

TUNING SUPPLEMENT

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This supplement is prompted by some major developments in the understanding of *cerdd dant* composition that have occurred in the years since my 'Tuning' dissertation was written.¹ That dissertation drew confident conclusions as to the identity of the nominal pitches the harp was tuned to in order to perform the pieces intabulated in the Robert ap Huw manuscript. Numerous strong arguments were presented against the hypothesis that the diagrams on pp. 108-9 of the manuscript are scordatura tunings² and the viability was demonstrated of each of the tablature letters referring to its literal written nominal pitch – *i.e.* all natural notes apart from B-flat – rather than to an unwritten and unidentified substitute nominal pitch.³ Subsequently, the *cerdd dant* scholar Paul Whittaker has taken care to guide the reader through illustrations of exactly how my tuning interpretation makes artistic and historical sense of the harmony and the melodic phrasing, using the *clymau cytgerdd*, *Caniad Cadwgan* and *Caniad Cynwrig Bencerdd* as examples, on pages 11-16 of his deeply-probing article: 'Harmonic Forms in the Robert ap Huw Manuscript',⁴ and Paul Dooley and I have aired my translations of the manuscript, in illustration of the melodic and harmonic comprehensibility of the nominal pitch solution when set into the historical context

¹ Peter Greenhill, 'The Robert ap Huw Manuscript: an exploration of its possible solutions', 3: 'Tuning' (2000), CAWMS dissertation, Bangor University, <<http://www.cl.cam.ac.uk/~rja14/musicfiles/manuscripts/aphuw/aphuw-t.pdf>>.

² *ibid.*, pp. 33-52.

³ *ibid.*, pp. 53-67. Note, however, that as regards the historical background to the intabulation of the piece *Caniad Tro Tant* theories have abounded in discussions over many years amongst Paul Dooley, Paul Whittaker and myself, and that Dooley and Whittaker admit a possibility that tablature E in this piece represented E-flat. My current opinion is that the turned string – *tro tant* – of the title referred to the need to alter the tuning of one of the string courses of the crwth by a tone in order to match the harmony of the piece as intabulated.

⁴ Paul Whittaker, 'Harmonic Forms in the Robert ap Huw Manuscript', *Welsh Music History*, 7 (2007), pp. 1-34. The 'scordatura' hypothesis was first demonstrated to produce "nonsense" in relation to *Caniad Cadwgan* in Paul D. Whittaker, 'British Museum, Additional MS 14905; An Interpretation and Re-examination of the Music and Text', M.A. thesis, University College of North Wales, Bangor, 1974, pp. 37-8.

of double-tonic folk music in the British Isles.⁵ Robert Evans and Bill Taylor have continued to recommend a variety of substitute nominal pitches and yet the evidence, reasoning and demonstrations presented by Whittaker, Dooley and myself remain unchallenged.⁶

However, my examination of the topic of intonation was unable to be conclusive about the precise microtunings of those notes, about the detection of the precise intonational basis upon which the notes were historically set into relationship with one another. As my chapter on intonation⁷ makes clear, the problem arises because the music is dominated by tertian harmony and in consequence it would be unwise to assume that intonational systems used elsewhere for non-tertian music would have applied. On the other hand, the music is not known to have been embedded in any wider 'tertian' culture for which modern scholarship has been able to establish the intonational aspects. It presents a difficult challenge.

Important new information relevant to the enquiry has now been brought to light in Whittaker's article. Working from my identification of the nominal values of the notes intabulated and using the access that that gives to the intabulated music, together with my identifications of the boundaries of the harmonic-metrical units therein (the 'digital' '1's and '0's of the traditional metrical notation)⁸ and of which notes were sounded together and for how long,⁹ Whittaker was able to deduce with confidence many further rules upon which its harmonic, melodic and tonal structures were built. The acquisition of those rules has allowed the enquiry into the intonation of the music to move forward and to tackle some of the most vexatious problems concerning the music theory held by the medieval tradition, such as the true nature and origin of the unexplained pair of complementary terms that were the very foundation of the theory and practice of *cerdd dant: cyweirdant and tyniad*.

⁵ Paul Dooley, *Music from the Robert ap Huw Manuscript Volume I* (CD pub. Paul Dooley, 2004); Peter Greenhill, 'The Robert ap Huw Manuscript: an exploration of its possible solutions', 6: 'Rhythm' (1998), pp. 86-121, app. pp. 1-62, <<http://www.cl.cam.ac.uk/~rja14/musicfiles/manuscripts/aphuw/aphuw-rhythm.pdf>>; Sally Harper, 'Dafydd ap Gwilym, poet and musician', pp. 11, 47-51, in *Dafydd ap Gwilym.net*, ed. Dafydd Johnston, <<http://www.dafyddapgwilym.swansea.ac.uk>>; Peter Greenhill, 'Discussions' (2016), pp. 9-12, 52-3, 59-61, <<https://www.scribd.com/document/321067721/Peter-Greenhill-Discussions-on-the-Music-of-the-Robert-ap-Huw-Manuscript#>>.

⁶ Robert Evans, 'Cerdd Dant' in Bill Taylor, *Musica: Welsh medieval harp music from the Robert ap Huw manuscript* (CD pub. taithrecords, 2010).

⁷ Greenhill, 'Tuning', chapter IX, 'Intonation', pp. 74-96.

⁸ Greenhill, 'The Robert ap Huw Manuscript: an exploration of its possible solutions', 5: 'Metre' (1998), CAWMS dissertation, Bangor University, <<http://www.cl.cam.ac.uk/~rja14/musicfiles/manuscripts/aphuw/aphuw-metre.pdf>>.

⁹ Greenhill, 'Rhythm'.

Subsequent to Whittaker's article and partly in collaboration with him I have been able to extend the identification of the operation of those same principles within the parts of the manuscript for which his article did not identify the principles, that is, the parts on pp. 56-65 of the manuscript.¹⁰ This results from my detection of frequent harmonic modulations within those pieces, and fuller details will appear in a forthcoming book by Whittaker. For each of the harmonic modalities there exists a *cyweirdant* note group and a *tyniad* note group, and the notes in each group are those from which the composer would normally make selections to serve as melodic plain notes or as chordal notes during the *first* beat of the 'digit' or bar. The notes for subsequent beats do not have to be restricted to these groups, and if they are not then they are drawn from the opposite group: the *tyniad* group in a *cyweirdant* bar, or the *cyweirdant* group in a *tyniad* bar.¹¹ The original four modal centres set out in Whittaker's article¹² along with their corresponding *cyweirdant* and *tyniad* note groups have now been joined by others that have been identified, so that the full list is as follows; note that 'B' throughout this supplement refers to B-flat¹³:

Tonal centre	Harmonic Modality	<i>Cyweirdant</i> notes	<i>Tyniad</i> notes
G	Dorian	E-G-B-D	D-F-A-C
A	Phrygian	F-A-C-E	E-G-B-D
B	Lydian	G-B-D-F	F-A-C-E
C	Mixolydian	A-C-E-G	G-B-D-F
D	Aeolian	B-D-F-A	A-C-E-G
E	Locrian	C-E-G-B	B-D-F-A
F	Ionian	D-F-A-C	C-E-G-B

Note the absolute consistency with which the *cyweirdant* note groups are derived from the tonal centre for each mode, through the interval of the third, and the absolute consistency with which the *tyniad* notes are derived from the *cyweirdant* notes of each mode, through the interval of the second. Thus is the entire manuscript now understood to conform at the deepest level to a single set of principles in respect of tonality, melody and harmony. This is a significant development: the discovery of a hitherto unknown comprehensive system of

¹⁰ The relatively short *profiadau* and the other very short pieces.

¹¹ Greenhill, 'Metre', pp. 42-3, 48-52, 56,

¹² Whittaker, pp. 2-9.

¹³ B-natural being absent in the intabulated music.

vertical and linear harmony, and not just one that a theorist has proposed but one that has been in actual operation.¹⁴

Note, however, that when expressed in terms of the tonal centre as the root these tetradic stacks of thirds produce the pattern of consonances: unison, third, fifth, sixth: the same pattern as those of the discant options in relation to the tenor of Leonel Power's exposition of vocal polyphony.¹⁵ If we choose to view, then, the pattern of alternation between the tonal centre and the second below - the subtonic - that is expressed or implied in the measures of *cerdd dant* as a simple two-note tenor, Power's description of available consonances in discant fits the stacks of *cerdd dant*. The theory of consonance is the same; the implementation differs.

Also note the antiquity of the classification by theorists of the major third and the minor third as consonances (albeit 'imperfect' ones) in actual use in all discant against the tenor, dating from c. 1220 (*De musica libellus*, Anonymous VII):

Let it be observed that the unison, semiditone, ditone, diatessaron, diapente, and diapason are more essential than the other intervals, for all discant forms one of these consonances with its tenor.¹⁶

The concordance of the *cerdd dant* stacks of thirds with the organisation of discant harmonies has repercussions for the issue of intonation, in that it confirms and emphasises the tertian nature of the music in the manuscript, and so it is that deeply tertian nature along with the high degree of integration that the music displays which calls for a change of emphasis in the investigation into intonation.

¹⁴ I use the term 'tetradic' to describe the four-fold nature of the stacks of thirds, wherever it is important to distinguish this system of harmony from the familiar triadic system that relies on three-fold stacks. Both systems, being built out of stacks of thirds, are of course tertian. It is a fundamental distinction, because in *cerdd dant* out of the diatonic octave you can only draw two groups (*cyweirdant* and *tyniad*) compared to the six triads you can draw. But because four, and not three, notes are available for *cyweirdant* and *tyniad* they can be much richer and more diverse than triads can be, in terms of what notes are included in a chord and in what inversions. So both systems have massive validity, and chordal music in the modern era has been the poorer for the loss of the tetradic *cerdd dant* system.

¹⁵ Leonel Power and 'Pseudo-Chilston': *Lb/ MS Lansdowne 763*, ff. 105-113, ff. 113-16. For the relationship of discant terminology to Welsh sources see Stephen Rees, 'English Discant and a Source of Vernacular Music Theory from Medieval Wales', *Welsh Music History*, 1 (1996), pp. 144-53; Sally Harper, *Music in Welsh Culture before 1650: A Study of the Principal Sources* (Aldershot, 2007), pp. 131-34.

¹⁶ Cited in James Tenney, *A history of 'consonance' and 'dissonance'* (New York, 1988), p. 22.

In order to illustrate the high degree of integration between all the pieces intabulated it is worth taking stock of the main points that all the pieces have in common:

Tuning. A single diatonic series, duplicated for each octave used, with a high degree of exchange between different octaves: *i.e.* not only are the notes of one octave commonly vertically duplicated in another octave but in variations the notes in one octave are commonly substitutions for the notes from another (usually lower) octave in an earlier variation.

Harmonic structure. The entire music text is united in that the selection of notes and harmonies available to the composer at any point is defined by a set of precise rules relating to *cyweirdant* and *tyniad* which are now understood. The same rules underpin each of the harmonic modes.

Melodic structure. This is also defined by the same rules, and insofar as the melodic tonality may sometimes depart from that of the harmonic mode it never becomes entirely independent from it: departure is generally limited to the single case of the fifth above the harmonic mode. Almost every piece is either directly or indirectly linked to every other piece by duplicated melodic formulas, sometimes of substantial length.¹⁷ The techniques by which variations are formed are often common to multiple pieces.

Rhythmic structure. Within the bar, a single rhythmic template determines the note positions available irrespective of bar length.¹⁸ Thus none of the pieces are in suite form, and even if two or more pieces were strung together they would not form a suite.

Technique. This is tied in closely to the rhythmic structure. A note's position within the bar commonly plays an important part in determining the finger used to pluck or to damp it. All pieces use similar collections of fingering movements drawn from the single common stock of movements.¹⁹

Instrumental idiom. All the above features of standardization are reflective of the music being truly and fully instrumental in its fundamental nature, rather than

¹⁷ Peter Greenhill: 'Melodic Formulas in the Robert ap Huw Manuscript', *Welsh Music History*, 3 (Cardiff, 1999), pp. 217-236.

¹⁸ Greenhill, 'Rhythm', esp. pp. 78-110.

¹⁹ Greenhill, 'The Robert ap Huw Manuscript: an exploration of its possible solutions', 4: 'Technique' (1996), CAWMS dissertation, Bangor University, <<http://www.cl.cam.ac.uk/~rja14/musicfiles/manuscripts/aphuw/aphuw-tech.pdf>>.

being imitative of singing; the profundity of its instrumental nature is made particularly apparent by the homophonic accompaniment of the lower part and by the absence here of the decorative fast passage-work that instrumental music elsewhere has developed in order to imitate the floridity of vocal melismata. In this tradition the harp was used very much *as a harp* and not as a substitute for the voice.

The fuller appreciation that we now have of the great extent to which the various pieces in the text are integrated with one another is of course very useful when considering the issue of whether the entire repertory - or much of it - was accommodated by a single intonational tuning or whether different pieces would commonly have required different intonations and therefore some adjustments to the tuning of the harp as the harper passed from one piece to another. The estimate of the historical probability of the former of those two possibilities is strengthened by our new, fuller appreciation both of the extraordinarily high level of integration between pieces that the music exhibits and of the depth of the compositional reliance on the concept of the interval of the third. A re-examination of that important issue follows, placing greater emphasis on the relevance of Pythagorean intonation and of meantone temperaments, both of which, on account of having just a single size of tone, have been used in other traditions as universal solutions throughout a repertory to the problems of intonation.

1. Pythagorean intonation

The arguments in favour of Pythagorean intonation for this music were presented in my 'Intonation' chapter:

In its favour, this Pythagorean-type scale is very simple to tune and possesses several pure intervals. In addition to its pure $3/2$ 5ths and $4/3$ 4ths, the scale's tones are all pure $9/8$ major tones. It is necessary here to immediately point out that if Pythagorean intonation had been used in *cerdd dant*, these pure major tones would have had much greater impact than they could in any other early music because several intervals of a single tone were used as vertical sonorities in the manuscript; fairly commonplace chords include F-G, G-A and C-D. Thus in *cerdd dant* the purity of major tones would have been exploited harmonically, not just melodically, if Pythagorean intonation was used.²⁰

Intonation is not just a matter of vertical sonority but also of linear sonority. The double-tonic nature of the music has been apparent ever since I arrived at my

²⁰ Greenhill, 'Tuning', p.75.

solution to tuning, but Whittaker's demonstration that the principle of the double-tonic reaches to the very heart of the music's conception and composition means that the potential significance of these pure major whole tones needs further emphasis. It is now apparent from the double-tonic that as much as the composers and performers thought in terms of vertical stacks of thirds, they also thought in terms of linear seconds. Insofar as achieving purity in the one is a trade-off against achieving purity in the other, which is the more plausible historical alternative?

An answer may be supplied by the English writer Walter Odington (*fl.* 1298-1316), who implied that in practice singers used just thirds, to make consonances out of such intervals if they are skilfully and beautifully sung.²¹ This should be understood in the context of all the evidence of the prevalence of tertian vocal harmonies in England in that period (as exemplified by the double-tonic Reading Rota in particular) provided by such sources such as Theinred of Dover (*fl.* 12th century) and Anonymous IV (*c.* 1275). Since the tertian harmonies of the ap Huw manuscript are not at all anomalous when set beside that contemporary English polyphonic context, there is a strong indication here that Welsh instrumentalists would have been concerned to achieve just thirds also. The implication is that Pythagorean intonation is unlikely to have been widely used in *cerdd dant* in spite of the importance of vertical and linear seconds there.

However, the use of Pythagorean intonation cannot be entirely eliminated on historical grounds. For Gothic polyphony the current wisdom is that Pythagorean intonation was generally used, at least by singers and at least in the Parisian Notre Dame tradition.²² Robert Evans and Bill Taylor have been claiming Pythagorean intonation as the sole historical solution for *cerdd dant*, citing the influence of Boethius although without addressing the other intonational possibilities, the musical diversity within the British Isles or the divergences between the British Isles and the Continent.²³ A speculative explanation for how Pythagorean intonation might have existed in late medieval Wales is that perhaps it had once been universal in the plainchant of the Roman Church but had been displaced by just intonation in Insular tertian polyphonic chant in England *alone*, thus cutting off a postulated 'Pythagorean' polyphonic Wales from the Continent; Welsh harpists may have resisted the influence of English chant and imitated, or continued to imitate, such a postulated Pythagorean intonation of vocal chant in Wales. As we know from Giraldus Cambrensis, however, in the late 12th century

²¹ See Tenney, *op. cit.*, p. 25.

²² The Notre Dame composers were, of course, operating in a contrapuntal environment, one that was very different from the fundamentally homophonic environment of the *cerdd dant* composers.

²³ Evans, *op. cit.*

multi-voiced polyphony was present and commonplace in Wales when it was not in England, and there is a record from 1217 of 3- or 4-voiced polyphonic singing "in the manner of seculars" (*more secularum*) at the Cistercian monasteries of Abbey Dore and Tintern.²⁴ For this whole scenario of a 'Pythagorean' Wales to have taken place it would be necessary for English tertian harmony to have developed independently of the Welsh vocal polyphony and along different lines. That, whilst possible, appears unlikely in view of the geography, especially in the light of Anonymous IV's account, late 13th century, of the best *organistae* in England, located in the land called "Westcuntre" and possibly referring to the Welsh borderland, considering major and minor thirds as the *best* consonances.²⁵ Furthermore, the 'Pythagorean' Wales scenario would deny there having been indigenous antecedents of the just-intonational style of modal post-Reformation Welsh *plygain* singing which, where it is polyphonic as it most commonly is, has some resemblance to English discant.

Whatever about the possibilities concerning the historical context, it remains the case that musically the tertian harmony of *cerdd dant* is not suggestive of Pythagorean intonation. The claim by Evans and Taylor for Pythagorean intonation needs to be understood in the context of their readings of the tablature, in which tertian harmonies play a far reduced role, largely because, without offering any refutations of my work on tuning and of Whittaker's validation of the heptatonic scale I uncovered, they interpret the alphabetical symbols of the tablature as each representing, according to context, a *variety* of nominal pitches rather than its literal nominal pitch, that is, they use different diatonic scales for different pieces.²⁶ This is the approach that first emerged around the turn of the 18th century which appears to have been as exposed as erroneous.²⁷ The scales they use undermine some of the triads in the pieces they believe to be heptatonic, where they accept the diminished fifths A to E-flat and B-natural to F as a normal part of the harmonic language of *cerdd dant*, and their pentatonic scales eliminate altogether many more triads in the pieces to which they apply those scales. A much reduced appreciation of the extent to which the original music was tertian and, indeed, of the contribution to the music of harmony in general and of conventional concepts of consonance may account in part for why Evans and Taylor do not bring into consideration any possibility of justness in tertian intervals - through just-intonational tunings or temperings - and disregard the evidence and arguments presented in their favour in 'Tuning'.

²⁴ Harper (2007), p. 193.

²⁵ Gustave Reese, *Music in the Middle Ages* (London, 1940), p. 400.

²⁶ Robert Evans, 'Robert ap Huw's Harp Tunings: Some Possible Solutions', *Welsh Music History*, Vol. 3 (Cardiff, 1999) pp. 336-7; Evans, 'Cerdd Dant'.

²⁷ Greenhill, 'Tuning', pp. 15-22 & following chapters.

