CHAPTER III

THE DIVISION OF THE MONOCHORD ACCORDING TO

BARTOLOMEO RAMOS DE PAREIA

The attacks that were directed toward Ramos personally and toward his theoretical proposals focus primarily upon two propositions: his alteration of traditional Pythagorean tuning and his elimination of the hexachordal system as the organizing framework of Western music theory. Due to its affect upon traditional Pythagorean tuning, Ramos's division of the monochord ultimately required him to abandon the Guidonian hexachordal system. For the fifteenth-century theorist, however, the concept of auctoritas was an issue that demanded respect. Ramos's open disregard for the traditional reverence of the ancients was the insurmountable obstacle that led to the unwillingness, and even inability, of his contemporaries to consider his alternative theories.

In his De institutione musica (sixth century), Boethius provides Western music with its tripartite division of the music discipline and establishes the categories into which musicians would fall well into the Renaissance:
Thus, there are three classes of those who are engaged in the musical art. The first class consists of those who perform on instruments, the second of those who compose songs, and the third of those who judge instrumental performance and song.

But those of the class which is dependent upon instruments and who spend their entire effort there—such as kitharists and those who prove their skill on the organ and other musical instruments—are excluded from comprehension of musical knowledge, since, as was said, they act as slaves. None of them makes use of reason; rather, they are totally lacking in thought.

The second class of those practicing music is that of the poets, a class led to song not so much by thought and reason as by a certain natural instinct. For this reason this class, too, is separated from music.

The third class is that which acquires an ability for judging, so that it can carefully weigh rhythms and melodies and the composition as whole. This class, since it is totally grounded in reason and thought, will rightly be esteemed as musical. That person is a musician who exhibits the faculty of forming judgments according to speculation or reason relative and appropriate to music concerning modes and rhythms, the genera of songs, consonances, and all things which are to be explained subsequently, as well as concerning the songs of the poets.¹

Further, Boethius establishes the hierarchical order of the categories of musicians:

Now one should bear in mind that every art and also every discipline considers reason inherently more honorable than a skill, which is practiced by the hand and the labor of an artisan. For it is much better and nobler to know about what someone else fashions than to execute that about which someone else knows; in fact, physical skill serves as a slave, while reason rules like a mistress. Unless the hand acts according to the will of reason, it acts in vain. How much nobler, then, is the study of music as a rational discipline than as composition and performance!²

¹Anicius Manlius Severinus Boethius, Fundamentals of Music, trans., intro., and notes by Calvin M. Bower, ed. by Claude V. Palisca (New Haven, Conn.: Yale University Press, 1989), 51. See also Boethius, De institutione musica, ed. by Godofredus Friedlein (Lipsiae: Teubneri, 1867), 225.

²Ibid., 50. See also Friedlein edition, 224.
With respect to the societal role of the theorist, a profound change may be observed in the fifteenth century. Previously, the theorist was one who considered himself to be the guide and critic of the performer; he filled his treatises with speculative theories and wrote primarily for the approval of his academic peers. In a break with tradition, Ramos attempts to bridge the gap between the speculative theorist and the practicing musician. In the Prologue to the *Musica practica*, Ramos forewarns the reader of his emphasis on music as a "practical" discipline, making his intentions quite clear:

> Let no one fear the majesty of philosophy, nor the complexity of arithmetic, nor the digressions of proportions. For here, anyone is able to become a most outstanding and skillful musician—even if he is unskilled in everything—provided that he is willing to devote attention to learning and is not completely destitute of reasoning. For indeed, inasmuch as we have desired to serve intelligence, we have retained the blending of expression and the control of style, so that in these readings the experts will be able to be amply refreshed, the poorly educated will be able to make great progress, and the altogether untrained may be able to be instructed with the greatest of pleasure. We undertake [this work] not so much for the purpose of preparing philosophers or mathematicians here; anyone instructed only with the first rudiments of grammar may understand this our [discourse]. Here, the mouse and the elephant alike can float side by side; Daedalus and Icarus can fly away together.

Here Ramos attempts to bring together the two previously estranged species of the mouse (practicing musician) and the elephant (speculative theorist). Ramos is well-equipped for such a task, for as a speculative theorist and a practicing theorist, Ramos de Pareia, *Musica practica*, 1.

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^{Ramos de Pareia, *Musica practica*, 1.}
composer he realizes the necessity of providing instruction that is useful for the performer--the one who will ultimately realize speculative theories in the manner of performing compositions.

