1 The tetrachord in experimental music

WHY, IN THE LAST quarter of the twentieth century, would someone write a lengthy treatise on a musical topic usually considered of interest only to students of classical Greek civilization? Furthermore, why might a reader expect to gain any information of relevance to contemporary musical composition from such a treatise? I hope to show that the subject of this book is of interest to composers of new music.

The familiar tuning system of Western European music has been inherited, with minor modifications, from the Babylonians (Duchesne-Guillemin 1963). The tendency within the context of Western European "art music" to use intervals outside this system has been called *microtonality*, *experimental intonation* (Polansky 1987a), or *xenharmonics* (a term proposed by Ivor Darreg). Interest in and the use of microtonality, defined by scalar and harmonic resources other than the traditional 12-tone equal temperament, has recurred throughout history, notably in the Renaissance (Vicentino 1555) and most recently in the late nineteenth and early twentieth century. The converse of this definition is that music which can be performed in 12-tone equal temperament without significant loss of its identity is not truly *microtonal*. Moreover, the musics of many of the other cultures of the world are microtonal (in relation to 12-tone equal temperament) and European composers have frequently borrowed musical materials from other cultures and historical periods, such as the Ottoman Empire and ancient Greece.

We owe our traditions of musical science to ancient Greece, and the theoretical concepts and materials of ancient Greek music are basic to an

understanding of microtonal music. Greek musical theory used the *tetrachord* as a building block or module from which scales and *systems* could be constructed. A current revival of interest in microtonality, fueled by new musical developments and technological improvements in computers and synthesizers, makes the ancient tetrachord increasingly germane to contemporary composition.

Contemporary microtonality

Although 12-tone equal temperament became the standard tuning of Western music by the mid-nineteenth century (Helmholtz [1877] 1954), alternative tuning systems continued to find partisans. Of these systems, perhaps the most important was that of Bosanquet (Helmholtz [1877] 1954; Bosanquet 1876), who perfected the generalized keyboard upon which the fingering for musical patterns is invariant under transposition. He also championed the 53-tone equal temperament. Of nineteenth-century theorists, Helmholtz and his translator and annotator A. J. Ellis (Helmholtz [1877] 1954) are outstanding for their attempts to revive the use of just intonation.

The early twentieth century saw a renewed interest in *quarter-tones* (24-tone equal temperament) and other equal divisions of the octave. The Mexican composer Julián Carrillo led a crusade for the equal divisions which preserved the *whole tone* (*zero modulo 6* divisions) through 96-tone temperament or sixteenths of tones. Other microtonal, mostly quarter-tone, composers of note were Alois Hába (Czechoslovakia), Ivan Wyschnegradsky (France), and Mildred Couper (USA). The Soviet Union had numerous microtonal composers and theorists, including Georgy Rimsky-Korsakov, Leonid Sabaneev, Arseny Avraamov, E.K. Rosenov, A.S. Obolovets, and P.N. Renchitsky, before Stalin restrained revolutionary creativity under the doctrine of Socialist Realism (Carpenter 1983). Joseph Yasser (USA) urged the adoption of 19-tone equal temperament and Adriaan Fokker (Holland) revived the theories of his countryman, Christian Huygens, and promoted 31-tone equal temperament. More recently, Martin Vogel in Bonn and Franz Richter Herf in Salzburg have been active in various microtonal systems, the latter especially in 72-tone equal temperament.

No discussion of alternative tunings is complete without mentioning Harry Partch, an American original who singlehandedly made extended

just intonation and home-built instruments not only acceptable, but virtually mandatory for musical experimenters at some stage in their careers. Composers influenced by him include Lou Harrison, Ben Johnston, James Tenney, and younger composers such as Larry Polansky, Cris Forster, Dean Drummond, Jonathan Glasier, and the members of the Just Intonation Network.

Ivor Darreg is an American composer working in California. He has been very actively involved with alternative tunings and new instrument design for more than five decades. Darreg has employed both non-12-tone equal temperaments and various forms of just intonation in his music, theoretical writings, and instruments. More recently, he has begun to use MIDI synthesizers and has explored all the equal temperaments up to 53 tones per octave in a series of improvisations in collaboration with Brian McLaren.