However, tertian harmonies are still commonplace in their readings so the impurity of Pythagorean thirds and sixths are prominent in the general harmonic texture there, reflecting a strength of conviction that Pythagorean intonation was the only intonation used in *cerdd dant*.²⁸

As regards harmonic texture: if the intabulated pieces had been played using Pythagorean intonation, how significant might all the diatonic thirds and sixths impure by the syntonic comma have been? That degree of impurity is accepted as having been an integral part of the harmonic language of Gothic polyphony. Imperfect consonances were quite abundant there, and the major third in particular was used as a preface to perfect consonances. The linear interplay between not just imperfect and perfect consonances but also between the impurity inherent in Pythagorean thirds and sixths and the purity of just fourths, fifths and octaves is perceived as having been the expressive beating heart of Gothic polyphony: impurity is resolved into purity, in an apparent paradigm of medieval Christian spirituality. Given that impurity of the size of the comma is as very evident to the ear as it is, it is not surprising that successions of thirds and sixths, although quite common, are generally brief. But in cases such as the Insular Hymn to St Magnus of Orkney where there are protracted successions of thirds and sixths the appropriateness of Pythagorean intonation has to be extremely doubtful, and this is the case generally with the intabulated pieces. For example, in *Caniad Llywelyn ab Ifan ab y Gof* from 53.3.5 there are twenty-four 8:6 chords in succession, involving five intermediate cadences or phrase endings (at 53.3.14, 3.19, 3.24, 4.6 and 4.10), preceding a long closing passage which itself is centred on sixths and thirds until the final cadential progression from 6:5 through 8:5 to 8 is reached. Aesthetically, such an overwhelming disproportion of impurity to purity is surely untenable, that is, unless it can be explained as an expression of the overwhelmingness of grief. This particular piece is elegiac but there are many other thoroughly tertian pieces which are not. If Pythagorean intonation had a place in *cerdd dant* it would need to have been for pieces in which imperfect consonances play a much reduced role. Yet tertian harmony thoroughly pervades most of the intabulated pieces. Some, such as *Caniad Cadwgan* and *Gosteg Dafydd Athro*, are less imbued with tertian harmony than most, and *Profiad Cyffredin*, *Profiad yr Eos* and *Caniad Hun Wenllian* contain passages which are free of it. These passages might reflect a style which relied on Pythagorean intonation but which, so far as we can judge from the intabulated corpus, appears not to have been in contemporary currency alongside this particular repertoire. We will have cause to return later to the subject of

²⁸ For many years I too used Pythagorean intonation - in part because of the prominence of major seconds and cadential fourths in the manuscript's harmony - until that was queried by Paul Dooley, for which I am most grateful.

Pythagorean intonation, in connection with the *cras gywair* and in connection with resonance.

2. Multiple just-intonational tunings

The emergence of tertian harmonies in large quantity in the mainstream of European vocal polyphony, particularly through the works and influence of John Dunstable, is believed to have been accompanied by a shift in intonation from Pythagorean to just thirds, albeit possibly with some tempering of intermediate, non-cadential fifths and fourths. Thus the contrast between imperfect and perfect intervals is retained but shorn of its former concomitant contrast between impurity and purity. This is a radical shift in objective: no longer can the dynamism, the narrative, of a 'pilgrim's progress' toward purity be read into music; instead is the relative languor of the circulation of seemingly infinite heavenly purity: the voices of contented angels rather than those of striving humankind. The appropriateness for *cerdd dant* of those two very different, tremendously important objectives will be assessed in a later section (section 5.).

Might there have been an attempt at a similar shift in the music of instruments where that was imitative of vocal polyphony? As far as is known, outside of *cerdd dant* when instruments were used it was either to accompany the voice or to substitute for it. Instrumental harmony, where it existed, will probably have quite closely matched the form of vocal polyphony. Some of the prominent instruments – the fretless lute, the fretless fiddle and spike fiddle, most wind instruments – had the flexibility in performance that gave them the capability of matching the subtle intonational adjustments of the voice. But as observed earlier *cerdd dant* is a very different type of music from the medieval music we know of from elsewhere, in being truly and fully instrumental. The system of harmony upon which *cerdd dant* was composed, as it emerges clearly in Whittaker's article, was fully integrated within itself. All of the music intabulated in the manuscript conforms to the system, which is to say that the music is not only extremely homogeneous at the immediately apparent level (for example, in its melodic formulas) but in its deepest structures as well. And whilst singers can make convenient intonational adjustments as they proceed through a piece, players of single-rank diatonic harps cannot. The crwth, being fretless, has the flexibility that makes it capable of matching the subtle intonational adjustments of the voice but the harp does not, nor does the organ. Any one single just-intonational tuning that relies on deploying two sizes of just major second (*i.e.* '5-limit', 'quintal' just intonation) - the major $9/8$ Pythagorean whole tone of 204 cents and the minor $10/9$ one of 182 cents - cannot accommodate as pure all of the thirds or all of the fifths (and all of both of their inverses or compounds) of the

harp music in the manuscript. And insofar as various just-intonational tunings are more or less successful in delivering those intervals as pure in any single piece, the application of just intonation necessarily would have had to involve multiple intonational tunings: different intonational tunings for different pieces, unlike Pythagorean and meantone tunings with their capacity to carry the whole of a repertory.

The first point to be made about this is that a typical *cerdd dant* piece takes a short amount of time to perform in comparison with the suite forms of traditional classical music in the Orient. A full exposition of a *nauba*, a *maqam* or a *raga* is traditionally expected to require taking somewhere in the region of two hours to perform; whereas it may be realistic to expect the longest piece in the *cerdd dant* repertory to have been somewhere around just half-an-hour long. On my understanding of the tempi involved, a duration of fifteen to twenty minutes may have been common. It is certain that a professional *gŵr wrth gerdd dant* harper would have been expected to perform for much longer than fifteen to twenty minutes, so a programme consisting of several or of many pieces must have been performed. Adjusting the intonational tuning of a metal-strung harp, even just a diatonic one with only the twenty-five strings the manuscript requires, is a rather time-consuming business, and is much more so in the case of the harp used by the *datgeiniad* vocalists to accompany their performing of poetry: a harp with a leathern soundtable, braided horsehair (or sometimes gut) strings and, most critically of all, L-shaped bray pins. That does not preclude the making of intonational adjustments between pieces; after thirty minutes of use a metal-strung harp can usually benefit from a little correcting of its tuning anyway. But it is a factor which weighs against multiple intonations, at least where the adjustments that need to be made are of the substantial order of the syntonic comma.

The inconvenience of often needing between pieces to change the tuning by substantial amounts does not displace as the main factor against just-intonational tunings that many pieces in the manuscript use all six of the intervals of the fifth in the diatonic series. To the list of the nine pieces in 'Tuning' p. 83 need to be added *Yr Osteg Fawr* and *Caniad Bach ar y Gogywair*.²⁹ It is noteworthy that this collection of pieces is not united by sharing in a single mode: they contain amongst them the F, G, C and D melodic modes³⁰ and all of the main three harmonic pitch levels identified by Whittaker (the F, G and C

²⁹ I had overlooked that G and D occur together in *Yr Osteg Fawr* at 21.2.12 and following locations and that in *Caniad Bach ar y Gogywair* D and A occur together at 45.3.2 and following locations and F and C occur together at 44.1.14 and following locations.

³⁰ Greenhill, 'Tuning', pp. 64-7.

harmonic modes). Five of them contain modulations of melodic mode and two of them modulations of harmonic mode, and they include divergences between melodic and harmonic mode. So, if indeed multiple intonations were used in the repertory it is clearly evident from this collection of eleven pieces, along with many other pieces in the manuscript which contain changes of mode within them, that changes in intonation did not have to be triggered by changes in mode. That of course begs the question: what else, other than modality, would trigger a need for multiple intonations? In Oriental music intonation is so closely wedded to modality that it is very difficult, if not actually invalid, even to separate the two out from one another as discrete concepts in the first place.

A possible answer could be the retention in parts of the repertory of relics of earlier intonational systems which had once been universal, and that possibility is what originally drew my attention to the potential for just intonation amongst some of those pieces which lack one or more fifths (and their inverses and compounds) in the diatonic series,³¹ necessarily excluding the ten pieces with absent fifths identified in 'Tuning', pp. 80-1. Given that the music is so predominantly heptatonic, these absences are potentially interesting, particularly because they are not restricted to only those pieces which are not fundamentally heptatonic. As I explained,³² the absence of certain fifths in some pieces makes it possible to achieve pure major thirds whilst retaining intervals of a pure fifth for all such fifths as the piece employs, leading to the selection of six just-intonational tunings suggested for some pieces shown on p. 79 of 'Tuning'. Unfortunately, in selecting those intonations I overlooked an impure major third (F-A) of 364 cents in intonation no. 2 and another (B-D) of the same in intonation no. 4. The latter is not used in the piece I associate with intonation no. 4 (Caniad Cadwgan) but the former is present in the two pieces I associated with no. 2: Caniad Bach ar y Gogywair and Caniad San Silin, so the associations of those two pieces fail. Since every just-intonational tuning must yield at least one third, major or minor, which is not pure, just as it must yield at least one fifth which is not pure, it is to be expected that, with their bias toward heptatonicism and full vertical harmony, the pieces in the manuscript are generally not well served by just-intonational tunings. These harmonic restrictions on intonation are, of course, in sharp contrast to the intonational freedom enjoyed by traditional Oriental music with its absence of vertical harmony other than the implied or expressed drone background, an environment in which a great multiplicity of intonations with just bases has been able to blossom.

³¹ *op. cit.*, pp. 77-80.

³² *op. cit.*, p. 78.

Nevertheless, quantification of the extent to which various just-intonational tunings deliver or compromise the purity of the intervals in each piece in the manuscript is helpful in assessing the historical probability of multiple just-intonational tunings having been used. My investigation into just intonation in 'Tuning' concentrated on identifying those few pieces which lack particular fifths and to which, therefore, just-intonational tunings can be applied without compromising any of the fifths present in them, and subsequently Paul Dooley has extended the investigation to all of the pieces that do *not* lack any fifths, quantifying the minimal degree of compromise in justness possible for each of those pieces, in a paper presented in 2007³³ and in current research.

A second argument against just-intonational tunings concerns the assignment of notes to the harp strings. If on the harp just major thirds were to be pursued not by tempering but through the principle of 5-limit just-intonational tuning, rather than retuning between pieces it would be far easier to have some pairs of strings dedicated to a single nominal pitch but tuned a comma apart, as was proposed for keyboards by Lodovico Fogliano: *Musica Theoretica*, 1529. For example, for the Mixolydian harmonic mode two nominal Gs would work: one set at 702 cents and pure with C and A and the other set low at 680 cents and pure with D and B. This may well be the origin of the otherwise unaccounted for practice on the Irish metal-strung harp of having one pair of strings in the bass tuned in unison to either G or C and variously termed '*na comhluighe*' and in English: 'the sisters' or, by James Talbot c. 1690 and most tellingly in terms of intonation: '*the Wolf*',³⁴ which implies a connection with wolf intervals such as 680 cents. Now where such pairings were not used on the *cerdd dant* harp can be demonstrated by referring to those fingering movements that involve three strings which are necessarily all adjacent: *i.e.* *crifiad senl* and *crifiad dwbl*, in which the next to lowest string has to be a singleton, not paired with a near unison.³⁵ This is the case with *d'*, *f'-e''* and *a'''-b'''*, and since all other strings double those at the octave there can be no hidden, extra, doubled near-unison strings. This is very significant: the absence of an equivalent in *cerdd dant* to split keys on keyboards tells against the existence of a general motivation in *cerdd dant* to achieve 5-limit just-intonational tuning, and in turn through its default that fact suggests tempering as the preferred route to just thirds.

³³ Paul Dooley, 'So what's a *cywair* when it's at home? Harp tuning practice in medieval Wales', paper presented at the Eighth Conference of The Centre for Advanced Welsh Music Studies, University of Wales, Bangor, 22.6.2007.

³⁴ See Simon Chadwick, 'Early Gaelic Harp Info', <<http://www.earlygaelicharp.info/tradition/sisters.htm>>.

³⁵ Greenhill, 'Technique', pp. 93-5, 60-1.

The strongest indication of just-intonational tunings that I have identified thus far remains the fact introduced in 'Tuning' and discussed above that several intabulated pieces lack one or more fifths of the diatonic series whereas most pieces do not. That is partly a reflection of the nature of several whole pieces, and of passages in a great many more, that are essentially on gapped scales, that is, that some of the notes of the diatonic series are only ever sounded as short, linking, unaccented notes.³⁶ But since many of these examples of gapped scales are embedded within pieces which in their entirety are heptatonic they do not offer justly-intoned intervals throughout, so it may simply be that the composers wished to exploit gapped scales for their own sake. Such a predilection would be entirely comprehensible as a reflection of the hexatonic nature of the six-stringed accompaniment lyre which the harp came to replace. Set into those contexts, the pieces that have absent fifths throughout are not particularly remarkable in any sense that they demand an explanation involving multiple intonations.

3. The tempering of fifths

It is hard to imagine the fullness of the tertian harmony and the modulatory freedom of *cerdd dant* having developed in any environment other than a tempered one. Neither the Pythagorean intonational basis of early ecclesiastical Roman and Byzantine music nor that of Oriental music allowed tertian harmony to flourish. The implication is that tempering was used on the harp in the British Isles and that it encouraged the development of tertian harmony in a modal and chordal context, and also that it permitted the development of modulation even in this strongly chordal context. As with 3-limit Pythagorean intonation and 5-limit just intonation, neither the natural series nor the 7-limit just intonation of septimal scales offers as wide a platform for the development of tertian harmony as tempering does.³⁷ Coping, or attempting to cope, with the syntonic comma as an undivided unit inevitably leads to substantial 22-cent impurities in the imperfect intervals of Pythagorean intonation and in any just-intonational tuning amongst some of the perfect fifths and fourths as well. Given, then, that neither approach to intonation can deliver entire justness on the harp nor indeed on any instrument of fixed intonation, it may very well be a mistake to assume that the maximisation of justness wherever possible was indeed a goal pursued in the *cerdd dant* tradition. The appropriate placement of comma impurities was apparently important in Gothic polyphony, and the avoidance of them was

³⁶ See Greenhill, 'Tuning', pp. 64-7 for the details of the gapped scales.

³⁷ Tuning systems are commonly described as limited by the largest prime factor contained in the interval ratios from which their scales are generated. Thus 5-limit and 7-limit admit progressively more intervals than 3-limit tuning.

important in tertian justly-intoned vocal polyphony, but when the comma is broken down by tempering into smaller units the presence and avoidance of impurities becomes a smaller matter, where the total avoidance of them, being impossible, ceases to be an objective. In the right place tempered intervals become relished. We should not presume, therefore, that for any intabulated piece a temperament that yields an abundance of tempered chords is less appropriate than one that does not. We need to be open to *other* guides for assessing the historical credibility of each member of the assortment of possible temperaments, particularly the *placement* of impurities within phrases, passages, sections and the whole of a piece.

Highly suggestive of tempering is the term '*lleddf*': awry, oblique, askew, warped, inclined, soft, tender. It occurs in *y lleddf gywair* or *y lleddf gywair gwyddel*, one of the five principal *cyweiriau*, and in the term *tannau lleddfon* in connection with three of the other four in the version of the Dosbarth Cerdd Dannau treatise which contains the most information on *cywair*: AB NLW 836D, p. 107:³⁸

Pump kowar y sydd yn yn safedig ac yn warrantedig, ac or rhai hynny y gellir gwneuthyr a fynnir o gowyria. Un bus i Grythor a geidw dri chowar nid amgen, is gowar, cras gowar, ar lleddef gowar, ac wel dyma r tri chowar y mae r hirfus yn i gadw. Y manegfus sydd yn cadw Gogowar ar bragod gowar, ac wela dyma r 5 kowar prifedig neu Brinsipal. Bawd i Grythor sydd yn gwasnathy, ac yn ymrafaely ymhob kowar ynghyfar y 4 bus eraill, y graenfys ar bus bach sydd yn gwasnaethy ac yn ymrafaely ymhob kowar yn i rhan i hinain, pob bus sydd yn cadw arno r bragod gowair, or achos i mae n cael i enw. o blegid bod peth o bob kowar yn i fyske, ac oherwydd hynny y gelwir ef y Bragod gowar. Pedwar rhiw dana lleddfon sydd; tanna lleddfon y bragod gowar, tana lleddfon y Gogowar, tanna lleddfon isgowar a thanna lleddfon y lleddef gowar, or hwn i mae n cael i enw, oblegid y neb ni wypo'r yspysrwydd heb ddusg kelfyddyd ni bydd ef athro namyn tebygwr kerdd

There are five established and warranted *cyweiriau*, and from these can be made as many *cyweiriau* as one would like. One finger of the crythor keeps three *cyweiriau*, that is to say, *is gywair*, *cras gywair* and the *lleddf gywair*, and these are the three *cyweiriau* that the middle finger keeps. The forefinger keeps *gogywair* and the *bragod gywair*, and these are the five main or principal *cyweiriau*. The thumb of the crythor is ministering and varying in every *cywair* in association with the other four fingers; the ring finger and the little finger are ministering and varying in every *cywair*

³⁸ Transcribed in Bethan E. Miles, 'Swyddogaeth a Chelfyddyd y Crythor', M.A. thesis, University of Wales, Aberystwyth, 1982, vol. 2, p. 578.

in their own part. Every finger keeps the *bragod gywair*, for which reason it gets its name, because there is something of every *cywair* in its mixture, and because of that it is called the *bragod gywair*. There are four types of *tannau lleddfon*: *tannau lleddfon* of the *bragod gywair*, *tannau lleddfon* of *gogywair*, *tannau lleddfon isgywair*,³⁹ and *tannau lleddfon* of the *lleddf gywair*, from which it gets its name, on account of which whosoever shall know the information without the learning of the art itself shall not be accounted a professor but simply one who imitates music.

The last phrase expresses the truth of the situation here, that this short passage cannot hope to succeed in conveying the complexity of playing the *crwth*, with the four fingers and the thumb all active in producing by means of multiple stoppings melody and supporting harmonies of the richness of the type of music intabulated in the manuscript for the harp. The passage remains obscure at this time, but insofar as it may refer in part to the stopping in first position by the first and second fingers on particular strings then the passage would indicate the existence of two positions for the sounding of a second in relation to the tone of the open string and three for a third, which would be consistent with the use of a variety of intonations. Because the evidence of the *cywair* ascriptions to the pieces in the manuscript does not equate with modality, it appears that this passage will not be describing the fingering of different modes transposed to a common tonal centre, even though it is an extraordinary consequence of the mismatch between *cywair* ascriptions and modality that it appears that in the *cerdd dant* tradition the concepts of mode and modulation which were so fundamental to the tradition appear never to have crystallized as concepts such that terms were developed for them, and that the four main *cyweiriau* other than the *bragod gywair* were not the four main modes used: Mixolydian, Ionian, Dorian and Lydian, and that the *bragod gywair* was not the term for those pieces that modulate and so mix various modes. It is the evidence in the records of the mismatch between *cywair* and modality that forces us to encounter conundrums of such extraordinary complexity, ones which the modern researcher would be entitled to expect not to encounter. But unless and until the records which produce the mismatch are revealed to be faulty an explanation of *cywair* has to be sought in directions other than modality.

As regards the *tannau lleddfon*, Osian Ellis interpreted these as scordatura tunings for the harp achieved by using bray pins as sharpening levers and relates that interpretation to the diagrams on pp. 108-9 of the manuscript,⁴⁰ but since,

³⁹ Unusual amongst sources for the *Dosbarth*, *AB MS Gwysaney 28*, f. 64^r supplies *cras gywair* in place of *is gywair*, a fact to be discussed below in section 9.

⁴⁰ Osian Ellis, 'Welsh Music: History and Fancy', *Transactions of the Honourable Society of Cymmrodorion*, Session 1972-73 (1973), pp. 83-85.

as far as is known, bray pins were only ever used on harps as buzzing mechanisms and would not have had the precision sharpening levers require, and since the diagrams include many flattening associations between notes this interpretation cannot be maintained. Moreover, the general thrust of the passage is for the *crwth* and so it is to the *crwth* that we should first look for its application. Four *types of tannau lleddfon* implies more than four *tannau lleddfon* in total, in which case '*tannau*' here will not refer to strings *per se* but to stopping positions on strings as well as, perhaps, the tones of open strings. The implication is that certain stopping positions – a different set for each *cywair* – underwent alteration. Unless the *crwth* was used to transpose different modes to a common tonal centre the alteration would not be chromatic inflection but intonational adjustment: either just-intonational or tempered, and '*lleddf*' most strongly implies the latter.

The association between the forefinger and the *bragod gywair* is maintained in the more detailed passage on *crwth* fingering contained within the *Dosbarth*:⁴¹

Wyth o gyweirdannau a thyniadau sydd yn lle eu cilydd, heb na mwy na llai.

Llyma ddangaws y modd y cenir yr 8 gyweirdant, a'r 8 dyniad, priv gychwynawl.

Cyweirdannau priv, a ddechreuir â'r mynegvys yn y bragodgywair, a chyweirdant y vawd â'r graenvys yn ei le ei hun, a'r hirvys tan vwrddwn y cyweirdant, a'r bys bach dan vwrddwn y cyweirdant isav, ar y cildant canol a'r cildant uchav.

