to speak of it because the controversy is between the Syntonic and what we sing today. If those imperfections are in the Syntonic, what does he wish us to infer when he says that they do not serve for the Syntonic? Now I have found it! Zarlino wishes that when the Syntonic is sung, only those

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[274] The replicates of a given interval are simply that interval plus one or more octaves. For example, the replicates of a major third are the major tenth, major seventeenth, etc.

[275] Zarlino, *Sopplimenti* I.6, 24: "Et tanto maggiormente restano ostinati, quanto nell'ordine Arteficiale di cotal specie hanno ritrouato molte imperfettioni, & molti Interualli che non seruono al Syntono; per esser contenuti da altre forme, che da quelle che sono tra le parti del Senario: Laonde hanno sopra di questo discorso mille cose ridiculose & fuori d'ogni proposito, & concluso molte & molte cose uane, come si uede ne i loro scritti pieni di mille sogni: ancorache di questo potessero esser chiari col mezo de gli accordi fatti da loro in molti Istrumenti, ne i quail si conosceuano le Terze, le Seste, & le loro Replicate essere consonanti, & lo poteano imparare da i Principii, che pigliano per concludere & condurre al fine le loro Dimostrationi, iquali dicono & affermano, che cotali Interualli sono Dissonanti; & poteano sapere, che ciò non potea esser uero à patto alcuno."

[276] Zarlino is referring to the artificial Syntonic system, that is, a diatonic scale constructed entirely from Ptolemy's tetrachord. Although Galilei has already rejected the notion of an "artificial" Syntonic scale and a "natural" Syntonic scale, in this instance he appears not to understand the scale systems described by Zarlino in the *Sopplimenti* IV.6. See pp. 129-32 *supra* for an explanation of Zarlino's tripartite scale system.

[277] The printed text reads *Diatono*, but Galilei probably intended the species *Ditonieo*, or ditonal, rather than the genus, diatonic.

consonant intervals from it that are found [-89-] among the parts of the *senario* may be taken. Now when this is conceded to him, what has he to do with those fifths and those fourths and those[278] dissonant major and minor thirds that are found among the strings of the same Syntonic and their forms outside of the parts of the *senario*? He wishes that they be made in the measure of the others that are consonant contained among the parts of the *senario*.

Let us turn now to the same matters. What we will sing, therefore, is not the Syntonic as Zarlino and Ptolemy design it for us but another distribution of strings, for after he had ordered and distributed the Syntonic, Ptolemy never said that only those intervals that are found among the parts of the *senario* were adopted by him, and I remain surprised that this man should have so much courage to seek anew to persuade the world of his vapidities that, in addition, he goes about raving in a dream the blunders that he adds about the tunings of their instruments, mixing indistinctly (like one who does not know what he wants to say) the Syntonic[279] with the diatonic[280] with the tuning and mistuning of the intervals because the sailing chart[281] would not give him his bearings.[282] Now he wishes that I should necessarily show him (when beyond reason, all that he would wish was already conceded to him) that in the manner of singing so many parts together, the consonant intervals are not sung in the measure in which they are contained among the parts of the *senario*, on [-90-] which he has made such a racket.

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[278] The printed text reads *quello*. Galilei surely intended the plural *quelle*.
[279] The printed text has a period immediately following *Syntonic*.
[280] See fn. 277. The species *ditonieo* was probably intended.
[281] *Carta di nauicare*.
[282] Galilei's allusion to cartography may be a pointed reference to the impact of modern editions of Ptolemy's *Geographica* on sixteenth-century mapmakers. The *Geographica* provided scholars with a tripartite model for mapping the known world in early modern Europe and was especially influential in Venice. The analogy reminds us that Zarlino's intrest in Ptolemy is part of a larger intellectual trend in Italian culture. For a discussion of Ptolemy's impact on cartography, see Denis Cosgrove, "Mapping New Worlds: Culture and Cartography in Sixteenth-Century Venice," *Imago mundi* 44 (1992): 65-89.

Now let me expand a bit on the fifteen strings of the Greatest System, the extremes of which are in the quadrupla [4:1] proportion—three contiguous sesquialteras [3:2s] and one sesquiquinta [6:5][283] or truly four sesquitertias [4:3s] and one sesquiquinta [5:4],[284] as he goes about babbling in the eleventh chapter of the fourth Book without any true conclusion (and at that time I will believe that the *senario* number and amazing nature, together with Morgan le Fay, may be able to do the miracles that he says). But it is not possible from the parts of the *senario* or from whatever other numbers that may be in the nature of these parts to have perfect consonances and imperfect[285] consonances successively that are consonant because they do not have the capacity for it. But when all the perfect are consonant, the parts of the imperfect must necessarily turn out to be dissonant, and whoever wishes all the imperfect consonances to be consonant will make parts of the perfect consonances dissonant, as we can clearly gather from the examples placed below.[286]

[-91-]

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aa. 40
      sesquialtera [3:2]
d.  60
      sesquialtera [3:2]
G.  90
      sesquialtera [3:2]
C. 135
      sesquiquinta [6:5]
A. 162
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[283] I.e., three fifths and a minor third, or 3x3x3x6:2x2x2x5 = 162:40 = 81:20, which is larger than 4:1 by a syntonic comma, i.e., 81:20-4:1 = (81x1):(20x4) = 81:80.

[284] I.e., three fourths and a major third, or 4x4x4x4x5:3x3x3x3x4 = 1280:324 = 320:81, which is slightly smaller than 4:1 by a syntonic comma, i.e., 4:1-320:81 = (4x81):(1x320) = 324:320 = 81:80.

[285] The printed text reads *imperfetre*.

[286] The following examples present four sequences of intervals that add up to a double octave. In adding up the ratios that constitute each series, however, it is clear that only the second and fourth examples, which contain dissonant thirds, are numerically equal to 4:1.

aa. 40
sesquialtera [3:2]
d. 60
sesquialtera [3:2]
G. 90
sesquialtera [3:2]
C. 135
32:27 dissonant semiditone
A. 160[287]

[-92-]
aa.324
sesquiquarta [5:4]
f. 405
sesquitertia [4:3]
c. 540
sesquitertia [4:3]
G. 720
sesquitertia [4:3]
D. 960
sesquitertia [4:3]
A.1280

aa.320
81:64 dissonant ditone[288]
f. 405
sesquitertia [4:3]
c. 540
sesquitertia [4:3]
G. 720
sesquitertia [4:3]
D. 960
sesquitertia [4:3]
A.1280

[287] In his "Discourse Concerning the Various Opinions that the Three Most Famous Sects of Ancient Musicians had Concerning the Matter of Sounds and Tunings," Galilei suggests that the Pythagoreans derived the 32:27 semiditone by subtracting three 3:2 intervals from the double-octave of the Greater Perfect System, just as adding a semiditone and three perfect fifths equals a 4:1 double-octave in this example. A transcription and translation of the essay is found in Palisca, *Florentine Camerata*, 166-69.

[288] In the "Disourse . . . Most Famous Sects," Galilei claims that the Pythagoreans derived the dissonant 81:64 ditone by subtracting four 4:3 intervals from the Greater Perfect System. See Palisca, *Florentine Camerata*, 168-69.

If any distribution of strings has to give us demonstratively a single constitution among the stable strings, there is none other than the Intense Diatonic of Aristoxenus. The musical intervals that are contained among the parts of the [-93-] *senario* are just as natural (as I have said) as the others that are outside its parts, and[289] the ditone contained by sesquiquarta [5:4] is just as natural as the one that is contained by 81:64. Just as, again, it is just as natural to tune the octave within the dupla [2:1] as it is natural for the seventh within 9:5 to sound dissonant. And Zarlino may break his brains as much as he likes.

Later on the eleventh clause continues, saying:

> *And to conclude, I say that it is express madness to believe that nature can be corrected as if she were inferior to art and that the latter can be compared to the former.*[290]

Express madness is truly his for having affirmed above with the Philosopher that nature, erring in what is emendable, can be corrected by art,[291] and now he denies that she can be corrected by art, as inferior to her, not noticing that in all that art can do and nature cannot, art is superior to nature, and in all that nature can do and art cannot, art is inferior to nature. Therefore, whenever nature comes to be corrected by art, it occurs because she is inferior to it.

He goes on later, continuing:

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[289] The printed text reads *è*.

[290] Zarlino, *Sopplimenti* I.6, 24: "Et per concluder, dico, che è pazzia espressa, il creder che si possa corregger la Natura; come ch'ella fusse inferiore all'Arte; & che si possa agguagliare à quella . . . ." Galilei ends this quotation in the middle of a clause. The remainder of the clause is included in the next quotation.

[291] Cf. the passage from Zarlino on pp. 75-76 of the *Discorso* (p. 334 *supra*): "And if indeed the artisan ofttimes (as the Philosopher opines) compensated in many things for the defects of nature herself, . . . [Et se ben l'Artefice spesse fiate (come auisa il Filosofo) sopplisse in molte cose à i deffetti di essa Natura]."

For just as the natural is greatly different from the artificial—and especially in genus—so nature and art are very different as operants and efficients.[292]

Responding to this, I say:[293] nature and art are two efficient causes, each of which is perfect in its genus, nature in doing natural things and art in doing artificial things.[294] Thus, [-94-] in doing natural things, art cannot be compared to nature, and in doing artificial things, nature cannot be compared to art. When it occurs that art and nature work on the same subject, art is born from being able to do something nature cannot do, and nature will be able to do something art will not be able to do. There is no one who does not know the difference that is between them. Zarlino wishes to put the difference where it is not and never was, i.e., between the musical intervals because he wishes that a fifth, fourth, a third, etc., be natural in the voices and artificial in instruments among the strings. I repeat again that sound and voice,[295] as the material of these intervals, is natural, as much in instruments as in voices. Just as it is natural, too, that intervals of this measure sound consonant and of that other measure sound dissonant, measure is artificial as much among the natural voices as among the strings of artificial instruments, as has been said, and Zarlino may find as many fantasies as he likes.

Later on, he adds:

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[292] Zarlino, *Sopplimenti* I.6, 24: "percioche si come il Naturale è di gran lunga differenti dall'Arteficiale, & specialmente nel Genere; cosi sono molto differinti, come operanti & efficienti la Natura e l'Arte."

[293] The printed text has a period after *dico*.

[294] In Aristotle's conception of the four causes (*Physics* 2.3 [192b8-195a3]), the efficient cause is the "primary source of change or rest." Galilei argues that both nature and art are capable of fulfilling this function and each excels in its own genus. See *The Complete Works of Aristotle*, 1:332.

[295] Galilei is referring to the sound that is produced by instruments (*suono*) and the sound that is made by the voice (*voce*).

And just as it cannot be that operative nature imitate art in operating, so we cannot conclude from art anything in nature that is not beside the point.[296]

Therefore, I respond that it is true that operative nature does not ordinarily imitate art because she operates without cognition. But in the course of time, nature also accustoms herself to imitate art in its operation, as occurs with regard to the Macrocephali [-95-] of whom Hippocrates speaks, and from this it does not follow that we cannot conclude from art some things about those of nature, as was proved above.

He then adds:

Because if by chance anyone shall wish to argue and conclude from a thing of art, as I have said, or from the artificial about a thing of nature or about the natural, he will turn out (so to speak) to wish to conclude from the things contained in one genus about those that are contained in another.[297]

These so subtle distinctions declare Mr. Gioseffo to be a very penetrating philosopher, but please draw to your attention that "to not pass from one genus to another," according to the precept of Aristotle in the *Posterior Analytics,* is understood in those genera in which there is no occasion among them to pass from one to another. But in art and in nature, because they sometimes have the same subject (as has been demonstrated), an occasion is born, based on the commonality of the subject, to pass and argue from one of the two about the other without defacing one whit the order of philosophy. He is, however, to be thanked for the advice and for having the pleasure of seeing him zealous

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[296] Zarlino, *Sopplimenti* I.6, 24: "Et si come non può esser, che la Natura operatrice imiti l'Arte nell'operare; cosi non si può dall'Arte concludere alcune cose nella natura, che non sia fuor di proposito."

[297] Zarlino, *Sopplimenti* I.6, 24: "Ilperche se per auentura alcuno da una cosa dell'Arte, come hò detto ouer dall'Arteficiale uorrà argomentare & concludere in una cosa della Natura ò nella Naturale, uerrà (per modo di dire) à uoler concludere dalle cose contenute in un Genere à quelle che sono contenute in un'altro." Zarlino is drawing from Aristotle, *Posterior analytics* I.7: "One cannot, therefore, prove anything by crossing from another genus—e.g. something geometrical by arithmetic." See *The Complete Works of Aristotle*, 1:122.

in regard to the conservation of the order of things, although his fashion may be more often to destroy them than to conserve them.