Ervin Wilson is one of the most prolific and innovative inventors of new musical materials extant and has been a major influence on me as well as a source for many tetrachords and theoretical ideas. He holds patents on two original generalized keyboard designs. Wilson has collaborated with Kraig Grady and other experimental musicians in the Los Angeles area. He also assisted Harry Partch with the second edition of *Genesis of a Music* by drawing some of the diagrams in the book.

Some other North American microtonal composers are Ezra Sims, Easley Blackwood, Joel Mandelbaum, Brian McLaren, Arturo Salinas, Harold Seletsky, Paul Rapoport, William Schottstaedt, and Douglas Walker.

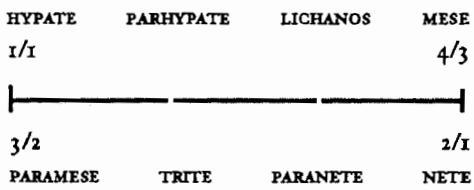
While still very much a minority faction of the contemporary music community, microtonality is rapidly growing. Festivals dedicated to microtonal music have been held in recent years in Salzburg under the direction of Franz Richter Herf; in New York City, produced by Johnny Reinhard; and in San Antonio, Texas, organized by George Cisneros.

Partch, Darreg, Wilson, Harrison, Forster, and William Colvig, among others, have designed and constructed new acoustic instruments for microtonal performance. Tunable electronic synthesizers are now available commercially and provide an an alternative to custom-built acoustic or electroacoustic equipment. A great deal of software, such as *HMSL* from Frog Peak Music, *JICalc* by Robert Rich and Carter Scholz, and Antelope Engineering's *TuneUp*, has been developed to control synthesizers microtonally via MIDI.

Good references for additional information on the history of microtonal systems are Helmholtz ([1877] 1954), Barbour (1951), Partch ([1949] 1974), and Mandelbaum (1961). Small press publications are a rich source and several journals devoted to music in alternative tunings have been published. The major ones are *Xenharmonikon*, *Interval*, *Pitch*, and *1/1: The Journal of the Just Intonation Network*. Finally, *Musical Six-Six Bulletin*, *Leonardo: The International Journal of Arts, Science, and Technology*, *Experimental Musical Instruments*, and *Musicworks* have also contained articles about instruments in non-traditional tuning systems.

The tetrachord in microtonal music

Tetrachords are modules from which more complex scalar and harmonic structures may be built. These structures range from the simple heptatonic scales known to the classical civilizations of the eastern Mediterranean to experimental gamuts with many tones. Furthermore, the traditional scales of much of the world's music, including that of Europe, the Near East, the Catholic and Orthodox churches, Iran, and India, are still based on tetrachords. Tetrachords are thus basic to an understanding of much of the world's music.



1-1. *The tetrachord.*

The tetrachord is the interval of a *perfect fourth*, the *diatessaron* of the Greeks, divided into three subintervals by the interposition of two additional notes.

The four notes, or strings, of the tetrachord were named *hypate*, *parhypate*, *lichanos*, and *mese* in ascending order from 1/1 to 4/3 in the first tetrachord of the central octave of the *Greater Perfect System*, the region of the scale of most concern to theorists. Ascending through the second tetrachord, they were called *paramese*, *trite*, *paranete*, and *nete*. (Chapter 6 discusses Greek scales and nomenclature.)

Depending upon the spacing of these interposed tones, three primary genera may be distinguished: the *diatonic*, composed of *tones* and *semitones*; the *chromatic*, of semitones and a *minor third*; and the *enharmonic*, with a *major third* and two quarter-tones. Nuances or *chroai* (often translated "shades") of these primary forms are further characterized by the exact tuning of these intervals.

These four tones apparently sufficed for the recitation of Greek epic poetry, but soon afterwards another tetrachord was added to create a heptachord. As a feeling for the octave developed, the *gamut* was completed,

and from this gamut various sections were later identified and given ancient tribal names (Dorian, Phrygian, et cetera). These *octave species* became the *modes*, two of which, the Lydian and Hypodorian, in the diatonic genus form the basis for the European tonal idiom. Although a formal nomenclature based on the position of the strings later developed, the four tetrachordal tones remained the basis for the Greek solfège: the syllables τε, τω, τη, τα, (pronounced approximately teh, toe, tay, and tah in English) were sung in descending order to the notes of every genus and shade.