Llyma y priv dyniadau.

Y tyniad croes a'r hirvys tros y tannau a'r bys yn ei le ei hun, a'r graenvys tan vwrddwn y cyweirdant, a'r bys bach yn ei le, a'r tant lleddyv uchav a chrasdant y vawd a'r graenvys a'r hirvys tros y tannau.

There are eight *cyweirdannau* and *tyniadau* in the place of one another, without more or less.

Here is set forth the way of playing the eight *cyweirdannau* and the eight *tyniadau*, primary and commencing.

The primary *cyweirdannau* are begun with the forefinger in the *bragod gywair*, and the thumb *crasdant* and the ring finger in its own place, and the second finger under the burden of the *cyweirdant*, and the fourth finger under the burden of the lower *cyweirdant*, upon the middle *cildant* and the upper *cildant*.

Here are the principal *tyniadau*.

The cross *tyniad* is with the middle finger over/across/above the strings and the finger in its own place, and the ring finger under the burden of

⁴¹ The version printed in *The Myvyrian Archaiology of Wales*, 2nd. ed. (Denbigh, 1870), pp. 1206, 1071, attributed therein (p. 1205) to a book in the possession of Sir Watkin Williams Wynn.

the *cyweirdant*, and the little finger in its place, and the upper *lleddf* string and the thumb *crasdant* and the ring finger and the middle finger over/across/above the strings.

As I have suggested before,⁴² it may be that the *cyweirdannau* here are produced on one onboard course and the *tyniadau* on the other. The number eight here may refer to the eight notes of the diatonic octave or to a series of intervals relating to them. The passage is defective in that the number of operations it describes for the *cyweirdannau* does not total eight but apart from that it appears to be authentic and also to be capable of resolution if only more was understood about the terms used and about the usage of those terms in this particular context. The *cildannau* of the harp were its uppermost strings but here *cildant* seems to refer to stopping positions – another use of ‘*tant*’ as note rather than string.

4. Meantone tuning

The most obvious candidate for harp intonation in *cerdd dant* with its rich tertian harmony is meantone tempering, because it allows instruments of fixed intonation to cope with the demands of tertian harmony. As we have seen from Whittaker’s scheme of the principles that underlie *cerdd dant* harmony and melody, *cerdd dant* was a unified field in which all intervals other than the semitone and tritone could be consonant⁴³ and in which the third played the central role, *irrespective of the mode*. Through keeping the size of the (narrow) fifth and the (meantone) major second constant every meantone tuning is a ‘leveller’ in that it treats all modes with equanimity: it is equally appropriate to each and every mode: a ‘one-size-fits-all’ solution. So retuning the harp as one passes from a piece in one mode to another piece in another mode is unnecessary, and it confers the freedom on the harp to be able to pass without concern from one mode to another *within* a piece, as often happens in the intabulated pieces. It opens up all the possibilities of developing tertian harmony to its fullest extent, including developing all of the diatonic modes and all the modulations between them. Meantone is an intonational environment in which tertian harmony can easily flourish, as indeed it did during the Renaissance and the Baroque eras in Western Europe. The only thing that brought about the eventual demise of meantone was the inherent problem that by the tuning sequence of the *closed cycle* of the twelve fifths of the chromatic scale the ‘wolf’ fifth is produced, but of course no wolf is produced by the *open, non-circulating chain* of the six fifths of the diatonic scale used by *cerdd dant*. But even in the

⁴² Greenhill, ‘Technique’, p. 140, n. 21.

⁴³ ‘Consonance’ here is defined as: commonly sounded without requiring resolution.

chromatic context meantone proved to be very resilient in the face of the well temperaments and Equal Temperament that were only developed as pressure mounted to be able to fully exploit all keys: as one preferred choice it only finally succumbed during the late nineteenth century.

As to whether there was any direct historical connection between the intonation of *cerdd dant* and the documented emergence of meantone into the historical record in Western European music generally, the geographical proximity suggests there might well have been, especially in view of the established Insular contribution to the development of tertian harmony in Continental music, which influence, characterised by Martin le Franc as '*la contenance Angloise*', reached a peak in the 15th century just as theorists such as Gafori, 1496, and Aron, 1523, were beginning to home in on meantone.

But a remarkable new development suggests that there need not necessarily have been an historical connection and that meantone is not so complex nor so obscure as to have only been developed on the planet once. A huge set of sixty-five ancient Chinese bells from 433 B.C., each producing two strike tones a pure major or minor third apart has revealed quite reliable data on intonation: 1/4-comma meantone gives the best fit, better than just intonation or 1/3-comma meantone, and Pythagorean intonation was not used: that is, all fifths were tempered to approximate 696 cents in order to yield pure major thirds.⁴⁴ The inference is that once a culture wants to concentrate on thirds it will temper the fifths and develop an approximation to meantone. This is a very strong counterargument indeed to any suggestion that developing 1/4-comma meantone would have been beyond the capabilities of medieval Wales or Ireland. After all, it is easy enough to produce on the diatonic harp (very much easier indeed than in the making of bi-tonal bells) and if one aims in practice for pure major thirds it will emerge by trial-and-error in time; that is to say it is by nature more the product of practical experience than of mathematical theory and of the measuring of the monochord: if one perceives one's major thirds as too wide, one will set about narrowing them.

If indeed meantone was used in harp *cerdd dant*, there are several plausible scenarios that could explain its presence there. One is that it could have been developed as the nearest match achievable on a fixed-intonation instrument to tertian vocal polyphony. The pattern of tertian harmonies cadencing onto 8:5 chords in English vocal polyphony would explain the same in *cerdd dant*. The need to adapt to the harp or the lyre the flexibility in performance of the

⁴⁴ Martin Braun: 'Bell tuning in ancient China: a six-tone scale in a 12-tone system based on fifths and thirds.', 2003, <<http://www.neuroscience-of-music.se/Zengbells.htm>>.

presumably approximately just intervals throughout that the vocalists would have achieved could have prompted meantone as a solution. Alternatively, meantone could well have developed on the harp or the lyre independently of vocal music: the lyre was in use locally at least as early as the Late Iron Age, which allows a vast span of time for tertian harmony to develop on a fixed-intonational instrument. Insofar as the intabulated pieces commonly operate on a basis of fusing melody with supporting chords below, it appears that the melodic elements may have been imitative of vocal music, monophonic and polyphonic, whilst the chordal accompaniment was probably developed on the strummed six-stringed lyre, the antecedent of the accompaniment harp. With its relatively wide compass, the harp can use different registers to carry the melodic line above the supporting accompaniment with an adequate separation of register between them which the six-stringed lyre cannot provide.

One of the many respects in which the harmony of *cerdd dant* differs from that of European music of the Renaissance and Baroque eras is that it makes rather less use of triads. Whilst meantone was dominant in European composition it was the practice to avoid 'empty', open fifths by including the third, which helps to obscure the narrowness of the fifth. In *cerdd dant* the same practice was used. Potential examples of simple empty fifths such as the $a''-e''$ at 87.6.20 are covered by preceding sustained notes, in this case the c'' at 87.6.18 provides the third. At 96.1.4 the fifth $b''-f''$ is covered by the sixth from the harmonics of the $g-g'$ indicated in the preceding column. Closes generally focus on the fourth and otherwise the focus in closes is more commonly on the octave and on thirds and sixths than on the fifth. Covered closes on the fifth occur in *Gosteg yr Halen*: $f-c'$, covered by $a'-c'-f'$ from the preceding chord, and in *Yr Osteg Fawr* and *Gosteg Lwyteg*: $f-a'-c'-f'-c''$.

There are exceptional pieces. Stark empty fifths occur in *Caniad Marwnad Ifan ab y Gof* at 72.2.2-12 but in the context of the grieving part of a lament, where the narrowness of meantone fifths could be an enhancement; in the same piece note the augmented eleventh in the prominent chord $b'-f'-e''$ at 72.5.8, 72.7.8 and 73.1.12, resolving onto the major tenth. *Gosteg Dafydd Athro* uses the open twelfth (the compound fifth) in the chord $c-c'-g''$ extensively throughout although not as a close to cadences, and *Profiad yr Eos* has unique intermediate cadences with the open fifth uppermost, at 58.5.10-12 and 58.6.6-8. Perhaps, like the early sections of *Caniad Marwnad Ifan ab y Gof*, these two pieces were designed for sorrowful affect, capitalising on the ability of meantone fifths to contribute to that. *Gosteg yr Halen* and *Caniad y Gwyn Bibydd* have empty fifths uppermost in the course of many passages but not at closes. *Caniad Llywelyn Delyniol* has two examples closing intermediate cadences, at 97.1.8 and 97.2.5.

The most common types of cadence close on fourths with octave doublings. The most prevalent close by far is on $g-g'-c''$, so much so that we could call it the 'standard' chord for closes. Other closes where the fourth is uppermost are on $g-c'-g'-c''$, $c'-g'-c''$, $c'-e''-g''-c'''$, $f-c'-f'$, $f-a'-c'-f'$, $g-d'-g'$ and $b'-f'-b''$, all of which are based on the chord pattern of 8:5, the octave divided into upper fourth and lower fifth. This is the ideal cadential consonance of Gothic polyphony in evidence in the period 1200-1420 referred to as '*trina harmoniae perfectio*' by Johannes de Grocheio c. 1300. It is very distinct from the triadic harmony which in European polyphony eventually displaced it. The same chord pattern comprising the three perfect intervals was used to form cadences in English discant writing known from the 13th century to the 15th century, to close passages which themselves centred on the tendency for 6:3 harmony that was also used in examples of English polyphony of the period, *i.e.* the first inversion with the fourth uppermost, as in the upper three voices of the *cerdd dant* closes above: $c'-e''-g''-c'''$ and $f-a'-c'-f'$. That the fourth had general primacy over the fifth in *cerdd dant* is demonstrated by its standard 11:8 closing chord: $g-g'-c''$: the fourth above the octave and no fifth.

We are presented, then, with the great majority of pieces focussing, in terms of what is uppermost where the principal voice lies, in closes on the fourth, that is, in terms of meantone, on the wideness of meantone fourths. In one respect this bias argues against meantone: the wide meantone fourth beats faster than the narrow meantone fifth because the fourth is the smaller interval in relation to the fixed size of the meantone adjustment from just. However, the way in which the fourth is always set up in a context of an octave doubling above the lowest note of the chord favours the wide meantone fourth in a way in which it can never favour the narrow meantone fifth. The note which adds the fourth never struggles, as the fifth would, against a harmonic of a lower note. In the case of the standard chord: $g-g'-c''$, the g has harmonics at g' , d'' , g'' , f''' etc., and the g' has harmonics an octave above those. So the upper voice of the chord, the melodic tonic, the relatively slightly sharp c'' , is not in conflict with any C-note harmonics. If here it were not a fourth - sharp c'' - but a fifth - slightly flat d'' - it would conflict with the harmonics, especially the d'' 3rd harmonic of the g fundamental, hence the Renaissance and Baroque tactic of adding in the third to fill meantone fifths. Essentially, the fourth to the fundamental is unique amongst the perfect intervals in being relatively alien to the harmonic series⁴⁵ and in the case of metal strings with their strong harmonic partials the difference between

⁴⁵ The 21st harmonic is the lowest harmonic to sound a compound fourth against the fundamental; whereas the 3rd harmonic is the lowest harmonic to sound a compound fifth against the fundamental, as do the 6th, 12th and 24th harmonics.

strong interaction with harmonics by the fifth and the relative lack of such by the fourth is profound. The fact that *cerdd dant* so strongly favoured the fourth over the fifth in superior position to close cadences is very powerful evidence of the use of tempering.

There is a fundamental divide here, between on one hand the *cerdd dant*, the English discant and faburden and the *ars antiqua* traditions, all with the emphasis in cadences on fourths uppermost, in superior position, and on the other hand the early tradition of Guido d'Arezzo (c. 1030) who in three-part organum placed the fifth above the fourth, the *ars nova* tendency to close with the fifth, and later often with the third, and the Renaissance and Baroque tendency to close with triads. The close on the fourth in *cerdd dant* calls to mind the heavy use of parallel fourths in early organum, but plain parallelism in *cerdd dant* is restricted to the octave, the fifth, sixths and thirds. On the harp the separation in *cerdd dant* of the principal voice, normally the upper part, from the supporting accompaniment is important. The separation is generally maintained by the substantial height of the upper part above the lower part. In cadences, where the upper part descends in register to near the lower part, the separation becomes slightly threatened, but here the closes with the fourth uppermost help to maintain the separation. To take the standard close: $g-g'-c''$, the root of the fourth $g'-c''$ is c'' – the melodic voice – whereas if the close had the melodic voice as the fifth uppermost: $g-g'-d''$, the root of the fifth $g'-d''$ is g' which is part of the supporting accompaniment, and the separation would become eroded. The same happens with cadences onto root position triads. In meantone, cadences onto the fourth where the melodic voice is slightly sharp of the accompaniment helps to preserve the separation, in contrast to how it would be if triads were used there.

Nevertheless, notwithstanding these mitigating factors, the fact remains that *cerdd dant* generally has its final cadences on perfect consonances, as had Gothic polyphony. In meantone the slightly sharp fourths, where they occur in superior position, lend a touch of hollowness, a martial quality, to *cerdd dant* which is lacking in the mellow triadic cadences of the European meantone tradition. Meantone does not always necessarily lead to the mellow sweetness that we today associate it with. This point about the perfect cadences in *cerdd dant* is a very important one, and it will be developed in section 5. following. It is, however, not by any means sufficient reason to discount meantone in favour of Pythagorean intonation, because in meantone the sweetness of the thirds and sixths and the mellowness of the fifths are overwhelmingly prevalent. *Cerdd dant* is fundamentally and profoundly a tertian tradition, and it has to be a possibility that it was as thoroughly settled in 1/4-comma meantone as was Renaissance and Baroque music.

The case for 1/4-comma meantone in particular is strengthened by an important adventitious feature it possesses. Although the general avoidance of the tritone in the intabulated pieces stands out very strongly, there are examples of E and B sounding together undamped. The most unabashed examples of undamped E above B, an augmented fourth, occur in superior position in the *clymau cytgerdd* at 26.2.10-4.12 as $b'''-e'''$ (with a *crychu y fawd* on the e''') above the prominent *cyweirdant* chord $g-c'-e'-g''$ from the preceding column. The sense of the b''' here being resolved onto the e''' by the *crychu y fawd* which provides an extra strike on the e''' is brought out more strongly in the closely related passage later in the text at 29.7.1-16, where the b''' is placed earlier, on the $g-c'-e'-g''$ chord, and only *then* is it followed by the *crychu y fawd* on e''' . Nevertheless, the presence of the b''' in this chord appears to be a proud statement of satisfaction with the harmonies it creates. There is, incidentally, no doubt that the B strings are tuned to B-flat and not B-natural here because of the part B-flat plays in the major triad B-D-F which is the fundamental *tyniad* harmony of the *clymau cytgerdd*. It should be mentioned that these pieces were probably not for performance but were didactic, most probably for the instructing of the art of composition.⁴⁶ Nevertheless, there are other instances of the tritone, in performance contexts, so there must have been a need for the tritone not to be too discordant. We have already noted in *Caniad Marwnad Ifan ab y Gof* the augmented eleventh (a compound augmented fourth) in the prominent chord $b'-f'-e''$ at 72.5.8, 72.7.8 and 73.1.12, resolving to the major tenth. It is a fleeting special effect, but elsewhere the augmented fourth is structurally embedded in common formulas, as in the chord $c'-g'-b''-e''$ at 85.5.4 and 91.1.18 (where the symbol for *plethiad dwbl* has been omitted) which is part of a formulaic preface to a very common type of relatively contrapuntal cadence. Brief but undamped augmented fourths occur, such as in $c'-g'-b''-e''-g''$ at 91.5.19, in $d'-f'-b''-e''$ formed at 69.3.14 (although there is some indication there that e'' might be damped) and a compound augmented fourth in $b'-d'-g'-e''$ formed at 41.3.18. Undamped B above E, the diminished fifth, occurs most prominently in *Caniad Ystafell* in $g-e'-b''$ at 38.3.13 & 38.3.18, 38.4.3 & 38.4.10, and it also occurs in $d-g-c'-e'-b''$ at 47.3.7 and 47.3.20 *etc.*, and in $c-g-c'-e'-b''$ at 64.6.14.

It is evident that the *cerdd dant* composers were facing a classic dilemma: they were naturally reluctant to augment their fourths or diminish their fifths yet various circumstances would easily arise where these were called for, and the composers were sometimes prepared to use them instead of abandoning the whole of each train of compositional musical logic that calls for them. From the modern perspective of equal temperament this seems extraordinary but

⁴⁶ This is an important point examined in section 9. below.

meantone removes the physical, acoustic dissonance of the tritone that the modern equal-tempered tritone at 600 cents produces, well adrift as that is of any low-integer harmonic. 1/4-comma meantone yields an E at 386.31 cents and a B at 1006.84 cents. The interval between them, 620.53 cents, is very close indeed – 3.04 cents – to the 10/7 greater septimal tritone at 617.49. Hence the chain of narrow meantone fifths is completed into a cycle by a virtually just diminished fifth: E-B. The 1/4-comma meantone augmented fourth B-E at 579.47 cents is necessarily also only 3.04 cents off the inverse of the greater septimal tritone: the 7/5 lesser septimal tritone of 582.51 cents. These near approaches to justness are not achieved in 1/3-comma meantone, which yields a dissonant diminished fifth E-B of 631.28 cents. Pythagorean intonation produces an interval E-B of 588.27, 5.76 cents off the 7/5 lesser septimal tritone of 582.51 cents, creating a significantly less pure diminished fifth than 1/4-comma meantone. Rarely, augmented fourths and diminished fifths were also tolerated in Gothic polyphony and a most interesting point of close similarity between the two traditions is that Johannes Boen in 1357 identified the presence of a minor third below the augmented fourth as rendering the augmented fourth particularly acceptable.⁴⁷ That condition is met by the presence of the *g''* in the *cw/wm cytgerdd* augmented fourth chords discussed above: *g-c'-e'-g''-b'''-e'''* and of the *g'* in the chords: *c'-g'-b''-e''* and *c'-g'-b''-e''-g''* also discussed above. The underlying logic is that by encasing the augmented fourth in a major sixth its paradoxical nature is mitigated, and in meantone that is achieved. However, in Pythagorean intonation it hardly helps to encase a rather impure augmented fourth (impure by 5.76 cents) in an even more impure major sixth (impure by the syntonic comma of 21.51 cents), so Boen's observation would make little sense in a Pythagorean context. If any instruments of fixed intonation had any relevance at all to Boen's observation then they would have needed to be tuned in 1/4-comma meantone to benefit from the tactic.

In summary, the case for tempering and for 1/4-comma meantone in particular is strong. It is strongest for those pieces which cadence onto tertian chords, such as *Yr Osteg Fawr*, and for those which modulate, such as *Caniad Marwnad Ifan ab y Gof* and many of the *profiadau*, and for the *clymau cytgerdd* with their augmented fourths. There is also something of a case for 1/3-comma meantone in respect of *Caniad Ystafell*, which uses minor thirds and major sixths to an unusual extent, and a less strong case for *Caniad Bach ar y Gogywair* on the same grounds. The case for any meantone tempering is less strong for those pieces that cadence onto exclusively perfect intervals, and yet suspended tertian harmonies created through the sustain of previously sounded and undamped

⁴⁷ See Margo Shulter, 'Tritones in early music: were they always prohibited?', <<http://www.medieval.org/emfaq/harmony/tritone.html>>.

strings are usually present. Cadences on the octave alone are unaffected by tempering, and cadences on compound split octaves with the fourth uppermost are less affected by tempering than those with the fifth uppermost. It is notable that the latter appear, arguably, only at 84.4.12 in *Caniad Hun Wenllian*,⁴⁸ in which piece elsewhere cadences are onto the standard closing chord with the fourth uppermost. Nevertheless, it remains an odd proposition to be contemplating commonplace final cadences onto split octaves with 1/4-comma or 1/3-comma beating. Music in equal temperament aside, music worldwide generally exploits the opportunity for progression and resolution onto just intervals. That was the case with Gothic polyphony and medieval Oriental classical music, and in the latter enormously so through the addition of *meend* (elaborate *glissando*). Also, there remains the possibility that the various *cywair* terms of *cerdd dant* refer to different intonations, for which I set out the arguments in 'Tuning' pp. 84-94. It is important, then, to continue with the exploration into possible candidates for intonation in *cerdd dant*, and that has led me to evolve a number of irregular temperaments tailored to the double tonic which solve the problem of the slightly impure meantone cadences and, in the process, solve some other problems including - it appears to me - the greatest problem central to an understanding of *cerdd dant* theory and practice: the full meaning of the concepts *cyweirdant* and *tyniad*.