It is precisely this new understanding of the role and need of the practicing musician that prompted Ramos to present an alternative to the cumbersome ratios of traditional Boethian (Pythagorean) tuning. As acknowledged by James Barbour, Ramos had no intent of thwarting tradition just for the sake of innovation by "nailing his ninety-five theses to the church door"; rather, Ramos sought to make speculative theory more relevant to the practicing musician.

In Part 1, Treatise 1, Chapter 2, Ramos states that his division of the monochord--which ultimately results in a new method of tuning--is rooted in practicality:

The regular monochord is accurately divided by Boethius with numbers and measurement. Although it is agreeable and useful for theorists, it is laborious and difficult for singers to understand. Truly, since we have promised to satisfy both [the theorists and the singers], we will render an extremely easy division of the regular monochord. Let no one think that we came upon it with ordinary labor, inasmuch as we devised it with hard work during many sleepless nights, reading and re-reading the precepts of the ancients and avoiding the error of the modern theorists. Anyone even moderately educated will be able to easily understand it.⁵


⁵Ramos de Pareia, Musica practica, 4.
Again, near the end of the *Musica practica*, Ramos reiterates his intent to provide a simpler explanation of the monochordal division:

In the first division of our regular monochord we have said that Boethius accurately divided his regular monochord by numbers and measurement. However, for the sake of the inexperienced [singers], we have divided our [monochord] with common fractions by means of a continuous quantity, so that it would not be necessary for the student to have previously learned both arithmetic and geometry; for, without a doubt, he would fall into error, which we have prevented. Indeed, we have said that neither of these things are necessary in order for our doctrine to be understood--provided that [the student] has been thoroughly instructed in the beginning rudiments.⁶

### The Tetrachord and the Three Genera

An understanding of Ramos's proposed division of the monochord requires a familiarity with the monochordal division espoused by Boethius as well as an understanding of the earlier Greek system, out of which the Boethian system emanated.

The Greek musical system was divided into two components: the Greater Perfect System (GPS) and the Lesser Perfect System (LPS). The GPS consists of a descending scale of two octaves, comprised of four tetrachords (each with a fixed intervallic pattern of tone--tone--semitone) plus an additional note. The tetrachords of the GPS are linked either conjunctly (a *synaphe*, in which the tetrachords share a common pitch) or disjunctly (a *diazeuxis*, in which the tetrachords are separated by a whole tone) to span the range of an octave plus

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⁶Ibid., 76.
a seventh. The two-octave scale was made complete by the addition of a pitch one whole tone below the lowest tone of the fourth tetrachord. The highest tetrachord of the GPS was given the designation hyperbolaion, followed by the tetrachords—in descending order—diezeugmenon, meson, and hypaton. The lowest note of the gamut was identified as proslambanomenos, while the other individual notes within the tetrachords were identified both by their tetrachordal encompassment as well as by their relative position within the individual tetrachord (see Table 1).

In Part 1, Treatise 1, Chapter 3 of the Musica practica, Ramos explains the Greater Perfect System according to the (incorrect) description given by Boethius in the sixth century, i.e., from the lowest hypaton tetrachord to the highest hyperbolaion tetrachord. This reversal is wholly in accordance with Boethius's transmission of the GPS, brought about by Boethius's misunderstanding of Greek theory.

Likewise, both Boethius and Ramos reverse the order of the Lesser Perfect System. The Lesser Perfect System (LPS) consisted of three conjunct tetrachords with the addition of proslambanomenos in the lowest position. The LPS differed from the GPS by the absence of the tetrachord hyperbolaion, and by the substitution of a conjunct synemmenon tetrachord
TABLE 1
THE GREATER PERFECT SYSTEM
ACCORDING TO BOETHIUS

