PART 1

Exposition

'You must take measurements. And you must square out your paper.'
– W. Somerset Maugham

Chapter 1

Proportional structure and the Golden Section

Proportional balance in any piece of music is something we tend to take instinctively for granted – provided it is instinctively satisfactory. If a painting or building is clumsily proportioned, any sensitive observer can see the fact in an instant; in music, though, we have to hear the piece through to make the equivalent evaluation. Nevertheless, this aspect is equally vital in music, whether the composer applied it merely by instinct or by careful design. Most experienced listeners know the instinctive feeling of either sluggishness or breathlessness that results from a musical framework, or a part of one, too large or too small to contain its musical argument or to balance its surrounding formal sections. This reminds us that it is not just the mathematical proportions themselves that matter, but also whether they are well matched to what they contain.

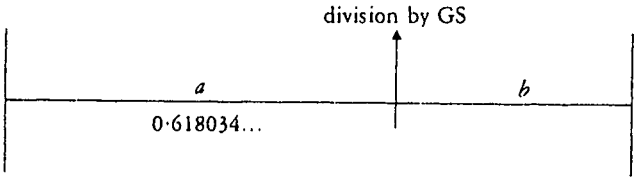
When this twofold balance sounds well managed, how did the composer achieve it? – purely by instinct, by design, or by a mixture of the two? Whatever the answer, can the resulting sense of coherence be matched with any demonstrable system of architecture in the music? – a question of special interest with music which, like much of Debussy's, diverges radically from conventional musical forms.

Some answers to those questions have prompted the writing of this book. The primary one is the discovery that much of Debussy's music contains intricate proportional systems which can account both for the precise nature of the music's unorthodox forms and for the difficulty in defining them in more familiar terms. Most important of all, they show ways in which the forms are used to project the music's dramatic and expressive qualities with maximum precision. These systems are based principally on two ratios traditionally associated with formal balance in many fields of art and science: exact symmetry or bisection, as achieved by dividing into halves; and the ratio known as the Golden Section.

As the concept of Golden Section is central to this book, some explanation of it is apt here. Recognized since ancient times as important in architecture, painting and natural organic growth, the Golden Section (Golden Mean, Golden Ratio –

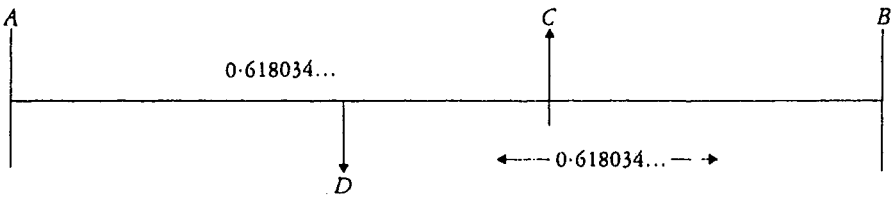
henceforth 'GS') is the way of dividing a fixed length in two so that the ratio of the shorter portion to the longer portion equals the ratio of the longer portion to the entire length. In mathematical terms, $\frac{b}{a} = \frac{a}{a+b}$. Fig. 1.1 shows this. The ratio's exact value is irrational, its decimal places continuing indefinitely; it approximates to 0·618034... (a little under two-thirds) of the length measured.

Fig. 1.1: Golden Section



Its special characteristic is shown in Fig. 1.2. *C* divides the line *AB* by GS; *D* is then added to divide *AC* by GS. But in doing so, *D* also divides the whole length *AB* by GS in the other direction, the shorter portion lying to the left. No other ratio has this property. The system of Fig. 1.2 can be extended inwards and outwards by GS with similar results, producing a network of interlocking GS divisions in both directions, and this is the main reason not only for the special place of GS in Classical mathematics (particularly as Euclid's 'extreme and mean ratio') but also for its importance in organic structuring.[1]

Fig. 1.2



The irrational value of GS can be expressed in a more manageable way. It is *approached* more and more closely by the ascending numbers of the 'Fibonacci' summation series 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144... Each number in this series, as well as being the sum of the previous two terms, gives the nearest whole number to the GS of its two neighbouring terms in the series. For example, 34 × 0·618034 = 21·013...; 34 ÷ 0·618034 = 55·013... Indeed, any summation

1. F. Lasserre (1964, 76–106) traces the importance of GS in Classical mathematics. Its role in nature is documented by A. H. Church (1904), S. Colman and C. A. Coan (1912; 1920), T. A. Cook (1903; 1914) and D'A. W. Thompson (1917), who list examples ranging from snail shells to sunflowers, pine cones and catkins.