5. Mixed intonation: tempering for the double tonic: partial tempering

There is a way by which meantone-style tempering can accommodate pure cadences in *cerdd dant*. The purity of the cadences can be preserved within the scheme of meantone tempering by tuning the particular fifth that is involved in the cadences as pure whilst distributing the comma evenly amongst the tempered tunings of the other five fifths. In terms of meantone that requires a stronger tempering, by 1/3 of the comma per fifth rather than by 1/4. Here are the results in cents for each of the harmonic modalities:

⁴⁸ N.B. the oblique stroke following the *c* implies that it may have been damped; see Greenhill, 'Technique', pp. 125-7.

Pure:	B-F	F-C	C-G	G-D	D-A	A-E
C	1200	1200	1200	1200	1200	1200
B	1003.26	1003.26	1010.43	1010.43	1010.43	1010.43
A	884.36	884.36	891.53	891.53	891.53	884.36
G	694.79	694.79	701.96	694.79	694.79	694.79
F	505.21	498.05	505.21	505.21	505.21	505.21
E	379.15	379.15	386.31	386.31	386.31	386.31
D	189.57	189.57	196.74	196.74	189.57	189.57
C	0	0	0	0	0	0

Taking the Mixolydian C harmonic modality as an example, shown above as the C-G column, the fifth C-G is tuned pure at 701.96 cents and the remaining five fifths narrow of 701.95 cents by 1/3 of the comma (that is, by: $1/3 \times 21.51 = 7.17$ cents) to arrive at a value of 694.79 cents for each. In consequence the major triad on C, the one that mainly features in *cyweirdant* digits in the Mixolydian C harmonic modality, is wholly just: 701.95:386.31. The *tyniad* equivalent, the major triad on B is tempered: 694.79:386.31. For the other harmonic modes the appropriate *cyweirdant* root triad, whether major or minor, is also just and the *tyniad* equivalent not so.

Before examining in detail the sonorities involved in these partial temperaments, let us focus immediately on the significance of the intonational contrast that is created here between *cyweirdant* and *tyniad*, that is to say, the contrast between *just* and *tempered* fifths. The match between the two pairs of terms is inescapable. Of particular significance here is the substitution of the term '*temheriad*' for the more commonly-used '*tyniad*' in the version of the Dosbarth in *AB MS Peniarth 270*:⁴⁹ "a dosparthv pob gwahan a rhacgwahan, a phob cynhwysiad, a phob gorphwysbha, a phob symvdbha ar *demheriad* a chyweirdant;" ("and classify every separation and prior separation, and every containing, and every gap, and every movement on *tymheriad* and *cyweirdant*"). This is the only passage where the *Peniarth 270* version needs to make reference to *tyniad* and *cyweirdant*, and it may be contrasted with that, for example, in *Lb/ MS Add. 19711* (William Llŷn): "a gwybod dosbar pob gwan a ragwan vob kynhwysiad ac ysmvdfa pob gorhwynfa ar *dyniad* a chywairdant".⁵⁰ That in *Peniarth 270* is the first recorded use of the modern word '*tymheriad*' (cf. the verb: ME *tempren*, OE *temprian* & OF *temprer*, *temperer* & L *temperāre*) meaning a 'tempering'. It consolidates the link between '*tyniad*' and 'tempering'. It is unclear to what extent the use of the Middle English verb '*tempren*' in

⁴⁹ Transcribed in Thomas Parry, 'Statud Gruffudd ap Cynan', *Bulletin of the Board of Celtic Studies*, 5:1 (1929), p. 29.

⁵⁰ Transcribed in 'Rhôl Eisteddfod Caerwys 1523', *Transactions of the Liverpool Welsh National Society* (1908-9), p. 94.

association with musical instruments was used in the general sense of 'to tune' or in the specific modern sense of 'to temper' because of the difficulty of separating the two out as distinct actions,⁵¹ but by the 16th century when the tempering of fifths is known to have been commonplace in European instrumental music there is every likelihood that the author of this variant passage used the word in the specific sense in order to help clarify the opposition between the standard traditional word: '*tyniad*' and its antonym: '*cyweirdant*'.

So, as used in the sense of the digits of the measures, we arrive here at ***cyweirdant*** and ***tyniad*** as a ***justness*** and a ***tempering***. This makes entire musical sense, that intonational impurity was harnessed in the service of coherency of expression rather than left to be distributed in a haphazard fashion as a by-product of whatever particular chords happened to be used at any point in a piece. And the use of moderate degrees of impurity, at 7.17 cents as opposed to the 21.51 cents of Pythagorean intonation, to construct a narrative of motion from impurity to purity, a sense of progression from tension to its resolution, creates a softer, more subtle and more humane paradigm of spirituality than that of Gothic polyphony. It can be imagined that medieval Christendom could have perceived the measures as containing little moment-to-moment 'parables' of Redemption. As approached from a general philosophical perspective, the measures, in their play between tension and resolution and *vice versa*, present the interesting proposition that just as in nature homeostatic systems seek equilibrium, purity contains within itself the seed of its dissolution. To thoroughly institutionalise the incorporation of the progression toward purity through the measures into the structure and metre of music is to reveal a more sophisticated, more mature grasp of the expressive potential of vertical harmony than that held by Gothic polyphony. On the other hand the way in which impurity of intonation lends traction to music to create expressive dynamism - such a very human attribute - is exploited here in a way which is lacking in the ethereal justness of the *ars nova*. These tunings are solutions for the double tonic of technical elegance, musical polish and meaningful purpose. They raise the modern perception of the double tonic to a hitherto unsuspected high level of sophistication.

Accordingly, a radical shift is necessary in the method by which individual pieces are judged as suited to this or that intonation. The theory of meantone relies on the objective of minimising in general the impurities of any tertian material. But here, instead of using the minimisation of impurity as the sole means of arriving

⁵¹ For early references to tempering see Mark Lindley, 'Temperaments', <<http://www.academia.edu/1134048/Temperaments>>.

at judgements, that method needs to be joined by another which, whilst maximising purity in *cyweirdannau*, ensures at least a modicum of *impurity* in *tyniadau*. And to be precise about that, where the method is applied an intonation needs to be judged according to the success with which it delivers these requirements: the leading, first chord of *cyweirdant* digits needs to be as pure as possible whilst that of *tyniad* digits needs to be at least in part *impure*, whilst a subsequent *reversal* of those states later in the digit is to be welcomed. This is a much more precisely defined method than is used in the assessment of the suitability of Pythagorean intonation for material from elsewhere.

As regards the texture produced by this principle, harmonic beating occurs mainly in *tyniad* digits and is absent in *cyweirdant* closes to cadences. This is effectively the selective application of harmonic beating as a textural dynamic, one akin to vibrato, applied to this chord but not to that one. It raises the metal-strung harp to the level of a mildly polytextural instrument, capable of the selective application of an expressive dynamic, one where its placement is deeply embedded within a composition, controlled by the measures.

Note that the general concept of traction in double-tonic music exists today on the bagpipes, except that here the traction is far less subtle - indeed it is quite crude by comparison - relying as it does on the nominal pitches of the notes rather than their precise intonation. The traction is created by the *tyniad* notes against the drones where the drones sound the tonic and/or its fifth, irrespective of whether there ought to be a tempering component to enhance that. This theory of double-tonic intonation suggests that properly perhaps there ought to be, although drone-based music in general encourages the use of just intervals against the drone: *i.e.* including the just fifth and just thirds and their inverses.⁵²

To continue with the detail of the sonorities here, whilst the *cyweirdant* major triad is just the third below the tonal centre is narrow by 7.17 cents; so, in the context of the Mixolydian harmonic mode with the centre on C, A is sharp by 7.17 cents. Thus where the sixth step of the mode is used (which is not very commonly) even a *cyweirdant* has some impurity here, but – significantly – it is not usual for the sixth step to be used in cadences. The exceptions are the final chord of *Caniad y Gwyn Bibydd* at 37.6.12, in *Profiad Fforchog* at 62.1.19 and as

⁵² It may well be relevant here, because *piobaireachd* is the only other known Insular traditional classical music and because it has some similarities to *cerdd dant*, that the C of the Great Highland Bagpipe traditionally sounds a just major third and not a Pythagorean one against its A drones, a point which argues against the use of Pythagorean intonation in *cerdd dant*. See Barnaby Brown, 'The Iain Dall chanter: material evidence for intonation and pitch in Gaelic Scotland, 1650-1800', in *The Highland Bagpipe: Music, History, Tradition*, ed. Joshua Dickson (Aldershot, 2009), pp. 25-46.

a suspension at 56.2.9-10 at the end of Pwnc ar Ôl Pob Profiad. The sixth step is also not usually used even at the end of any *cyweirdant* digits, including those that begin with it (such as the treatment of A in the two *cyweirdant* digits at 44.1.1-4 and 44.1.5-7). That would indicate a playing-out of the narrative of motion away from impurity not just at the level of *tyniad* digit to *cyweirdant* digit but *within* the *cyweirdant* digit. Thus is the distinction across digits between *cyweirdant* purity and *tyniad* impurity maintained.

The same treatments apply to the *tyniad* sixth step, which is also sharp by 7.17 cents (see the treatment of G in the pair of *tyniad* digits at 44.1.8-14).

The diminished fifth E-B at 624.09 cents is rather significantly wider of the 10/7 just greater septimal tritone at 617.49 cents than is the 1/4-comma meantone diminished fifth at 620.53 cents.

For those pieces which do not modulate, and they are in the majority, the achievement by these partial 1/3-comma temperaments of just final chords at sectional endings is musically more satisfactory than the delivery of final chords with tempered fifths and fourths which full meantone entails. When that point is taken together with the meaningfulness and the coherence with which partial 1/3-comma temperaments explain and enhance the contrast between *cyweirdant* and *tyniad*, there is a very strong case indeed for each non-modulating piece having been played using the appropriate partial temperament. The range of those along the chain of fifths is from B Lydian (for Caniad Tro Tant alone), through F Ionian and C Mixolydian (the most common) to G Dorian. The case is somewhat weaker for those pieces which contain occasional instances of the tritone, because, as we have noted, 1/4-comma meantone yields rather better results for the tritone. That is not necessarily a factor that should outweigh the case for partial temperaments in those pieces, but it may do so in the case of the *clymau cytgerdd* where the tritone is used with such confidence.

Not all pieces which do modulate need to forsake the purity of perfect cadences offered by partial 1/3-comma temperaments. Caniad Llywelyn ab Ifan ab y Gof has a division between two harmonic modes: the piece is in C Mixolydian except that G Dorian appears for the first two-thirds only of sections v to xii, so the C-mode partial 1/3-comma temperament can round off each section satisfactorily. Most of the *profiad* pieces are showcases of modulation. This is consistent with the interpretation of '*profiad*' as a testing, a tasting, a trying of tuning in the manner of a prelude, as if any error in the fine tuning will become exposed. I suspect the section in common that all the *profiadau* mysteriously run into at 61.1.13 may have been used to accompany the Pater Noster, since it has a

hymn-like quality. It is in C Mixolydian and is followed by the short Pwnc ar Ôl Pob Profiad which begins in G Dorian and modulates to C Mixolydian. The constraints that the 'Pater Noster' piece and the Pwnc place on intonation are not so great however: both have E absent as a sustained note so the C major root triad is absent, the melody line winds continuously uninterrupted by any strongly-defined cadences and the Pwnc ends with simply G doubled at the octave. Profiad Cyffredin, which was perhaps the most commonly-used *profiad*, and Profiad Fforchog Ifan ab y Gof are sufficiently centred on C Mixolydian that they can be satisfactorily carried by the C-mode partial 1/3-comma temperament. Profiad y Botwm is perhaps also credible in C-mode partial 1/3-comma temperament, or in F-mode partial 1/3-comma temperament. The short piece Cainc Dafydd Broffwyd is simply in C Mixolydian throughout and so is suited to C-mode partial 1/3-comma temperament.

6. In pursuit of the *is gywair*

Profiad Brido ar Isgywair and Profiad Brido ar Uwchgywair warrant close investigation, because if it were the case that the music made use of the series of partial 1/3-comma temperaments that contain a single pure fifth, it ought to be that the part of the series it used would be bounded at the lower end in the chain of fifths by *is* (low) and at the upper end by *uwch* (high), that is: by the two *cyweiriau* that have *profiadau* named for them and which are placed adjacent to each other in the manuscript as if paired together by contrast in height.

Profiad Brido ar Isgywair begins at 63.4.1-6 with a passage which is difficult to analyse, where the Ionian *cyweirdant* digit of the first column containing the notes F-A-C is followed by a *tyniad* digit with its notes drawn not from the *tyniad* notes of the Ionian mode C-E-G-B but from those of the Mixolydian mode: G-B-D-F. Instead of being a classic double-tonic harmonic shift down by a second, this is a shift down by a fourth or up by a fifth. The following sections are in F Ionian: *cyweirdant*: D-F-A-C, *tyniad*: C-E-G, followed by the standard C Mixolydian section common to all the *profiadau*. Thus:

63.4.1-6, 63.4.1-6 : F Ionian (*cyweirdant*), C Mixolydian (*tyniad*).

63.4.7-5.21, 63.4.7-5.21, 63.6.1-64.2.8 : F Ionian.

64.2.9-64.3.19 *etc.* : C Mixolydian.

The F-mode partial 1/3-comma temperament has the major root triad F-A-C pure, the major third B-D and the minor third E-G are also pure, and it is designed to accommodate the F Ionian mode, in which the main body of this piece lies. The 'Pater Noster' section is Mixolydian but largely restricted to the

thirds A-C (*cyweirdant*) and B-D (*tyniad*) and as both are pure in the F-mode tuning that tuning accommodates the section. The Pwnc has impurities in the F-mode tuning but cadences onto an open octave. Essentially, the entire piece apart from the first part of the Pwnc is thoroughly major and that enables the F-mode tuning to accommodate it. The pure setting of a fifth for the F-mode tuning, F-C, is indeed low in the chain of fifths and that offers an explanation of the term *is gywair*. The F-mode tuning should, then, mark the lower end of the series of partial temperaments that were customarily used, although as noted above Caniad Tro Tant alone requires the B-mode partial 1/3-comma temperament, at the actual bottom of the chain of fifths.

7. In pursuit of the *uwch gywair*

Profiad Brido ar Uwchgywair begins with a passage drawing on the F-A-C triad alone and is therefore difficult to analyse but based on what follows these will be G Dorian *tyniad* digits. The harmonic modality of the next section is G Dorian: *cyweirdant*: G-D, *tyniad*: D-F-A-C. Then there is a modulation up a fifth for a longer section which is ostensibly in D Aeolian: *cyweirdant*: D-F-A, *tyniad*: C-E-G, although as Paul Whittaker has very usefully pointed out in personal communication the 'O' digit above 64.6.2 and the 'I' digit above 64.6.6-7 imply that that classification should be reversed, thus: *cyweirdant*: C-E-G, *tyniad*: D-F-A, *i.e.* the E Locrian mode. Then like all the *profiadau* the piece moves into the C Mixolydian mode for the section that is common to all the *profiadau* (the 'Pater Noster' section) via the Mixolydian and largely *tyniad* bridge passage on the triad B-D-F. Here are the locations and the analysis:

64.4.1-5.19, 64.4.1-5.19 : G Dorian

64.6.1-65.1.5, 64.6.1-65.1.5, 65.1.6-2.5 : D Aeolian or E Locrian

65.2.6-3.15 *etc.* : C Mixolydian.

Thus the main body of the piece is decidedly minor. Setting the piece in the E-mode partial 1/3-comma temperament does not find favour in the Mixolydian later sections, whereas the G-mode partial 1/3-comma temperament carries the minor part of the Pwnc well. The D Aeolian or E Locrian passage is best carried by the D-mode partial 1/3-comma temperament with its pure minor root triad D-F-A, and if that passage is the one that led in particular to the title Profiad Brido ar Uwch Gywair, with the *uwch gywair* being an unusual *cywair*, then that would imply the D-mode tuning more strongly than the G-mode one, the G Dorian mode being far more common in the manuscript than the D Aeolian mode. Note that in the chain of fifths F-C and D-A are in matching positions, one step away from the lower and upper extremities of the chain respectively and so mark out a

symmetry within the chain which is in sympathy with the opposition in the meanings of the terms *is* and *uwch*. But these lines of reasoning are not cause to rule out the G-mode partial 1/3-comma temperament here. Two possibilities for the *lleddf gywair* are left open by these *is/uwch* framings: the C-mode and the G-mode partial 1/3-comma temperaments.

8. In pursuit of the *bragod gywair*: modulating pieces

There are many pieces in the manuscript which exhibit modulation in profound ways – either through modulating almost constantly or through modulating *across* the fundamental major-minor divide that exists between those major modes which are centred on and below C in the chain of fifths and those minor modes which are centred on and above G. But before examining each of the modulating pieces the adoption of partial 1/3-comma temperaments for those pieces that are not profoundly modulatory necessitates a re-evaluation of the significance of meantone temperaments in general. Much of the contrast between *cyweirdant* as justness and *tyniad* as tempering could be preserved in the realm of meantone for those pieces that do *not* modulate, by giving precedence to the root triad of the *cyweirdant* stack of the appropriate harmonic mode of the piece. The B Lydian, F Ionian and C Mixolydian harmonic modes with their *cyweirdant major* root triads ought to be, in logic, better served by the just *major* thirds of 1/4-comma meantone; whereas the G Dorian, D Aeolian, A Phrygian and E Locrian modes with their *cyweirdant minor* root triads are arguably better served by the just *minor* thirds of 1/3-comma meantone. This point will be returned to later in connection with the subject of expression

When it comes to the pieces that *do* modulate, it would often be impossible to keep all *cyweirdant* digits just in terms of their root triad: the sections that have departed from the main harmonic modality and moved into a mode in which the root triad contradicts the major or minor nature of the main root triad will not have just *cyweirdant* root triads. The principle of *cyweirdant* as justness and *tyniad* as tempering will become scrambled or reversed, and that incoherence would, in terms of the conventional operation of the principle, be a far worse musical result than not having the principle in operation in the first place. But a third option exists in the realm of meantone, by which the principle can be neutralised without it leaving a residue of intonational confusion: 2/7-comma meantone. Tempering by 2/7-comma, 6.14 cents, lying as that does between 1/4-comma and 1/3-comma, apportions the impurities *evenly* between major and minor thirds, and that will have been its attraction for the Continental theorists who made notice of it: Zarlino 1558, Salinas 1577, Galilei 1589, Cerone 1613, van der Elst 1662 and Rossi 1666. It creates this scale:

C	1200
B	1008.38
A	887.43
G	695.81
F	504.19
E	383.24
D	191.62
C	0

For Renaissance and early Baroque music, where the occurrence of major and minor thirds is less prescribed than it is in *cerdd dant*, 2/7-comma meantone should be expected to have had less appeal than in *cerdd dant*, and especially so in chromatic music. Through its impartiality in respect of the purity of major and minor thirds, 2/7-comma meantone offers the only possibility for carrying any of the profoundly multimodal pieces of *cerdd dant* without seriously scrambling in each of them the relationship of *cyweirdant* and *tyniad* to intonational purity. It means that all the diatonic modes are equally available for any one single composition, and that allows for multiple modulations to flourish, such that the contrasts between modes are unobscured by intonational complications and contradictions. Half of the impurity that defines *tyniad* in partial 1/3-comma temperaments is exchanged with half of the justness of *cyweirdant* there, to create an admixture – a blending – of purity and impurity throughout. Thus tempering by 2/7-comma offers an explanation of the term ‘*bragod*’ in the sense of bitter-sweet harmony. *Bragod* was created through the addition of honey to malted ale mash prior to fermentation, to achieve a depth of blend and a balance between sweetness and bitterness. Whereas tempering by 1/4-comma yields sweet major thirds and bitter minor thirds, and tempering by 1/3-comma yields sweet minor thirds and bitter major thirds, tempering by 2/7-comma – lying as it does between those two extremes – combines and mixes those qualities so that sweetness and bitterness no longer stand apart from one another. The combined or blended nature of the *bragod gywair* is further brought out by the statements in the *Dosparth* relating to the *crwth* introduced above, that: “Every finger keeps the *bragod gywair*, because of which it gets its name. Because there is something of every *cywair* in its midst, and because of this it is called the *bragod*”.⁵³ One gets the sense that it stood in a central position to other *cyweiriau*. The proposition that the identity of the *bragod gywair* was 2/7-comma meantone will

⁵³ The version of the ‘*Dosparth Cerdd Dannau*’ copied by Lewis Morris into the Robert ap Huw manuscript at pp. 5-7, is one source of the names of the five principal *cyweiriau* and in which the *bragod gywair* is described as follows: “Bob bys sydd yn cadw arno y *Bragod gowair*, o’r achos y mae yn cael ei Enw. oblegid fod peth o bob cowair yn ei fysg, ag o herwydd hynny y gelwir ef y *bragod*”.

be picked up later in connection with the names of the other *cyweiriau* but at this point the proposition should be taken as offering support for the hypothesis that 2/7-comma meantone was in use, since no other intonations achieve such a thorough and consistent combining of the intonational properties of major and minor thirds, apart from Pythagorean intonation in which all major and minor thirds are equally impure by the 21.51 cents of the syntonic comma but there, of course, there is no sweetness at all to any of the thirds.

