

University of Southampton Research Repository ePrints Soton

Copyright © and Moral Rights for this thesis are retained by the author and/or other copyright owners. A copy can be downloaded for personal non-commercial research or study, without prior permission or charge. This thesis cannot be reproduced or quoted extensively from without first obtaining permission in writing from the copyright holder/s. The content must not be changed in any way or sold commercially in any format or medium without the formal permission of the copyright holders.

When referring to this work, full bibliographic details including the author, title, awarding institution and date of the thesis must be given e.g.

AUTHOR (year of submission) "Full thesis title", University of Southampton, name of the University School or Department, PhD Thesis, pagination

THE APPLICATION OF NUMERICAL METHODS TO THE TAXONOMY OF SPERMATOPHYTES

with evaluation of the taxonomic implications of the results

by

David John Young

Thesis submitted for the Degree of Doctor of Philosophy

University of Southampton

Botany Department

August 1969

CORRECTIONS

Page	Line	Error	Correction
v	2	ANALSES	ANALYSES
5	10	Engler	Melchior
24	1	Willis	Airy-Shaw
60	16	at eigh	the eight
69	1	absence	absent
143	10	Cucrubitaceae	Cucurbitaceae
162		GUTTIFFERAE	GUTTIFERAE

ABSTRACT

FACULTY OF SCIENCE

BOTANY

Doctor of Philosophy

THE APPLICATION OF NUMERICAL METHODS TO THE TAXONOMY OF SPERMATOPHYTA

by David John Young

543 genera of Dicotyledons are recorded for available comparative data on floral and vegetative morphology, anatomy, cytology, palynology and embryology, and this is analysed under three different numerical methods (INFO, ASOC and MULASS). A comparison of the results throws light on the high-level taxonomy of Dicotyledons: the currently unfashionable polypetalous/sympetalous dichotomy is strongly supported by all analyses and on the basis of available evidence seems a fully justified primary division of the group. Within the polypetalous subgroup 'magnolioid', 'caryophylloid' and 'celastroid' circles of affinity are recognised, but equally significantly many genera cannot be satisfactorily placed on the basis of the information despite their apparent positions in most published systems, suggesting a desperate need for more careful examination and recording of features to allow a taxonomic reassessment at this level. The smaller and more closely defined sympetalous grouping is split into the 'Asclepioids', 'Acanthoids', Compositae and Umbelliferae.

Pilot analyses on anatomical data for hardwoods and softwoods are also considered. In the former case the interrelationships

of the three subfamilies of Leguminosae are questioned, The Caesalpinioideae, regarded by phylogenists as the most primitive, appear in terms of wood anatomy to be 'intermediate' between the Mimosoideae and Papilionoideae, confounding the phylogenetic ideas. In the case of the softwoods a hitherto unsuspected major dichotomy between the Pinaceae and the remaining families is suggested and supported by external evidence; within the latter grouping the geographic split into northern and southern forms, originally based on fossil evidence, is backed up anatomically.

CONTENTS

	Page
<u>INTRODUCTION</u>	1
HIGH LEVEL TAXA OF SPERMATOPHYTA	1
THE CONIFERALES s.l.	3
THE DICOTYLEDONS	5
AIMS OF THE PRESENT INVESTIGATION	13
<u>NUMERICAL METHODS</u>	18
CODING OF DATA	18
CHOICE OF PROGRAMS	20
<u>ANALYSES OF DICOTYLEDONS</u>	23
SAMPLING OF INDIVIDUALS AND CHARACTERS	23
SELECTION OF INDIVIDUALS	23
SELECTION OF CHARACTERS	24
Habit	26
Leaf	26
Stem	28
Flower	29
Seed and Fruit	33
CODING	34
RESULTS OF THE ANALYSES	35
THE MAJOR DICHOTOMY	39
THE 'CRASSINUCELLI'	40
The 'Caryophylloids'	41
The 'Magnolioids'	45
(a) General Discussion	45

	Page
(b) Some Sub-groupings of the 'Magnolioids'	48
(c) The Genus Piper	50
Review of the Treatment of the Members of the Dilleniidae	51
The Rosidae	51
(a) The Leguminosae and the Order Rosales	53
(b) The 'Celastroid' Circle of Affinity	54
Families of Uncertain Position	56
(a) Betulaceae, Fagaceae and Platanaceae	56
(b) Rosaceae, Saxifragaceae s.s. and Crassulaceae ..	56
(c) Thymeleaceae and Proteaceae	57
(d) Santalaceae and Loranthaceae	57
(e) Umbelliflorae	58
(f) Myrtaceae, Melastomataceae and Onagraceae ..	58
THE 'TENUINUCELLI'	59
The Main Sub-division of the 'Tenuinucelli' into	
'Asclepioids' and 'Acanthoids'	60
(a) Families Seemingly Related to the 'Asclepioids'	60
(b) Families Seemingly Related to the 'Acanthoids'	62
(c) Families Seemingly Intermediate between the	
'Asclepioids' and 'Acanthoids'	62
(d) The Interrelationships among the Central	
'Asclepioids'	64
(e) The Interrelationships among the Central	
'Acanthoids'	65
The Compositae	65
The Umbelliferae	66

	Page
<u>ANALYSES OF HARDWOODS</u>	120
THE DATA AND THE ANALSES	120
THE DICOTYLEDONOUS HIERARCHY	121
THE LEGUMINOSAE	121
<u>ANALYSES OF SOFTWOODS</u>	129
THE DATA AND THE ANALYSES	129
RESULTS OF THE ANALYSES	129
DISC ELECTROPHORESIS OF CONIFERS	133
<u>CONCLUSIONS</u>	142
METHODOLOGICAL	142
TAXONOMIC	143
<u>ACKNOWLEDGEMENTS</u>	146
<u>REFERENCES</u>	147
<u>APPENDICES</u>	156

INDEX TO FIGURES, TABLES AND DIAGRAMS

								Page
Figure 1	..	..	..	..	..	..	..	2
Figure 2	..	..	..	..	..	..	..	15
Figure 3	..	..	..	..	..	..	..	117
Figure 4	..	..	..	..	..	..	..	118
Figure 5	..	..	..	..	..	..	..	119
Figure 6	..	..	..	..	..	..	..	141
Table 1	..	..	..	..	..	..	..	16
Table 2	..	..	..	..	..	..	..	68
Table 3	..	..	..	..	..	..	..	76
Table 4	..	..	..	..	..	..	..	88
Table 5	..	..	..	..	..	..	..	90
Table 6	..	..	..	..	..	..	..	91
Table 7	..	..	..	..	..	..	..	94
Table 8	..	..	..	..	..	..	..	97
Table 9	..	..	..	..	..	..	..	99
Table 10	..	..	..	..	..	..	..	100
Table 11	..	..	..	..	..	..	..	101
Table 12	..	..	..	..	..	..	..	102
Table 13	..	..	..	..	..	..	..	103
Table 14	..	..	..	..	..	..	..	103
Table 15	..	..	..	..	..	..	..	104
Table 16	..	..	..	..	..	..	..	106
Table 17	..	..	..	..	..	..	..	109
Table 18	..	..	..	..	..	..	..	112
Table 19	..	..	..	..	..	..	..	113
Table 20	..	..	..	..	..	..	..	115
Table 21	..	..	..	..	..	..	..	125
Table 22	..	..	..	..	..	..	..	126
Table 23	..	..	..	..	..	..	..	127
Table 24	..	..	..	..	..	..	..	135
Table 25	..	..	..	..	..	..	..	139
Table 26	..	..	..	..	..	..	..	140
Diagram I	..	..	..	..	..	..	..	81
Diagram II	..	..	..	..	..	..	..	82
Diagram III	..	..	..	..	..	..	..	83
Diagram IV	..	..	..	..	..	..	..	84
Diagram V	..	..	..	..	..	..	..	85
Diagram VI	..	..	..	..	..	..	..	86
Diagram VII	..	..	..	..	..	..	..	87
Diagram VIII	..	..	..	..	..	..	..	124
Diagram IX	..	..	..	..	..	..	..	138

I INTRODUCTION

This study is concerned with high-level taxa of living Spermatophyta, but before embarking on an exposition of my own work it is necessary to consider the current taxonomic situation in this region of the plant kingdom.

Any taxonomic scheme should reflect the sum of available knowledge and can only rightly be based on comparative observation. There should be no place for guesswork and conjecture, and the acquisition of new facts which do not fit the existing scheme should lead to reappraisal from first principles. In evaluating currently available systems it is necessary to examine them with these points in mind.

THE HIGH-LEVEL TAXA OF THE SPERMATOPHYTA

The Spermatophyta embrace all plants which produce seeds, and though obscure in evolutionary origin they stand well apart in many respects from the other main plant groups. Taxonomically they are divided into the Gymnospermae and Angiospermae, the former further splitting into the 'Coniferophyte' (Coniferopsida- Pilger and Melchior 1954) and the 'Cycadophyte' (Cycadopsida) lines, with the latter subdivided into Monocotyledons and Dicotyledons. The first formal account of this plan appears to be that of Alexander Braun (1864; Fig I), and knowledge accumulated since has altered it but little.

Fig. I. The Scheme for the Spermatophytes suggested by A. Braun (1864).

Anthophyta (Spermatophytes)

Gymnospermae

Frondosae (Cycad line. c. 100 species)

Acerosae (Conifer line. 550-600 species)

Angiospermae

Monocotyledons (55,000 species)

Dicotyledons (165,000 species)

The recognition of the Monocotyledons and Dicotyledons dates back to John Ray (1703) and his perspicacity has become more and more apparent with the passage of time (see Cronquist 1968 p. 128 for a table of some of the differences between the groups). It was not until 1827 that Robert Brown demonstrated the difference between angiospermous and gymnospermous flowers and reproductive systems, and these facts, with the subsequent observations of Hofmeister (1851), provided the basis for Braun's system. The Cycads are convincingly separable from the Conifers on morphological, anatomical and paleobotanical grounds (Chamberlin 1934; Arnold 1948; Sporne 1965). Thus far, despite its antiquity, the familiar Spermatophyte hierarchy seems to represent good taxonomy in that names are highly informative and useful in practice. At lower levels the situation is far less satisfactory. I propose to confine discussion (as I have confined my work) to Conifers and Dicotyledons. The former far outweigh Cycads in the modern world,

whether one judges them in terms of species (Fig. I) or economic value; and the latter constitute the bulk (about three-quarters) of the Angiosperms - i.e. they are for practical purposes the most important group of plants on earth.

THE CONIFERALES s.l.

The living representatives of the 'Coniferophyte' line are almost entirely members of the order Coniferales s.l. (Ginkgo biloba, the sole extant member of the Ginkgoales, is a mere curiosity. The Gnetales are often presented as a third line equal in rank to the 'Coniferophytes' and 'Cycadophytes' e.g. Pilger and Melchior 1954; however they are a tiny and insignificant assemblage of plants which may well have little in common with one another and on which too much effort may already have been expended.) Within the Coniferales there has long been a feeling that there are two main groups: de Jussieu (1789) hinted at this and separated Taxus from the rest of his Conifers, including it with Ephedra and Casuarina as 'Coniferae calix staminifer'. Later systems all show a separation of those genera which possess a solitary ovule from those with ovuliferous cones: thus Lindley (1830) separated as a group the modern Taxaceae plus Podocarpaceae, in which he included Cephalotaxus (1845); and Parlatore (1868) reflects this same idea in his two tribes Taxinae and Abietinae. The advent of 'phylogenetic' classifications did not change matters: Eichler (1889) and Buchholz (1934) maintain Parlatore's system;

and Sahni (1921), on consideration of the known antiquity of Taxus, suggested the order Taxales (Taxaceae and Cephalotaxaceae only) of equal rank to the Coniferales, comprising the remainder of the Conifers. Florin (1948; 1951) reviewed the situation in the light of the discovery of fertile material of Paleotaxus (Triassic) and Taxus jurassica (Jurassic). These fossils show solitary terminal ovules and he suggested that the Taxaceae never possessed the female cones seen in other Conifers. The Podocarpaceae and Cephalotaxaceae he considers as showing a reduction from the compound female cone, and therefore not on the same evolutionary line as the Taxales, so he returns them to the rest of the Coniferales s.s. This view is the one now generally accepted, though Pilger and Melchior (1954) elevate the Taxaceae to the level of a class (Taxopsida) equivalent in rank to their Coniferopsida, Gnetopsida and Cycadopsida (a change of rank which, like so many others, achieves nothing but the addition of a new name to the literature). However the Taxaceae form less than 5% of the total species of Conifers, so from a practical standpoint their location is relatively inconsequential. The main mass of Coniferales are distributed amongst the families Araucariaceae, Cephalotaxaceae, Cupressaceae, Pinaceae, Podocarpaceae and Taxodiaceae. These mostly seem to represent acceptable taxonomy, based on correlated features and supported by such external evidence as geographical distribution and chromosome

counts. Exceptions may be the Cupressaceae, where the wide geographic scattering of genera seems suspicious; and the maintenance of a family for the single genus Cephalotaxus, which seems taxonomically escapist. There have never been any fixed ideas about grouping these families above family level. The Podocarpaceae and Cephalotaxaceae are usually associated with one another even when separated from the Taxaceae; but the remainder are either regarded as a more or less cupressaceous group versus the rest (e.g. Lindley 1830; 1845; Eichler 1889), or left as a single unit (e.g. Engler 1964).

THE DICOTYLEDONS

Accounts of the more important early botanical systems (dating back to Theophrastus in 300 B.C.) can be seen in Rendle (1904), Lindley (1845), Le Maout and Decaisne (1873), Lawrence (1951) etc. Many of the morphological features still quoted in dicotyledonous arrangements today were established in taxonomy hundreds of years ago, and their present usage may owe at least as much to historical familiarity as to scientific reasoning. Tournefort (1694) proposed groups of Dicotyledons which were defined largely on corolla form and he recognised all the now traditional conditions of apetaly, polypetaly, zygomorphy etc. Ray (1682 and 1703) divided his Dicotyledons on a combination of floral, fruit and leaf characters: he recognised the need to seek correlations, incorporating as much variation as possible in his system.

However it appeared in the context of an unwieldy nomenclature and was largely eclipsed by the more accessible but taxonomically indefensible 'sexual' system of Linnaeus (1735), based almost entirely on the numbers and arrangement of the androecial and gynoecial parts. The taxonomic achievements of Linnaeus were stupendous (including his 'sexual' system, which should be regarded as a primitive key rather than an attempt at classification). However his descriptions of angiospermous plants are couched mainly in terms of a relatively few aspects of floral morphology, and they set the standard for subsequent generations of taxonomists. The result can be seen in any modern flora, where descriptions of plants are still to a disproportionate extent descriptions of flowers; similarly classifications of Dicotyledons were for long (and to a large extent still are) based largely on variation in relatively few aspects of floral morphology. De Jussieu (1789) having established to his own satisfaction (in by modern standards curious fashion; Stafleu 1964) that features should be 'weighted' for taxonomic purposes, used corolla and staminal characters to divide the Dicotyledons into apetalous, sympetalous, polypetalous and diclinous (unisexual and often apetalous) series, which he further subdivided into 'Classes' (roughly equal to modern Orders) and 'Natural Orders' (equivalent to modern Families). The next hundred years saw a proliferation of systems mainly inspired by that of de Jussieu. Those of de Candolle (1813) and Bentham and Hooker (1862-1883) are the most comprehensive and can be considered as representative of the period. The former

merges the apetalous and diclinous types as one major group, the Monochlamydeae (with a single perianth whorl), and contrasts them with all those with two whorls, the Dichlamydeae, which are further divided on free or fused corolla parts and hypogyny or epigyny. Bentham and Hooker's system is similar except that three major aggregates are retained, the Polypetalae, Gamopetalae (sympetalous) and Monochlamydeae. Both schemes commence with the Ranunculaceae and end with the amentiferous types.

It is relevant to mention the earlier work of Adanson (1763) at this point. He realised (as apparently did Ray) the need for a 'natural' system in which no character was emphasised at the expense of others, and endeavoured to set one up on crude statistical grounds. He produced sixty-five single character systems and grouped the plants known to him by each of these. The position of genera varied from one scheme to the next, but where they came out together in several systems he considered they should be associated as they show a number of similarities. The system was not a great success since the characters were often poorly known and homologies even less well established than today; but it was a valiant attempt to use as much information as possible in an objective way, and deserves credit. At worst it was as good as any existing scheme of the day, and a few suggestions of a novel nature are only now gaining support - for example the separation of the Umbelliferae from other polypetalous families and their positioning with sympetalous ones.

These schemes were set up before Darwin's evolutionary ideas were widely publicised. Sequences arose out of placing in order families purportedly showing less and less similarity in 'important' floral features. The history of the classification of Angiosperms (including Dicotyledons) from this point becomes increasingly the history of attempted phylogenetic arrangements of groups rather than of continued taxonomic reassessment in the light of accumulating information. Probably nobody would deny that a 'good' classification based on overall similarities might well reflect evolutionary inter-relationships; but in the absence of fossil evidence phylogenetic arguments can at best be highly speculative, and should not be allowed to interfere in practical aspects of classification. Certainly the method employed by systematists who push groups into 'phylogenetic' sequences which are then claimed as phylogenetic 'evidence' to support the groups, is to be deplored. The first step in erecting a system (whether one's aims are 'phylogenetic' or utilitarian) must be to define groups reflecting overall similarities. In the absence of fossils the classificatory exercise must precede evolutionary speculation; if the groups are 'good' (i.e. if they reflect patterns of correlation in the data from which they were derived and have value in information-retrieval; have predictive value; are informative and educational) they will probably reflect genetic relationships, and evolutionists can sensibly try to arrange them in meaningful sequences. If the basic exercise

of group forming has not been sound, evolutionary discussion is a waste of time; and under such circumstances to feed back 'phylogeny' into the taxonomy is surely placing the cart before the horse.

The system of Engler was first published in 1892 and subsequently revised through twelve editions, the latest (Melchior 1964) being essentially the same as the first as regards the overall pattern of relationships expressed. This was the first classification to reflect 'evolutionary' ideas. The Dicotyledons are here divided into two great sub-classes, the Archichlamydeae (petals absent or free) and the Sympetalae (petals fused); the latter being considered as more 'advanced' and derived from the former, of which the apetalous types are considered the most 'primitive'. Again the form of the corolla is presumably supposed to inform us on the whole plant, but the matter is never set out in scientific terms. Within the corolla-groups the families are arranged in orders, with taxa of pre-evolutionary vintage now supposedly representing phylogenetic affinities. Subsequent to the formulation of the original scheme came the publication of the 'Pflanzenfamilien', which remains the only comprehensive work on Dicotyledons with keys to genera. (Perhaps this last fact has led to the widespread acceptance of the entire system in floras even up to the present day, despite the lack of real evidence to support it.)

Good accounts of many systems following on Engler's can be found in Lawrence (1951) and Melchior (1964), and only a few need

be mentioned here to indicate their range. Rendle (1904) and Wettstein (1923-1924) followed the Englerian view that the most 'primitive' Dicotyledons are the apetalous amentiferous types with the others derived from them; but Bessey (1914) disagreed, set up a series of conditions he considered 'primitive' and on this basis placed the 'Ranalian' complex at the base of his dicotyledonous phylogeny. Much the same idea was suggested by Pulle (1952) who proposed eight series each starting with more 'primitive' polypetalous types and terminating in more 'advanced' and often sympetalous ones, but all derived directly or indirectly from the 'Ranales'. Hutchinson (1959) proposed in 1926 two separate evolutionary lines, one woody the other herbaceous, each line starting with the 'Ranalian' types and progressing through other Polypetalae to sympetalous forms. There is little one need say about a system which has to justify the large-scale separation of near identicals (e.g. Labiatae and Verbenaceae) on the grounds of convergent evolution. (I may be accused of ignoring the possibility of this phenomenon in my work. I do so because of the inherent improbability from the phylogenetic standpoint of it occurring over a wide range of characters; and because if two organisms are to all intents and purposes the same in terms of available comparative data, and if names are to be useful to the world at large, it seems reasonable to place them in the same taxonomic group.)

That much of the basic taxonomy of these 'phylogenetic' systems is not fundamentally new but represents earlier schemes

such as that of Bentham overlayed by evolutionary ideas, is readily seen in comparisons between pre and post Darwinian offerings. Thus the 'Ranales' appear not only at the start of many 'phylogenies' (e.g. Bessey) but also at the beginning of the systems of de Candolle and Bentham; and the sequence of families at the start of Engler's Sympetalae is, in all essentials, the same as that in Bentham's adjacent series Heteromerae and Bicarpellatae. No useful point is served by quoting further examples, but it is worth mentioning Stafleu's (1964) observation that of a sample of 225 genera placed by de Jussieu in eight families, 97% are still found in the same circle of affinity and 81% in the same family. Stafleu's conclusion that this illustrates the high quality of de Jussieu's work perhaps overestimates the degree of radical thinking brought to bear by his successors. No doubt similar studies of de Candolle or Bentham would provide still more impressive evidence of taxonomic conservatism.

The system that I shall mainly use for comparative purposes is that of Cronquist (1968). It is the most recent available; it seems to have been favourably received in the taxonomic world; and it is based in turn on Takhtajan (1964), thus reflecting the views of two of the world's leading systematists. The Dicotyledons (here called Magnoliatae) are divided into six sub-classes (Fig. 2), which in Cronquist's words 'can be characterised only in terms of critical tendencies. They are groups which hang together on the basis of all our information but which cannot be precisely defined phenetically'. It is noticeable that diagnoses for the sub-classes

(Table I) abound with such terms as 'usually', 'more or less' and 'relatively', indicating the recognition of groups in terms of trends and tendencies. It seems reasonable to suppose that absolutely definitive 'key characters' may be rare or non-existent at this hierarchical level, and that correlations based on all available characters are needed to bring out meaningful groups. However tendencies if they exist must surely be statistically recognisable; but here there is no indication that they have been established by any method other than an intuitive one, or that they are not influenced by preconceived phylogenetic notions of dubious validity. The sub-classes and orders in this latest scheme still reflect pre-Darwinian series disguised in evolutionary lines; it seems that the cart is still being placed before the horse.

A welcome attempt to introduce scientific method into investigating the evolution of Dicotyledons is made by Sporne (1948; 1949; 1954; 1956; 1969), who largely avoids confusing taxonomy with phylogeny. Having decided that 'primitive' features are those which are most highly correlated and best represented in the fossil record, and accepting that they will be proportionally more frequent in 'primitive' families, he goes on to work out statistically-based 'advancement indices' for all dicotyledonous families. The aim is to establish how far families have evolved relative to one another and the values are not used to erect a classification; as he points out a phylogeny

should not be a linked sequence of extant types, but rather a sphere with modern forms on the surface as 'twigs' of the 'tree' contained within which represents their evolutionary derivation.

Sporne's is a commendable (and solitary) attempt to consider dicotyledonous evolution in a rational way; and his seems as convincing an argument as is possible with the available information. Its weaknesses lie in the basic data. In the first place the fossil record for Dicotyledons is as yet far from being an infallible arbiter in deciding which set of correlated characters is 'primitive' and which 'advanced'. Secondly, the worth of any phylogeny, which is concerned with groups evolving one from another, must depend largely on the taxonomic credibility of the groups. Sporne is led to conclude (1969) that Engler's Myrtiflorae diverged early in dicotyledonous evolution, and that the spectacular range in individual advancement indices shown by constituent families indicates different rates of evolution since this divergence. However it is undeniably possible (I would suggest likely) that the Myrtiflorae are but one example of a meaningless name. He may be on safer ground arguing in terms of families. In any case the pitfalls in evolutionary considerations are at least made apparent in his work; taxonomists who confuse phylogenetic with the basic classificatory exercise merely disguise them.

AIMS OF THE PRESENT INVESTIGATION

There is no evidence that taxonomy succeeds or often even tries

to account for currently available data over large areas of the Spermatophyte hierarchy; I have set out to bring recently developed techniques to bear on modern taxonomic arrangements, and to suggest directions in which improvements (if needed) might be made. My main concern has been with the Dicotyledons. The work to be described on the Conifers is somewhat incidental, arising out of a pilot study.

Fig. 2. The suggested relationships among the subclasses of Cronquist's Magnoliatae. The size of each balloon is proportional to the number of species in each subclass.

FIG. 2

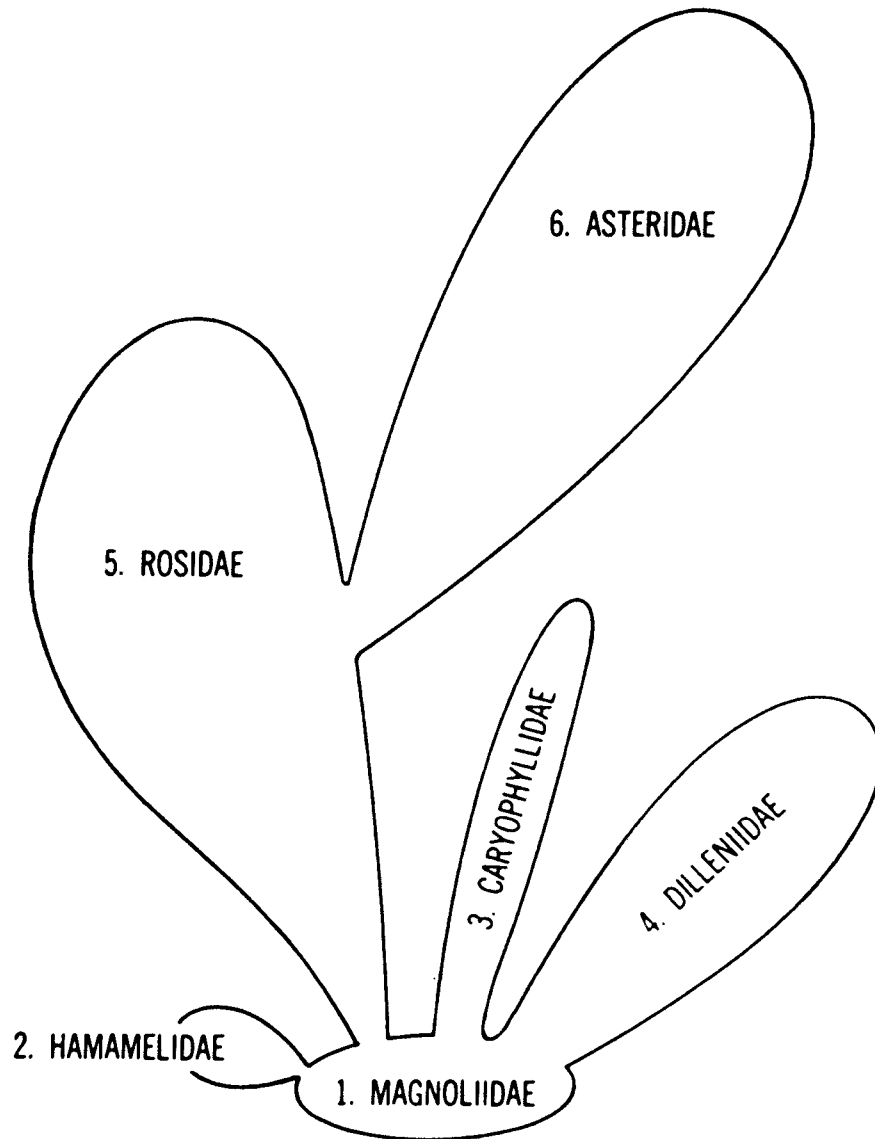


Table 1. Diagnoses of Cronquist's six dicotyledonous sub-classes.

Sub-class 1. Magnoliidae.

Plants relatively primitive, the flowers typically apocarpous, always polypetalous or apetalous and nearly always with an evident perianth, usually with numerous centripetal stamens, pollen always binucleate and often uniaperturate; ovules always bitegmic and crassinucellate.

(the remaining five sub-classes are all described as 'more advanced in one or more respects than the Magnoliidae, and never with uniaperturate pollen').

Sub-class 2. Hamamelidae.

Flowers more or less strongly reduced and often unisexual, the perianth poorly developed or wanting, often borne in catkins, but never forming bisexual pseudanthia, and never with numerous seeds on parietal placentae.

Sub-class 3. Caryophyllidae.

Flowers polypetalous or less often apetalous or sympetalous; pollen trinucleate; ovules bitegmic, crassinucellate, most often campylotropous or orthotropous; seeds very often with perisperm; plants usually either with betalains instead of anthocyanins or with free-central to basal placentation, or both; only a few species are ordinary trees.

Table 1 contd.

Sub-class 4. Dilleniidae.

Flowers polypetalous or sympetalous; pollen usually binucleate (notable exception: Cruciferae); ovules various but seldom campylotropous or orthotropous; seeds seldom with perisperm; placentation rarely free-central or basal except in the Primulales; many species are ordinary trees.

Sub-class 5. Rosidae.

Flower usually polypetalous; stamens when numerous, developing in centripetal sequence; flowers seldom with parietal placentation (notable exception: many Saxifragaceae) and also seldom with free-central or basal placentation in a unilocular, compound ovary, but very often (especially in the species with few stamens) with 2-several locules that have only 1 or 2 ovules each.

Sub-class 6. Asteridae.

Flowers sympetalous; stamens generally isomerous with the corolla lobes or fewer, never opposite the lobes; ovules unitegmic and tenuinucellate; carpels most commonly two, occasionally 3-5 or more.

II NUMERICAL METHODS

Before describing my numerical taxonomic exercises it is necessary to introduce the methods used and to state my attitudes to them. I wish to make it clear that my concern with numerical aspects is as user, not statistician; and my comments should be viewed accordingly.

CODING OF DATA

In any computational study the data must be coded in a form acceptable to the computer. It is at this stage that numerical taxonomy loses its objective status: one has to represent an organism in terms of a limited set of observations; in other words 'characters' have to be defined - a process inescapably subjective and arbitrary. This drawback is not confined to computational studies, since all taxonomic methods depend at present (and probably will in the future) on defining characters with non-mechanical methods usually suffering the further disadvantage of subjective examination of the data once coded. (They commonly also suffer from failure to record properly comparative data at the outset: a failing to which the need to prepare data matrices for numerical taxonomy draws attention). However a taxonomic scheme derived from any analysis (computational or not) must be carefully scrutinised for taxonomic usefulness, as it is at best an objective classification of limited data which we hope reflects overall similarities amongst the individuals studied.

Watson, Williams and Lance (1967) have found it convenient to

recognise three types of character. Qualitative, where there is a straight choice between two states (e.g. regular or zygomorphic flowers); multistate, where the character is one of more than two states (e.g. the various hair types found in Dicotyledons); and numerical, where the variation can be expressed numerically (e.g. the diameter of vessels). The decision as to which type a given feature conforms with is to some extent arbitrary and subjective, although often a given case is obviously more suited to one than another. A further distinction is made by Lance and Williams (1967) between:-

- a) Exclusive multistates. The presence of one state automatically excludes the others (e.g. if the leaf shape is linear it cannot logically be ovate or lanceolate or any of the alternative possibilities so it seems unreasonable to count such negatives as evidence of similarity).
- b) Non-exclusive multistates. More than one of the states can be logically present together (e.g. in a genus, or on a single leaf, several hair or stomatal types may exist side by side).

Absence of a facility for dealing with multistates means either (i) raising each state to a qualitative, which might over-emphasise some kinds of data; or (ii) discounting some of the available observations.

In some instances data may be unavailable, i.e. either 'missing'

or the nature of certain characters may be such that their presence (or absence) automatically makes others 'inapplicable' (e.g. leaf characters are inapplicable when plants are leafless). Computationally both such cases can be dealt with as 'unknowns'.

CHOICE OF PROGRAMS

Before considering the programs used I want to outline the facilities which various stratagems offer, and comment on their relative merits from a taxonomic point of view.

Monothetic divisive methods start with the total mass of individuals and break them into successively smaller units, each defined by a 'key character' which represents as far as possible the sum total of the information for the group. Such stratagems are relatively fast, but the use of key characters may exclude from a group individuals which really belong there on the basis of overall similarity; whilst dissimilar types possessing the character will be included. As the definitive characters selected are those which best indicate groups reflecting overall similarities among individuals the exceptions should be kept to a minimum, but the possibility of satisfactorily defining taxonomic groups accurately (especially at this level of the hierarchy) on single exclusive features seems remote.

Agglomerative methods start with separate individuals and progressively fuse them into a single mass. This avoids the use of key characters, but the programs may suffer from 'migration' - some individuals may be placed in the 'wrong' group because the

risk of misclassification is greater at low levels where the information content of the groups is small, and successive fusions will be affected by any such misplacements. 'Reallocation' programs to deal with this (El Gazzar et al. 1968) are available, but as yet only for small scale problems.

Qualitative programs can only deal with qualitative characters, and their disadvantages have already been mentioned.

Mixed data programs on the other hand can deal with all types of characters and 'unknowns', and are taxonomically preferable to those catering only for qualitatives.

These four facilities are combined in various ways in the increasing number of programs continually becoming available. Those used in the present work were chosen on the basis of suitability, convenience and availability.

ASOC. (Williams and Lambert (1959; 1960.)

A qualitative monothetic divisive (and therefore taxonomically somewhat frail) method, having the advantage of being fast and well tried. Has often proved useful in helping to pinpoint migrations in agglomerative analyses.

INFO. (Williams, Lambert and Lance 1966.)

An agglomerative qualitative method, also suffering from the lack of a mixed data facility, but with the enormous taxonomic advantage of being agglomerative without being unduly slow and expensive.

MULASS. (Lance and Williams 1968.)

The program used differs from the original specification in the following respects (Williams 1969; personal communication).

- (i) The division-parameter has been changed. Let N be the number of individuals in the group to be divided for which a given attribute is known; then for every attribute we calculate $N^{\frac{1}{2}}\Sigma/r/$.
- (ii) The trichotomy has been abandoned; those individuals for which the division attribute is unknown are allocated to one side or the other by polythetic similarity.
- (iii) The next group to be divided is that for which the division-parameter is the next largest.

This is a mixed data divisive method which ought therefore to represent an improvement over ASOC.

Mixed data agglomerative methods exist (e.g. MULTBET; Lance & Williams 1967) and are undoubtedly more appropriate to taxonomic problems. However at present they are limited in size (i.e. in terms of numbers of individuals that can be dealt with), and are in any case very prohibitive in cost to the user.

III ANALYSES OF DICOTYLEDONS

SAMPLING OF INDIVIDUALS AND CHARACTERS

Any taxonomic investigation of this kind involves sampling both in terms of individuals (because of the time factor) and characters (largely limited by availability of data).

SELECTION OF INDIVIDUALS

For the present purpose I have elected to sample in terms of genera. Most families are too heterogeneous or too little known to be convincingly and consistently recorded for a reasonable range of features; and species too circumscribed to permit the kind of extrapolative recording which is unavoidable in this kind of exercise. (These points may become more readily appreciable during discussion of the problems I have encountered even with genera.)

Although the number of families (250-300) and species (c. 165,000) of Dicotyledons is large, it is possible to represent a high proportion of them with a relatively small sample of genera, as both families and genera exhibit Willis's 'hollow curve' - i.e. there are a few large families such as the Compositae making up the bulk, with many small ones of relatively little significance. Likewise in each family there are a few large genera and many small ones. Thus using as the basis of my sample the largest genera of the largest families has seemed a logical approach to the Dicotyledons.

In order to arrive at the 543 genera in Appendix I the sizes of all families of Dicotyledons in terms of genera and species

were recorded (Willis 1966) and the families with the most of each noted. From these the largest genera were taken (the number depending on the size of the family). The main genera from certain small families such as the Magnoliaceae and Betulaceae were added because they occupy significant or controversial positions in many currently accepted taxonomic schemes. A final list of over 600 genera was prepared and data recorded; but before computation it was reduced to those in Appendix I (by removal of (i) genera for which too much data proved unavailable or of dubious accuracy; (ii) near identicals).

SELECTION OF CHARACTERS

If it achieves nothing else my work emphasises the acute shortage of truly comparative observations available for a taxonomic reappraisal of Dicotyledons. For even such conspicuous features as whether trees or shrubs are evergreen or deciduous, and whether herbs are annual or perennial, are remarkably poorly recorded. Regarding features requiring more intimate observation (details of anatomy, cytology etc.) the situation is far worse, with positive records for a genus or even a family often based on few or an **unspecified** number of observations for species; and negatives may represent either genuine absences or failure to seek the features concerned (the two being rarely distinguishable). Although I was recording in terms of genera, the nature of available data and the manner in which they are published meant that the data often had to be taken from family descriptions.

Highly unsatisfactory but unavoidable extrapolation of this kind proves necessary even for much of the traditional floral morphology. From a taxonomic point of view this can only mean that my analyses are necessarily inherently conservative, family units having thus been read into the data. Extrapolation has also proved necessary within genera, especially in the anatomical and cytological fields, where often a genus is 'known' in terms of observations on only one or a few species: such observations for genera are genuine as far as they go but it is always possible that species sampled are anomalous for the character and not a fair reflection of their genera.

Ideally attributes should come from all aspects of plant variation (e.g. morphology, anatomy, phytochemistry, cytology, palynology etc.) but in practice data are not available for many of the more 'modern' aspects such as phytochemistry, and even in the traditional areas of floral morphology and anatomy it is difficult or impossible to distinguish in taxonomic descriptive work between genuine observation on the one hand and conjecture on the other. I have had to rely on available information for my characters, be it the result of genuine study or otherwise: taxonomy can do no more than incorporate current knowledge.

In general a character was recorded as 'positive' if it is known from any part of a genus; but in cases where a genus has been (or appears to have been) widely recorded for a feature, rare conditions were omitted (e.g. I have disregarded the fact

that leaf margins in Gossypium are very occasionally more or less entire). As far as possible I have also tried to keep the number of attributes with a high proportion of negatives or 'inapplicables' to a minimum, but it is impossible to omit them all without serious information loss.

Details on the aspects of variation summarised below were recorded from all the available literature (a general source list is included in the bibliography, specific references being made only where relevant) in the form of copious notes. From these a data matrix was to be compiled preparatory to coding for the analyses.

Habit

Of the many habit categories to which people commonly refer four were selected as being practicable for a taxonomic exercise on this scale. Genera were recorded for the presence of trees, shrubs, perennial and annual herbs; any marked degree of succulence of stem or leaf was noted; and parasitic types were listed (Ozenda 1965) although this gave a large number of negatives. Adaptations for climbing were recorded under four headings: stem twiners, tendrill climbers, scramblers and root climbers, the last being extended to include epiphytes.

The Leaf

The partial or complete absence of leaves in a genus was recorded; and when present whether they were evergreen or

deciduous - a feature remarkably poorly recorded in the literature. Loudon (1880) provides information for the species known to him and regional floras are sometimes helpful. Perennial herbs I have considered 'evergreen' if the phytosynthetic regions are evident throughout the year, and 'deciduous' if they die back to the rootstock seasonally.

The Lamina may be simple or compound and its margin or that of the leaflets entire or variously lobed, serrate, dissected etc. I have recognised two venation types, 'Pinnate' and 'Palmate'. The former covers all cases where one main vein enters the lamina from the petiole, including small-leaved types such as Erica with a single strand and no laterals; the latter applies to those where several veins of approximately equal dominance enter the leaf, covering not only the typically palmate leaves of Malvaceae, Cucurbitaceae etc. but also types such as those seen in the Lauraceae and Melastomataceae where several main veins run more or less in parallel up the leaf. The occurrence in the leaf of a papillose epidermis, a hypodermis and vertically transcurrent veins are all noted; and I have found it necessary to reduce the enormous diversity of foliar hairs to the six basic types listed in Table 2.

Stomata of the types anomocytic, anisocytic, paracytic and diacytic (as defined by Metcalfe and Chalk, 1950) occur in the sample and I have noted their distribution among the genera so far as the records allow. Where leaves are lacking, records are

taken from other photosynthetic areas.

The Phyllotaxy in Dicotyledons is opposite, alternate or whorled, and this and the occurrence of a 'radical rosette' were noted. The latter term is here applied not only where all the leaves are radical (e.g. Taraxacum), but where cauline leaves occur as well (e.g. Centaureum).

The Petiole varies in its vascular configuration at the distal end (Metcalfe and Chalk, 1950); I have noted whether there is a complete ring or an arc of vascular tissue and whether it is dissected or entire.

The presence or absence of Stipules is a feature both relatively unambiguous and widely mentioned in descriptions, but even here pitfalls occur; any competent observer wielding the authoritative British Flora is led to place many members of the genus Ranunculus in the Rosaceae on the alledged absence of stipules!

The Stem

Good large-scale comparative observations on the anatomy of dicotyledonous stems are scarce. Boodle and Fritsch (1908) and Metcalfe and Chalk (1950) summarise most of the available information, but much of this is fragmentary. The presence of bicollateral bundles, scalariform end plates to the vessels and the position of origin of the cork cambium are all fairly widely recorded features, as is the width of primary medullary rays in the young stem. The latter is a reflection of whether there is a ring of primary bundles

or a more or less continuous primary vascular cylinder.

Of wood features only the occurrence of vestured pits in the vessels, septate fibres, wood fibres with bordered pits and ring porosity are sufficiently widely recorded to be useable. References to the distribution of crystals (type and position in the plant) proved of little value due to lack of consistency in their observation.

Metcalf (1966) lists families and genera known to have lactiferous systems.

The Flower

The flower still provides many of the features available for taxonomic use, but in addition to information on traditional morphology, data from embryology, cytology, palynology etc. are now becoming available on a sufficiently wide scale to be incorporated.

Flowers may be actinomorphic or definitely zygomorphic (cases of slight irregularity, as in some Umbelliferae or Rhododendron, being considered here as regular); and they may be aggregated in inflorescences or borne more or less singly and separated by vegetative leaves. Types universally regarded as 'truly' single (e.g. Magnolia) and those theoretically representing 'reduced' inflorescences (e.g. Viola) have both been recorded in the latter category. Inflorescences are either cymose or racemose; often they are compounded but for comparative purposes the ultimate branches only have been considered.

Hypogyny, perigyny and epigyny all occur, some genera (e.g. Mesembryanthemum) being variable in this respect. Expression of sexuality also varies; most genera are hermaphrodite, but some are unisexual or polygamous and some have different species exhibiting different conditions (e.g. Chrysanthemum). Usually the flower is basically pentamerous, but some families and genera show departures from this condition (e.g. Cruciferae, tetramerous; Magnolia, polymerous). In some instances the torus becomes expanded to form a disc lying internal to the calyx and corolla and continuous or broken up into nectiferous glands (if present in epigynous flowers it caps the ovary).

Sepals are normally present and I have noted whether they are free, partially (calyx 'fidus' or 'partitus', Bentham etc.) or more or less completely fused (calyx 'integer', 'dentatus' or 'lobatus', Bentham etc.). In epigynous and perigynous flowers it is often impossible to decide on the degree of fusion of sepals due to morphological confusion over the nature of inferior ovaries and differences in descriptive terminology, and this feature then has to be ignored. The aestivation of the sepals or calyx lobes was recorded as either imbricate, valvate or open.

Petals are often present, but sometimes there is only one perianth whorl which is then normally considered as sepalar (e.g. Anemone, Urtica) and very occasionally the perianth is completely lacking (e.g. Piper, Salix). If present the petals may be in one or more whorls, free or variously fused, and with imbricate,

valvate or contorted aestivation.

The Androecium provides many features, not only morphological but cytological and palynological as well. I have noted the presence of staminodes replacing stamens in hermaphrodite flowers; also the numbers of stamens (plus staminodes when present), not in absolute terms, but relative to the components of the perianth whorls (see Table 2 for the categories). The unusual cases (e.g. Piper, Salix) where there is no perianth have been recorded relative to their supposed symmetry (i.e. pentamerous etc.). Stamens may be of unequal sizes (e.g. Labiatae) or all equal; and they may arise from the receptacle or be attached to the perianth (epipetalous; except where the petals are small or lacking and they are fixed to the calyx, e.g. Thymeleaceae). The filaments are either free from each other or fused (e.g. some Papilionoideae), and the same applies to the anthers, which dehisce by pores or longitudinal slits (including valves, e.g. Lauraceae) either introrsely or extrorsely. The anther may be appendaged due to an extension of the connective (e.g. Viola) or the pollen sacs (e.g. some Ericaceae) and I have noted any such condition. The mode in which the filament and anther are joined varies as summarised in Table 2, (intermediates between states being recorded for both).

Davis (1966) summarises known facts of anther development: the number of pollen sacs, the nature of the tapetum and the initial number of middle layers in the anther wall being

sufficiently widely recorded to be useful, for the present purpose.

The pollen when mature may be shed as single units or in aggregates of different kinds (Erdtman 1945; Davis 1966); each grain may be two or three celled when shed (Brewbaker 1967); germination is usually monosiphonious but can be polysiphonious e.g. Cucurbitaceae (Maheshwari 1963); and the apertures which are generally present are either globally (peri-aperturate) or equatorially (stephano-aperturate) distributed, though occasionally they are lacking or confined to the poles.