Later on, he adds this other pretty attention-getter:

In music, however, we will never be able to say that this is proper: among the sounds in[298] *the artificial instrument, we always find such a thing and such a defect; therefore, we also always find this among the voices. Likewise:* [-96-] *this thing is not found in the artificial instrument; therefore, it is also not found in the natural instrument.*[299]

To this, I repeat that it is very proper to say: such defects are always found in the artificial instrument (as would come about when correctly playing the Syntonic designed for us by him); therefore, the same defects the Syntonic has in itself will always be found among the voices every time that it is correctly sung by them[300] as played. But if the instruments will play some distribution perfect in all parts (as they truly can, but not according to the rule of Zarlino) and the voices will sing an imperfect one, who (except for him) is so insensible to say that they are the same when they are different?[301]

Later on, he adds one of his importune repetitions, so saying:

Also, on artificial instruments, we do not find and do not play the natural Syntonic species of Ptolemy; therefore, we neither sing nor compose the said species.[302]

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[298] The printed text reads *uell*.

[299] Zarlino, *Sopplimenti* I.6, 24: "Però nella Musica non si potrà mai dire che stia bene; nell'Istrumento Arteficiale tra i Suoni sempre si troua cotal cosa ò cotal diffetto, adunque si troua anco sempre tra le Voci. Simigliantemente; Questa cosa non si troua nell'Istrumento Arteficiale; adunque non si troua anco nel Naturale."

[300] I.e., the voices.

[301] The printed text reads *diffe renti*.

[302] Zarlino, *Sopplimenti* I.6, 24: "Ancora; Ne gli Istrumenti Arteficiale non si troua & non si sona la specie naturale ò Syntona di Tolomeo, adunque non si canta, non si compone la detta Specie." Zarlino continues to cite Galilei's ideas with which he does not agree.

To this repetition, I respond that he has done it with the natural Syntonic and the artificial Syntonic, and I say again that Ptolemy made only one Syntonic Diatonic, to which he did not give some name or cognomen of natural or artificial. To say, then, that it so pleases him seems to me to be the same reason that Orlando used at the height of his fury.[303] If he has no other defense than this for his escape, it was more honorable to consent to the truth as soon as he recognized he was in error; to seek to defend himself with [-97-] means such as these makes the offense greater. Therefore, I say that the Syntonic species of Ptolemy will be found in those artificial instruments whenever their sounds are divided according to the intervals placed by Ptolemy in that distribution, and instruments that will be divided otherwise will never have any relationship with it; the same will come about for the voices.

The final clause of the chapter is such:

> *With respect to this matter, every time that anyone will wish on this foundation or artificial order of the Syntonic to conclude anything about the natural order, which is noted with respect to the following things, we will be able to say that he has a very great branch of madness and that all the reasons and demonstrations that he will make, either with numbers and proportions or with measures, will be vain and useless and he will not have any good cognition of the things from which all the arts and sciences are generated.*[304]

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[303] Galilei is referring to Ludovico Ariosto's version of the story of Charlamagne's paladin Orlando. After learning that his beloved Angelica has married the African soldier Medor, Orlando loses control of his actions and begins a murderous rampage through the European countryside. See Ludovico Ariosto, *Orlando Furioso* (canto 23), trans. Guido Waldman (Oxford: Oxford University Press, 1974), 279-84 (canto 23).

[304] Zarlino, *Sopplimenti* I.6, 24: "Per laqual cosa tutte le fiate ch'alcun uorrà da questo fondamento, ouer'ordine Arteficiale del Syntono concludere alcuna cosa nell'Ordine naturale; ilche è da notare, per le cose seguenti; si potrà dire, che habbia un grandissimo ramo di pazzia, & che tutte quelle ragioni & dimostrationi ch'ei farà, ò con numeri & proportioni ò con misure, saranno uane & inutili, & non

Does it seem with respect to the final clause that Mister Gioseffo could have found a more sensible conclusion than this? Now listen to the response. The order of the Syntonic is wholly artificial, made by the artifice of the same Ptolemy. If this will be played by instruments, the instruments will be made with the same divisions as the Syntonic was divided by this Ptolemy. If it will be sung with voices, if indeed the voices are natural, it will be sung nonetheless according to the artifice learned by the singer in the course of carrying the voices precisely according to the intervals from which it is composed. If, however, they will wish [-98-] to consent to its imperfection, so, this Syntonic or whatsoever other distribution of strings—whether sung or played—will always be artificial and will always have those consonances and dissonances that their author established there, without the *senario* number or other impertinent Zarlinesque innovations having any part.

It is, then, notable madness to believe that this Syntonic should be artificial when sounded by instruments and natural when sung by voices, inasmuch as voices will never sing it unless with long practice they have first learned it from the art of singing. When anyone repeated to me that those who go along the roads of the city crying and singing the names of things they have to sell proceed altogether naturally from their exercises without having learned about tones, semitones, and any other composite interval greater than these from art, I responded to him that if he described them in the precise measure they are sung by them[305] and compared them to the true,[306] he would perceive a greater difference there than between the animals, birds and anything else that nature sometimes

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haurà alcuna buona cognitione delle cose, dellaquale si generano tutte l'Arti e tutte le Scienrie [*sic*]." The printed text of the *Discorso* is missing a period after *scientie*.

[305] I.e., the singing hawkers.

[306] I.e., the true forms of the intervals.

depicts as a joke in speckled marble and in the veins and nodes of ash[307] and olive compared to those that are designed and colored by a learned hand.[308] The expert singer, then, is one who when jesting in imitating them—or for his own comfort—makes them become the true measure, just as artisans, too, improve [-99-] with their artifices the design and coloring of the aforesaid animals and birds.

Laughter and tears are natural to men, Mr. Gioseffo, and we laugh and cry naturally without having to learn from art. But to sing—and, even more, in a regulated fashion—is taught by art. Although the material of singing, which is the voice (as has been said), is had from nature, to know how to form the intervals at will, consonant as well as dissonant (be they of whatever measure and proportion), is taught by art. So, all the reasons Zarlino could adduce that depend on his false principles, upon which almost all his work is founded (according to what he says), will be vain and useless. With these reasons he will come, little by little, to declare himself fully as a man without any cognition of the truth of things from which all the arts and all the good sciences are generated.[309]

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[307] The printed text reads *Fra sino*.

[308] Ancient writers, including Pliny and Aristotle, discussed the fortuitous manner in which man can find images in clouds, stones, and tree trunks. Renaissance artists, beginning with Leon Battista Alberti, recognized nature's ability to randomly form objects, and Leonardo da Vinci wrote about it in his unfinished treatise on painting: "look at walls splashed with a number of stains or stones of various mixed colors. If you have to invent some scene, you can see there resemblances to a number of landscapes, adorned in various ways with mountains, rivers, rocks, trees, great plains, valleys and hills. Moreover, you can see various battles, and rapid actions of figures, strange expressions on faces, costumes, and an infinite number of things, which you can reduce to good, integrated form." For an overview of this phenomenon in Renaissance literature on the visual arts, see H. W. Janson, "The 'Image Made by Chance' in Renaissance Thought," in *De artibus opuscula XL; Essays in Honor of Erwin Panofsky*, 2 vols., ed. Millard Meiss (New York: New York University Press, 1961), 254-66.

[309] Galilei concludes his discussion of *Sopplimenti* I.6 by mocking Zarlino's final statement in the chapter.

Let as much as I have said in regard to his works be sufficient for now because at another time on a better occasion I have to treat them at greater length.[310] Returning, therefore, to my discussion elsewhere, I say that if indeed in my *Dialogo dell'antica, et della moderna musica* and anew in this, my *Discorso*, I have demonstrated that the species of melody that is sung today is not (according to the way in which Zarlino designs it for us) the Syntonic of Ptolemy, for all that, I have not demonstrated (as a matter not pertaining to me until now) [-100-] what it is.[311]

At present, then, I wish to demonstrate it for the greater satisfaction of the scholars of this field, with a greater brevity than he[312] will have conceded to me. I will do so at the request of those who believe that perfection in this affair consists of the stability of demonstrable strings, and I will bring this out without much difficulty after we understand the different opinions the ancient musicians and philosophers had in regard to their diatonic distributions.

Commencing from this, I say that among the different species of melody that were distributed and ordered by the aforesaid musicians and philosophers, three have been the most famous. First was that of Pythagoras or, to say it better, what he believed was sung in his times. This species, copious in tones, acquired the name Ditonic Diatonic. Second was that of Didymus, and he named it Syntonic Diatonic. After many years, Ptolemy attributed it to himself—or it was attributed to him by others.[313] Third and final was that

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[310] Perhaps this is an allusion to his unfinished critique of the *Sopplimenti*.

[311] Galilei will finally offer his own description of modern tuning.

[312] I.e., Zarlino.

[313] Galilei's discussion of the ancient tuning systems is a response to a similar tract in the *Sopplimenti*. In regard to musical science, Zarlino considers two important ancient sects, the Pythagoreans and the Aristoxenians. Both sects are reconciled in the writings of Ptolemy, in which both reason and sense are considered. In Galilei's formulation of the ancient sects, Didymus gets credit for balancing the needs of reason and sense and Ptolemy (Zarlino's model) is relegated to the role of transmitter of others' ideas. See Zarlino, *Sopplimenti* I.15, 40-42.

of Aristoxenus, called by him Intense Diatonic. In ordering their distributions, those musician and philosophers together had no other goal then to represent to the sense and the intellect the measure and proportion by which the intervals were or ought to be sung by practitioners. This speculation is truly worthy of great praise for each of them, for with it and with no other means were we able until the present day to conserve in our [-101-] memories what the precise form of each one of the said intervals was and ought to be, according to their different opinions. With these means, we can with few words transfer the fashion of singing and the temperament of whatever musical instrument, wind or string, from whatsoever place to another.[314]

Pythagoras, therefore, in seeking the exact form of the musical intervals of his times, great arithmetician that he was, aimed as a worthy purpose only for the reason of number. Basing himself on this, he ordered his distribution of strings according to the way in which he believed the said intervals were sung or according to the way in which it was necessary to color his designs.

Didymus, then, in the distribution of his system, had the same respect for numbers but not with such severity that he did not seek more than what Pythagoras had first sought: to satisfy—as in part he satisfied—the sense of hearing with their means.

Aristoxenus, finally,[315] with a greater will than any other ancient musician to satisfy the same sense, having recognized the imperfections (insofar as we are accustomed today to the fashion of singing more parts together in consonance) of the two

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[314] In other words, musicians can transfer tunings from voice to instrument or vice versa, regardless whether the instruments are natural or artificial, by understanding the elements of each tuning system.

[315] The text suggests that Aristoxenus developed his system after the Syntonic Diatonic was created by Didymus, but Aristoxenus lived centuries before Didymus was born. It is difficult to imagine that Galilei did not know this, but this sentence suggests that he does not understand the chronology of these tuning systems.

distributions with respect to being able to demonstrate them among stable strings, sought the matter elsewhere and where it truly was.[316] Having found it at last, he was content without any prejudice of reason and with little prejudice of the sense of hearing that his distribution was such that we could [-102-] have and desire, both by the nature of the thing from which he extracted it and from the sufficient need of the art of demonstrating.

Now, for a fuller explanation of this business, it must be known that before Pythagoras was born, we sang and played (according to the different opinions of musicians) both in unison and in consonance. It must be known, in addition, that the same musicians named their intervals with names that correspond to ours, part of which we have taken as a loan from them, such as tone, semitone, tritone, and semidiapente. Later on, they had the ditone and the semiditone corresponding to our major and minor third. Those that we postulate as fourth, fifth, and octave, they called their diatessaron, diapente, and diapason. In addition, those that were called by them major hexachord and minor hexachord are claimed by us major sixth and minor sixth. And finally, those that we postulate as major seventh and minor seventh were called by them major heptachord and minor heptachord after the number of the strings.[317]

Although the names of our intervals correspond, as I have said, to those of the ancients, they are not the same as those the Pythagorean numbers contain.[318] Pythagoras knew all of these particulars and, in addition, that the tone was the excess by which the diapente surpasses the diatessaron and that [-103-] the semitone was the space (to say it

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[316] Aristoxenus certainly did not write about any music similar to sixteenth-century polyphony, but Galilei is asserting that monochord divisions, such as the one Zarlino used to demonstrate Syntonic tuning in the *Istitutioni* II.39, do not explain the function of a given tuning system in polyphonic music and therefore hide many of the dissonances that occur when such a system is strictly applied in performance.