<table>
<thead>
<tr>
<th>Tetrachord</th>
<th>Proslambanomenos</th>
<th>Hypate Hypaton</th>
<th>Parhypate Hypaton</th>
<th>Lichanos Hypaton</th>
<th>Hypate Meson</th>
<th>Parhypate Meson</th>
<th>Lichanos Meson</th>
<th>Mese</th>
<th>Paramese</th>
<th>Nete Diezeugmenon</th>
<th>Parane Diezeugmenon</th>
<th>Nete Diezeugmenon</th>
<th>Trite Diezeugmenon</th>
<th>Parane Hyperbolaion</th>
<th>Nete Hyperbolaion</th>
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</thead>
<tbody>
<tr>
<td><strong>Hypaton</strong></td>
<td>A</td>
<td>T</td>
<td>B</td>
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<td>conjunct</td>
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<tr>
<td><strong>Meson</strong></td>
<td>f</td>
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<td>diazeuxis</td>
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<tr>
<td><strong>Diezeugmenon</strong></td>
<td>c(^1)</td>
<td>T</td>
<td>d(^1)</td>
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<td>conjunct</td>
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<tr>
<td>synaphe</td>
<td>f(^1)</td>
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<td>g(^1)</td>
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<td><strong>Hyperbolaion</strong></td>
<td>a(^1)</td>
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for the disjunct diezeugmenon tetrachord. The synemmenon tetrachord \((a, bb, c, d)\) results in a fixed intervallic pattern of semitone--tone--tone. Table 2 illustrates the arrangement of the tetrachords in the Lesser Perfect System.
**TABLE 2**

**THE LESSER PERFECT SYSTEM ACCORDING TO BOETHIUS**

<table>
<thead>
<tr>
<th>Tetrachord</th>
<th>Proslambanomenos</th>
<th>Hypate Hypaton</th>
<th>Parhypate Hypaton</th>
<th>Lichanos Hypaton</th>
<th>Hypate Meson</th>
<th>Parhypate Meson</th>
<th>Lichanos Meson</th>
<th>Mese</th>
<th>Trite Synemmenon</th>
<th>Paranete Synemmenon</th>
<th>Nete Synemmenon</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hypaton</strong></td>
<td>A</td>
<td>T</td>
<td>B</td>
<td>S</td>
<td>c</td>
<td>T</td>
<td>d</td>
<td>T</td>
<td>e</td>
<td>f</td>
<td>a</td>
</tr>
<tr>
<td><strong>Meson</strong></td>
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<td></td>
<td></td>
<td></td>
<td>d</td>
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<tr>
<td><strong>Synemmenon</strong></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>bb</td>
<td>c†</td>
<td>d†</td>
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</tbody>
</table>
synemmenon, hyperbolaion, and for his misunderstanding of the conjunct and disjunct nature of the synemmenon and diezeugmenon tetrachords:

Truly, it was discussed and demonstrated above that the synemmenon tetrachord is conjunct but the diezeugmenon [tetrachord] is disjunct. However, some [people] being ignorant of this (as we have found in a long dispute with the Spaniard Tristan de Silva--our dearest friend, and a man with the most sagacious talent) establish the diezeugmenon [tetrachord] after they reach mese. After this, they place the synemmenon [tetrachord], [and] then the hyperbolaion. And thus, they cause the nete hyperbolaion to stand apart from the proslambanomenos by [the distance of] three strings beyond a bisdiapason, which is clearly contrary to the truth and the teaching of Boethius.\(^7\)

Likewise, Ramos criticizes Marchettus de Padua for the employment of an Immutable System that merely adds the synemmenon tetrachord to nete hyperbolaion by conjunction and for the appendage of two additional pitches:

Indeed, I do not doubt that [Marchettus] may be saved, since Christ on the cross prayed for those who know not what they do. A certain brother--the Frenchman Johannes Carthusiensis--saves him by saying that he is "both untrained and deserving of chastisement." However, I value this Marchettus so much that I have no doubt that four marchetti could be swallowed down together in one gulp by the Frenchman Roger Caperon . . . .

. . . And thus, sinking into the error of others, [Roger Caperon also] establishes [a total of] twenty strings.\(^8\)

It is surprising that Ramos attacks Marchettus with such vehemence, for Marchettus, unlike Tristan de Silva,

\(^7\)Ibid., 12.

\(^8\)Ramos de Pareia, Musica practica, 12-13.
continued to preserve the conjunct and disjunct character of these tetrachords. Here, however, we see Ramos following the mandates set down by Boethius, preserving the Greater Perfect System of fifteen pitches and the Lesser Perfect System of eleven. Ramos was appalled by Marchettus's use of the Immutable System and by his extension that incorporated twenty notes by the addition of the pitch Γ at the bottom of the gamut and the pitch e² at the top.

In Greek theory, the inner two notes of each tetrachord could be altered to effect a "modulation" by means of three different genera--diatonic, chromatic, and enharmonic. The two outer notes of the tetrachord were considered "immovable" and thus provided tetrachordal stability for the variable inner notes.