The Gynoecium I have considered as either syncarpous or apocarpous (including in the latter term genera supposed to have a single carpel, e.g. Leguminosae). Types where the ovary seems secondarily divided (e.g. Labiatae) have also been accounted for. Locule (carpel in apocarpous genera) numbers vary and are conveniently considered partly relative to the numbers of perianth parts and partly in exact terms, as listed in Table 2. Within each locule (or carpel) the ovule number and type (orthotropous, anatropous or campylotropous) has been noted. Placentation varies, certain types being restricted by definition to plurilocular ovaries (i.e. axile) others to unilocular ones (i.e. parietal and free central) whilst the basal and apical conditions can occur in either (see Tables 2 and 3 for coding methods). Stigmas may be borne on recognisable styles or directly on the ovary, and in the former case in syncarpous genera the style is a compound structure

whose components show differing degrees of fusion which can be expressed numerically (Table 2 gives details).

Recently data on ovule development has begun to accrue and much useable information can be obtained from the summaries of Davis (1966) and Maheshwari (1950 and 1963); Bhandari (1965) and Maheshwari and Kapil (1966) provide additional information on the Ranunculaceae. There may be one or two integuments; the inner surface sometimes differentiates to give an endothelium; and in bitegmatic ovules the contribution of the two layers to the micropyle varies. The development of the nucellus (tenuinucellar or crassinucellar) and of the endosperm (cellular or nuclear) also represent fairly widely available information. The latter situation often applies in genera conventionally described as 'exalbuminous', for it seems there is always at least a microscopic amount of endosperm formation. Embryo sac development varies among Dicotyledons (see Maheshwari 1950 for terminology) but the commonest is the 'Monosporic Polygonum Type'; I have recorded this and departures from it. Johansen (1960) describes courses which the early divisions of the fertilised embryo may follow and these are noted.

The Seed and Fruit

The seed is sometimes at least partially surrounded by an aril developed from the funicle (see especially Corner 1949, 1953) and the fruit itself may be dry or fleshy. Dry fruits may be indehiscent or loculicidally or septicidally dehiscent - the

latter condition being here conveniently extended to include any case where there is splitting along the septa, regardless of whether the seed is exposed or not (e.g. the separation of mericarps of Umbelliferae).

CODING

Three analyses, MULASS, INFO and ASOC were carried out, for which the data as compiled in matrix form had to be coded. This task was simplest for MULASS with its mixed data facility. The manner of coding for MULASS is summarised in Table 2 and details of the coded data given in Appendix 2.

As already stated, INFO and ASOC impose severe and distinctly unsatisfactory limitations on coding; but these analyses seemed worthwhile, ASOC as an arbiter in doubtful cases and INFO because of its taxonomically more desirable strategy. Coding procedure for ASOC and INFO is given in Table 3, and full details of the data as coded are provided in Appendix 3. The qualitative characters of MULASS were here left unchanged, except for the omission of a few (such as the presence of parasitic types) with very small numbers of positive records and others with a high number of inapplicables (e.g. wood data). Thus all the qualitatives listed in Table 2 were employed apart from nos. 2,3,4,21, 23-25, 33, 56 and 62 which were omitted. The single numerical character (degree of styler fusion) was converted to a qualitative by contrasting styles more or less fused (Numerical values 6-10) with styles more or less free (Numerical values 2-5); apocarpous types being

considered as free, and in the absence of a style the stigmas being treated as either free or fused. States of the multistates were in general raised to qualitatives, but certain rarely occurring states (e.g. *Chenopodiad* embryogeny) were omitted altogether and certain others combined (e.g. the six hair types of MULASS were coded as two qualitatives). Genuine 'inapplicables' were coded as negative (e.g. the Cactaceae were treated as negative for the various leaf characters) but in cases where a feature was inapplicable through lack of records, I extrapolated from information on other genera of the family when available; only when genera in the family proved totally unknown or variable for the feature under consideration was a spurious negative awarded.

RESULTS OF THE ANALYSES

For comparative purposes all three hierarchies are figured (Diagrams I-VII), terminated at levels convenient for discussion; (the complete outputs are deposited in the Departmental Library, Botany Department, University of Southampton). No one should imagine that computational analyses are infallible (I have already emphasised the taxonomic weaknesses inherent in the programs employed in this study); they are merely mechanical attempts at sorting plants, as represented by the data, into groups expressing the overall pattern of similarities. It is to be hoped that they will be successful in this, but success can only be confirmed by a reconsideration of the original data in the light of the

suggested groups, in order to establish that a useful pattern has indeed emerged. If the computations have been reasonably successful, any mistakes should be apparent and can be corrected. I took first the consistent aspects of the analyses (i.e. groupings which always emerge), using them as a starting point for a re-examination of the data prior to delimiting groups for discussion. The computational methods used are so diverse in approach that any grouping emerging consistently must be very robust, and seems likely to be taxonomically sound.

The divisive methods ASOC and MULASS have evidently made the mistakes expected as a result of their dependence on key characters. For example the inclusion of Oxalis, Ranunculus and Clematis (Group II Diag. V; Group 9 Diag. VII) on the 'tenuinucellate' side of the hierarchy is certainly taxonomically unsound, and these genera are dealt with more appropriately by INFO. The distribution of Group F. INFO (Diag. I; the 'Magnolioids') across MULASS Groups 1-5, 7, 11 (Diags. IV, V) or ASOC Groups 1-6, 8, 9, 11 (Diags. VI, VII) illustrates the point that a seemingly valid group based on overall trends among the characters can be disastrously broken up under a monothetic analysis relying on key characters for absolute definition. MULASS has proved in some cases worse than ASOC for while (judged by examination of the re-arranged data matrices) it has produced some good groups (especially the 'Caryophylloids') many of its decisions are hard to commend. The treatment of Malvaceae is a prime example: the family have

been separated out with the Cucurbitaceae (Group 5, Diag. IV) at a very low level* of similarity (on the basis of polysiphonious germination of pollen grains) although a cursory examination of the data shows that in terms of the coded information (i), the two families differ in a great many features (Table 4) whilst (ii), the Malvaceae differ from the Tiliaceae and Sterculiaceae, families with which they are placed by INFO, ASOC and most systematists, in relatively few features (Table 5). This is a case where MULASS, having 'made' a heterogeneous and thoroughly unacceptable grouping has then ignored its heterogeneity and maintained it to a high level of similarity. A similar situation holds for the Melastomataceae and Cruciferae (Group I, Diag. IV), which differ in over twenty characters and yet are brought out together at a fairly low level of dissimilarity. Considerations of this sort cause me to have considerable reservations about MULASS in its present form: it seems on several occasions not to have performed the task demanded of it: i.e. it has failed to associate conspicuously similar individuals, and has maintained alarmingly heterogeneous groupings at high similarity levels.

* In discussing the hierarchies, the terms 'high level' and 'low level' refer to high and low degrees of similarity. They refer respectively to groupings appearing near the 'bases' and 'tops' of the hierarchies (Diags. I-VII).

Table 6 summarises the groupings which I intend to discuss. This arrangement is different in many respects from any published taxonomic system, but is certainly more consistent with the data presented in appendices 2 and 3. Certain aspects of it are apparent in all three analyses, and having thus emerged under fundamentally different programs seem particularly worthy of consideration. Thus the main division into tenuinucellate and crassinucellate groups, and the major subdivisions of the tenuinucellate series are all well demonstrated. Certain families (discussed later) are consistently fragmented despite the tendency to build in family units inherent in the method of data recording. However no one analysis shows all the groups as suggested in Table 6, though the INFO version comes the nearest: it has been derived, with the aid of all three analyses, from a careful reconsideration of the coded data; many individuals and minor groups (see Table 6) have proved difficult to place during my subsequent inspection. The position of these 'problem' genera varies enormously in the different analyses and the reasons may lie (at least partly) in the quality of the data. Only the acquisition of better comparative data seems likely to determine their proper positions. Indeed the Dicotyledons as a whole seem to have provided the computer with a difficult task (witness the alternative hierarchies from the three analyses which are less consistent than is usual in comparative analyses of this kind); and this could well be a

result of the poor quality of the available data, rather than anything inherent in the plants.

THE MAJOR DICHOTOMY

All the analyses show essentially the same low level distinction between two major groups, which are keyed out in divisive programs on the tenuinucellate or crassinucellate condition (e.g. Diag. I). There is a clear implication here that there are two rather distinct kinds of Dicotyledon (see Table 7 for a list of distinguishing features). Certain genera (25) are not placed consistently at this level, appearing with the 'Tenuinucelli' under divisive strategies but moving across to the 'Crassinucelli' under INFO. Subsequent sorting of the data shows that in terms of the characters listed in Table 7, Plantago, Leucopogon, Fraxinus and Jasminum definitely warrant inclusion in the 'Tenuinucelli', their position in INFO being due presumably to migration. Two convolvulaceous genera may also fall into this category, but the position of the family as a whole will be considered later. The remaining genera (Oxalis, Ranunculus etc.) seem to be rightly placed among the 'Crassinucelli' by INFO, giving a final composition of the two groups as shown in Table 6.

The concept of two main dicotyledonous series along these lines is far from new: the 'Crassinucelli' and 'Tenuinucelli' correspond to a large extent with the ideas of de Jussieu, Bentham and Hooker and Engler, all of whom accepted the Sympetalae as

a major division of the Dicotyledons (roughly equivalent to my 'Tenuinucelli') which was set against one (Engler - the Archichlamydeae) or two (Bentham and Hooker - the Polypetalae and Monochlamydeae) others. Recent systems present disguised approximations to the Sympetalae (e.g. Cronquist's Asteridae) but of late the seemingly useful division into two main groups has lost ground through taxonomists favouring several groupings of equal status. On the evidence available to me (which is neither more nor less than that available to other systematists), I agree with the earlier taxonomists that there is a group of basically sympetalous (and tenuinucellate) dicotyledonous families, standing very clearly apart from the rest.

The analyses are the result of overall similarity assessments and it is hard - indeed it would be surprising if it were otherwise - to pick out many clear cut distinctions between the 'Crassinucelli' and 'Tenuinucelli'. However inspection of the data readily reveals characters which are very unevenly distributed across the two groups, as summarised in Table 7. There is no single criterion for absolute distinction, but in a sample of this size and diversity the array of differences is impressive: they represent all aspects of the plant from floral and vegetative morphology to embryology and palynology. This appears to represent a very sound primary division of the Dicotyledons.

THE 'CRASSINUCELLI'

As Table 7 shows, this is the largest group and also the most

diverse in terms of recorded features. No single character absolutely defines it, though the crassinucellate ovules and polypetalous flowers seem to come the nearest. It may well be the size and diversity of the group together with the unreliability of available data that have led to inconsistent results among the analyses on this side of the hierarchy. The groupings proposed (Table 6) result from careful re-examination of all the data in the light of all three analyses, and do not correspond exactly with any one hierarchy; but as usual the INFO version seems to be the best. For several families (see Table 6) I am able to suggest no more than vague possibilities as to their relationships.

The 'Caryophylloids'

All analyses pick out a group or groups (Group 2, Diag. IV; Groups 9-11, Diag. II; Groups 5, 8, Diag. VI) centred on the Caryophyllaceae and roughly equivalent to Cronquist's sub-class Caryophyllidae (or the Centrospermae of earlier workers), but with certain novel additions. The best version in this circle of affinity seems to be that of MULASS, which (despite the need to remove a few misclassified genera) here achieves one of its rare successes.

Features shared by the eight 'central' families are summarised in Table 8, and they correspond to a fair extent with the diagnosis given by Cronquist for his sub-class (Table 1). It is evident from Table 8 that Cactaceae, Polygonaceae and

Nyctaginaceae contribute rather frequent exceptions to the general rules, and indeed these families tend to be isolated from the rest in the analyses. Thus INFO removes all three from this circle of affinity (Groups 13, 18a, 20b; Diag. II). They are certainly outliers here when considered alongside the other five families, but they seem more at home in this region than elsewhere.

The families so far considered comprise all my representatives from Cronquist's Caryophyllidae; but there are several other families drawn from elsewhere in his system which the analyses and subsequent studies indicate as meriting inclusion, or at least consideration, as 'Caryophylloids'; and I now propose to deal with these in turn.

The Cruciferae (Cronquist - Dilleniidae; Capparales Fig. 3) show an association with some part of the caryophylloid assemblage in all my analyses (Group E, Diag. II; Group I. Diag. IV; Groups 2, 8, Diag. VI); and despite the almost unique tetramerous flowers with tetradynamous stamens and the 'falsely' bilocular ovary, which have tended to isolate the family in taxonomic schemes (e.g. Cronquist), they share most of the definitive characters of the 'Caryophylloids' (Table 9). If the ovary is considered as 'falsely' bilocular (i.e. 'truly' unilocular), in accordance with current morphological opinion (see Lawrence 1951), even this character is in line. Their unique features mark out the Cruciferae as somewhat remote from the central members of the 'Caryophylloids', but their closest affinities appear to lie

here and they can be quite comfortably accommodated in this region.

The Primulaceae and Myrsinaceae (Cronquist - Dilleniidae; Primulales Fig. 3) are in most respects very similar families, and in past schemes are usually to be found at the base of the sympetalous group (e.g. Engler). Indeed they are sympetalous, and they are tenuinucellate as well; but they lack many of the other features (unitegmatic ovules, bilocular ovaries etc.) which are no less important in defining the 'Tenuinucelli' as a taxonomically sound group, and all things considered they seem best placed in the 'Crassinucelli'. Some systematists (e.g. Bessey 1914; Pulle 1952) have suggested relationships with the Caryophyllaceae, a view which INFO Group 10, Diag. II) fully bears out. Table 10 illustrates the extensive similarities between these two families and the central 'Caryophylloids'. There is certainly more evidence here for associating them with the 'Caryophylloids' than for placing them at the apex of the Dilleniidae (Cronquist; Fig. 3).

The Urticaceae and Moraceae (Cronquist - Hamamelidae; Urticales) are two closely related families associated with the Polygonaceae by both INFO and ASOC (Group 11a, Diag. II; Group 7c, Diag. VI). The implications of this deserve further consideration, particularly since such a relationship has been suggested in the past (e.g. Soo 1953; Novak 1964). Despite the lack of three-celled pollen the features listed in Table 11 indicate some correspondence with the 'Caryophylloids' as a whole,

and further features which the Urticales share with the Polygonaceae suggest a link with them via that family. Phylogenists such as Engler and Cronquist consider the Urticales as the climax of a sequence commencing with the amentiferous types (i.e. Engler's Amentiferae; Cronquist's Hamamelidaceae); but the highly reduced flowers of these plants present enormous difficulties when it comes to working out homologies and recording comparative data, and here in particular the lack of information from other morphological regions is serious. In the absence of further data there seems as much to be said for placing the Urticales near the 'Caryophylloids' as elsewhere.

The Oxalidaceae and Geraniaceae (Cronquist - Rosidae; Geraniales Fig. 4) are another pair of closely related families, whose similarities with the central 'Caryophylloids' (Table 12) are not as impressive as in the preceding cases. They also have similarities with the 'Celastroids' (see below), but in the absence of more and/or better data and in view of the unsatisfactory nature of the Rosidae as a group (see below) their affinities in this direction should be borne in mind.

The Araliaceae (Cronquist - Rosidae; Umbellales Fig. 4) are one of the families in the apparently unsound order Umbellales (see page 58 for further details), so that their position in the vicinity of the 'Caryophylloids' under MULASS (Group 2, Diag. IV) and ASOC (Group 7, Diag. VI) is interesting. When considered in terms of Table 8 the Araliaceae conform in having

three-celled pollen, wide primary medullary rays, no glandular hairs and dorsifixed anthers; but apart from these there are few other similarities, and a position for these plants among the 'Caryophylloids' does not appeal to me. However I am unable to suggest any other location for them.

Of the 'Caryophylloid' families only the Caryophyllaceae and Aizoaceae have disintegrated to any significant extent under my analyses. In the former the genus Paronychia is taken away and finds itself nearer the Chenopodiaceae and Amarantaceae (e.g. Group 9, Diag. II), lending support to the idea of Illecebraceae as a distinct family (accepted by several authors; e.g. Hutchinson 1959, though there is no support here for the relationship with Polygonaceae suggested by him). The subfamilies of Aizoaceae (Aizooideae and Molluginoideae) have separated to some extent under the divisive programs (e.g. groups 3, 4, Diag. VI) but the genera concerned still seem too close to justify separate families as suggested in (e.g.) Melchior (1964). INFO (Group 9, Diag. II) unites them at a very high similarity level.

The 'Magnolioids'

(a) General discussion

Of the other crassinucellate sub-classes recognised by Cronquist only the Magnoliidae (corresponding roughly with the 'Ranalian Complex' of earlier writers) receive any support at all here. Group F INFO (Diags. I and II) at least contains all the

representatives (except Piper) of this sub-class (Table 13).

However it also includes many of the Dilleniidae (Table 14), and seems in this form to provide the basis of a sound group (Table 6). Indeed the computations and subsequent consideration have failed to uncover any consistent pattern of correlations, at any level, to support a distinction between the two sets of genera making up the Magnoliidae and Dilleniidae of Cronquist.

This 'Magnolioid' aggregate (in common with the conventional, more restricted Magnoliidae) has no single defining character which is remotely serviceable, probably explaining the failure of the divisive strategies to recognise it in toto (instead they present the genera concerned as a series of discrete but scattered sub-units; e.g. Groups 3d, 3e, 4c Diag. IV). We are faced with a situation which is only to be expected at this level in the taxonomic hierarchy: i.e. trends in various characters which must be taken in combination to provide a diagnosis. The more widespread features of my 'Magnolioids' are summarised in Table 15, and in Table 16 the frequency of their occurrence in various families is scored, each family gaining a 'character value' according to the number of magnolioid features it possesses. On this basis the Malpighiaceae, Cactaceae and Myrtaceae are the only families in group F INFO which show little similarity to the central 'Magnolioids' both in terms of the number of characters in common with them, and in terms of those unusual features (apocarpy, adnate anthers, multiple perianth parts etc.) most characteristic

of the group as a whole. Clearly none of these three belong here (they do not occur in Cronquist's Magnoliidae or Dilleniidae either).

All the remaining families in group F INFO go together well though the character values in Table 16 vary. It is notable that some of the families with the highest values (i.e. the most typically magnolioid) are from Cronquist's Dilleniidae as well as Magnoliidae, for example Dilleniaceae and Flacourtiaceae. Indeed of the former Cronquist states, 'if the rest of the sub-class Dilleniidae did not exist the order Dilleniales could easily be accommodated within the Magnoliidae'. Coupled with his admission that the Dilleniidae cannot be characterised morphologically and that 'it takes its origin in the Magnoliidae' I find it hard to accept his distant separation of such similar genera as Dillenia, and Magnolia on the one hand, the while grouping together such extremes as Dillenia, Primulaceae and Ericaceae. His evidence consists entirely of supposed phylogenetic relationships for which he advances no supporting facts apart from purported 'tendencies' (i.e. correlations?) which my computational analyses repudiate. A demonstrable high degree of similarity in terms of recorded information is surely of greater taxonomic significance.

Viola and Passiflora (Cronquist - Dilleniidae; Violales, Fig. 3) are the only sampled genera not in INFO Group F which seem to merit inclusion in the 'Magnolioids'. In terms of my sample they show a general similarity with other members of the Violales

(i.e. Flacourtiaceae, Cucurbitaceae and Begoniaceae) and this idea is held by most other systematists. Even Hutchinson, who places the Violaceae at the greatest distance from any of the other families, still derives them from the region of the Flacourtiaceae. The separation of these two genera, both from each other and from the 'Magnolioids', under INFO (Groups IIb, 26b Diag. II) is evidently a case of migration: Table 16 shows they have considerable similarities with the flacourtiaceous region of the 'Magnolioids' as indicated in the ASOC analysis (Group I Diag. VI). In these terms Passiflora differs from Viola only in its regular flowers, disc and onagrad embryogeny, and both genera are comfortably accommodated in the magnolioid region.

(b) Consideration of certain sub-groupings of 'Magnolioids'

In the Ranunculaceae the sub-families Ranunculoideae and Helleboroidae are recognised under all the analyses (e.g. Groups 2d and 6, Diag. VI), the divisive programs making the distinction at a much lower level: there in fact they have emerged at levels which, in other circles of affinity, serve to distinguish families (a suggestion in line with several published opinions e.g. Hutchinson 1959). However there is no doubt that the genera are all quite closely related (and also that they have connections with the Menispermaceae; e.g. Group 17b Diag. II) and the recognition of two families only further burdens the literature with names.

The Guttiferae have often been considered as two families,

Hypericaceae and Clusiaceae (e.g. Hutchinson, 1959), and the analyses fully justify this (e.g. Groups IIb and 15a, Diag. II). Examination of Table 16 shows that both families have many magnolioid features; and the positions awarded to Hypericum in the analyses (with the 'Tenuinucelli' in divisive programs and the 'Caryophylloids' in INFO) are misleading.

The genus Salix is found with the Flacourtiaceae in all three analyses (e.g. Group 15c, Diag. II) which is in accord with modern ideas (e.g. Cronquist). The view that they are a 'primitive' family (in the 'Amentiferae') justifiably finds little credence nowadays despite its reiteration in the latest Syllabus of Engler (1964).

The Capparidaceae are a small family represented in my sample by the type genus Capparis alone. The family as a whole are generally considered to be very closely related to Cruciferae (order Capparales, Cronquist etc.), but no such idea emerges in my analyses. Perhaps Hutchinson's woody/herbaceous notion can take a crumb of support here: he alone suggests (1967) that the sub-family Capparoideae (containing Capparis) is completely distinct from the Cleomoideae, with the latter related to Cruciferae (in the 'Herbaceae') and the former connected with Flacourtiaceae ('Lignosae'; c.f. Group 15, Diag. II). Certainly the Cleomoideae have many features in common with the Cruciferae (especially in the unusual nature of the corolla and ovary) which are lacking in Capparis; and the latter seems to fit well among the 'Magnolioids'.

The Order Magnoliales is represented in my sample by the families Magnoliaceae, Annonaceae, Lauraceae, Winteraceae and Myristicaceae. The value of the order is affirmed by all analyses, and Table 16 confirms the high degree of similarity among them.

(c) The Genus Piper

Only one genus from my sample of those usually regarded as magnolioid (e.g. in the Magnoliidae of Cronquist) has been excluded from my much extended 'Magnolioid' assemblage. This is Piper. The very reduced nature of the flower makes the coding of data for this genus particularly difficult, and its exclusion may be due to a high number of fallacious negative correlations. However these same factors have also been operative with Salix without apparently upsetting the result; and even allowing for them, the number of magnolioid features exhibited by Piper is low (Table 16). If considered as a 'Magnolioid' it is the only genus to have cruciferous stomata, the anthers are neither adnate nor extrorse, the ovary syncarpous, unilocular and with a long style, the ovules orthotropous with cellular endosperm, the placentation basal and the embryogeny and stem anatomy of an unusual nature. There seems to be no evidence anywhere to support Cronquist's strongly asserted view that 'the Piperales are clearly derived from the Magnoliales'; but in the absence of further data I find it hard to suggest any alternative position for the genus.

A Review of the Treatment of the Members of the Dilleniidae

Cronquist considers this sub-class as one of the two major lines of dicotyledonous evolution from the 'primitive' Magnoliidae, though seemingly not leading to the 'advanced' Asteridae (Fig. 2). His claim that the group can be characterised by 'critical tendencies' is not borne out by my computational work, so it may be useful to summarise here the fate of the constituent families.

Of the twenty-one families of Dilleniidae represented in my sample, twelve appear to belong with the 'Magnolioids'. Three of the remaining nine, the Ericaceae, Epacridaceae and Sapotaceae, are transferred on what appear to be reasonable grounds to the 'Tenuinucelli', whilst the other two sympetalous families (Primulaceae and Myrsinaceae) show abundant similarities with the 'Caryophylloids' where they are comfortably at home. The Cruciferae also seem best placed in that region though they are somewhat distinct from the rest, and their separation from the sub-family Capparoideae of the Capparidaceae seems fully justified. The other three sampled families form the taxonomically convincing Malvales (Malvaceae, Tiliaceae, Sterculiaceae) whose position in the overall scheme of things will be considered later.

The Rosidae

This is the largest of Cronquist's sub-classes and is proportionately represented in my sample by genera from twenty-seven families. Like the Dilleniidae the group is defined only

in terms of unsubstantiated tendencies and appears to represent feeble taxonomy. It is scarcely surprising that under INFO Rosidae form significant proportions of Groups E, G, H and I (Diag. II), and are just as widely scattered across the hierarchies for ASOC and MULASS.

The mass of families encompassed by this sub-class undoubtedly pose the biggest problem in the taxonomy of the Dicotyledons, and I freely acknowledge that my analyses come nowhere near solving it. However I hope I can at least draw attention to the fact that a major problem exists which the erection of a group, the Rosidae, serves only to hide. There seem to be no measureable correlations, so far as recorded data go, to justify such an assemblage; neither do the families here (unlike most of those in the Dilleniidae) lend themselves to disposal among the other groupings on the basis of character correlations. Indeed the position in the hierarchies of some of the representatives seems to be governed rather by a lack of overwhelming similarity with any group than close affinity with those in which they find themselves (e.g. Malpighiaceae in Group F, Diag. II; Table 16).

Taken as a whole the genera concerned lack most of the more 'unusual' characters which, in various combinations, help to mark out the other groups. The Rosidae consist of disconcertingly 'ordinary' Dicotyledons; genera exhibiting throughout their character lists the commonest dicotyledonous features. My information is as good and as extensive as that available to

anyone; so it seems that the data used are too poor or too few in the present state of knowledge for these genera to be placed with any confidence. The real need is not for yet more permutations of the families to give different, supposedly phylogenetic, arrangements, but for the genera concerned to be studied much more carefully at the primary level of assessing variation, prior to a complete re-assessment. It seems highly probable that it is the inadequacy of the data (rather than the computational stratagems) that is responsible for my inconsistent results.

Having painted an intentionally gloomy picture of the Rosidae, I shall now discuss such groupings among the genera concerned as the analyses and subsequent considerations allow one to define with any confidence.

(a) The Leguminosae and the Order Rosales

Nearly twenty-five per cent of the total species in the Rosidae belong to this family. In most systems (e.g. Engler 1892; Cronquist 1968) they are placed with the Rosaceae in the order Rosales or its equivalent. If Cronquist's statement that the order is 'held together by a complex pattern of overlapping similarities' had any substance, a computational analysis of the Dicotyledons on this scale should have established it beyond reasonable doubt; but no such verification is evident in my work. Indeed an examination of the data matrix for the two families, whilst showing a degree of heterogeneity for each,

shows many more significant differences between the two than have hitherto been remarked on (Tables 17 and 18). Several of the coincident features listed in Table 18 are actually of very wide-spread occurrence in the 'Crassinucelli' at large, which reduces their significance as evidence of relationship. In terms of all the three computed hierarchies the supposed relationship of these two families receives no support at all. Wood studies (page 121) further emphasise the enormous differences in relative dicotyledonous terms between the two; and in view of all this I am highly sceptical about the possibility of anyone defining a credible grouping to encompass them. (The introduction of additional 'Rosalean' families, e.g. Saxifragaceae, lends still more diversity).

The Leguminosae occupy an isolated position in all the analyses (e.g. Group I, Diag. II), and in the absence of any clear indication of affinity this seems to do them justice. The three sub-families appear in all three analyses (though sometimes at a high level of similarity); but it is noteworthy that whilst the Mimosoideae and Papilionoideae are always separated, the Caesalpinioideae, at very high levels of similarity, shift their position nearer to one or the other depending on the hierarchy considered, and appear somewhat intermediate. (For further discussion see page 121).

(b) The 'Celastroid' Circle of Affinity

Table 6 lists the families which seem possible candidates for this group. (INFO Groups 22-23, Diag. II present the basis of the group, the other central families listed being variously

associated with them in the divisive hierarchies e.g. Groups 3k and 3i, Diag.IV). Again no neat diagnosis is possible, as the group reflects correlations among features few of which are even approximately of constant occurrence. However the constituent families seem to form a useful collection, characterised largely by woody species with entire evergreen leaves and anomocytic stomata, regular flowers, axile placentation and bitegmic ovules with the outer integument contributing to the micropyle; though admittedly none of these features is particularly unusual amongst Dicotyledons as a whole.

The families making up my 'Celastroids' are placed by Cronquist in the three orders Sapindales, Celastrales and Rhamnales, which are generally placed in close proximity (e.g. Cronquist 1968, Fig. 4; Engler 1892). The Zygophyllaceae, placed by Cronquist in the Sapindales, seem nearer Geraniaceae and Oxalidaceae (see Group IIb, Diag. II) in accordance with Takhtajan's (1964) suggestion that the family belongs in the Geraniales. This order is undoubtedly somewhat remote from the central 'Celastroids', and the latter two families have certain similarities with the 'Caryophylloids' (see page 44). Geraniales may prove to be a link between the two main groups; but in the Dicotyledons the taxonomic situation regarding major assemblages is insufficiently clear to speak of 'intermediates' with much conviction.

The three families of Malvales (Malvaceae, Tiliaceae and Sterculiaceae) are one of the most convincing aggregates of

Dicotyledons. Their relationship with the Euphorbiaceae and in turn with the central 'Celastroids' (e.g. INFO Group H, Diag. II) seems genuine. Indeed relating them with the Euphorbiaceae is not even a new idea (e.g. Pulle 1952), so it is hard to be enthusiastic about Cronquist's action in placing the Malvales far away in the Dilleniidae (Fig. 3).

Families of Uncertain Position

There follow sporadic, miscellaneous remarks about various families of the 'Crassinucelli' which have been treated inconsistently under the three analyses and whose overall position subsequent contemplation has not clarified.

(a) Betulaceae, Fagaceae and Platanaceae

These three families form part of the small Hamamelidae (Fig. 2) of Cronquist or the Amentiferae of earlier schemes. They at least appear together in all my analyses (e.g. Group 20c, Diag. II), but the greatly reduced flowers make them particularly inaccessible for comparison with other forms in terms of the kind of data most widely available. This fact coupled with the small size of my sample (3 genera only) makes their erratic behaviour under my analyses understandable.

(b) Rosaceae, Saxifragaceae s.s. and Crassulaceae

The sub-family Chrysobalanoideae of the Rosaceae, so far as my tiny sample goes, certainly merit the family status they are awarded

nowadays (e.g. Cronquist). In fact there are indications that the Rosaceae and Chrysobalanaceae may be much more different than is implied even by authors who separate them at family level (e.g. Groups 18b and 20b, Diag. II).

That the samples from Crassulaceae and Saxifragaceae s.s. are closely related is manifest (e.g. Group II, Diag. II), but there is no indication that they are connected with the Rosaceae - a further nail in the coffin of the Rosales, in which they supposedly belong.

(c) Thymeleaceae and Proteaceae

Some authors group these two families close together on their undoubted similarity, while others separate them and claim convergent evolution. My representatives are all very similar and the INFO analysis joins them at a high level (Group 21, Diag. II). In the absence of factual evolutionary evidence (which in a situation like this can only mean very complete series of fossils) it seems absurd to invoke the unlikely event of convergence over so wide a range of attributes. From the standpoint of functional taxonomy we are clearly dealing with one distinct and probably rather isolated group.

(d) Santalaceae and Loranthaceae

The widely acknowledged close relationship of these two families (the order Santalales) is confirmed (e.g. Group 20b, Diag. II). However their association with other genera characterised by reduced floral apparatus (Piper, Betula, Quercus etc. e.g. Groups

20b and 20c, Diag. II) probably reflects the impossibility of placing such forms in the absence of sufficient alternative data.

(e) 'Umbelliflorae' (Umbellales; see also pages 44 and 66)

These families (Cornaceae, Araliaceae, Umbelliferae) have so little in common apart from inferior ovaries and inconspicuous calyces that it is hard to see why they were ever associated, let alone why they persist into modern times as a group. The Cornaceae have for long been recognised as entirely different from the others (on the basis of leaf form, phyllotaxy, nodal anatomy, inflorescence etc.) by all but taxonomists writing floras, and my analyses merely emphasise the facts. The fundamental differences between the Umbelliferae and Araliaceae seem to be less widely appreciated even outside formal taxonomic circles, although they are quite impressive: Table 19 shows a large number of distinctions, and these are reflected in the complete separation of the two families (on either side of the main dichotomy) in all analyses. In this light Walters' (1961) choice of Araliaceae and Umbelliferae to illustrate an important aspect of taxonomic theory seems particularly unfortunate.

(f) Myrtaceae, Melastomataceae and Onagraceae

These families are all members of the order Myrtales (Fig. 4) which has long been recognised in some form (e.g. Engler's Myrtiflorae). The presence of internal phloem has been taken as testifying to the soundness of the group, and indeed its

presence is not in dispute. However while the majority of species are said (see Cronquist) to be tetramerous, and whilst this condition undoubtedly occurs here (e.g. Onagraceae) it by no means typifies the two largest families (Myrtaceae and Melastomataceae). Sporne (1969) notes a large range of Advancement Indices for the order - Myrtaceae 27, Melastomataceae 45, Onagraceae 60 (see also page 39) which could be taken as a further indication that there may be something wrong taxonomically. My analyses scatter the families and it appears that the order needs reconsideration: too much emphasis may have been placed on the occurrence of internal phloem, which is in any case quite widespread elsewhere in the Dicotyledons (see Metcalfe and Chalk 1950).

THE 'TENUINUCELLI

Table 7 shows that of the two main dicotyledonous series this is the more clearly defined: a fact perhaps due partly (but not necessarily entirely) to its smaller size. The constitution of the group set out in Table 6 is that of Engler's Sympetalae, with Primulaceae and Myrsinaceae excluded (see page 43) and Umbelliferae added. When a sympetalous group is evident in modern schemes (e.g. Cronquist's Asteridae) all the pentacyclic families are omitted; and no system formally suggests the inclusion of the Umbelliferae though in several (e.g. Engler's) they are placed at the culmination of the polypetalous types.

The Main Sub-division of the 'Tenuinucelli' into 'Asclepioids' and 'Acanthoids'

Within the 'Tenuinucelli' there seem to be two basic circles of affinity, which have been picked out in all my analyses (e.g. Groups A and C Diags. I and II) - the 'Asclepioids' and 'Acanthoids'. The constituent families are given in Table 6. These two groups are largely overlooked in published taxonomic schemes; but Table 20 draws attention to the considerable differences between them. The 'Asclepioids' comprise most of the families found near the base of phylogenetic trees for sympetalous genera: e.g. Cronquist's Gentianales and Rubiales, Fig. 5; together with the Ebenales (which are placed as climax to his 'lower' Dilleniidae, Fig. 3). The 'Acanthoids' on the other hand are to be found at 'higher phylogenetic' levels (e.g. Lamiales, Scrophulariales and Dipsacales of Cronquist; Fig. 5).

In terms of the data in Table 20 at eight tenuinucellate families in parentheses in Table 6 do not conform so well with the main sub-groupings and a number do not fall convincingly in either. It is these that I shall now consider.

(a) Families Seemingly Related to the 'Asclepioids'

The Convolvulaceae, of all the families sampled, are treated in the most puzzling way under all the analyses. The genera persistently appear with the 'Crassinucelli' (e.g. Group II, Diag. II), despite their consistent and apparently justified

position among the other sympetalous families in all published taxonomic schemes. Certainly the nucellus, where known (Davis 1966), is far from consistently tenuinucellate, the Convolvulaceae would be unique among the 'Tenuinucelli' in the possession of free sepals and bitegmic ovules. However, with the exception of the small number of ovules per locule (acanthoid), they have many similarities with the 'Asclepioids' (e.g. regular sympetalous flowers, bicollateral bundles, nuclear endosperm, latex). As things stand at present, I am inclined to think that these genera do belong in the 'Tenuinucelli', and with the 'Asclepioids' (indeed this is where such genera as do ever appear in the 'Tenuinucelli' in my analyses occur; e.g. Group 7a, Diag. V; Group 11b, Diag. VII). (The position of Convolvulaceae under INFO, Group II, Diag. II, is of passing interest since they are here found with Geranium, Oxalis, Crassula and Saxifraga - genera suggested by Wettstein (1923) as their possible ancestors).

The Ericaceae and Epacridaceae are usually considered closely related and this is fully confirmed by the analyses (e.g. Group 9b, Diag. V) - the removal of Leucopogon from the 'Tenuinucelli' under INFO being presumably a case of migration. With the exception of the usually cellular endosperm and the few ovules/locules in Leucopogon (due however to abortion after fertilization - see Paterson 1961) the families possess many asclepioid characters and a position in this region seems justified.

(b) Families Seemingly Related to the 'Acanthoids'

The Genus Plantago (Plantaginaceae) has long puzzled systematists trying to place it in a taxonomic scheme. The reduced, tetramerous, wind pollinated flowers with scarious corollas mark the genus out as unusual (and render it somewhat intractable when so much of the available comparative data is floral), but it is normally regarded as a secondary reduction derived from the 'advanced' Scrophulariales (Engler, Wettstein, Cronquist etc.; an argument however which is not put with much conviction). My analyses do not throw much light on the problem: the endosperm and embryogeny are in line with the 'Acanthoids' but the regular flowers are asclepiod. Probably the present state of knowledge allows no definite conclusions as to its 'correct' taxonomic position, but the greater similarities with the 'Acanthoids' suggest (in conformity with the phylogenists) that it has more in common with this group.

(c) Families Seemingly more or less Intermediate between 'Asclepioids' and 'Acanthoids'.

Four families seem to share the characteristics of the two main sub-groups in terms of the data in Table 20. The computed hierarchies reflect this situation in that the families appear first with one, then with the other sub-grouping.

The Solanaceae appear to come nearer to the 'Asclepioids'; the usually regular flowers, bicollateral bundles, solanad embryogeny and albuminous ovules all suggest this. However the

cellular endosperm, occasional reduction of stamen number and the zygomorphic nature of the flowers of some genera (e.g. Schwenkia, Brunfelsea) are acanthoid.

The Boraginaceae also usually have regular flowers, and this fact taken with the five equal stamens and basifixed anthers suggest affinities with the 'Asclepiods'; but the small numbers of exalbuminous ovules/locule are acanthoid. Again an intermediate position, but one nearer the 'Asclepioids', is perhaps indicated.

Fraxinus and Jasminum, the genera sampled from the Oleaceae are asclepioid in their regular flowers with equal stamens and in their solanad embryogeny; but the cellular endosperm and few exalbuminous ovules/locule are acanthoid and in terms of my data they can only be regarded as intermediate.

The Campanulaceae consistently split into the sub-families Lobelioideae and Campanuloideae at some level in all analyses (e.g. Croups 10a and 11f, Diag. VII), but only under ASOC (where the key character Regular/Zygomorphic is used at a low level of similarity) is this distinction at a level justifying the family rank awarded by some writers (e.g. Hutchinson 1959). Phylogenetically the Campanulaceae s.l. are often placed near the climax of sympetalous series; but my data suggest that they fall between the 'Asclepioids' (many ovules/locule, solanad embryogeny, some with regular flowers) and the 'Acanthoids' (cellular endosperm, well developed disc, some with zygomorphic flowers).

(d) The Interrelationships among the central 'Asclepioids'

All the families maintain their identities to very high levels, but the differences between Asclepiadaceae and Periplocaceae are so small that the long-held (e.g. Engler) view that the latter should be considered as a sub-family of the former seems warranted. These two together with the Apocynaceae and Gentianaceae always appear in close proximity (e.g. Groups 7a and 7b, Diag. V), confirming the taxonomic soundness of the order Gentianales (Engler, Cronquist Fig. 5, etc.). The Rubiaceae are more remote from these families but clearly belong near at hand. Until fairly recently they were usually placed near the Compositae (Engler, Bessey etc.) and widely separated from the members of my 'Asclepioid' grouping; but more recently suggestions in line with the results of my analyses have appeared, with Wagenitz (1959) considering them part of the Gentianales and Cronquist 'deriving' them directly from that order.

Cronquist's view that the Sapotaceae (order Ebenales) are climactic to his Dilleniidae and have no connection with his Asteridae (i.e. my 'Tenuinucelli' p.p.) is hard to swallow in view of (a) the frailty of the former sub-class (page 51) and (b) the great similarity of the family with the rest of the 'Asclepioids'. They are perfectly at home in the 'Tenuinucelli' and probably belong with the Ericaceae and Epacridaceae as indicated in ASOC Group 11f (Diag. VII).

(e) The Interrelationships among the central 'Acanthoids'

The only family in this vicinity which does not retain its identity to high levels is the Scrophulariaceae, where Selago and Hebenstretia are consistently removed (e.g. Groups 1b and 2, Diag. III). This is in keeping with the view now often expressed (e.g. Hutchinson 1959) that they merit a separate family (Selaginaceae). The usual position for this family is near to the Scrophulariaceae, but my analyses, and the original data, suggest more intimate relationships with the Labiatae and Verbenaceae (e.g. Group 1b, Diag. III).

An unexpected inclusion in this group is Lonicera. The usual theory about Caprifoliaceae is that they are related to Rubiaceae (Engler etc.); but none of my analyses give any indication of this. Wagenitz (1959) has suggested that the similarities between Rubiaceae and Caprifoliaceae are due to convergence, and that the two are not closely related. In terms of my sample there are not many similarities between them, and Lonicera rightly belongs in the 'Acanthoids'.

The Compositae

These were one of the earliest assemblages of plants to be recognised (e.g. Theophrastus, c. 300 B.C.) and though they are the largest of dicotyledonous families, there seems no reason for doubting the taxonomic worth of the group. All my analyses pick them out sharply from the rest of the 'Tenuinucelli' (e.g. Group 3, Diag. III); and they seem best treated as an isolated

grouping at the same level as 'Asclepioids' and 'Acanthoids'. If they are referable to either of these two main sub-groupings, they must be considered as acanthoid (zygomorphy, cellular endosperm and single basal exalbuminous ovule).

The Umbelliferae

All analyses place this family in the 'Tenuinucelli'. They have most of the characteristic features of that group (Table 7) differing only in their free petals (though the epigynous nature of the flower could be used to argue that morphologically the corolla is fused to the ovary) and the divided style. In older 'phylogenetic' schemes (e.g. Engler) the family terminate the polypetalous series, presumably indicating an approach to the sympetalous forms. With the steady obscuring of the Polypetalae/Sympetalae distinction their position has varied (though they usually terminate one group or another). As long ago as 1763, Adanson, on the basis of his primitive statistical work, placed them at the start of a sympetalous series which preceded any of his polypetalous groups, but this idea has been ignored. I see no reason for excluding the Umbelliferae from the 'Tenuinucelli' despite their polypetalous flowers; but like the Compositae their distinctive nature seems to warrant a position somewhat apart from the two main sub-divisions of that group. Their distant affinity with the 'Asclepioids' as indicated by INFO (Group 8, Diag. III) lends support to phylogenists (Bessey, 1914; Pulle, 1952 etc.) who place them as ancestral to the Rubiales, and they

are certainly asclepioid in their regular flowers, embryogeny and endosperm formation.

At the highest levels of similarity the differences between the Hydrocotyloideae, Saniculoideae and the rest of the family are reaffirmed, but on this evidence separate families appear unjustified.

Table 2. Summary of coding procedure for comparative observations on Dicotyledons, for MULASS analysis. First mentioned state is scored as positive if present.

QUALITATIVE

- | | |
|---------|--|
| General | 1. Climbing exhibited by genus / not. |
| | 2. Parasitic habit / not. |
| | 3. Leaves and/or stems succulent / not. |
| Leaf | 4. At least some species leafless / all with leaves.
(Characters 5-16 inapplicable if all species in genus leafless.) |
| | 5. Both evergreen and deciduous species in genus / only one or the other (inapplicable if all annual). |
| | 6. Deciduous leaves only / evergreen leaves only
(inapplicable if all annual or if 5 is positive). |
| | 7. Compound leaves present / all leaves simple. |
| | 8. Leaf or leaflet margins both entire and nonentire in genus / only one or other. |
| | 9. Leaf or leaflet margins nonentire only / entire only (inapplicable if 8 is positive). |
| | 10. Stipulate / estipulate. |
| | 11. Pinnate venation only / palmate venation only
(inapplicable if 12 is positive). |
| | 12. Both pinnate and palmate venation in genus / only one or the other. |

Table 2 contd.

	13. Radical rosette present / absence (inapplicable if all trees or shrubs).
	14. Leaf epidermis papillose / not.
	15. Hypodermis present / absent.
	16. Vertically transcurrent veins in leaf / not.
Stem	17. Bicollateral bundles recorded / not.
	18. Primary medullary rays in young stem wide / narrow.
	19. Lactifers present / absent.
	20. Cork cambium arising deep in cortex / in the epidermis.
	21. Wood ring or semi-ring porous / diffuse porous (inapplicable if all herbs).
	22. Vessels with scalariform end-plates / simple end-plates.
	23. Vessels with vestured pits / not.
	24. Wood with septate fibres / normal fibres (inapplicable if all herbs).
	25. Wood-fibres with bordered pits / simple pits (inapplicable if all herbs).
Flower	26. Zygomorphic / actinomorphic.
	27. At least some species in genus with inflorescences / all species in genus single-flowered.

Table 2 contd.