To return to the multimodal pieces in the tablature, *Caniad Marwnad Ifan ab y Gof* provides a prime example of the inability, according to the conventional logic of harmony, of temperings other than 2/7-comma to cope with modulations which involve a switch between *cyweirdant* major and minor root triads. The piece contains just one harmonic modulation, from G Dorian to C Mixolydian, but it is between section iii and section iv, dividing the piece into two really substantial portions. The first three sections constitute such a substantial block that, on the face of it, it would not do to set them in the C-mode partial 1/3-comma temperament appropriate for the last fourteen sections. To do so would involve the important *cyweirdant* cadence onto the chord $b'-g'-b''$ in the first three sections (as at 71.6.14) containing its minor third above its major sixth having both intervals impure by 7.17 cents whereas the corresponding *tyniad* cadence onto the chord $a'-f'-a''$ (as at 71.6.7) would be just. To set the piece in 1/4-comma meantone would result in the same status (but with the *cyweirdant* chord 5.38 cents impure). To set the piece in 1/3-comma meantone would reverse the status but then in the remainder of the piece *cyweirdant* major chords such as $c'-g'-c''-e''-g''$ at 73.4.2 would become impure by 7.17 cents. Only 2/7-comma meantone avoids altogether any reversal of status between *cyweirdant* as pure and *tyniad* as impure. Significantly, this piece is ascribed to the *bragod gywair*, as is *Y Caniad Crych ar y Bragod Gywair* which is essentially C Mixolydian but has many brief excursions into and back out of G Dorian, as at 78.6.7-13, and in section viii a substantial passage of G Dorian which then hybridises at 80.6.6 with D Aeolian for another equally substantial passage before returning to C Mixolydian via a short bridge passage at 81.1.4-8 in what I read as A Phrygian. Section viii is a masterful display of the complexities of modulation which only 2/7-comma meantone can articulate really satisfactorily.

The other intabulated pieces to which the *bragod gywair* is ascribed are *Caniad y Gwyn Bibydd*, *Caniad Ystafell*, *Caniad Cynrhig Bencerdd*, *Caniad Pibau Morfydd*, *Caniad Hun Wenllian* and *Caniad Llywelyn Delyniol*. *Caniad y Gwyn Bibydd* contains no modulations that would require 2/7-comma meantone. However, the closing chord on the major sixth $c'-a''$ is a touch that is out of character with the C Mixolydian harmonic modality of the piece, and if the C-mode partial 1/3-

comma temperament was used for the piece this final chord would be 7.17 cents impure compared with 3.07 cents in 2/7-comma meantone. The piece is also rather unusual in having a bass drone throughout, on C, which is alien to its *tyniad* stack and, in view of the '*bibydd*' of the title, was presumably inspired by reed-pipe music. Recalling the point made above that in double-tonic bagpipe music the double tonic is very strongly articulated indeed by the contrast between the *tyniadau* and the *cyweirdant*-style drone which is alien to the *tyniad* stack, that fact makes it less important that the contrast between *cyweirdant* and *tyniad* be brought out by having the added intonational bias between the two that the C-mode partial 1/3-comma temperament would supply. The same logic applies to Caniad Ystafell which is suited to the G-mode partial 1/3-comma temperament although it too has a bass drone, on G, through most of its last section which is alien to its *tyniad* stack and – as noted above – it has examples of the diminished fifth, possibly indicative of 1/4-comma meantone.⁵⁴ Caniad Cynrhig Bencerdd also develops a drone alien to its *tyniad* stack: the F in the treble at 49.6.1-12 and the F low in the bass for the passage at 50.2.1-4.13. The former passage is a brief modulation of the upper part alone from F Ionian to the *tyniad* stack for C Mixolydian. Indeed the piece involves almost constant shuttling back-and-forth *within* digits between the home tonality of the digit and its counterpart;⁵⁵ 2/7-comma meantone smoothes those out. Caniad Pibau Morfydd is solidly in C Mixolydian throughout apart from some brief modulations into D Aeolian, as at 92.5.3-4 and 92.6.1-2.⁵⁶ Caniad Hun Wenllian is also solidly in C Mixolydian apart from a subtle touch of A Phrygian at 87.6.5-8. Caniad Llywelyn Delyniol has no features that suggest C-mode partial 1/3-comma temperament would be inappropriate except that, along with all of these *bragod gywair* pieces apart from Caniad y Gwyn Bibydd, Caniad Ystafell and Caniad Cynrhig Bencerdd, it commonly has the *cyweirdant* lower-part chord $c'-g'-b''$ resolving onto $d'-g'-b''$. This is an intra-digit mini-modulation, in that both B and D are borrowings from the *tyniad* stack. In the C-mode partial 1/3-comma temperament the G-B and the G-D are impure, and since these mini-modulations within *cyweirdant* digits are so common it would be understandable if that temperament was rejected in favour of the smoothing-out of 2/7-comma meantone, as was suggested above may have been the case with the intra-digit mini-modulations of Caniad Cynrhig Bencerdd.

⁵⁴ The minor character of Caniad Ystafell suggests that it is a sorrowful piece, one in which an impure tritone is not necessarily less effective than a just one.

⁵⁵ For a discussion of the metre of Caniad Cynrhig Bencerdd see Greenhill, 'Metre', pp. 39-41, 69-70.

⁵⁶ The former is a *tyniad* modulation and the latter its *cyweirdant* counterpart.

However, to set into perspective these argued associations of modulating *bragod gywair* pieces with 2/7-comma meantone, they are dependent on the correctness of minimising cadential impurity *throughout* each piece. The tradition may not have worked in that way. The partial meantone tunings necessarily deliver impure cadential chords in *parts* of a modulating piece, but that might have been actually desirable in sorrowful pieces or sorrowful parts of pieces. To return to Caniad Marwnad Ifan ab y Gof as an example, the first five sections are sorrowful; the remaining twelve joyful. In C-mode partial 1/3-comma tuning the contrast between the two groups is *enhanced* by the impurity of the cadential chords in the former and the purity of those in the latter. And in practice the partial meantone tunings yield rather satisfactory results for the modulating pieces in general, in spite of the scrambling in parts of these pieces of the basic associations between *cyweirdant* and justness and *tyniad* and impurity. This, I believe, is due to the apperception of intonation by the listener: immediately the precise intonation of the notes of a fixed diatonic scale are grasped as a diatonic gestalt the ear tends to accept them irrespective of exactly where any impure intervals they produce occur, because of the consistency inherent in a fixed scale.

It is by no means certain, then, that the modulating pieces were played in 2/7-comma meantone, or that that intonation was used for the *bragod gywair*. Both stand as propositions only, supported by the reasoning presented above and by the difficulties involved in ascribing the *bragod gywair* to the *range* of partial meantone tunings that are required and which seem to require a *collection* of *cywair* names such as '*is*' and '*uwch*'. It seems unlikely that the term '*bragod gywair*' would have been applied to a range of intonational tunings, although the strong contrast between sweetness and bitterness that each partial meantone tuning produces might perhaps have led to it as a collective term.

9. In pursuit of the *cras gywair*

As has been noted above, *cras* is included amongst the four designations of types of *tannau lleddfon* in AB MS 17116B (Gwysaney 28) at the exclusion of *is*, but it is excluded in those in AB MS Peniarth 155, AB MS Peniarth 62 and AB NLW MS 836, all of which include *is*. If indeed *is* and *uwch* involve temperings and if tempered strings is what *tannau lleddfon* implies then the three sources that contradict Gwysaney 28 will be the correct ones here and *cras* will be untempered. That is implied by the term *cras* when the meanings of the term which are in opposition to *lleddf* are taken into account: '*cras*' as hard, harsh, parched, dry, acrid, and therefore untempered, as opposed to '*lleddf*' as soft, calm, tender, placid, and therefore tempered. The proposition of '*cras*' as untempered, where all the fifths are pure, takes us back to Pythagorean tuning.

So the *cras gywair* could be assigned tentatively to Pythagorean intonation, for which the next strongest candidate, a much weaker one, would have to be the *is gywair* as per Gwysaney 28. The case for the three sources which exclude *cras* being the accurate ones is strengthened by the fact that these sources are not all simply copies that spring from a single oral source: in Peniarth 155 the four types of *tannau lleddfôn* are ordered: *bragod, is, go, lleddf*; whereas Peniarth 62 and NLW 836 have the different order: *bragod, go, is, lleddf*. Also, unlike '*cras*', '*is*' does not lend itself to interpretation as an antonym of '*lleddf*'.

The term '*cras*' appears to lend itself to interpretation as involving Pythagorean thirds and sixths, but if that degree of harshness had been an acceptable quality then it becomes difficult for us to identify where in the repertory it would not be appropriate. Most pieces have closes on perfect intervals, as did Gothic polyphony, and so presumably Pythagorean tertian intervals would have been handled in a similar manner to their treatment in Gothic polyphony: as prefaces or preludes to perfect intervals. As noted earlier (in section 1.), Caniad Cadwgan ('Kaniad Kydwgan' in the manuscript), associated with the *cras gywair*, is rather less dominated by tertian harmony than most pieces, on account of the harmony of this piece being thinner than is usual and particularly in that the final close to each section is perfect, as at 42.2.26, and that one of its two intermediate cadences – a *tyniad* one at 42.2.4 – is also perfect. The other – a *cyweirdant* one as at 42.1.11 – contains the root position major triad F-A-C. The association of the *cras gywair* with Caniad Cadwgan appears on f. 72^r of AB MS Gwysaney 28,⁵⁷ where the title "kanniad kadowgon" is the second item in a list of titles "*ar y kras gowair*". The association would be more secure if it was incorporated in the title, or if it was made in the intabulation. The association might be erroneous but there is no indication that it is so unless it be the apparent contradiction that the title "kanniad ynghywair y wrach" also appears in the Gwysaney *cras gywair* list, since "*kower ynghower y wrach*" is depicted on p. 109 of the Robert ap Huw manuscript as a distinct entity from the "*kras gower*" on p. 108 of the same. It is not impossible that the piece was played using Pythagorean intonation, and it is the strongest candidate for that in the manuscript (followed perhaps by Gosteg Dafydd Athro). The thoroughly major character of the piece suggests that grief cannot be an explanation of Pythagorean impurity here, but perhaps the piece had martial associations where harsh Pythagorean tertian intervals would be an asset.

⁵⁷ The association also applies to the title Caniad Bach i Gydwgi in AB MS Panton 56, p. 80 and other manuscripts, for which see Miles, pp. 619-626, 632, and - in the hand of Lewis Morris - on p. 113 of the Robert ap Huw MS copied from Siôn Dafydd Rhys' Grammar: *Cambrobrytannicae Cymraecaeve Linguae Institutiones et Rudimenta* (London, 1592), p. 299. This may very well be the same piece as Caniad Cadwgan, as argued by Whittaker (1974), p. 38, n. 4.

The other part of the manuscript which is associated with the *cras gywair* is the *clymau cytgerdd* section. This is thoroughly tertian throughout and lacks perfect cadences, and indeed any cadences altogether apart from at 23.2, 23.4, 30.4 and 32.4, and these are tertian. It is hardly credible, then, that this whole section would be played with Pythagorean intonation unless the general purpose of the *clymau* was to demonstrate various options to the student of composition, including the effect of a variety of intonations. Now because this association with the *cras gywair* bears strongly on our understanding of the relationship between *cywair* and the intabulations in general it is important to clarify what can be gleaned about the role of the *clymau cytgerdd*. By viewing them through the regulations of the 'Statute of Gruffudd ap Cynan', the *clymau cytgerdd* emerge as very different indeed from the rest of the repertory. As the *clymau* in the manuscript are relatively simple to play, one would expect a requirement to know them all to appear early on in the apprenticeship ladder laid out in the Statute, but this is not the case. It is an odd thing - and a very telling thing - that knowing all of the 24 *clymau cytgerdd* was only required at the *disgybl pencerddaid* level in the 1523 versions of the Statute and at the level of winning the silver jewel in the 1567 versions. Knowing the 24 *difrau* only appears in the 1567 versions, and only at the *pencerdd* or *athro* level. This does not fit with an interpretation that they were performance pieces such as the *caniadau*, the *clymau ymryson* and the *gostegion* were. It does fit with composition, which also appears in the Statute syllabus (1567) high up and late in the hierarchy, at the level of the *pencerdd* in relation to his elevation to an *athro*, a professor, and not before that level. The *pencerdd* must, if he is a *telyniwr*: "dangos kerdd gwarantidic oi waith e hwn yn bennkerddiaidd ac yn athrawaidd val y bo kydwbybodus i bennkerddiaid a doethion varnv ai ddewisso yn awdur ac yn athraw ar i gelfyddyd" (present a warranted *cerdd* (instrumental piece) of his own work, in *pencerdd*- and *athro*-like manner, so that it may be possible in the judgement of *penceirddiaid* and wise men to judge whether he may be selected as an *awdur* (author, composer) and *athro* (professor) in his art). The *athro* was the producer of instrumental compositions, as is apparent from later in the passage.⁵⁸

The association with the *cras gywair* for the *clymau cytgerdd* is found in AB MS NLW 836B, p. 105, transcribed in the period 1718-1742 by David Williams of Bodeulwyn, Llanfechell, a collector of old manuscripts, and in a close variant transcript by Lewis Morris on p. 5 of the Robert ap Huw manuscript itself. Lewis Morris was in contact with Williams. It is at the head of a section embedded within the treatise *Dosbarth Cerdd Dannau* which is an interpolation of material

⁵⁸ See, for example, the passage located within the 'Statute' text of *Lbl* MS Add. 19711 transcribed in *Welsh Music History*, 3 (1999), pp. 288-9, lines 172-184.

not found in other sources containing the Dosbarth.⁵⁹ The section interrupts the continuity of the Dosbarth passage within which it lies. The section also contains potentially highly valuable technical information on the fingering of the crwth and although it is misplaced it has all the appearance of informed and detailed authority. I think the only grounds for any doubt about the association with the *cras gywair* here might be that, just as the *cwlwm cytgerdd* form as illustrated in the manuscript was an elastic concept that was applied to all the canonic measures, perhaps in practice it was also applied to all the principal *cyweiriau*. This concern would not arise if the *cras gywair* association was embedded in the intabulation of the *clymau cytgerdd* but it clearly has an origin apart from the intabulation and as such it is conceivable that it applied to a different version, a different set, of twenty-four *clymau*. Morris has “*a’r Clym-mau hynny a genir ar y Crâs gowair Cimin hyn.*”: “and those *clymau* are played on the *cras gywair* all without exception”, *i.e.* all the *clymau* in whatever set of them was known to the author. The use of ‘*clymau hynny*’: ‘*those clymau*’ might suggest the existence of other sets of *clymau*.

The fact that Caniad Cadwgan and the *clymau cytgerdd* have no melodic or harmonic features in common prompts concern about their *cras gywair* associations. Caniad Cadwgan is F Ionian in both melodic and harmonic mode whereas the *clymau* are C Mixolydian in both melodic and harmonic mode. It is hard to imagine, then, what the common features might be that would prompt both pieces to require Pythagorean intonation, or how Pythagorean intonation might prompt the composition of both pieces. The one clear indication of intonation in these pieces is the remarkable, confident and repeated use of the augmented fourth in the *clymau cytgerdd* at 26.2.10-4.12 and 29.7.1-16 discussed above (in section 4.). It is a clear indication of specifically 1/4-comma meantone. And 1/4-comma meantone is one answer that of course reconciles the difference in modality between Caniad Cadwgan and the *clymau cytgerdd*. And there is no reason why Pythagorean intonation with its pure fifths *has* to have been viewed as the default condition of tuning from which temperings made departures: if Pythagorean intonation had no place in *cerdd dant* practice then the tuning with the lightest tempering used would have been the one viewed as the default tuning from which the other *cyweiriau* were made. That 1/4-comma meantone has its impure minor thirds and major sixths, that it does not produce the regulated contrast between *cyweirdant* justness and *tyniad* impurity that the partial meantone temperaments produce, and that it does not produce just perfect cadences are sufficient points to justify the adjective ‘*cras*’ being applied

⁵⁹ These include: AB MS Peniarth 155, pp. 79-83; AB MS 17116B (Gwysaney 28), ff. 63-64^v; AB MS Peniarth 62, p. 17; AB MS NLW 836. p. 107. The Peniarth 155 version of this very important treatise is supplied with translation and discussion in Harper (2007), pp. 118-121.

to it. In the 18th century musicians had no name for the meantone tuning that they used.

A choice of 1/4-comma meantone for these two pieces could lie in their extremely major character. The lower-part *tyniad* chord of the *clymau cytgerdd* is the major triad in root position: $b'-d'-f'$, and Caniad Cadwgan eschews its minor equivalent in favour of the perfect consonance: $c-g-c'$, avoiding the minor third $e-g$. Rather than using the partial 1/3-comma distinction between *cyweirdant* and *tyniad* as the warp and weft of the intonational language, a selection here of 1/4-comma meantone fully brings out the major character of such pieces as these.

10. In pursuit of the *gogywair*

Caniad Bach ar y Gogywair, the sole piece in the manuscript to which is attributed the *gogywair*, also has mini-modulations: the *cyweirdant* lower-part chord $c'-g'-a''$ resolving onto $d'-g'-a''$. Here only the D is a borrowing from the *tyniad* stack, and the resolution chord is not triadic but on perfect consonances: 5:4. In the C-mode partial 1/3-comma temperament the fifth D-A is tempered by 1/3-comma so again that is quite a strong intonational contrast to feature within a digit. 2/7-comma or 1/4-comma tempering involves less intonational contrast. In addition to its intra-digit mini-modulations this piece contains hybrid modulations where, in contravention of the general rule that a digit must begin with notes drawn from the appropriate tertian stack, there are rare instances in some pieces where the first column of a digit is a hybrid chord: the lower part is standard but the upper part draws on the stack appropriate to the mode a major third or a fifth above the standard one. Thus is the stack expanded upwards, so that the upper part forms a distinctive upper partial structure, usually a root position triad in order for it to cohere as an easily recognisable structure that stands apart from the underlying harmony of the lower-part chord. This is an advanced chordal technique very familiar today from jazz. An example is in Caniad Bach ar y Gogywair at 45.3.7: the *tyniad* chord $b'-f'-g'-d''-f''-a'''$, where the lower part $b'-f'-g'$ is drawn from the tetradic *tyniad* stack for the Mixolydian harmonic mode which is standard for this piece whilst the upper-part minor triad $d''-f''-a'''$ is drawn from the *tyniad* stack for the Locrian mode, a major third above. The compound major seventh interval of the frame here ($b'-a'''$) is the same interval as that used most commonly and effectively in forming the upper partial structures of jazz. It is a truly remarkable fact that here in this early music the concept of the upper partial structure was already in operation, *so long ago*, and handled with all the clarity and confidence of modern music. There is even a nonchalance in the way in which it is only the two sections viii and ix of

this piece, at 45.3.1-17 and 45.4.1-23, that exploit upper partial structures; the other ten sections are essentially single-line in the upper part.