The "diatonic" genus of the tetrachord is comprised of a semitone followed by two tones (E F G A), the "chromatic" genus of two semitones plus a semiditone of some sort (E F F# A), and the "enharmonic" genus of two quarter tones plus a ditone (E E* F A). In this regard, Ramos follows Boethius's discussion in Book I, Chapter 23 of De institutione musica, which contains an explanation and illustration of the use of the three genera and from

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9The asterisk symbol denotes the raising of a note by a quarter tone.
which the three scales of the diatonic, chromatic, and enharmonic genera are generated. Theorists typically recognized six variants or "shades" of the genera, that is—two diatonic, three chromatic, and one enharmonic; however, for the purposes of this study a discussion of their most typical forms will suffice.

In his comprehensive survey of monochord division, Cecil Adkins proposes that "within limits, the upper interval in the enharmonic and chromatic genera and the upper two intervals in the diatonic seem to be the real determinants of genus." Adkins confirms his assertion with a discussion of J.F. Mountford's article, "The Musical Scales of Plato's Republic," which demonstrates that the two most common variations of the diatonic genus (256:243 x 9:8 x 9:8; or 16:15 x 9:8 x 10:9) result in the whole tone ratios of 9:8 and 10:9, while the three possible variations of the chromatic genus (28:27 x 15:14 x 6:5; or 28:27 x 243:224 x 32:27; or 22:21 x 12:11 x 7:6) focus recurrently upon the pure minor third of 6:5, and finally, the

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10Boethius, *Fundamentals of Music*, 43. See also Friedlein edition of *De institutione musica*, 216-17.

tetrachordal division of the enharmonic genus (28:27 x 36:35 x 5:4) results in the pure major third of 5:4.  

Ramos believed that the three genera had been abused by contemporary theorists and sought to resurrect their correct use by means of his own theories. Examination of Ramos's division of the monochord demonstrates that Ramos did, in fact, implement the "real determinants" of the genera in his tuning by employing the pure major third (5:4), the pure minor third (6:5), and the two different whole tones (10:9 and 9:8).

Pythagorean Tuning

To comprehend the radical innovations that resulted from Ramos's division of the monochord, an understanding of both the authority and mechanics of Pythagorean tuning is required. The tuning that was attributed to Pythagoras (fifth century B.C.) had enjoyed a long-standing and unchallenged tradition throughout the Middle Ages and well into the Renaissance until the new emphasis upon practicality initiated its decline. Due to the simplicity of its application on the monochord, Pythagorean tuning had retained its popularity among speculative theorists who reveled in concrete evidence; practicing musicians,

however, preferring the sound of pure intervals and contending on a daily basis with the ever-increasing use of *musica ficta*, eventually rejected Pythagorean tuning in favor of alternative and more "practical" tunings.

Pythagorean tuning is based upon a preponderance of perfect fifths (3:2). Beginning on the pitch $F$ and continuing in a series of perfect fifths (i.e., $F \ c \ g \ d \ a \ e \ b$), Pythagorean tuning can generate seven pitches that can subsequently be combined into a single octave scale. An alternative demonstration of the scale occurs through the superparticular ratios of the numbers from one to four, which are used to designate the consonances of the perfect octave (2:1), the perfect fifth (3:2), and the perfect fourth (4:3). This method was especially useful for demonstrating the ratios upon the monochord, because the remaining pitches of the system could be deduced by calculating the differences between these various intervals. Table 3 illustrates such a deduction of the various intervals, while Table 4 demonstrates the formation of the Pythagorean diatonic scale by means of five whole tones (each possessing a 9:8 ratio) and two semitones (each possessing a ratio of 256:243).

The necessity for temperament, or the slight adjustment for "purer" tunings in instrumental music, is a consequence of the enharmonic discrepancy that occurs in a
series of pure intervals. The generation of three pure major thirds, for example, fall short of a pure octave by the *lesser diesis*—approximately one-fifth of a whole tone (41.1 cents); the generation of four pure minor thirds exceed the pure octave by the *greater diesis* (62.6 cents);