-
28. At least some species in genus single-flowered /
all species with inflorescences.
 29. Ultimate portion of inflorescence cymose /
racemose (inapplicable if all species single-
flowered).
 30. Apetaly recorded for genus / not.
 31. Petals in more than one whorl / in one whorl
(inapplicable if all species apetalous).
 32. Non-pentamerous / pentamerous.
 33. Stamens all fertile / some replaced by
staminodes.
 34. Stamens epipetalous / not.
 35. Stamens equal-sized / unequal-sized.
 36. Filaments all free from each other / at least
some partly fused.
 37. Anthers free / connate.
 38. Anthers dehiscent by pores / slits.
 39. At least some anthers dehiscent extrorsely /
all introrse.
 40. Anthers bisporangiate / tetrasporangiate.
 41. Anthers appendaged / not.
 42. Initially more than one middle layer in anther
wall / only one middle layer.

Table 2 contd.

	43. Tapetum amoeboid / glandular.
	44. Pollen shed in aggregates / as single grains.
	45. Pollen germination polysiphonious / monosiphonious.
	46. Pollen peri-aperturate / stephano-aperturate (inapplicable where other conditions occur).
	47. At least some pollen two-celled when shed / all three-celled.
	48. Gynoecium syncarpous / apocarpous.
	49. True apocarpy / 'secondary' apocarpy (e.g. Labiatae) (inapplicable if 48 positive).
	50. Style lacking / present.
	51. Ovule bitegmic / unitegmic.
	52. In bitegmic ovules outer integument contributing to micropyle / not (inapplicable if 51 negative).
	53. Endothelium formed by inner layer of integument / not.
	54. Tenuinucellate / crassinucellate.
	55. Endosperm formation cellular / nuclear.
	56. Embryo-sac development at least sometimes departing from <u>Polygonum</u> type / always <u>Polygonum</u> type.
	57. Aril present / absent.
	58. Disc present / absent.
Fruit and seed	59. Seed albuminous / exalbuminous.

Table 2 contd.

-
60. Fruit fleshy / dry.
61. Fruit dehiscent / indehiscent. (inapplicable if 60 positive).
62. Dehiscence at least partly septicial / all loculicidal (inapplicable if 60 positive or 61 negative).

NON-EXCLUSIVE MULTISTATES

- | | |
|---------|---|
| General | 1. Habit. (i) Annual herbs; (ii) perennial herbs; (iii) shrubs; (iv) trees. |
| | 2. Type of climbing. (i) Stem twiners; (ii) tendril climbers; (iii) root climbers; (iv) scramblers. |
| | (Inapplicable if Qualitative 1 negative). |
| Leaf | 3. Arrangement. (i) Alternate; (ii) opposite; (iii) whorled. |
| | (Inapplicable if all species leafless). |
| | 4. Stomata. (i) Anomocytic; (ii) anisocytic; (iii) paracytic; (iv) diacytic. |
| | 5. Appearance of bundle at distal end of petiole. |
| | (i) Dissected; (ii) entire; (iii) ring; (iv) arc. |

Table 2 contd.

	6. Hairs. (i) Unicellular, unbranched, nonglandular; (ii) unicellular, branched, nonglandular; (iii) unicellular, unbranched, glandular; (iv) multicellular, unbranched, nonglandular; (v) multicellular, branched, nonglandular; (vi) multicellular, glandular.
Flower	7. Ovary position. (i) Hypogynous; (ii) perigynous; (iii) epigynous. 8. Sexuality. (i) Hermaphrodite; (ii) unisexual; (iii) polygamous. 9. Sepalar fusion. (i) Free; (ii) partly fused; (iii) more or less completely fused. (Inapplicable if flower epigynous or perigynous). 10. Calyx aestivation. (i) Imbricate; (ii) valvate; (iii) open. 11. Petalar fusion. (i) Free; (ii) partly fused; (iii) more or less completely fused. (Inapplicable if all species apetalous). 12. Corolla aestivation. (i) Imbricate; (ii) valvate; (iii) contorted. (Inapplicable if all species apetalous). 13. Stamen (+ staminode) numbers. (i) Equal to the number of perianth parts; (ii) less than the number of perianth parts; (iii)

Table 2 contd.

- essentially double the number of perianth parts. This is an indication of two whorls of stamens, the number may not be exactly double, but show some reduction between double and equal; (iv) many.
14. Anther fixing. (i) Dorsifixed; (ii) basifixed (iii) apifixed; (iv) adnate; (v) versatile.
15. Locule (or carpel) number. (i) Essentially the same or more than the components of each perianth whorl; (ii) reduced to the bilocular state; (iii) reduced to the unilocular state; (iv) reduced to the trilocular state.
16. Ovules / locule. (i) One; (ii) two; (iii) several.
17. Placentation in unilocular ovaries. (i) Parietal; (incl. apocarpous types) (ii) basal; (iii) apical; (iv) free central.
(Inapplicable if ovary plurilocular).
18. Placentation in plurilocular ovaries. (i) Axile; (ii) basal; (iii) apical.
(Inapplicable if ovary unilocular).

Table 2 contd.

-
19. Ovule type. (i) Orthotropous; (ii) anatropous;
(iii) campylotropous.
20. Embryogeny. (i) Onagrad; (ii) asterad;
(iii) caryophyllad; (iv) solanad;
(v) chenopodiad.

NUMERICAL

1. Degree of stylar fusion.

<u>Numerical Value</u>	<u>Category</u>
2	Styles free.
4	Styles fused near base.
6	Styles fused above base but split below stigmas.
8	Only stigmas free.
10	Stigmas fused also.

Intermediate values are used when a genus shows
a range across two categories.

(Inapplicable to apocarpous types, and groups
such as the Asclepiadaceae where stigmas are
fused and styles free).

Table 3. Coding instructions for ASOC and INFO analyses. All characters are qualitative, the first state being recorded in Appendix 3 as positive, the second as negative. (Characters 4-5 masked out in the analyses).

General.	1. Climbing / not.
	2. Woody / not.
	3. Herbaceous / not.
Leaf	4. Evergreen / not (Annuals negative).
	5. Deciduous / not (Annuals positive).
	6. Compound leaves present / not.
	7. Leaf or leaflet margin entire / not.
	8. Leaf or leaflet margin non-entire / not.
	9. Stipulate / estipulate.
	10. Palmate venation present / absent.
	11. Radical rosette present / absent.
	12. Leaves all alternate / at least some opposite or whorled.
	13. Stomata anomocytic / not.
	14. Stomata anisocytic / not.
	15. Stomata paracytic / not.
	16. Stomata diacytic / not.
	17. Epidermis papillose / not.
	18. Hypodermis present / absent.
	19. Vertically transcurrent veins present / absent.
	20. Glandular hairs present / absent.

Table 3 contd.

	21. Nonglandular hairs present / absent.
Stem	22. Bicollateral bundles present / absent.
	23. Primary medullary rays in young stem wide / narrow.
	24. Lactifers present / absent.
	25. Vessels with scalariform end-plates / simple end-plates.
Flower	26. Zygomorphic / actinomorphic.
	27. At least some species in genus with inflorescences / all species in genus single-flowered.
	28. At least some species in genus single-flowered / all species in genus with inflorescences.
	29. Ultimate portion of inflorescence cymose / racemose (genera where all species are single- flowered recorded as negative).
	30. Hypogynous / not.
	31. Hermaphrodite only / at least some unisexual or polygamous.
	32. Sepals definitely free / sepals to some extent fused (perigynous and epigynous flowers recorded as negative).
	33. Aestivation of calyx imbricate / not.
	34. Aestivation of calyx valvate / not.
	35. Corolla definitely sympetalous / not.
	36. Apetaly recorded for genus / not.

Table 3 contd.

-
37. Petals in more than one whorl / in one whorl
(apetalous types negative).
 38. Aestivation of corolla imbricate / not.
 39. Aestivation of corolla valvate / not.
 40. Aestivation of corolla contorted / not.
 41. Flowers pentamerous / non-pentamerous.
 42. Stamens in a definite numerical relationship
to perianth parts / not.
 43. Stamens less in number than perianth parts / not.
 44. Stamens many / not.
 45. Stamens epipetalous / not.
 46. Stamens unequal-sized / equal-sized.
 47. Filaments all free from each other / at least
some at least partly fused.
 48. Anthers free / connate.
 49. Anthers dehiscent by pores / slits.
 50. At least some anthers dehiscent extrorsely /
all introrse.
 51. Anthers bisporangiate / tetrasporangiate.
 52. Anthers dorsifixed / not.
 53. Anthers basifixed / not.
 54. Anthers adnate / not.
 55. Anthers versatile / not.
 56. Anthers appendaged / not.

Table 3 contd.

-
57. Initially more than one middle layer in anther wall / only one middle layer.
 58. Tapetum amoeboid / glandular.
 59. Pollen shed in aggregates / as single grains.
 60. Pollen germination polysiphonious / monosiphonious.
 61. Pollen peri-aperturate / stephano-aperturate (other conditions negative).
 62. At least some pollen two-celled when shed / all three-celled.
 63. Syncarpous (incl. 'secondary' apocarp) / apocarpous.
 64. Locule (or carpel) number equal to number of perianth parts / not.
 65. Ovary bislocular (or of two carpels) / not.
 66. Ovary unilocular (or of one carpel) / not.
 67. Ovary trilocular (or of three carpels) / not.
 68. Several ovules per locule (or carpel) / one or two ovules per locule (or carpel).
 69. Placentation parietal / not.
 70. Placentation basal / not.
 71. Placentation apical / not.
 72. Placentation free-central / not.
 73. Placentation axile / not.

Table 3 contd.

	74. Style lacking / present.
	75. Styles (or stigmas if styles lacking) more or less fused / more or less free (apocarpous types recorded as free).
	76. Campylotropy recorded for genus / not.
	77. Ovule bitegmic / unitegmic.
	78. Outer integument contributing to micropyle / not (unitegmic ovules negative).
	79. Endothelium formed by inner layer of integument / not.
	80. Tenuinucellate / crassinucellate.
	81. Endosperm formation cellular / nuclear.
	82. Embryogeny onagrad / not.
	83. Embryogeny asterad / not.
	84. Embryogeny caryophyllad / not.
	85. Embryogeny solanad / not.
	86. Aril present / absent.
	87. Disc present / absent.
Fruit and seed	88. Seed albuminous / exalbuminous.
	89. Fruit fleshy / fruit dry.
	90. Fruit dehiscent / fruit indehiscent.

Diagram I. The INFO hierarchy at the nine group level. For the actual constitution of the groups see the legends to Diagrams II and III.

Scale: Information Content

DIAGRAM I

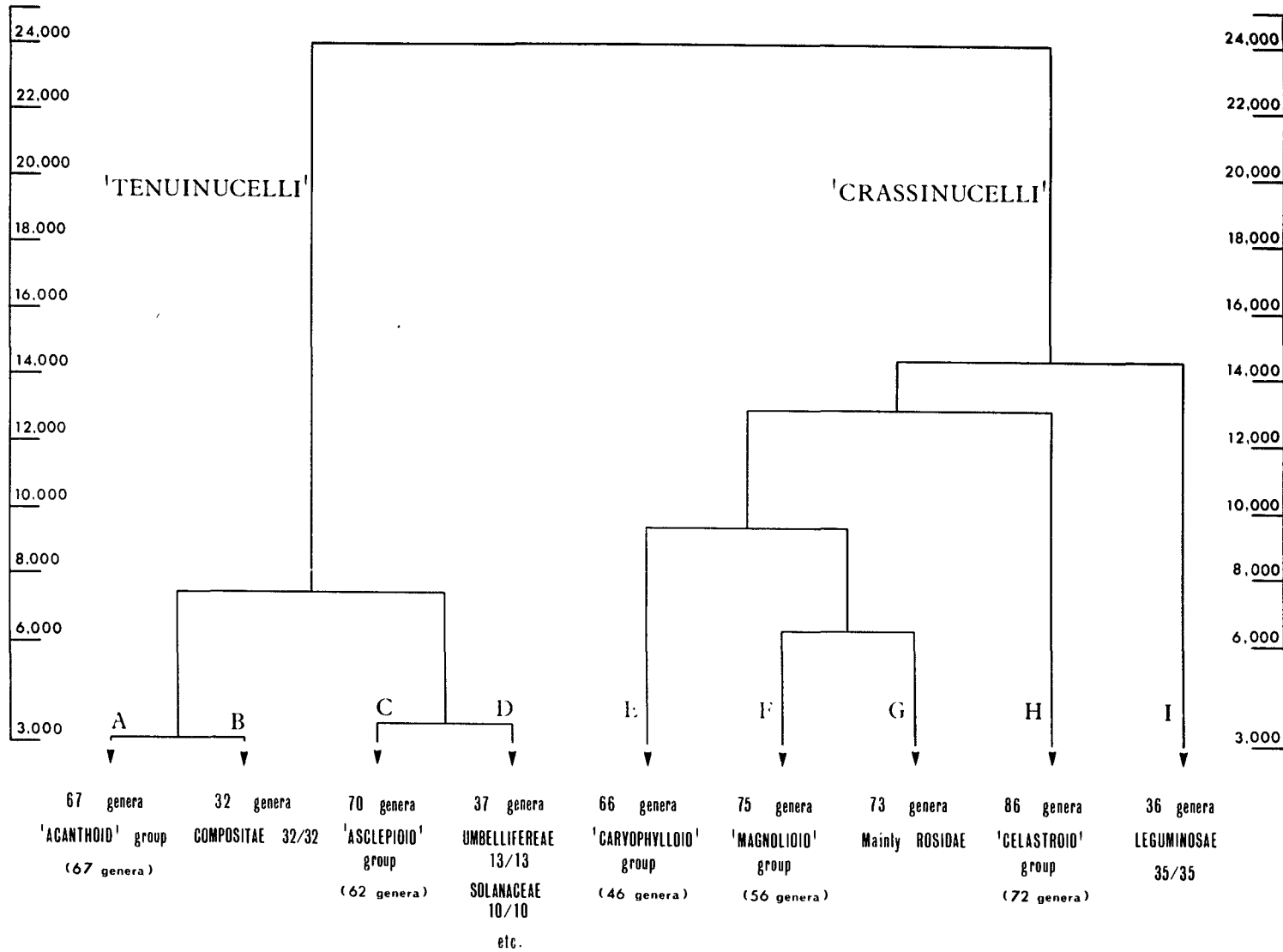


Diagram II. The INFO hierarchy for the 'Crassinucelli'. The numbers refer to the genera list (Appendix I).

Scale: Information Content

Group E

Subgroup 9.

Aizoaceae; 9-13. Amarantaceae; 14-8.. Chenopodiaceae;
98-105. Caryophyllaceae; 87.

Subgroup 10

Caryophyllaceae; 82-6, 88-90. Myrsinaceae; 497-9.
Primulaceae; 511-2.

Subgroup 11.

Convolvulaceae; 138-44. Onagraceae; 504-5. Aceraceae; 522.
Geraniaceae; 535. Plantaginaceae; 540. Crassulaceae; 482-3.
Saxifragaceae; 514-5. Violaceae; 520. Zygophyllaceae; 521.
Oxalidaceae; 537. Guttiferae; 489. Plumbaginaceae; 542.

Subgroup 12.

Cruciferae; 145-57.

Group F

Subgroup 13.

Cactaceae; 69-74. Myrtaceae; 307-15.

Subgroup 14.

Malpighiaceae; 267-70. Dipterocarpaceae; 484-5. Ochnaceae;
501.

Subgroup 15.

Capparidaceae; 481. Berberidaceae; 531. Magnoliaceae; 527.

Diagram II. contd.

Dilleniaceae; 534. Myristicaceae; 536. Winteraceae; 543.
Guttiferae; 487-8. Nymphaeaceae; 528. Papaveraceae; 538.
Aristolochiaceae; 529. Begoniaceae; 530. Lauraceae;
490-3. Flacourtiaceae; 188-95. Salicaceae; 525.

Subgroup 16.

Annonaceae; 26-32.

Subgroup 17.

Cucurbitaceae; 158-65. Menispermaceae; 296-300.
Ranunculaceae; 326-33.

Group G.

Subgroup 18.

Moraceae; 301-6. Urticaceae; 516-9. Polygonaceae; 306-10.
Rosaceae; 340-4, 347-53.

Subgroup 19.

Anacardiaceae; 19-25. Icacinaceae; 212-6.

Subgroup 20.

Araliaceae; 41-5. Loranthaceae; 494-6. Nyctaginaceae; 500.
Santalaceae; 513. Piperaceae; 526. Rosaceae; 345-6.
Epacridaceae; 486. Oleaceae; 502-3. Betulaceae; 523.
Fagaceae; 524. Cornaceae; 532. Platanaceae; 541.

Subgroup 21.

Proteaceae; 319-25. Thymeleaceae; 446-52.

Group H

Subgroup 22.

Celastraceae; 91-7. Sapindaceae; 396-403. Rhamnaceae; 334-9.

Diagram II contd.

Subgroup 23.

Meliaceae; 291-5. Rutaceae; 384-94.

Subgroup 24.

Melastomataceae; 277-90.

Subgroup 25.

Euphorbiaceae; 173-87. Malvaceae; 271-6. Sterculiaceae;
439-45. Tiliaceae; 453-8. Rutaceae; 495.

Group I

Subgroup 26.

Leguminosae; 232-66. Passifloraceae; 539.

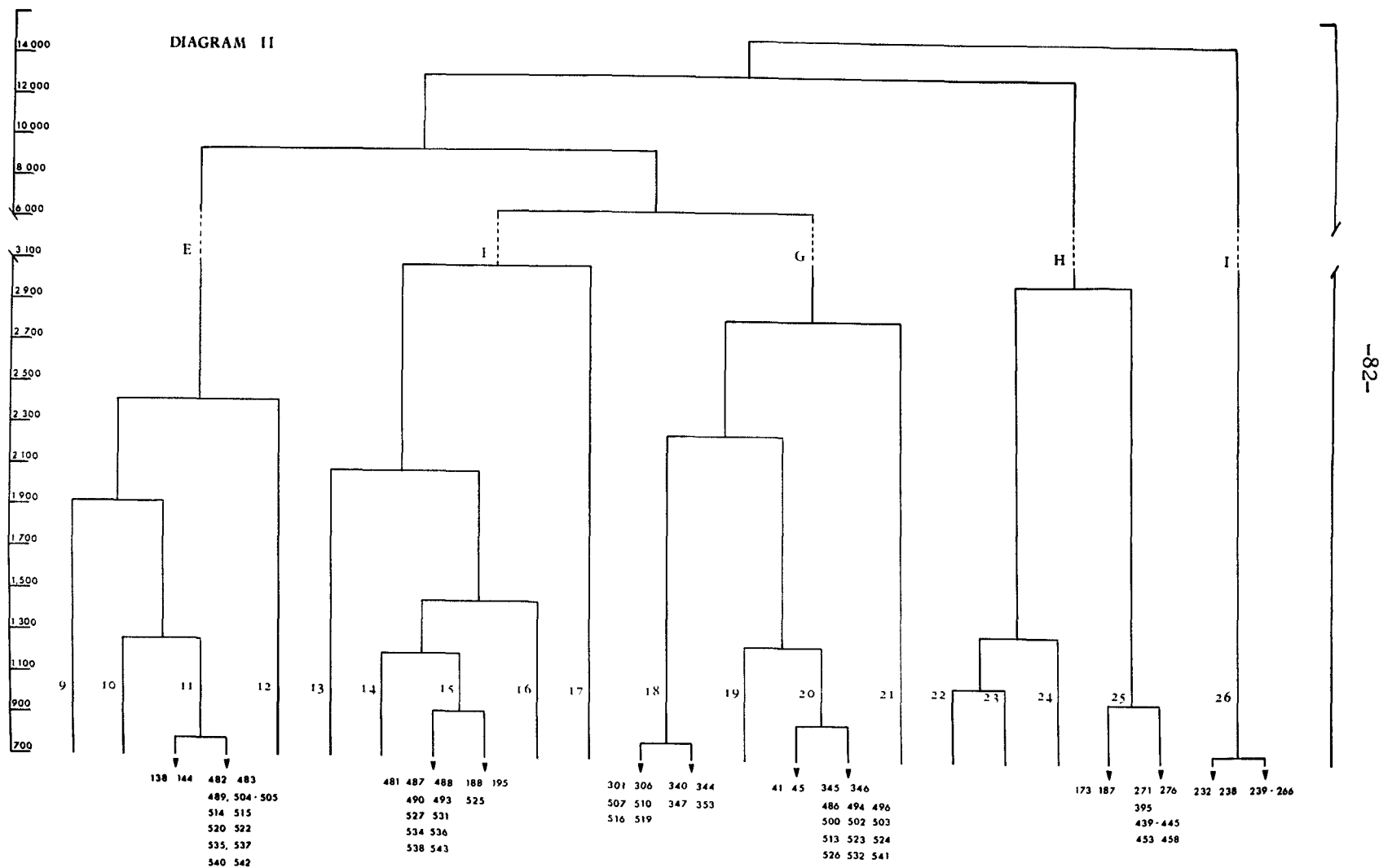


Diagram III. The INFO hierarchy for the 'Tenuinucelli'. The number of genera in each family is indicated, and in the case of Scrophulariaceae the distribution of genera.

Scale: Information Content

DIAGRAM III

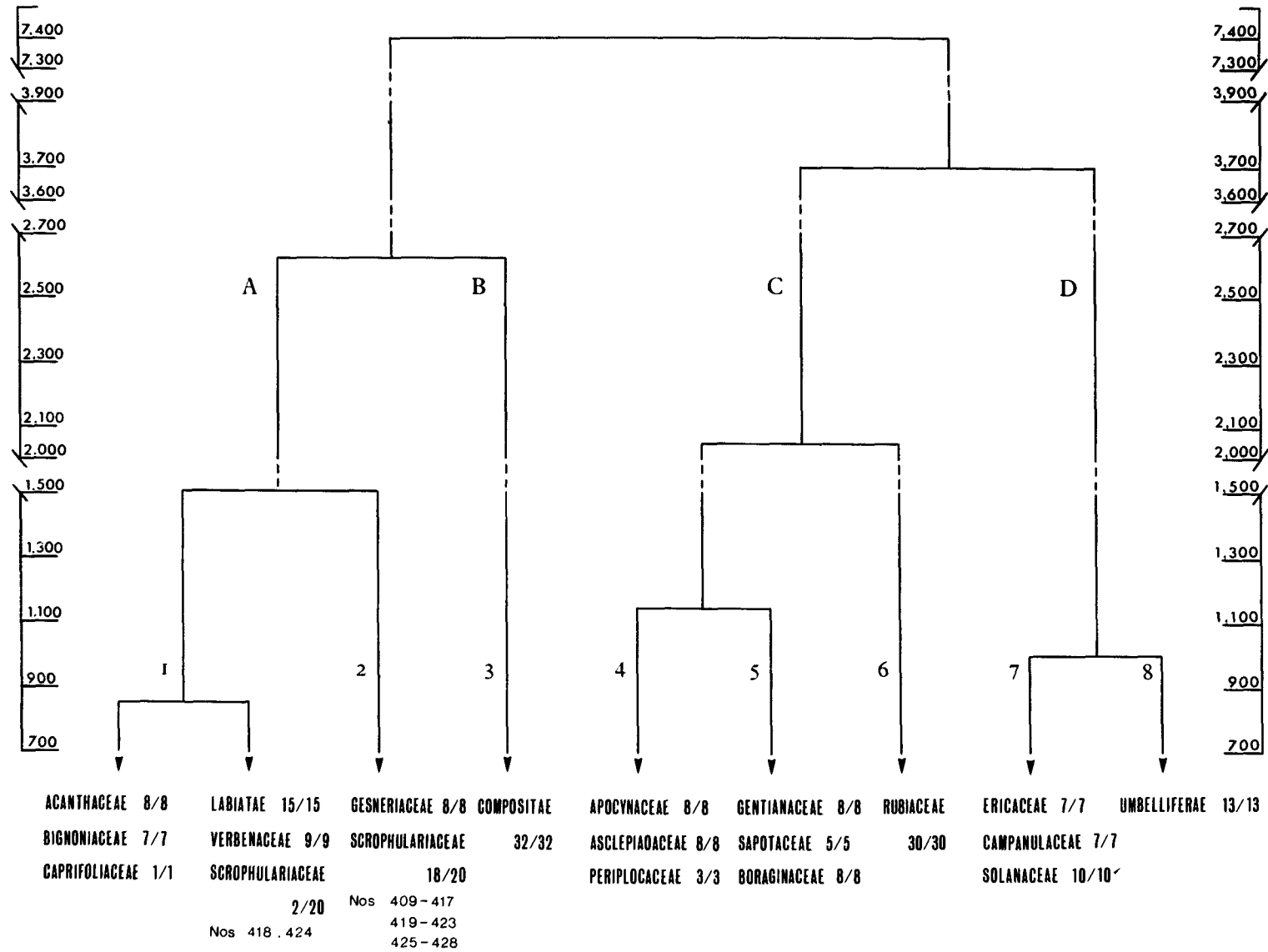


Diagram IV. The MULASS hierarchy for the 'Crassinucelli'. The features shown on the diagram are those used as Key Characters by the analysis. The constitution of the groups is set out below, the numbers referring to the genera list (Appendix I).

Scale: Information Content.

Group 1.

- a). Melastomataceae; 277-90.
- b). Cruciferae; 145-57.
- c). Thymeleaceae; 446-52. Icacinaceae; 213.
- d). Nymphaeaceae; 528. Papaveraceae; 538. Aizoaceae; 10-1.

Group 2.

- a). Caryophyllaceae; 82-90. Chenopodiaceae; 98-105.
Amarantaceae; 14-8. Nyctaginaceae; 500. Polygonaceae;
506-10. Aizoaceae; 9, 12-3.
- b). Plumbaginaceae; 542. Geraniaceae; 535. Celastraceae;
91, 95-7. Euphorbiaceae; 178, 183. Rutaceae; 385-6, 393.
- c). Araliaceae; 41-5. Cactaceae; 69-74.

Group 3.

- a). Euphorbiaceae; 173-5, 177, 179, 181-2, 184-7. Urticaceae;
518.
- b). Convolvulaceae; 139-40, 142-3. Crassulaceae; 482.
- c). Proteaceae; 319-20, 322-5. Rosaceae; 345-6.
- d). Flacourtiaceae; 188-9, 191-3, 195. Salicaceae; 525.
Violaceae; 520. Piperaceae; 526. Sapindaceae; 398.
Sterculiaceae; 443.

Diagram IV contd.

-
- e). Annonaceae; 26, 28-30, 32. Magnoliaceae; 527.
Myristicaceae; 536. Lauraceae; 490-3. Flacourtiaceae;
194.
- f). Berberidaceae; 531. Fagaceae; 524. Aristolochiaceae;
529. Dilleniaceae; 534. Menispermaceae; 296-8.
Ranunculaceae; 326, 332. Icacinaceae; 215.
- g). Urticaceae; 516-7, 519. Moraceae; 301-6. Betulaceae;
523. Platanaceae; 541. Tiliaceae; 453, 455-8.
Sterculiaceae; 439-40, 444-5.
- h). Rosaceae; 340-3, 347-8, 350-3. Rhamnaceae; 334-9.
Cornaceae; 532.
- i). Anacardiaceae; 19-25. Sapindaceae; 396-7, 399-403.
Aceraceae; 522. Meliaceae; 291-5. Rutaceae; 384,
388, 390-2. Passifloraceae; 539. Icacinaceae; 212,
216. Celastraceae; 92.

Group 4

- a). Myrtaceae; 307-15. Zygophyllaceae; 521. Rutaceae; 387.
- b). Malpighiaceae; 267-70. Saxifragaceae; 514.
- c). Onagraceae; 504-5. Begoniaceae; 530. Capparidaceae;
481. Winteraceae; 543. Dipterocarpaceae; 484-5.
Convolvulaceae; 144. Proteaceae; 321. Crassulaceae;
483. Saxifragaceae; 515. Euphorbiaceae; 176, 180.
Flacourtiaceae; 190. Leguminosae; 263. Sterculiaceae;
441-2. Tiliaceae; 454. Menispermaceae; 299-300.
Ranunculaceae; 326, 330, 333. Annonaceae; 27, 31.

Diagram IV contd.

d). Leguminosae; 247-62, 264-6.

e). Leguminosae; 232-46. Rutaceae; 389, 394-5.

Ranunculaceae; 328. Rosaceae; 344, 349.

Group 5.

Cucurbitaceae; 158-65. Malvaceae; 271-6.

DIAGRAM IV

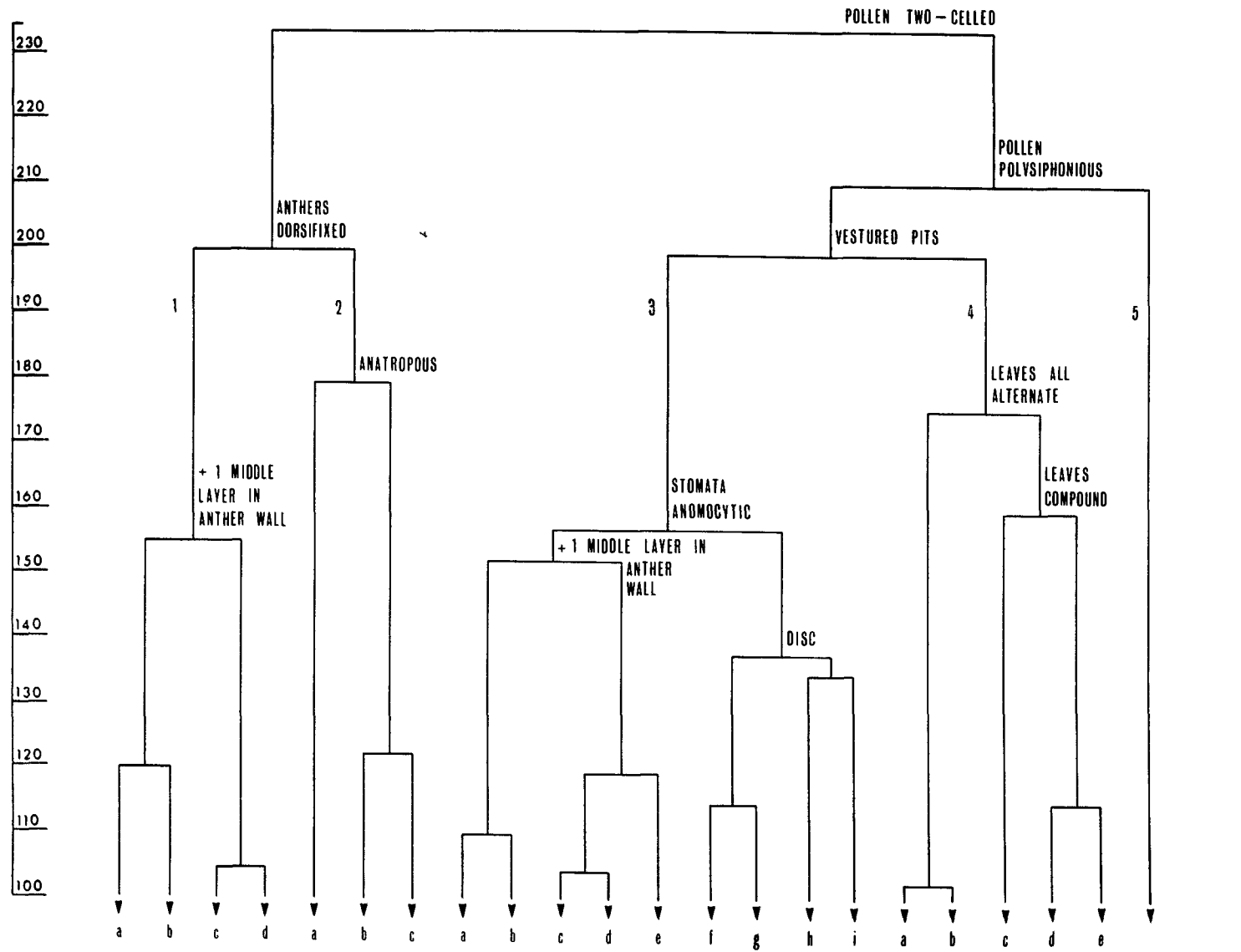


Diagram V. The MULASS hierarchy for the 'Tenuinucelli'. The features shown on the diagram are those used as Key Characters by the analysis. The constitution of the groups is set out below, the numbers referring to the genera list (Appendix I).

Scale: Information Content

Group 6

Rubiaceae; 354-83. Myrsinaceae; 398.

Group 7

a). Gentianaceae; 196-203. Myrsinaceae; 397. Convolvulaceae; 138, 141.

b). Asclepiadaceae; 46-53. Periplocaceae; 316-8.
Apocynaceae; 33-40.

c). Sapotaceae; 404-8. Boraginaceae; 68. Solanaceae; 433.
Myrsinaceae; 399. Guttiferae; 487-9. Ochnaceae; 501.
Celastraceae; 93-4.

Group 8

- a). Campanulaceae; 75-7. 79-81. Caprifoliaceae; 533.
- b). Boraginaceae; 61-7. Acanthaceae; 1, 5-6. Labiatae; 219.
- c). Verbenaceae; 472-80. Labiatae; 217-8, 220, 222-31.
Acanthaceae; 2-4, 8. Scrophulariaceae; 418, 424.
- d). Gesneriaceae; 204-11. Scrophulariaceae; 409-17, 419-23, 425-8. Acanthaceae; 7. Bignoniaceae; 56-9.

Group 9

a). Oleaceae; 502-3. Loranthaceae; 494-6. Santalaceae; 513.

Diagram V contd.

b). Ericaceae; 166, 168-72. Epacridaceae; 486.

c). Solanaceae; 429-32, 434-8.

Group 10.

a). Compositae; 106-37. Labiatae; 221.

b). Primulaceae; 511-2. Bignoniaceae; 60. Campanulaceae; 78.

c). Umbelliferae; 459-71.

Group 11.

Oxalidaceae; 537. Plantaginaceae; 540. Ranunculaceae;

329, 331. Ericaceae; 167. Icacinaceae; 214.

Bignoniaceae; 54-5.

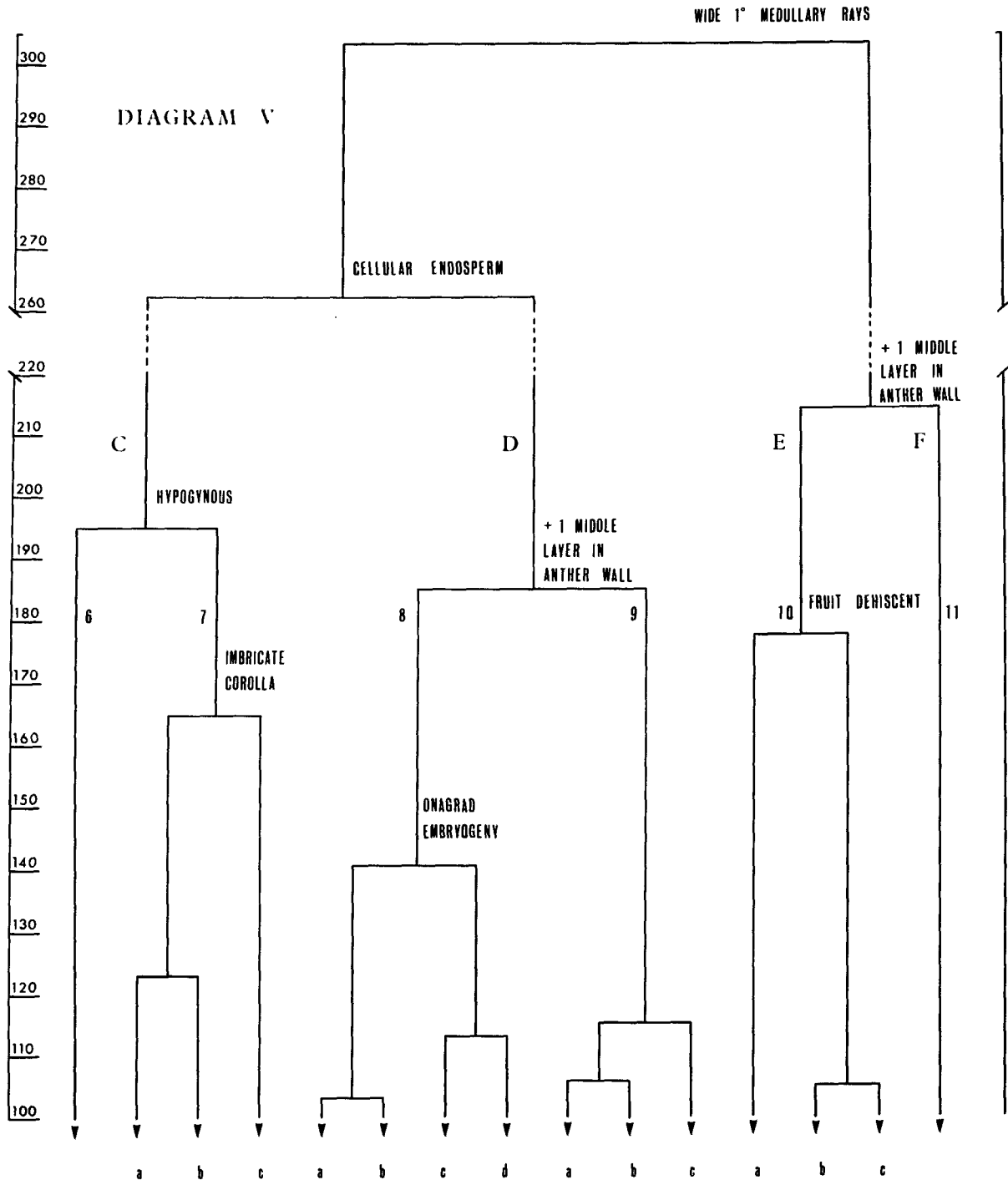


Diagram VI. The ASOC hierarchy for the 'Crassinucelli'. The features shown on the diagram are those used as Key Characters by the analysis. The constitution of the groups is set out below, the numbers referring to the genera list (Appendix I).

Scale: Chi-Square

Group 1

- a). Flacourtiaceae; 188-95. Salicaceae; 525. Capparidaceae; 481. Dilleniaceae; 534. Magnoliaceae; 527. Leguminosae; 232, 234, 237, 246. Rosaceae; 350, 352.
- b). Leguminosae; 239-45, 247-66. Passifloraceae; 539.
- c). Leguminosae; 233, 235-6, 238. Violaceae; 520.

Group 2.

- a). Cruciferae; 145-9, 151-3, 155-7. Cactaceae; 69-74. Papaveraceae; 538. Proteaceae; 319-22, 324.
- b). Cucurbitaceae; 158, 160-2, 164-5.
- c). Crassulaceae; 482-3. Saxifragaceae; 514. Convolvulaceae; 140, 143. Anacardiaceae; 22. Myrtaceae; 307, 315. Rosaceae; 353. Rutaceae; 387, 391.
- d). Menispermaceae; 296-300. Ranunculaceae; 326, 328, 330, 333. Nymphaeaceae; 528. Winteraceae; 543. Annonaceae; 30-2.

Group 3

- a). Malvaceae; 271-6. Sterculiaceae; 439-45. Tiliaceae; 453-8. Dipterocarpaceae; 484-5.
- b). Betulaceae; 523. Begoniaceae; 530. Rosaceae; 342-3, 347.

Diagram VI contd.

-
- c). Aizoaceae; 12-3. Zygophyllaceae; 521. Geraniaceae;
535. Malpighiaceae; 267-70. Celastraceae; 97.
- d). Euphorbiaceae; 173-87. Fagaceae; 524. Celastraceae; 92.

Group 4

- a). Sapindaceae; 396-401, 403. Aceraceae; 522. Rutaceae;
384-6, 388-90, 392-5. Meliaceae; 291-5. Celastraceae;
95. Anacardiaceae; 25.
- b). Myrtaceae; 308-14. Aristolochiaceae; 529. Cucurbitaceae;
163. Saxifragaceae; 515. Aizoaceae; 9, 11.
- c). Melastomataceae; 277-90. Onagraceae; 504-5.

Group 5

Caryophyllaceae; 82-90.

Group 6

Lauraceae; 490-3. Annonaceae; 26-9. Myristicaceae;
536. Cucurbitaceae; 159. Icacinaceae; 216. Ranunculaceae;
327, 332.

Group 7

- a). Araliaceae; 41-5. Celastraceae; 91.
- b). Rhamnaceae; 334-9.
- c). Urticaceae; 516-9. Moraceae; 301-6. Piperaceae; 526.
Platanaceae; 541. Polygonaceae; 506-10. Sapindaceae; 402.
- d). Rosaceae; 340-1, 344-6, 348-9, 351.

Group 8

- a). Chenopodiaceae; 98-105. Amarantaceae; 14-8. Nyctaginaceae;
500. Aizoaceae; 10. Cruciferae; 150, 154.

Diagram VI contd.

- b). Thymeleaceae; 446-52. Berberidaceae; 531. Anacardiaceae;
19-21, 23-4. Icacinaceae; 212-3, 215. Celastraceae; 96.
Proteaceae; 323, 325.
- c). Cornaceae; 532. Plumbaginaceae; 542. Convolvulaceae;
138-9, 142, 144.

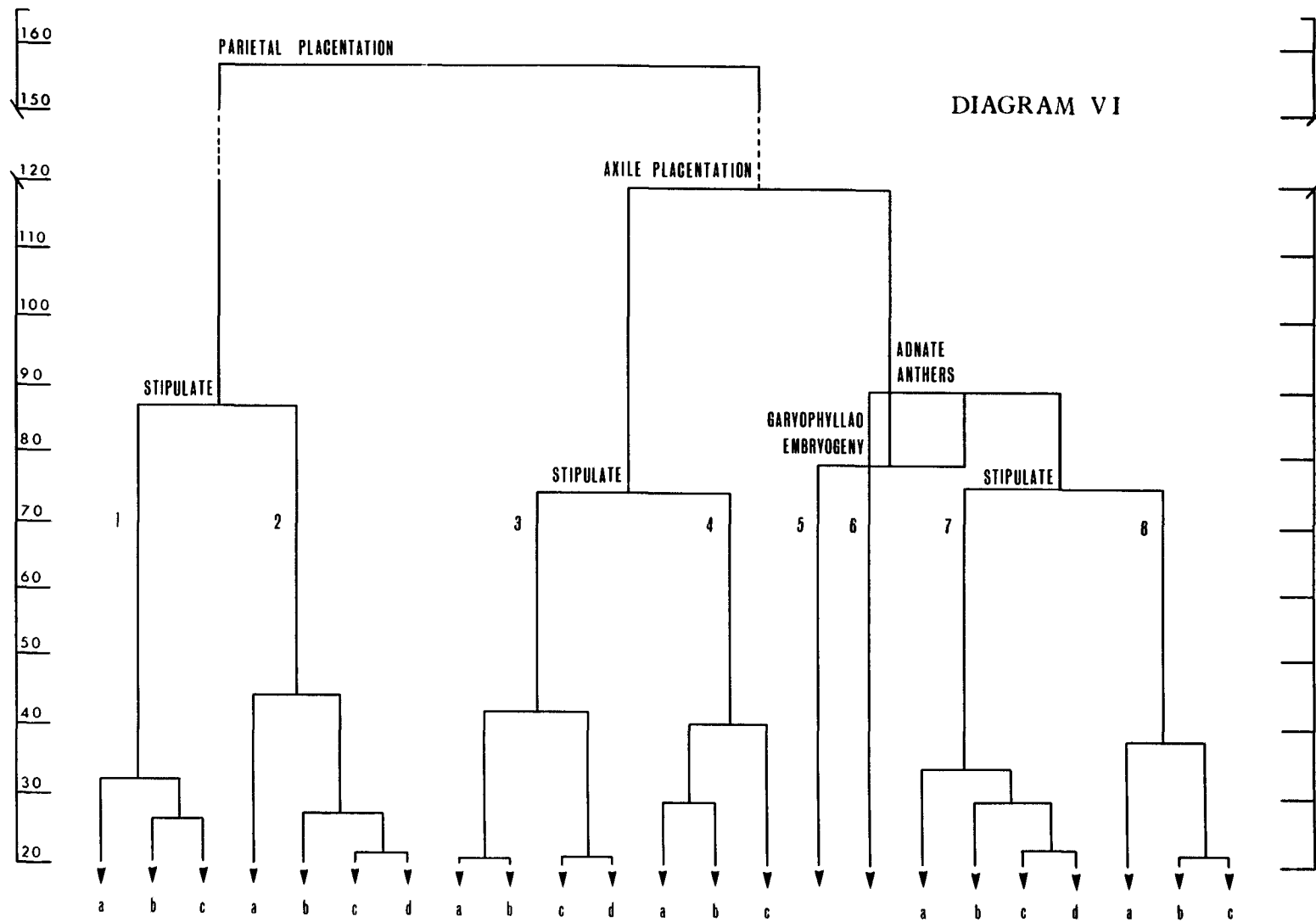


Diagram VII. The ASOC hierarchy for the 'Tenuinucelli'. The features shown on the diagram are those used as Key Characters by the analysis. The constitution of the groups is set out below, the numbers referring to the genera list (Appendix 1)

Scale: Chi-Square

Group 9.

- a). Primulaceae; 511-2. Oxalidaceae; 537. Plantaginaceae; 540. Bignoniaceae; 54-5, 60. Ranunculaceae; 329, 331. Labiatae; 221. Icacinaceae; 214.
- b). Umbelliferae; 459-71.
- c). Compositae; 106-37.