The exact value of GS, also traditionally represented by the Greek letter ϕ, is $\frac{\sqrt{5} \pm 1}{2}$; the plus value gives 1·618034... (GS by extension) and the minus value gives 0·618034... (GS by division). The two numbers are reciprocals: $\frac{1}{1{\cdot}618034} = 0{\cdot}618034$ and vice versa.

series in which each term is the sum of the previous two terms approaches nearer and nearer to a geometric series with its successive terms linked by GS. Thus we can start, for example, by adding 1 and 3, producing the series 1, 3, 4, 7, 11, 18, 29, 47, 76... The ratio 1:3 is far (0·3333...) from 0·618034; 3:4 is less so (0·75), 4:7 better (0·5714...), 7:11 better yet (0·63636...), 11:18 already accurate in its first two decimal places (0·6111...) and so on. From 4, 7 upwards that series gives nearest whole numbers to GS.[2]

Fibonacci's series also provides a simple way of calculating the GS of any number (demonstrated on page 7 below), so that no great mathematical skill is needed to manipulate numbers in this way. This prompts the question of whether the proportional patterns in Debussy's music were designed consciously or intuited subconsciously, a question discussed more in the following pages. Whatever the case, one's attention is attracted by how often well-defined sections in Debussy's music follow Fibonacci's numbers at strategic places – the 55 bars of introduction to the last movement of *La mer*, the 21 bars of introduction to 'Rondes de Printemps' from the orchestral *Images*; the 34 bars comprising the first 3/8 section of *Jeux*; the 34 bars of build-up to the climactic coda of *L'isle joyeuse* (bars 186–219 –pages 219–20 below), and likewise to the recapitulation of *Masques* (bars 236–69); the first reprise in 'Reflets dans l'eau' after 34 bars and the beginning of its climax after 55 (pages 196–8 below). The following chapters trace many more examples, relating them musically and proportionally to what surrounds them.

Lucid and objective general surveys of GS, its history and use in the visual arts, and the varying attitudes taken towards it at different times, are provided by P. H. Scholfield (1958) and R. Wittkower (1949; 1960). One of the best-known modern applications of GS is the Swiss-French architect le Corbusier's 'modulor', first announced in 1948, a GS-based architectural grid produced by extending the GS system of Fig. 1.2 above to follow the vertical proportions of the human body. Le Corbusier was anticipated earlier this century by two writers in particular, Matila Ghyka and Jay Hambidge, who produced numerous volumes on the Golden Section (listed in the Bibliography below), basing their theories on artistic and archaeological evidence, and in some cases on esoteric traditions. Hambidge's arguments were not all watertight, and the enthusiasm his theories roused in some circles was equalled by the disparagement they suffered in others, the arguments for and against sometimes showing more passion than reason. GS had earlier taken a place in the theories of the German scientist, psychologist and parapsychologist extraordinary Gustav Fechner,

2. The Fibonacci series takes its nickname from that of the medieval mathematician Leonardo da Pisa (1170 – 1250), known to his contemporaries as 'Figlio Bonaccio' (son of Bonaccio), and instrumental in establishing the use of Arabic numbers in Europe. The 3, 4, 7. . . series is known as the Lucas sequence, after the nineteenth-century French mathematician Edouard Lucas; it has a simple relationship to the Fibonacci series in that 11 = 3 + 5 + 3, 18 = 5 + 8 + 5, 29 = 8 + 13 + 8 and so on, allowing the two sequences to coincide and interact. The importance of this will be seen in the following chapters.

whose work, as we shall see later, was known to the French Symbolists with whom Debussy associated in early years. Fechner's attempts (1876) to prove an instinctive visual preference for GS were discredited after his death, when it was found he had suppressed some possibly contradictory evidence; but recently I. C. McManus (1980) has, to his own surprise, partly vindicated Fechner.[3]

There is no doubt, though, about how significant a role GS plays in organic nature. Indeed one of Hambidge's severest critics was the same Theodore Cook (1922) whose treatises on GS in organic nature (1903; 1914) are still standard reference works. Whatever the whole truth is about GS in art and psychology (and the field has not been one monopolized by the most objective of investigations), if GS is seen to be consistently present, and above all influential, in the musical forms analysed here, it calls for study, whether it came about through instinct, design or both.