<table>
<thead>
<tr>
<th>TABLE 3</th>
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<tbody>
<tr>
<td><strong>THE DEDUCTION OF THE PYTHAGOREAN RATIOS</strong></td>
</tr>
<tr>
<td><strong>FROM THE DIFFERENCES OF THE INTERVALS</strong>¹³</td>
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<table>
<thead>
<tr>
<th>Interval</th>
<th>Difference</th>
<th>Equivalent Interval</th>
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<tbody>
<tr>
<td>Perfect 8ve</td>
<td>- Perfect 5th</td>
<td>= Perfect 4th</td>
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<tr>
<td>(2:1)</td>
<td>(3:2)</td>
<td>(4:3)</td>
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<tr>
<td>Perfect 5th</td>
<td>- Perfect 4th</td>
<td>= Whole Tone</td>
</tr>
<tr>
<td>(3:2)</td>
<td>(4:3)</td>
<td>(9:8)</td>
</tr>
<tr>
<td>Perfect 4th</td>
<td>- 2 Whole Tones</td>
<td>= Diatonic Semitone</td>
</tr>
<tr>
<td>(4:3)</td>
<td>(9:8)²</td>
<td>(256:243)</td>
</tr>
<tr>
<td>Perfect 4th</td>
<td>- Whole Tone</td>
<td>= Minor 3rd</td>
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<tr>
<td>(4:3)</td>
<td>(9:8)</td>
<td>(32:27)</td>
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<tr>
<td>Minor 3rd</td>
<td>- Whole Tone</td>
<td>= Minor Semitone</td>
</tr>
<tr>
<td>(32:27)</td>
<td>(9:8)</td>
<td>(256:243)</td>
</tr>
<tr>
<td>Whole Tone</td>
<td>- Minor Semitone</td>
<td>= Major Semitone</td>
</tr>
<tr>
<td>(9:8)</td>
<td>(256:243)</td>
<td>(2187:2048)</td>
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<tr>
<td>Major Semitone</td>
<td>- Minor Semitone</td>
<td>= Comma</td>
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<td>(2187:2048)</td>
<td>(256:243)</td>
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TABLE 4

THE PYTHAGOREAN DIATONIC SCALE

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<tbody>
<tr>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
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the generation of twelve pure fifths result in the Pythagorean comma (an enharmonic difference of 23.5 cents).\(^{14}\)

Although the octave, fifth, and fourth are "pure" in Pythagorean tuning, the disadvantage of this system becomes apparent in the practical employment of thirds; these are not only "impure," but are considerably "sharp." The sum of four perfect fifths above the pitch $C$, for example, will produce an $E$ whose ratio is 81:64 rather than the pure third 5:4. The discrepancy inherent in the difference between these two ratios—the syntonic comma—subsequently became a source of dispute between those theorists who preferred the pure fifths of Pythagorean tuning and those who subscribed to alternative tunings that allowed for pure thirds and sixths.

Traditional Applications of the Monochord

The monochord was used by the Greeks as early as the sixth century B.C. to test the mathematical ratios of musical acoustics. Although this device figures significantly in the history of music theory, its actual construction is quite unpretentious:

A device consisting of a single string stretched over a long wooden resonator to which a movable bridge is attached so that the vibrating length of the string can be varied.\textsuperscript{15}

By the time of the Renaissance, the monochord had assumed three primary functions in the disciplines of speculative and practical theory: (1) to visually and audibly demonstrate intervallic proportions; (2) to aid and instruct singers in the study of intonation through the comparison of various intervals; and (3) to serve theorists in experiments with new methods of tuning and in their application to the construction of new instruments.\textsuperscript{16}

Adkins explains that three basic acoustical systems can be applied to the monochord: (1) a proportional system that is a result of the manual division of the monochord—a division in which a "linear mechanical operation" is utilized with a single, tensioned string; (2) a system


\textsuperscript{16}Adkins, "The Theory and Practice of the Monochord," 192-93.
utilizing various string lengths to effect a comparison of the pitches; and (3) a system of "cents"--a nineteenth-century measurement of one one-hundredth of a semitone that provides a constant for the comparison of various intervals.\textsuperscript{17} Because Ramos proposes a manual division, this discussion focuses upon the aspects inherent to the first category; measurement by cents, however, will be used to clarify discrepancies between the Pythagorean division of the monochord and the division proposed by Ramos.

Adkins further notes that the monochord division is discussed in terms of either sub-superparticular or superparticular proportions. A division that compares the sound of the total length of the string (the lowest pitch) to a higher stopped note produces sub-superparticular proportions (e.g., 8:9, 2:3, etc.), whereas a division that compares the sound of a stopped note (usually two octaves above the fundamental pitch) to another stopped note below this pitch produces superparticular proportions (e.g., 9:8, 3:2, etc.). Thus, an "ascending division" occurs by means of the sub-superparticular proportions that arise from lower- to higher-sounding pitches through the employment of increasingly shorter portions of the string, whereas a "descending division" occurs by means of the superparticular proportions that result from the employment

\textsuperscript{17}Ibid., 12-17.
of increasingly longer portions of the string from higher- 
to lower-sounding pitches.  