[317] Hexachord is the Greek term for "six strings." Likewise, "heptachord" could be translated as "seven strings."

[318] The printed text does not have a period here, but there is a large space at the presumed end of the sentence, and the next word, *Sapeu*, begins with a capital letter.

in our usage) that we find between *b fa* and *b mi*—or we might wish to say that interval by which the diatessaron surpasses the ditone. With all this cognition, however, Pythagoras did not know the proportion and measure of any of these intervals or by how much the one measurably surpassed or was surpassed by the other, but he had familiarity with this from the sound and weight of the hammers, as Boethius recounts for us with the testimony of Macrobius,[319] by which means he knew that the diapente was in its extreme perfection contained by the sesquialtera [3:2]; the diatessaron by the sesquitertia [4:3], and the diapason equally in its extreme perfection by the dupla [2:1]. I have used this epithet of "extreme perfection"[320] in respect to the fifth and the octave because they would not be allowed to be sharp but rather would be allowed to be flat.[321] Since

[319] The story of Pythagoras and the blacksmith shop is a principal myth in the history of western music theory, repeated in many treatises from antiquity up through Galilei's era. For Boethius's narration, see Godofredus Friedlein, ed., *Boetii De institutione musica libri quinque* (Leipzig: B. G. Teubner, 1867), 196-97; translated in Anicius Manlius Severinus Boethius, *Fundamentals of Music*, translated with introduction and annotations by Calvin M. Bower, edited by Claude V. Palisca, Music Theory Translation Series (New Haven, CT: Yale University Press, 1989), 17-19. An English translation of Macrobius's account of the blacksmith story can be found in Ambrosius Aurelius Theodosius Macrobius, *Commentary on the Dream of Cicero*, translated with an introduction and notes by William Harris Stahl, Records of Western Civilization (New York: Columbia University Press, 1952), 186-87. Macrobius's narration follows: "[Pythagoras] happened to pass the shop of some blacksmiths who were beating a hot iron with hammers. The sound of the hammers striking in alternate and regular succession fell upon his ears with the higher note so attuned to the lower that each time the same musical interval returned, and always striking a concord. Here, Pythagoras, seeing that his opportunity had been presented to him, ascertained with his eyes and hands what he had been searching for in his mind. He approached the smiths and stood over their work, carefully heeding the sounds that came forth from the blows of each. Thinking that the difference might be ascribed to the strength of the smiths he requested them to change hammers. Hereupon the difference of tones did not stay with the men but with the hammers. Then he turned his whole attention to the study of their weights, and when he recorded the difference in the weight of each, he had other hammers heavier and lighter than these made. Blows from these produced sounds that were not at all like those of the original hammers, and besides they did not harmonize. He then concluded that harmony of tones was produced according to a proportion of the weights, and made a record of all the numerical relations of the various weights producing harmony." The narrative continues with an account of Pythagoras's alleged experiment in which he suspended various weights from strings.

[320] The printed text reads *diestrema perfettione*.

[321] In the *Dialogo*, Galilei suggests that contemporary audiences cannot tolerate a perfect fifth in the ratio 3:2 (or its "extreme perfection) because they have become accustomed to a flatter tuning of that interval. Likewise, he claims that the octave will not be tolerated outside of the ratio 2:1. Bardi concludes the discussion of tuning systems in the *Dialogo* (p. 55) with this remark: "Di già vi ho detto, che la Quinta rispetto al mal'vso, quando ella è nella sua vera forma, ci si rappresenta all'vdito piu tosto vn poco acuta (per non dire come altri, noiosa) che altramente; hora pensate quanto piu ella diuerrebbe tale, col tenderla maggiormente di quello che la contiene la Sesquialtera sua proportione. . . . donde nasca poi che l'Ottaua

Pythagoras knew, therefore, that the tone was the excess by which the diapente surpasses the diatessaron, it was not difficult, in subtracting the form of the latter from the former, to then come to a cognition (as he did come) of the proportion by which it was contained, having in addition first recognized by the sound and weight of the hammers, if not the exact proportion, at least close to it. With these and other more efficacious means, Pythagoras found the form of all the other intervals, according to his belief and the capacity of the arithmetic field.

In this place, I wish to draw attention to two false opinions born among men, [-104-] persuaded by the writings of some. I, too, had been among those. About these opinions, inasmuch as I am finally assured by means of experience, the master of things, I say this. They believe that the weights that Pythagoras attached to the strings in order to better hear the consonances were the same as those of the hammers from[322] which he first heard them.[323] Now, that this neither was nor could in some fashion be, experience (as I

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non si comporti ne diminuita ne superflua"; trans. in *Dialogue*, 134: "I already stated that the fifth in its true ratio, because of our abusive custom [of mistuning it], strikes the hearing as rather sharp, and some would say annoying. Now think of how much more so it would be if it were stretched beyond its ratio of 3:2. . . . We do not tolerate the octave either diminished or augmented."

[322] The printed text reads *martellida*.

[323] I.e., the consonances. Evidence of Galilei's "first false opinion" is found in a woodcut from Franchino Gaffurio's *Theorica musica* (Milan: Ioannes Petrus de Lomatio, 1492; reprint in Monuments of Music and Music Literature in Facsimile, II/21, New York: Broude Bros., 1967), an influential and often-cited treatise. The image shows the biblical Jubal discovering the consonances through the sounds of blacksmiths' hammers, but three other scenes depict Pythagoras doing experiments with the same set of proportions noted in the blacksmith story (figure 36).

have said) demonstrates to us because one who wished to hear the diapason from two strings of equal length, thickness, and purity would of necessary suspend weights that were not in duple proportion (as were the hammers) but in quadruple.[324] The diapente will be heard whenever weights of duple sesquiquarta [9:4] proportion are suspended from the same strings, the diatessaron from those in superseptipartiens nonas [16:9], and the sesquioctave [9:8] tone from those in superdecimiseptimipartiens sexagesimasquartas [81:64]. With this method, which is nothing other than multiplying the numbers that form

Figure 36. Franchino Gaffurio, *Musica theorica*, f.bvir.

Claude Palisca has shown that the only experiment that would actually work with these ratios is represented in the final square where Pythagoras and Philolaus are blowing pipes of various lengths. See Claude V. Palisca, *Humanism in Italian Renaissance Musical Thought* (New Haven, CT: Yale University Press, 1985), 227-29.

[324] Galilei offers a more lucid treatment of this topic in his "Discorso particolare intorno all'unisono." In this unpublished essay, Galilei further emphasizes the role of senses in understanding musical intervals. For example, he notes that a "unison" interval is one in which the sense perceives no difference between two notes. In other words, a representive music ratio (1:1) will not constitute a unison between sounding bodies if other physical attributes (e.g., material, thickness, purity) are not equal. For a transcription and translation of this essay, see Palisca, *Florentine Camerata*, 198-207.

the said intervals according to field of arithmetic, all the others will be had.[325] It is not true, therefore (and this is the other abuse), that the consonances cannot be had from other genera of proportions than the multiple and the superparticular.

Turning to the strings, equally, I say that we will be able to have all the intervals from the equality of weights whenever the length of the strings corresponds to the form that the intervals accept from the said field of arithmetic. [-105-] Equally, we will have the diapason from pipes whenever the length and the void—or we might wish to say the diameter—of the low pipe is double the higher pipe. We will have the diapente from those where the diameter and the length are sesquialtera; and the diatessaron from those where their diameter and length be sesquitertia. With this rule, we will have all the other consonant and dissonant intervals. So, the void of these pipes corresponds to the cube; the weights suspended from the strings correspond to the surfaces; and the strings simply stretched on the instrument correspond to the line.[326]

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[325] These ratios are the same as the squares of each number in the proportion. For example the proportion of weights needed to hear the 9:8 tone is equal to 9x9:8x8 = 81:64. Galilei's remarkable rebuttal of the the second Pythagorean experiment, in which consonances are created on hollow pipes, is also found in the *Dialogo*, pp. 134-35; trans. in *Dialogue*, 329-33.

[326] From this statement, it is clear that to find consonances between pipes, Galilei suggests that we must cube the ratios of the string lengths. In other words, to find the octave, or 2:1, the size of the pipes must be in an 8:1 ratio. Likewise, to find the diapason, we would need pipes in a 27:8 (3^3:2^3) ratio. In response to Galilei's theory, D. P. Walker contends that "here it is evident that Galilei did not do any experiments, since the pitch of a pipe is a function of its length and not of its cubic capacity." Although the length of an organ pipe is the chief factor in determining pitch, the width of the shaft is also important. Palisca countered Walker's findings in a later essay, showing that Galilei must have tried out some of the experimental scenarios that he described. With regard to the size of pipes, Palisca does not justify the cubic relations described by Galilei, but he does note Marin Mersenne's observation that an 8:1 relationship between concave bodies will produce an octave. Both Walker and Palisca agree, however, that Galilei's writings were convincing in that they showed that ratios other than the Pythagorean 2:1 could be used to represent octaves. See D[aniel] P[ickering] Walker, "Vincenzo Galilei and Zarlino," in *Studies in Musical Science in the Late Renaissance*, Studies of the Warburg Institute, ed. J. B. Trapp, vol. 37 (London: Warburg Institute, 1978), 24; Claude V. Palisca, "Was Galileo's Father an Experimental Scientist?" in *Music and Science in the Age of Galileo*, ed. Victor Coehlo, The University of Western Ontario Series in Philosophy of Science, no. 51 (Dordrecht: Kluwer Academic Publishers, 1992), 143-52. Galilei himself offers an explanation of this idea in his unpublished "Discorso particolare intorno alla diuersita delle forme del diapason." For a transcription and translation of the essay, see Palisca, *Florentine Camerata*, 181-97.

This doctrine, published as true by Pythagoras, a man of greatest authority, was lent such faith that even today, it is maintained without seeking any further by some who are content only because Pythagoras has said it. But there are two matters that must be considered. The first is whether the musical intervals that were sung before Pythagoras investigated their form were really sung by the measure within which he constituted them after his art; and the second, how it could have come about, given that he heard thirds and sixths to be consonant in instruments and voices and to be dissonant within the forms assigned them by him, that he did not seek the means to make them such as he heard them outside his numbers, as Didymus then did.[327]

In regard to these considerations, I say it is not likely that all intervals were precisely sung as such by practitioners before Pythagoras came to a cognition of their measure, [-106-] and particularly by those who sang in consonance. It can be that those who sang in unison, after having accepted the norm from his[328] distribution, tempered their instruments in that precise manner and together with them[329] sang the intervals in that measure, according to their needs. But this is neither credible nor even possible for those who sang in consonance, first because it has dissonant thirds and sixths, and then because it was impossible to make them consonant by means of the field of arithmetic without making dissonant (as has been demonstrated) parts of the perfect consonances.

From this, then, was born that Pythagoras allowed dissonant thirds and sixths in his distribution, hearing them—from another form beyond—to be consonant, both in

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[327] Galilei assumes that the Greeks sang in tertial harmony, although he does not cite any evidence in the theoretical literature, which adhered to the Pythagorean view of consonance. In the *Istitutioni*, Zarlino discusses the "poverty of consonance" in antiquity. Although he acknowledges the Pythagorean view of intervals, Zarlino also (incorrectly) notes that the wind instruments used in Greece did not have holes and were used only to accompany the choruses in Greek drama. In other words, instruments were not combined to form ensembles or play in tertial harmony. See Zarlino, *Istitutioni* II.1-2, 58-60.

[328] I.e., Pythagoras's.

[329] I.e., the instruments.

voices and in instruments. I respond that when he recognized by means of numbers that it was impossible among stable strings to have one and the other intervals consonant, he more often wished that all those called perfect by us be consonant, rather than part of the perfect and part of the imperfect. For his points, as we also read in Plato and Aristotle, had no need of being served, in treating matters of music incidentally as they treated them, except for those consonances called perfect by us, contained by the forms assigned them by Pythagoras.[330] Nor did they care whether the Greatest System [-107-] had the capacity of three sesquialteras or four sesquitertias, or anything other, leaving (as not pertaining to their speculations) the thought to the practitioners.[331] And so, equally, they did not think about the method of making consonant what are called imperfect consonances by us, nor do I hold now that without having experience of it, Pythagoras might have believed that the consonant sixths and thirds that we have said were sung and played in his time and before were contained by the same numbers as those of his distribution, as men for the most part believed until Lodovico Fogliano came to reveal their error.[332] And this is enough with respect to the invention of Pythagoras.

