

A Chronology of Equal Temperament and its Musical Exploration

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Around **450 B.C.E.** the Chinese court of the Marquis Yi of Zeng has developed a large set of bronze bells with a chromatic scale over 3 octaves. The motivation appears to be able to transpose the pentatonic scale 12 times to match the 12 years of the Chinese Zodiac which is based on the almost 12 years orbit of Jupiter. The method of calculating the pitches is not known.

1350 Keyboards in Europe have accumulated five black keys between the seven white keys though the intervals between them were not all equal.

1450 major and minor triads spread from England through Europe and are used to articulate the rhythm of dance music mostly in root position as continues today in much popular dance music.

From around **1500** instrument makers place each fret roughly 1/18 of the remaining string on instruments such as the cittern, bandola, viol and lute.

1547 Observing that two new scales had gained currency, exemplified by the white note scales beginning on C and A, Glareanus named them Ionian and Aeolian, respectively, after Greek provinces. The Dorian, exemplified by the white notes beginning on D, is still regarded as the first mode/scale.

1567 Giacomo Gorzanis' suite of minor and major dances on every fret. The dances are identified by their characteristic chord sequences ornamented by scalic runs. The minor 3rd dances termed *antico* appear first followed by those using the major 3rd termed major *moderno*. The minor dances are still Dorian in character in that the major 6th is treated as an independent note. While the major dances can be thought of as Myxolydian in that the lowered 7th degree is freely used. The *antico* dances use a major 3rd in the final chord of a cadence. Both *antico* and *moderno* use the raised 7th at in the penultimate dominant chord of a cadence. At this point the fretted instruments are leading the trends in music practice and theory.

1584 Vincenzo Galilei's suite of minor and major dances on every fret expanding the design of Gorzanis' cycle.

1584 Chinese mathematician Chu Tsi-yu suggests slightly flattening the ratio 3:2 to 749:500 which, when repeated twelve times arrives slightly flat of an octave.

1605 the mathematician Simon Stevin arrives at a the 12th root of 2 as the ideal guide to the placement to frets. The 749:500 method is slightly flatter and the 18/17 method slightly flatter still.

1691 The eclipse of the Dorian is heralded by the French mathematician M.Ozanam who lists twelve major (Ionian) and minor (Aeolian) keys in his *Dictionaire Mathematic*.

1713 A similar list appears in Johann Mattheson's *Das neueroeffnete Orchestre*.

1722 J S Bach's Well-tempered Clavier follows a similar design to Gorzanis and Galilei except that now the Ionian (major scale) pieces comes first followed by the minor. Within the minor scale the major 6th has lost its independent status and is only permitted as an adjunct to the raised 7th (leading note). Bach adjusts the key signature to make the minor scale clearly Aeolian rather than Dorian greatly strengthening this trend. The pieces, a prelude and fugue, are of a more serious nature than Gorzanis' or Galieii's, influenced by church music and containing many modulations now made easier by the reduction of scale options.

Around 1750 the capo is invented allowing guitarists to transpose fingering shapes.

1757 C.P.E.Bach in his *True Art of Keyboard Playing* list only what has come to be know as the *melodic minor* e.g. 0 2 3 5 7 9 11 12 frets in ascent, 12 10 8 7 5 3 2 0 in descnt.

1797 Gossec institutes the *harminic minor* at the Paris Conservatoire, e.g. 0 2 3 5 7 8 11 12 in ascent and descent.

Gradually Equal Temperament spreads to all instruments of the orchestra, the organ being the last and most expensive to adapt.

After **around 1850** classical composers begin to look beyond the Ionian/Aeolian options to revisit the Dorian and other modes and explore the full chromatic potential of Equal Temperament. Various alternatives to the Ionian/Aeolian options are widely explored in 20th and 20st century popular music and jazz.

1880 Alexander divised the Equally tempered fret into a hundred parts know as *cents* and use this measure to describethe scales of global cultures. Subsequently modern media has contributed to the global spread of equal temperament and the obliteration of many such tunings.

1959 Miles Davis released the recording *Kind of Blue* which explores new ways of improvising on the modes. One track *So what* holds the improvisors to the Dorian as strictly as early plainchant, much more strictly than the musicians of the Renaissance. The bridge shifts the Dorian

up a fret, a move first made by Gorzanis in 1567. This album signals the end of the Dorian eclipse and this scale is now part of the jazz curriculum.

It seems to be a multiple coincidence that the Chinese Zodiac has 12 years imitating the orbit of Jupiter, that the Babylonian Zodiac has 12 months imitating the number of moon orbits of the earth in a year and that Equal Temperament divides the octave into 12 options. Such options can closely imitate the simple vibration ratios up to $4/3$ (with a maximum deviation of 2 cents) and can approximate higher ratios (up to and including the number 10) with a maximum deviation of 35 cents. As the adjacent numbers get higher the intervals between them get smaller and our discrimination in live music dwindles. This loss of discrimination is used to musical effect in harmonic symmetries such as the whole tone scale, the diminished 7th chord, the augmented triad, and tritone substitution which also exploit the several factors of 12, these are 2,3,4 and 6. It is also coincidence that the biological limit to the number of memorable and easily singable notes per octave is 7 which is not a factor of 12 and therefore produces asymmetrical scales which make it easier for singers to orientate themselves and pick up melodies. Likewise 5 is not a factor of 12 and can only produce asymmetrical pentatonic scales. The octatonic scales (0 2 3 5 6 8 9 11 12 and 01 3 4 6 7 9 10 12 frets) appearing in classical music and jazz are rich in symmetry but do not lend themselves to popular song.

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