Golden Section in musical forms

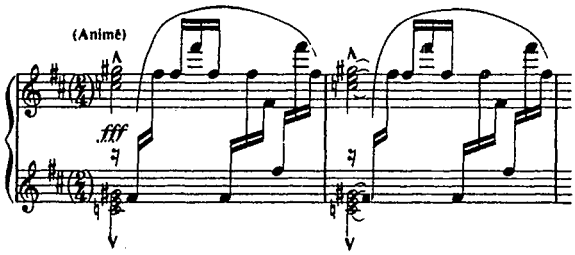
One of the clearest applications of GS in Debussy's music occurs in the two sets of piano *Images* of 1905 and 1907. In 'Reflets dans l'eau' (reproduced on pages 194–200 below), the first of the 1905 set, the principal climax, at bars 56–61, lies symmetrically over the piece's overall point of GS (after 58 bars out of a total of 94 – it makes only about 1% overall difference to the calculation whether or not one allows for the digressions from the predominating 4/8 metre in bars 11 and 23). If this example lacks immediately obvious precision, 'Mouvement', the third of the 1905 *Images*, is less ambiguous, with a sharply focused principal climax in bars 109–10, again placed precisely over the overall point of GS in the middle of the bar 110 (Ex. 1). 'Cloches à travers les feuilles', the first of the 1907 *Images*, is even more precise, with only half a bar of *fortissimo* at its climax, again exactly at the point of overall GS (in the second half of bar 31, also shown in Ex. 1 – remembering that bars 9, 11, and 15, in 2/4, count as half the value of the surrounding 4/4 bars). All three pieces begin and end quietly, giving maximum force to their dynamic shapes.

Three out of six *Images* make a sufficiently high tally to prompt closer attention, both to the music and to the questions that naturally follow. Does it signify anything worthwhile in musical terms? If so, what about the other *Images* whose climaxes are not thus placed? In the pieces mentioned, are the GS climaxes proportionally isolated, or might they involve more complex proportional networks?

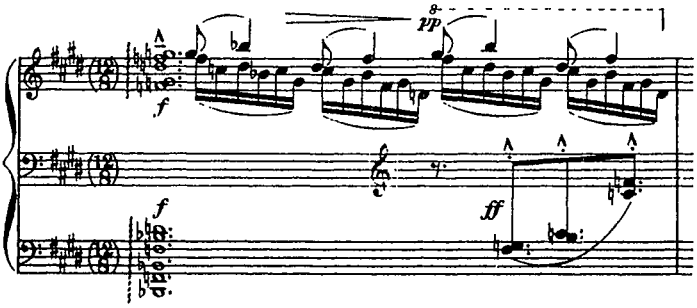
The three questions are most easily answered in reverse order. As already suggested, these musical climaxes are also the structural climaxes of intricate

3. Dr McManus's conclusions, based on much more sophisticated experimental equipment and thorough analysis than were available to Fechner, are the more remarkable in view of his initial expectation (communicated to me in conversation) of disproving Fechner.

Ex. 1
(a) 'Mouvement', bars 109–10



(b) 'Cloches à travers les feuilles', bar 31



proportional systems which, when analysed, account for the sequence and positioning of all the important musical events in the pieces involved. The system of logic revealed by these analyses can then account in equal detail for the forms of the remaining *Images* and other works by Debussy. The musical significance of all this is discussed throughout the present book: Chapter 2 discusses the analytical techniques involved, and detailed proportional analyses follow from Chapter 3 onwards.

Two other fundamental questions follow. Of these the first – whether the proportional schemes were the result of conscious design or purely of a highly refined subconscious instinct – is discussed at various stages of this book. To the second question – whether or not this technique was unique to Debussy – a more immediate answer presents itself in the form of a number of proportional studies of the music of various composers. Among the many such studies that seek or find only approximate proportions,[4] there are a few significantly accurate or comprehensive discoveries: for example, Marcus van Crevel's astonishingly complex numerological analyses (1959; 1964) of two masses by Obrecht, some of which findings are paralleled by Brian Trowell's recent work on Dunstable

4. J. H. Douglas Webster (1950) and C. Pascoe (1973) cover the widest ranges of composers from this aspect, though their methods of analysis severely limit what they can positively conclude. They are discussed in more detail, together with a number of other proportional investigations, in Howat (1979), Chapters 1 and 2.