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[330] Plato discusses the Pythagorean ratios in the *Timaeus* (35b-36b). See Francis MacDonald Cornford, *Plato's Cosmology: The* Timaeus *of Plato Translated with a Running Commentary* (London: Routledge & Kegan Paul, 1937; reprint, Indianapolis: Bobbs Merrill, 1966), 66-72. Aristotle compares the Pythagorean worldview with other Greek philosophies in the *Metaphysics* (985b23-990a32). See *The Complete Works of Aristotle*, 2:1559-65.

[331] Galilei has already shown that in the Greater Perfect System, three 3:2 fifths are less than the double octave by a dissonant minor third. Likewise, four 4:3 fourths are short by a dissonant major third. He cites this as evidence that a purely numerical definition of intervals cannot produce a complete set of perfect and imperfect consonances. See pp. 348-49 *supra*.

[332] Fogliano claimed that our senses hear so many more consonances than were described by Pythagoras. He writes in the *Music theorica*: "They reckon among the consonances no more than these, as it appears from those opinions of his [Pythagoras's] that have reached us. Although this position leans upon the greatest authority, nevertheless it seems false to me, since it contradicts sensation. For who—unless he were deprived of the sense of hearing—would deny that consonances other than the five established ones could be found? [Nec plures his posuerunt consonantias: ut apparet ex suis quae ad nos peruenerunt opinionibus: Sed haec positio licet maxima innitatur auctoritate nihilominus mihi uidetur falsa: quum sensui contradicat: quis enim nisi sensu aurium diminutus neget plures alias a praedictis quinque: inueniri consonantias?]" See Fogliano, *Musica theorica* II.1, f. 11v; trans. in Palisca, *Humanism*, 236.

Didymus, then, comprehending with the intellect the form of the ditone and semiditone and the one and another hexachord, and with the sense, hearing them to be dissonant according to the distribution of Pythagoras and, on the contrary, others beyond those to be consonant both among the voices and in instruments, proceeded to seek whether with the same field of arithmetic they could be made consonant by forming them of another measure. Given, however, as some believe, that such was his goal, he accomplished it too well. And this was, on my advice, the means that he kept, deferring always to the opinion of whoever might have understood better than me.

He proceeded to consider that from the arithmetic division of the dupla was born the sesquialtera and the sesquitertia, as we see here: 4:3:2,[333] which form the diatessaron and [-108-] diapente.[334] Then, dividing the terms of the diapente in the same manner resulted in the sesquiquinta [6:5] and the sesquiquarta [5:4], as we see here: 6:5:4.[335] He found these two intervals to be fairly close to the ditone and semiditone of Pythagoras and especially consonant.[336] The greater of these is equally in its extreme perfection, and one whit sharper would please much less. Then, accompanying the sesquitertia [4:3] with the sesquiquarta [5:4], and the sesquiquinta [6:5] anew with the same sesquitertia [4:3], he had from such pairing the major and minor sixth very close to the major and minor

[333] In an arithmetic division of a ratio, the difference between the upper extreme and the mean is equal to the difference between the mean and the lower extreme. I.e., 4-3 =1; 3-2 = 1.

[334] I.e., 4:3 and 3:2 signify the perfect fourth and perfect fifth.

[335] I.e., 3:2 = 6:4, which can be arithmetically divided by the middle term 5, or 6:5:4. Of course, Didymus did not personally give an account of how he developed his diatonic tetrachord. Galilei's description of Didymus's tuning system, however, is very similar to the manner in which Zarlino explained Syntonic tuning in Part II of the *Istitutioni*. See pp. 57-62 *supra.* In addition to suggesting that Zarlino's work is quite unoriginal, Galilei wants to show that the Syntonic intervals can be formed with arithmetic divisions of larger intervals, just as Zarlino always used harmonic divisions in his proof of Syntonic tuning.

[336] The major third is one syntonic comma smaller than the Pythagorean ditone. I.e., 81:64-5:4 = (81x4):(64x5) = 324:320 = 81:80. The minor third is one syntonic comma larger than the semiditone. I.e., 6:5-32:27 = (6x27):(5x32) = 162:160 = 81:80.

hexachord of Pythagoras and, in addition, consonant.[337] After he seemed to have done this acquisition, he divided the greater part of the sesquialtera [3:2] in this fashion: 10:9:8, from which resulted the sesquinona [10:9] and the sesquioctave [9:8],[338] in which arithmetic disposition Dydimus left them[339] in his system.[340] Ptolemy then corrected it by setting the sesquioctave [9:8] in the low part and the sesquinona [10:9] in the high, perhaps in order to avoid the two contiguous sesquioctaves [9:8s] that come in the distribution of Didymus, the extremes of which are not otherwise dissonant than the Ditonic of Pythagoras. This is the difference that is found between Didymus and[341] Ptolemy. Then, how the other intervals were themselves born in the systems has been sufficiently stated above. That Didymus, in addition, improved or worsened the distribution from what Pythagoras had first ordered, I shall leave to be judged by those [-109-] who have a good cognition of this field.

Now, for an explanation of the Intense Diatonic of Aristoxenus, I shall commence the discussion from a bit of a distance, and I shall speak in his favor (because such is the desire of some of my Aristoxenian friends) insofar as will be conceded to me by the capacity of my intellect. Reserving for its place, however, the truth of which I am about to speak with the permission of each one I sense among them, I say first that I am very

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[337] I.e., 4:3+5:4 = 20:12 = 5:3, the ratio of the major sixth in Syntonic tuning; 4:3+6:5 = 24:15 = 8:5, the ratio of the minor sixth in Syntonic tuning.

[338] The greater part of the divided sesquialtera is 5:4. By multiplying each term by 2, the ratio can then be divided by the middle term 9. I.e., 5:4x2 = 10:8 = 10:9:8.

[339] I.e., the 9:8 and 10:9, or major and minor tone.

[340] Didymus's arithmetic octave, as described by Galilei, would result in the following sequence of intervals in a C-c scale:

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  10:9 9:8 16:15 10:9 9:8 9:8 16:5
C   D   E    F   G   A   B   c
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A dissonant 81:64 major third is found between G and B. Zarlino cites this problem as one of the chief differences between Didyms's and Ptolemy's distributions. See Zarlino, *Sopplimenti* I.1, 115-16.

[341] The printed text reads *è*.

surprised by those who reprehend him when he[342] said that all judgment one ought to make of sounds and voices had to be referred entirely to the sense of hearing, conscious that it derived from this and from no other reason that men considered the forms of musical intervals to be among the proportions of numbers and among those of lines, applying them in addition to strings, pipes, and other sonorous bodies.[343]

Coming to the distribution of his Intense Diatonic, we must first commit to memory that the octave in whatever diatonic consists of five tones and two semitones. It is the custom of practicing contrapuntists to divide each of the tones into two semitones; whenever they are not equal, it will follow from this that among the musical elements, many will be idle and useless, considered alone in themselves and accompanied by others in different manners. And it is true: in what sort of counterpoint is the minor semitone found put in action between two parts? In some, [-110-] I am certain.[344]

The minor semitone, therefore, is useless and idle in this instance. Furthermore, from this inequality of semitones is born in our system that difference that is between *D*♯ and *E*♭, equally the difference that is found between *G*♯ and *A*♭.[345] Not only are these differences not found in counterpoint between two parts but also not in any interval, whether augmented or decreased. The same occurs with the interval by which the semidiapente surpasses the tritone, by which the major seventh exceeds the diminished diapason, by which the major semitone surpasses the minor, by which the minor ninth

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[342] I.e., Aristoxenus.

[343] If Pythagoras had not first heard consonances emanating from the blacksmith's shop, he would have had no reason to investigate their causes.

[344] Galilei insinuates that some contrapuntal writing contains minor semitones because certain composers, such as Zarlino, do not understand intervals.

[345] Galilei contends that because the distance from *G* to *G*♯ and *A* to *A*♭ is a minor semitone (25:24), the distance from *A* to *A*♭ would be slightly larger than the distance from *A* to *G*♯. Because the interval *G*-*A* is a minor tone, the the size of the difference may be calculated by subtracting two minor semitones from the minor tone. I.e., $25:24+25:24 = 25^2:24^2 = 625:576$; $10:9-625:576 = (10:576):(9x625) = 5760:5625 = 128:125$. See Galilei, *Dialogo*, 9; trans. in *Dialogue*, 29-30.

surpasses the augmented diapason, by which the intervals that are enclosed between *D#* and *F* surpass the tone, by which the ditone is inferior to the semidiatessaron, and without saying more, by which the minor sixth is superior to the augmented fifth. The inequality of semitones is the reason for these inconveniences (if they can be so claimed),[346] from which different sorts of thirds and minor sixths will also come about. It is the greatest disorder to think of this, let alone speak of it. More would be born from such inconveniences as these if it were true that we sing tones of more breadth between stable strings, which is the most insipid thing that man could ever imagine to say because in practice it has not, is not, and never will be, as I have demonstratively proved in [-111-] my *Dialogo dell'antica, et della moderna musica*.[347] But between movable strings, it is most true that they are there in potentiality, as I am about to demonstrate in its place.

This inequality, recognized by Aristoxenus, was deservedly detestable. I believe that before he ordered his system, this great intellect had considered and very properly drawn attention to each least accident of the two famous distributions,[348] and in particular these: in that of Pythagoras, he saw that the major semitone held the high part of the tone

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[346] In most of these cases, the substitution of the middle (135:128) semitone for the major (16:15) semitone results in a 2048:2025 difference between the two compared intervals. For example, the 64:45 semidiapente (which is the perfect fifth less the 135:128 semitone) is 2048:2025 larger than the 45:32 tritone. For the intervals collected between *D#* and *F*, however, Galilei appears to be mistaken. In the Syntonic octave, the semitone *D#-E* should be 25:24. Combining this semitone with the semitone between E and F (16:15), the total interval will be a minor tone (10:9). Zarlino might have countered that all of these inconsistencies are only relevant to instruments, and that voices would naturally correct all of these "inconveniences" in practice.

[347] The ratio created by combining six 9:8 tones together is one Pythagorean comma (531441:524288) larger than the 2:1 octave. In order to tune an instrument with equal tones, therefore, Galilei suggests that each tone must be 1/6 comma smaller than the 9:8 tone. See Galilei, *Dialogo*, 42; trans. in *Dialogue*, 108.

[348] Aristoxenus lived centuries before Didymus was born, and it is impossible that he would have studied his distribution. On the contrary, Didymus composed a comparison of Pythagorean and Aristoxanian music theory that was preserved in a commentary on Ptolemy's *Harmonics* by the third-century Neoplatonist Porphyrius. Didymus actually contended that it was Aristoxenus who tried to reconcile sense and reason, but that in Aristoxenus's method, reason was not useful when it contradicted what was correctly perceived by the senses. A translation of passages from Didymus's commentary may be found in Andrew Barker, *Greek Musical Writings*, 2 vols., Cambridge Readings in the Literature of Music (Cambridge: Cambridge University Press, 1989), 2:242-44.

and the minor the low;[349] and, on the contrary, in that of Didymus the minor semitone held the high and the major the low. He saw, in addition, that the Pythagorean tritone surpassed the semidiapente, whereas the latter in the distribution of Didymus is greater than the former.[350] When these things were recognized by Aristoxenus, because they were reputed as inconveniences, he resolved that in his Intense Diatonic there should be only one semitone, which should be the entire half of a tone and the common measure for all the other intervals, diatonic and chromatic. He wished, in addition, that the octave should contain six of his tones and twelve semitones and that the one and the other should have equal capacity for the same quantity of sound. From these, then, he composed all the other intervals in his system. The interval, therefore, that consisted of one of these twelve parts he named "semitone," which also comes to be called "minor second" because of its difference from the major second (that is what contains two parts), [-112-] called by him "tone." The interval that consists of three is the minor third, considered in a tone and a semitone. The major of it contains four, although it may be considered principally to consist of two tones. The fourth consists of five of these semitones and comes to be considered in two tones and a semitone. The tritone and the semidiapente contain six each, but the former comes to be considered among four strings in the content of three tones and the latter among five in two tones and two semitones. The extreme sounds of each of these has the same proportion between them as has the side of the square to its

[349] Galilei assumes that the small 256:243 semitone that completes the Pythagorean tetrachord must have been complemented by a very large semitone (i.e., 9:8-256:243 = 2187:2048) to fill out the 9:8 tone.

[350] In the Pythagorean system, a tritone would be equal to three 9:8 tones or $(9:8)^3 = 729:512$. Galilei is not clear as to the size of the semidiapente in Pythagorean tuning, but if we assume the Syntonic (64:45) semidiapente, the Pythagorean tritone is larger than that interval by a mere 32805:32768 or 1.95 cents. In Syntonic tuning, the semidiapente is larger than the 45:32 tritone by 2048:2025 or 19.5 cents.

diameter.[351] The fifth contains seven of the said semitones, or we might wish to say three tones and a semitone. The minor sixth contains eight, or we shall say too that it consists of three tones and two semitones. The major contains nine, although it may be considered to be composed of four tones and a semitone. The minor seventh consists of ten, or we shall say too it contains four tones and two semitones. The major contains eleven, or we might wish to say it contains five tones and a semitone. The octave, finally, consists of twelve, or we shall say too that it contains five tones and two semitones.