Geoup 10

- a). Campanulaceae; 77, 79-80. Solanaceae; 429.
- b). Scrophulariaceae; 409-17, 419, 421-3, 425-8. Labiatae; 217-9, 224-5, 230.
- c). Labiatae; 220, 222-3, 226-9, 231. Verbenaceae; 472-80. Scrophulariaceae; 418, 424. Bignoniaceae; 56-9.
- d). Acanthaceae; 1-8. Caprifoliaceae; 533.
- e). Gesneriaceae; 204-11. Scrophulariaceae; 420. Campanulaceae; 78.

Group 11

- a). Asclepiadaceae; 46-53. Periplocaceae; 316-8. Apocynaceae; 33-40.
- b). Gentianaceae; 196-203. Convolvulaceae; 141.

Diagram VII contd.

- c). Solanaceae; 430-8.
- d). Ochnaceae; 501. Celastraceae; 93-4.
- e). Rubiaceae; 354-83.
- f). Campanulaceae; 75-6, 81. Guttiferae; 489. Santalaceae; 513
Ericaceae; 166-72. Epacridaceae; 486. Sapotaceae;
404-8. Boraginaceae; 61-8. Oleaceae; 503.
- g). Myrsinaceae; 497-99. Guttiferae; 487-8. Loranthaceae;
494-6. Oleaceae; 502.

DIAGRAM VII

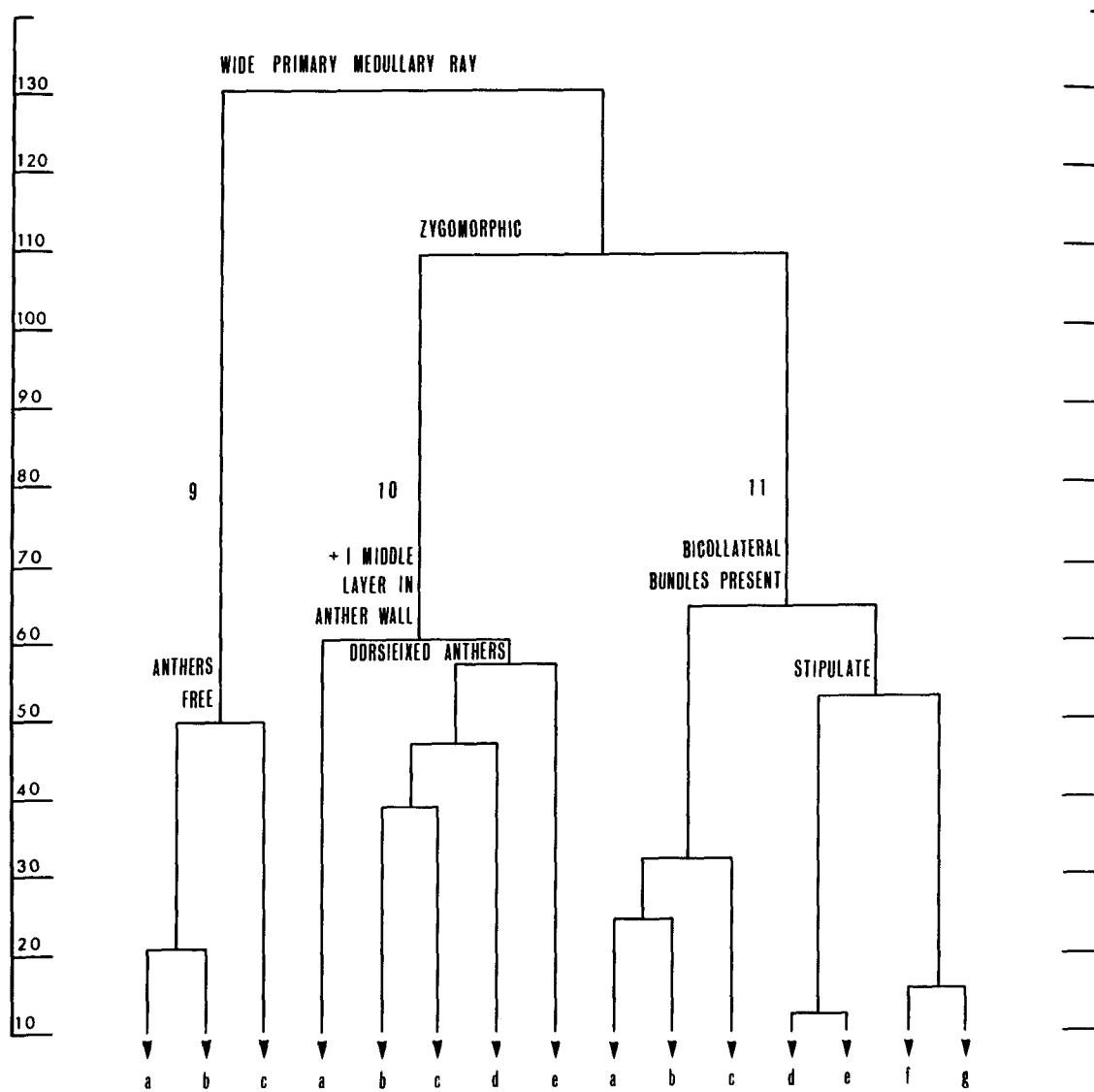


Table 4. The most striking differences in the coded data for
Cucurbitaceae and Malvaceae.

Cucurbitaceae	Malvaceae
1. Climbing herbs, shrubs rare.	Not climbing, often shrubby.
2. Estipulate.	Stipulate.
3. No vertically transcurrent veins.	Vertically transcurrent veins.
4. Bicollateral bundles present.	Absent.
5. Wide primary medullary rays.	Narrow primary medullary rays.
6. Racemose.	Cymose.
7. Filaments free.	Filaments fused.
8. Extrorse dehiscence of anthers.	Probably introrse (but not clearly described).
9. Initially more than one middle layer in anther wall.	Initially one middle layer in anther wall.
10. Inferior ovary.	Superior ovary.
11. Unisexual.	Hermaphrodite.
12. (Inapplicable).	Sepals fused.
13. Calyx imbricate.	Calyx valvate.
14. Petals at least partly fused.	Petals free.
15. Corolla valvate.	Corolla contorted.
16. Stamen number reduced below number of perianth parts.	Stamens many.
17. Anthers adnate.	Anthers dorsifixed.

Table 4 contd.

18. Locule number reduced below number of perianth parts.	Locule number same as number of perianth parts.
19. Glandular tapetum.	Amoeboid tapetum.
20. Bitegmic ovule with inner integument forming micropyle.	Bitegmic ovule with outer integument forming micropyle.
21. Parietal placentation.	Axile placentation.
22. Onagrad embryogeny.	Asterad embryogeny.
23. Disc present.	Disc absent.
24. Exalbuminous.	Albuminous.
25. Fruit usually fleshy, never septicidal.	Fruit dry and often septicidal.
26. Multicellular, unbranched hairs present.	Multicellular, branched hairs present.

Table 5. Differences in the coded data between Malvaceae and Sterculiaceae/Tiliaceae.

Malvaceae	Sterculiaceae/Tiliaceae
1. Herbs to shrubs.	Shrubs to trees.
2. Vertically transcurrent veins.	None.
3. Multicellular unbranched hairs.	Multicellular branched hairs.
4. Sepals definitely fused.	Sepals free to fused.
5. Anthers bisporangiate.	Anthers tetrasporangiate.
6. Initially only one middle layer in anther wall.	Initially more than one middle layer in anther wall.
7. Amoeboid tapetum.	Glandular tapetum.
8. Pollen germination polysiphonious.	Pollen germination monosiphonious.

Table 6. The main groups of Dicotyledons, derived from comparison of three numerical analyses of a selected sample of genera. The order of groups is arbitrary and of families alphabetical. Families in parentheses are those about which I am particularly dubious; they have been placed tentatively in groups where they seem to fit best, and some appear in more than one position.

Main Group 1. 'Crassinucelli'

Secondary Group 1. 'Caryophylloids'

Aizoaceae.	Plumbaginaceae.
Amarantaceae.	Polygonaceae.
Cactaceae.	Primulaceae.
Caryophyllaceae.	(Araliaceae.)
Chenopodiaceae.	(Geraniaceae.)
Cruciferae.	(Moraceae.)
Myrsinaceae.	(Oxalidaceae.)
Nyctaginaceae.	(Urticaceae.)

Secondary Group 2. 'Magnolioids'

Annonaceae.	Menispermaceae.
Aristolochiaceae.	Myristicaceae.
Begoniaceae.	Nymphaeaceae.
Berberidaceae.	Ochnaceae.
Capparidaceae.	Papaveraceae.
Cucurbitaceae.	Ranunculaceae.
Dilleniaceae.	Salicaceae.

Table 6 contd.

Dipterocarpaceae.	Winteraceae.
Flacourtiaceae.	(Guttiferae - Hypericaceae)
Guttiferae - Clusiaceae.	(Passifloraceae.)
Lauraceae.	(Violaceae.)
Magnoliaceae.	
<u>Secondary Group 3. Leguminosae.</u>	
Leguminosae.	
<u>Secondary Group 4. 'Celastroids'</u>	
Aceraceae.	(Euphorbiaceae.)
Anacardiaceae.	(Geraniaceae.)
Celastraceae.	(Malvaceae.)
Icacinaceae.	(Oxalidaceae.)
Meliaceae.	(Sterculiaceae.)
Rhamnaceae.	(Tiliaceae.)
Rutaceae.	(Zygophyllaceae.)
Sapindaceae.	
<u>Crassinucellate families of uncertain position</u>	
Betulaceae, Fagaceae,	Cornaceae.
Platanaceae.	
Crassulaceae, Saxifragaceae.	Araliaceae.
Rosaceae.	Malpighiaceae.
Loranthaceae, Santalaceae.	Piperaceae.
Proteaceae, Thymelaeaceae.	Onagraceae, Myrtaceae,
	Melastomataceae.

Table 6 contd.

Main Group 2. 'Tenuinucelli'

Secondary Group 1. 'Asclepioids'

Apocynaceae.	Sapotaceae.
Asclepiadaceae.	(Convolvulaceae.)
Gentianaceae.	(Epacridaceae.)
Periplocaceae.	(Ericaceae.)
Rubiaceae.	

Intermediate between 1 and 2 : (Boraginaceae), (Campanulaceae),
(Oleaceae), (Solanaceae).

Secondary Group 2. 'Acanthoids'

Acanthaceae.	Labiatae.
Bignoniaceae.	Scrophulariaceae.
Caprifoliaceae.	Verbenaceae.
Gesneriaceae.	(Plantaginaceae.)

Secondary Group 3. Compositae.

Compositae.

Secondary Group 4. Umbelliferae.

Umbelliferae.

Table 7. Comparison of the 'Tenuinucelli' (223 genera) and 'Crassinucelli' (320 genera) in terms of the coded data.

'Tenuinucelli'	'Crassinucelli'
1. All tenuinucellate.	Only 19 genera tenuinucellate.
2. Sympetalous (except <u>Umbelliferae</u> , <u>Ledum</u> , <u>Bejaria</u>). Usually polypetalous.	Usually polypetalous.
3. Ovules always unitegmic.	Ovules usually bitegmic (unitegmic in 28 genera only).
4. Ovary most often bilocular.	Ovary various but rarely bilocular.
5. Stamens most often epipetalous.	Rarely epipetalous.
6. Estipulate (except <u>Rubiaceae</u>).	Stipulate or estipulate.
7. Zygomorphy more common in 'Tenuinucelli'.	-
8. Compound leaves rare (<u>Oleaceae</u> , <u>Umbelliferae</u> ?).	Most genera with compound leaves (92) in this group.
9. Palmate venation of leaf rare (28 genera).	120 genera with palmate venation.
10. Over half the genera have mainly opposite or whorled leaves.	Only c. 80 genera show a departure from entirely alternate leaves.
11. Sepals never free (except <u>Convolvulaceae</u>).	Sepals free or fused.
12. Never apetalous or with petals in more than one whorl.	Apetalous, or one or more whorls of petals may occur.

Table 7 contd.

-
- | | |
|--|---|
| 13. Only ten genera not pentamerous. Over 100 genera depart from | pentamery. |
| 14. Stamens never many and in a
quarter of genera regularly
reduced below number of perianth
parts. | 100 genera with many stamens,
the rest usually showing a
definite numerical relationship
with the number of perianth
parts. |
| 15. Anther fixing never adnate. | Anther fixing of all types. |
| 16. Filaments free (except
<u>Asclepiadaceae</u>). | 74 genera with fused filaments. |
| 17. Anther <u>locule</u> sometimes
appendaged. | Anther <u>locule</u> never appendaged. |
| 18. Pollen only stephano-
aperturate. | Pollen stephano-aperturate,
peri-aperturate, mono-
aperturate, non-aperturate. |
| 19. Syncarpous. | 84 genera apocarpous. |
| 20. Styles usually more or less
completely fused (except
<u>Umbelliferae</u>). | Styles often more or less free. |
| 21. 139 genera have endothelium
formed from inner layer of
integument. | Only 17 genera have endothelium. |
| 22. No aril. | Some with aril. |

Table 7 contd.

23. Placentation never free-central. Placentation of all types.	
24. Cellular formation of	Cellular formation of endosperm
endosperm known in 14/23	known in only 20 genera.
families (125 genera).	

Table 8. Features markedly characteristic of the central
'Caryophylloids'.

1. Mostly herbs, with a tendency to succulence (Polygonaceae and Nyctaginaceae may be shrubby).
2. Leaves simple, estipulate (except Molluginoidae, Spergularia, Drymaria, Paronychia and Polygonaceae) and entire (except Atriplex, Chenopodium, Rumex).
3. Glandular hairs absent (except Chenopodium and Polygonaceae).
4. Primary medullary rays in young stem wide.
5. Inflorescences usually cymose (racemes in some Amarantaceae and Chenopodiaceae, solitary in Cactaceae).
6. Hypogynous (except Cactaceae).
7. Trends to apetaly.
8. Pentamerous.
9. Calyx imbricate (except Nyctaginaceae) and sepals may be free.
10. Filaments usually free (fused in Nyctaginaceae and some Polygonaceae).
11. Dorsifixed anthers (near base in Cactaceae and Polygonaceae).
12. Strong tendencies to peri-aperturate pollen grains where known (not in Plumbaginaceae, Nyctaginaceae or some Polygonaceae).
13. Syncarpous, unilocular ovaries (Aizoaceae several locules).
14. Ovules campylotropous or orthotropous (except Cactaceae and Plumbaginaceae).
15. Placentation basal or free-central (except Cactaceae and some Aizoaceae).

Table 8 contd.

-
16. Ovule bitegmic, micropyle formed from inner integument only.
 17. Chenopodiad and caryophyllad embryogeny almost restricted in the 'Crassinucelli' to this group though not universal in it.
 18. Pollen always three-celled when shed.
 19. Albuminous (sparse in Cactaceae).
 20. Fruit dry (tendencies to fleshy in Cactaceae).
 21. Initially only one middle layer in anther wall (two in Nyctaginaceae and some Aizoaceae and Chenopodiaceae).

Table 9. Features shared by Cruciferae and the central
'Caryophylloids' (c.f. Table 8).

1. Herbs with tendencies to succulence.
2. Estipulate.
3. Glandular hairs absent.
4. Primary medullary rays in young stem wide.
5. Hypogynous.
6. Some tendencies to apetalý.
7. Calyx imbricate and sepals free.
8. Filaments free.
9. Syncarpous.
10. Campylotropous.
11. Bitegmíic ovules.
12. Pollen three-celled when shed.
13. Fruit dry.
14. Initially only one middle layer in anther wall.

Table 10. Features of the Primulaceae and Myrsinaceae shared with the central 'Caryophylloids' (c.f. Table 8).

1. Herbs (not Myrsinaceae).
2. Leaves simple, estipulate and sometimes entire.
3. Glandular hairs absent (not Primulaceae).
4. Primary medullary rays in young stem wide (not Myrsinaceae).
5. Inflorescence cymose.
6. Hypogynous.
7. Pentamerous.
8. Calyx imbricate.
9. Anthers dorsifixed (near base).
10. Syncarpous, unilocular ovaries.
11. Campylotropous.
12. Free-central placentation.
13. Ovule bitegmie, and in Myrsinaceae only inner integument forming micropyle.
14. Caryophyllad embryogeny (not Myrsinaceae).
15. Albuminous.
16. Dry fruit (not Myrsinaceae).

Table 11. Features of the Urticaceae and Moraceae shared with the central 'Caryophylloids' (c.f. Table 8).

1. Herbs (not most Moraceae).
2. Leaves simple and some Moraceae entire.
3. Cymose.
4. Hypogynous (probably not all Moraceae, but compacted inflorescences make interpretation difficult).
5. Strong tendencies to apetal.
6. Calyx imbricate where discernable.
7. Filaments free.
8. Dorstenia (Moraceae) has peri-aperturate pollen grains.
9. Syncarpous, unilocular ovaries.
10. Orthotropous or campylotropous ovules.
11. Basal placentation (not Moraceae).
12. Ovule bitegmic, inner integument only forming micropyle.
13. Albuminous.
14. Fruit dry (though often in a fleshy receptacle).
15. Initially only one middle layer in anther wall (Urticaceae unknown).

Table 12. Features of the Oxalidaceae and Geraniaceae shared with the central 'Caryophylloids' (c.f. Table 8).

1. Herbs, often succulent in Geraniaceae.
2. Primary medullary rays wide.
3. Cymose.
4. Hypogynous.
5. Pentamerous.
6. Calyx imbricate.
7. Dorsifixed anthers.
8. Campylotropous (not Oxalidaceae).
9. Ovules bitegmic.
10. Pollen three-celled when shed.
11. Albuminous (not Geraniaceae).
12. Fruit dry.
13. Initially more than one middle layer in anther wall
(not Oxalidaceae).

Table 13. The families of Cronquist's Magnoliidae appearing
in my 'Magnolioids'

Annonaceae.	Myristicaceae.
Aristolochiaceae.	Nymphaeaceae.
Berberidaceae.	Papavaraceae.
Lauraceae.	Ranunculaceae.
Magnoliaceae.	Winteraceae.
Menispermaceae.	

Table 14. The families of Cronquist's Dilleniidae appearing in
my 'Magnolioids'.

Begoniaceae.	Guttiferae.
Capparidaceae.	Ochnaceae.
Cucurbitaceae.	Passifloraceae.
Dilleniaceae.	Salicaceae.
Dipterocarpaceae.	Violaceae.
Flacourtiaceae.	

Table 15. The more consistent features of the 'Magnolioids'.

1. Woody.
2. Leaves simple.
3. Leaves all alternate.
4. Stomata anomocytic or paracytic.
5. Non-glandular hairs only.
6. Primary medullary rays wide.
7. Vessels with scalariform end-plates.
8. Regular flowers.
9. Tendency to solitary flowers.
10. Hypogynous.
11. Sepals free.
12. Calyx imbricate.
13. Polypetalous.
14. Tendency for several perianth whorls, or if only one then
of 'tepals'.
15. Tendencies to non-pentamery.
16. Many stamens.
17. Stamens never epipetalous.
18. Filaments free.
19. Anthers free.
20. Extrorse dehiscence of anthers.
21. Adnate fixing of anthers.
22. Initially more than one middle layer in anther wall.
23. Glandular tapetum.

Table 15 contd.

- 24. Pollen two-celled when shed.
- 25. Apocarpous.
- 26. Styles short or lacking.
- 27. Locule (or carpel) number not reduced below number of parts
in perianth whorls.
- 28. Placentation axile or parietal (not basal or apical).
- 29. Anatropous.
- 30. Ovules bitegmic.
- 31. No endothelium formed.
- 32. Nuclear endosperm formation.
- 33. Onagrad embryogeny.
- 34. Aril present.
- 35. Disc present.
- 36. Albuminous.

Table 16. The occurrence of magnolioid features in selected families and the Character Values for these families.

1 = Feature $\frac{+}{-}$ universally present in family.

0 = Feature $\frac{+}{-}$ universally absent in family.

$\frac{1}{2}$ = Feature sometimes present in family.

* = Unknown or inapplicable.

Key to Families

1. Berberidaceae	10 Menispermaceae	19 Salicaceae
2 Magnoliaceae	11 Ranunculaceae	20 Cucurbitaceae
3 Myristicaceae	12 Dipterocarpaceae	21 Malpighiaceae
4 Winteraceae	13 Ochnaceae	22 Cactaceae
5 Nymphaeaceae	14 Capparidaceae	23 Hypericaceae
6 Papaveraceae	15 Dilleniaceae	24 Myrtaceae
7 Aristolochiaceae	16 Clusiaceae	25 Piperaceae
8 Lauraceae	17 Begoniaceae	26 Violaceae
9 Annonaceae	18 Flacourtiaceae	27 Passifloraceae

Table 16 contd.

Key to characters

a	Woody	s	Anthers free
b	Simple leaves	t	Extorse dehiscence of anthers
c	Leaves all alternate	u	Adnate fixing of anthers
d	Stomata anomocytic or paracytic	v	Initially more than one middle
e	Non-glandular hairs only		layer in anther wall
f	Primary medullary rays wide	w	Glandular tapetum
g	Scalariform end-plates to vessels	x	Pollen two-celled when shed
h	Flowers regular	y	Apocarpous
i	Flowers solitary	z	Styles lacking or short
j	Ovary superior	aa	Carpels or locules many or at least equal to no. of
k	Sepals free		perianth parts
l	Calyx imbricate	bb	Placentation axile or parietal
m	Polypetalous	cc	Ovules anatropous
n	Perianth of one whorl, two similar whorls or several whorls	dd	Ovules bitegmic
o	Flower non-pentamerous	ee	No endothelium formed
p	Stamens many	ff	Nuclear endosperm
q	Stamens not epipetalous	gg	Onagrad embryogeny
r	Filaments free	hh	Aril present
		ii	Disc present
		jj	Albuminous

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	bb	cc	dd	ee	ff	gg	hh	ii	jj	Ch.	Value.
1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0	1	1	1	1	1	0	0	1	1	1	1	1	0	0	1	28	
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	33	
3	1	1	1	1	1	0	1	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	*	1	0	1	1	26
4	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	0	*	0	0	1	26	
5	0	1	1	1	1	1	0	1	1	0	*	*	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	27	
6	0	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	*	0	1	1	0	0	1	0	1	1	1	1	1	0	0	1	1	1	25	
7	1	1	1	1	1	1	0	0	1	0	*	0	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	0	1	24	
8	1	1	1	1	1	0	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	1	28
9	1	1	1	1	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	$\frac{1}{2}$	1	1	1	1	0	1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$30\frac{1}{2}$
10	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	0	$\frac{1}{2}$	$29\frac{1}{2}$	
11	0	$\frac{1}{2}$	$\frac{1}{2}$	1	$\frac{1}{2}$	1	$\frac{1}{2}$	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	$\frac{1}{2}$	1	1	1	0	0	1	$29\frac{1}{2}$
12	1	1	1	1	1	0	0	1	0	1	0	1	1	0	0	1	1	1	0	*	1	1	1	0	1	1	1	1	1	1	1	1	*	0	0	0	23	
13	1	1	1	1	1	0	0	1	0	1	1	1	1	0	0	1	1	1	*	0	0	1	1	$\frac{1}{2}$	0	1	1	*	1	1	1	*	0	$\frac{1}{2}$	0	22		
14	1	1	1	1	1	0	0	1	1	1	1	1	1	$\frac{1}{2}$	0	1	1	1	0	0	1	1	1	0	1	0	1	0	1	0	1	1	1	1	0	0	$24\frac{1}{2}$	
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	0	1	30	
16	1	1	0	1	1	0	0	1	$\frac{1}{2}$	1	1	1	1	0	1	1	1	$\frac{1}{2}$	1	1	0	*	1	1	0	$\frac{1}{2}$	0	0	1	1	1	1	1	1	1	1	1	$25\frac{1}{2}$
17	1	1	1	1	1	1	0	0	0	*	0	1	1	1	1	0	1	0	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	0	22	
18	1	1	1	1	1	0	$\frac{1}{2}$	1	$\frac{1}{2}$	$\frac{1}{2}$	1	1	1	$\frac{1}{2}$	0	1	1	1	$\frac{1}{2}$	0	1	1	1	0	$\frac{1}{2}$	0	1	1	1	1	1	*	$\frac{1}{2}$	1	1	1	$26\frac{1}{2}$	
19	1	1	1	1	1	0	1	1	0	1	*	*	*	*	1	1	*	1	1	0	0	1	1	1	0	0	0	1	1	0	1	1	0	1	1	0	22	
20	$\frac{1}{2}$	1	1	1	1	1	0	1	1	0	*	1	1	0	0	0	1	$\frac{1}{2}$	$\frac{1}{2}$	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	1	0	$23\frac{1}{2}$	
21	1	1	0	1	1	0	0	1	$\frac{1}{2}$	1	0	1	1	0	0	0	1	0	1	0	*	1	1	1	0	0	0	1	0	1	1	1	0	0	$\frac{1}{2}$	0	18	
22	$\frac{1}{2}$	*	*	1	1	0	0	1	1	0	0	1	1	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	*	1	1	0	$19\frac{1}{2}$	
23	$\frac{1}{2}$	1	0	1	1	0	1	1	1	1	1	1	1	0	0	1	1	0	1	0	0	1	1	1	0	0	$\frac{1}{2}$	1	1	1	1	1	0	0	0	1	23	
24	1	1	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	$\frac{1}{2}$	1	0	0	1	1	1	0	0	0	0	0	1	1	1	1	0	1	0	$19\frac{1}{2}$	
25	0	1	1	0	$\frac{1}{2}$	1	1	1	0	*	*	*	*	1	$\frac{1}{2}$	*	1	1	0	0	1	1	1	0	0	0	0	0	0	1	1	0	0	0	1	0	16	
26	$\frac{1}{2}$	1	1	1	$\frac{1}{2}$	1	0	0	1	1	1	1	1	0	0	0	1	1	1	0	0	1	1	1	0	0	0	1	1	1	1	1	1	0	1	1	22	
27	$\frac{1}{2}$	1	1	1	$\frac{1}{2}$	0	0	1	1	1	*	1	1	0	0	0	1	1	1	*	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	24	

Table 16 cond.

Table 17. The more obvious trends in the coded data separating the Leguminosae and Rosaceae.

Leguminosae	Rosaceae
1. A tendency to tendril climbers and twiners.	Rarely climbers and then only scramblers.
2. Herbaceous members with no basal rosette.	Herbaceous* members with basal rosette.
3. Stomata most usually paracytic.	Stomata anomocytic (except <u>Chrysobalanoideae</u>)
4. Unicellular, unbranched, non-glandular hairs only in <u>Caesalpinioideae</u> .	Unicellular, unbranched, non-glandular hairs universal
5. None.	Unicellular, branched non-glandular hairs in 50%.
6. Multicellular non-glandular hairs in <u>Papilionoideae</u> .	None.
7. Vertically transcurrent veins present.	Absent (except <u>Chrysobalanoideae</u>).
8. Vessels with vestured pits present.	Absent.
9. Absent.	Wood fibres with bordered pits present.
10. Primary medullary rays narrow.	Wide in 50% of sample.
11. Zygomorphic in <u>Papilionoideae</u> and some <u>Caesalpinioideae</u> .	Regular (except <u>Chrysobalanoideae</u>).

Table 17 contd.

12. Always racemose.	Some genera with cymes.
13. Hypogynous.	Perigynous - epigynous.
14. All with petals.	30% of sample tending to apetalous.
15. Petals fused in <u>Mimosoideae</u> .	Petals never fused.
16. Filaments fused in many <u>Papilionoideae</u> .	Filaments never fused.
17. Stamens rarely many (except some <u>Mimosoideae</u>).	Stamens many (except <u>Chrysobalanoideae</u>).
18. Anthers versatile.	Not.
19. Pollen aggregated in <u>Mimosoideae</u> .	Not.
20. One carpel.	Several carpels (except <u>Chrysobalanoideae</u>).
21. Many ovules per carpel.	1-2 ovules per carpel.
22. Parietal placentation.	Rarely parietal placentation (3 genera).
23. Campylotropous in <u>Papilionoideae</u> .	All anatropous.
24. Ovules bitegmic, with outer integument contributing to micropyle.	Only 2 genera known to be bitegmic and then outer integument not contributing to micropyle.
25. Embryogeny onagrad or caryophyllad where known.	Embryogeny asterad.

Table 17 contd.

26. Aril in some Caesalpinioideae and No aril.

Mimosoideae.

27. No disc.

Disc.

28. Dry, usually dehiscent fruit.

Fruit may be fleshy, and if
dry rarely dehiscent.

Table 18. The more obvious trends in the coded data relating
the Leguminosae and Rosaceae.

1. Compound alternate stipulate leaves.
2. Presence of multicellular glandular hairs.
3. Mainly racemose (but see also no. 12, Table 17).
4. A tendency to polygamous flowers in Mimosoideae and Rosaceae.
5. Sepals and petals imbricate (valvate in Mimosoideae) and
petals free (fused in Mimosoideae).
6. Initially more than one middle layer in anther wall.
7. Glandular tapetum.
8. Pollen two-celled when shed.
9. Apocarpous.
10. Nuclear endosperm.

Table 19. The more obvious differences separating the Araliaceae and Umbelliferae.

Araliaceae	Umbelliferae
1. Crassinucellate.	Tenuinucellate.
2. Onagrad embryogeny.	Solanad embryogeny.
3. Usually evergreen trees or shrubs.	Herbs.
4. Stipulate.	Estipulate.
5. Palmate venation of leaves.	Pinnate venation of leaves (occasionally palmate).
6. Stomata paracytic.	Stomata anomocytic.
7. Main petiolar strand a dissected ring.	Main petiolar strand a dissected arc.
8. Hypodermis in leaf.	Hypodermis only recorded for <u>Bupleurum</u> and <u>Eryngium</u> .
9. None	Unicellular non-glandular hairs present.
10. Initially more than one middle layer in anther wall.	Initially only one middle layer in anther wall.
11. Anthers never versatile.	Anthers versatile.
12. Locule number essentially the same as number of components in perianth whorls.	Bilocular ovary.
13. Styles free to fused.	Styles free

Table 19. contd.

14. Fruit fleshy.	Fruit dry.
15. No alkaloids.	Alkaloids produced.
16. Chromosome number $n = 12$ (very rarely $n = 11$).	Chromosome number $n = 6-11$ (very rarely 12).

Table 20. The more characteristic differences between the central
'Acanthoids' and 'Asclepioids'.

'Acanthoids'	'Asclepioids'
1. Zygomorphic.	Regular.
2. Cellular endosperm.	Nuclear endosperm.
3. Many with unequal-sized stamens (didynamous).	Stamens equal-sized.
4. Bicollateral bundles very occasional	Bicollateral bundles in <u>Apocynaceae</u> , <u>Asclepiadaceae</u> , <u>Gentianaceae</u> , <u>Periplocaceae</u> .
5. Corolla rarely contorted (2 genera).	Corolla contorted in 50% of sample.
6. Stamens reduced to 4 or 2 in most genera.	Stamens never reduced below 5
7. Generally few ovules per locule.	Many ovules per locule (except <u>Sapotaceae</u> and some <u>Rubiaceae</u>).
8. Embryogeny onagrad (some <u>Acanthaceae</u> solanad).	Embryogeny solanad.
9. Greater tendency to develop- ment of a disc.	Less obvious disc.
10. Anthers rarely basifixed.	Tendency to basifixed anthers.
11. Exalbuminous or with scanty endosperm.	Albuminous.

Table 20. contd.

12. Pollen not aggregated (except <u>Catalpha</u>).	Pollen aggregated in at least some <u>Apocynaceae</u> , <u>Asclepiadaceae</u> , <u>Periplocaceae</u> and <u>Rubiaceae</u> .
13. No latex.	Latex in <u>Apocynaceae</u> , <u>Asclepiadaceae</u> , <u>Periplocaceae</u> and <u>Sapotaceae</u> .

Fig. 3. The suggested relationships among the orders of
Cronquist's Dilleniidae.

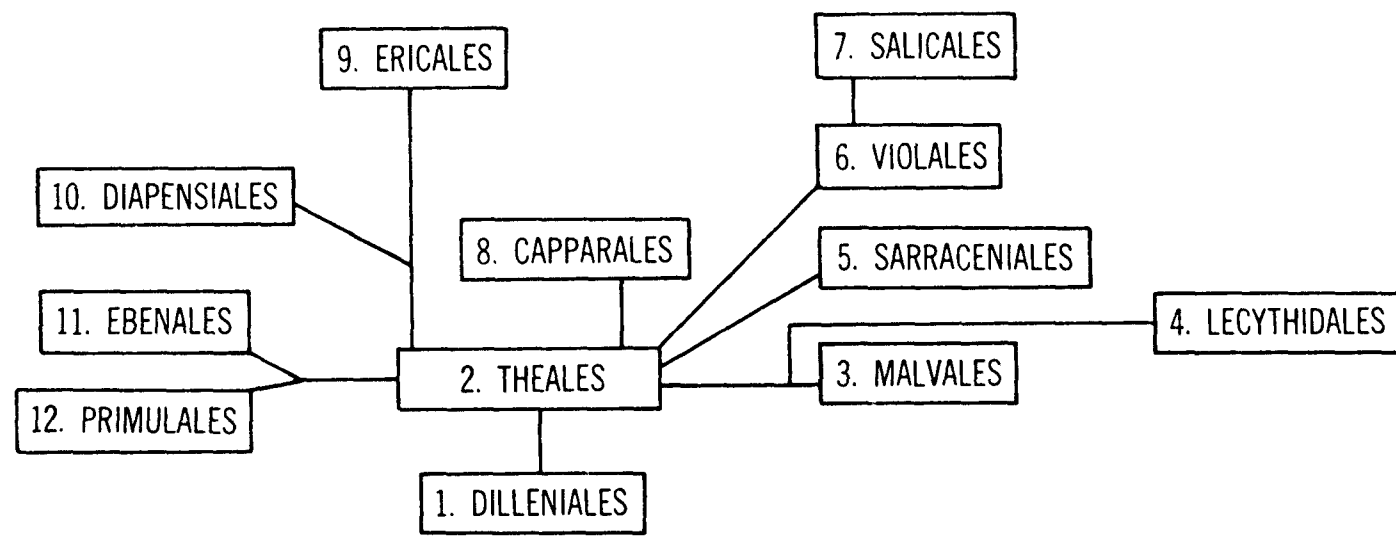


FIG. 3

Fig. 4. The suggested relationships among the orders of
Cronquist's Rosidae.

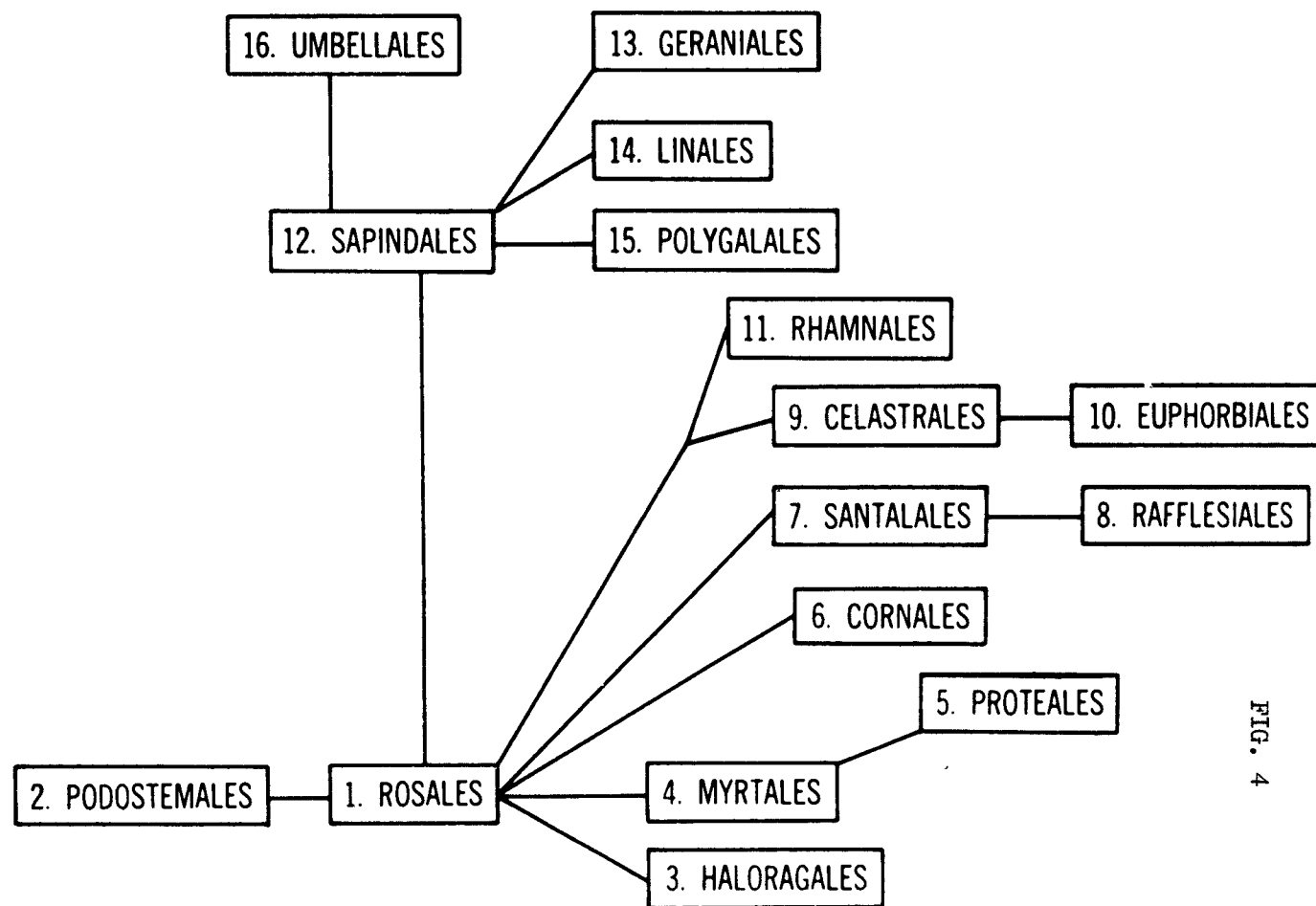


FIG. 4

Fig. 5. The suggested relationships among the orders of Cronquist's
Asteridae.

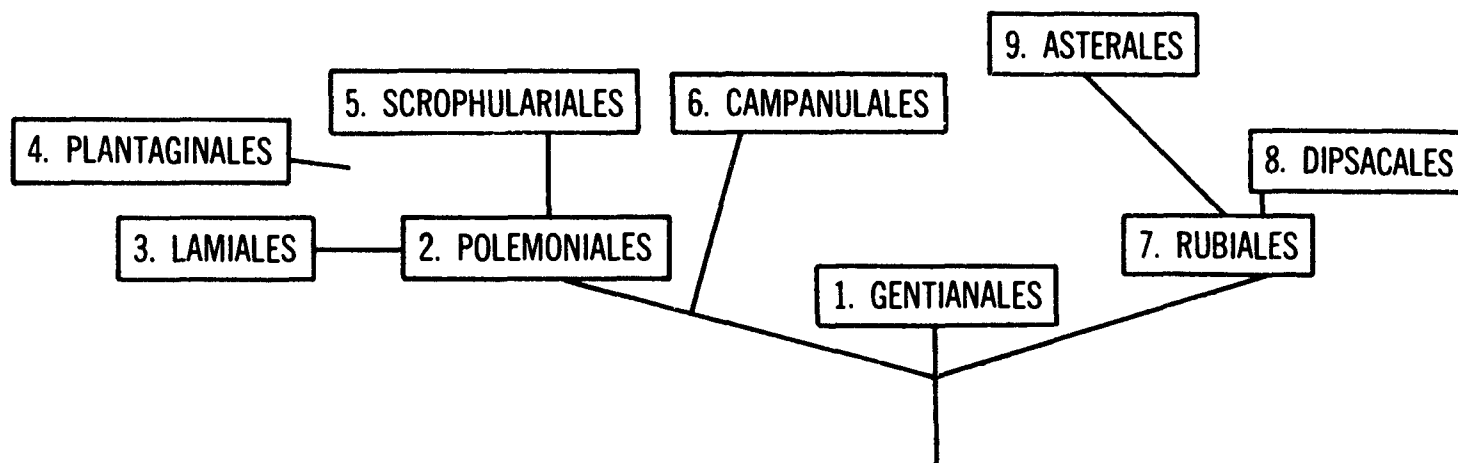


FIG. 5

IV ANALYSES OF HARDWOODS

THE DATA AND THE ANALYSES

Following the success of the softwoods analyses (page 128) it seemed that there might be a way into the Dicotyledons via the data contained in the Forest Products Research Laboratory's two keys to hardwoods Anon (1960); Brazier and Franklin (1961). The Dicotyledon samples are essentially the same in both versions of the key, except that the later form calls for a microscope rather than a hand lens and so contains more detailed observations. The sample is quite large (c. 400 individuals) but has its limitations as a sample of Dicotyledons in that it is confined to commercial hardwoods; while a commercial softwood sample is comprehensive for coniferous genera (page 128), the same is far from true for Dicotyledons, (e.g. nine species of the genus Dalbergia are recorded but only one species in the whole family Compositae). Nevertheless these data, properly comparative, recorded in tabulated form and extensive, certainly merit taxonomic consideration.

The original data are available in the key. They were coded as a series of qualitatives for each individual, and analysed under INFO and ASOC. The complex nature of the data clearly calls for a mixed-data approach, and they were accordingly also coded for MULTBET (a Mixed-Data Agglomerative method; Lance and Williams, 1967). Because of the extent of the data however, an Information-statistic variation with no facility for multistates had to be resorted to. This necessitated converting all the multistates into qualitatives, though 'unknowns' and numerical values were still accounted for.

THE DICOTYLEDONOUS HIERARCHY

The results of all this effort as far as the Dicotyledon hierarchy is concerned are in the main undistinguished. In view of the disadvantages of the hardwood data as a dicotyledonous sample, there seems no point in pursuing the matter further in the absence of a more suitable analysis. However one suggestion of obvious taxonomic interest does arise from this work. It concerns the arrangement of the representatives from Leguminosae.

THE LEGUMINOSAE

The three sub-families Caesalpinioideae, Mimosoideae and Papilionoideae are represented in the sample by seventy-nine species (fifty-eight genera), this being by far the largest family sampled (Appendix 4). All three analyses pick out the family (i.e. the Leguminosae as a major dicotyledonous grouping are supported by wood anatomy); and the alledged relationship with the Rosaceae is once more refuted, the differences in terms of wood anatomy being summarised in Table 21. Further, all three analyses give patterns of species within the family which are not consistent with the usual sub-families. To confirm that the pattern for legume woods was not upset by intrusion of the occasional outsider (e.g. from Meliaceae and Rutaceae under INFO) in the original analyses, the legume data were analysed separately under INFO and ASOC. The results were the same, and the INFO hierarchy alone is illustrated (Diag. VIII) as representative. The Mimosoideae and Papilionoideae appear almost completely separated on either

side of a main dichotomy (the anomalous position of Acacia aneura being explicable by a higher-than-normal number of negative values); but the most striking feature of the analyses is the treatment of species from the Caesalpinioideae. All the analyses tell the same story in that the Mimosoideae always form a very discrete group and the Papilionoideae, while never as discrete, are never confused to any extent with the 'Mimosoids'. The Caesalpinioideae however are always unevenly distributed between the other two and, significantly, the group with which individual 'Caesalpinoids' are associated varies from analysis to analysis. Four of the thirty-five Caesalpinioideae are constantly found on the 'Mimosoid' side (Burkea africana, Guibourtia arnoldiana, G. coleosperma and Trachylobium verrucosum) and eight on the Papilionoid side (Brachystegia eurycoma, Caesalpinia echinata, C. granadillo, Haematoxylon campechianum, Koompassia excelsa, K. malaccensis, Peltogyne porphyrocardia, Swartzia madagascariensis), while the other twenty-three vary in position from one analysis to the next. This could be taken as an indication that the species in question show a fairly high degree of similarity of wood structure with both the fixed groups, and that minor differences in coding or computational strategem are responsible for the shift across the hierarchies. In other words in terms of wood structure the Caesalpinioideae are mainly genera which serve to blur a good (but evidently not absolute) distinction in the family: i.e. most of them are 'intermediate'.

Table 22 summarises the more obvious differences between the woods of the 'Mimosoids' and 'Papilionoids'; the 'Caesalpinoids' vary to a much greater extent in these respects. A phylogenetic sequence depending on wood anatomy therefore would surely run Mimosoideae-Caesalpinioideae-Papilionoideae (or the reverse) but this is at variance with the usual phylogenetic idea of the family, according to which the 'Caesalpinoids' are the most 'primitive' and the 'Mimosoids' more 'advanced', with the 'Papilionoids' representing the climax of the family. (It is pertinent to note that the Papilionoideae of the sample come entirely from the woody genera, conventionally regarded as most primitive in the sub-family and therefore nearest the Mimosoideae; and yet in terms of wood structure the two are seemingly quite distinct.)