(1979); various types of proportion found by John Rutter (1975) in music by Haydn, Mozart and Beethoven; and, though not always quite accurate, Ernő Lendvai's proportional analyses (1971) of Bartók's music. Lendvai's findings are the more striking here in view of Bartók's admiration for Debussy's music.[5] Some precise proportional structures in music by other composers are shown briefly in Appendix 2 below, which also lists some more existing proportional analyses in music. In the main, though, this book restricts itself to Debussy, not only for reasons of space but also because the techniques involved will be seen to be crucial to Debussy's style – whether he was consciously aware of them or not.

This brings us back to the first question, still unanswered, of Debussy's awareness or otherwise in proportional matters. Full discussion of this is reserved until Chapter 11, since much of the most important musical evidence will emerge only in the intervening analytical chapters. Suffice it here to mention two basic pieces of evidence, one general and one specific.

First, none of Debussy's surviving manuscripts contains any signs of numerical calculations concerning structure.[6] This however is inconclusive, and also not surprising. Most of these manuscripts are the final copies given to the engraver; an artist as meticulous as Debussy was over the visual presentation of his scores – both manuscript and printed – would hardly have been so unprofessional as to deliver his finished product with scaffolding still attached. In any case these final copies are mostly third or fourth drafts of the works concerned, by which stage their forms would be well established.[7] Apart from these final copies, only a very small number of sketches have survived. Debussy is known to have destroyed the large majority of his sketches, and, while that proves neither side of the question, it could be conjectured that the few sketches which remain are those that divulge no secrets – a person as secretive as Debussy being especially unlikely to allow himself to be seen in such a compositional state of undress. No firm conclusion can therefore be drawn from the above.

The second, more positive piece of evidence is a letter of August 1903 from Debussy to his publisher Jacques Durand. Returning the corrected proofs of the *Estampes*, Debussy writes:

> You'll see, on page 8 of 'Jardins sous la pluie', that there's a bar missing – my mistake, besides, as it's not in the manuscript. However, it's necessary, as regards number; the

5. Similarities in procedure between the two composers are documented in Howat (1977; 1983).

6. The numbers found on some of the drafts in short score for his orchestral works (for example, that of *La mer*, a manuscript discussed in Chapters 6–9 below) refer to the proposed (and actual) pagination of the full scores he prepared from the short scores. In this sense at least, he took his measurements and literally squared out his paper (cf. page 1 above).

7. See Debussy (1927) pages 18, 20, 140, 155 and 156 for some of Debussy's own allusions to the extent to which he recopied his works. For example, at his death were left four complete autograph manuscripts of *Jeux* (one of them now untraced since being auctioned by Emma Debussy in 1933).

divine number [*elle est nécessaire, quant au nombre; le divin nombre*], as Plato and Mlle Liane de Pougy would say, each admittedly for different reasons.[8]

This leaves no doubt that at least on that occasion Debussy was consciously constructing with numbers. Tantalizingly, the exact terms are left unspecified; *divin nombre*, however, is more likely to signify *nombre d'or*, the usual French term for GS, than any other known possibility – particularly since 'Jardins sous la pluie' is indeed built on a GS–symmetrical pattern, one whose maximum accuracy depends on the bar added to the proofs by Debussy. Moreover, the bar in question (bar 123, missing in the autograph)[9] is not essential to the music's grammatical sense, being merely a repetition of the previous bar. (Ex. 2 quotes both the manuscript and printed versions of the passage; the piece's proportions are investigated in Chapter 10 below.) Debussy's concluding banter, characteristic of his correspondence, does not demean the passage's significance; otherwise rather inexplicable in the context, it could be an attempt to mask his self-consciousness at raising the subject at all. Even if this piece of evidence is not absolutely conclusive, Debussy's statement certainly gives us good reason for investigating numerical possibilities in his musical forms.