Now it not only seemed to Aristoxenus that this distribution had eliminated by itself all the imperfections that I have demonstrated were born in the two others but also that it was as full [-113-] of the greatest perfections as could be desired. If we shall apply the semitones of this, so to speak, to our ordinary pound of twelve ounces,[352] we shall know the exact measure or weight (as we may wish to postulate as example) of each interval, whether it be simple or composite. This matter is so difficult in the other distributions that there are few practitioners today who, without much labor, know how to say to us (even if they have them continuously at hand)[353] what part of the octave it is that virtually contains any of the intervals, whereas in the Intense Diatonic of Aristoxenus, whatever the inexpert boy, he will be able through the simplicity of its division to know

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[351] A tritone or semidiapente constructed out of six equal semitones should be exactly half as large as the 2:1 octave, or 600 cents. If we assume a square with a side of 2, the area of the square will be 2^2, or 4, and the diameter, which is the distance from corner to corner will be $\sqrt{8}$ (using Pythagoras's theorem for finding the hypotenuse of a right triangle ($a^2+b^2 = c^2$), we have $2^2+2^2 = 8$; the diameter, then, is $\sqrt{8}$). The ratio of $4:\sqrt{8}$ is also equal to 600 cents.

[352] Galilei may be referrring to the Troy pound, named after the town of Troyes in France. The twelve-ounce Troy pound was used to weigh precious metals.

[353] In the *Dialogo* (p. 15), Galilei lamented the poor awareness of the size of intervals by the modern practitioner: "Pare impossibile al prattico, che sottratto dal Tritono la Quarta, gli habbia à rimanere piu d'vn minore ordinario Semituono; et tutta la difficultà che egli ha nello intendere queste à lui nouità, nasce dal non hauere degli interualli che del continouo ha tramato, quella cognitione che douerebbe"; trans. in *Dialogo*, 43: "It seems impossible to the practitioner that if you subtract a fourth from a tritone, the remainder is more than an ordinary minor semitone. All the difficulty that practitioners have understanding this idea—novel to them—arises from not having sufficient knowledge of the intervals they are continually weaving."

how immediately. In this division, there is not the least thing whatsoever that is idle, vain, useless, or irrational, and each of these—alone and accompanied with whichever and whatever are wished—can be put in action in counterpoint. Beside this one, no other demonstrable distribution can be found among stable strings more simple, more perfect, and with more capacity to be played as well as sung. Whereupon, what part each interval is of the whole comes to be exactly comprehended by the sense with the greatest ease and clarity as one can desire. Nor is it a surprise because the subject of music, which is the voice and sound, is a continuous and not discrete quantity.

When musical intervals are considered in discrete quantity, such difficulty and so many [-114-] imperfections are born when it is wished that they be demonstrated between stable strings, thanks to the many divisions that can be made by means of that and not this field.[354] The inventors of this new counterpoint were led to speak of following the division of Pythagoras and of Ptolemy by no one else than by Guido of Arezzo—and this Guido by the authority of Boethius—and later on, without thinking any further, by Lodovico Fogliano and then by Zarlino.[355] For anyone of mediocre intellect who does not wish to obstinately malign—when the absurdities are recognized that musical intervals carry when they are considered between numbers in discrete quantity, whatever they may be (between stable strings, as I have said many times)—will confess that those we sing today in so many parts together do not have and cannot have any relationship (as has

[354] Galilei is referring to the fields of arithmetic and geometry. Arithmetic is required to describe intervals as discrete quantities, whereas geometry is used for continuous quantity.

[355] Zarlino writes that he explicitly follows the division of Ptolemy. Fogliano, however, does not credit Ptolemy although his distribution does correspond to Ptolemy's Syntonic Diatonic tetrachord. Galilei insists on tying Folgiano's distribution to Ptolemy so that Zarlino's contributions seem less original. His list of the "inventors of new counterpoint" seems to have confused later readers of the *Discorso*, including Ercole Bottrigari, who wrote in the margins of his copy: "Guido was served by the Ditonic Diatonic, which is the ancient [distribution] of Pythagoras, not of Ptolemy . . . [Guido li serve della diatona diatonica che è l'Antica di Pitagora, non di Tolomeo . . .]."

been demonstrated) to the forms of these numbers and are of the same breadth one time as another.

I will now say that since the tritone in the distribution of Aristoxenus is equal to the semidiapente, it corresponds to the order of the consonances. Because there are those among them that do not have major or minor—as are the fifth and the fourth—and perhaps are therefore called perfect, it is equally seemly that there be some made among the dissonances, and these are the tritone and the semidiapente. From the privilege they have, more than any other dissonances (as I will demonstrate [-115-] in my other discourse written in regard to the use of these), I do not deem them unworthy of being named perfect dissonances.[356] We have, in addition, the seventh and the second, now major and now minor; the third and the sixth correspond in the same manner to these variables. Therefore, from this variability of musical elements, we can say in truth that the unison represents the center and the octave the circumference of a circle because, except for these, all the other intervals have been sounded within these extremes and distributed in different breadths. Therefore, we do not have another perfect interval besides the octave because it alone (in the fields of arithmetic and geometry) is always contained by the dupla, whereas the others have been and are tolerated when more or less sharp than their true[357] form, which is the form that, according to Aristoxenus, he gives them in his Intense Diatonic, distributed by means of continuous quantity, under which both the voice and sound are comprised—not under discrete quantity. We gather that the voice and sound are a quantity of such sort from being able to divide whatever interval,

[356] The "Discorso intorno all'uso delle dissonanze" includes copious examples that show how to use the tritone and semidiapente in counterpoint, but Galilei does not discuss the idea of "perfect dissonances."

[357] The printed text reads *dellavera lor'forma*.

whether sung or played, into two or more equal parts, which is impossible in discrete quantity. After having—according to the opinion of Aristoxenus—the direct, brief, plain, and secure path to lead us to the desired goal, it seems in a certain fashion to be the greatest error to walk along a crooked, long, mountainous, and uncertain path, after which we do not even join with the goal.[358]

Therefore, [-116-] inasmuch as the species of melody that we sing, as many believe, with such excellence cannot have any relationship to the species of Pythagoras or that of Didymus or Ptolemy (as we might wish to say) or any other but only to that of Aristoxenus—if between stable strings, as his are, there has to be this perfection—, someone could now demand of me which of the two fifths is more consonant, that of Pythagoras contained by the sesquialtera or that of Aristoxenus, which contains seven twelfths of the octave, which is somewhat smaller.[359] Responding to this, I say that when there was no other reason, the reason would be, rather, that we remain satisfied by what we hear on the keyboard instrument, which is not only smaller than the fifth already shown in the sesquialtera but also than the fifth the lute plays, which is the same as

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[358] Galilei is referring back to two passages in the *Discorso*. On p. 37 he writes: "Therefore, inasmuch as [Zarlino] now finds himself clearly outside the direct path that he can lead him in this truth, he should have to accommodate himself to what obligation wishes, at least until a better one is found." In the current context, Galilei appears to have fulfilled his promise to explain the "better path" for understanding the consonances, which is by interpreting the intervals through the field of geometry, as a continuous quantity. Galilei refers as well on p. 37 to his *Discorso all'uso della dissonanze*. Inasmuch as increasing amounts of dissonance and chromaticism were now becoming commonplace in the composition of madrigals and instrumental music, it is interesting that he should tie his interval theories to his writings that attempt to redefine the use of dissonance. Zarlino's student and rival to Galilei, Giovanni Maria Artusi would also attempt to define a hierarchy of dissonant intervals in his *L'arte de contrapponto ridotta in tavole* (Venice: Vincenti, 1598; reprint, Hildesheim: G. Olms, 1969), chapters 38-49.

The second passage is found on p. 77. Galilei notes again that Zarlino was on the wrong path: "I see that this man goes about paving a street along which he does not have to pass in order to join with his desired goal, and he may rack his brains as much as he likes." The printed text has no punctuation here. We may assume that the following word begins a new sentence because the first word is capitalized and is not a noun.

[359] I.e., the perfect fifth represented by the ratio 3:2 is equal to 701.9 cents, and the Aristoxenian fifth is 700 cents. The difference between the two intervals is about 1/10 of a syntonic comma.

Aristoxenus's.[360] Once again, these least differences are, however, comprehensible. From this, it appears in a certain fashion that the fifth of Pythagoras is somewhat sharp, that of the keyboard instrument somewhat flat, and that of the lute, which is in the middle of these two, is the true fifth, which as we have said, is the same as Aristoxenus's. Once again, for our point we would only have to seek to demonstrate whatever is adopted today in singing and not whatever is more consonant: for nature, in her operations, has no respect for this or that other comfort or goal of ours because she operates without cognition. Although the goal of [-117-] music is to be heard and as in this current practice of singing so many parts together we cannot demonstrate that what we sing is not comprised by the sesquialtera, this is no more important to nature than it may be important that a crow or a raven lives three hundred to four hundred years and a man lives only fifty to sixty.[361] From this, nature does not merit being reprehended nor is it suitable to make some complaint about it. This is as much as has occurred to me to treat in favor of Aristoxenus.

In order to declare myself more fully, I come now to say that the fifth contained by the sesquialtera is more perfect, more smooth than any other form, as I have judged by my hearing after many, many experiments (because I do not know how to be able to have certainty of it with another better means).[362] Inasmuch as this is true and even most true, it necessarily follows that the species of melody we sing today is not and cannot be, in

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[360] In Galilei's 4/7 comma temperament (and Zarlino's 2/7 comma temperament), the fifths are diminished by 2/7 comma or just over 6 cents. Thus, the fifth on the keyboard would be 4 cents smaller than the Aristoxenian fifth, which is 2 cents smaller than the 3:2 fifth.

[361] Galilei's estimation of the life span of a crow or a raven is, of course, wrong. Several ancient authors, including Hesiod and Aristophanes, claim that a crow can live for at least three hundred years. See R. van den Broek, *The Myth of the Phoenix, According to Classical and Early Christian Traditions*, Etudes préliminaires aux religions orientales dans l'Empire romain, vol. 24 (Leiden: Brill, 1972), 84-85.

[362] Perhaps a response to Zarlino's claim that in order to improve their products, instrument makers seek "no other means than the example and model made by nature herself." See p. 332 *supra*.

some fashion any of the species shown or another that up to the present has been recognized by men, as I am about to make manifest at present.

Commencing from this, I say that well-exercised singers, because of the sonority of the voices and their perfect hearing, will always sing as they wish all the musical intervals in as great an excellence as can be desired. As the simplicity or arrogance of men will wish altogether and thoroughly to limit excellence between the stability of the strings with numbers, lines, [-118-] or otherwise, they will always say a thousand impertinences because artificial instruments do not have the same faculty and power as natural instruments. I know that men of judgment feel no surprise in this because they perceive the same difficulty in many other things of nature. For this reason, I say it is no less difficult to describe with words or really demonstrate by way of numbers or lines the system that we use in its exact form and proportion (I speak of the system that is sung when modulating, in company with many, so many parts together in the said excellence[363]) than it is difficult to regulate and proportion among them the motions of the celestial bodies with limited periods and[364] stable canons. This is perhaps a good part of the arrangement that Pythagoras judged to exist between the celestial and human harmony.

What will be, therefore, the system that we sing in such excellence? The system that through the instability of its strings cannot—without the said labor[365]—be described by words or by measured lines or limited by numbers. Because I do not wish at present to do a new book on this, as would be necessary for whoever wished to properly clear up all

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[363] The printed text reads *eccelleuza*.

[364] The printed text reads *è*.