Ramos's Division of the Monochord

Ramos's monochordal division is based upon the 
Boethian ascending division. At the beginning of the 
Musica practica, Ramos describes a monochordal division 
that provides the seven notes of what is essentially a two- 

octave A natural minor scale notated with the letters A–P. 
It should be noted that Ramos includes the pitch Bb even in 
this simple division of the monochord. Later, in Part 1, 
Treatise 2, Chapter 5, he provides those notes that are 
needed to complete the chromatic scale (C#, Eb, F#, and 
Ab).

Ramos's division of the monochord results in sub- 

superparticular proportions; Ramos is not, however, 
particularly conscientious in his description of these 
proportions. In Part 3, Treatise 1, Chapter 3, Ramos 
discusses the relationships of the sounds produced by the 
entire string in comparison to increasingly shorter 
portions, i.e., in comparison to higher stopped notes. 
In this discussion, Ramos incorrectly describes these 
proportions as "superparticular" rather than "sub- 
superparticular."

This oversight does not affect the sound

\[\text{Ibid.}, \; 19-24.\]
of the pitches; it may, however, prove confusing for those concerned with the speculative aspects of his division.

The technique of an ascending or descending derivation is not a significant matter for Ramos. Although his step-by-step method proposes an ascending division, he notes that one can either compare the high sound to the low sound or vice-versa, and that this option will not make a difference in pitch:

Let the stretched string be struck in its entire length and let the sound be noted. Then, let the finger, or something else more accurate and indeed not very wide, be placed above [the string] and again let the string be struck: the result will be that it emits a considerably higher sound. And when you will have considered a comparison of the higher sound with the low sound or, if you prefer, the lower sound with the high sound, you will perceive the distance to be that of a tone.\footnote{Ramos de Pareia, \textit{Musica practica}, 5.}

As previously mentioned, Ramos's division of the monochord does not appear to be an attempt to effect a new system of tuning; rather, it is the result of his avid interest in providing a simpler division for the practicing musician, and possibly of an attempt to reflect the type of ratios that were actually being sung by the performers of his time. While Ramos may not have intended to create a new tuning, a new tuning was, in fact, advanced by Ramos in the \textit{Musica practica}--a treatise that contains the first published explanation of a complete system of just

\footnote{Ramos de Pareia, \textit{Musica practica}, 5.}
intonation. *The New Harvard Dictionary of Music* defines just intonation in the following manner:

> Any tuning that incorporates five or more acoustically pure types of interval within the octave; in the case of diatonic or chromatic scales, those based on acoustically pure major thirds and acoustically pure fifths.\(^2\)

Ramos's monochordal division results in pure perfect octaves, fifths, and fourths, pure major and minor thirds, and pure major and minor sixths.\(^1\)

In the *Errori di Franchino Gafurio da Lodi*, Giovanni Spataro responds to Gaffurius's remark that the syntonic comma (the difference between the Pythagorean third and the pure major third, i.e., 21.5 cents) is imperceptible--an argument used by many theorists to justify their retention of the Pythagorean tuning.

> ... the more you try to criticize Bartolomé Ramos, my master, the more you get enmeshed and show clearly your ignorance, small knowledge, malice, and obstinacy ... Bartolomé Ramos has said that (only in practice, that is in musical usage and activity) the ditone corresponds to the 5/4 ratio, but not in


\(^{21}\)Although Ramos was the first to publish a complete tuning that incorporated these intervals as pure entities, he cannot be awarded credit as the first theorist to propose the use of pure thirds. As early as 1275, Walter Oddington notes in his *De speculatione musice* that singers were using the pure thirds of 5:4 and 6:5 more often than the tertian ratios of 81:64 and 32:27 extracted from Pythagorean tuning. See Hugo Riemann, *History of Music Theory: Polyphonic Theory to the Sixteenth Century*, trans. with preface, commentary, and notes by Raymond H. Haggh (Lincoln, Nebraska: University of Nebraska Press, 1966; reprint, New York: Da Capo Press, 1974), 94–99.
speculative music, . . . where the ditone corresponds to the ratio 81/64 . . . the 81/80 ratio [the syntonic comma] (which is the difference between the Pythagorean intervals and the intervals used by experienced musicians is audible—not imperceptible as in your above-mentioned chapter you have concluded. For were it not appreciable, the harsh Pythagorean monochord would not [have to] be reduced, smoothing [it] to the sense of hearing . . . Bartolomé Ramos [also] judged that the difference is perceptible between the 6/5 minor third and the minor third corresponding to the 32/27 ratio, because otherwise it would be self-defeating to add the 81/80 interval in order to reduce the musical intervals from harshness to smoothness.22