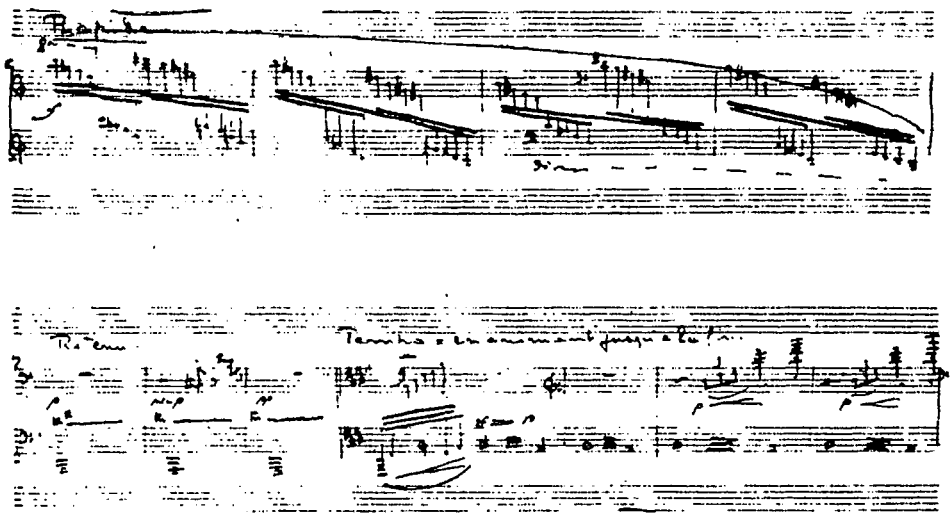
Debussy would have had ample opportunity to learn about GS through his constant associations with painters and other artists; that interest in GS was endemic in the visual arts at that time is documented by the exhibition in Paris by the *Section d'or* (Golden Section) group of painters in 1912. This is all discussed more fully in Chapter 11, along with other possible ways in which Debussy's attention could have been drawn to proportional techniques in art. It is worth saying straight away, though, that number and proportion were ideas much in circulation among the French Symbolist artists with whom Debussy mixed in his formative years.

It need hardly be added that Debussy has never before enjoyed fame as a mathematician. But, as mentioned on page 3 above, there is an easy way of finding the GS of any number, by breaking the number down into Fibonacci components. Thus a number chosen at random, for example 347, can be broken down into 233 + 89 + 21 + 3 + 1; GS of this by Fibonacci procedure is 144 + 55 + 13 + 2 + 0·6 = 214·6. 347 × 0·618034 by long division yields 214·45... Other random examples are 66 which yields 41 and 40·79... respectively by the two methods, and 86 which yields respectively 53 and 53·15... Obviously the Fibonacci method is reliable easily to the nearest whole number, which is as near

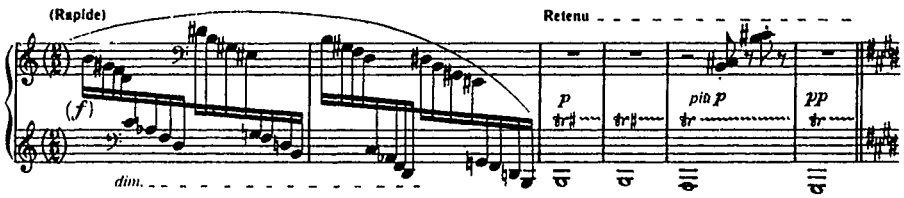
8. Autograph letter in the archives of Durand et Cie; published in Debussy (1927, 10). Liane de Pougy (diplomatically rendered in the published version as 'X. de Z.') was a well-known Parisian *demi-mondaine*. *Le divin nombre* as applied to her suggests a pun on the expression connoting 'the divine few' or 'the elite' (synonymously *le nombre des élus*), which would be consistent with her *demi-mondaine* reputation. By an odd coincidence, in later life she married a relation of Matila Ghyka.

9. Music department of the Bibliothèque Nationale, Paris: Ms. 988. This, the only known autograph of the three *Estampes*, is the manuscript used by the engraver. The extract reproduced in Ex. 2 forms the last system on page 4 and the first on page 5 of 'Jardins sous la pluie'.

Ex. 2: 'Jardins sous la pluie',
(a) Bars 118ff reproduced from Debussy's autograph (by courtesy of the Bibliothèque Nationale, Paris)



(b) Bars 120–5 of the printed version after Debussy's proof alteration



as musical notation can approach anyway. Edward Lockspeiser's definitive work on Debussy (1962; 1965) has probably destroyed any lingering notions of the composer as an anti-intellectual who eschewed understanding of what he was about. Dreamer in a more special sense he was, but one knowledgeable about an enormous range of subjects, and with a mind of exceptional retentive power. It would be less than reasonable, then, to consider him incapable of the elementary addition and subtraction involved in the above method of calculating GS. Whether or not he consciously did so is of course another question, as yet undecided. But the point here is that the possibility cannot be ruled out on technical grounds.