[365] On p. 371 *supra*, Galilei notes that there are few practitioners today who can determine the size of any interval relative to the octave without much labor.

of the difficulties and doubts that appear to me beforehand in order to properly decide each particular of this new business, I shall give some bit of light to it to prove demonstratively that the tones that are sung are [-119-] of two different breadths and the semitones are of three. I will proceed, touching superficially, in addition, on some other matters to the point and of some moment, reserving what may be especially desired[366] of this affair for a better occasion. This bit of light will draw us securely from the darkness in which we have been enveloped by what the fashion of singing many parts together has introduced, until the present day.[367]

That the tones are sung in two breadths, as I have said, is recognized from this. Let us have two parts that sing this interval: *C* to *c*; then let us make the low part ascend by a fifth to *G* and the high part by a tone to *d*. I say that the tone that is sung between *c* and *d* is an entire sesquioctave [9:8], and I demonstrate it in this manner. Between *C* and *G* is a fifth, and from *G* to *c*, a fourth, which will become a fifth whenever it is augmented by a sesquioctave, by which the high part has been augmented in passing from *c* to *d*. Therefore, the sesquioctave tone is adopted between *c* and *d*. Q.E.D.[368]

Here is an example that a tone may be sung smaller than this. Two parts sing *G* and *d*. Afterwards, I make *G* descend to *C*, and *d* ascend to *e*. I say that inasmuch as *G* descended by a fifth to *C*, *d* has ascended to *e* by a tone smaller than a sesquioctave. And

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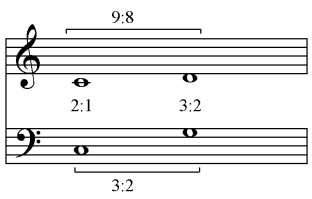
[366] The printed text reads *desidarasse*.

[367] As in the *Dialogo*, Galilei continues to treat the Renaissance polyphonic tradition as an extension of medieval musical practice and, therefore, a lingering emblem of the dark ages.

[368] I.e.,



it is true: two fifths added together contain[369] an octave and a sesquioctave more, which makes a ninth. So, whenever this ninth is [-120-] augmented by another sesquioctave, it will become a dissonant major tenth because it will be of the same breadth as the replicate of the ancient ditone. Likewise, if the tenth is said to be consonant, it necessarily follows that in going from *d* to *e*, the high part has gone, as I said,[370] by an interval smaller than a sesquioctave. *C–e* is consonant. Therefore, I have demonstrated my intent,[371] from which it follows that inasmuch as there are two tones, there should be at least three semitones.[372]

But from what I have demonstrated at present, Zarlino could argue, saying that I have inadvertently confessed that the major tone is sung between *C* and *D* and the minor tone between *D* and *E*, as he says. I affirm this to be true, but there is this difference between us: he wishes that the intervals be contained (as is recognized in the example of the Syntonic monochord) by stable strings, and I (as I have just now demonstrated) by movable strings.[373] He is moved by what Lodovico Fogliano already wrote about it in a simple manner, pledging him undeniable faith without seeking any further, and then, instead of making evident to us that what he said about it was true, Zarlino has led us

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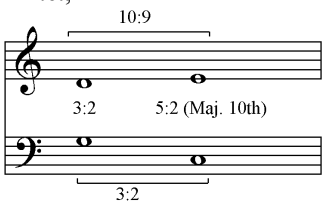
[369] The printed text reads *contengano*, the subjunctive form of the verb *contenere*. It is emended to *contengono*, the present indicative, to fit the syntax of the sentence.

[370] The printed text has a period after *dissi*.

[371] I.e.,



[372] Galilei discusses the derivation of the three semitones on pp. 303-6 *supra*.

[373] Galilei's argument is relevent with respect to Zarlino's comments about Syntonic tuning in the *Istitutioni*, but it does not take into account Zarlino's defense the *Sopplimenti* IV.4. As was discussed in chapter 2 *supra*, Zarlino views the static set of intervals based on the Syntonic tetrachord as an "artificial scale," which is not used by voices. The "natural" Syntonic scale used by voices, according to Zarlino, is not bound by any static sequence of major and minor tones because the voices will always alter their pitch to form consonances. See Zarlino, *Sopplimenti* IV.6, 141.

with his mountebankery into a thousand more errors and a thousand more confusions than previously. Therefore, we, moved by the truth founded on the experience of the matter, come to reveal anew their error with different demonstrations.[374]

He wishes that the major tone succeed the minor tone [-121-] and[375] the minor succeed the major, and I say that three or four of the same species can succeed one after the other; there are, rather, many times when this follows of necessity. According to the way in which there are more major or minor occurrences in the cantilena, whether ascending or descending, singers are found at the end of the cantilena to have raised or lowered the voices from the intonation of its beginning.[376] I do not say, therefore, that such an accident cannot be caused by anything else, for this can very well come about from the weakness or vigorousness of the voices or from the greater or lesser discretion of the singers in proceeding to consent to or resist the one for the other because of their strong or poor hearing. But when the voices are uniform—and with equal discretion and judgment of exercised singers—, the raising or lowering of the cantilena proceeds from nothing other than from the first stated cause.

To better declare my intention with respect to the position of the tones, I say that between whatsoever strings that have the capacity for the tone, the major and minor are there in potentiality, by which the voices are served according to their comforts and

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[374] Earlier in the *Discorso*, Galilei noted that Fogliano "came to reveal" the error of those who believed that Pythagoras's Ancient Ditonic tuning was actually used by practitioners. See p. 365 *supra*.

[375] The printed text reads *è*.

[376] The scientist Giovanni Battista Benedetti proved Galilei's point in a letter addressed to the composer Cipriano de Rore in 1563. Benedetti showed that if voices adhered to the intervals of the Syntonic tuning system in polyphonic textures, the overall pitch would rise or fall incrementally by a series of Syntonic commas (81:80). The fluctuations were created by the different sizes of tones and semitones that would be employed by the singers. For an explanation of Benedetto's letter, see Claude V. Palisca, *Music and Ideas in the Sixteenth and Seventeenth Centuries*, Studies in the History of Music Theory and Literature, vol. 1 (Urbana: University of Illinois Press, 2006), 145-49.

needs, as exchanging the given examples or transposing them upward or downward will make even more greatly manifest to whosoever will take care with this.

In order to make this truth more recognizable, I say (on the basis of the reasons adduced) that if one part after having sung this string *a* will descend to *D* and [-122-] meanwhile another departs from *e* and goes to *f* (aided by the sign called diesis [#]) to make with *D* a major tenth, the interval that has followed between *e* and *f*[#] will be smaller than when the low part departed from *E* and went to *b mi*, with the high part meanwhile singing the same two strings shown.[377]

That there are three semitones will be recognized (in addition to what I have said of them above) by what I am about to say at present. If we wish to go from the major third to the fourth, we necessarily adopt the major semitone contained[378] by these numbers 16:15. If we wish to go from the fourth to the tritone, we adopt the minor

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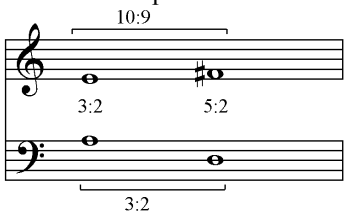
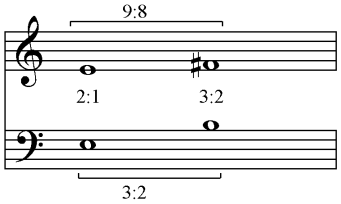
[377] Galilei is trying to show that on some occasions a 10:9 tone will be sung between *e* and *f*#, as we see in his first example:



The first example uses the same logic as the demonstration on pp. 377-78 *supra*. If there is a perfect fifth (3:2) between the *a* and the *D* in the lower voice, the interval between *a* and the *d* above must be a perfect fourth (4:3). Because *a* to *e* is also a perfect fifth, the interval between *d* and *e* must be a 9:8 tone (i.e., 3:2-4:3 = (3x3):(4:2) = 9:8). To form a consonant major tenth between the *D* and *f*# (like the interval *C* to *e* discussed on p. 378), the interval between *e* and *f*# must be a 10:9 tone. In the second example, Galilei demonstrates a situation in which the interval between *e* and *f*# must be a 9:8 tone:



In this sequence, we know that the interval between *E* and *b mi* is a perfect fifth (3:2). Likewise, the interval between *b mi* and *e* is a perfect fourth (4:3). To form a consonant fifth between *b mi* and *f*#, therefore, the interval between *e* and *f*# must be the difference between a perfect fifths and perfect fourth. I.e., 3:2-4:3 = (3:3):(4:2) = 9:8.

[378] The printed text reads *contenuti*. It has been taken as *contenuto*.

semitone within these other numbers 135:128.[379] This was never recognized by Zarlino. If we wish to go from the major third to the minor, or from the minor to the major, it is impossible to go there without the aid of the least semitone (understood until the present day as "minor semitone"), which is contained by these other terms 25:24.[380] I have therefore said, not without reason, that the major thirds and the replicates[381] of the Intense Diatonic of Aristoxenus (thanks to their length[382]) do not satisfy, for in making them become major from minor, he augments them by the entire half of a tone, and those that are naturally major exceed the minor by the same quantity. Whereas when we sing, so that they may satisfy us entirely, we augment them not by an entire half of a tone or even by a minor semitone, but [-123-] by the least semitone because by this much are the minor thirds naturally (so to speak) surpassed by the major.[383]

Although I have demonstrated that the voices, while singing, are served by three semitones and two tones, necessarily different, and that by such quantity of intervals the voices are perforce served whenever they have properly composed and sung the other

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[379] The difference between the fourth (4:3) and the major third (5:4) is the 16:15 semitone; i.e., 4:3-5:4 = (4x4):(3x5) = 16:15. The difference between the tritone (45:32) and the fourth (4:3) is the 135:128 semitone; i.e., 45:32-4:3 = (45x3):(32:4) = 135:128.

[380] The difference between the major third (5:4) and the minor third (6:5) is the 25:24 semitone; i.e., (5x5):(4x6) = 25:24.

[381] I.e., the major tenth.

[382] Galilei writes *lunghezza*, although he probably intended *grandezza* (breadth), which he has used throughout the *Discorso* when referring to the size of an interval. Perhaps Galilei thought he was writing about string lengths.

[383] I.e., 5:4-6:5 = (5x5):(6x4) = 25:24. Galilei claims that the Aristoxenian major third—the same third that would be heard on the lute—is larger than that which is sung in performance. Although he brushes over the problem in this instance, the tuning problems that occurred in combinations of voices and instruments were hotly debated by Zarlino's student Giovanni Maria Artusi and Ercole Bottrigari. See Giovanni Maria Artusi, *L'Artusi, overo Delle imperfettioni della moderna musica ragionamenti dui* (Venice: Giacomo Vincenti, 1600; reprint in Bibliotheca musica bononiensis, II/36, Bologna: Forni, 2000). For an English translation, see Malcolm Litchfield, "Giovanni Maria Artusi's *L'Artusi overo delle imperfettioni della moderna musica* (1600): A Translation and Commentary" (M.A. thesis, Brigham Young University, 1987). Bottrigari's argument is found in Ercole Bottrigari, *Il desiderio* (Venice: Ricciardo Amadino, 1994; reprint in Bibliotheca musica bononiensis, II/28, Bologna: Forni, 1969), which is translated in Ercole Bottrigari, *Il desiderio, or, Concerning the Playing Together of Various Musical Instruments,* trans. Carol MacClintock, Musicological Studies and Documents, vol. 9 (n.p.: American Institute of Musicology, 1962).

intervals greater than these, Aristoxenus did not want more than one tone and more than a single semitone in his so-called Intense Diatonic. Considering that such a necessity was not recognized by him or by any other ancient or modern musician and—to a greater degree—in the manner that we have necessarily demonstrated them necessarily to be, his Intense Diatonic therefore neither is nor can be the true and perfect distribution of strings (as some believe who allow themselves to be flattered by its many accommodations, seemingly shown) but only the distribution finally considered and first drawn attention to by us, which had been considered and drawn to attention by others. In this distribution, the extremes of the consonant intervals, brought forth by the voices—either mediately or immediately—to be heard at the same time, are always comprehended by the sense in the measure in which their supreme perfection contains them, even if they sometimes (as is not necessary) distance themselves from this[384] in being brought forth when modulating their one and then the other extreme by the same voice, as when that voice in respect or relation to another has what is forbidden to it or from [-124-] another bad effect that can cause this between them.

Turning therefore to the semitones, I say that the same comes about for the minor and the least semitone as I said of tones: that is, that they are in potentiality in the same place and the voices adopt now this and now that according to what better accommodates them. On such a matter, Zarlino, as he did not know how to find where to employ it, has never posed a word about it. And yet, as much as I have said of this business is according to his principles, limits,[385] and forms of the intervals.

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[384] I.e., perfection.
[385] The printed text reads *è termini*.

Turning[386] to my point, I say that this is one of these limits that art has not as yet reached with one instrument played by a single player,[387] and from a distance obscured by a cloud, it was first indistinctly seen by Fogliano and then by Zarlino. They wrote what they knew of it, and we ought to be obliged to them for this (as I have said another time)[388] because it has given us an occasion to do what we might to seek and perhaps find—as I hope by the grace of God to have found—the truth. But the belief that the one and the other had in the Syntonic of Ptolemy (poorly understood by them) made them slip into the error shown by the remedy Zarlino found for it in the *Sopplimenti*: his chimeras of "natural" and "artificial." Whenever he may wish to consent to what I have said and demonstratively proved (as I believe he will be able to do no less), I shall immediately confess that what we sing today agrees [-125-] with the same Syntonic of Ptolemy more than with another distribution.