Further consideration of the Leguminosae suggests that this view of the Caesalpinioideae, though based at the outset entirely on wood anatomy, is taxonomically useful. They are never defined convincingly in floristic works and text-books: for example Table 23 summarises the diagnoses of the sub-families given by Airy-Shaw in Willis (1966). The diagnosis of the 'Caesalpinoids' rather clearly implies a group of plants which do not fall conveniently into either of the main series. In the main Dicotyledon analyses the Caesalpinioideae form a more discrete unit, but they still vary in position relative to the other two sub-families depending on the analysis considered, again indicating their 'intermediate' nature.

Diagram VIII. The INFO hierarchy for the analysis of legume woods.

The numbers refer to the species listed in

Appendix 4.

Scale: Information Content.

DIAGRAM VIII

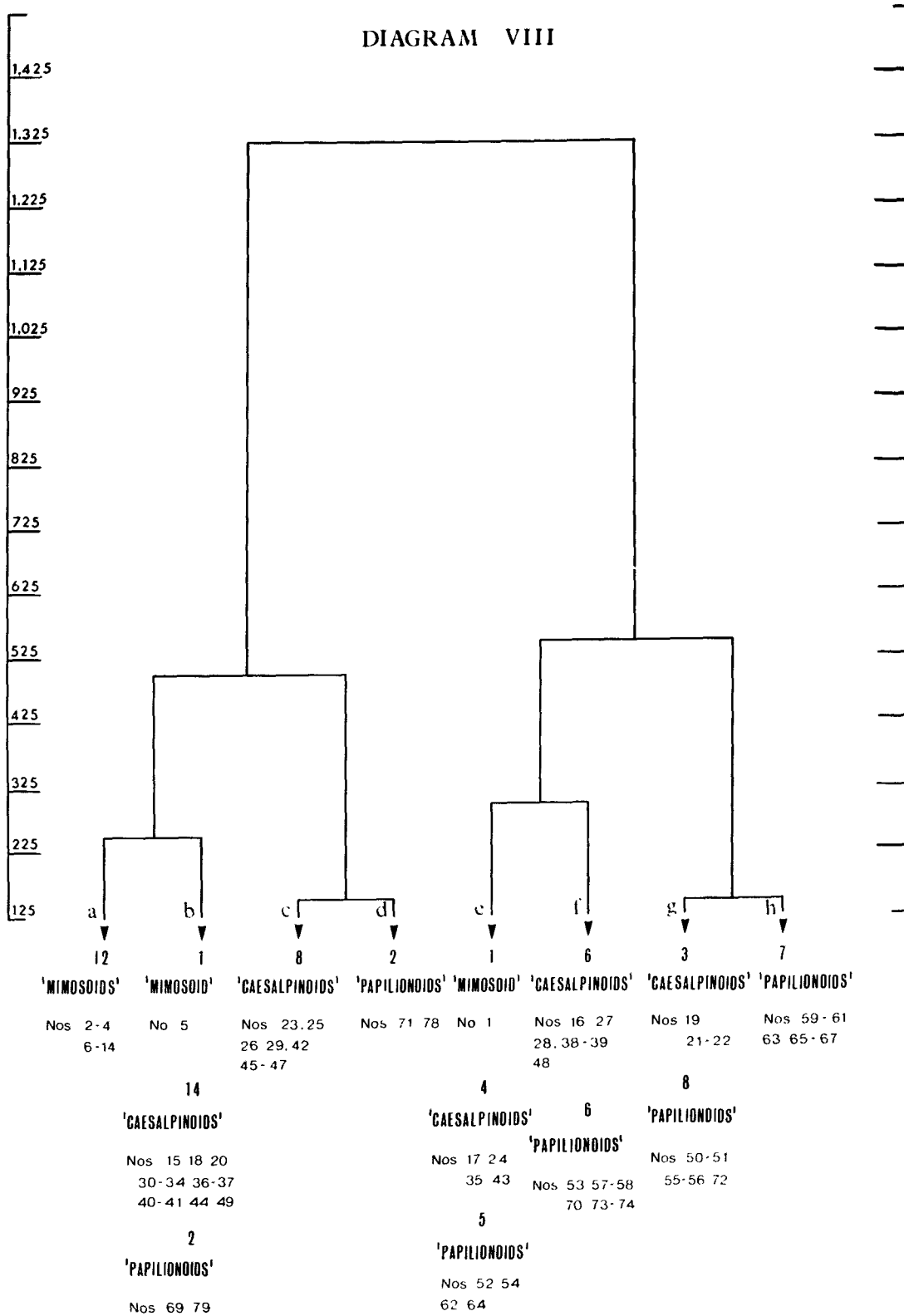


Table 21. The outstanding differences in wood structure between the Rosaceae and Leguminosae.

Rosaceae	Leguminosae
1. Vessels appearing solitary in T.S. sections.	Vessels appearing aggregated in T.S.
2. Fibre trachieds present.	Absent.
3. Parenchyma apotracheal.	Parenchyma paratracheal.
4. Absent.	Crystals in chambered cells present.
5. No storied structure.	Storied structure sometimes (see no. 3 Table 22).

Table 22. The outstanding differences in wood structure between
the Mimosoideae and Papilionoideae.

Mimosoideae	Papilionoideae
1. More than 50% with septate fibres.	None.
2. The ray tissue homogeneous, i.e. Some homogeneous ray tissue, composed of only one type of cells.	but also some heterogeneous.
3. Rays and axial elements such as fibres and tracheids not storied (i.e. in tiers) when seen in T.L.S.	Rays and axial elements storied.
4. Banded parenchyma absent. That is more or less continuous bands of parenchyma in each growth ring as seen in T.S.	Banded parenchyma present.
5. Heartwood not coloured.	Heartwood coloured.

Table 23. The diagnoses for the sub-families of Leguminosae,
based on Airy-Shaw (1966).

1. Mimosoideae.

Flowers regular. Sepals valvate (except Parkieae). Petals valvate in bud. Stamens 4-10 or numerous. Pollen compound. Seeds generally with areoles. Leaves often bipinnate.

2. Caesalpinioideae.

Flowers more or less irregular. Sepals imbricate, rarely valvate. Petals imbricate-ascending in bud. Stamens ten or fewer occasionally numerous. Pollen grains usually simple. Seeds generally without areoles. Leaves usually pinnate, occasionally bipinnate or simple.

3. Papilionoideae.

Flowers irregular (more or less regular in Sophorae). Sepals imbricate. Petals imbricate-descending in bud. Stamens generally ten. Pollen grains simple. Seeds without areoles. Leaves pinnate, digitate, trifoliate or simple.

V ANALYSES OF SOFTWOODS

THE DATA AND THE ANALYSES

In view of the shortage of properly recorded comparative data for Spermatophyte plants, the Forest Products Research Laboratory Bulletins on the identification of hardwoods (see page 12a) and softwoods (Phillips 1948) seemed to offer a useful starting point for my work. I tackled the Conifers first, on the grounds that if the results did not justify the effort for this relatively small group it would be pointless to progress to the far more complex (and less comprehensive) hardwood data.

The softwood key provides students of Coniferae with the most extensive set of data presented unambiguously in tabulated form. (The work of Greguss (1955), though admirable in some respects, suffers from a lack of consistency in sampling and recording which greatly limits its taxonomic value). Designed to enable the user to identify commercially important softwoods by their anatomical nature, this publication contains copious tabulated data on a wide range of anatomical features recorded for carefully selected comparable samples. The acknowledged reliability of the key in itself attests to the dependability of the observations. The sample is very comprehensive, covering forty-two of the fifty-four genera currently recognised by Harrison (Dallimore and Jackson 1966), and about 20% of the species (Appendix 5). Furthermore in terms of genera and species the families are represented more or less in proportion to their sizes. Fortunately this information is of a kind

which can conveniently be coded as qualitatives (Table 24 gives details of how the key characters were interpreted), obviating the need to call in one of the more sophisticated mixed-data programs. The coded data (Appendix 5) were accordingly examined under INFO, and the resultant hierarchy is shown in Diag. IX, terminated arbitrarily at a level of similarity convenient for discussion. The complete computer output is available in Appendix 6. (Preliminary INFO and ASOC experimental analyses employing somewhat different coding and an ASOC on the data interpreted as in Table 24, gave results differing only in detail from Diag. IX. They need not be discussed further.)

RESULTS OF THE ANALYSES

On this evidence coniferous woods fall into two markedly distinct groups (A and B, Diag. IX), the salient characteristics of which are presented in Table 25. These represent a division at a relatively high level between the Pinaceae and the rest of the Coniferae; an idea not expressed in any existing modern taxonomic scheme, but one which draws attention to certain correlations never before remarked upon. The pinaceous proembryo exhibits a different organisation from that found elsewhere (see Doyle, 1963, for a study of about forty coniferous genera) and this correlates with the production in the Pinaceae alone of two very transient prothallial cells in the male gametophyte (Sterling 1963), as well as the possession male and female nuclei of

markedly unequal size (a phenomenon known elsewhere only in Sciadopitys; Saxton 1913). Further testimony to the usefulness of these groups are the records of Roberts and Doyle (1938) on the pH of leaf cell sap: in their twenty-two species of Pinaceae they note a pH of below 4.5 (in sixteen of these it is below 4), while fifty-four of the seventy-seven species from elsewhere have a pH above 4.5 and only eleven fall below four. A diploid chromosome number of $2n=24$, universal in the Pinaceae apart from Pseudolarix, is rare in the other families, where it is known in only nine of about 150 recorded. The pinaceous genera stand alone in having cones with bracts and ovuliferous scales more or less free, and two ovules per scale. Even parasites from the Loranthaceae acknowledge the same distinction; the genus Arceuthobium seems to be nearly restricted to the Pinaceae where it has been reported on seven of the ten genera, whilst in the Cupressaceae, the only other coniferous family recorded as susceptible to Loranthaceae, Phoradendron is the genus usually concerned (one species of Arceuthobium is recorded on Juniperus, and one species of Phoradendron on Abies (see Gill 1935; Boyce, 1961; Trelease, 1916)). It seems that groups A and B (Diag. IX) probably represent taxonomic enlightenment despite their derivation from information restricted to wood structure.

Within group B the well known families with one notable exception largely retain their identity, although often at a level

of similarity above the maximum shown in Diag. IX. Nevertheless the structure of the hierarchy is provocative and interesting in that the genera fall into two subgroups (see Table 27 for anatomical distinctions) containing respectively the southern hemisphere families Araucariaceae, Podocarpaceae and the majority of southern Cupressaceae (Diag. IX, C); and the overwhelmingly northern Taxodiaceae, Taxaceae and Cephalotaxaceae, plus most northern Cupressaceae (Diag. IX, D). Here, I feel, is splendid confirmation of Florin's view, based on fossil studies, that the northern and southern elements of the Coniferae have long and separate evolutionary histories (Florin, 1940). The taxonomic soundness of the Cupressaceae, however, is called into question, the wood of southern representatives being closer to that of the other southern families than to that of their supposed relatives. On the other hand, these southern cupressaceous genera are somewhat isolated from the Podocarps and Araucarians even in terms of wood structure (i.e. Group e, Diag. IX); and they do not have the characteristics (persistence and proliferation of male prothallial cells; one ovule per ovuliferous scale; a tendency to broad leaves) which further distinguish Podocarpaceae and Araucariaceae from other conifers. If Glyptostrobus and Dacrydium intermedium are ignored (see below), the constitution within Group D of minor Group i seems significant. Taxus and Torreya, popularly either separated from the 'Coniferales' as the 'Taxales' or associated with the Podocarpaceae, on this evidence join some

northern members of the Cupressaceae and the overtly yew-like Saxegothaea and Cephalotaxus.

It seems worth commenting on the treatment of genera at relatively high levels of similarity. In group A (Pinaceae) these have anatomical support, although mostly in terms of early fusions not shown in Diag. IX. Pinus is markedly distinct from the rest, in conformity with the taxonomically familiar split into sub-families Pinoideae and Abietoideae founded on gross morphology (Pilger, 1926); and within that genus the sample of twenty-two species divides into two groups (c and d, Diag. IX) corresponding with the series Haploxylae and Diploxylae, originally defined on leaf-trace number. In group B, of the eleven genera represented by more than one species, six gain support from the pattern of fusions at high levels of similarity among the species sampled; and of the fragmented podocarpaceous genera Podocarpus and Dacrydium, the former has largely retained its identity. D. cupressinum, however, at a level of similarity not shown in Diag. IX, is anatomically more like Podocarpus - a fact in keeping with Erdtman's views based on heartwood chemistry (Erdtman, 1963). The three cupressaceous genera Cupressus, Chamaecyparis, and Thuja are at best taxonomically fragile, and their diverse wood anatomy further undermines confidence in their usefulness. Indeed it seems that the Cupressaceae as a whole need careful reconsideration in terms of both generic delimitation and their position within the taxonomic framework of Coniferae.

There are certain instances where this INFO analysis seems not to have given a good taxonomic result. Thus the presentation of Glyptostrobus in group i seems to be a vagary of this particular computation: in the preliminary analyses it always appeared with the main body of the Taxodiaceae. The location of Dacrydium intermedium in group i may also be misleading, since it is represented by an unusually high proportion of negatives in the anatomical data. Otherwise I am satisfied that Diag. IX at least provides an acceptable classification of softwoods, despite familiar uncertainties over coding the data. Further, I believe that the hierarchy has its merits as a taxonomic treatment of these plants; but it would be unreasonable to expect anything like absolute reliability in this respect from an analysis of one aspect of their variation. With this reservation in mind the positions of Taiwania and Sciadopitys (groups h and g), and the splitting off of two Podocarpus species (group e) from the rest seem suspicious. In particular the assignment of Sciadopitys to group g seems taxonomically uninspired; but it is noteworthy that the wood of this monotypic genus, no less than vegetative morphology, is drastically at odds with the taxodiaceous appearance of its cones.

DISC ELECTROPHORESIS OF CONIFERS

In the course of my search for 'external' evidence to support these ideas on conifers, I briefly examined seed-proteins. Proteins were extracted in the manner described by

Boulter et al. 1966 from seeds of Pinus nigra, Abies procera, Thuja plicata, Taxus baccata and Torreya grandis (i.e. from a fair range of coniferous forms) and the extracts subjected to disc-electrophoresis (Davis 1964; Boulter et al., 1966). The results were disappointing: on this evidence conifer seeds are poor both quantitatively and qualitatively in storage proteins and attempts at comparisons are not worthwhile (Fig. 6). The resulting gels show so few bands, and even fewer different ones that distinction between coniferous genera on this basis does not seem feasible.

I mention this abortive effort, lest anyone else impressed by the success of disc-electrophoretic studies in other groups (e.g. Legumes, Boulter et al., 1967) should be led to waste time to Coniferae.

Table 24. Anatomical features used in the analysis of conifers.

The figures in parentheses refer to the feature number in Phillips 1948, in which a full account and illustrations of the features may be found. Features scored as - in the key are recorded as positive but those scored as ? negative.

General	1. Growth rings indistinct / distinct (1).
	2. Heartwood distinctively coloured / not (2).
	3. Latewood conspicuous / not (3).
	4. Odour of wood pronounced / not (4).
	5. Definite taste / not (5).
	6. Greasy to the touch / not (6).
	7. Grain dimpled / not (7).
Tracheids.	8. Alternate bordered pits on the radial walls / not (8).
	9. Opposite multiseriate bordered pits present / absent (9).
	10. Margins of tori scalloped / not (10).
	11. Spiral thickenings present in early wood / absent (11).
	12. Callitroid thickenings across the pit border present / absent (12).
Parenchyma.	13. Small amounts of smooth-walled parenchyma present / absent (13 present, 14 and 15 absent).

Table 24. contd.

	14. Abundant smooth-walled parenchyma present / absent (13 and 14 present, 15 absent).
	15. Small amounts of nodular-walled parenchyma present / absent (13 and 15 present, 14 absent).
	16. Abundant nodular-walled parenchyma present / absent (13, 14 and 15 present).
Rays.	17. Smooth-walled ray tracheids regularly present / usually absent (16 present, 17 absent).
	18. Dentate ray tracheids regularly present / usually absent (16 and 17 present).
	19. Horizontal walls in early wood thin / not (18).
	20. Horizontal walls upitted / not (19).
	21. Horizontal walls strongly pitted / not (20).
	22. Indentures present at the corners of ray cells / absent (21).
	23. End-walls of ray cells nodular / not (22).
Cross-field pitting	24. Cross-field pits 1-(3), large, simple or nearly so / not (23).
	25. Cross-field pits having narrow apertures often extended beyond the border ('piceoid') / not (24).
	26. Cross-field pits having apertures included within, and rather narrower than, the border ('cupressoid') / not (25).

Table 24. contd.

	27. Cross-field pits having apertures included within, and much wider than, the border ('taxodioid') / not (26).
	28. Cross-field pits 1-6 small and simple ('pinoid') / not. (27).
Resin ducts.	29. Normal, vertical thin-walled resin ducts present / absent (28 present, 31 absent).
	30. Traumatic, vertical thin-walled resin ducts present / absent (29 present, 31 absent).
	31. Normal, vertical thick-walled resin ducts present / absent (28 and 31 present).
	32. Traumatic, vertical thick-walled resin ducts present / absent (29 and 31 present).
	33. Horizontal thin-walled resin ducts present / absent (30 present, 32 and 33 absent).
	34. Horizontal thick-walled resin ducts with 5-6 epithelial cells present / absent (30, 31 and 32 present).
	35. Horizontal thick-walled resin ducts with 7-12 epithelial cells present / absent (30, 31, and 33 present).
Extra features	36. Crystals noted in ray cells / not (Phillips 1948, page 10).
	37. Parenchyma definitely zonate / not (Phillips 1948, page 11).

Diagram IX. The INFO hierarchy for conifers derived from an analysis of anatomical data. A, Araucariaceae; C, Cupressaceae; Ce, Cephalotaxaceae; P, Pinaceae; Po, Podocarpaceae; T, Taxodiaceae; Ta, Taxaceae. Fractions indicate species in group/species in generic sample. Scale: Information Content.

The species are listed in Appendix 5. Listed below are species whose genera appear in more than one group.

Group c: *Pinus banksiana*, *canariensis*, *caribaea*, *contorta*, *echinata*, *halepensis*, *leucodermis*, *nigra*, *palustris*, *patula*, *pinaster*, *pinea*, *ponderosa*, *radiata*, *resinosa*, *sylvestris*, *taeda*.

Group d: *Pinus cembra*, *koraiensis*, *lambertiana*, *monticola*, *strobus*.

Group e: *Chamaecyparis thyoides*; *Cupressus funebris*, *lusitanica*; *Podocarpus dacrydioides*, *salignus*.

Group g: *Dacrydium colensoi*, *cupressinum*, *franklinii*; *Podocarpus falcatus*, *ferrugineus*, *gracilior*, *henkelii*, *latifolius*, *spicatus*, *totara*, *usambarensis*, *milanjianus*.

Group h: *Chamaecyparis lawsoniana*, *obtusata*; *Cupressus macrocarpa*, *sempervirens*, *torulosa*.

Group i: *Dacrydium intermedium*; *Chamaecyparis nootkatensis*; *Thuja occidentalis*, *orientalis*.

Group j: *Thuja plicata*, *standishii*.

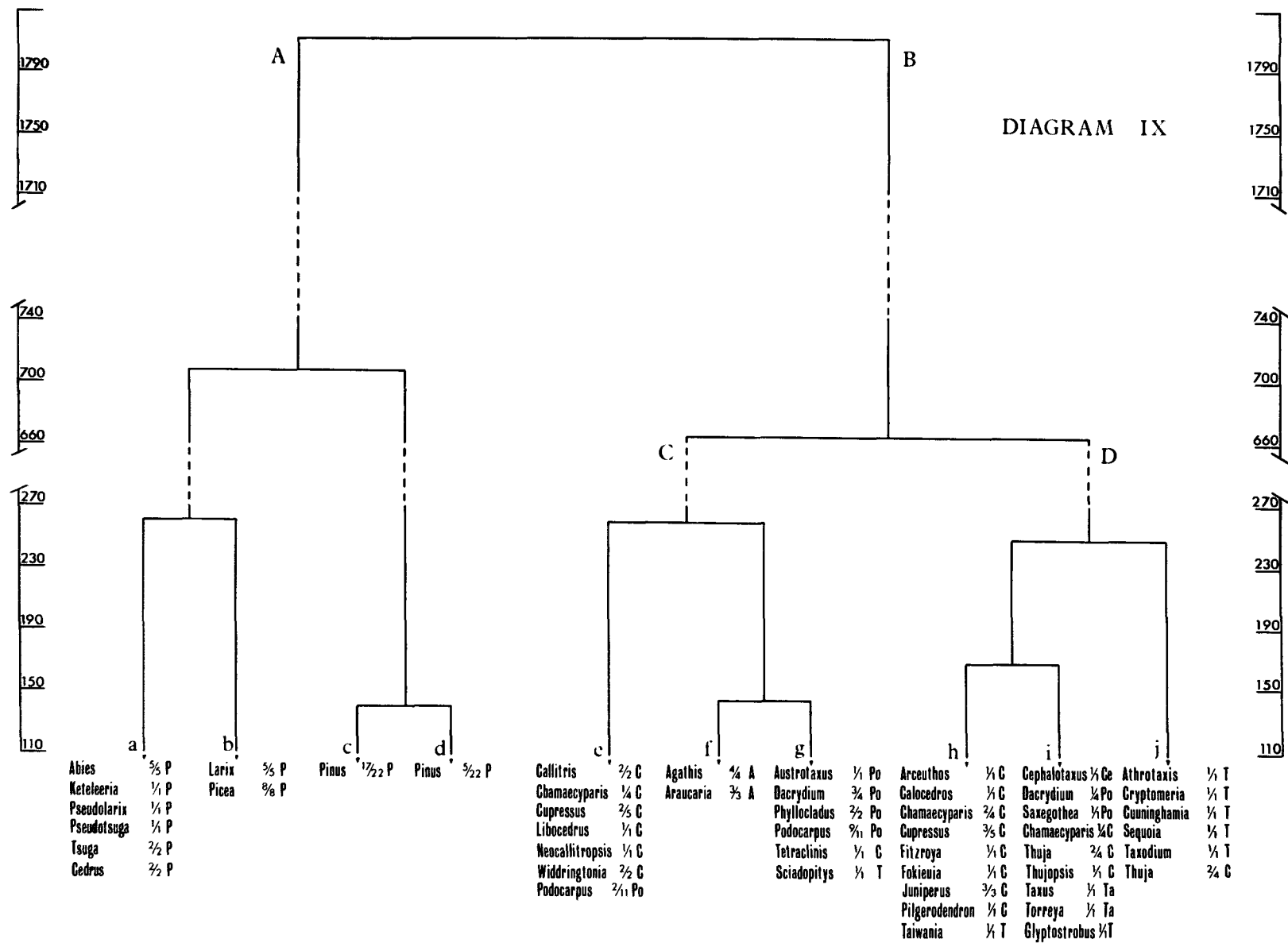


Table 25. Salient anatomical characteristics of the groups A and B, Diag. IX.

Group A (47 species)	Group B (66 species)
1. Latewood sometimes conspicuous (18 spp.).	Latewood never conspicuous.
2. Resin ducts usual (39 spp.).	No resin ducts.
3. Ray tracheids usually present (40 spp.).	No ray tracheids (except <u>Chamaecyparis nootkatensis</u>).
4. Horizontal walls of rays often well pitted (27 spp.; rare in <u>Pinus</u>).	Horizontal walls of rays never well pitted.
5. End-walls of rays often nodular (32 spp.).	End-walls of rays rarely nodular (8 spp.).
6. Cross-field pitting mostly 'piceoid' and 'pinoid'; very rarely 'cupressoid' (4 spp.).	Cross-field pitting never 'pinoid', very rarely 'piceoid' (3 spp.); usually 'cupressoid' (46 spp.).
7. Parenchyma scarce (17 spp.) or absent (30 spp.).	Parenchyma usually present (51 spp.) and abundant (46 spp.).
8. Crystals present except in <u>Pinus</u> .	No crystals recorded.

Table 26. Marked anatomical distinctions between groups C and D, Diag. IX.

Group C (35 species)	Group D (31 species)
1. Growth rings usually indistinct (29 spp.).	Growth rings usually distinct (27 spp.).
2. Wood parenchyma always smooth walled.	Walls of wood parenchyma often nodular (26 spp.).
3. Horizontal walls of rays thin (32 spp.) and unpitted (29 spp.)	Horizontal walls of rays usually thick (29 spp.) and slightly pitted (28 spp.).
4. Indentures generally absent from ray cells (3 spp. only).	Indentures common (23 spp.).

Fig. 6. Densitometer traces of the stained gels produced by disc electrophoresis of the seed proteins of Thuja plicata (top), Taxus baccata (centre) and Abies procera (bottom). The peaks at the right of each trace are due to the dye marker run in advance of the protein.

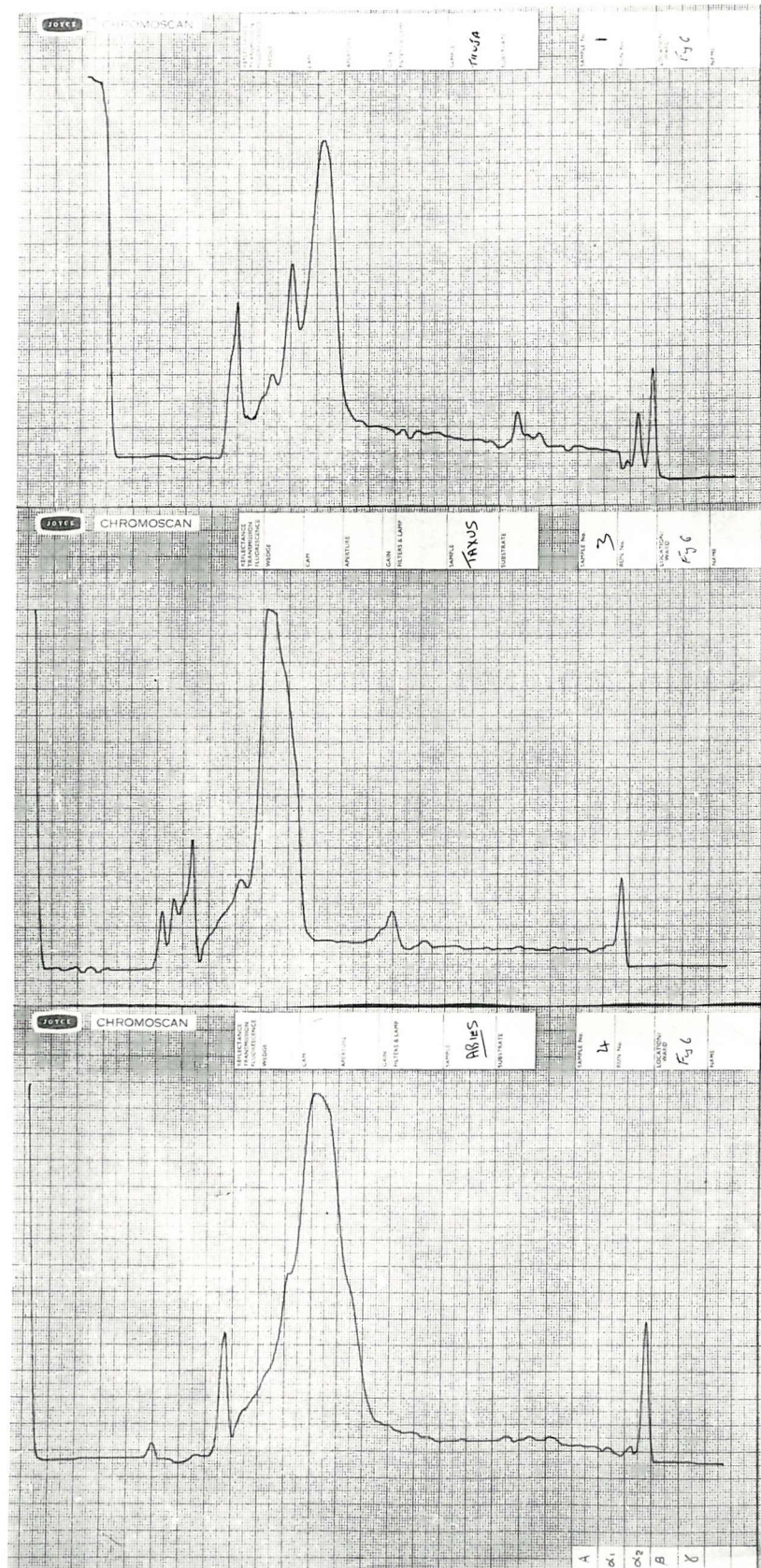


FIG. 6

VI CONCLUSIONS

My general conclusions fall under two headings; the methodological and the taxonomic.

METHODOLOGICAL

Despite all the problems of coding, involving subjective decisions over defining characters it is evidently possible to use numerical methods to obtain defensible taxonomic results at all hierarchical levels. Even in the absence of a really appropriate mixed data program, when the very complex and unreliable dicotyledonous data had to be reduced entirely to qualitatives (with all the distortion that goes hand in hand with this), some worthwhile taxonomic ideas seem to have emerged.

The most useful program by and large was INFO, the disadvantages of its restriction to purely qualitative data being more than compensated for by a (for this purpose) more appropriate sorting strategy. In all sections of my work this program has given the best taxonomic results when judged in terms of the rearranged data. The divisive programs ASOC and MULASS are taxonomically not in the same class as INFO, though it is probably significant that in the smaller and therefore less difficult problems (i.e. conifers; legumes taken alone) ASOC is less noticeably inferior to INFO, indicating a certain usefulness for this quick, relatively cheap method. But with a large and complex problem (Dicotyledons) the monothetic divisive programs have been unduly taxed and forced into too many serious errors for their hierarchies to prove of much value in taxonomic discussion. Nevertheless

they have succeeded in picking out the fundamental 'Tenuinucelli'/'Crassinucelli' dichotomy, which modern taxonomists are prone to overlook. MULASS with its facility for dealing with mixed data should have proved much superior to ASOC; that it has not done so leads me to conclude that there may be something radically wrong on the computational side with the present program. Certainly it is prone to take demonstrably poor decisions, resulting in a hierarchy that manifestly does not reflect overall similarities over large areas (e.g. grouping Malvaceae with Cucurbitaceae, at high levels of similarity). The failure of MULASS is a disappointment, for it is a relatively fast (and therefore cheap) method of dealing with mixed data.

TAXONOMIC

Before summarising the taxonomic results of this work it is necessary to point out certain relevant facts. Firstly it should be made clear that the remarks made here are not suggested as a formal taxonomic scheme, but only as an indication of those groupings of Spermatophyta which are consistent with the available data. This data is in fact often poor and with additional knowledge the groups may well alter and others become apparent. This is particularly true for those genera with a reduced floral apparatus, for here there is often an acute lack of data and this is reflected in the difficulty I have found in placing many of them. Also it should be remembered that the groupings are based on a sample of genera and differences in the

size or constitution of this could again alter the situation, but all taxonomy is based on sampling and my samples are at least as comprehensive as any I know.

Bearing these facts in mind, points of taxonomic interest do arise. The primary division of the Dicotyledons into essentially polypetalous and sympetalous groups ('Crassinucelli' and 'Tenuinucelli') is strongly reaffirmed despite current opinion being against the idea. Within these two groups sub-groupings appear, some new, some confirming older ideas. In the 'Crassinucelli' I have recognised the 'Magnolioids', 'Caryophylloids' and 'Celastroids' as definable groups, but many genera (notably from the Rosidae of Cronquist or its equivalent) are very hard to place and need more study. None of my groups has a constitution exactly as suggested elsewhere - thus the inclusion of the Cruciferae in the caryophylloid circle of affinity or the exclusion of Piper from that of the 'Magnolioids' are both novel, but they are supported by an examination of the data. In the 'Tenuinucelli' the main dichotomy 'Asclepioids'/'Acanthoids' is new, but seems well founded, with certain genera and families showing a degree of similarity with both groups. This is one of the rare cases where it is possible to suggest an interrelationship between the definable groups via 'intermediate' forms. The inclusion of the Umbelliferae on this side of the hierarchy is unusual but is amply verified by the known facts, which also completely destroy the idea of the order Umbelliflorae.

The studies on hardwoods provide evidence that the Leguminosae and Rosaceae are not closely related, which is reaffirmed by the main Dicotyledon analyses, and also throw some interesting ideas on the interrelationships and validity of the three sub-families of Leguminosae. Whilst the Mimosoideae and Papilionoideae are fully separable, the Caesalpinioideae are 'intermediate' and serve to blur the distinction.

For coniferous woods, where the sample was very comprehensive, several interesting results appeared. The main dichotomy between the Pinaceae and the remaining families is novel but well supported by external evidence, and within these remaining families the split into northern and southern groups is in accordance with views on their fossil history. The whole picture of the Conifers gained from the analyses seems taxonomically sensible, and the fact that a comprehensive sample recorded in comparative terms can provide such good material for taxonomic reassessment is an indication of the approach needed if the much more complex dicotyledonous problem is going to be satisfactorily evaluated. Information must be sought and recorded in a consistent fashion so that the interrelationships of the individuals can be objectively assessed.

ACKNOWLEDGEMENTS

I wish to thank Mr. L. Watson who supervised this work, and Professor S.H. Crowdy who stepped in when Mr. Watson left for Australia for their help and encouragement; Dr. A. Myers and Mr. L. Mockett for advice during the disc electrophoresis of seed proteins; and Miss M. Portman and Mr. J. Bailey for their work on the diagrams and figures. Thanks are also due to Mrs. D.D. Trenchard for typing this thesis.

The financial support of the S.R.C. is acknowledged.

REFERENCES

- Adanson, M., 1763. Familles des Plantes. Paris.
- Airy-Shaw, H.K. (ed), 1966. Willis, J.C., Dictionary of Flowering Plants and Ferns, 7th ed. Cambridge.
- Anon, 1960. The Identification of Hardwoods - a Lens Key. For. Prod. Res., 25.
- Arnold, C.A., 1948. Classification of Gymnosperms from the viewpoint of Paleobotany. Bot. Gaz., 110, 2.
- Backer, C.A. and Van den Brink, R.C.B., 1963. Flora of Java, I. Groningen.
- Backer, C.A. and Van den Brink, R.C.B., 1965. Flora of Java, II. Groningen.
- Bailey, L.H., 1914-17. The Standard Cyclopedia of Horticulture. New York.
- Bailey, L.H., 1924. Manual of Cultivated Plants. New York.
- Bean, W.J., 1913-34. Trees and Shrubs hardy in the British Isles I-III. London.
- Bentham, G., 1861. Flora Hongkongensis. London.
- Bentham, G., 1863-73. Flora Australiensis. 1-6. London.
- Bentham, G. and Hooker, J.D., 1862-83. Genera Plantarum. London.
- Bessey, C.E., 1914. Phylogenetic taxonomy of flowering plants. Ann. Mo. Bot. Gar., 2, 109.
- Bhandari, N.N., 1965. Studies in the family Ranunculaceae, VIII. Phytomorph., 15, 285.
- Boodle, L.A. and Fritsch, F.E., 1908. Solereder's Systematic Anatomy of the Dicotyledons. Oxford.

- Bossier, E., 1867-88. Flora Orientalis. Geneva.
- Boulter, D., Thurman, D.A. and Turner, B.L., 1966. The use of disc electrophoresis of plant proteins in systematics. Taxon, 15, 135.
- Boulter, D., Thurman, D.A. and Derbyshire, E., 1967. A disc electrophoretic study of globulin proteins of legume seeds with reference to their systematics. New Phyt., 66, 27.
- Boyce, J.S., 1961. Forest Pathology. London.
- Braun, A., 1864. In Ascherson, Flora der Provinz Brandenburg. Berlin.
- Brazier, J.B. and Franklin, G.L., 1961. Identification of Hardwoods, a Microscope Key. For. Prod. Res., 46.
- Britton, N.L. and Rose, J.N., 1920. The Cactaceae. Washington.
- Brown, R., 1827. The Character and Description of Kingia, with observations on the unimpregnated ovulum and on the female flowers of Cycadeae and Coniferae. See 'Miscellaneous works of Robert Brown', Ray Soc. 1866.
- Buchholz, J.T., 1934. The classification of Coniferales. Trans. Ill. Acad. Sci., 21,
- de Candolle, A.P., 1813. Theorie Elementaire de la Botanique, Ed. I. Paris.
- de Candolle, A.P., 1824-73. Prodromus. Paris.
- Chamberlain, C.J., 1934. Gymnosperms: Structure and Evolution. Chicago.
- Corner, E.J.H., 1940. Wayside Trees of Malaya, 1 and 2. Singapore.

- Corner, E.J.H., 1949. The durian theory or the origin of the modern tree. Ann. Bot., 13, 367.
- Corner, E.J.H., 1953. The durian theory extended - 1. Phytomorph., 3, 465.
- Cronquist, A., 1969. The Evolution and Classification of Flowering Plants. London.
- Curtis, W., 1787-. Curtis' Botanical Magazine. Vols. I-. London.
- Dallimore, W. and Jackson, A.B. 1966. A Handbook of Coniferae and Ginkgoaceae, 4th edn. (Revised by S.G. Harrison). London.
- Davis, B.J., 1964. Disc Electrophoresis II. Ann. New York Acad. Sci. 121, 404.
- Davis, G.L., 1966. Systematic Embryology of the Angiosperms. New York.
- Davis, P.H. and Heywood, V.H., 1963. Principles of Angiosperm Taxonomy. Edinburgh.
- Doyle, J., 1963. Proembryogeny in Pinus in relation to that in other Conifers - a survey. Proc. R. Ir. Acad., 62, B13, 181.
- Eichler, A.W., 1889. Coniferae in Engler and Prant's, Die Natürlichen Pflanzenfamilien, II. Leipzig.
- El-Gazzar, A., Watson, L., Williams, W.T. and Lance, G.N., 1968. The taxonomy of Salvia: a test of two radically different numerical methods. J. Linn. Soc. (Bot.), 60, 237.
- Erdtman, G., 1945. Pollen morphology and plant taxonomy V - the occurrence of tetrads and dyads. Svensk. Bot. Tidskr., 39, 286.

- Erdtman, G., 1966. Pollen Morphology and Plant Taxonomy. New York.
- Erdtman, H., 1963. Chemical Plant Taxonomy (Ed. by T. Swain).
London.
- Exell, A.W. and Wild, H. (Eds.), 1960. Flora Zambesica, 1. London.
- Fawcett, W. and Rendle, A.B., 1914-36. Flora of Jamaica, 3-7.
London.
- Fernald, M.L., 1950. Gray's Manual of Botany, 8th ed. New York.
- Florin, R., 1940. The tertiary fossil Conifers of South Chile
and their phytogeographical significance. K. Svenska
Vetensk. Handl., 19(2), 1.
- Florin, R., 1948. On the morphology and relationships of the
Taxaceae. Bot. Gaz., 110, 31.
- Florin, R., 1951. Evolution in Cordaites and Conifers. Acta
Horti. Bergiani, 15, 285.
- Gill, L.S., 1935. Arceuthobium in the United States. Trans.
Conn. Acad. Arts Sci., 32, 111.
- Gleason, H.A. and Cronquist, A., 1963. Manual of Vascular Plants
of Northeastern United States and Adjacent Canada. Princetown,
New Jersey.
- Gooding, E.G.B., Loveless, A.R. and Proctor, G.R., 1965.
Flora of Barbados. London.
- Greguss, P., 1955. The Identification of Living Gymnosperms on
the basis of Xylotomy. Budapest.
- Gundersen, A., 1950. Families of Bicotyledons. Waltham, Mass.
- Harvey, W.H. and Sonder, O.W., 1894. Flora Capensis, 1-3. London.

- Hofmeister, W., 1851. Wergleichende Untersuchungen der höherer Cryptogamen und der Samenbildung der Coniferen. Leipzig.
- English translation by Currey, F. Ray Soc. 1862.
- Hutchinson, J., 1959. The Families of Flowering Plants, 2nd ed. Oxford.
- Hutchinson, J., 1964. The Genera of Flowering Plants, I. Oxford.
- Hutchinson, J., 1967. The Genera of Flowering Plants, II. Oxford.
- Hutchinson, J. and Dalziel, J.M., 1954-63. Flora of West Tropical Africa, 1 and 2. London.
- Hyde, H.A. and Adams, K.F., 1958. An Atlas of Airborne Pollen Grains. London.
- James, W.O. and Clapham, A.R., 1935. The Biology of Flowers. Oxford.
- Johansen, D.A., 1950. Plant Embryology. Waltham, Mass.
- Jones, S.G., 1939. Introduction to Floral Mechanism. London.
- de Jussieu, A.L., 1789. Genera Plantarum. Paris.
- Lance, G.N. and Williams, W.T., 1967. Mixed-Data classificatory systems. I. Agglomerative methods. Aust. Computer J., 1, 15.
- Lance, G.N. and Williams, W.T., 1968. Mixed-Data classificatory systems II. Divisive systems. Aust. Computer J., 1, 82.
- Lawrence, G.H.M., 1951. Taxonomy of Vascular Plants. New York.
- Lindley, J., 1830. A Natural System of Botany. London.
- Lindley, J., 1845. The Vegetable Kingdom. London.
- Linnaeus, C., 1737. Genera Plantarum.
- Linnaeus, C., 1751. Philosophia Botanica.
- Loudon, J.C., 1880. Encyclopaedia of Plants. London.

- Lubbock, J., 1889. On Buds and Stipules. London.
- Macbride, J.F., 1959-. Flora of Peru. Chicago.
- Maheshwari, P., 1950. An Introduction to the Embryology of Angiosperms. New York.
- Maheshwari, P. (Ed.), 1963. Recent Advances in the Embryology of Angiosperms. Dehli.
- Maheshwari, P. and Kapil, R.N., 1966. Some Indian contributions to the embryology of Angiosperms. Phytomorph., 16, 240.
- de Maout, E. and Decaisne, J., 1873. (Trans. Mrs. Hooker). A General System of Botany. London.
- Melchior, H., 1964. Engler's Syllabus der Pflanzenfamilien, II; 12th ed. Berlin.
- Metcalf, C.R., 1966. Distribution of latex in the Plant Kingdom. Notes from the Jodrell Laboratory, III.
- Metcalf, C.R. and Chalk, L., 1950. Anatomy of the Dicotyledons, I and II. Oxford.
- Ohwi, J., 1965. Flora of Japan. Washington.
- Ozenda, P., 1965. Recherches sur les Phanerogames Parasites. I. Revue des Travaux Recents. Phytomorph., 15, 311.
- Parlatore, A.P., 1868. Coniferae in de Candolle's Prodromus, XVI 2, Paris.
- Paterson, B.R., 1961. Studies of floral morphology in the Epacridaceae. Bot. Gaz., 122, 259.
- Phillips, E.W.J., 1948. The identification of Coniferous woods by their microscopic structure. For. Prod. Res., 22.

- Pilger, R., 1926. Pinaceae in Engler and Prantl's Die Natürlichen Pflanzenfamilien, Auf. 2, 13. Leipzig.
- Pilger, R. and Melchior, H., 1954. Gymnospermae. In Engler's Syllabus der Pflanzenfamilien. Berlin.
- Preston, R.J., 1948. North American Trees. Ames, Iowa.
- Pulle, A.A., 1952. Compendium van de Terminologie, Nomenclatuur en Systematiek der Zaaplanten. 3 Aufl. Utrecht.
- Ray, J., 1682. Methodus Plantarum.
- Ray, J., 1703. Methodus Emendata et Aucta.
- Rehder, A., 1954. Manual of Cultivated Trees and Shrubs, 2nd ed. New York.
- Rendle, A.B., 1904. The Classification of Flowering Plants. I. Cambridge.
- Rendle, A.B., 1938. The Classification of Flowering Plants. II. Cambridge.
- Ridley, H.N., 1922-24. The Flora of the Malay Peninsular. 1-3. London.
- Roberts, O. and Doyle, J., 1938. The pH of Conifer leaves in relation to systematy. Scient. Proc. R. Dubl. Soc. N.S., 21, 655.
- Sahni, B., 1920. On certain archaic features in the seed of Taxus baccata with remarks on the antiquity of the Taxinae. Ann. Bot., 34, 117.
- Sargent, C.S., 1922. Manual of the Trees of North America. New York.
- Saunders, E.R., 1937-9. Floral Morphology. 1 and 2. Cambridge.
- Saxton, W.T., 1913. The classification of Conifers. New Phytol., 12, 242.