The detailed history of the Greek tetrachordal scales is somewhat more complex than the sketchy outline given above. According to literary testimony supported at least in part by archaeology, the diatonic scale and its tuning by a cycle of *perfect fifths*, fourths, and octaves was brought from Egypt (or the Near East) by Pythagoras. In fact the entire *12-tone chromatic* scale in this tuning is thought to have been known to the Babylonians by the second millennium BCE and was apparently derived from earlier Sumerian precursors (Duchesne-Guillemin 1963, 1969; Kilmer 1960). Having arrived in Greece, this scale and its associated tuning doctrines were mingled with local musical traditions, most probably *pentatonic*, to produce a plethora of scale-forms, melody-types and styles (see chapter 6). From a major-third pentatonic, the enharmonic genus can be derived by splitting the semitone (Winnington-Ingram 1928; Sachs 1943). The chromatic genera, whose use in tragedy dates from the late fifth century, may be relicts of various *neutral* and minor-third pentatonics, or conversely, descended from the earlier enharmonic by a process of "sweetening" whereby the pitch of the third tone was raised from a probable 256/243 to produce the more or less consonant intervals 5/4, 6/5, 7/6 and possibly 11/9 (Winnington-Ingram 1928).

The resulting scales were rationalized by the number theory of Pythagoras (Crocker 1963, 1964, 1966) and later by the geometry of Euclid (Crocker 1966; Winnington-Ingram 1932, 1936) to create the body of theory called *harmonics*, which gradually took on existence as an independent intellectual endeavor divorced from musical practice. The acoustic means are now available, and the prevailing artistic ideology is sympathetic enough to end this separation between theory and practice.

Many composers have made direct use of tetrachordal scales in recent compositions. Harry Partch used the pentatonic form of the enharmonic (16/15 · 5/4 · 9/8 · 16/15 · 5/4) in the first of his *Two Studies on Ancient Greek*

Scales (1946) and the microtonal form in the second (in Archytas's tuning, 28/27 · 36/35 · 5/4). Partch also employed this latter scale in *The Dreamer that Remains*, and in verse fifteen of *Petals*. His film score *Windsong* (1958) employs Ptolemy's equable diatonic *(diatonon homalon)*. Ivor Darreg's *On the Enharmonic Tetrachord* from his collection *Excursion into the Enharmonic*, was composed in 1965 and published in *Xenharmonikon 3* in 1975. Lou Harrison has used various tetrachords as motives in his "free style" piece *A Phrase for Arion's Leap (Xenharmonikon 3*, 1975). An earlier piece, *Suite* (1949) was based on tetrachords in 12-tone equal temperament. Larry London published his *Eight Pieces for Harp in Ditone Diatonic* in *Xenharmonikon 6* (1977) and his *Four Pieces in Didymus's Chromatic* in *Xenharmonikon 7+8* (1979). In 1984, he wrote a *Suite for Harp* whose four movements used Archytas's enharmonic and a chromatic genus of J.M. Barbour. Gino Robair Forlin's song in Spanish and Zapotec, *Las Tortugas* (1988), is based on the tetrachord 16/15 · 15/14 · 7/6. There are of course many other recent pieces less explicitly tetrachordal whose pitch structures could be analyzed in tetrachordal terms, but doing so would be a major project outside the scope of this book. Similarly, there is a vast amount of music from Islamic cultures, Hindustani, and Eastern Orthodox traditions which is also constructed from tetrachordal scales. These will not be discussed except briefly in terms of their component tetrachords.

A psychological motivation for the consideration of tetrachords is provided by the classic study of George A. Miller, who suggested that musical scales, in common with other perceptual sets, should have five to nine elements for intuitive comprehension (Miller 1956). Scales with cardinalities in this range are easily generated from tetrachords (chapter 6) and the persistence of tetrachordal scales alongside the development of triad-based harmony may reflect this property.

Tetrachords and their scale-like complexes and aggregates have an intellectual fascination all their own, a wealth of structure whose seductive intricacy I hope to convey in this book.