In common with the *bragod* pieces: Caniad y Gwyn Bibydd, Caniad Ystafell and Caniad Cynrhig Bencerdd, Caniad Bach ar y Gogywair in its last section adopts an intermittent drone alien to its *tyniad* stack: the recurring low C at 46.1.9-3.8.

It is difficult, thus far, to draw a fundamental distinction between the intonational requirements of Caniad Bach ar y Gogywair and the *bragod gywair* pieces. Broadly, 2/7-comma meantone appears to be equally appropriate to both groups. The degree of modulation is slightly less in Caniad Bach ar y Gogywair, in that what tends to be $c'-g'-b''$ in the *bragod* pieces is $c'-g'-a''$ in this piece and is therefore not a chord that includes a borrowing from the *tyniad* stack, that the C drone in the last section is an intermittent ostinato drone rather than continuous one, and that no passages of substantial length are modulations away from the basic C Mixolydian harmonic modality of the piece (excepting the detachment of the upper part into upper partial structures at the beginning of sections viii and ix). There is a slightly stronger argument here then for the C-mode partial 1/3-comma temperament than there is for the *bragod* pieces. But on the basis of 'go-' as 'rather', 'somewhat', the *gogywair* might be expected to involve tempering to a lesser degree than most *cyweiriau*, including the *bragod gywair* and – most obviously – the *lleddf gywair*. If that was so and if the *bragod gywair* is to be maintained as 2/7-comma meantone then the *gogywair* could be predicted to have been either 1/4-comma meantone or a smaller fraction of the comma such as 1/6. The purity of perfect cadences in partial 1/3-comma temperaments is always forfeited in 2/7-comma meantone but that loss is of course mitigated in lighter temperings.

Nevertheless, I have never been very content with the sound of Caniad Bach ar y Gogywair in 1/4-comma meantone. One reason is that the piece employs major seconds rather more than do other pieces, notably in the lower-part chords: $c'-g'-a''$, $b'-f'-g'$ and $c'-d'-f'$, and in particular the meantone G-A in the *cyweirdant* chord $c'-g'-a''$ I do not find very satisfactory precisely because it is a *cyweirdant*. But the main reason is that the piece in its *cyweirdant* digits uses the fifth A-E very much more than is usual in C Mixolydian pieces, and that fifth is generally open, unsplit by the minor third on C. The result is that the interval of the fifth is more prominent here relative to the thirds than in the other pieces, and that fact places more emphasis on any tempering of the fifth, as in 1/4-comma meantone. Here the fifth A-E is so prominent that it calls more attention to the tempering – the compromise – involved in using full meantone than is entirely comfortable. Now, the series of partial 1/3-comma temperaments that I have advanced thus

far is of the first order of partialness but there is also a second order available, where not just one fifth is tuned pure but two. That necessitates tempering the remainder of the fifths by 1/2 of the comma rather than by 1/3. Amongst those tunings is one in which not just the fifth C-G is tuned pure but also the fifth A-E:

Pure:	C-G, A-E
B	1017.60
A	884.36
G	701.96
F	508.80
E	386.31
D	193.16
C	0

Tempering by 1/2 of the comma may seem at first to the reader to be an extreme value to bring into consideration but, to put it into modern perspective, the four fifths and two thirds that are produced here that are narrow, by 10.75 cents (half the comma), are less impure than the modern equal-temperament major thirds and minor thirds adrift of just respectively by 13.69 cents and 15.64 cents, and of course it compares very favourably with any suggestions of just-intonational tunings that have to involve impurities the size of the entire comma. Also, in compensation for the severity of the tempering here, this tuning offers two just 10/9 minor tones: G-A and B-C, so some of the flavour of 5-limit just intonation enters into it. It contains only two impure thirds: F-A and B-D, which at 375.56 cents are both narrow major thirds by the 1/2 comma of 10.75 cents. Thus the contrast that partial 1/3-comma temperaments bring out between *cyweirdant* as justness and *tyniad* as tempered is here amplified, but the fact that it contains *less* impure fifths than any regular meantone temperament or any of the partial meantone temperaments proposed above may explain the term 'go-', as if it qualified not the *degree* of tempering but its *extent*, that is, rather than tempering *six* or *five* out of the chain of fifths here only *four* are tempered. This partial 1/2-comma temperament is a proposition that solves the problems of the meantone G-A and the tempered A-E that this piece has when set in regular meantone temperaments, by delivering 100% justness to its main *cyweirdant* harmonies, at the 'price' of increased impurity to its *tyniad* ones. That increased sense of definition, of harmonic incisiveness, between *cyweirdant* and *tyniad* would mark out the *gogywair* as a tuning with a character that was very distinct from that of partial 1/3-comma temperaments as well as from regular meantone ones.

With these second order of partialness tunings, with the entire *cyweirdant* tetrad pure and the impurity of the *tyniad* tetrad maximised, the harp speaks with two voices: one clean and the other dirty. A clear dialogue between the two becomes apparent, as the conversation bounces back-and-forth as the measures dictate, interspersed with interjections where digits contain borrowings from the other tetrad. It is as if there are two instruments, each taking its turn. Sometimes the one starts the exchange, sometimes the other, but no matter which leads and which responds, the pure one always has the final word. That resolution, the consequence of the measures always ending in *cyweirdant*, has obvious aesthetic and spiritual validity. It is unlikely, then, that any of the pieces that contain a substantial modulation such that a reversal of purity in respect of *cyweirdant* and *tyniad* would take place in a second-order partial temperament would have used such a tuning; whereas the remainder might well have done so. Thus I believe it is possible that many of the pieces that here are suggested as being suited to first-order partial temperaments may have used second-order ones. It is a question of trying to estimate the strength of the taste of the tradition for contrast between *cyweirdant* and *tyniad*:- lighter contrast: first order; heavy contrast: second order, and that is a question that - it is to be hoped - in time musicians, scholars and philosophers might collectively ponder.

11. Allocating tunings to other modulatory pieces

Many of the *profiadau* contain so many modulations and these between so many modes that partial temperaments cannot really do them justice. Such is the case with *Profiad yr Eos*, *Profiad Chwith ab Ifan ab y Gof*, *Profiad yr Eos Brido* and also with the short pieces *Y Ddigan y Droell* and *Cainc Ruffudd ab Adda ap Dafydd*. Full details of the modulations involved will be set out in Paul Whittaker's forthcoming book on the manuscript. *Profiad yr Eos* and *Profiad yr Eos Brido* both involve a number of crossings of the major-minor division that lies between C and G in the chain of fifths and in consequence they cannot use any single partial temperament to give coherence to the principle of *cyweirdant* justness and *tyniad* impurity. The solution, then, is to neutralise the principle by taking refuge in 2/7-comma meantone. *Profiad Chwith ab Ifan ab y Gof* is quite consistently major in character and only dips briefly into a minor mode, D Aeolian, at 60.5.14-16, suggesting 1/4-comma meantone rather than 2/7-comma meantone. *Y Ddigan y Droell* is in minor modes – D Aeolian and G Dorian – until its final passage at 57.1.9-17 in the major F Ionian mode, suggesting a need for 2/7-comma meantone but, being a short piece, perhaps the earlier passages would have been tolerated in the F-mode partial 1/3-comma temperament. *Cainc Ruffudd ab Adda ap Dafydd* is half in B Lydian and half in C Mixolydian and therefore major

throughout, suggesting 1/4-comma meantone, or perhaps, because the piece is very short, the C-Mode partial 1/3-comma temperament.

Caniad Suwsana – the half of it that we have in the manuscript - is in the C Mixolydian harmonic mode apart from a modulation of a *tyniad* digit into G Dorian at 54.6.1-5 and of another at 54.7.20-25. These digits are very prominent and dramatic, placed as they are right at the beginning of sections v and vi, but their opening chords: $a''-f''-a'''$ and $c''-c'''$ respectively are just in the C-Mode partial 1/3-comma temperament, so there is no particular temptation here to reject that in favour of another tuning. Caniad y Wefl like many of the *bragod gywair* pieces makes much use of the hybrid lower-part chord $c'-g'-b''$ resolving onto $d'-g'-b''$, implying 2/7-comma meantone. As with Caniad Llywelyn Delynior which it closely resembles harmonically, this is a soothing piece and the smoothing-out effect of 2/7-comma meantone is in sympathy with that: that there should be no roughness of intonational contrast between *cyweirdant* and *tyniad* or between major and minor. The same logic applies to Caniad San Silin. Conversely, it can be argued that in such pieces it is important to have the closing chords just, in which case the C-Mode partial 1/3-comma temperament would serve.

A list of tentative proposals for each of the pieces in the manuscript follows, with the more probable tuning given first where there are two proposals presented.⁶⁰ Note that, as suggested above (in section 10.), a piece for which a partial 1/3-comma temperament is proposed might have used a partial 1/2-comma temperament, and also possibly only as an alternative. Also note that some proposals here are prompted more by their *cywair* associations than by analysis of their harmonies, and others less so, in consequence of the mismatch between *cywair* and modality. If I was to rely solely on an analysis of the harmonies and to dismiss the relevance or reliability of the *cywair* associations, I would propose the partial meantone tunings of the most appropriate mode for each and every one of the pieces, such is their efficacy in delivering a comprehensible distribution of pure and impure chords in alignment with the measures.

Gosteg Dafydd Athro	C-mode partial 1/3-comma
Gosteg yr Halen	F-mode partial 1/3-comma
Yr Osteg Fawr	F-mode partial 1/3-comma
Gosteg Llwyteg	F-mode partial 1/3-comma
Y Clymau Cytgerdd	1/4-comma meantone
Caniad y Gwyn Bibydd	1) 2/7-comma meantone; 2) C-mode partial 1/3-comma
Caniad Ystafell	1) 2/7-comma meantone; 2) G-mode partial 1/3-comma

⁶⁰ Pwnc ar ôl pob Profiad, as explained above, may have been the subject of various intonations according to which *profiad* it followed.

Caniad Cadwgan	1/4-comma meantone
Caniad Bach ar y Gogywair	1) C-mode partial 1/2-comma; 2) 1/4-comma meantone
Caniad Cynrhig Bencerdd	1) 2/7-comma meantone; 2) F-mode partial 1/3-comma
Caniad Llywelyn ab Ifan ap y Gof	C-mode partial 1/3-comma
Caniad Suwsana	C-mode partial 1/3-comma
Profiad Cyffredin	C-mode partial 1/3-comma
Y Ddigan y Droell	1) 2/7-comma meantone; 2) F-mode partial 1/3-comma
Cainc Ruffudd ab Adda ap Dafydd	1) 1/4-comma meantone; 2) C-mode partial 1/3-comma
Cainc Dafydd Broffwyd	C-mode partial 1/3-comma
Profiad yr Eos Brido	2/7-comma meantone
Profiad yr Eos	2/7-comma meantone
Profiad Chwith Ifan ap y Gof	1/4-comma meantone
Profiad Fforchog Ifan ap y Gof	C-mode partial 1/3-comma
Profiad y Botwm	1) C-mode partial 1/3-comma; 2) F-mode partial 1/3-comma
Profiad Brido ar Isgywair	F-mode partial 1/3-comma
Profiad Brido ar Uwchgywair	1) D-mode partial 1/3-comma; 2) G-mode partial 1/3-comma
Caniad y Wefl	1) 2/7-comma meantone; 2) C-mode partial 1/3-comma
Caniad Tro Tant	B-mode partial 1/3-comma
Caniad San Silin	1) 2/7-comma meantone; 2) C-mode partial 1/3-comma
Caniad Marwnad Ifan ap y Gof	2/7-comma meantone
Y Caniad Crych ar y Bragodgywair	2/7-comma meantone
Caniad Hun Wenllian	1) 2/7-comma meantone; 2) C-mode partial 1/3-comma
Caniad Pibau Morfydd	1) 2/7-comma meantone; 2) C-mode partial 1/3-comma
Caniad Llywelyn Delyniol	1) 2/7-comma meantone; 2) C-mode partial 1/3-comma

12. Practical considerations

A summary follows of the size in cents of the temperings involved in the tunings which have been considered:

Fifths:	B-F	F-C	C-G	G-D	D-A	A-E
1/4-comma	-5.38	-5.38	-5.38	-5.38	-5.38	-5.38
2/7-comma	-6.14	-6.14	-6.14	-6.14	-6.14	-6.14
B-F 1/3	0	-7.17	-7.17	-7.17	-7.17	-7.17
F-C 1/3	-7.17	0	-7.17	-7.17	-7.17	-7.17
C-G 1/3	-7.17	-7.17	0	-7.17	-7.17	-7.17
G-D 1/3	-7.17	-7.17	-7.17	0	-7.17	-7.17
D-A 1/3	-7.17	-7.17	-7.17	-7.17	0	-7.17
A-E 1/3	-7.17	-7.17	-7.17	-7.17	-7.17	0
C-G, A-E 1/2	-10.75	-10.75	0	-10.75	-10.75	0

The following are the pitches involved in the proposed tunings:

	1/4-comma	2/7-comma	B-mode partial 1/3-comma	F-mode partial 1/3-comma	C-mode partial 1/3-comma	G-mode partial 1/3-comma	D-mode partial 1/3-comma	C-mode partial 1/2-comma
C	1200	1200	1200	1200	1200	1200	1200	1200
B	1006.84	1008.38	1003.26	1003.26	1010.43	1010.43	1010.43	1017.60
A	889.74	887.43	884.36	884.36	891.53	891.53	891.53	884.36
G	696.58	695.81	694.79	694.79	701.96	694.79	694.79	701.96
F	503.42	504.19	505.21	498.05	505.21	505.21	505.21	508.80
E	386.31	383.24	379.15	379.15	386.31	386.31	386.31	386.31
D	193.16	191.62	189.57	189.57	196.74	196.74	189.57	193.16
C	0	0	0	0	0	0	0	0

Note that the distinctions between these tunings are very fine indeed in comparison with the size of the retunings involved in the just-intonational tunings proposed for some pieces in 'Tuning', or in comparison with the size of the retunings involved in switching between those and meantone temperaments. This is an important practical point because of the complex response of high-tension metal-strung harps to retuning. If the pitch of a string is raised slightly the neighbouring strings will flat slightly, and the converse also holds true. The greater the change in pitch the greater is the impact on neighbouring strings and the greater is the number of neighbouring strings affected. If indeed multiple tunings were used, then the small range of adjustments proposed here is the range that least threatens the stability of the harp whilst retuning and keeps the number of resettings of a string needed to a minimum. It should allow a harp to perform better than one that needs to accommodate retunings of a tone, a semitone or a syntonic comma without eating into the tensional safety margin needed to avoid string breakages.

Also note the practical point that certain string pitches are common to several of these intonations, so it is often not necessary to adjust many strings per octave to pass between one tuning and another (the number varies from between one and six).

Given that tuning portable stringed instruments is necessarily a trade-off between precision and – always - limited time available, I imagine that the medieval harpists would have found it adequate to set the various narrow fifths involved from memory and then check that the appropriate purity of thirds had been achieved, and if not to do some resetting until that was achieved. In the case of 2/7-comma I expect the same except that the check would need to be that *no* pure thirds had been achieved; I do not expect they would have always been concerned to actually match the beats of the thirds by counting them but they may have done so sometimes. As regards the accuracy of memory in

judging relative intervals in musical traditions it is worth reflecting here on the fact that in the Middle East the exact intonation of some notes in each *maqam* varies slightly but consistently from region to region and even from one town to the next, such that the locality involved can be instantly identified by an auditor familiar with the region. Exact intonations can be replicated from memory by traditional musicians, including, in Oriental traditions, the ability to deliberately alter the pitch of certain notes very slightly in the course of a piece, slides aside, in order to heighten particular moods as the piece develops.

It needs to be appreciated that the above values are theoretical and should not be aimed at by using a simple digital tuner as a guide. In the applied theory of metal strings the situation is more complex. On a small diatonic metal-strung harp with progressive foreshortening of the string lengths towards the bass inharmonicity is prone to come into play in tuning, prompting the musician to respond with octave stretching such that a string tuned to another an octave below will be tuned to the actual second harmonic of the lower string which will be somewhat sharp of its theoretical second harmonic. The amount of inharmonicity varies somewhat irregularly from string to string on any individual metal-strung instrument and so any tuning-up or resetting of the tuning is always necessarily a matter of the art of compromise. Fine tuning is in the hands of the tuner not the composer and, whilst I have argued here that there may often have been a general aim which we today can simply and conveniently express as precise quantities on the spectrum of meantone, that may not have been the case on every occasion. For example, the drift in tuning during performance of any particular harp in any particular environment is to some extent predictable, the gradual absorption by it of body heat being one factor to take into account, so the tuner does well to partially anticipate that drift in the tuning. So I would advise any harpist against taking a rigid stance on implementing my proposals here.

What other evidence about the *cyweiriau* can be brought to bear on the hypothesis that they equate with intonations? The enigmatic diagrams that are labelled with the names of various *cyweiriau* on page 108 and page 109 of the manuscript ought to be able to help here, if indeed the links proposed above between particular *cywair* terms and various intonational tunings are valid.

13. The diagrams as intonational tunings

The first point to be made here, and it must not be overlooked, is that the diagrams do not present any initial impression of being concerned with intonation. So any attempt to use them to validate the hypothesis of an

equivalence between *cywair* and intonation necessarily involves projecting onto the diagrams meanings which are not immediately apparent.

Secondly, if the *cyweiriau* were intonations and no more than intonations, one would expect that the diagrams would illustrate the contrasts in the way in which the intervals of each were derived: a different tuning sequence for each. Thus, for example, one *cywair* might have D pitched a major whole tone above C and another *cywair* might have D pitched a minor whole tone above C. The difference could be illustrated by the tuning sequence C > G > D for the former and C > F > D for the latter. But that is not what we encounter. We only have distinctions illustrated by some letters in the left-hand oblique columns of page 108 being associated with different letters in the right-hand column, and the same in respect of the upper and lower rows of letters on page 109. Most of these associations link letters which are adjacent in the alphabet of Odonian pitch notation and, therefore, if the letters relate to pitches of harp strings they mainly span seconds, not the thirds on the purity of which intonation in this tertian music must depend.

Given then that it is not methodologically ideal to approach the diagrams with an expectation that they might contain within them information on intonational harp tunings, is there any plausible way in which they can be read that way? By 'plausible' here I mean not just musically and historically plausible in the light of what is known of *cywair* from elsewhere but *graphically* plausible: that is, that intonational tunings are indicated here with sufficient clarity that it becomes credible that the scheme of the diagrams would have been chosen by its designer for that purpose in preference to any other scheme, and – further – that he would have expected the reader to have been able to understand the scheme without needing verbal directions explaining it. In my long experience of considering the diagrams I have been able to produce only one way of reading the diagrams as intonational tunings which even remotely approaches credibility from the graphic point of view. I doubt that the reading was the way the diagrams were intended to be read, so some readers may choose to pass over the following discussion of it.

Let us take the example of the diagram for the *cras gywair*. The tablature letters of the diatonic series in the left column are each followed by the same letter in the right column apart from the tablature letters for F, which is followed by E, and for B, which is followed by A. Let us consider the case of F followed by E. If F was not tuned to E (the rejected scordatura hypothesis discussed above (in sections 1. & 3.) then the next question has to be: was it tuned from what E was tuned from? In other words: does the linking of F with E mean that they shared

their source? The source of E would have been A, since E is at one end of the diatonic chain of fifths, so in the *cras gywair* was F also sourced from A instead of from C as it would be in the chain of fifths?

Let us see if to do so would make sense, by a demonstration. Is there some point in tuning F from A? Do we not end up with F at the same pitch as we did when we tuned it from C? No, because a new and different route would now be used to source F. The original F produced by the chain of fifths and tuned a pure fifth or fourth from C would be pitched at 498 cents above C. The new F is pitched 22 cents (the syntonic comma) higher at 520 cents, since A (tuned in the chain of pure fifths) is at 906 cents, and when used to source F that leads to it pitched at 520 cents. The result is that the interval F-A has now been 'sweetened' out of a 'wide' Pythagorean major third of 408 cents into a pure major third of 386 cents. So here, at last, we do have one potential explanation of the diagrams which relates to the subject of intonation.