- Sporne, K.R., 1948. Correlation and classification in Dicotyledons.
Proc. Linn. Soc. Lond., 160, 40.
- Sporne, K.R., 1949. A new approach to the primitive flower.
New Phytol., 48, 259.
- Sporne, K.R., 1954. Statistics and the evolution of Dicotyledons.
Evolution Lancaster Pa., 8, 55.
- Sporne, K.R., 1956. The phylogenetic classification of the
Angiosperms. Proc. Linn. Soc. Lond., 171, 83.
- Sporne, K.R., 1965. Morphology of Gymnosperms, London.
- Sporne, K.R., 1969. The ovule as an indicator of evolutionary
status in Angiosperms. New Phytol., 68, 555.
- Stafleu, F.A., 1964. Introduction to facsimile edition of de
Jussieu's Genera Plantarum. Weinheim.
- Sterling, C., 1963. Structure of the male gametophyte in
Gymnosperms. Biol. Rev., 38, 167.
- Takhtajan, A.L., 1964. The taxa of higher plants above the rank
of order. Taxon, 13, 160.
- Thiselton-Dyer, W.T.(ed.), 1909-25. Flora Capensis, 4-5:2. London.
- de Tournefort, J.P., 1694. Elemens de Botanique. Paris.
- Trelease, W., 1916. The Genus Phoradendron. University of
Illinois Press.
- Trimen, H., 1893-98. A Handbook to the Flora of Ceylon. I-IV.
London.
- Van Steenis, C.G.G.J. (general editor), 1950-. Flora Malesiana.
P. Noordhoff, Leyden.

- Wagenitz, G. 1959. Die Systematische Stellung der Rubiaceae.
Bot. Jahrb., 79, 17.
- Walters, S.M., 1961. The shaping of Angiosperm taxonomy. New
Phytol., 60, 74.
- Watson, L., Williams, W.T. and Lance, G.N., 1967. A mixed-data
numerical approach to Angiosperm taxonomy. The classification
of Ericales. Proc. Linn. Soc. Lond., 178, 25.
- Wettstein, R.R., 1923-4. Handbuch der Systematischen Botanik. Ed.
3. Leipzig and Vienna.
- Williams, W.T. and Lambert, J.M., 1959. Multivariate methods
in plant ecology. I. Association Analysis in plant
communities. J. Ecol., 47, 83.
- Williams, W.T. and Lambert, J.M., 1960. Multivariate methods
in plant ecology. II. The use of an electronic digital
computer for Association Analysis. J. Ecol., 48, 689.
- Williams, W.T., Lambert, J.M. and Lance, G.N., 1966. Multivariate
methods in plant ecology. V. Similarity analysis and
information analysis. J. Ecol., 54, 427.
- Wodehouse, R.P., 1935. Pollen Grains. New York.
- Wooton, E.O. and Standley, P.C., 1915. Flora of New Mexico.
Washington.

APPENDICES

Appendix 1. The 543 dicotyledonous genera analysed under INFO, ASOC and MULASS. The citations are from the 7th edition of Willis, Dictionary of Flowering Plants and Ferns (Airy-Shaw; 1966).

- I. ACANTHACEAE.
 1. Acanthus L.
 2. Aphelandra R.Br.
 3. Barleria L.
 4. Dicliptera Juss.
 5. Hypoestes Soland. ex R.Br.
 6. Justicia Houst. ex L.
 7. Ruellia L.
 8. Strobilanthes Blume.
2. AIZOACEAE.
 9. Aizoon L.
 10. Galenia L.
 11. Mesembryanthemum L.
 12. Mollugo L.
 13. Pharnaceum L.
3. AMARANTACEAE.
 14. Achyranthes L.
 15. Alternanthera Forsk.
 16. Amaranthus L.
 17. Celosia L.
 18. Gomphrena L.
4. ANACARDIACEAE.
 19. Anacardium L.
 20. Eanea A.Rich.
 21. Mangifera L.
 22. Mauria Kunth.
 23. Rhus L.
 24. Semecarpus L. f.
 25. Spondias L.
5. ANNONACEAE.
 26. Annona L.
 27. Artabotrys R.Br.
 28. Duguetia A.St-Hil.
 29. Guatteria Ruiz & Pav.
 30. Monodora Dun.
 31. Uvaria L.
 32. Xylopia L.
6. APOCYNACEAE.
 33. Aspidosperma Mart. & Zucc.
 34. Landolphia Beauv.
 35. Mandevilla Ldl.
 36. Parsonsia R.Br.
 37. Prestonia R.Br.
 38. Rauvolfia L.
 39. Strophanthus DC.
 40. Tabernaemontana L.
7. ARALIACEAE.
 41. Aralia L.
 42. Dendropanax Dcne. & Planch.
 43. Hedera L.
 44. Polyscias J.R. & G.Forst.
 45. Schefflera J.R. & G. Forst.
8. ASCLEPIADACEAE.
 46. Asclepias L.
 47. Caralluma R.Br.
 48. Ceropegia L.
 49. Gonolobus Michx.
 50. Hoya R.Br.
 51. Oxypetalum R.Br.
 52. Secamone R.Br.
 53. Stapelia L.
9. BIGNONIACEAE.
 54. Adenocalymna Mart. ex Meissn.
 55. Anemopaegma Mart. ex Meissn.
 56. Catalpa V.Wolf.
 57. Jacaranda Juss.
 58. Phyllarthron DC.
 59. Tabebuia Gomes ex DC.
 60. Tecoma Juss.
10. BORAGINACEAE.
 61. Anchusa L.
 62. Cynoglossum L.
 63. Echium L.
 64. Eritrichium Schrad.
 65. Heliotropium L.
 66. Lithospermum L.
 67. Myosotis L.
 68. Tournefortia L.
- II. CACTACEAE.
 69. Cereus Mill.
 70. Echinocereus Engelm.
 71. Mammillaria Haw.
 72. Opuntia Tourn. ex Mill.
 73. Pereskia Mill.
 74. Rhipsalis Gaertn.
12. CAMPANULACEAE.
 75. Adenophora Fisch.
 76. Campanula L.
 77. Centropogon Presl.
 78. Cyphia Bergius.
 79. Lobelia L.
 80. Siphocampylus Pohl.
 81. Wahlenbergia Schrad. ex Roth.

13. CARYOPHYLLACEAE.
82. Arenaria L.
83. Cerastium L.
84. Dianthus L.
85. Drymaria Willd.ex R. & S. L. f. 2.
86. Gypsophila L.
87. Paronychia Mill.
88. Silene L.
89. Spergularia J.& C.Presl.
90. Stellaria L.
14. CELASTRACEAE.
91. Cassine L.
92. Celastrus L.
93. Euonymus L.
94. Hippocratea L.
95. Maytenus Molina.
96. Microtropis Wall.
97. Salacia L.
15. CHENOPODIACEAE.
98. Anabasis L.
99. Atriplex L.
100. Bassia All.
101. Chenopodium L.
102. Corispermum Juss.ex L.
103. Salicornia L.
104. Salsola L.
105. Suaeda Forsk.ex Scop.
16. COMPOSITAE.
106. Crepis L.
107. Hieracium L.
108. Lactuca L.
109. Leontodon L.
110. Taraxacum Weber.
111. Bidens L.
112. Espeletia Mutis.
113. Helianthus L.
114. Pectis L.
115. Aster Tourn.ex L.
116. Baccharis L.
117. Achillea L.
118. Artemesia L.
119. Chrysanthemum L.
120. Arctotis L.
121. Ursinia Gaertn.
122. Antennaria Gaertn.
123. Gnaphalium L.
124. Helichrysum Mill.cor.Pers.
125. Inula L.
16. COMPOSITAE. (Cont.)
126. Senecio L.
127. Calendula L.
128. Osteospermum L.
129. Ageratum L.
130. Brickellia Ell.
131. Eupatorium L.
132. Piptocarpha R.Br.
133. Vernonia Schreb.
134. Carduus L.
135. Echinops L.
136. Gerbera L.ex Cass.
137. Mutisia L.f.
17. CONVOLVULACEAE.
138. Argyreia Lour.
139. Convolvulus L.
140. Erycibe Roxb.
141. Evolvulus L.
142. Falkia L.
143. Ipomoea L.f.
144. Jacquemontia Choisy.
18. CRUCIFERAE.
145. Alyssum L.
146. Arabis L.
147. Brassica L.
148. Cardamine.L.
149. Cochlearia L.
150. Crambe L.
151. Draba L.
152. Heliophila Burm.f.ex L.
153. Iberis L.
154. Isatis L.
155. Lepidium L.
156. Matthiola R.Br.cor. Spr.
157. Sisymbrium L.
19. CUCURBITACEAE.
158. Bryonia L.
159. Cayaponia S.Manso.
160. Cucumis L.
161. Cucurbitar L.
162. Echinocystis Torr & Gr.
163. Fevillea L.
164. Momordica L.
165. Peponium Engl.
20. ERICACEAE.
166. Arctostaphylos Adans.
167. Bejaria Mutis ex L.
corr.Zea ex Vent.

20. ERICACEAE. (Cont.)
 I68. Erica L.
 I69. Gaultheria L.
 I70. Ledum L.
 I71. Rhododendron L.
 I72. Vaccinium L.

21. EUPHORBIACEAE.
 I73. Acalypha L.
 I74. Bridelia Willd. corr. Spreng.
 I75. Cleistanthus Hook.f.ex Planch.
 I76. Clutia L.
 I77. Croton L.
 I78. Euphorbia L.
 I79. Jatropha L.
 I80. Julocroton Mart.
 I81. Macaranga Thou.
 I82. Mallotus Lour.
 I83. Manihot Mill.
 I84. Phyllanthus L.
 I85. Sapium P.Br.
 I86. Sebastiana Spreng.
 I87. Suregada Roxb.ex Rottl.

22. FLACOURTIACEAE.
 I88. Banara Aubl.
 I89. Casearia Jacq.
 I90. Flacourtia Comm.ex L'Herit.
 I91. Homalium Jacq.
 I92. Hydnocarpus Gaertn.
 I93. Mayna Aubl.
 I94. Scolopia Schreb.
 I95. Xylosma G.Forst.

23. GENTIANACEAE.
 I96. Centaurium Hill.
 I97. Chironia L.
 I98. Exacum L.
 I99. Gentiana L.
 200. Halenia Borckh.
 201. Lisianthus B.Br.
 202. Sebaea Soland.ex R.Br.
 203. Swertia L.

24. GESNERIACEAE.
 204. Achimenes Pers.
 205. Aeschynanthus Jack.
 206. Besleria L.
 207. Columnea L.
 208. Cyrtandra J.R. & G.Forst.

24. GESNERIACEAE. (Cont.)
 209. Gesneria L.
 210. Kohleria Regel.
 211. Streptocarpus Ldl.

25. ICACINACEAE.
 212. Icacinia A.Juss.
 213. Iodes Blume.
 214. Phytocrene Wall.
 215. Pyrenacantha Hook.ex Wht.
 216. Stemonurus Blume.(1825)

26. LABIATAE.
 217. Ajuga L.
 218. Gomphostemma Wall.
 219. Lamium L.
 220. Lavandula L.
 221. Nepeta L.
 222. Ocimum L.
 223. Plectranthus L'Herit.
 224. Pogostemon Desf.
 225. Prostanthera Labill.
 226. Satureja L.
 227. Salvia L.
 228. Scutellaria L.
 229. Stachys L.
 230. Teucrium L.
 231. Thymus L.

27. LEGUMINOSAE.
 232. Acacia Mill.
 233. Entada Adans.
 234. Inga Mill.
 235. Mimosa L.
 236. Parkia R.Br.
 237. Pithecellobium Mart.
 238. Prosopis L.
 239. Bauhinia L.
 240. Caesalpinia L.
 241. Cassia L.
 242. Cynometra L.
 243. Dimorphandra Schott.
 244. Macrolobium Schreb.
 245. Sclerolobium Vog.
 246. Swartzia Schreb.
 247. Aeschynomene L.
 248. Astragalus L.
 249. Baphia Afzel.
 250. Crotalaria L.
 251. Dalbergia L.f.

27. LECUMINOSAE. (Cont.)
252. *Desmodium* Desv.
253. *Hedysarum* L.
254. *Lathyrus* L.
255. *Lonchocarpus* Kunth.
256. *Lotus* L.
257. *Lupinus* L.
258. *Indigofera* L.
259. *Millettia* Wight & Arn.
260. *Mucuna* Adans.
261. *Ononis* L.
262. *Phaseolus* L.
263. *Pultenaea* Sm.
264. *Sophora* L.
265. *Trifolium* L.
266. *Vicia* L.
28. MALPIGHIACEAE.
267. *Byrsonima* Rich. ex Juss.
268. *Heteropterys* Kunth. emend. Gr.
269. *Malpighia* L.
270. *Stigmaphyllon* A.Juss.
29. MALVACEAE.
271. *Abutilon* Mill.
272. *Gossypium* L.
273. *Hibiscus* L.
274. *Malva* L.
275. *Pavonia* Cav.
276. *Sida* L.
30. MELASTOMATACEAE.
277. *Astronia* Blume.
278. *Blakea* P.Br.
279. *Clidemia* D.Don.
280. *Lavoisiera* DC.
281. *Leandra* Raddi.
282. *Melastoma* L.
283. *Meriania* Sw.
284. *Medinilla* Gaud.
285. *Miconia* Ruiz & Pav.
286. *Microlicia* D.Don.
287. *Monochaetum* (DC.) Naud.
288. *Osbeckia* L.
289. *Sonerila* Roxb.
290. *Tibouchina* Aubl.
31. MELIACEAE.
291. *Dysoxylum* Blume.
292. *Entandrophragma* C.DC.
(incl. *Khaya* A.Juss.)
31. MELIACEAE. (Cont.)
293. *Melia* L.
294. *Toona* M.Roem.
(incl. *Cedrela* P.Br.)
295. *Trichilia* P.Br.
32. MENISPERMACEAE.
296. *Abuta* Aubl.
297. *Hyperbaena* Miers ex Benth.
298. *Menispermum* L.
299. *Stephania* Lour.
300. *Tinospora* Miers.
33. MORACEAE.
301. *Artocarpus* J.R. & G.Forst.
302. *Brosimum* Sw.
303. *Dorstenia* L.
304. *Ficus* L.
305. *Morus* L.
306. *Pseudolmedia* Trec.
34. MYRTACEAE.
307. *Calythrix* Labill.
308. *Eucalyptus* L'Herit.
309. *Eugenia* L.
310. *Melaleuca* L.
311. *Metrosideros* Banks ex Gaertn.
312. *Myrcia* DC. ex Guillem.
313. *Myrtus* L.
314. *Psidium* L.
315. *Verticordia* DC.
35. PERIPLOCACEAE.
316. *Cryptolepis* R.Br.
317. *Periploca* L.
318. *Raphionacme* Harv.
35. PROTEACEAE.
319. *Banksia* L.f.
320. *Grevillea* R.Br.
321. *Hakea* Schrad.
322. *Leucadendron* R.Br.
323. *Persoonia* Sm.
324. *Protea* L.(1771)
325. *Roupala* Aubl.
37. RANUNCULACEAE.
326. *Aconitum* L.
327. *Anemone* L.
328. *Aquilegia* L.
329. *Clematis* L.

37. RANUNCULACEAE. (Cont.)
 330. Delphinium L.
 331. Ranunculus L.
 332. Thalictrum L.
 333. Trollius L.
38. RHAMNACEAE.
 334. Colletia Comm.ex Juss.
 335. Gouania Jacq.
 336. Pomaderris Labill.
 337. Rhamnus L.
 338. Ventilago Gaertn.
 339. Ziziphus Mill.
39. ROSACEAE.
 340. Alchemilla L.
 341. Cliffortia L.
 342. Cotoneaster Medik.
 343. Crataegus L.
 344. Geum L.
 345. Hirtella L.
 346. Licania Aubl.
 347. Malus Mill.
 348. Potentilla L.
 349. Poterium L.
 350. Prunus L.
 351. Rosa L.
 352. Rubus L.
 353. Spiraea L.
40. RUBIACEAE.
 354. Alibertia A.Rich ex DC.
 355. Anthospermum L.
 356. Antirhea Comm.ex Juss.
 357. Argostemma Wall.
 358. Asperula L.
 359. Borreria G.F.W.Mey.
 360. Canthium Lam.
 361. Chomelia L.
 362. Cinchona L.
 363. Coffea L.
 364. Coprosma J.R. & G. Forst.
 365. Cousarrea Aubl.
 366. Exostema (Pers.) Rich.
 367. Gardenia Ellis (1761).
 368. Ixora L.
 369. Lasianthus Jack.
 370. Leptodermis Wall.
 371. Morinda L.
 372. Mussaenda L.
 373. Myrmecodia Jack.
40. RUBIACEAE. (Cont.)
 374. Oldenlandia L.
 375. Paederia L.
 376. Psychotria L.
 377. Randia L.
 378. Rondeletia L.
 379. Rubia L.
 380. Spermacoce L.
 381. Timonius DC.
 382. Urophyllum Wall.
 383. Wendlandia Bartl.ex DC.
41. RUTACEAE.
 384. Acronychia J.R. & G. Forst.
 385. Adenandra Willd.
 386. Agathosma Willd.
 387. Boronia Sm.
 388. Citrus L.
 389. Cusparia Humb.
 390. Esenbeckia Kunth.
 391. Fagara L. (sensu Engl.)
 +Zanthoxylum L.
 392. Glycosmis Correa.
 394. Ruta L.
 395. Spathelia L.
 393. Melicope J.R. & G. Forst.
42. SAPINDACEAE.
 396. Allophylus L.
 397. Cupania L.
 398. Harpullia Roxb.
 399. Nephelium L.
 400. Otophora Blume.
 401. Sapindus L.
 402. Serjania Mill.
 403. Talisia Aubl.
43. SAPOTACEAE.
 404. Bumelia Sw.
 405. Chrysophyllum L.
 406. Mimusops L.
 407. Palaquium Blanco.
 408. Sideroxylon L.
44. SCROPHULARIACEAE.
 409. Antirrhinum L.
 410. Aptosimum Burchell.
 411. Calceolaria L.
 412. Castilleja Mutis.
 413. Celsia L.
 414. Diascia Link & Otto.
 415. Digitalis L.

44. SCROPHULARIACEAE. (Cont.)

- 416. Euphrasia L.
- 417. Gratiola L.
- 418. Hebenstretia L.
- 419. Mimulus L.
- 420. Nemesia Vent.
- 421. Penstemon Schmid.
- 422. Rhinanthus L.
- 423. Scrophularia L.
- 424. Selago L.
- 425. Torenia L.
- 426. Verbascum L.
- 427. Veronica L.
- 428. Zaluzianskia F.W.Schmidt.

45. SOLANACEAE.

- 429. Brunfelsea L.
- 430. Cestrum L.
- 431. Datura L.
- 432. Hyoscyamus L.
- 433. Lycium L.
- 434. Nicotiana L.
- 435. Physalis L.
- 436. Salpichroa Miers.
- 437. Schwenckia Royen ex L.
- 438. Solanum L.

46. STERCULIACEAE.

- 439. Dombeya Cav.
- 440. Helicteres L.
- 441. Hermannia L.
- 442. Lasiopetalum Sm.
- 443. Melochia L.
- 444. Sterculia L.
- 445. Theobroma L.

47. THYMELEACEAE.

- 446. Aquilaria Lam.
- 447. Daphne L.
- 448. Dicranolepis Planch.
- 449. Gnidia L.
- 450. Peddiea Harv.
- 451. Phaleria Jack.
- 452. Pimelea Banks & Soland.

48. TILIACEAE.

- 453. Brownlowia Roxb.
- 454. Corchorus L.
- 455. Grewia L.
- 456. Pentace Hassk.
- 457. Tilia L.
- 458. Triumfetta L.

49. UMBELLIFERAE.

- 459. Angelica L.
- 460. Anthriscus Hoffm.
- 461. Bupleurum L.
- 462. Chaerophyllum L.
- 463. Daucus L.
- 464. Eryngium L.
- 465. Hydrocotyle L.
- 466. Laserpitium L.
- 467. Peucedanum L.
- 468. Pimpinella L.
- 469. Pleurospermum Hoffm.
- 470. Sanicula L.
- 471. Trachymene Rudge.

50. VERBENACEAE.

- 472. Callicarpa L.
- 473. Caryopteris Bunge.
- 474. Citharexylum L.
- 475. Clerodendrum L.
- 476. Lippia L.
- 477. Petrea L.
- 478. Priva Adans.
- 479. Verbena L.
- 480. Vitex L.

51. CAPPARIDACEAE.

- 481. Capparis L.

52. CRASSULACEAE.

- 482. Crassula L.
- 483. Sedum L.

53. DIPTEROCARPACEAE.

- 484. Hopea Roxb.
- 485. Shorea Roxb. ex Gaertn.

54. EPACRIDACEAE.

- 486. Leucopogon R.Br.

55. GUTIFERAE.

- 487. Calophyllum L.
- 488. Garcinia L.
- 489. Hypericum L.

56. LAURACEAE.

- 490. Cinnamomum Schaeffer.
- 491. Cryptocarya R.Br.
- 492. Litsea Lam.
- 493. Persea Mill.

57. LORANTHACEAE.
494. Loranthus Jacq.
495. Phoradendron Nutt.
496. Viscum L.
58. MYRSINACEAE.
497. Ardisia Sw.
498. Maesa Forsk.
499. Rapanea Aubl.
(+Myrsine L.)
59. NYCTAGINACEAE.
500. Pisonia L.
60. OCHNACEAE.
501. Ochna L.
61. OLEACEAE.
502. Fraxinus L.
503. Jasminum L.
62. ONAGRACEAE.
504. Epilobium L.
505. Oenothera L.
63. POLYGONACEAE.
506. Calligonum L.
507. Coccoloba P.Br. mut.L.
508. Erogonum Michx.
509. Polygonum L.
510. Rumex L.
64. PRIMULACEAE.
511. Lysimachia L.
512. Primula L.
65. SANTALACEAE.
513. Thesium L.
66. SAXIFRAGACEAE.
514. Heuchera L.
515. Saxifraga L.
67. URTICACEAE.
516. Boehmeria Jacq.
517. Cecropia Loeft.
518. Pellionia Gaudich.
519. Urtica L.
68. VIOLACEAE.
520. Viola L.
69. ZYGOPHYLLACEAE.
521. Zygophyllum L.
70. ACERACEAE.
522. Acer L.
71. BETULACEAE.
523. Betula L.
72. FAGACEAE.
524. Quercus L.
73. SALICACEAE.
525. Salix L.
74. PIPERACEAE.
526. Piper L.
75. MAGNOLIACEAE.
527. Magnolia L.
76. NYMPHAEACEAE.
528. Nymphaea L.
77. ARISTOLOCHIACEAE.
529. Aristolochia L.
78. BEGONIACEAE.
530. Begonia L.
79. BERBERIDACEAE.
531. Berberis L. (inc. Mahonia Nutt.)
80. CORNACEAE.
532. Cornus L.
81. CAPRIFOLIACEAE.
533. Lonicera L.
82. DILLENIACEAE.
534. Dillenia L.
83. GERANIACEAE.
535. Geranium L.
84. MYRISTICACEAE.
536. Myristica Gronov.
85. OXALIDACEAE.
537. Oxalis L.

- 86. PAPAVERACEAE.
538. Papaver L.
- 87. PASSIFLORACEAE.
539. Passiflora L.
- 88. PLANTAGINACEAE.
540. Plantago L.
- 89. PLATANACEAE.
541. Platanus L.
- 90. PLUMBAGINACEAE.
542. Limonium Mill.
- 91. WINTERACEAE.
543. Drimys J.R.& G.Forst.

Appendix 2. Comparative observations recorded for 543 genera of Dicotyledons as coded for analysis under MULASS. The serial numbers refer to the genera in Appendix 1. They are grouped at the 180 level and sub-grouped at the 100 level as shown in Diagrams IV and V. Description of the characters is given in Table 2. The first state of a qualitative is scored as 1 the second as 0; numerical values run from 2-10; serial numbers were ascribed to the states of each multistate character (see Table 2) and the numbers of the states recorded for a genus are entered between strokes. (Due to the number of multistate characters they are continued across two pages but the group numbers and the serial numbers of the genera are not repeated.) Asterisks represent 'unknown' or 'inapplicable' features.

Group 1.

277. 0000*000000*010100000100010100010011000100000*1*0110000000010 IO.0
 278. 100000001000*0101000001000111001100111*0100000*1*01100000001* IO.0
 279. 0000*01*000*1111000001000101000100111*0000000*1*01100000001* IO.0
 280. 0000*01*000*0001001*000*001*000101111*0100000*1*0110000000010 IO.0
 281. 0000*01*000*101100*001100101000100111*0000000*1*01100000001* IO.0
 282. 000000000000*0001001001100111000101111*01000001*0110000000110 IO.0
 283. 00000001*000*0101001001000101000101111*0100000*1*0110000000010 IO.0
 284. 100000000000*1101000001100101000101111*0100000*1*01100000001* IO.0
 285. 0000*01*000*1111000001100101000100111*0100000*1*0110000000000 IO.0
 286. 0000*01*000*0001001*000*001*000101111*0100000*1*0110000000010 IO.0
 287. 0000*000000*100100*000*0101001001111*0100000*1*0110000000010 IO.0
 288. 0000000000000000001*000*011100101111*00000001*0110000000010 IO.0
 289. 0000*01*000*110100*00100010100100111*00000001*0110000000010 IO.0
 290. 100000000000*0101001001100111000101111*0100000*1*0110000000010 IO.0

 I45. 00000001*010100010*0*0*0100011101110000000001*0110*00000011 IO.0
 I46. 00000001*010100010*0*0*0100011101110000000001*0110*00000011 IO.0
 I47. 000000001010100010100101010011101110000000001*0110000000011 IO.0
 I48. 00001*0010100000010*0*0*0100111101110000000001*0110000000011 IO.0
 I49. 00000101*0*1100010*0*0*0100111101110000000001*0110*00000011 IO.0
 I50. 00001*0010100000010*0*0*0100011101110000000001*1110*0000000* *
 I51. 00000001*010100010*0*0*0100011101110000000001*0110*00000011 IO.0
 I52. 0000000010100000010*0*0*0100011101110000000001*0110*00000011 IO.0
 I53. 00100001*01000000101*0*0*0100011101110000000001*0110*00000011 IO.0
 I54. 0000*01*0100000010*0*0*0100011101110000000001*1110*0000000* *
 I55. 00001*01*0100000010*0*0*0100111001110000000001*0110*00000011 IO.0
 I56. 00000001*0101000101*0*0*0100011101110000000*01*0110*00000011 IO.0
 I57. 0000000010100000010*0*0*0100011101110000000001*0110*00000011 IO.0

 2I3. 1000*000010*0000100*0*0*0101000*001100*010000*1*10*00*000110* *
 446. *000*000010*0001000001010100000101100001000*01*1*000000*100010 *
 447. 00001*000010*11010001010101001*1110110000100010011100000001* *
 448. 0000*000010*000100000101011001011000010001001010000001000* *
 449. 000000000010*0001000001010100011101100001000100101000000100* *
 450. 0000*000010*00010000010101001*11101100001000101*01000000101** IO.0
 451. *000*000010*00010000010101001*01101100001000101*01000000101** IO.0
 452. 00001*000010*01010000010101001*11101100001000100101000000100* *

 IO. 0000000000000000010*0*0*01111*01001100001000001*1100001001110 *
 II. 00100000001011000101*0*0*01110110001100001000001*1100001001110 *
 528. 00000001*0000000011*0*0*001*011001110001100000111100010111110 *
 538. 0000011010*10000011*0*0*001*011100110*001000101*1110000001010 *

Group 2.

9. 0000000000100000010*0*0*01111*00000100001000001*1100000001010 *
 12. 0000*0001101000010*0*0*01111*00001100000000001*1100000011010 *
 13. 0000000001101*0*0*01011*00001100000000001*110000*011010 *
 14. 0000000000100000010*0*0*01001*000001000100000101*010000000100* IO.0
 15. 0000000000100000010*0*0*01001*000001000100000101*010000000100* IO.0
 16. 0000*00001000000100*0*0*01011*000011000100000101*1100000001010 *
 17. 1000*0000100000010*0*0*01011*000001000100000101*1100000001010 *
 18. 0000000000100000010*0*0*01001*000001000100000101*011000000100* 8.0

Group 1.

277.	3,4/	*/	2	/I	/I,	4/	5,6/	2	/I	/	*/I	/
278.	3 /	3,4/	2	/I	/I	4/	5,6/	3/I	/	*/I	/	/
279.	3 /	*/	2	/I	3,4/I	4/	5,6/	3/I	/	*/I	/	/
280.	3 /	*/	2	/I	/I	4/	5,6/I,2,3/I	/	*/I	/	/	/
281.	3,4/	*/	2	/I	3,4/I	4/	5,6/	3/I	/	*/I	/	/
282.	3,4/	*/	2	/I	/I	4/	5,6/I,2	/I	/	*/I	/	/
283.	3,4/	*/	2	/I	/I	4/	5,6/I,2	/I	/	*/I	/	/
284.	3 /	3,4/	2,3/I	4/I	4/	4/	5,6/	3/I	/	*/I	/	/
285.	3,4/	*/	2	/I,	3,4/I	4/I	5,6/	3/I	/	*/I	/	/
286.	3 /	*/	2	/I	4/I	4/	5,6/I,2	/I	/	*/I	/	/
287.	3 /	*/	2	/I	/I	4/	5,6/I,2	/I	/	*/I	/	/
288.	2,3 /	*/	2	/I	/I	4/	5,6/	3/I	/	*/I	/	/
289.	3 /	*/	2	/I	4/I	4/	4,5,6/	3/I	/	*/I	/	/
290.	3 /	4/	2	/I	/I	4/	4,5,6/	2,3/I	/	*/I	/	/
I45.	I,2 /	*/I	/	2	/I	4/I,2	/I	/I	/I	/I	/I	/
I46.	I,2 /	*/I	/	2	/I	4/I,2	/I	/I	/I	/I	/I	/
I47.	I,2,3 /	*/I	/	2	/I	4/I	/I	/I	/I	/I	/I	/
I48.	I,2 /	*/I	/	2	/I	4/I	/I	/I	/I	/I	/I	/
I49.	I,2 /	*/I	/	2	/I	4/I	/I	/I	/I	/I	/I	/
I50.	I,2,3 /	*/I	/	2	/I	4/I	/I	/I	/I	/I	/I	/
I51.	I,2 /	*/I	/	2	/I	4/I,2	/I	/I	/I	/I	/I	/
I52.	I,2 /	*/I	/	2	/I	4/I	/I	/I	/I	/I	/I	/
I53.	I,2,3 /	*/I	/	2	/I	4/I	/I	/I	/I	/I	/I	/
I54.	I /	*/I	/	2	/I	4/I	/I	/I	/I	/I	/I	/
I55.	I,2 /	*/I	/	2	/I	4/I	/I	/I	/I	/I	/I	/
I56.	I,2,3 /	*/I	/	2	/I	4/ 2	6/I	/I	/I	/I	/I	/
I57.	I,2 /	*/I	/	2	/I	4/I	/I	/I	/I	/I	/I	/
2I3.	3 / 2	/	2	/	*/	*/	*/I	/ 2	/	3/I	/	/
446.	4/	*/I	/I	/	*/I	*/I	/I	/I	/	3/I	/	/
447.	3 /	*/	2	/I	/ 2	4/I	/I	/I	/	3/I	/	/
448.	3 /	*/I	/I	/	*/I	*/I	/I	/I	/	3/I	/	/
449.	3 /	*/	2	/I	/	*/I	/I	/I	/	3/I	/	/
450.	3 /	*/	2	/I	/	*/I	/I	/I	/	3/I	/	/
451.	4/	*/	2	/I	/	*/I	/I	/I	/	3/I	/	/
452.	3 /	*/	2	/I	/	*/I	/I	/I,2	/	3/I	/	/
IO.	2 /	*/I,2	/I	/	*/ 2	/I,2	/I	/	*/I	/	/	/
II.	I,2 /	*/	2	/I	3 /	*/I	/	3/I	/	*/I	/	/
528.	2 /	*/I	/I	/I	3 /	4	6/I,2	/I	/	*/	*/	/
538.	I,2 /	*/I	/I	/I	4/	5	/I	/I	/I	/I	/	/

Group 2.

9.	I,2 /	*/I	/I	/	*/ 2	/I,2	/I	/	*/I	/	/	/
I2.	I /	*/I	3/I	/	*/	5	/I	/I	/I	/I	/	/
I3.	I,2 /	*/I	3/	*/	*/	*/I	/I	/I	/I	/I	/	/
I4.	2,3 /	*/	2	/I	/	*/	4	/I	/I	/I	/I	/
I5.	I,2,3 /	*/	2	/I	/	*/	4,5	/I	/I	/I	/I	/
I6.	I /	*/I	/I	/I	4/	4	/I	/	2,3/I	/I	/	/
I17.	I 3 /	4/I	/I	/I,	3,4/	4	/I	/I	/I	/I	/	/
I8.	I,2 /	*/	2	/I	/I	4/	4	/I	/I	/I	/I	/

I	/I	/	3	/	2	/I,2	4/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	4/	3/	*/I	/	2	/I	/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	4	/
I	/I	/	3	/	2	/I	4/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I,2	4/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/	4/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	4/	3/	*/I	/	2	/	*/	
I	/I	/I	3	/	2	/	4/	3/	*/I	/	2	/I	/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	4/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	4/	3/	*/I	/	2	/I	/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I	/	3/	*/I	/	2	/	*/	
I	/I	/	3	/	2	/I								

82.	oooo*ooo*loooooo*o***olllllooloolloooo*ooo*ol*olooooooooolloll	2.0
83.	ooooooooooooolooooool*o***ololooloolloooo*ooo*ol*olooooooooolloll	2.0
84.	ooooooooooooolooooool*o***olllllooloolloooo*ooo*ol*olooooooooolloll	2.0
85.	ooo*o*oolloo*o***o*o***olllllooloolloooo*oolol*olooooooooollolo	6.0
86.	ooooolooooolooloolo*o***olllllooloolloooo*ooo*ol*olooooooooolloll	2.0
87.	oooooooooollooooool*o***ololl*oollooloooooolol*oloooooooooolo*	7.0
88.	ooooolooooolooloolo*o***olllllooloolloooo*ooo*ol*olooooooooolloll	2.0
89.	ooooolooooolooooool*o***ololllooloolloooo*ooo*ol*olooooooooollolo	2.0
90.	ooooolooooolooooool*o***olllllooloollooooooolol*olooooooooolloll	2.0
98.	oolooooooooolooooool*o***ollll*oollooloollooolol*oloooooooooooo*	8.0
99.	oooooooo*o*ooloolooloooooololl*o*oolloooloolool*lloooooooooolo*	*
100.	oolooooooooolooooool*o***ololl*oollooolooloolol*oloooooooooolo*	2.0
101.	oooooooo*o*ooloolo*o***ololl*oollooolooloolol*lloooooooooolo*	*
102.	ooo*o*ooloooooooool*o***llool*oollooolooloolol*lloooooooooolo*	*
103.	olll*o*ooooooooooooool*o***oolol*lloollooolooloolol*oloooooooooooo*	5.0
104.	ooloooooooooloooooololoooooollll*oollooolooloolol*oloooooooooooo*	8.0
105.	oooooooooooooloooooololoooooololl*oollooolooloolol*lloolooloolo*	*
500.	loooooooooool*ooloooooooooololl*o*ooloooooooooolooloolooloolool	*
506.	ool*o*oooooooooooooololooloololl*llooloooooooo*ol*ooloooooooooolo*	2.0
507.	looooooooooll*oolooloolooloololl*llooloooooooo*ol*ooloooooooooolo*	2.0
508.	ooooolooloolooloolooloololl*lloolooooooooool*oloooooooooolo*	2.0
509.	loool*ol*llooloolool*o***ololl*lloolloooooooooool*oloooooooooolo*	4.0
510.	oooo*ol*llooloolool*o***ololl*lloolloooooooooool*oloooooooooolo*	2.0
91.	oooooooo*olo*ollloooloolooloolooloollooooo*o*llll*oollll*	*
95.	ooooooooolllo*oolooloolooloolooloolooloolool*llll*oollllo	*
96.	oooooooooooool*oooooooooolooloolooloolooloolool*o*llll*oolololo	10.0
97.	loo*o*ol*olo*oolooloolooloolooloolooloolool*olooooooooool*	9.0
178.	ooloooooooooolooloolooloolooloololl*o*ollloooloolool*ollloooloololl	3.0
183.	oooooooo*oolooloolooloolooloololl*o*oolloooooooooool*ollloooloololl	3.0
385.	oooooooooooool*oooooooo*o***ollloooooooooooloolooloolool*ollloooloololl	10.0
386.	oooooooo*olo*oooooooo*o***oolooooooooooloolooloolool*ollloooloololl	10.0
393.	ooo*o*ll*olo*oooooooooolooloolool*oolloooloolool*ollloooloololl	10.0
535.	ooooolllooolooloolool*o***ool*oooooooool*ooo*ool*ol*oooooooooll	7.0
542.	oooooooo*olooloolo*o***olllooolooloolooooooooool*oloolooloolo	2.0
41.	ooooolloll*o*ooloolooloolooloolooloolool*ooloooooooo*oollooolll*	3.0
42.	oooooooo*loo*ooloolooloolooloolooloolool*ooloooooooo*oollooolll*	7.0
43.	looooooll*o*ooloolooloolooloolooloolool*ooloooooooo*oollooolll*	4.0
44.	oooooooooollo*llooloolooloolooloolooloolool*ooloooooooo*oollooolll*	2.0
45.	loo*o*ll*loo*oolooloolooloolooloolooloolool*ooloooooooo*oollooolll*	10.0
69.	olll*o*ooooooooooooooloolooloolool*ollloooloooooooo*ol*oloooooooooll*	8.0
70.	olll*o*ooooooooooooooloolooloolool*ollloooloooooooo*ol*oloooooooooll*	8.0
71.	olll*o*ooooooooooooooloolooloolool*ollloooloooooooo*ol*oloooooooooll*	8.0
72.	olll*o*ooooooooooooooloolooloolool*ollloooloooooooo*ol*oloooooooooll*	8.0
73.	looolooloolool*oolloooloolooloolooloolooloolooloolooloolool*ol*oloooooooooll*	8.0
74.	olll*o*ooooooooooooooloolooloolool*ollloooloooooooo*ol*oloooooooooll*	8.0

Group 3.

173.	oooooooooll*loooooooooooloolllll*o*oolll*looooo*ll*ollloooloololl	2.0
174.	looooooooooll*ooooooooooloolllloo*ooloooooooo*o*ollloo*olll*	2.0

82.	I,2	/	*/	2	/I	4/	*/	4	/I	/I	/I	/I	/
83.	I,2	/	*/	2	/I	4/	*/	4,5	/I	/I	/I	/I	/
84.	2	/	*/	2	/	4/	*/	4	/I	/I	/I	3/I	/
85.	I	/	*/	2	/I	/	*/	4	*/I	/I	/I	/I	/
86.	I,2	/	*/	2	/	4/	*/	4	/I	/I	/I	3/I	/
87.	I,2	/	*/	2	/I	/	*/I	4	/	2	/I	/	*/I
88.	I,2	/	*/	2	/	4/	*/	4	6/I	/I	/I	3/I	/
89.	I,2	/	*/	2	/	4/	*/	4	6/I	/I	/I	/I	/
90.	I,2	/	*/	2	/I	4/	*/	4	/I	/I	/I	/I	/
98.	2,3	/	*/	2	/I	/	*/	4	/I,2	/I,2	/	*/I	/
99.	I	3	*/I	/I	/I	3	/	4	/I	/	2	/	2
100.	2	/	*/I	/I	/	/	*/	4	/I	/I,2	/	3/I	/
101.	I,2	/	*/I	/I	/I	4/	*/	4	6/I,2	/I	/	*/I	/
102.	I	/	*/I	/I	/	/	*/	4,5	/I	/I	/I	/I	/
103.	I	3	*/	*/I	3	/	*/	4	/I	/I	3/	3/I	/
104.	I,2,3	/	*/I	/I	3	/	*/I	4	/I	/I	/	2	/I
105.	I,2,3	/	*/I	/I	3	/	*/	4	/I,2	/I,2	/	*/I	/
500.	3,4/	4/	2	/	3	/	*/	5	/I	/	2	/	3/
506.	3	/	*/	*/I	/	/	*/I	4	/I	/I	/	2	/I
507.	3,4/	4/I	/	3	/I	/I	/I	4	6/I	/I,2	/	2	/I
508.	I,2,3	/	*/I	/I	/I	/I	/I	4	6/I	/I	/	2	/I
509.	I,2,3	/I	/I	/I	3	/I	3	5,6/I	/I	/I	3/	2	/I
510.	2	/	*/I	/I	/I	3	/I	6/I	/I,2	/	2	/I	/
91.	3	/	*/	2	/I	/	2,3	*/I	/I	/	2	/I	/
95.	3,4/	*/I	/I	/	/	2,3	/	*/I	/I	3/	2	/I	/
96.	3,4/	*/	2	/I	/	2	4/	*/I	/I	3/I	/I	/I	/
97.	3,4/I,2	4/	2	/I	3	/I	3,4/	*/I	/I	/	2	/I	/
178.	I,2,3	/	*/I,2	/	3	/I	4/	4	6/I	/	2	/	*/
183.	2,3	/	*/I	/	3	/I	3	4	6/I	/	2	/	3/I
385.	3	/	*/I	/I	/	2,3,4/I	/	6/I	/I	/	2	/I	/
386.	3,4/	*/I	/I	/	/	2,3	/I	6/I	/I	/	2	/I	/
393.	3	/	*/	2	/I	/	2,3	6/I	/	2	/I	/I	/
535.	I,2	/	*/I,2	/I	/I	3	/	6/I	/I	/I	/I	/I	/
542.	2,3	/	*/I	/I,2	/I	3	/I	/I	/I	/	3/	*/	*/
41.	2,3	/	*/I	/	3	/I	3	4,5	/	3/I	3/	*/	*/
42.	3,4/	*/I	/	3	/I	3	/	*/	3/I	3/	*/	*/	*/
43.	3	/	3	/I	/	3	/I	5	/	3/I	3/	*/	*/
44.	3,4/	*/I	/	3	/I	3	/	*/	3/I	3/	*/	*/	*/
45.	3,4/	3	/I	/	3	/I	3	5	/	3/I	3/	*/	*/
69.	3,4/	3	/	*/	3	/	*/	4	/	3/I	/	*/I	/
70.	2,3	/	*/	*/	3	/	*/	4	/	3/I	/	*/I	/
71.	2,3	/	*/	*/	3	/	*/	4	/	3/I	/	*/I	/
72.	3,4/	*/	*/	3	/	*/	*/	4	/	3/I	/	*/I	/
73.	3,4/	3,4/I	/	3	/	*/	*/	4	/I,2,3/I	/	*/I	/	/
74.	3	/	3	/	*/	3	/	4	/	3/I	/	*/I	/

Group 3.