Similarly, the idea of Debussy using such scientific means of formal regulation (consciously or not) is quite compatible with his known distaste for musical *formules*. Taken exactly (and especially in French usage), a formula is a prescribed

method, convention or recipe – a definition applicable to such constructions as fugue, sonata form and so forth. Debussy's own use of the word – for example, 'la formule wagnérienne' in an article of 1902 (Debussy, 1971, 61) – confirms this. By contrast, GS is a natural principle, like the harmonic series, whose physical existence antedates mankind. As such it would hardly be disregarded by Debussy, were he aware of it. When he wrote, more than once, about his musical 'search for a world of sensations and forms in constant renewal', his aim was evidently to free music from rigidly stereotyped forms.[10] At the same time his concern for proportional balance within his formal freedom is well documented in his own writings – the most notable example being the second piece of *En blanc et noir*, in which he restored to the proofs a long passage previously cut from the manuscript, explaining to Jacques Durand (Debussy, 1927, 143) that 'concern for proportions absolutely demanded this change'.[11]

Two objections are sometimes raised to the idea itself of investigating proportional coherence in musical form. The first is the opinion that such coherence merely springs from a fairly ubiquitous proportional instinct, and is thus banal or unimportant. The second is the opinion that the human mind cannot instinctively evaluate precise temporal proportion on such a scale, and thus that such proportional plans are musically irrelevant. Clearly both objections cannot apply at once, as they are mutually exclusive. If, on the one hand, such precise and logical proportional schemes are indeed a result purely of instinct, then the existence of this instinct is proved (at least on the composer's part, even if it may be less developed in many listeners). If, on the other hand, such instinct does not exist, then the structures can only have been designed intentionally. (It will be seen that they are too comprehensive and accurate for there to be any possibility of their being merely fortuitous.) But for Debussy, of all composers, instinct and design would never have been so arbitrarily detached: it is a safe assumption that any conscious compositional techniques, proportional or otherwise, would have been used for ensuring maximum accuracy in the music's instinctive effect – and that they would be rejected unless the musical results felt instinctively correct to him. That is to say, if Debussy designed such schemes consciously, the implication must be that he also believed in a corresponding proportional instinct.

But scepticism from both the reader and the analyst is a healthy safeguard against jumping to conclusions; in the matter of proportional analysis it is the more understandable in view of rampant inaccuracy in many existing studies on the subject. It is essential therefore to define the methods by which the following

10. 'La recherche d'un monde de sensations et de formes incessamment renouvelé' (Debussy, 1971, 56 and 114).

11. The superseded shorter version can be found in the autograph copy (Music department of the Bibliothèque Nationale, Paris: Ms. 989). Other examples of Debussy's sensitivity to proportion are his Cello Sonata, of which he wrote in 1915: 'J'aime les proportions et la forme presque classique, dans le bon sens du mot' (Debussy, 1927, 142); and a review in which he praises Lucien Capet's *Poème* for Violin and Orchestra: 'La liberté de sa forme n'en contrarie jamais l'harmonieuse proportion' (Debussy, 1971, 220).

analyses and measurements are to be undertaken, what degree of accuracy is to be sought as acceptable, and precisely what the analyses can tell us about the music. To this the next chapter is devoted.

One other danger has to be guarded against. Proportions can too easily become the type of study where one finds whatever one wants by looking hard enough. The main safeguard against this is constant vigilance with regard to the musical logic of the systems discovered here, and the light they cast on other structural aspects. That many of Debussy's early works betray *no* sign of any proportional systems, even after exhaustive examination, is of additional reassurance here that the schemes found in the more mature works are not merely wishful analytic thinking. Those musical structures without any detectable proportional schemes are investigated and discussed in Chapter 4.

A more positive corroboration can be added. In the mature works whose proportional systems are analysed, it will be seen that the systems are comprehensive to the extent that not a single significant musical event in any of the pieces defies their logic or lies outside them. The proportional structures will also be seen to have maximum possible accuracy in musical terms: in the case of any small inaccuracy there is always a musical reason – and sometimes another proportional one – why the system could not be made more accurate. In this regard the following chapters discuss some last-minute changes Debussy made to scores – in one case after publication – all of which improve proportional accuracy. An example already seen is the bar he added to 'Jardins sous la pluie', specifying number as the reason. Therefore proportional structure in Debussy's music is not theory but demonstrable fact. The element of hypothesis concerns only how aware Debussy was of it, and, if aware, his reasons for using it.