Comments from the late fifteenth century--such as that of Gaffurius in the Practica musicae (1496) regarding participata (the tempering of intervals)--suggest that the properties of tuning and intonation were gradually becoming more of an aural consideration governed by the practicing

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22" . . . quanto piu tu cerchi reprehendere Bartolomeo Ramis mio preceptore, tanto piu te ne vai intricando: et fai manifesta la tua ignorantia: poco sapere: malignita: et obstinatione . . . da Bartolomeo Ramis e stato dicto che (solo in practica overo in la Musica usitata: et activa el ditono cadete in la comparatione sesquiquarta: & non in la Musica speculativa . . . in la quale cade el ditono tra .81. ad .64. comparati . . . la proportione cadente tra .81. ad .80. laquelle e la differentia cadente tra li pythagorici intervalli: & li intervalli da li modulanti usitati e sensibile; & non insensibile come nel predicto tuo capitulo hai concluso. Perche non essendo sensibile: el duro monochordo pythagorico non seria riducto in molle al senso de lo audito . . . da Bartolomeo Ramis e stato inteso essere differentia sensibile tra il semiditono sesquiquinto & il semiditono cadente tra .32. ad .27. comparati: perche altramente: el seria frustratorio la addictione de lo intervallo cadente tra .81. ad .80. circa el riducere li Musici intervalli de duro in molle . . . ." Giovanni Spataro, Errori di Franchino Gafuria da Lodi (Bologna, 1521), ff. 21v-22r; quoted and translated by Mark Lindley, "Fifteenth-Century Evidence for Meantone Temperament," Proceedings of the Royal Music Association 102 (1975-6): 42.
musician, rather than a speculative issue. Although Gaffurius advocated the Pythagorean third of 81:64 rather than the pure major third of 5:4, he was not completely inflexible to alterations in Pythagorean tuning. While quite apart from Ramos on the matter of specific tuning procedures, Gaffurius was, in fact, probably the first theorist to suggest the concept of temperament:

Nevertheless, the fifth itself, so organists assert, leniently sustains a diminution of a very small and hidden and somewhat uncertain quantity which indeed is referred to by them as \textit{participata}.\textsuperscript{23}

In this regard, Barbour notes that the organs which were tuned according to Gaffurius's instructions were probably closer to equal temperament than to either just intonation or meantone temperament; for when a Pythagorean fifth of 702 cents is tempered by a "very small and hidden quantity," it could easily approximate 700 cents—the size of the perfect fifth in equal temperament.\textsuperscript{24}

In addition to a new type of "pure" third, Ramos's division of the monochord results in a tuning that requires two types of whole tones—in ratios of 9:8 and 10:9—to replace the single 9:8 whole tone of Pythagorean tuning.

\textsuperscript{23}``Tamen quinta ipsa (quod organistae asserunt) minimeae ac latentis incertaeque quodammodo quantitatis diminutionem patienter sustinet quae quidem ab ipsis participata vocatur." Book III, Chapter 3, Rule 2, Gaffurius, \textit{Practica musicae}, fol. dd1r.

\textsuperscript{24}Barbour, \textit{Tuning and Temperament}, 5-6.
Barbour calls attention to the fact that the ratios of just intonation result from a combination of Ptolemy's syntonic-diatonic tuning and Didymus's diatonic arrangement of the monochord. Indeed, an examination of Ramos's diatonic arrangement of the monochord applied to a C major scale reveals that Ramos's tuning employs the ratios of Didymus's diatonic tuning in the lower diatessaron from the pitches C-F, and Ptolemy's syntonic-diatonic tuning in the upper diapente from the pitches F-C. A comparison of Tables 5, 6, and 7 demonstrates these similarities.