173.	2,3,4/	*/I	/	3	/I	3	/I	4,5,6/I	/	2	/	3/I,2	/
174.	3,4/	4/I	/	3	/	2	4/I	4	/I	/	2	/I,2	/

I	/I	3/	3	/I	/	3	/	3/	4/	*/	3/	3	/	
I	/I	3/	3	/I	/	3	/	3/	4/	*/	3/	3	/	
I	/	3/	3	/I	/	3	/	3/	4/	*/	3/	3	/	
I	/I	3/I		/I	/	3	/	3/	4/	*/	3/	3	/	
I	/	3/	3	/I	/	3	/	3/	4/	*/	3/	3	/	
	*/	*/I		/I	/	3	/I	/ 2	/	*/	3/		*/	
I	/	3/	3	/I	/	3	/	3/	4/	*/	3/	3	/	
I	/I	/	3	/I	/	3	/	3/	4/	*/	3/	3	/	
I	/I	/	3	/I	/	3	/	3/	4/	*/	3/	3	/	
	*/	*/I		/I	/	3	/I	/ 2	/	*/	3/		5/	
	*/	*/ 2		/I	/	3	/I	/ 2	/	*/	3/		5/	
	*/	*/I		/I	/	3	/I	/ 2	/	*/	3/		5/	
	*/	*/I		/I	/	3	/I	/ 2	/	*/	3/		5/	
	*/	*/I, 2		/I	/	3	/I	/ 2	/	*/	3/		5/	
	*/	*/ 2		/I	/	3	/I	/ 2	/	*/	3/		5/	
	*/	*/I		/I	/	3	/I	/ 2	/	*/	3/		5/	
	*/	*/I		/I	/	3	/I	/ 2	/	*/	3/		5/	
	*/	*/ 3		/I, 2	/	3	/I	/ 2	/	*/	3/ 2		/	
	*/	*/ 3, 4/I		5/	3	/I	/ 2	/	/	*/I	/ 2		/	
	*/	*/ 3, 4/I		5/	3	/I	/ 2	/	/	*/I	/ 2		/	
	*/	*/ 3, 4/I		5/	3	/I	/ 2	/	/	*/I	/ 2		/	
	*/	*/I 3		/I	5/	3	/I	/ 2	/	*/I	/ 2		/	
	*/	*/I 3		/I	5/	3	/I	/ 2	/	*/I	/ 2		/	
I	/I	/I		/I	/ 2	4/ 2	/		*/	3/ 2	/		*/	
I	/I	/I		/I	/I, 2	4/I, 2	/		*/I, 2	/ 2	/		*/	
I	/I	/I		/I	/ 2	4/ 2	/		*/	3/ 2	/		*/	
I	/I	/ 2		/I	/	4/ 2, 3/			*/I	/ 2	/		*/	
	*/	*/I		/I	/	4/I	/		*/I	/ 2	/I		/	
	*/	*/ 3		/I	/	4/I	/		*/I	/ 2	/I		/	
I	/I	/I		/I	/I	/ 2	/		*/I	/ 2	/I		/	
I	/I	/I		/I	/I, 2	4/ 2	/		*/I	/ 2	/I		/	
I	/I, 2	/	3	/I	/I	/ 2	/		*/I	/ 2	/I		/	
I	/I	/	3	/I	5/I	/ 2	/		*/I	/ 2, 3/I			/	
2	/	3/I		/I	/	3	/I	/ 2	/	*/	2	/	4	/
I	/I, 2	/I		/I	/I, 2	4/I	/		*/	3/ 2	/I			/
I	/ 2	/I		/I	/I	/I	/		*/	3/ 2	/			*/
I	/ 2	/I		/I	/I	/I	/		*/	3/ 2	/I			/
I	/ 2	/I		/I	/I	/I	/		*/	3/ 2	/			*/
I	/I	/		4/I, 2	/	3	/	3/I	/	*/	2	/		*/
I	/I	/		4/I, 2	/	3	/	3/I	/	*/	2	/		*/
I	/I	/		4/I, 2	/	3	/	3/I	/	*/	2	/		*/
2	/I	/		4/I, 2	/	3	/	3/I	/	*/	2	/		*/
I	/I	/		4/I, 2	/	3	/	3/I	/	*/	2	/		*/
I	/I	/		4/I, 2	/	3	/	3/I	/	*/	2	/		*/
	*/	*/ 3, 4/I	3	/	/	4/I	/		*/I	/ 2	/I		/	
I	/	3/I		/I	/ 2	/	3/		*/I	/ 2	/I		/	

518. oooo*al*1*loooooo*o**ololl*1*oolloooo**oololllloooooooloo* *
 175. oooo*oollo*ooooooooooooollloo*oollooooooo**1*olloo*olloll 2.0
 177. looooool*1*1*loolloloooooololoo*oollooooooo**1*olloo*olloll 2.0
 179. oooooool*loooooooloooooolololl*oollooooooo**1*olloo*olloll 4.0
 181. oooo*ol*1*1*looolooloolololl*1*oollooooooo**1*olloo*oololl 2.0
 182. ooooool*1*1*loollollllooooooll*1*oollooooooo**1*olloo*oololl 3.0
 184. looloooooolloolllooooooololl*o*oolloooooool*oolloooooolloll 3.0
 185. ooooooollo**1*oooooooooll*1*oollooooooo**1*olloo*oollo 3.0
 186. oooo*oollooooooollooooooololl*1*oollooooooo**1*olloo*oollo 2.0
 187. ooooooollo*olooooooloololl*o*oollooooooo**1*olloo*oollo 3.0
 139. loooloolo*looololooooool*oolllllloooooool*ol*ooooolloll 8.0
 140. loo**oolo*looloooooolololoollooooooo**1*1*o*oolll** *
 142. oooooooooooloololooooool*oollooooooo**olol*o*oolloo* 2.0
 143. looolooloooooolololoooooollllooolllllloooooool*ol*ooooolllo 9.0
 482. oolol*oolololoooooolooooolllooollooooo*oolololoollooolol* *
 319. ooooooololo*olloloooooolool*lllo*looollooooooololooooool* *
 320. oooooool*olo*oollooooooollool*lllo*looollooooooololooooool* *
 322. ooooooollo*oollooooooolool*1*lo*looollooooooololooooool* *
 323. ooooooollo*oollooooooololl*lllo*looollooooooololooooool** *
 324. ooooooollo*oollooooooollool*lllo*looollooooooololooooool* *
 325. *ooooool*olo*oollooooooolool*lllo*looollooooooololooooool* *
 345. ooooooollo*olllooooooollooooooolloooooool*olo**oooool** *
 346. ooooooollo*olllooooooolloooloololooooool*olo**oooool** *
 188. oooooool**1*oloooooololooloooooolloolloloolooo*1*olllooooooll** 10.0
 189. oooooool*lllo*oloooooololoollo*ooloololollloool*ollloooooolllo 9.0
 191. ooooooollllo*oloooooololoolloollloolloloolooo*1*ollloooooolllo 2.0
 192. *ooooool*lllo*ooloooooololoollooo*oollo*oolooo*1*lllooooooll** *
 193. oooooool*lllo*ooloooooololoollooollooll*oolooo**1*ollloooooolllo 10.0
 195. *oooooollllo*oloooooolloool*o*oollo*oolooo*1*lllooooooll** 8.0
 398. oooo*1*olo*olooooooloooooolooo*oollooooooo**1*olllooolloolo 10.0
 443. ooooooollooo**1*o*oolooooooloooooollooolloool*olllooooooollo 3.0
 520. oool*ool*lllooooo*oollllllooollooollooolloool*olllooolololo 10.0
 525. ooolol*lllo*oloooooololool*1*ollloooooool*ool*oollooollo 8.0
 526. lolooooool*looollooololool*ll*ollloooooool*oollooollo** 8.0
 26. oool*oolo*loooo*oolool*ollloollololllo*lololoolollll** *
 28. loo**oolo*ooloo*oolloollloollololllo*lollllooolll** *
 29. ooooooooool*ooloo*oolloollloollololllo*lollllooolll** *
 30. loo*oolo*ooloooooolool*ollloollololllo*ll*lllooollo** *
 32. ooooooooool*ooloo*oolloollloollloolllo*lololoolollll** *
 194. oooooool*1*1*oooooooooollooooooollo*olllooo*1*olllooooooll** 10.0
 490. oooooooooool*loloolololoolool*looolloolllo*lololloooooool** *
 491. oooooooooool*1*llloooooooloolool*looolloolllo*lololloooooool** *
 492. *ooooooooool*1*llloooooooloolool*1*oolloolllo*lololloooooool** *
 493. oooooooooool*1*llloooooooloololl*looolloolllo*lololloooooool** *
 527. oool*oollo*llloooloolool*olllooollooollooollllooollool* *
 536. *ooooooooool*oollooololoolool*1*oolloolllo*lolllloooooolllo *
 215. loo**ol*o*1*ooo*o*oolloooooool*oolloo*olooo*1*lo*oo*oolll** *
 296. loo**oooo*oollooooooolool*1*oollooolooo*lo*o*oooooll** *
 297. loo**ooo**oololo*oolloooooool*oollooolooo*lo*o*ooooool** *
 298. loool*ooloo*lolololoooooolloool*oollooolooo*lo*o*oooooll** *

518.	2	/	*/I,2	/	2	/	*/I	6/I	/	2	/	2	/I	/
I75.	3,4/		*/I	/	3	/	2	4/I	4	/I	/	2	/I,2	/
I77.	3,4/		4/I	/	3	/I	3	/I	4,5,6/I	/	2	/	2	/I,2
I79.	2,3	/	*/I	/	3	/I	3	/	4	6/I	/	2	/	3/I
I81.	3,4/		*/I	/	3	/I	3	/I	4	6/I	/	2	/	2
I82.	3,4/		*/I	/	3	/I	3	/	4	6/I	/	2	/	2
I84.	2,3,4/		4/I	/	2,3	/	2	4/I	4,5,6/I	/	2	/I	/I	/
I85.	3,4/		*/I	/		*/I	3	/I	4	/I	/	2	/	3/I
I86.	2,3,4/		*/I	/	3	/I	3	/I	4	/I	/	2	/	3/I
I87.	3,4/		*/I	/	3	/I	3	/	4	6/I	/	2	/I	/I
I39.	I,2,3	/I	/I	/	3	/	2	4/	4,5,6/I	/I	/I	/I	/I	/
I40.	3	/I	4/I	/	2,3	/		*/	5,6/I	/I	/I	/I	/I	/
I42.	2,3	/	*/I	/	3	/		*/	5,6/I	/I	/I	/I	/I	/
I43.	I,2,3	/I	/I	/	3	/	2	4/	4,5,6/I	/I	/I	/I	/I	/
482.	I,2,3	/	*/	2	/	2	/I	4/I	/I,2	/I	/		*/I	/
319.	3,4/		*/I	/	3	/I	3	/I		/I	/I	/	2	/
320.	3,4/		*/I	/	3	/I	3	/I	5	/I	/I	/	2	/
322.	3,4/		*/I	/	3	/I		/I		/I	/	2	/	2
323.	3,4/		*/I	/	3	/I		/I		/I	/I	/	2	/
324.	3,4/		*/I	/	3	/I		4/I		/I	/I	/	2	/
325.	4/		*/I	/	3	/I		/I		/I	/I	/	2	/
345.	3,4/		*/I	/	3	/	2,3	/I		/	2	/I	/	*/I,2
346.	3,4/		*/I	/	3	/	2,3	/I	6/	2	/I	/		*/I,2
I88.	3,4/		*/I	/	3	/		*/I,2	5	/I,2	/I	/		*/I,2
I89.	3,4/		*/I	/	3	/		*/I	5	/I	/I	/	2,3/I	/
I91.	3,4/		*/I	/	3	/	2	/I,2	5	/	2	/I	/	*/I
I92.	4/		*/I	/	2	/	2,3	/	5	/I	/	2	/I	/I
I93.	3,4/		*/I	/	2,3	/	2	4/		*/I	/I,2	/I	/I	/
I95.	4/		*/I	/	3	/	2	4/		*/I	/	2	/I	/I
398.	3,4/		*/I	/	3	/	2,3	/	5,6/I	/	2	/I	/I	/
443.	2,3,4/		*/I	/		*/		*/		*/I	/I	/	3/	2
520.	2,3	/	*/I	/	2,3	/I		4/I	4	/I	/I	/I	/I	/
525.	3,4/		*/I	/	3	/I		4/I		/I	/	2	/	*/
526.	2,3,4/		4/I	/	2	/I	3,4/		4	6/I	/I,2	/		*/
26.	3,4/		*/I	/	3	/I		4/	4,5	/I	/I	/I	/	2
28.	3,4/		4/I	/	3	/I		4/	4,5	/I	/I	/I	/	2
29.	3,4/		*/I	/	3	/I		4/	4	/I	/I	/I	/	2
30.	3,4/		4/I	/	3	/I		4/	4	/I	/I	/I	/	2,3/
32.	3,4/		*/I	/	3	/I		4/	4	/I	/I	/I	/	2
I94.	3,4/		*/I	/	3	/	2	4/		*/I	/I	/I	/I,2	/
490.	3,4/		*/I	/	3	/	2	4/I		/I	/I	3/	3/I	/
491.	3,4/		*/I	/	3	/	2	4/I		/I	/I	/	3/I	/
492.	4/		*/I	/	3	/	2	4/I		/I	/	2	/	3/I
493.	3,4/		*/I	/	3	/	2	4/I		/I	/I,2,3/		3/I	/
527.	3,4/		*/I	/	3	/I	3	/I	4	/I	/I	/I	/I	/
536.	4/		*/I	/	3	/		*/	5	/I	/	2	/	3/
215.	3	/I	/I	/		*/		*/		*/I	/	2	/	3/I
296.	3	/I	/I	/I	/			*/	4	/I	/	2	/I	/I
297.	3	/I	/I	/I	/			*/	4	/I	/	2	/I	/I
298.	3	/I	/I	/I	/I	3	/		4	/I	/	2	/I	/I

	*/	*/I	/ 2	/	3	/I	/ 2	/	*/I	/ 2	/
I	/	3/I	/I	/	4	4/I	3/	*/I	/ 2	/I	/
I	/	3/	4/	/	/	4/I	/	*/I	/ 2	/I	/
	3/	3/	4/I	/ 2	4/I	/	/	*/I	/ 2	/I	/
	*/	*/I,2,3,4/I	/	/ 2	4/I	/	/	*/I	/ 2	/I	/
	*/	*/	4/I	/	4/I	/	/	*/I	/ 2	/I	/
	*/	*/I	/I	/I	4/I	3/	/	*/I	/ 2	/	4
	*/	*/I	/	4	/I,2	4/I	/	*/I	/ 2	/I	/
	*/	*/I	/	4	/I	4/I	/	*/I	/ 2	/I	/
	*/	*/	4/I	/	4/I	/	/	*/I	/ 2	/I	/
	3/	2	/I	/I	/ 2	/	2	*/	2	/I	/
	3/	2	/I	/I	/	3	/	/	*/	2	*/
	3/	2	/I	/I	/ 2	/	2	/	*/	2	*/
	3/	2	/I	/I	/ 2	/	2	*/	/	2	/
I,2	/I	/I	/I	/I	/	3/I	/	*/	/ 2	/	3
	*/	*/I	/ 2	/	3	/	2	/I	*/	3/	2
	*/	*/I	/ 2	/	3	/	2	/I	*/	3/	2
	*/	*/I	/ 2	/	3	/I	/I	/	*/	*/	2
	*/	*/I	/ 2	/	3	/	2	/	*/	/	2
	*/	*/I	/ 2	/	3	/I	/I	3	*/	3/	2
	*/	*/I	/ 2	/	3	/	2	/	*/	/	2
I	/I	/I,2,3	/I	/	3	/	2	/	*/	2	/
I	/I	/I,2,3	/I	/	3	/	2	/	*/	2	/
I	/I	/	4/	*/	3	/	3/I	/	*/	2	*/
	*/	*/	3,4/I	5/	3	/	3/I	/	*/	2	*/
I	/I	/I	4/I	/	3	/	3/I	/	*/	2	*/
I	/I	/I	/ 2	/	3	/	3/I	/	*/	2	*/
I	/I	/	4/	*/	3	/	3/I	/	*/	2	*/
	*/	*/	4/I	5/	3	/	3/I	/	*/	2	*/
I	/I	/I	3	5/	2	/	2	*/	/	2,3/	*/
I	/	3/I	/I	/I	/	2	/	*/	/	2,3/	2
I	/	2,3/I	/I	/	3	/	3/I	/	*/	2	/
	*/	*/I	4/I,2	/	3	/	3/I	/	*/	2	/
	*/	*/I,2,3,4/I,2	/	/	3	/I	/ 2	/	*/	/	*/
I	/ 2	/	4/	4	/I	/I	/ 2	/	*/	2	/I
I	/I	/	4/	4	/I	/I	/ 2	/	*/	2	/I
I	/I	/	4/	4	/I	/I	/ 2	/	*/	2	/I
I	/ 2	/	4/	4	/I	/I	/I	/	*/	2	/I
I	/ 2	/	4/	4	/I	/	2,3/I	/	*/	2	/I
I	/I,2	/	4/	*/	3	/	3/I	/	*/	2	*/
	*/	*/	4/	4	/	3	/I	/	*/	2	/I
	*/	*/	4/	4	/	3	/I	/	*/	2	*/
	*/	*/	4/	4	/	3	/I	/	*/	2	/I
	*/	*/	4/	4	/	3	/I	/	*/	2	2
I	/I	/	4/	4	/I	/	2	/I	/	2	/I
	*/	*/	4/	4	/	3	/I	/ 2	/	2	*/
I,2	/ 2	/I	/	*/	3	/	2	/	*/	2	*/
	*/	*/I	3	4	/I	/I	/I	/	*/	3/I	/
I	/I	/I	3	4	/I	/I	/I	/	*/	3/I	/
I	/I	/	3,4/	4	/I,2	/I	/I	/	*/	3/I	/

[illegible]

327.	2	/	*/	*/I	/I	3	/I	3	/I	/I	/I	/I	/
332.	2	/	*/I	/I	/I	3	/I		/I	/I	/I	/I	/
524.		4/	*/I	/I	/I,2,3	/I		5,6/	3/	2	/	*/I	/
529.	2,3	/I	4/I	/I	/I	3,4/		4	/	3/I	/	*/	2
531.		3	/	*/I	/I	/I	4/I	4	/I	/I	/I	/I,2	/
534.		4/	*/I	/I	/	2,3	/I	5	/I	/I	/I	/I	/
301.		4/	*/I	/I	/I	3	/I		6/I,2	/	2	/	*/I
302.		4/	*/I	/I	/I		4/I		6/	2,3/	2	/	*/
303.	2,3	/	*/I	/I,2	/		*/I		6/	2,3/	2	/	*/
304.	3,4/I		3	/I	/I	/I,2,3,4/I		4	6/I,2	/	2	/	*/I
305.	3,4/		*/I	/I	/I	4/I			6/I,2	/	2	/	*/I
306.	3,4/		*/I	/I	/		*/I		6/	2,3/	2	/	*/
439.	3,4///		*/I	/I	/I	3	/I		4,5,6/I	/I	/	2	/
440.	3,4/		*/I	/I	*/		*/I		4,5,6/I	/I	/	3/	2
444.	4/		*/I	/I	/I	3	/I		4,5,6/I	/	2,3/	2	/
445.	4/		*/I	/I	/I	3	/I		4,5,6/I	/I	/	2	/
453.	4/		*/I	/I	/I	3	/I		4,5,6/I	/I	/	3/	2
455.	3,4/		*/I	/I	/	2,3,4/I			4,5,6/I	/I	/I	/	2
456.	4/		*/I	/I	/	2,3	/I		4,5,6/I	/I	/	3/	2
457.	4/		*/I	/I	/		*/I		4,5,6/I	/I	/I	/	2
458.	2,3	/	*/I	/I	/	2	4/I		4,5,6/I	/I	/I	/	2
516.	3,4/		*/I	/I,2	/I		4/I		6/I	/	2	/	2
517.	4/		*/I,2	/I	/I	3	/I		6/I	/	2	/	3/
519.	I,2	/	*/	2	/I	/I	4/I		6/I	/	2	/	2
523.	3,4/		*/I	/I	/	2	4/I		6/	*/	2	/I	/
541.	4/		*/I	/I	/I	3	/		4,5,6/I,2	/	2	/	*/
334.	3	/	*/	2	/I	3	/	2	4/I	4	/	2	/I
335.	3	/	/I	/I	/	2	4/I		4	/	3/	3/	*/
336.	3	/	*/I	/I	/	2	4/I		4,5	/	2,3/I	/	*/
337.	3,4/		*/I	/I	3	/	2	4/I	4,5	/	2	/I	3/
338.	3,4/		4/I	/I	/	2	4/I		4	/	2	/I	/
339.	3,4/		*/I	/I	3	/	*/I		4	/	2	/I	/
340.	2	/	*/I	/I	/I		4/I		6/	3/I	3/	*/	2
341.	2,3	/	*/I	/I	/		*/I		/	3/	2	/	*/I
342.	3,4/		*/I	/I	/	2	4/I,2		/	3/I	/	*/I	/
343.	3,4/		*/I	/I	/I,2		4/I,2		/	3/I	/	*/I	/
347.	3,4/		*/I	/I	/I,2		4/I		/	3/I	/	*/I	/
348.	2,3	/	*/I	/I	/I,2		4/I,2		6/	2	/I	/	*/I
350.	3,4/		*/I	/I	/I,2		4/I		6/	2	/I	3/	*/I
351.	3	/	4/I	/I	/I		4/I		6/	2	/I	/	*/I
352.	2,3	/	4/I	/I	/I		4/I,2		6/	2	/I	/	*/I
353.	3	/	*/I	/I	/I,2		4/I,2		/	2	/I	3/	*/I,2
532.	3,4/		*/	2	/I	/I,2	4/I,2		6/	3/I	/	*/	*/
19.	3,4/		*/I	/I	/		*/I		/I	/	3/	2	/I
20.	4/		*/I	/I	/		*/I		/I	/	3/	2	/I
21.	4/		*/I	/I	/I	3	/I		/I	/	3/	2	/I
22.	4/		*/I	/I	/		*/I		/I	/I	3/	2	/I
23.	3,4/		3	/I	/I	/I	3	/I	4	6/I	/	3/	2
24.	4/		*/I	/I	/		*/I		/I	/	3/	2	/I
25.	4/		*/I	/I	/		*/I		/I	/	3/	2	/I,2

	*/	*/	4/	4	/I	/I	/	3	/	*/	2	/I	/
	*/	*/	4/	4	/I	/I	/	3	/	*/	2	/I	/
	*/	*/I	3,4/	2	/I	4/	2	/	*/I	/	2,3/I	/	/
	*/	*/I	3,4/	4	/I	/	3/	2	*/I	/	2	/	4
I	/I	/I	3	/	/	3	/	2,3/	2	/	*/	2	/I
I	/I	/	4/	4	/I	/	3/I	/	/	*/	2,3/I	/	/
	*/	*/	2	/I,2	/	3	/I	/	3	/	*/	2,3/	2
	*/	*/	2	/I,2	/	3	/I	/	3	/	*/	2,3/	2
	*/	*/I	/	/I,2	/	3	/I	/	3	/	*/	2,3/	2
	*/	*/I,2	/	/I,2	/	3	/I	/	3	/	*/	2,3/	2
	*/	*/I	/	/I,2	/	3	/I	/	3	/	*/	2,3/	2
	*/	*/	4/I,2	/	/	3	/I	/	3	/	*/	2,3/	2
I	/	3/	3,4/I	/I,2	4/	2	/	*/I	/	2,3/	2	/	/
I	/	3/I	3	/	4	/I	/	3/	*/I	/	2,3/	2	/
	*/	*/	3,4/	4	/I	/	2,3/	*/I	/	2,3/	2	/	/
I	/	3/	3,4/I	/I	/	3/	*/I	/	2,3/	2	/	/	/
I	/	3/	4/	*/I	/	2	/	*/I	/	2	/	2	/
I	/	3/	4/	*/I,2	4/	2,3/	*/I	/	2	/	2	/	/
I	/	3/	4/	*/I	/	2	/	*/I	/	2	/	2	/
I	/	3/	4/	*/I	/	2	/	*/I	/	2	/	2	/
I	/	3/	4/	*/I	/	2	/	*/I	/	2	/	2	/
I	/	3/	3,4/	*/I,2	4/	2	/	*/I	/	2	/	2	/
	*/	*/I	/	2	/	3	/I	/	2	/	*/I	/	2
	*/	*/I	/	2	/	3	/I	/	2	/	*/I	/	2
	*/	*/I	/	2	/	3	/I	/	2	/	*/I	/	2
	*/	*/	2	/	3	/	2	/I,2	/	*/I	3/	2	/
I	/	*/I	/I,2	/I	/I	/I	/	3	/	*/I	/	*/	*/
I	/	2	/I	/I	5/	4/I	/	*/	2	/	2	/	*/
I	/	2	/I	/I	5/	4/I	/	*/	2	/	2	/	*/
I	/	2	/I	/I	5/	4/I	/	*/	2	/	2	/	*/
I	/	2	/I	/I	5/I	4/I	/	*/	2	/	2	/	2
I	/	2	/I	/I	5/	2	/I	/	*/	2	/	2	/
I	/	2	/I	/I	5/	2	/I	/	*/	2	/	2	4
	*/	*/	2	/I	/I	/I	/	2	/	*/	2	/	2
	*/	*/	4/I	/	3	/I	/	3	/	*/	2	/	2
I	/I	/	4/I	/I,2	4/	2	/	*/I	/	2	/	2	/
I	/I	/	4/I	/I,2,3,4/	2	/	*/I	/	2	/	2	/	/
I	/I	/	4/I	/I	4/	2	/	*/I	/	2	/	2	/
I	/I	/	4/I	/I	/I	/	3	/	*/	2	/	2	/
I	/I	/	4/I	/	3	/	2	/I	/	*/	2	/	2
I	/I	/	4/I	/I	/I	/	3	/	*/	2	/	2	/
I	/I	/	4/I	/I	/	2	/I	/	*/	2	/	2	/
I	/I	3/	4/I	/I	/	2,3/I	/	*/	2	/	2	/	/
I	/	2	/I	/I,2	/	2	/I	/	*/	3/	2	/	*/
	/I	/	3	/I	5/	3	/I	/	2	/	*/	2	/
I	/I	/	3	/I	5/	3	/I	/	3	/	*/	2	/I
I	/I	/I	/I	/I	5/	3	/I	/	2	/	*/	2	/
I	/I,2	/	3	/I	5/	3	/I	/I	/	*/	2	/	*/
I	/I	/I	3	/I	5/	3	/I	/	2	/	*/	2	/I
I	/I	/I	/I	/I	5/	3	/I	/	3	/	*/	2	/I
I	/	2	/	3	/I	5/I	/I	/	*/	3/	2	/	*/

92. 10001*01*110*01000101001101010001001100010100011*0111000111010 9.0
 212. 1000*000010*0000*0*0000101000001001100*01000*1*00*00*001110* 10.0
 216. 0000*000010*0000*0*0100101010001001100*010000*1*10*00*00111* 10.0
 291. *000*100010*0000000001101000010001000100011*0110000110010 10.0
 292. *000*100010*0100000000110100011000100010000*1*0110000011011 10.0
 293. 00001*101010*00000010001010000100010001100011*01100000111* 10.0
 294. *0001*100010*0000001001101000000011000110000*1*0110000011010 10.0
 295. 00000100010*0000000000*01000010001000010000*1*1110000010010 10.0
 384. *0000100010*000000*00001010100110011000010000*1*0110000011110 10.0
 388. 0000011*010*0000000000101100010001000100011*01100000101* 10.0
 390. 0000*100010*0000000000101000010011000110000*1*0110000010011 10.0
 391. 0000011*010*00000010001010100010011000010000*00011000001100* 10.0
 392. 0000011*010*000000*000010100001001100010000*1*11100000101* 10.0
 396. 0000*11*010*0000000000101101101*001100001000*1*011000001000* 4.0
 397. 00000100010*110000000010011100*001100001000*1*0110000110010 9.0
 399. 00000100010*101000000010011100*001100001000*1*0110000110011 6.0
 400. 0000*100010*000000000010011100*001100001000*1*111000001000* 10.0
 401. 10000100010*000000100110110100*001100001000*1*0110000010011 6.0
 402. 10000101110*0000000000110100*001000010000*1*0110000010011 9.0
 403. 0000*100010*010000000010010100*001100011000*1*011000001000* 2.0
 522. *0000100100*10101100000010010010010*001000011*0100000010011 2.0
 539. 1010000011*101000001001101010100100010000100011*0110000111110 2.0

Group 4.

307. 00000000010*000100*00000*01100001001100011000011*011000001000* 10.0
 308. 00000000010*00010110010101100001001100011000011*0110000010010 10.0
 309. 00000000010*00010010111101011001000100011000011*00*0000101* 10.0
 310. 0000000000*1*00010010010101100001000100011000011*0110000010010 10.0
 311. 10000000010*01010010010101010001001100011000011*0110000010010 10.0
 312. 00000000010*000100*0010101010001001100011000011*01100000101* 10.0
 313. 00000000010*0001001010101110001001100011000011*01100000101* 10.0
 314. 00000000010*01010010010101110001001100011000011*01100000101* 10.0
 315. 00000000010*000100*000000000111*011000011*011000001000* 10.0
 387. 0000011*010*000000*011*0000011000110000*00011000001100* 10.0
 521. 00101*1001000000000*01101110001001100001000011*0101000011011 10.0
 267. 100001000110*0000000011001000001000100011000011*01*000101010* 2.0
 268. 100000000110*1000000011001000001010100001000*11*01*000101000* 2.0
 269. 0000001*110*0000000011001100001010100011000111*0100010101* 2.0
 270. 1000001*110*10000*00100100000010100001000111*011000101000* 2.0
 514. 0000100100010000101*0*010001001100001000*11*0110010011010 2.0
 27. 10000000010*0010000*00000*01100110001101011000*10101000100111* 10.0
 31. 10000000010*0010000*00000*001*0111001101011000*10111000100111* 10.0
 144. 1000001*00001001000*00000*011100011110000000*11*01*000011011 8.0
 176. 000000000110*100010*00000*0111000*000100000000*1*011000*011011 2.0
 180. 0000*01*100*0001010*00000*0101000*001100000000*1*011000*011011 3.0
 190. 000000001110*000000*00000*01011*0*00110*0010000*1*01100000111* 3.0
 263. 000000000110*1110000*00000*111000010011000010000101011000010101* 10.0
 299. 1000*00000*110010*00000*0100011*001101001000010100*0000011* 10.0
 300. 1000*00000*000010*00000*0100011*001101001000*10100*0000011* 10.0

92.	3 /I	/I	/I	/ 2	4/	*/I	/I	3/ 2	/I	/
212.	3 /I	/I	/	*/	*/	*/I	/I	/ 2,3/I	/	/
216.	3,4/	*/I	/I,2	/	*/	*/I	/I	3/ 3/I	/	/
291.	4/	*/I	/I	/I 3	/I,2	/I	/I	/ 3/I	/	/
292.	4/	*/I	/I	/I 3	/	6/I	/I	/ 3/I	/	/
293.	3,4/	*/I	/I	/I 3	/	5,6/I	/I	/ 2 /I	/	/
294.	4/	*/I	/I	/I 3	/	6/I	/I	/ 2 /I	/	/
295.	3,4/	*/I	/I	/I 3,4/I		5 /I	/I	/ 3/I	/	/
384.	4/	*/I,2	/	*/	*/	*/I	/	3/ 3/I	/	/
388.	3,4/	*/I	/I	/ 2,3	/I	6/I	/I	/ 3/I	/	/
390.	3,4/	*/I	/I	/ 2,3	/I	6/I	/I	/I 3/I	/	/
391.	3,4/	*/I	/I	/ 2,3	/I	6/I	/	3/ 3/I	/	/
392.	3,4/	*/I	/	*/	*/I	6/I	/I	/ 2 /I	/	/
396.	3,4/	*/I	/I	/ 2,3	/	6/I	/ 2	/I /I	/	/
397.	3,4/	*/I	/I	/ 2,3	/	6/I	/ 2	/I /I	/	/
399.	3,4/	*/I	/I	/ 2,3	/I,2	5,6/I	/ 2	/ 3/I,2	/	/
400.	3,4/	*/I	/I	/ 2,3	/	6/I	/ 2	/I /I	/	/
401.	3,4/ 2	/I	/I	/ 2,3	/	6/I	/ 2	/I /I	/	/
402.	3 /I,2	/I	/I	/ 2,3	/	6/I	/ 2	/I /I	/	/
403.	3,4/	*/I	/I	/ 2,3	/	6/I	/ 2	/I /I	/	/
522.	4/	*/ 2	/I	/I 3	/I,2	4 6/I	/	3/I,2 /I	/	/
539.	2,3 / 2	/I	/I	/I 3	/I	4 6/I,2	/I	/ */I	/	/

Group 4.

307.	3,4/	*/ 2	/I	/ 2	4/I	/	3/I	/	*/I	/
308.	3,4/	*/ 2	/I	/ 2	4/I,2	/	3/I	/	*/	*/
309.	3,4/	*/ 2	/I	/ 2	4/I,2	/	3/I	/	*/I	/
310.	3,4/	*/ 2	/I	/ 2	4/I	/	2,3/I	/	*/I	/
311.	3,4/ 3	/ 2	/I	/ 2	4/I	/	2,3/I	/	*/I	/
312.	3,4/	*/ 2	/	3 / 2	4/I	/	3/I	/	*/I	/
313.	3,4/	*/ 2	/I	/ 2	4/I	/	3/I	/	*/I 3/	/
314.	3,4/	*/ 2	/I	/ 2	4/I	/	3/I	/	*/ 2	/
315.	3,4/	*/ 2	/I	/ 2	4/I	/	3/I	/	*/I	/
387.	3,4/	*/I	/I	/ 2,3	/I	6/I	/I	/ 3/I	/	/
521.	2,3 /	*/ 2	/I	/I,2,3	/I,2	/I	/I	/I /I	/	/
267.	3,4/I	/ 2	/	3 / 2	4/ 2	/I	/I	/ 2 /I	/	/
268.	3 /I	/ 2	/	3 / 2	4/ 2	/I	/I	/ 2 /I	/	/
269.	3,4/	*/ 2	/	3 / 2	4/ 2	/I	/I	/ 2 /I	/	/
270.	3 /I	/ 2	/	3 / 2	4/ 2	/I	/I	/ 2 /I	/	/
514.	2 /	*/ */I	/I	4/		4 6/	2,3/I	/ */I	/	/
27.	3 / 2	/I	/	3 /I	4/	4 /I	/I	/I / 2	/	/
31.	3,4/I,2	/I	/	3 /I	4/	4,5 /I	/I	/I / 2	/	/
144.	2,3 /I	/I	/	3 /	*/	4,5,6/I	/I	/I /I	/	/
176.	3 /	*/I	/	3 /I	3 /	4 6/I	/ 2	/I /I	/	/
180.	3 /	*/I	/	3 /I	3 /I	4 6/I	/ 2	/ 3/I	/	/
190.	3,4/	*/I	/	3 / 2	4/	*/I	/ 2	/I /I	/	/
263.	3 /	*/I	/ 2	/	*/	4,5 /I	/I	/ 3/I	/	/
299.	3 /I	/I	/I	/I 3	/	4 /I	/ 2	/I /I	/	/
300.	3 /I	/I	/I	/I 3	/	3,4 /I	/ 2	/I /I	/	/

I	/I	/I	/I	/I,2	4/	2	/	*/I,2	/	2	/	3,4	/
I	/	2	/I	/I	/	3	/	2	/	3	/	*/	*/
I,2	/	2	/I	/I	3,4,5/	3	/	2	/	3	/	*/	*/
I	/	2	/	3	/	*/I	4/	2	/	*/I	/	2	/I
I	/	3/	3	/	*/I	/	3/	*/I	/	2	/I	/	/
I	/	3/	3	/	*/I	4/	2	/	*/I	/	2	/I	/
I	/I,2,3/I	/I	/I	5/I	/	3/	*/I	/	2	/I	/	/	/
I,2	/I,2	/	3	/	*/	2	4/	2	/	*/I	/	2	/I
I	/	2	/	3	/I	/I	/	2	/	*/I	/	2	/I
I	/I	/	4/I	/I	/	3/	*/I	/	2	/	4	/	/
I	/I,2	/I	/I	/I	/	2	/	*/I	/	2	/I	/	/
I	/I,2	/I	/I	/I,2	/	2	/I	/	*/	2	/I	/	/
I	/I	/	3	/I	/I,2	4/I	/	*/I	/	2	/I	/	/
I	/I	/	3	/I	5/	2	/I	/	*/I,2	/	2,3/	*/	*/
I	/I	/	3	/I	5/	2	4/I	/	*/I,2	/	2,3/	*/	*/
I	/I	/	3	/I	5/	2	4/I	/	*/I	/	2,3/	*/	*/
I	/I	/	3	/I	5/I	4/I	/	*/I	/	2,3/	*/	*/	*/
I	/I	/	3	/I	5/I,2	4/I	/	*/I,2	/	2,3/	*/	*/	*/
I	/I	/	3	/I	5/	4/I	/	*/	3/	2,3/	*/	*/	*/
I	/I	/	3	/	2	/	4/I	/	*/I,2	/	2,3/	*/	*/
I	/I	/	3	/I	5/	2	/	2	/	*/I,2	/I,2	/I	/
I,2	/I	/I	/I	5/	3	/	3/I	/	*/	2	/I	/	/

I	/I	/	4/I	5/	3	/	2	/I	/	*/	2,3/	*/	*/
I	3/	*/	4/I	5/I	4/	3/	*/I	/	2,3/	*/I	/	2,3/	*/
I	3/I	/	4/I	5/	2	/	3/	*/I	/	2,3/	*/I	/	2,3/
I	/I	/	4/I	5/I,2	4/	3/	*/I	/	2,3/	*/I	/	2,3/	*/
I	/I	/	4/I	5/	4/	3/	*/I	/	2,3/	*/I	/	2,3/	*/
I	/I	/	4/I,2	5/	2	4/	2	/	*/I	/	2,3/	*/I	/
I	/I	/	4/I,2	5/	2	4/	3/	*/I	/	2,3/I	*/I	/	2,3/I
I	/I	/	4/	2	/I	/	3/	*/I	/	2,3/	*/I	/	2,3/
I	/I	/	3	/I	5/	3	/I,2,3/I,2	/	*/	2,3/	*/I	/	2,3/
I	/I	/	3	/I	/I	/	2	/I	/	*/	2	/I	/
I	/	2,3/	3	/I	5/I	/	2,3/	*/I	/	*/	4	/	/
I	/I	/	3	/	*/	4/I	/	*/I	/I	/	4	/	/
I	/I	/	3	/	*/	4/I	/	*/I	/I	/	4	/	/
I	/I	/	3	/	*/	4/I	/	*/I	/I	/	4	/	/
I	/I	/I	/I	/	3	/	3/I	/	*/	2	/	4	/
I	/	2	/	4/	4	/I	/	2	/	2	/I	/	/
I	/I	/	4/	4	/I	/	3/I	/	*/	2	/I	/	/
I	3/	2	/I	/I	/	2	/	2	/	*/	2	/	*/
I	/	3/I	/I	/	4/I	/	*/I	/	2	/I	/	/	/
I	/	3/	3	/	4	/	4/I	/	*/I	/	2	/I	/
I	*/	*/	4/I	5/	3	/	3/I	/	*/	2	/	*/	*/
I	/I	/	3	/I	/	3	/	2,3/I	/	*/	3/	*/	*/
I	/I	/I	3	/	4	/	3	/I	/	*/	3/I	/	/
I	/I	/I	3	/	4	/I	/I	/I	/	*/	3/I	/	/

[illegible]

321.	3,4/	*/I	/	3	/I	3	/I	5	/I	/I	/	2	/	2	/
326.	2	/I	/I	/I	/I	3	/I		/I	/I	/I	/I	/I	/	/
330.	I,2	/	*/I	/I	/I	3	/	3	/I	/I	/I	/I	/I	/	/
333.	2	/	*/I	/I	/I	3	/	3	/I	/I	/I	/I	/I	/	/
441.	2,3	/	*/I	/I	/I	3	/I	4,5,6/I	/I	/	3/	2	/	/	/
442.	3	/	*/I	3/I	/I	3	/I	4,5,6/I	/I	/	2	/	2	/	/
454.	I,2,3	/	*/I	/I	/	2	4/I	4,5,6/I	/I	/I	/I	/	2	/	/
481.	3,4/	4/I	/I	/I	4/I,2	4,5	/I	4,5	/I	/I	/I	/I,2	/	/	/
483.	I,2	/	*/I,2,3/	2	/I	4/	*/I,2	/I,2	/	*/I	/	/	/	/	/
484.	4/	*/I	/	3	/I	3	/I	5,6/I	/I	/	3/I	/	/	/	/
485.	4/	*/I	/	3	/I	3	/I	5,6/I	/I	/	3/I	/	/	/	/
504.	I,2	/	*/I,2	/	2	/	2	4/I	/	3/I	/	*/I	/	/	/
505.	I,2	/	*/I	/	2	/	2	4/I	/	3/I	/	*/I	/	/	/
515.	I,2	/	*/I	/I	/I	4/	4,5,6/I,2,3/I	/	*/I	/	/	/	/	/	/
530.	2,3	/	3	/I	/	*/I	3	/	4,5,6/	3/	2	/	*/	2	/
543.	3,4/	*/I	/	3	/I	4/	*/I	/I	3/	3/	3/	*/	/	/	/
247.	I	3	/	*/I	/	2	/	*/	4	/I	/I	/	3/I	/	/
248.	I,2,3	/	*/I	/I,2	/I	4/	4,5	/I	/I	/	3/I	/	/	/	/
249.	3,4/	'	*/I	/	2	/	*/	4	/I	/I	/	3/I	/	/	/
250.	I,2,3	/	*/I	/	2	/I	3,4/	4,5	/I	/I	/	3/I	/	/	/
251.	3,4/I,2	/I	/	3	/	*/	4	/I	/I	/	3/I	/	/	/	/
252.	2,3	/	4/I	/	3	/I	4/	4	6/I	/I	/	3/I	/	/	/
253.	2,3	/	*/I	/	2	/	*/	4	/I	/I	/	3/I	/	/	/
254.	I,2	/	2	/I	/I	3	/I	3,4/	4	/I	/I	/	3/I	/	/
255.	3,4/	4/I	/	3	/	2,3	/	4	6/I	/I	/	3/I	/	/	/
256.	I,2,3	/	*/I	/I	/I	4/	4	/I	/I	/	3/I	/	/	/	/
257.	I,2,3	/	*/I	/	*/I	3	/	4	/I	/I	/	3/I	/	/	/
258.	I,2,3	/	*/I	/	2	/	2	4/	4,5	/I	/I	/	3/I	/	/
259.	3,4/	4/I	/	3	/	*/	4	6/I	/I	/	3/I	/	/	/	/
260.	2,3	/I	/I	/	3	/I	3	/	4	6/I	/I	/	3/I	/	/
261.	I,2,3	/	*/I	/	3	/	*/	4	6/I	/I	/	3/I	/	/	/
262.	I,2	/I	/I	/	3	/I	3	/	4	6/I	/I	/	3/I	/	/
264.	3,4/	*/I	/	2	/	2,3,4/	4	/I	/I	/	3/I	/	/	/	/
265.	I,2	/	*/I	/I	/	*/	4	6/I	/I	/	3/I	/	/	/	/
266.	I,2	/	2	/I	/I	3	/I	4/	4	/I	/I	/	3/I	/	/
232.	3,4/	*/I	/	3	/I	3	/	6/I	/I	3/I	3/	2	/	/	/
233.	3,4/	2	4/I	/	3	/	2,3	/	6/I	/I	3/	3/	2	/	/
234.	3,4/	*/I	/	3	/	2,3	/I	6/I	/I	/	3/	2	/	/	/
235.	3,4/	4/I	/	3	/	2,3	/	5,6/I	/I	3/	3/	2	/	/	/
236.	3,4/	*/I	/	3	/	*/	6/I	/	3/	3/I	/	/	/	/	/
237.	3,4/	*/I	/	3	/	2,3	/	6/I	/I	3/	3/	2	/	/	/
238.	3,4/	*/I	/	3	/I	3	/	5,6/I	/I	/	3/	2	/	/	/
239.	3,4/I,2	/I	/	3	/I,2,3	/I	5,6/I	/I	/	3/I	/	/	/	/	/
240.	3,4/	4/I	/I	3	/I,2,3	/I	6/I	/I	/	2	/I	/	/	/	/
241.	I,2,3,4/	*/I	/	3	/I,2,3	/I	5,6/I	/I	/	2	/I	/	/	/	/
242.	3,4/	*/I	/	3	/I,2,3	/I	/I	/I	/	2	/I	/	/	/	/
243.	3,4/	*/I	/I	3	/I,2,3	/I	/I	/I	/	3/I	/	/	/	/	/
244.	4/	*/I	/	3	/I,2,3	/I	/I	/I	/	3/I	/	/	/	/	/
245.	4/	*/I	/	3	/I,2,3	/I	6/I	/I	/	2	/I	/	/	/	/
246.	4/	*/I	/	3	/I,2,3	/I	4	/I	/I	/	3/	2	/	/	/

	*/	*/I	/	2	/	3	/	2	/I	/	*/	3/	2	/
I	/I	/	4/		4	/I	4/	3/I		/	*/	2	/I	/
I	3/I	/	4/		4	/I, 2, 3, 4/		3/I		/	*/	2	/I	/
I	/I	/	4/		4	/I	/	3/I		/	*/	2	/I	/
I	/	3/I	/I			/I	/	2	/	*/I	/	2, 3/	2	/
,	*/	*/I	/I			/I	4/	2, 3/		*/I	/	2, 3/	2	/
I	/	3/	3, 4/			*/I, 2	4/	3/		*/I	/	2	/	2
I	/I	/	4/I, 2			/	2, 3, 4/	3/I		/	*/	3/I		/
I	/I	/	3	/I		/I	/	3/I		/	*/	2	/	3
I, 2	/	3/	3, 4/			*/	4/	2	/	*/I	/	2	/	*/
I, 2	/	3/	3, 4/			*/	4/	2	/	*/I	/	2	/	2
I	/	3/	3	/I		/I	/	3/		*/I	/	2	/I	/
I	/	3/	3	/I		/I	/	3/		*/I	/	2	/I	/
I	/I	/I, 2	/I			/	2	3/		*/I	/	2	/	3, 4
I	/I	/	4/	2		/I	4/	3/		*/I	/	2	/I	/
I	/I	/I	4/		4	/I	/	3/I		/	*/	2	/	*/
I	/I	/	3	/I		5/	3	/	2, 3/I	/	*/	3/I		/
I	/I	/	3	/I		/	3	/	3/I	/	*/	3/		*/
I	/I	/	3	/I		/	3	/	2, 3/I	/	*/	3/		*/
I	/I	/	3	/I, 2		5/	3	/	3/I	/	*/	3/I		/
I	/I	/	3	/I, 2		5/	3	/	3/I	/	*/	3/		*/
I	/I	/	3	/I		5/	3	/	2, 3/I	/	*/	3/		*/
I	/I	/	3	/I		5/	3	/	3/I	/	*/	3/	3	/
I	/I	/	3	/I		5/	3	/	3/I	/	*/	3/	3	/
I	/I	/	3	/I		5/	3	/	2, 3/I	/	*/	3/		*/
I	/I	/	3	/I, 2		5/	3	/	2, 3/I	/	*/	3/		3/
I	/I	/	3	/I		5/	3	/	3/I	/	*/	3/		*/
I	/I	/	3	/I		5/	3	/	3/I	/	*/	3/		*/
I	/I	/	3	/I, 2		5/	3	/	3/I	/	*/	3/		*/
I	/I	/	3	/I, 2		5/	3	/	2, 3/I	/	*/	3/I		/
I	/I	/	3	/I		5/	3	/	3/I	/	*/	3/I		/
I	/I	/	3	/I		5/	3	/	3/I	/	*/	3/		*/
I	/I	/	3	/I		5/	3	/	3/I	/	*/	3/I	3	/
I	/I	/	3	/I		5/	3	/	3/I	/	*/	3/		/
I, 2, 3/	2	/	4/I			5/	3	/	2, 3/I	/	*/	2	/I	/
I, 2, 3/	2	/	3	/I		5/	3	/	3/I	/	*/	2	/I	/
	3/	2	4/I			5/	3	/	3/I	/	*/	2	/I	/
	2, 3/	2	/I, 2	/I		5/	3	/	2, 3/I	/	*/	2	/I	/
I, 2, 3/	2	/	3	/I		5/	3	/	3/I	/	*/	2	/I	/
	3/	2	4/I			5/	3	/	3/I	/	*/	2	/I	/
	3/	2	3	/I		5/	3	/	3/I	/	*/	2	/I	/
I	/I	/	3	/I		5/	3	/	2, 3/I	/	*/	2	/	*/
I	/I	/	3	/I		5/	3	/	3/I	/	*/	2	/I	/
I	/I	/I	3	/I, 2		5/	3	/	3/I	/	*/	2	/	*/
I	/I	/	3	/I		5/	3	/	2	/I	/	2	/	*/
I	/I	/I	/I			5/	3	/	3/I	/	*/	2	/	*/
I	/	*/	2	/I		5/	3	/	3/I	/	*/	2	/	*/
I	/I	/	3	/I		/	3	/	3/I	/	*/	2	/	*/
I	/I	/	4/I, 2			/	3	/	3/I	/	*/	2	/	*/

328. ooooo11olooooooooo1o**o**o11oooooooo11olooloo*1ololooooooooolol* *
 344. ooooo11ol11oloooooooo1o**o11oooooolooloooooooooooooooo1o*ooooooooo* *
 349. ooo1*1ol11oloooooooo1o**o1ool*11ool1oooooooooooooooo1o*ooooooooo* *
 389. ooooo111*olo*olooooo***11olooooooooooloooooooo1*o11ooooooooool1 10.0
 394. ooo1*1ooooooloooooooo***ololooooooooooloooooooo1*o11ooooooooool* 10.0
 395. *oooooooo1olol*oooooooo***ololooooooooooloooooooo1*o11oooooooool** 6.0

Group 5.