Continuing to read the *cras gywair* diagram in this way, we encounter its other puzzle: wherever we have B in the left column, we have A against it in the right column. The Pythagorean B-flat that is sourced from the chain of fifths, our 'initial B', is pitched at 204 cents below C but, if we now reset it by tuning from the source of A, which is D at 204 cents, we arrive at the new B-flat at 182 cents below C.

This is the resulting scale:

C	1200
B ⁺	1017.60
A	905.87
G	701.96
F ⁺	519.55
E	407.82
D	203.91
C	0

All the fifths are no longer pure: F-C is narrow by 22 cents. The pure major thirds are B-D and F-A; the pure minor thirds are G-B and D-F. The remainder remain Pythagorean: A-C, C-E and E-G.

Now let us refer the scale to the two pieces in the Robert ap Huw manuscript to which is attributed the *cras gywair* – the *clymau cytgerdd* and *Caniad Cadwgan* –

to see how useful the scale would be in serving them. The *clymau cytgerdd* are harmonically based on the tonal centre of C:

Tonal centre	Harmonic modality	<i>Cyweirdant</i> notes	<i>Tyniad</i> notes
C	Mixolydian	A-C-E-G	G-B-D-F

Firstly, the precluded fifth F-C is indeed absent. The lower part emphasis is on the permissible pair of chords: G-C-E (*cyweirdant*) and B-D-F (*tyniad*). Interestingly, the *tyniad* chord B-D-F is now a pure major triad, but the *cyweirdant* chord G-C-E remains Pythagorean. The intonation of the two chords is different. This, then, would be a radically new proposition: that, for the *cras gywair* at least, each measure might tell a story, of a journey to and fro between two different intonational systems, no longer just between two note groups both sharing in a single intonational system. It is curious that here it is the *tyniad* chord which is pure, not the *cyweirdant* chord. It implies that the *clymau cytgerdd* had a forward momentum rather than the sense of repose at the end of a measure we might expect which would be achieved if we had each measure closing on a pure *cyweirdant* chord rather than a Pythagorean one as here. Perhaps this might be what led the *cras gywair* to be so-named, *cras*: hard, harsh, parched, dry, acrid. Perhaps there might have been another commonly-used *cywair* which had the reverse arrangement: Pythagorean *tyniad* and pure *cyweirdant*, but we are not in a position to explore that, lacking as we do in the manuscript any pieces associated with any of the names of the remaining diagrams

The avoidance of the fifth F-C becomes more marked when we take into account the modifications to the lower part chords at 24.5.1-7.15, where the *g'* of the *cyweirdant* chord *g-c'-e'* is, as I argue, damped and substituted by *a'* as part of the chord *a'-c'-e'*.⁶¹ The note A, like C and E, is drawn from our stack of *cyweirdant* chords shown above, and as A has been unaltered by our *cras gywair* resetting of strings, the Pythagorean nature of the *cyweirdant* here is maintained. The counterpart modification to the *tyniad* chord *b'-d'-f'* in the piece is the chord *c'-d'*. Note, then, that it is not *c'-d'-f'* which it would be if, as commonly happens in this and other pieces, it echoed the fingering pattern of the modification to the *cyweirdant* chord, with the thumb playing a third, upper note. The avoidance of F-C in the piece appears to be studious, meaningful.

So the *clymau cytgerdd* can bear this reading of the *cras gywair* diagram, with the proviso that a contrast between just intonation and Pythagorean intonation is

⁶¹ Greenhill, 'Technique', pp. 120-122.

necessarily involved, although that is, I believe, a novel proposition in the history of intonation.

Caniad Cadwgan, the other piece in the manuscript attributed to the *cras gywair*, cannot bear this reading of the diagram. The fifth F-C is widespread throughout all the *cyweirdant* digits, and the two groupings of the just thirds (A-C, C-E and E-G) and the Pythagorean ones (D-F, F-A, G-B) are not kept separate from one another as in the *clymau cytgerdd* but have members in both *cyweirdant* digits and *tyniad* digits, so no coherency as in the *clymau cytgerdd* emerges here in the assignment of intonation between the two types of digit. That the *clymau cytgerdd* can bear this reading of the *cras gywair* diagram whilst Caniad Cadwgan cannot is a function of the fact that the harmonic and melodic modalities of the two pieces are not the same. The former has C as its tonal centre, whereas the latter has F, as follows:

Tonal centre	Harmonic modality	<i>Cyweirdant</i> notes	<i>Tyniad</i> notes
F	Ionian	D-F-A-C	C-E-G-B

Again, this leads us back to the oddity that if *cywair* equates with intonation modality does not. As discussed above (in section 3.), changes in intonation did not have to be triggered by changes in modality, and here with these two pieces we have one example from amongst the many the manuscript offers where a change in modality was not triggered by a change in *cywair*.

Given that the reading of the *cras gywair* fails in respect of Caniad Cadwgan it should not be necessary here to set out all the details of the intonational tunings that this method of reading the diagrams yields for the remainder of the diagrams, but I will point out that the *cywair chwith/dieithr* diagram yields the same result as the *cywair yr wrach* diagram: the Pythagorean scale with adjusted B⁺, A⁻ and E⁻, and that the former yields the same result in its lowest octave as it does in the higher octave in spite of the difference between the two in the diagram. Thus the rejection of the reading is not entirely dependent on the veracity of the association of the *cras gywair* with Caniad Cadwgan.

14. The diagrams as chord progressions

The emphasis on associations of a second in the diagrams is what led me to propose as one possible alternative to the scordatura theory of the diagrams that they indicate what in the year 2000 was still the missing lynchpin of the music

theory of *cerdd dant* : the chord progressions between *cyweirdant* and *tyniad*.⁶² In the music text of the manuscript the 'voice' produced by a single finger either shifts up or down, usually by a second but sometimes by a third, or remains at the same level between *cyweirdant* and *tyniad*. For example, the *cyweirdant* upper-hand melodic line of 49.3.6-20 is then duplicated in its *tyniad* counterpart at 49.4.1-15 but with the first six columns shifted up a third, the next eight columns with no shift and the last column shifted down a second. This is far more complex than the 'classic' double-tonic shift of a phrase down a second and has some of the flavour of the complexity of the diagrams. There is no contradiction here with Whittaker's scheme of *cyweirdant-tyniad* relationships since within his scheme there is no restriction on the actual shifts that can occur between the *cyweirdant* and *tyniad* notes as long as the notes involved are indeed drawn from the appropriate harmonic groups. A more pervasive and wider type of shift occurs at the beginning of *Profiad y Brido ar Isgywair*, at 63.4.1-6, as discussed above (in section 3.). The Ionian *cyweirdant* digit of the first column (containing the notes F-A-C) is followed by a *tyniad* digit with its notes drawn not from the *tyniad* notes of the Ionian mode (C-E-G-B) but from those of the Mixolydian mode (G-B-D-F). As mentioned above, instead of being a classic double-tonic harmonic shift down by a second, this is a shift down by a fourth or up by a fifth.

Since this opening passage forms only a small part of the piece, one might think that it could not have led to the naming of the piece for the *is gywair*, but *Y Caniad Crych ar y Bragodgywair* is evidently named '*crych*' from the dense *crychu y fawd* movements in its section viii even though such movements hardly occur in the piece's eleven other sections. Whether one looks at shifts of the harpist's fingers or at shifts of harmony within the diatonic series, the chordal progressions and resolutions in the intabulations involve complex meanderings around the basic notes of the harmonic mode. We might well expect these to have been codified into a system such as the *cyweiriau*.

However, if the diagrams were indeed designed to capture the essence of chordal relationships one would think that they would centre more on the deep level of Whittaker's scheme than on the surface level of the intabulations. More tellingly, the shifts in the *clymau cytgerdd* and in *Caniad Cadwgan*, both associated with the *cras gywair*, outnumber the 'shifts' of the diagram for that on page 108. The diagram contains only two 'shifts' within the octave: between F and E and between B and A, whereas fundamental (as revealed in the lower hand chords) to the *clymau cytgerdd* - in addition to the shift between E and F - are the shifts between C and D and between G and B, and fundamental to *Caniad Cadwgan* is the shift between A and G. Indeed, because the diagrams offer at the most only

⁶² Greenhill, 'Tuning', pp. 45-8.

a single 'shift' for each letter of the left column, they cannot offer the multiple options for each that the chordal progressions theory requires.

15. A reorientation of perspective on the *cywair* problem

The inability to reconcile the diagrams with either the 'scordatura',⁶³ the 'multiple intonational-tunings' or the 'chord progressions' hypotheses leaves open the question of what it was the diagrams were designed to illustrate. In an attempt to settle that question, I have found it important to draw well back from closely examining the detail of the diagrams and the detail of what the pieces in the manuscript require of intonation, and instead to examine firstly some of the foundations of the modern approaches to the *cywair* problem.

Some salient observations may be helpful regarding the significance of the *cyweiriau*.

The detailed extant treatise on the *cyweiriau* that has its origin *ante* 1600 during the time the *cerdd dant* tradition was still operating - the *Dosparth Cerdd Dannau* - explains some of the workings of the *cyweiriau* with reference only to the *crwth*. In view of that emphasis on the *crwth* it has to be wondered whether the emphasis is merely the product of the accidents of survival of material - that counterpart treatises for the *telyn* may have been lost - or whether it indicates that the concept of *cywair* applied more closely to the *crwth* than it did to the *telyn*. The alarming fact remains that the harp manuscript does not specify the *cywair* for most of the pieces intabulated, nor can they be gleaned from all the extensive repertory lists that have survived. In the repertory lists, sometimes the *cywair* of a piece appears in its title but otherwise the appropriate *cywair* is generally not supplied. In those cases where repertory lists are ordered according to the *cywair* they are associated with and in addition the measures of some of the tunes are also given in notation it is possible to ascertain whether a list is for the *crwth* or the *telyn*, since the *crwth* notation is the inverse of the *telyn* notation. The main extant list that is ordered according to *cywair* is the list of *caniadau* supplied by a group of manuscripts of which *AB MS Gwysaney 28*, ff. 71-72v is prominent.⁶⁴ It does have some measure notations, and they are in form for the *crwth*.⁶⁵

⁶³ Greenhill, 'Tuning', pp. 33-52.

⁶⁴ See Miles, pp. 620-622.

⁶⁵ Item 43 in *AB MS 17116-B (Gwysaney 28)*, fo. 72^r and item 54 on fo. 72^v.

The repertory lists in respect of the *cadeiriau* (a group of particular *cwlwm* pieces relating to the syllabus requirements of the 'Statute') for the crwth are particularly rich in *cywair* detail. Their titles (in modern orthography) are:⁶⁶

Barf y Cawr ('ar y Bragod Gywair' is added to a restatement of the title immediately below the list.)
Cwlwm Mawr ar Cywair Seisyllt
Cwlwm Mawr ar y Gogywair Gwynedd
Cwlwm Mawr ar y Lleddf Gywair Gwyddel

The inclusion here of the otherwise unknown *cywair Seisyllt* and the association of *gogywair* with Gwynedd is striking, as is the fact that the list is also unique in that each piece is on a different *cywair*,⁶⁷ as if the group is particularly designed to test and exhibit the *cywair* knowledge of the crythor. This is not the case with the *cadeiriau* for the telyn:⁶⁸

Cleddau Cerdd
Cwlwm Gwilym ap Llywelyn Ddu
Cwlwm Hir ar y Bragod Gywair
Cadarn Ynghadair
Cwlwm y Frechdan
Cwlwm y Wefl/Wefus

Also in sharp contrast to the crwth *cadeiriau* list is the only case where a repertory list known to be for the telyn supplies the *cywair* for each piece: that of the four *colofnau* (which are known from other sources to be those for the *telyn*) on p. 102 of the manuscript, where the *cras gywair* is assigned to the whole group.

It would strengthen the association between the harp and the *cyweiriau* if the titles of pieces associated with harpers rather than crwth players contained their *cywair* designation. There are remarkably few titles which include both the name of a musician and the name of a *cywair*:

Profiad Brido ar Is Gywair
Profiad Brido ar Uwch Gywair
Cwlwm ar Lleddf Gywair Brido

⁶⁶ AB MS 17116-B (Gwysaney 28), fo. 66; CDp MS 43, p.7; AB MS NLW 37B, p. 6.

⁶⁷ The title 'Cwlwm Mawr ar y Bragod Gywair' appears with the four *cadeiriau* in Gwysaney 28, fo. 66 and NLW 37B, p. 6.

⁶⁸ For detail of the sources of these types of piece see Sally Harper, 'The Robert ap Huw Manuscript and the Canon of Sixteenth-Century Welsh Harp Music', *Welsh Music History*, 3 (1999), pp. 151-155.

Caniad Anwylyd y Pasant ar y Bragod Gywair
Cwlwm Llywelyn Fychan ar y Lleddf Gywair

It has not yet been clearly established whether Y Brido was a harper or a crythor, but a reference to his two hands is more suggestive of the harp than it is of the crwth. Y Pasant, with whom he was associated, was a crythor. The instrument of Llywelyn Fychan (possibly the father of the poet Ieuan ap Llywelyn Fychan of Lleweni) is not known.

In summary, the evidence that playing the crwth required a detailed knowledge of the *cyweiriau* consists of the Dosbarth passage on crwth fingerings, the Gwysaney 28 list of *caniad* titles grouped by *cywair* for the crwth, and the *cadeiriau* list for the crwth. Almost all the documented information on *cywair* is in connection with the crwth. In sharp contrast is the absence of counterpart evidence in respect of the harp, and, most significantly, the fact that it was not felt necessary to specify the *cywair* of most pieces intabulated in the manuscript for the harp. Armed with this adjustment in our orientation, a greater emphasis on the association of *cywair* with the crwth, let us continue the investigation into the full meaning of *cywair*.

16. *Cywair* and the crwth

Might it have been that the knowledge of the *cywair* of a piece was essential only for the crythor? That would be the case if a *cywair* was a particular tuning for the crwth. I have put forward arguments in support of that in the chapter 'Crwth Tunings' in 'Tuning'.⁶⁹ However, it seems doubtful that it could ever be possible to reconcile that proposition with the diagrams on pp. 108-9 or with the Dosbarth passage on crwth fingerings, as both seem to address differentiations down to the level of adjacent notes rather than the fourths, fifths and octaves involved in the recorded crwth tunings. The concept of '*cywair*' may have involved a variety of crwth tunings but it could not have been restricted to that meaning.

17. A new approach to the diagrams: the slides interpretation

The concentration of detail concerning *cywair* in the records relating to the crwth implies that *cywair* was more particularly or more intimately concerned with crwth technique than with harp technique, and specifically with the production of what is not available on the harp: that is, articulated slides from one note to another. Musical instinct across the world inclines towards using them a lot on any instrument capable of slides, to add expressiveness, as is still done today in

⁶⁹ Greenhill, 'Tuning', pp. 97-104.

the related traditional double-tonic dance music, and it would surely be very odd if the *cerdd dant* crwth specialists did not capitalize on the opportunity for this that the crwth affords. All bowed instruments that are played beyond first position involve unarticulated shifts at each change of position (that is, unarticulated through releasing the pressure of the stopping finger) and it is of course a small step from there to fully sound shifts to create slides (by not releasing but continuing to maintain the pressure of the stopping finger).

In effect, I suggest here that the crwth was more than a bowed substitute for the harp. If the crwth's appeal was solely that it was a bowed instrument, it would be hard to account for the continued popularity in late medieval Ireland of the timpan, which I argue was the plucked lyre with a fretless fingerboard that was the precursor of the crwth.⁷⁰ The key factor in common here is the fretless fingerboard.

Through its function of connecting one note with another, the slide offers an explanation of the hitherto unexplained technical term in the *Dosbarth*: the '*cysylltiad*' or connection, which is defined as what connects *cyweirdannau* and *tyniadau*: "llyma yr achosion y mae y cysylltiaday yn cael y henw / achos y bod yn cysylldy cywirdane a thyniaday" (here is the reason why the *cysylltiadau* have the name they have – because they connect (or join) *cyweirdannau* and *tyniadau*).⁷¹ The other terms in this *Dosbarth* passage describe linear not vertical features, and the only way of connecting two notes in a linear fashion is the slide. So are the mysterious connections between certain pairs of notes illustrated in the diagrams slides? The slides interpretation offers a simple reconciliation with the diagrams. On this interpretation all the notes of the diatonic series are first set out, in the left columns of p. 108, and where some of them are approached through slides the note from which the slide is made is set out against them in the right column. To take the *cras gywair* diagram as an example, only the notes

⁷⁰ With only three strings and yet capable of producing high-status music, the form of the timpan cannot have been that of a simple plucked lyre, producing just three notes in total. It must have had a neck or fingerboard against which to stop those three strings. The form of the crwth is of course that of a lyre with a neck and fingerboard added, and it should be expected that on the introduction of the bow it was applied to a pre-existing, indigenous instrument: that is, a plucked or strummed lyre with a fingerboard running inbetween and parallel to the arms; see Greenhill, 'Technique', pp. 145-6.

⁷¹ *AB MS Peniarth 147*, p. 199, transcribed in T. Gwynn Jones, 'Cerdd Dant', *Bulletin of the Board of Celtic Studies / Bwletin y Bwrdd Gwybodau Celtaidd*, 1, no. 2 (1922), p. 143. Similar definitions are to be found in *AB Peniarth MS 155*, pp. 79-82 and *CDp MS 2.634* (formerly *Havod 24*), p. 792. The report in William Taylor, 'Robert ap Huw's harp technique', *Welsh Music History*, 3 (1999), pp. 85-6, that the *Dosbarth* passage defines not '*cysylltiad*' but '*crafiad*' as what connects *cyweirdannau* and *tyniadau* is in error.

B and F are subject to slides, and only from A and E respectively, that is, the slides are restricted to the only opportunities the diatonic series offers for slides of a semitone. Elsewhere, in the other diagrams, various slides up or down of a semitone, a whole tone or a major third are illustrated. The version of *y lleddf gywair gwyddel* on p. 109 is unusual but still musically comprehensible in that the diesis symbols below the lower row indicate that two of its slides begin from B-natural rather than the B-flat of the *cerdd dant* diatonic series.

The fact that the p. 109 version of *y lleddf gywair gwyddyl* contains a source note, B-natural, which does not occur in the standard *cerdd dant* diatonic series might provide a clue for understanding the absence in the diagrams of the other three principal *cyweiriau*: the *is gywair*, the *bragod gywair* and the *go gywair*. The designer of the p. 108 diagrams had created a means of illustrating connections between pairs of notes that lie within the standard diatonic series, and if the p. 109 version of *y lleddf gywair gwyddyl* is correct then the first attempt at it on p. 108 is a modified version in order to fit it within the scheme. Unsatisfied with this, the original writer or a later one presumably decided to add the diesis symbols needed to over-ride the modification but these would not easily be added to the p. 108 diagram with its stave lines, hence the second version on p. 109 with no stave lines. There is an implication here that there was no attempt to include the other three principal *cyweiriau* because they included notes other than B-natural from outside the diatonic series, for which there was no notation. Small slides from source notes lying outside the diatonic series and near to the destination note are common in Insular traditional music today, particularly small ascending slides.

Central to the execution of the *cyweiriau* on the crwth is the passage in the *Dosbarth* introduced above (in section 3.) referring to the fingers of the crythor 'keeping' various *cyweiriau*: "Vn bys i grythor sydd yn kadw iii chywair/ Is Kywair/ kras gywair/ ar lleddf gywair/ y mynagvys sydd yn kadw y gogywair y bragod gywair pob bys sydd yn kadw arno/ llymar achos y gelwir ef y bragod gywair/ am vod peth o bob kywair ynddaw" (One finger of the crythor keeps three *cyweiriau*: *is gywair*, *cras gywair* and the *lleddf gywair*; the forefinger keeps the *gogywair*, and every finger keeps in the *bragod gywair*. This is the reason it is called the *bragod gywair*, because there is some part of every *cywair* in it).⁷² Perhaps the index finger, which 'keeps' the *go gywair* and (in the majority of sources) the *bragod gywair*, used source notes to slide from that are close to the minor and major second to the open string or some other reference point, such as 13/12, 12/11, 11/10 and 8/7, and perhaps the middle finger,

⁷² AB MS Peniarth 155, pp. 81-82, transcribed in Miles, pp. 561-2. The similar version in AB NLW 836D, p. 107, has been quoted above (in section 3.).

which 'keeps' the *is gywair*, the *cras gywair* and the *lleddf gywair* used source notes close to the minor and major third to the open string or whatever, such as 7/6, 11/9 and 9/7.