Here, someone could demand of me in what manner men might sing in the same places with their voices tones and semitones of the different breadths I have shown, inasmuch as no prior attention has been drawn to them because they[389] have not been drawn to attention by the masters of this practice of singing. Responding to this, I say: when one learns to carry the voices, the master makes the student sing alone or he sings together with him at the unison, at least until he has them well learned. Meanwhile, he has indistinctly sung many times between the same strings now the major and now the minor tone, and so this has come about from the least and the middle semitone. After

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[386] The printed text reads *è tornando*.

[387] On instruments with fixed frets or holes, the player would be restricted by the tuning system; therefore, the different semitones would not be potentially available at any given time.

[388] See Galilei, *Dialogo*, 39: "nulla di meno, à quest'huomo essemplare di costumi, di vita, & di dottrina, deue il modo [sic] per le molte belle fatiche che egli ha fatte particolarmente intorno la musica, perpetuo obbligo"; trans. in *Dialogue*, 100: "Nevertheless, the world owes perpetual debt to Zarlino, a man of exemplary habits, life and doctrine, for the many beautiful works he has written concerning music."

[389] I.e., the tones and semitones of different breadths.

being so exercised for many days, he commences to sing different cantilenas in the company of others, and because he has already trained the voice to bend more or less to his will, he then goes about bending it now downwards and now upwards in the better manner that he, aided by good hearing, judges to tune perfectly with the other voices. But why do I waste words in seeking to persuade about a thing so manifest? Do we not hear all day long excellent singing by those who may not even recognize the difference from the tone to the semitone and from the major third to the minor? From this, it comes about that the singing masters say (although they may not know the cause, they judge it [-126-] by the effect) that one cannot learn to sing well alone; it is necessary to practice in the company of many with a diversity of cantilenas for many voices.[390]

The fashion of teaching the art of designing and depicting agrees much with the fashion of learning to sing, for from the former, too, one learns first (as we said another time)[391] to design the nose of a figure, the mouth, the ear, the eye, the hand, etc., and so they do these things now of one and now of another breadth and view so that they may then know how to apply such parts to a portrait of Camillus,[392] Hannibal, etc., proportioning them together again in making a painting or a design of fancy.

Turning to the voices, I say that after having taught them the art of singing well, they are able—at their will and without any difficulty—to form whatever musical interval of each singable and sensible measure. Let experience be a sign for us that this is true, which demonstrates it to us daily when we hear them unite perfectly as they sing together

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[390] The singing masters may hear the different sizes of tones and semitones but not be able to explain their cause. As Zarlino proposed in the *Sopplimenti*, however, singers in company will instinctively adjust their intervals to form consonances with the other singers.

[391] See pp. 279-80 *supra*.

[392] Marcus Furius Camilius (fl. late fifth- to early-fourth century B.C.E.). Camilius was a great military hero and served four times as the dictator of Rome. His achievements are detailed in Plutarch, *The Lives of the Noble Grecians and Romans*, translated by John Dryden and revised by Arthur Hugh Clough (New York: Modern Library, [1979?]), 155-82.

with whatever instrument, their strings contained by whatever measures and proportions.[393]

Now we shall see if any of the artificial instruments may or can play in the same perfection that I have said whatever cantilena is sung. For a fuller explanation of this, it must first be known that in the temperament of the ordinary and common keyboard instrument, it is credible that [-127-] perfection of the intervals has been sought many times in different ages by men of judgment, well exercised in music.[394] These men were resolved in the end to accept and tolerate them[395] just as we hear them today because, furthermore, they prudently judged that the capacity of the instrument should not be stretched by the quality and quantity of strings struck by the quills. In this temperament, the fifths really are flat and the fourths sharp in respect to their being true, as I have written in many places. They allowed them to be so made because they recognized that by as much as these[396] might be improved, by so much would the imperfect consonances be worsened.

Lutenists, then, when they recognized in the fifths and the fourths of the said instrument the imperfection shown—or possibly it came about haphazardly (as is more than likely) that these were made—they took away part of it with the different temperament and positioning of frets on their instrument,[397] but in doing so, they also took away part of the good from the thirds and sixths.[398] For they made them such (from the measure to which they are accustomed on the lute) that they would be a little less than

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[393] In other words, voices and instruments concord together because the voices bend their intervals to fit the temperament of the instrument, not because of the "natural" qualities of voices.

[394] The printed text reads *esercitato. nella musica*.

[395] I.e., the intervals heard in keyboard temperament.

[396] I.e., the fifths and fourths.

[397] I.e., part of the distance between the true fifth and the fifth heard on the harpsichord.

[398] According to the the temperament of the lute described in the *Dialogo* (p. 42), the major third on the lute is slightly larger than 5:4 and the the major sixth is slightly larger than 5:3.

intolerable on the harpsichord, and they come to be tolerated on the lute because of the softness and delicacy of the material of the moved and the moving, which are the fingers and the strings, in producing and causing the sound. Whoever might remove these causes by setting steel strings on the lute and might strike them [-128-] with one or more quills or by setting on a keyboard instrument strings of a lute, made (as everyone knows) of male sheep gut, would equally remove the effect. Everyone can be made certain in his belief by experience, which assures him that if he tempers the keyboard instrument like the lute, without removing the strings and the quills, or sets strings on the lute like the keyboard instrument uses, and he strikes the instrument with one or more quills, the major tenths will be made so barely agreeable to the hearing—and to a greater degree those that will be born by means of the diesis [#]—that they will be a little less than intolerable. The temperament of the lute would be allowed on the double harp as much as on the lute, and perhaps more. I have experimented on these things many times together with others.[399]

Those, finally, who wished the said perfect consonances in their instruments and systems (by "system," I understand in this place nothing other than the temperament of an instrument) to be in their highest excellence, as the Pythagoreans wished them to be, had the said thirds and sixths so unbearable that they acquired the name not of imperfect

[399] Galilei offers a similar comparison of the temperament of keyboard instruments and lutes in the *Dialogo*. With regard to the double harp, he writes a similar passage (*Dialogo*, 48): ". . . temperisi l'Harpa secondo il modo del Liuto, doue le corde et l'agente che le percuote sono gli istessi; nella quale gli accordi verranno indubitatamente non meno sopportabili che nell'istesso Liuto. et farebbono ancora in questa insopportabili, tutte le volte che si mutassi l'agente et la materia delle corde; come piu volte habbiamo esperimentato"; trans. in *Dialogue*, 115: " . . . if you temper the harp in the manner of the lute, where the agent [the finger] that strikes the strings is the same, the chords will undoubtedly be no less sufferable than in the lute, and they would become less supportable in the lute every time you change the agent or the material of the strings, as we have experimented numerous times."

consonances but of dissonances (as after the same Pythagoreans) because they really were made so.

Up to this point, we have demonstrated that the keyboard instrument, the lute, and the system of Pythagoras, together with that of Didymus and of Ptolemy (according to the description that Zarlino makes of it), [-129-] neither give us nor can give us the exact system the voices give us when singing, notwithstanding what might approach them in this and that part. From this, we openly recognize that the system and the temperament that nature uses (so to speak) by means of human voices neither is nor can be in some fashion any of those that have been recognized until the present day but only what we, by the grace of God, have finally recognized and demonstrated. We gather, in addition, that by however much the tones of the artificial instruments are smaller than the sesquioctave [9:8], by so much are their fifths distant from the true form of the sesquialtera [3:2], and the same would come about for voices whenever they might be deprived of this amount. This is a great argument that the true form of the fifth is the sesquialtera [3:2], and when the imperfect consonances were not in use, no other tone happened to be divided into two Pythagorean semitones than the sesquioctave [9:8].[400]

Which will be, therefore, the instruments that have the same faculty in playing cantilenas that the voices have in singing them? Among the wind instruments is the one that does not have holes, as for example the trombone, and[401] among the strings, the one that can be played without frets (if indeed imperfectly), as are the viola and the lyra.[402]

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[400] In other words, if no imperfect consonances were in use, only the 9:8 tone would be found in tuning systems. In order to ensure pure fifths and fourths, the tone would be divided into the two Pythagorean semitones: the *limma* (256:243) and the *apotome* (2187:2048). The *limma* is the difference between two 9:8 tones and a perfect fourth in Pythagorean tuning.

[401] The printed text reads *è*.

[402] Zarlino refers to these properties in the *Sopplimenti* IV.11, 152: "The natural instrument is that of the voice, with which (as has been said many times) we can form whichever interval. Nor is this ever

When singers sing together with other instruments that are deprived of this faculty—on which the frets and holes put a bridle (by way of example) [-130-] and limit on the intervals, just as art puts this same limitation on the system of Ptolemy, of Aristoxenus and elsewhere—, they,[403] through their desire to unite, deviate meanwhile from their proper power and nature, proceeding in their perfection to consent to the resistance made to them by the imperfection of the instruments. Liberated from this, the voices turn into their former exact perfection and potentiality, which (the impediments removed) they put into action at their will.

Because I said above that in the distribution of Aristoxenus played on the lute, and even more so on a keyboard instrument, the thirds and to a greater degree the major tenths are made barely agreeable to hear and in particular those that are born by means of the diesis [#] (although they really are of the same measure as the naturals), I shall render the cause of it at present, and here it is, for example: good voices are more sonorous, more delicate, more perfect, more tasteful, and in sum, they sing the musical intervals better than any instrument made by art may play them. Nevertheless, had we to hear the notes and not the words of a cantilena sung, either the notes of a ricercare well played on a keyboard instrument or the lute would please us more than notes not well sung by the voices. This would come about because we expect and desire still more from men, i.e., discussing and speaking when singing.

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found in whichever other instrument, except for the violin and the trombone and other similar instruments that do not have prefixed places or limits on the intervals [L'Istrumento naturale è quel della Voce, col quale (come si è detto più uolte) si può formar qual si uoglia Interuallo. Nè si trouerà mai in qual si uoglia altro Istrumento; dal Violino, e dal Trombone et altri simili impoi, che non habbiano i luoghi ò termini prefissi de gli Interualli . . .]."

[403] I.e., the voices.

Those thirds and major tenths [-131-] that barely satisfy us on the lute—and on the keyboard instrument, less than on the lute in that distribution of Aristoxenus—are between the movable (so to speak) strings and not between the stable, which are more tolerable than those. And why more between the latter than between the former? Because between the stable and natural strings, the intervals cannot in a certain fashion be otherwise than what they are, but that accident[404] could indeed make them of a measure and form that was less displeasing to us.

What, therefore, does that accident carry to the stated intervals that they are so displeasing to us? It makes the intervals seem to the hearing to be more than their natural length and not without reason, for the voice in forming a third or a major tenth by means of the diesis [#], sharpens them less than it does when it[405] forms a fifth with the same accident, as we have demonstratively proved above.

But why do I labor so much on this if the same Aristoxenus in his writings openly tells us that all the intervals smaller than a diatessaron are dissonant and all those that are between the diapason and the diapente?[406] From this, we openly gather that the goal of his distributions was anything other than making the thirds and the sixths consonant, and we can believe the same of Didymus and of Ptolemy.

So, worthy of reprehension are those who, against every obligation, want the perfect and the exact of the [-132-] musical intervals from those distributions of strings that cannot give these things to them in any relationship. Nor was such (as they believe)

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[404] The printed text reads *accidente*. Galilei is probably referring to the diesis [#], but he uses the term *accidentale* to signify "accidental" elsewhere in the *Discorso*.

[405] I.e., the voice.

[406] Aristoxenus, *The Harmonics of Aristoxenus*, edited with translation, notes, introduction, and index of words by Henry S. Macran (Oxford: Clarendon, 1902), 179. Aristoxenus claims explicitly that all intervals smaller than a diatessaron are dissonant. That the same is true for intervals between the diapente and diapason may be inferred from his writings, inasmuch as he cites only the diapason, diapente, diapason, and their replicates as consonances.

the intention of the authors of these in so ordering them. A sign especially that we cannot have such perfection in particular from the Intense Diatonic of Aristoxenus is to see daily excellent players of the lute and viol[407] and, in addition, musicians seeking manners and means to take away from their instruments (by increasing the frets) the aforesaid excess height of the thirds and major tenths. Furthermore, excellent keyboard players, every time they have drawn the fifths in their extreme perfection on their instrument, affirm finding dissonant thirds and sixths on it,[408] as they truly are. This matter argues that the fifth of the same Intense Diatonic of Aristoxenus, in the content of seven twelfths parts of the octave where he constituted it, is not in its[409] true proportion, but rather the fifth of Pythagoras within the sesquialtera. To these reasons we shall add, among the many that I could say, this for a final one: it is impossible in the fashion of singing today these many parts together (as has been said many times) for the hearing to be satisfied with the augmented diapason used as a minor ninth, resolved to the tenth or to the octave, in the same manner as it is satisfied with the ninth resolved to the two stated intervals. The sense would suffer the same offense in hearing [-133-] the diminished diapason used instead of our major seventh, resolved to the sixth.