TABLE 5
DIDYMUS'S DIATONIC TUNING
APPLIED TO THE C MAJOR SCALE

<table>
<thead>
<tr>
<th></th>
<th>10:9</th>
<th>9:8</th>
<th>16:15</th>
<th>10:9</th>
<th>9:8</th>
<th>9:8</th>
<th>16:15</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
</tbody>
</table>

TABLE 6
PTOLEMY'S SYNTONIC-DIATONIC TUNING
APPLIED TO THE C MAJOR SCALE

<table>
<thead>
<tr>
<th></th>
<th>9:8</th>
<th>10:9</th>
<th>16:15</th>
<th>9:8</th>
<th>10:9</th>
<th>9:8</th>
<th>16:15</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
</tbody>
</table>

Ibid., 21.
TABLE 7

RAMOS'S DIATONIC DIVISION OF THE MONOCHORD
APPLIED TO THE C MAJOR SCALE

<table>
<thead>
<tr>
<th>10:9</th>
<th>9:8</th>
<th>16:15</th>
<th>9:8</th>
<th>10:9</th>
<th>9:8</th>
<th>16:15</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>A</td>
<td>B</td>
</tr>
</tbody>
</table>

Initially, Ramos describes a "diatonic" tuning of the monochord; somewhat later, in Part 1, Treatise 2, Chapter 5, Ramos provides a "chromatic" tuning with the addition of the necessary coniunctae (accidentals).\(^2\) Table 8 illustrates the ratios that result when these additional coniunctae are applied to a chromatic scale beginning on C.

TABLE 8

THE CHROMATIC SCALE
ACCORDING TO PYTHAGOREAN TUNING\(^2\)

<table>
<thead>
<tr>
<th>C</th>
<th>C#</th>
<th>D</th>
<th>Eb</th>
<th>E</th>
<th>F</th>
<th>F#</th>
<th>G</th>
<th>Ab</th>
<th>A</th>
<th>Bb</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
</table>

Cents:

0 114 204 294 408 498 612 702 816 906 996 1110 1200

\(^2\) For a thorough explanation of the various meanings of this term coniunctae, see Chapter VI of this commentary.

\(^2\) Barbour, Tuning and Temperament, 90.
Barbour, however, notes that the series of pitches in perfect fifths from D to C# (D, A, E, B, F#, C#) lie a comma lower in Ramos's division than those brought about by Pythagorean tuning (see Table 9).

TABLE 9

THE CHROMATIC SCALE

ACCORDING TO RAMOS'S DIVISION OF THE MONOCHORD

<table>
<thead>
<tr>
<th>C</th>
<th>C#</th>
<th>D</th>
<th>Eb</th>
<th>E</th>
<th>F</th>
<th>F#</th>
<th>G</th>
<th>Ab</th>
<th>A</th>
<th>Bb</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>92</td>
<td>182</td>
<td>294</td>
<td>386</td>
<td>498</td>
<td>590</td>
<td>702</td>
<td>792</td>
<td>884</td>
<td>996</td>
<td>1088</td>
<td>1200</td>
</tr>
</tbody>
</table>

Cents:

| 0 | -1 | -1 | 0 | -1 | 0 | -1 | 0 | 0 | -1 | 0 | -1 | 0 |

*(−1 = pitches a comma lower than Pythagorean ratios)

Conclusion

Ramos's division of the monochord results in the essential intervals of the three genera, i.e., the two whole steps of 9:8 and 10:9 indigenous to the diatonic

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28Ibid., 89-90. Barbour's tables correctly illustrate his intended premise. His text, however, contains two errors: (1) the six notes "lie a comma higher" [sic., lower] than the corresponding notes of the Pythagorean scale; (2) the six notes that lie a comma lower are pitches in a series of perfect fifths from D-C#, not D-F# as Barbour incorrectly states in the text.

29Ibid.
genus, the minor third ratio of 6:5 from the chromatic genus, and the major third ratio of 5:4 from the enharmonic genus. An ardent disciple of Boethius, Ramos was justifiably proud of the fact that his division of the monochord incorporated the three genera in modern practice. The desire to prove that these genera could be used in modern practice may have been one of the reasons that Ramos was so insistent on creating a monochordal division with these ratios.

Ramos's method of tuning paved the way for the monumental changes in harmonic practice that were to be realized in the succeeding generation. Ramos's division of the monochord—which utilizes pure thirds and sixths—not only laid the foundation for Ramos's other controversial theories, but served as the framework for the tertian-based harmonic system espoused by the sixteenth-century theorist Gioseffo Zarlino.