Such small slides might explain the string spacing of the *crwth*. On current understanding, based on the surviving examples, the strings were paired in octave courses but with sufficient width between the two members of each pair to allow for some degree of independence in their stopping. This allows small slides, perhaps even as wide as up to a half tone in higher positions, to be played as 'split' slides by the pad on one string whilst the tip of the same finger is stopping and holding the destination note on the further string. This is most easily done for small ascending slides, by bringing the finger to an angle closer to a right angle to the strings whilst pivoting close to the finger's tip, a movement rather like an exaggerated vibrato action. The contrast between the slide and the held destination note highlights the slide and so adds dynamism, as it yearns for resolution at the octave. Such an intonationally exacting fingering has greater opportunity of being performed with precision nearest the nut, and that may explain why in the *Dosbarth* it is the index finger and the middle finger that are singled out as the fingers that 'keep' the main *cyweiriau*, and that the only mention of *cywair* in the *crwth* fingering passage is that the primary *cyweirdannau* are begun with the index finger '*ar y bragodgywair*'.

If indeed slides were used on the *crwth*, naturally it is difficult to identify from the harp tablature where they might have appeared in these actual pieces in their *crwth* versions. They may have been used to connect pairs of notes which are written in the tablature or they may have been ornamental additions to notes that are written as single notes in the tablature, or both these types may have been played. As regards the first possibility I can offer a useful example where quick slides might have been used to connect written notes. Scale-type melodic passages are rare in the manuscript but - as it happens - there is an example in *Caniad Cadwgan*, and because of that piece's association with the *cras gywair* the passage gives an opportunity to illustrate the musical practicability and sense of the *cras gywair* diagram on this interpretation, and thereby the potential of the other diagrams also. The passage, at 43.4.1-5, is an ascending series of *y plethiad byr* figures,⁷³ such that F, G, A, B and C in turn are each preceded by the note below, hence: E-F, F-G, G-A, A-B, B-C. Implementing the *cras gywair* diagram, all this passage, spanning a minor sixth, can be played on one string course of the *crwth* without the need for any unarticulated shift of position. Finger 1 stops E and slides to F which is sounded twice, finger 2 stops the two soundings of G, finger 3 stops A and on its second sounding slides to B, and

⁷³ See Greenhill, 'Technique', pp. 74-80.

finger 4 stops C. Thus the slides in the *cras gywair* diagram enable quite wide scale-type passages like this to be played smoothly and cleanly in true *legato* fashion without any minute interruptions. Regarding the need here to play this passage on a single string course of the crwth, the intabulated passage is above *cyweirdant* harmony throughout on its first appearance and that dictates, on my alternate stopping hypothesis,⁷⁴ that the passage must be played on a single string course. The later reprise of the passage would have the first note E above *tyniad* harmony and so that note must be played on the other of the two melodic string courses.

18. Tracing analogues of slides in the harp tablature

Although it is not possible to play slides on the harp, if slides on the crwth and the timpan were as important as this hypothesis suggests they were one might predict that some trace of them, some reflections of them, might be detectable in the harp intabulations. I have already noted that the expansions of chords in the tablature may have their origin as slurs on the crwth.⁷⁵ The expansions consist of a diagonal line, sometimes curving upward, connecting the lowest letter of a lower-part chord to the succeeding single letter, which is always the string immediately above the first and pitched a major second higher. On the harp one thing the diagonal line most probably denotes is that the first string needs to be damped, but the fact that the line connects two notes is not explained by that. The two notes are graphically presented as a *unit*, and indeed the second note supplies a resolution to the chord above in that it is generally more consonant with the chord than the first note. That is shown most clearly by the intervals between the lowest note and the note two notes above in the lower part chord, the most common interval patterns formed being a shift from a seventh to a sixth (157 instances) and from a sixth to a fifth (58 instances).

Were these expansions reflections of slides on the crwth? It is always the two lowest notes that are connected by the diagonal line, and to be reproduced on the crwth they would need to be played on the lowest course of the crwth: the offboard course, played by the thumb. Now since the thumb on its own cannot stop stepwise without shifting, the diagonal lines must indicate for the crwth - wherever the lowest note is not produced on the open offboard course - either unarticulated shifts or articulated slides. But the fact that what would be played on the crwth as unarticulated shifts of the thumb elsewhere in the tablature is *not* marked by diagonal lines leaves as the only explanation for their presence that where they appear they indicate what would be played on the crwth as

⁷⁴ *op. cit.*, pp. 137-40.

⁷⁵ Greenhill, 'Technique', p. 122.

slides. In other words, the *crwth* slide has given rise to the concept of an expansion as a unit and prompted the designer of the tablature to include the diagonal lines to form a unit across columns. The interpretation also explains the choice of symbol: the diagonal line, indicating a gradual rise in pitch from the first note to the second, across, as it happens, a major second. And that is in musical sympathy with the fact that the expansions are resolutions: the resolutions on the *crwth* are achieved gradually, thereby lending them a greater dynamism than can be achieved on the harp.

Given, then, that slides appear to have been part of the lexicon of *cerdd dant*, the arguments for slides being the explanation of the *cysylltiadau* and of the connections shown in the diagrams are strengthened. The proposition here, then, is that whilst a *cywair* may well constitute a particular intonational setting on the harp and *crwth* each *cywair* - or at least those mentioned on pp. 108-9 - is associated with a particular set of *cysylltiadau* or slides as detailed in the pp. 108-9 diagrams.

The use of slides by the *crwth*'s thumb ought to give some indication of the nature of any slides in the upper part. All of the thumb slides are ascending, over a major second. To the chord expansions need to be added those instances where the lower part has not a chord but a single note with a diagonal line above it followed by a single note a second above (as at 60.2), where the diagonal line cannot connect the two because the two notes are, as with all single notes in the lower part, necessarily written in the same top row of the lower part. The totals are:

C-D	209
D-E	5
E-F	0
F-G	13
G-A	41
A-B	0
B-C	6

Thus the slide C-D might be expected to be the most probable or the most common connection to be found if we possessed diagrams for all five of the main *cyweiriau*. As it stands only one C-D connection is written in the diagrams, and 4 for G-A.

In respect of pieces on named *cyweiriau* the totals are:

bragod: C-D 101, G-A 24, B-C 2

<i>go</i> :	C-D	19
<i>cras</i> :	G-A	18
<i>uwch</i> :	F-G	4

The *cras gywair* piece involved here is the *clymau cytgerdd*, but once again that attribution appears to be contradicted, here by the expansion G-A not being borne out by the p. 108 diagram of the *cras gywair*. The *bragod gywair* alone contains three types of expansions, two of which appear in the *gogywair* and the *cras gywair* pieces, and that might be a reflection of the all-inclusive and mixed nature of the *bragod gywair* implied by the Dosbarth passage discussed above (in sections 3. & 17.). That the F-G expansion is unique to the *uwch gywair* and that the *go gywair* and *cras gywair* each contain only one type of expansion is some support for the proposition that there was an association in general between particular chord expansions and particular *cyweiriau*.

19. Assessment of the slides interpretation

On the slides interpretation of '*cysylltiad*' the slides are seen to be codified into sets which apply to a whole piece, rather than being left up to the discretion of the performer. That sort of organization, codification and prescription, of course, is typical of this tradition as a whole. If this system of articulation also applied to the fretless timpan, an ancient instrument, then it may have been equally ancient, allowing plenty of opportunity for it to become organized and codified over the centuries.

An objection to the slides interpretation should be raised. The description of the *gogywair* in *CDp MS 2.634* (Havod 24), p. 810 in the hand of John Jones, Gellilyfdy, 1605, is expressly for the *telyn*. Its instruction for the *gogywair* is to lower the third string above the *cyweirdant* by half a note. The passage is:

Llyma y modd i gyweirio y gogowair ar y delyn / pa son bynnac y bo y koweirdant yn y delyn kymryd y trydydd tant or tu uchaf a chyfri y kyweirdant yn un or tri, a gostwng hanner not ar yr ucha or tri.

This is the way of tuning?/setting?/adjusting? the *gogywair* on the harp. Whichever sound you chose as the *cyweirdant* on the harp take the third string above, counting the *cyweirdant* as the first of the three, and lower by half a note the highest of the three.

As discussed in 'Tuning',⁷⁶ if this brief and otherwise unsupported passage is historically accurate then for it to be reconcilable with the literal interpretation of

⁷⁶ Greenhill, 'Tuning', pp. 5, 31-32.

the tablature symbols it must refer to the flattening of B to B-flat. However, there is another possibility: that the passage does not describe the preparation of the setting of the *gogywair* on the harp but that it illustrates for the harper and the reader the action that creates the characteristic *sound* that was associated with the *gogywair*, a descending slide of a semitone. Note that if that was the case the otherwise puzzling instruction: "whichever sound you chose as the *cyweirdant* on the harp" becomes explicable because the harp offers not one but three strings per octave above which a major third can be lowered to a minor one, and for illustration purposes it would not matter which is chosen. If this was so it would be that the *gogywair* was the opposite of the *cras gywair*, in the sense that it contained descending slides across the two semitones in the diatonic series, or perhaps only between B-natural and B-flat as in *y lleddf gywair gwyddel* on p. 109. The latter is perhaps more likely, on a basis of G as the *cyweirdant* in this particular context.

That *cywair* is not wedded more closely to modality, as discussed above (in sections 3. & 13.), continues to be puzzling here with the slides interpretation. In Oriental modal music slides are, along with mode, very much part of what defines a particular maqam, nauba or raga. Each individual maqam etc. has its own particular slides, often determined by local tradition. But the use of slides in traditional double-tonic music in the British Isles is more independent of mode, in that normally a slide between two particular notes is commonly shared by several different modes. As regards the two intabulated pieces which are associated with a *cywair* diagram: the *clymau cytgerdd* and *Caniad Cadwgan*, the former has both the notes that on this interpretation are slid onto as *tyniad* notes, whereas the latter has F as *cyweirdant* and B as *tyniad*. Such a contrast in arrangement does not mean the interpretation has to be rejected but it does contradict the tendency for *cerdd dant* to have symmetrical relationships between *cyweirdant* and *tyniad*, both in harmonic theory and in actual melodic phrasing. But again, as discussed above (in section 9.), it needs to be mentioned that one or the other of these two pieces might have been wrongly associated with the *cras gywair*.

At the least, the probability that slides were used on the crwth means the slides interpretation of the diagrams merits serious consideration. The great difficulty of course is that apart from the *cras gywair* diagram none of the diagrams has any known association with any of the intabulated pieces, so investigation and assessment of any hypothesis concerning the diagrams is necessarily severely restricted. But in offering an explanation of the *graphical* connections shown in the diagrams between pairs of notes as *physical* connections on the crwth it is the most convincing and the simplest solution available. And our need to identify somewhere or other a plausible candidate for the *cysylltiadau* – the connections –

between *cyweirdannau* and *tyniadau* is satisfied by the interpretation. If slides were used on the crwth then surely there would have been a term for them, and moreover one which we should expect to occur in the Dosparth passage explaining the technical terms. '*Cysylltiad*' appears to be that very term: a slide does indeed connect one note to the next, and in the diagrams the connections are generally across seconds and therefore across *cyweirdant* and *tyniad* and *vice versa*, as described in the Dosbarth.

20. Discussion

The identification of the nominal tuning of the harp that lies behind the tablature symbols was a crucial step forward that has enabled insight into many other aspects of the original music, not the least of which has been the true depth and extensiveness of its tertian harmony, and as examined here that has a very strong bearing on the topic of intonation. But, unlike the topic of nominal tuning, it happens that no other significant aspects of the decipherment of the tablature are dependent on the adoption of any particular conclusions on the topic of intonation, for the fine tuning of the harp is an end-point rather than a way-station in the chains of logic involved in decipherment. For that reason I believe there is no urgency about arriving at any kinds of conclusive settlement on historical intonation in *cerdd dant*. The study needs to advance in tandem with future advances in the understanding of historical intonation in other medieval traditions in Europe, particularly Insular vocal polyphony.

An understanding of the acoustic signatures of metal-strung harps is another evolving area that relates closely to the topic of intonation in *cerdd dant*.⁷⁷ The sustain and the sympathetic resonance sets up a 'halo' of sound from the other harmonic stack of thirds that surrounds the harmonies of the stack that is in progress. For example, where a *tyniad* digit is followed by a *cyweirdant* one there will be: a) residual sustain during the *cyweirdant* digit arising from: i) any *tyniad* strings that were played but have not been damped and ii) sympathetic resonance from any *tyniad* strings that were excited by those that were played and have not been damped, and b) fresh resonance arising during the *cyweirdant* digit that comes from any *tyniad* strings that are played during the *cyweirdant* digit: i) whilst those strings sound and also, if they are not damped, ii)

⁷⁷ For valuable recent advances concerning the three earliest surviving metal-strung harps see: Karen Loomis, 'The Lamont and Queen Mary harps', *Galpin Society Journal* LXV, 2012, pp. 113-29; Paul Dooley, 'Reconstructing the medieval Irish harp', *Galpin Society Journal* LXVII, 2014, pp. 107-142; Karen A. Loomis, 'The organology of the Queen Mary and Lamont harps', PhD thesis, University of Edinburgh, 2015; Paul Dooley, 'The harp in the time of Giraldus' in *Harp Studies*, ed. Sandra Joyce & Helen Lawlor (Dublin, 2016), pp. 32-56.

sympathetic resonance on other *tyniad* strings excited by those that have been sounded and iii) a little sympathetic resonance from some *tyniad* strings which have been excited by the *cyweirdant* strings that are played. Even in the upper registers a strong halo can quickly mount up, as at the *cyweirdant* at 76.5.16-20 where the two Ds bring in *tyniad* tones which – like D itself – are alien to the *cyweirdant* stack. The second D is undamped. Those two Ds are not really essential to the melody or to its rhythm: two Cs would have been adequate, so part of the intention here was to create and no doubt savour the strong halo. That is to say that despite all the damping measures that were standard and which create harmonic ‘hygiene’ in respect of *cyweirdant* and *tyniad*, the halo was something that was not undesirable but an accepted feature in its place and one that was attended to. For that reason I choose to term the effect ‘halo’ rather than ‘interference’. Some degree of halo is an essential component of the instrument’s timbre. The significance of the halo for intonation is that it throws significance onto particularly the interval of the major second: the interval that most strongly relates *tyniad* to *cyweirdant*. The purity and uniformity of the 9/8 major tones of Pythagorean intonation favour the halo effect most. It is difficult to assess the relative merits of justly-intoned tunings and meantone tunings in respect of the halo: 5-limit just intonation involves purity – 9/8 major whole tones and 10/9 minor ones – but lacks uniformity in its major seconds; meantone (by definition) has uniformity but lacks purity; partial meantone tunings have neither uniformity nor purity in their major seconds and so here the halo comes closer to the concept of interference. As to how significant a factor the halo may have been in practice, that is almost entirely dependent on what the design features of the harps of the tradition and their stringing were. Important here is the fact that all the damping that was standard in *cerdd dant* technique means that generally a strong halo was not desirable, so it is highly unlikely that harps were designed in such a way that would actually maximise the strength of the halo wherever it was allowed to build up. The optimum amount of resonance would not have been the maximum that can be achieved in design.

A close examination of chord progressions, particularly in cadences, has great potential for helping discriminate between different intonations and their appropriateness. For example, the common closing cadence I A along with its relatives⁷⁸ throws up a prominent difference between the partial 1/3-comma meantone tuning and the 1/2-comma one for the C-mode. The chords involved are *a'-a''-c''*, *d'-f'-b''*, *g'-g''-c''*. Both tunings produce the final chord as just and the intermediate one as impure but the 1/3-comma tuning produces the first chord as impure whereas the 1/2-comma tuning gives it as just. Musical logic

⁷⁸ See Greenhill, ‘Melodic Formulas’, pp. 227, 232 and in the manuscript at 66.1.1-13; 72.6.6-9; 76.5.5-8; 85.3.3-6; 91.2.1-4 etc., & Greenhill, ‘Technique’, pp. 76-8.

suggests that the first chord, even though it is the first chord of a *cyweirdant* digit, should here be impure, to highlight the resolution onto the purity of the final chord, and indeed the need for that is underscored by the impurity of the intervening chord. It should be expected, then, that the tradition, as a point of finesse, would have generally preferred amongst the two the 1/3-comma tuning for the pieces involved.

Probably the most fruitful advances from elsewhere for achieving greater clarity in respect of harp intonation should be expected from the field of *crwth* technique. For as long as the *Dosbarth* passages on *crwth* fingering (discussed above in sections 3. & 17.) remains as obscure as they do I believe it will be unrealistic to claim any substantial areas of certitude in respect of harp intonation, unlike its nominal tuning. The intabulated pieces and how they were played are well understood and the music that results is comprehensible today both to the ear and to the intellect, and *cywair* as intonation is a proposition that offers explanations of several of the more obscure aspects of the vernacular theory,⁷⁹ yet there may still be much that remains to be revealed about how the tradition viewed itself in terms of its own music theory, especially in the passages on *crwth* fingering.

The topic of musical expression in *cerdd dant* is of course closely bound up with that of intonation. The points have been made here that 1/4-comma meantone favours the major thirds of predominantly major pieces, that 1/3-comma meantone favours the minor thirds of predominantly minor pieces and that 2/7-comma meantone smoothes out those differences and accordingly may be appropriate for those pieces which appear to be soothing in nature. One possibility, then, amongst the myriad possibilities concerning the historical relationship between intonation and expression is that the medieval division of instrumental string music in Ireland into three according to mood and intention could have manifested at one time simply as these three degrees of meantone tempering, such that *geantraí*, appropriate for feasting, used 1/4-comma meantone, *goltraí*, appropriate for lamenting, used 1/3-comma meantone and *suantraí*, appropriate for sleeping, used 2/7-comma meantone. Some pieces in the manuscript are recorded as elegiac *marwnadau* but the classification by mood of the remainder is a matter of complex deduction which continues to evolve with the passage of time.⁸⁰ So my opinion is that it would be premature to draw any conclusions at this point as to whether the merits of such a simple system

⁷⁹ Greenhill, 'Tuning', pp. 92-3.

⁸⁰ Peter Greenhill, 'The Robert ap Huw Manuscript: an exploration of its possible solutions: Synopsis', 1995, p.18, <<http://www.cl.cam.ac.uk/~rja14/musicfiles/manuscripts/aphuw/aphuw-s.pdf>>.

outweigh those of the partial meantone temperaments introduced above that deliver just cadences. However, with the introduction here of the partial meantone temperaments it should be that the field of proposed intonational tunings is now sufficiently broad that we can be confident that the original intonations lie within that field.

As ever with the subject of historical intonation, there is a need for caution. The modern satisfaction with the fact that 'Western' ears today are generally most attuned to the substantially wide major thirds and narrow minor thirds of equal temperament means that nothing can be absolutely ruled out on the sole basis of a claim that an intervallic impurity of above any certain size could never have been found tolerable, including the thirds of Pythagorean intonation and the fifths which are impure amongst those of the just-intonational tunings. Since some impure intervals, of some degree of impurity, must necessarily sound when these pieces are played on the fixed-intonation diatonic harp it has been argued here that those impurities are most likely to have been distributed in a piece in a controlled way such that there is a regularity, a predictability, a *meaningfulness* to their positioning and not a randomness, an imbalance nor an erraticism. Weight has been given here to three factors: justness in cadential closing chords, a greater degree of justness in *cyweirdant* chords at the start of digits than in *tyniad* ones, and the occasional purposeful violation of that rule in *marwnadau*. But the relative weighting of those three factors is an extremely delicate, complex affair, even aesthetically not only historically. That is particularly the case with the strength of the intonational contrast between *cyweirdant* and *tyniad*, as regards between first-order partial 1/3-comma meantone temperaments and second-order partial 1/2-comma ones, as discussed in section 10. above, and between both of those and 2/7-comma meantone in respect of modulating pieces, as discussed in section 8. above. It may very well be that there are better combinations of weightings of these three factors to be arrived at, either aesthetically or historically, than those set out here, or that there are additional factors that should be included which await identification.

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