From this, it necessarily follows that the species of melody that we sing today is not nor can be in some fashion the so-called Intense Diatonic of Aristoxenus, even if it is accompanied by whichever of his three chromatic intervals. Moreover, a single species of semitone of one and the same breadth as he wanted in his Intense Diatonic (where the minor ninth is of the same breadth as the augmented diapason, and the major seventh as

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[407] The printed text reads *Viola*, which can refer both to fretted viols and the *viola da braccio* (violin).

[408] I.e., their instrument.

[409] I.e., the perfect fifth.

the diminished diapason) cannot give us the exact system of the matter, which has already been demonstrated.

Now let us solve this other doubt for a final one and then make an end. When the voices among five strings of the same system have to produce at the same time three contiguous sesquialteras together with a consonant minor third (for which the system does not have the capacity, as has been demonstrated),[410] which would the voices adjust at that time? They would contract among them the three fifths so that they would become the measure of those of Aristoxenus, and so made, they would give place to the said minor third to make it consonant. Nature was courteous, therefore, and not avaricious in making it so that in the Greatest System, whenever either of these two necessities occurred, the fifths have to be made flat and the fourths sharp—for such are tolerable—and not, on the contrary, by making the fourths flat and the fifths sharp. And let this [-134-] be sufficient for the end of my present *Discorso*.[411]

[410] On pp. 348-49 *supra*, Galilei shows that if three 3:2 fifths and a 6:5 minor third are stacked on top of each other, the resulting ratio would be 162:40, which is one syntonic comma (81:80) larger than a 4:1 double octave.

[411] At the conclusion of the *Discorso*, Galilei asks his readers to emend the text: "Whoever takes care to read my *Discourse*, do this for me please: first emend the errors that occurred in printing it [Facciami gratia, quello che si piglierà cura di legger questo mio Discorso, di prima emendare gli errori occorsi nello Stamparsi]." The table of errata that follows has been incorporated into the translation.

Chapter 6

Conclusion

The rancorous debate between the *maestro di cappella* and priest Gioseffo Zarlino and the lutenist Vincenzo Galilei demonstrates the existence of a musical culture war fought in the late sixteenth century. Even though their published writings show that there was as much common ground as contradiction in their opinions, the differing methodologies and conclusions they posited created an impasse they could never reconcile. Zarlino and Galilei vehemently debated central topics of music theory (tuning, scales, counterpoint), yet they inadvertently worked together to display the limits of applying ancient wisdom to modern music and opened up new paradigms for understanding the ways in which voices and instruments produce music.

Zarlino and Galilei worked in different intellectual milieus. The Venetian church musician served as an important figure in the Serene Republic of Venice and directed the Doge's chapel at St. Mark's Basilica. His attitudes towards music theory, which reflect his deference to authority and religious beliefs, are apparent in his dedications, his interest in ancient authority, and the Counter-Reformation tone he adopts in the *Sopplimenti musicali*. Much of his rhetoric is aimed at Galilei, but it is important to recognize that he is defending not only himself but also the principles and musical genres favored by his associates and readers. Galilei, likewise, uses his debate with Zarlino as an opportunity to promote the burgeoning interest in instrumental music among wealthy amateurs and monodic singing as an alternative to the polyphonic vocal music that had been given preference in most treatises of the *cinquecento*.

Polemical arguments are evidently more virulent when there is less certainty about the truth of the given positions. For example, a dispute about whether one tower is taller than another can be solved easily by measuring the height of both structures. But some quarrels cannot be decided by objective means, and there is often no limit to the intensity of the debate that arises. In the sixteenth century, no technology could accurately measure the intervals sung by vocal choirs. Individual intervals could be measured against a monochord, but no single tool could measure all of the simultaneous sonorities that occurred during a performance of polyphonic music. For this reason, basic arguments about tuning systems could expand into heated debates. Zarlino appeared to have solved the problem of describing consonant polyphony in Book II of the *Istitutioni*. His presentation of Syntonic tuning, which he demonstrated through principles of natural philosophy and tied to ancient authority, appealed to readers because of the beauty of his solution. Even if it could be shown that Syntonic tuning was inherently unable to describe the consonant harmony created by choirs, it was logical and confirmed widely held beliefs about order and nature in a universe created by a benevolent God.

In addition to its larger metaphysical appeal, Syntonic tuning bolstered the position of those who believed in the superiority of voices in relation to artificial instruments. Both Zarlino and Galilei knew that instruments with fixed tuning systems created by man could not possibly play with voices that strictly adhered to Syntonic intervals. Zarlino argued that the "natural" quality of voices allowed them to sing the Syntonic scale without producing unwanted dissonances. Furthermore, the "artificiality" of instruments was apparent because musicians had to alter the intervals inherent in instruments with fixed tuning systems so that they could be used in performance with

voices. Moreover, intervals in tempered scales could not be represented by simple ratios and were therefore considered inferior to the natural simplicity of Syntonic tuning. Zarlino's logic may have been flawed but his defense of Syntonic tuning demonstrates the extent to which his theoretical principles were guided by his and his readers' interest in vocal genres.

Galilei, on the contrary, argued in his 1589 *Discorso* that when voices and instruments perform together, the voices modify their intervals to fit the tuning systems used by the instruments. Because voices had to sing the same intervals played on instruments, it was ridiculous to think of tempered scales as being more artificial than any other scales.

The arguments about scale systems were more concrete and perhaps less virulent because the subject is directly related to musical composition and each writer could support his claims with precise references to practical music. Both Zarlino and Galilei were aware that ancient models could not appropriately describe the scales used in contemporary music, but their need to foster systems that were congruent with the musical genres they preferred led each writer to promote different features that were first discussed by ancient writers. Whereas Heinrich Glarean defended the 12-mode system, as well as the music of the Catholic church, by noting its similarity to ancient models, Zarlino understood that there were no true connections between the music of his day and that of the ancients; therefore, it was not essential to prove its origins in ancient authority. Zarlino did recognize, however, that Glarean's formulation was suitable for sixteenth-century polyphonic music because it could account for the variety of octave species in

contemporary polyphony while still conforming to Ptolemy's idealized notions about scale systems.

After Galilei attacked the 12-mode system for being unrelated to ancient practice, Zarlino reasserted its "natural" properties in his *Sopplimenti*. He claimed that Galilei's criticisms of the 12-mode system were irrelevant because it was a component of modern musical practice. Nevertheless, Zarlino tried to show that his new configuration of twelve modes (beginning with the C-c) scale embodied the same properties as the scale systems described by Ptolemy. Glarean had already proved in his *Dodecachordon* that the 12-mode system was an ideal analytical tool for determining the mode of a polyphonic composition. Through his three discussions of scales in the *Istitutioni*, *Dimostrationi*, and *Sopplimenti*, Zarlino transformed Glarean's formulation to become a suitable pre-compositional tool for determining the mode of a new composition. He changed the order of the modes in the *Dimostrationi* so that the most natural scale (C-c), which was the same octave species he used to describe Syntonic tuning, was now the foundation of the modal system. Upon completing his adaptation of Glarean's system in the *Sopplimenti*, Zarlino could then use it as further proof that the polyphonic vocal music he favored was superior to the newer idioms described by Galilei.

Galilei, on the other hand, championed an Aristoxenian approach to scale systems because it was more congruent with instrumental idioms and monody. The twelve sets of pieces that comprise the first part of his unpublished "Libro d'intavolatura di liuto" demonstrate the expressive possibilities of a modal system in which each scale is differentiated only by the relative height of pitch and all scales have the same order of tones and semitones. Furthermore, a transcription of the pieces composed in the various

positions of the lute would necessitate the use of key signatures that were never found in sixteenth-century vocal music. In other words, if Galilei were to agree that the 12-mode system was a legitimate tool for understanding modern music, it would be difficult for him to legitimize his works for lute, which did not conform to the parameters of that system. Galilei's monodic compositions are not extant, but his music for solo voices may well have exhibited a similar focus on the relative height of pitch.

Acrimony took center stage in the Zarlino-Galilei dispute, but musical science benefitted from the debate. Critical appraisals of both Zarlino's and Galilei's tuning systems forced each writer to consider the unique properties of voices and instruments. They may not have solved all of the tuning problems, but their exchanges inspired further discussions in the writings Giovanni Maria Artusi, Ercole Bottrigari, and others about the combination of voices and instruments. Although Galilei never discussed tonal harmony, such as one finds one hundred years later in the compositions of Arcangelo Corelli, his experiments with an Aristoxenian scale system created the possibility of a 24-key tonal system that is theoretically impossible within the idealized system offered by Ptolemy in his *Harmonics*. In music, as in other arenas of society, progress and change often follow fierce competition and struggle.

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NEWBERRY LIBRARY, CHICAGO, IL, SHORT-TERM FELLOWSHIP 2006
"Vincenzo Galilei: Practical Solutions to Theoretical Problems"

SOCIETY FOR AMERICAN MUSIC 2006
Student Endowment Travel Grant

INDIANA UNIVERSITY ASSISTANTSHIP 2002 to 2005

ST. BOTOLPH FOUNDATION GRANT 1998
Individual Research in Klezmer Music

RESEARCH PRESENTATIONS

"PURGING HERETICS THROUGH MUSIC THEORY: GIOSEFFO ZARLINO AND THE *SOPPLIMENTI MUSICALI*"
American Musicological Society, Allegheny Reg., Huntington W.V. October 2010

"DISCORDANT POLEMICS: TUNING SYSTEMS IN THE WRITINGS OF ZARLINO AND GALILEI"
Renaissance Society of America, Los Angeles, CA March 2009

"CLERICS VS. CAVALIERS: EARLY INVESTIGATIONS INTO THE ZARLINO-GALILEI DISPUTE"
Indiana University, Department of Musicology Colloquium Series April 2008

"A Passion Shared: Adaptive Practices in Carl Philipp Emanuel Bach's 1775 *Lukaspassion*"
Performance Practice: Issues and Approaches, Memphis, TN — March 2007

"David Krakauer's Klezmer Madness: Ethnic Identity in the Downtown Scene"
Society for American Music, Chicago IL — March 2006
American Musicological Society, Midwest Reg., Chicago, IL — October 2005

"How to Make a Hamburg Passion in One Hour or Less"
Indiana University, Early Music Institute — April 2005

Publications

Carl Philipp Emanuel Bach, "Passion According to St. Luke (1775)," *C.P.E. Bach: The Complete Works*, ser. IV, no. 6, pt. 5, Packard Humanities Institute — Accepted
Co-editor with Daniel R. Melamed

World of Baroque Music, Indiana University Press — Forthcoming
CD liner notes

Dictionary of the Middle Ages, Oxford University Press — 2010
13 entries

Francois Fowler, *Sonata*, Clear Note Publications — 2010
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Francois Fowler, *C.P.E. Bach*, Clear Note Publications — 2010
Introductory notes

Society for Seventeenth-Century Music Newsletter — Fall 2004
Conference Review:
"Eros and Euterpe: Music and Eroticism in the Sixteenth and Seventeenth Centuries"

Musical Borrowing: An Annotated Database — Fall 2002
http://www.chmtl.indiana.edu/borrowing/search.html
Sixteen abstracts

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"Contemporary Modality and Ancient Tonality:
Scale-Centered Discourse in Sixteenth-Century Music Theory"

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APOLLO'S FIRE, Trinity United Methodist Church — 2010
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AS YOU LIKE IT, YSU Theater Department — 2010
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"Proposing and Delivering Conference Papers," Panelist

CENTER FOR THE HISTORY OF MUSIC THEORY AND LITERATURE — 2005 to 2008
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ETHER GAME, WFIU Radio, Bloomington IN — 2006
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TROUVERE LYRICS WITH MELODIES, ed. Hans Tischler — 2006
Music typesetting and layout

THE EARLIEST POLYPHONIC ART MUSIC, ed. Hans Tischler — 2005
Music typesetting

A HISTORY OF WESTERN MUSIC, 7th ed. — 2005
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