158. 1oooooolooooooooo1lo**o**o11oooo*oollo11olool*11*olooooooooolol** 6.0
 159. 1ooooooloooo***o**o11oooo*oolool1olool111*olooooooooolol** 6.0
 160. 1oooooolooooooooo1lo**o**ool*ooo*oollo111olool1*olooooooooolollo 8.0
 161. 1oooooolooooooooo1lo**o**ool*ooo*oolool1olool111*olooooooooolol** 8.0
 162. 1oooooolooooooooo1lo**o**o11oooo*ooooooooooloolol1*11ooooooooolollo *
 163. 1ooo*oolooo*oollo*oooooooooooo*oollo11oloolol1*olooooooooolol** 2.0
 164. 1oooooolooooooooo1lo**o***ool*ooo*oollo11olool*11*olooooooooolollo 8.0
 165. 1ooo*oolooooooooollo**o***ool*ooo*oolool1olool*11*olooooooooolol** 8.0
 271. ooooooooo11ooooooloooooooooooo1*ooooooooo*oolol*11*o11oooooooool1 6.0
 272. ooooooooo11oooooolooooooloooo1*ooooooooo*oolol*11*o11ooooooooololo 8.0
 273. ooo1*oolooooooooooloooool*ooooooooo*oolol*11*o11ooooooooololo 6.0
 274. ooo1*ooloooooooooooo*o***o11ooooooooo*oolol*11*o11oooooooool1 6.0
 275. ooooooooo11ooooooloooooooooooo11ooooooooo*oolol*11*o11oooooooool1 6.0
 276. ooo1*ool1*ooloooooooooooo11ooooooooo*oolol*11*o11oooooooool1 6.0

Group 6.

354. oooo*oollo*ooooo*ooloooo11loo*1ol1ooooooooo*1*oo*oloooo111** 7.0
 355. oooooooooollo*ooooo***o11loool1ol1ooooooooo*1*oo*oloooool1 6.0
 356. oooo*oollo*ooooo*ooloooooloolol1ooooooooo*1*oo*oloooool* 8.0
 357. oooo*oolloooooooooo*o**o1oloooo1ololooooooooo*1*oo*olooooololo 10.0
 358. ooooooolool1ooooooooo*o**o1olool11ol1ooooooooo*1*oo*oloooool1 3.0
 359. oooo*oolloooooooooo***o1olool11ol1ooooooooo*1*oo*oloooool1 10.0
 360. oooooooooollo*ooooo*ooloooooloolol1ol1ooooo*1*oo*oloooo11** 10.0
 361. oooooooooollo*ooooo*ooloooooloolol1ol1ooooooooo*1*oo*oloooo11** 10.0
 362. oooo*oollo*oloooooooooloololoolol1ol1ooooooooo*1*oo*oloooool1 6.0
 363. oooooooooollo*oooooolol1oololoolol1ol1ooooooooo*1*oo*oloooo11** 6.0
 364. oooooooooollo*oloooooololoolol1ol1ol1ooooo*1*oo*oloooo11** 6.0
 365. oooo*oollo*ooooo*ooloooo11ool11ol1ooooooooo*1*oo*oloooo11oo* 6.0
 366. oooooooooollo*oooooooooolool11ool1ol1ooooooooo*1*oo*oloooool1 10.0
 367. oooooooooollo*oooooooooolool11ool1ol1ooooooooo*1*oo*oloooo111lo 9.0
 368. oooooooooollo*ooooooooooloololoolol1ol1ooooooooo*1*oo*oloooo11** 6.0
 369. oooo*oollo*ooooo*ol1ooooooloolol1ol1ooooo*1*oo*oloooo11** 6.0
 370. oooooooloollo*ooooooooooloololoolol1ol1ooooooooo*1*oo*oloooool1 8.0
 371. 1ooooooooollo*ooooo*oolooooooloolol1ol1ooooooooo*1*oo*oloooo11** 6.0
 372. 1oooooooool*1*ooooo*ol1ooooooloolol1ol1ooooooooo*1*oo*oloooo11** 6.0
 373. lol*oollo*oloooo***o11loool1ol1ooooooooo*1*oo*oloooo11** 8.0
 374. ooooooooo11ooooooooo***o11loool1ol1ooooooooo*1*oo*oloooo11lo 6.0
 375. 1ooooooooollo*oooooolol11oololoolol1ol1ooooooooo*1*oo*oloooool1 *
 376. 1ooooooooollo*olooooool11ool11oolol1ol1ooooooooo*1*oo*oloooo11** 6.0
 377. 1ooooooooollo*ooooooloolool11oolol1ol1ooooooooo*1*oo*oloooo11lo 10.0
 378. oooooooooollo*oooooooooololololoolol1ol1ooooooooo*1*oo*oloooo11** 7.0

328.	2	/	*/I	/I	/I	3	/	3	/I	/I	/I	/I	/		
344.	2	/	*/I	/I	/I	4/I		6/	2	/I	/	*/	2	/	
349.	2	/	*/I	/I	/I	4/I		/	3/I,2,3/			*/I	/		
389.	3,4/		*/I	/I	3	/	2,3	/I	/I	/I	/	3/I	/		
394.	2,3	/	*/I	/I		/I,2,3,4/I		/I	/I	/	2	/I	/		
395.	4/		*/I	/I		/	2,3	/I	6/I	/	3/	2	/	2	/

Group 5.

Group 5.																
I58.	I,2	/	2	/I	/I	/I	3	/I	4	6/	3/	2	/	*/I	/	
I59.	2	/	2	/I	/	*/		*/		*/	3/	2	/	*/I	/	
I60.	I,2	/	2	/I	/I	/I	3	/I	4	6/	3/	2	/	*/I	/	
I61.	I,2	/	2	/I	/I	/I	3	/I	4	6/	3/	2	/	*/I	/	
I62.	I,2	/	2	/I	/I	/I		4/I	4	6/	3/	2	/	*/I	/	
I63.		3	/	2	/I	/I	/	*/I	4	6/	3/	2	/	*/I	/	
I64.	I,2	/	2	/I	/I	/		*/I	4	6/	3/	2	/	*/I	/	
I65.	I,2	/	2	/I	/I	/		*/I	4	6/	3/	2	/	*/I	/	
271.	I,2,3	/		*/I	/I	/I,2,3	/I			5,6/I	/I	/		3/	2	/
272.	I,2,3	/		*/I	/I	/		*/I		5,6/I	/I	/		3/	2	/
273.	I,2,3,4/			*/I	/I	/	2,3	/I		5,6/I	/I	/		3/	2	/
274.	I,2	/		*/I	/I	/I	3	/I		5,6/I	/I	/		3/	2	/
275.	I,2,3	/		*/I	/I	/I	3	/I		5,6/I	/I	/		3/	2	/
276.	I,2,3	/		*/I	/I	/I	3	/I		5,6/I	/I	/		3/	2	/

Group 6.

354.	3,4/		*/	2	/	3	/	2	/I	4	/	3/	2	/	*/	3/
355.	3	/	*/	2,3/		3	/	2	/I	4	/	3/I,2,3/			*/	3/
356.	3,4/		*/	2	/	3	/	2	/I	4	/	3/I	3/		*/	3/
357.	I,2	/	*/	2	/	3	/	2	/I	4	/	3/I	/		*/	3/
358.	I,2	/	*/	2,3/		3	/	2	/I	4	/	3/I	/		*/	3/
359.	I,2,3	/	*/	2	/	3	/	2	/I	4	/	3/I	/		*/	3/
360.	3	/	*/	2	/	3	/	2	/I	4	/	3/I	/		*/	3/
361.	3	/	*/	2	/	3	/	2	/I	4	/	3/I	/		*/	3/
362.	3,4/		*/	2	/	3	/	2	4/I	4	/	3/I	/		*/	3/
363.	3	/	*/	2	/	3	/	2,3	/I	4	/	3/I	/		*/	3/
364.	3,4/		*/	2	/	3	/	2	/I	4	/	3/	3/		*/	3/
365.	3,4/		*/	2	/	3	/	2	/I	4	/	3/I	/		*/	3/
366.	3,4/		*/	2	/	3	/	2	4/I	4	/	3/I	/		*/	3/
367.	3,4/		*/	2	/	3	/	2,3	/I	4	/	3/I	/		*/	3/
368.	3,4/		*/	2	/	3	/	2	/I	4	/	3/I	/		*/	3/
369.	3	/	*/	2	/	3	/	2	/I	4	/	3/I	/		*/	3/
370.	3	/	*/	2	/	3	/	2	/I	4	/	3/I	3/		*/	3/
371.	3,4/		3,4/	2,3/		3	/	2	/I	4	/	3/I,2	/		*/	3/
372.	3	/I	/	2,3/		3	/	2	/I	4	/	3/I	/		*/	3/
373.	3	/	3	/	2	/	3	/	2	/I	4	/	3/I	/	*/	3/
374.	I,2,3	/	*/	2	/	3	/	2	/I	4	/	3/I	/		*/	3/
375.	3	/I	/	2,3/		3	/	2	/I	4	/	3/I	3/		*/	3/
376.	3,4/I		3,4/	2	/	3	/	2	4/I	4	/	3/I	3/		*/	3/
377.	3,4/		4/	2	/	3	/	2	4/I	4	/	3/I	/		*/	3/
378.	3,4/		*/	2,3/		3	/	2	/I	4	/	3/I	/		*/	3/

I	/I	/	4/	4	/I	/	3/I	/	*/	2	/I	/
I	/I	/	4/I		/I	/I	/	2	/	*/	2	/
	*/	*/	4/I		/	2,3,4/I	/	3	/	*/	2	/
	3/I,2	/I	/	2	/I	/	2	/	*/I	/	2	/I
I	/I	/	3	/I	/I	/	3/		*/I	/	2	/I
I	/I	/I	/I		/	4/	2	/	*/I	/	2	/I

2	/	2	/I,2	/	4	/	3,4/	3/I	/	*/	2	/I	/
2	/	2	/	2	/	4	/	4/I,2	/	*/	2	/I	/
2	/	2	/	2	/	4	/	3,4/	3/I	/	*/	2	/I
	3/	2	/	2	/	4	/	3,4/	3/I	/	*/	2	/I
2	/	2	/	2	/	4	/	3	/	2	/I	/	/
I	/	2	/I	/	4	/	4/	3/	*/I	/	2	/I	/
2	/	2	/	2	/	4	/	3,4/	3/I	/	*/	2	/I
I	/	2	/	2	/	4	/	3,4/	3/I	/	*/	2	/I
I	/	3/	4/I	/	/I	/	3/	3/	*/I	/	2	/	2
I	/	3/	4/	4	/I	/	3/	3/	*/I	/	2	/	2
I	/	3/	4/I	/	/I	/	3/	3/	*/I	/	2	/	2
I	/	3/	4/I	/	/I	/I	/	/	*/I	/	2	/	2
I	/	3/	4/I	/	/I	/I	/	/	*/I	/	2	/	2
I	/	3/	4/I	/	/I	/I	/	/	*/I	/	2	/	2

3/	3/I	/I	/I,2	4/	3/	*/I	/	2	/	4	/	
3/	2	/I	/I	/	2	*/	2	/	2	/	4	/
3/I	/I	/I	/I,2	4/	3/	*/I	/	2	/	4	/	
3/	2	/I	/I,2	/	2	*/I	/	2	/	4	/	
3/	2	/I	/I	/	2	*/I	/	3/	/	4	/	
3/	2	/I	/I	5/	2	*/I	/	3/	/	4	/	
3/	2	/I	/I,2	/	2	*/I	/	2	/	4	/	
3/	3/I	/I	/	/	2	*/I	/	2	/	4	/	
3/	2	/I	/I	/	2	*/I	/	2	/	4	/	
3/	2	/I	/I,2	/	2	*/I	/	3/	/	4	/	
3/	2	/I	/I,2	/	2	*/	2	/	2	/	4	/
3/	2	/I	/I	/	3	/	2	/	2	/	4	/
3/I	/I	/	2	/	2	*/I	/	2	/	4	/	
3/	3/I	/I	/	3	/	*/	/	2	/	4	/	
3/	3/I	/I	/	2	/I	/	/	3/	/	4	/	
3/	2	/I	/I,2	/I	/I	*/	2	/	2	/	4	/
3/	2	/I	/I	/I	/I	*/	2	/	2	/	4	/
3/	2	/I	/I	/	2	*/I	/	3/	/	4	/	
3/	2	/I	/I	/	2	*/I	/	2	/	4	/	
3/	2	/I	/I	/I	4/I	*/	2	/	2	/	4	/
3/	2	/I	/I	/	2	*/I	/	2	/	4	/	
3/	2	/I	/I,2	/	2	*/	2	/	2	/	4	/
3/	2	/I	/I,2	/	2	*/	2	/	2	/	4	/
3/	3/I	/I	/	/	2	*/I	/	2	/	4	/	
3/I	/I	/I	/	/	2	*/I	/	2	/	4	/	

379.	ooooo1ooo11ooooooo1*o**o1o1ooo11o11ooooooo*1*oo*o1o1ooo11	5.0
380.	ooooooooo1*1oooooo**:*:*o111o111o11ooooooo*1*oo*o1ooo11o11	7.0
381.	ooo*ooo1lo*ooooo*o1o1o111ooo11o11ooooooo*1*oo*o1ooo1o1*o	6.0
382.	ooo*o1ooo1lo*oooooo*o11ooo1o1ooo11o11ooooooo*1*oo*o1ooo111*o	7.0
383.	ooooooooo1lo*oooooo*o11ooo1o1ooo11o11ooooooo*1*oo*o1ooo11o1o	7.0
498.	ooo*o1*o1o*ooooooooo1o1o1ooooo11o11oooo**oo*1*o1o11ooo11**	8.0

Group 7.

138.	1000000000*101001000***0101000110110000000111*01*0001110*	8.0
141.	00000000001001001000***001*0001101100000000*11*01*0100011011	2.0
196.	0000000000001100100***0***0101000110110000000011*00*0100001011	8.0
197.	0000000000001000100*00000011100011011000000000*1*00*0100001011	10.0
198.	0000***0000000100100***0***01110001101110011000011*00*1100001011	10.0
199.	10001*0000001100100***0***01110001101001010100001*10*0100011011	8.0
200.	0000*0000001100100***0***010100011011010000000*1*10*0100001011	*
201.	0000000000*11000100*0000001110001111000100000*1*00*0100011011	8.0
202.	0000*0000000000100***0***011100011011000100000*1*00*0100001011	10.0
203.	0000000000001100100***0***0101000110110100100001*10*0100001011	8.0
497.	000000000010*000000*010110101000110110000***00011*01011000011**	10.0
33.	*000**000010*000101000101010100011011000110000*0000*110001001*	10.0
34.	1000**000010*100101000101010100011011000110000*1*00*11000011**	8.0
35.	10001*000010*0001010***101000001101100011010000000*110001101*	10.0
36.	100000000010*0001010***010100011011000110100*1*00*1100010010	10.0
37.	1000*000010******1*****010100011011000110100*0000*110001001*	10.0
38.	000000000010*00010100110101010001101100011000010000*11000111**	10.0
39.	100000000010*0001010***010100011011000110100*0000*110000101*	10.0
40.	000000000010*000101010110010100011011000110000*0000*110011111*	10.0
46.	10001000001000001010*0***01010001100000110010*0000*010010101*	*
47.	0011*****1010*0***001*0001100000100010*0000*010010101*	*
48.	10110000001000001010***101110001100000100010*0000*010010101*	*
49.	10001*000010*0001010***101010001100000100010*0000*010010101*	*
50.	101000000010*0101010***101010001100000110010*10000*010010101*	*
51.	1000000000100***1***101010001100000110010*0000*010010101*	*
52.	100000000010***1***101010001100000010010*0000*010010101*	*
53.	0011*****1010*0***001*0001100000100010*0000*010010101*	*
316.	1000*000010*00010100000101010001100000011010*0000*010000101*	*
317.	10001*000010*0001010100001010100011010000011010*10000*010000101*	*
318.	1000**000010******1*****010100011010000011010*0000*010000101*	*
68.	100000000010*00000100000010100011011000100000*1*00*01*00111**	8.0
93.	10001*01*110*010001000011010100010011000010000*1*0111100111010	9.0
94.	10000001*110*0100010000110101000000110101000001*0101100010010	7.0
404.	00001*000010*0110010000000101000010110100***00001*00*01000001**	10.0
405.	000000000010*0110010010000101000110110100***000*1*00*01000011**	10.0
406.	000000000010*0110010000000101011010010101**000*1*00*01000011**	10.0
407.	0000***000010*011001*000000101001110110101**000*1*00*01000001**	10.0
408.	000000000010*011001*000000101000010110100***000*1*00*01000011**	10.0
433.	10001*01*010*00010011000001110001101100001000011*00*11000111**	10.0
487.	*000000000010*0110000000001010100110000101*0***00011*01101001111**	10.0
488.	000000000010*110000*0001101110011000111*0***00011*11101000111**	*

3/	2	/I	/I	/	2	/I	/	*/I	/	3/	4	/
3/	2	/I	/I	/	2	/I	/	*/I	/	3/	4	/
3/	2	/I	/I,2	/I		/I	/	*/	3/	2	4	/
3/	2	/I	/I	/I		/	3/	*/I	/	2	4	/
3/I		/I	/I	5/	2	/	3/	*/I	/	2	4	/
3/I		/I	/I,2	/	3	/	3/	4/	*/	3/I		/

3/	2	/I	/I	/	2	/	2	*/	2	/	2	*/
3/	2	/I	/I	/	2	/	2	*/	2	/	2	*/
3/		3/I	/I,2	/	3	/	3/I	/	*/	2	4	/
3/		3/I	/I,2	/	3	/	3/I	/	*/	2	4	/
3/		3/I	/I,2	/	2	/	3/	*/I	/	2	4	/
3/		3/I	/I,2	5/	3	/	3/I	/	*/	2	4	/
3/		3/I	/I,2	5/	3	/	3/I	/	*/	2	4	/
3/		3/I	/I,2	5/	3	/	3/I	/	*/	2	4	/
3/		3/I	/I,2	/	2	/	3/	*/I	/	2	4	/
3/		3/I	/I,2	5/	3	/	3/I	/	*/	2	4	/
3/		3/I	/I,2	/	3	/	3/	4/	*/	3/I		/

3/		3/I	/	*/	2	/	3/I	/	*/	2,3/	3	/	
3/		3/I	/	*/	3	/	3/I	/	*/	2,3/	3	/	
3/		3/I	/	*/	2	/	3/I	/	*/	2,3/	3	/	
3/	2,3/	3/I	/	*/	2	/	3/	*/I	/	2,3/	3	/	
3/		3/I	/	*/	2	/	3/I	/	*/	2,3/	3	/	
3/		3/I	/	*/	2	/	2	/I	/	*/	2,3/	3	/
3/		3/I	/	*/	2	/	3/I	/	*/	2,3/	3	/	
3/		3/I	/	*/	2	/	3/I	/	*/	2,3/	3	/	
3/	2	/I	/	2	/	2	3/I	/	*/	2	4	/	
3/	2	/I	/	2	/	2	3/I	/	*/	2	4	/	
3/	2	/I	/	2	/	2	3/I	/	*/	2	4	/	
3/		3/I	/	2	/	2	3/I	/	*/	2	4	/	
3/	2	/I	/	2	/	2	3/I	/	*/	2	4	/	
3/		3/I	/	2	/	2	3/I	/	*/	2	4	/	
3/		3/I	/	2	/	2	3/I	/	*/	2	4	/	
3/	2	/I	/	2	/	2	3/I	/	*/	2	4	/	
3/		3/I	/	2	/	2	3/I	/	*/	2	4	/	
3/		3/I	/	2	/	2	3/I	/	*/	2	4	/	
3/		3/I	/	2	/	2	3/I	/	*/	2	4	/	

I	3/I,2	/I	/I,2	/	2	/	2	*/I	/	2	/	5/
I	/I	/I,2	/I	/I	4/	2	/	*/I	/	2	/	4
I	/I,2	/I,2,3	/I	/	4/	2,3/		*/I	/	2	/	*/
	3/I	/I	/I,2	5/I	/I	/		*/I	/	2	/	*/
	3/I	/I	/I,2	5/I	/I	/		*/I	/	2	/	*/
	3/I	/I	/I,2	5/I	/I	/		*/I	/	2	/	*/
	3/I	3/	3	5/I	/I	/		*/I	/	2	/	*/
	3/I	/I	/I,2	5/I	/I	/		*/I	/	2	/	*/
	3/I	/I	/	*/	2	/	3/	*/I	/	2,3/	4	/
I	/I	/	4/	2	/	3	/I	/	2	/I	/	/
I	/I	/	4/	2	/I,2	4/I	/	*/	2	/	2	/I

379.	2	/	*/	3/	3	/	2	/I	4	/	3/I	/	*/	3/	
380.	I,2,3	/	*/	2	/	3	/	2	/I	4	/	3/I	/	*/	3/
381.	3,4/		*/	2	/	3	/	2	/I	4	/	3/I	3/	*/	3/
382.	3	/	*/	2	/	3	/	2	/I	4	/	3/I,2	/	*/	3/
383.	3,4/		*/	2,3/		3	/	2	/I	4	/	3/I	/	*/	3/
498.	3	/	*/I	/I,2		/			*/		*/	2,3/I,2	/	*/I	/

Group 7.

I38.	2,3	/I	/I	/	3	/	*/		6/I	/I	/I	/I	/			
I41.	I,2,3	/	*/I	/	2,3	/	*/		5,6/I	/I	/I	/I	/			
I96.	I	/	*/	2	/I,2	/	*/		*/I	/I	/	2	/I			
I97.	2,3	/	*/	2	/I	/	*/		*/I	/I	/	2	/I			
I98.	I	/	*/	2	/I	/I	4/		*/I	/I	/	2	/I			
I99.	I,2	/I	/	2	/I	/I	4/		*/I	/I	/	2	/I			
200.	I,2	/	*/	2	/I	/	*/		*/I	/I	/	2	/I			
201.	I,2,3	/	*/	2	/I	/	*/		*/I	/I	/	2	/I			
202.	I	/	*/	2	/I	/	*/		*/I	/I	/	2	/I			
203.	2	/	*/	2	/I	/	*/I	4	/I	/I	/	2	/I			
497.	3,4/		*/I	/I,2	/I,2	4/		5	/I	/I	3/	2	/I			
33.	4/		*/I	/I	3	/	2	4/I	4	6/I	/I	/	2	/I		
34.	3	/	2	/	3	/	2,3,4/I	4	6/I	/I	/	2	/I			
35.	3	/I	/	2	/I	3	/	2	4/I	4	6/I	/I	/	2	/I	
36.	3	/I	/	2	/I	3	/	2	4/I	4	6/I	/I	/	2	/I	
37.	3	/I	/	2	/	*/	*/		*/I	/I	/	2	/I			
38.	3,4/		*/	3/I	3	/	2	4/I	4	6/I	/I	/	2	/I		
39.	3,4/I		4/	2	/	3	/	2	4/I	4	6/I	/I	/	2	/I	
40.	3,4/		*/	2	/I	/	2	4/I	4	6/I	/I	/	2	/I		
46.	2	/I	/	2,3/	3	/	2	4/I	4,5	/I	/I	/	2	/I	3/	
47.	2	/	*/	*/	3	/	*/I	4	/I	/I	/	2	/I	3/		
48.	2,3	/I	/	2	/	3	/	2	4/I	4	/I	/I	/	2	/I	
49.	3	/I	/	2	/	3	/	2	4/I	4	6/I	/I	/	2	/I	
50.	3	/I	3	/	2	/	2,3	/	2	4/I	4	/I	/I	/	2	/I
51.	2,3	/I	/	2	/	*/	*/		*/I	/I	/	2	/I	3/		
52.	3	/I	/	2	/	*/	*/		*/I	/I	/	2	/I	3/		
53.	2	/	*/	*/	2	/	*/I	4	/I	/I	/	2	/I	3/		
316.	3	/I	/	2	/	3	/	2	4/I	4	/I	/I	/	3/I	/	
317.	3	/I	/	2	/	3	/	2	4/I	4	/I	/I	/	2	/I	
318.	3	/I	/	2	/	*/	*/		*/I	/I	/	2	/I	/		
68.	3,4/I		/I	/I	/I	3	/I		6/I	/I	/	2	/I	3/		
93.	3,4/I		4/	2	/I	/	2,3,4/I		/I	/I	/	2	/I	/		
94.	3,4/I,2		/	2	/I	3	/I	4/	4,5	/I	/I	/	2	/I	/	
404.	3,4/		*/I	/I	/	2	4/	2	/I	/I	/	3/I	/			
405.	3,4/		*/I	/I	3	/	2,3	/	2	/I	/I	/	2	/I	/	
406.	3,4/		*/I	/I	/I	3	/	2	/I	/I	/	3/I,2	/			
407.	3,4/		*/I	/I	/I	3	/	2	/I	/I	/	3/I,2	/			
408.	3,4/		*/I	/I	/	2,3	/	2	/I	/I	/	2	/I	/		
433.	3,4/		4/I	/I	/	2	4/		4,5,6/I	/I	/	3/	2	/		
487.	4/		*/	2	/	3	/	2	4/I	4,5	/I	/	3/I	/I	/	
488.	3,4/		*/	2	/	3	/	2,3	/I	4	/I	/	3/I	/I	/	

489. oooool*ol*olollllooooolololollollllooollooolloololoooolll*ollolooooololll 2.0
499. ooooooooooloo*oooooooooolololoooolloolllooooo**ooo*1*olollllooooolll** 10.0
50I. oooooooooolllo*loloooooollooollooololoollll*oooooooooll*ollolooolol** 7.0

Group 8.

75. ooooolol*o*lllloooool**o***ololoooolloolllooooooooooolll*oo*lllloolllo 9.0
76. ooooolooloo*llllooooll*o***olllooolloolllooooooooooolll*oo*lllloolllo 9.0
77. looooooooololo*loooool*oooooooolllooollooloooollooolo*1*oo*llllooll** 9.0
79. oooool*oololoollooollooollooollllooollooloooollooolll*oo*lllloolllo 9.0
80. loooooooool*oollooollooollooollllooollooloooollooolll*oo*lllloolllo 9.0
8I. ooooooooool*o*lllloooool**o***olllooolloollloooooooooool*1*oo*lllloolllo 9.0
533. loooolloooloo*looooollooollllooloolloollloooooooooool*oo*olllooll** 10.0

I. loooolloololololololoo*****lllooooollllllo*olooooo*1*oo*olllooooolo 8.0
5. oooool*ol*oloo*****o*****llllooolloolllo*oooooooo*1*oo*ollloooloo 8.0
6. oooool*ooooolooooooooo**o***lloloolloolllo*oloooooll*oo*ollloooloo 8.0
6I. oooool*ol*olooooooooo**o***ololoolloollloooooooooooooooooool*1*olooo* 10.0
62. ooooollooolloooooooooo**o***ololoolloollloooooooooooooooooool*1*olooo* 10.0
63. ooooooooooolloooooooooooloolololoolloollllllloooooooooooooooooool*oolooo* 8.0
64. oooo**ooooolooooooooo**o***ololoolloolllooooooooooooo*oooo*ol*oolooo* 10.0
65. ooooooooool*olooooolooo*****ololoolloolllooollooooooll*oo*11*oolloo* 8.0
66. oooool*oooooloooooooooooo*****ololoolloolllooollooooooooooooo*ol*oolooo* 8.0
67. ooooollooolloooooooooo**o***ololoolloolllooollooooooooooooo*ol*oolooo* 10.0
2I9. oooool*oololooooooooo**o***lloloollllllooooooooooolooo*11loollloo* 7.0

2. ooooooooool*oollooooo*oooooooooloooooooolllllo*oloooooll*oo*ollloooloo 8.0
3. ooooooooooollooooooloooooooooollooloolloolllo*oooooooool*oo*ollloooloo 8.0
4. oooool*ooooolooooooooo**o***lloloolloolllo*olooooo*1*oo*ollloooloo 8.0
8. ooooooooool*oloooooooooooo*****ololoooollllllo*oooooooo*1*oo*ollloooloo 9.0
2I7. ooooolloololooooooooo**o***lloloollllllooooooooooolll*oo*llllooololl 7.0
2I8. oooo**ol*olooooooooo**o*1*lloloollllllooooooooooolooo*11looll** 7.0
220. oooooooooooloooooooooolloolllooloolllllloooooooooooooooooool*11loollloo* 7.0
222. oooooooooololooooooooo*****lloloolllllloooooooooooooooooool*11loollloo* 7.0
223. oooooooooololooooooooooloollooloolllllloooooooooooooooooool*11loollloo* 7.0
224. oooo**oollooooooooooooooollooloolllllloooooooooooooooooool*11loollloo* 7.0
225. oooooooooooloo*ooooo*oooooooolllooollllllooollooooooll*oo*11loollloo* 7.0
226. oooool*ooooolooooooooool*****lloloolllllloooooooooooooooooool*11loollloo* 7.0
227. oooool*ol*oloooooooooollooollooloolloollloooooooooooooooooool*11loollloo* 7.0
228. loool*oolloooooooooo**o***lllooollllllooooooooooolooo*11loollloo* 8.0
229. oooool*ol*olooooooooool*o***lloloollllllooooooooooolooo*11loollloo* 7.0
230. oooool*ol*oloooooooooollooollllooollllllooooooooooolll*oo*11looololl 7.0
23I. oooooooooooloo*oooooooooollooollooolllllloooooooooooooooooool*11loollloo* 7.0
4I8. ooooooooooollooollooooooooooollooollllllooooooooooolll*oo*11loollloo* 10.0
424. ooooooooool*olo*oooooooooollooollooollllllooooooooooolll*oo*11loolllo 8.0
472. oooool*oololo*oooooooooolloolllooolloolllooooooooo**1*oo*11looll** 8.0
473. ooooolol*olo*oooooooooolloolllooolllllloooooooooool*oo*11looololl 6.0
474. loool*ol*olo*oooooooooolloolllooolllllloooloooo*ol*oo*11looll** 7.0
475. loool*oooool*oooooooooolloolllooolllllloooooooooool*11*oo*11looll** 7.0
476. ooooooooool*oloooooooooolloolllooolloollloooooooooool*11*oo*11looololl 10.0
477. looooooooooloo*oooooooooollooollooollllllooollooooooll*oo*11looololo* 8.0
478. ooooooooooolloooooooooo**o***lllooolllllloooooooooool*1*oo*11loolllo 10.0

489.	2,3 /	*/ 2 /I,2,3 / 2 4/I	4 /I /I /I /I /
499.	3,4/	*/I /I,2 /I,2 4/	5 /I / 3/ 3/I /
501.	3,4/	*/I / 3 / 2,3,4/I	4 /I /I /I /I /

Group 8.

75.	2 /	*/I 3/I / 2 4/I	/ 3/I / */ 2,3/
76.	I,2 /	*/I /I / 2,3 /I	/ 3/I / */ 2,3/
77.	3 /I	4/I /I / 2,3 /I	/ 3/I / */ 2,3/
79.	I,2,3 /	*/I /I / */I	4 / 2,3/I,2 / */ 2,3/
80.	2,3 /	4/I /I / */I	4 / 2,3/I / */ 2,3/
81.	I,2 /	*/I /I / */I	/ 2,3/I / */ 2,3/
533.	3 /I	4/ 2 /I / 2 4/I	6/ 3/I / */ 3/
I.	2,3 /I	/ 2 / 4/I 3 /I	4 6/I /I / 2 /I,2,3/
5.	2,3 /	*/ 2 / */	*/I /I / 2 /I,2,3/
6.	2 /	*/ 2 / 4/ */	4 6/I /I / 2 /I,2,3/
61.	I,2 /	*/I /I /I 4/I	6/I /I / 2 /I /
62.	2 /	*/I /I /I 4/I	6/I /I / 2 /I /
63.	2,3 /	*/I /I /I 4/I	4 6/I /I / 2 /I /
64.	I,2 /	*/I /I /I 4/I	6/I /I / 2 /I /
65.	I 3 /	*/I 3/I /I,2 4/I	6/I /I / 2 /I /
66.	I,2,3 /	*/I /I /I 4/I	6/I /I / 2 /I /
67.	I,2 /	*/I /I /I 4/I	4 6/I /I / 3/I /
219.	I,2 /	*/ 2 /I,2 4/I 4/	4 6/I /I / 3/I 3/
2.	2,3 /	*/ 2 / 4/I,2 4/	4 6/I /I / 2 /I,2,3/
3.	2,3 /	*/ 2 / 4/I,2 4/I,2	4,5 /I /I / 2 /I,2,3/
4.	I,2 /	*/ 2 / 4/ */	4 6/I /I / 2 /I,2,3/
8.	2,3 /	*/ 2 / 4/I,2 4/	4 6/I /I / 2 /I,2,3/
217.	I,2 /	*/ 2 /I,2 / 4/	4 6/I /I / 3/I 3/
218.	2 /	*/ 2 /I,2 / 4/	4,5,6/I /I / 3/I 3/
220.	2,3 /	*/ 2 / 4/ 2 4/	4,5,6/I /I / 3/I 3/
222.	I,2,3 /	*/ 2 / 4/ 4/	4 6/I /I / 3/I 3/
223.	2,3 /	*/ 2 / 4/I 3,4/	4 6/I /I / 3/I 3/
224.	2,3 /	*/ 2 /I,2 4/ 4/	4 6/I /I / 3/I 3/
225.	3 /	*/ 2 /I,2 / 4/	4 6/I /I / 3/I 3/
226.	2,3 /	*/ 2 / 4/ 4/	4 6/I /I / 3/I 3/
227.	I,2,3 /	*/ 2 / 4/ 4/	4 6/I /I / 3/I 3/
228.	I,2 /I	/ 2 / 4/ 4/	4 6/I /I / 3/I 3/
229.	I,2 /	*/ 2 / 4/ 2,3,4/	4,5,6/I /I / 3/I 3/
230.	2,3 /	*/ 2,3/I,2 / 2,3,4/	4,5,6/I /I / 3/I 3/
231.	3 /	*/ 2 / 4/ 4/	4 6/I /I / 3/I 3/
418.	I,2,3 /	*/I,2 /I 3,4/ 2 4/	4 6/I /I / 3/ */
424.	3 /	*/I,2 /I 3,4/ 2 4/	4 6/I /I / 3/ */
472.	3,4/	*/ 2 /I / 2 4/I	4,5,6/I /I / 3/ 3/
473.	3 /	*/ 2 /I / 2 4/I	4 6/I /I / 3/ 3/
474.	3,4/	4/ 2 /I / 2 4/I	4 6/I /I / 3/ 3/
475.	3,4/I	/ 2 /I 4/ 2 4/I	4,5,6/I /I / 3/ 3/
476.	2,3 /	*/ 2,3/ 4/ 2 4/I,2	4 6/I /I / 3/ 3/
477.	3 /I	/ 2 / 3,4/ 2,3 /I	4 6/I /I / 3/ 3/
478.	2 /	*/ 2 /I / */I	4 6/I /I / 3/ 3/

I	/I	3/	4/I	5/I	3,4/	3/I	/I	/	2	/	4	/
I,2,3/I,2	/I	/I,2	/I,2	/	3	3/	4/	*/	3/I			/
I	/I	/	4/ 2	/I	4/I	/	*/I	/	*/		*/	

3/I	2	/I	/	*/	4/	3/	*/I	/	2	/	4	/
3/	2	/I	/	*/I	4/	3/	*/I	/	2	/	4	/
3/	2	/I	/	*/ 2	/	3/	*/I	/	2	/	4	/
3/	2	/I	/	*/ 2	/	3/	*/I	/	2	/	4	/
3/	2	/I	/	*/ 2	/	3/	*/I	/	2	/	4	/
3/	2	/I	/	*/I,2	4/	3/	*/I	/	2	/	4	/
3/I	/I	/I	/I	/ 2	4/	3/	*/I	/	2	/ 2		/
3/I	/	2	/I,2	/ 2	/ 2	/	*/I	/	2,3/		4	/
3/I	/	2	/I	/ 2	/ 2	/	*/I	/	2,3/		*/	
3/I	/	2	/I	/ 2	/ 2	/	*/I	/	2,3/		4	/
3/I	/I	/	/I,2	/ 2	/ 2	/I	/	*/	2	/		5/
3/I	/I	/	/I,2	/ 2	/ 2	/I	*/	*/	2	/		5/
3/I	/I	/	/I,2	/ 2	/ 2	/I	/	*/	2	/		5/
3/I	/I	/	/I,2	/ 2	/ 2	/I	/	*/	2	/		5/
3/I,2	/I	/	/I,2	/ 2	/ 2	/I	/	*/	2	/		5/
3/I	/I	/	/I,2	/ 2	/ 2	/I	/	*/	2	/		5/
3/I	/I	/	/I,2	/ 2	/ 2	/	*/ 2	/	2	/		5/
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/ 2		/
3/I	/	2	/I	/ 2	/ 2	/	*/I	/	2,3/		*/	
3/I	/I,2	/I	/I	/ 2	/ 2	/	*/I	/	2,3/		*/	
3/I	/	2	/I	/ 2	/ 2	/	*/I	/	2,3/		*/	
3/	3/I	/I	/I	/ 2	/ 2	/	*/I	/	2,3/		*/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/	2	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	
3/I	/I,2	/I	/I	5/ 2	/I	/	*/I	/	2	/	*/	
3/I	/I,2	/I	/I	5/ 2	/I	/	*/I	/	2	/	*/	
3/I	/I,2	/I	/I	/ 2	/ 2	/	*/I	/	2,3/I		/	
3/I	/I,2	/I	/I	/ 2	/I	/	*/I	/	2,3/I		/	
3/I	/I,2	/I	/I	/ 2	/I	/	*/ 2	/	2	/I	/	
3/I	/I,2	/I	/I	/ 2	/I	/	*/I	/	2,3/I		/	
3/I	/I,2	/I	/I	/ 2	/I	/	*/ 2	/	2	/I	/	
3/I	/I,2	/I	/I	/ 2	/I	/	*/ 2	/	2	/I	/	
3/I	/I,2	/I	/I	/ 2	/I	/	*/ 2	/	2	/I	/	
3/I	/I,2	/I	/I	/ 2	/ 2	/	*/ 2	/	2	/I	/	

479. ooooo*oolololoooooooo*****llloooooollllloooloooooooo*oo*lllloolooll 7.0
 480. loool*ll*ooo*oollooolloololololololoooooooo*ll*oo*lllloolol** 7.0
 7. ooooooooooolooloooooooo*****lllllooollllllo*oooooooool*oo*olllooloolo 9.0
 56. oooooolol*o*1*oooooooooloollllllooloolololoo*o*lllo*ol*oo*lllloooloolo 8.0
 57. *oooooll*olo*ooooooooooooooooolllooloollllllo*o*loo*ol*oo*llllooloolo 8.0
 58. *o*1*****oooooooo*****llolooooolllllo*o*loo*ol*oo*lllloolol** 8.0
 59. oooo**ll*ooo*oooooooooloollllooloollllllo*o*loo*ol*oo*llllooloolo 8.0
 204. ooooooloololoooooooo*****lllllooollllllo*oooooooooll*oo*lllloollolo 10.0
 205. loloooooooool*oloooo*****llolooooolllllo*oooooooooll*oo*lllloollolo 10.0
 206. looooool*oloooooooo*oololololooloololool*oooooooooll*oo*lllloollolo* 8.0
 207. loooooololol*oloooo*****lllllooollllllo*oooooooooll*oo*llllooll** 9.0
 208. lol**oololol*oooooooooololololooloololool*oooooooooll*oo*llllooll** 10.0
 209. oool*oolo*1*oooooooooloolollllllooollllllo*oooooooooll*oo*lllloollolo 10.0
 210. oool*oololoooooooo*****lllllooollllllo*oooooooooll*oo*lllloollolo 9.0
 211. oooooooooololololool*o*****llolooooololool*oooooooooll*oo*lllloollolo 10.0
 409. loooooooooooloooooooo*****llllooollllllooooooooooll*oo*lllloollolo 10.0
 410. oooo**oolool*oooo*ooooooooolooooooooolllllooooooooooll*oo*lllloollol 10.0
 411. loool*ol*ololoooooooo*ooooooooololoolololoooooooooll*oo*lllloollol 10.0
 412. oooooolol*oloooooooo*oooooooooloooooooolllllooooooooooll*oo*lllloollolo 10.0
 413. ooooooloolololool*****o*****llloooooolllllooooooooooll*oo*lllloollol 10.0
 414. oooo**oololoooooooo*****o*****llloooooolllllooooooooooll*oo*lllloollol 10.0
 415. oooooolol*ololoooooooo*****llloooooolllllooooooooooll*oo*lllloollol 8.0
 416. oloo**ooloooooooo*****o*****llloooooollllloooloooooooooll*oo*lllloollolo 10.0
 417. oooooolol*oloooooooo*****o*****llloooooolllooooooooooll*oo*lllloollol 9.0
 419. oool*oolo*looooooooo*****o*****llloooooollllloooloooooooooll*oo*lllloollolo 8.0
 420. oooooooooololoooooooo*****o*****llloooooolllllooooooooooll*oo*lllloollol 10.0
 421. oool*ol*olooooooooooloollloloollllllooooooooooll*oo*lllloollol 10.0
 422. oloo**oololoooooooo*****o*****llloooooolllllooooooooooll*oo*lllloollol 10.0
 423. ooooooloololoooooooo*****llolooooolllllooooooooooll*oo*lllloollol 10.0
 425. oooooooooololoooooooo*****o*****llloooooollllloooloooooooooll*oo*lllloollol 9.0
 426. oooooolol*ololoooooooo*****o*****llloooooolllooooooooooll*oo*lllloollol 10.0
 427. oool*oolo*looooooooooolllloooooolllooooooooooll*oo*lllloollol 10.0
 428. oooo**oololoooooooo*****llloooooolllllooooooooooll*oo*lllloollol 10.0

Group 9.

494. olooofoooo*1*oooooooooolololooloololooloolool*o***lllooll** 10.0
 495. olooooooooo*1*oooo*ooooooooolool*lolll**oloooo*1***llloll** *

496. olooooooooo*1*oooo*ooooooooolool*lolll**oloooo*1***llloll** *

502. *ooooollololol*looooooolooloollllllooll*oloooo*oo*lllloooloo* 8.0
 503. loool*looolo*oloooooooooollllooollooll*llloool*oo*lllloool** 8.0
 513. olool*oooooolooloooo*****ololl*ollloooloolool*oo*ollloooloo* 10.0

I66. ooooooooo*olo*ooloolllllooloolooloolll*olloloo*1*oo*llllooll** 10.0
 I68. ooooooooooolo*loloolooloollooollooll*ollolool*oo*lllloollolo 10.0
 I69. loooooooooolol*ooloololoolloooloolll*ol*olool*oo*lllloolllo 10.0
 I70. ooooooooooolo*ooloollllooloolooloolll*oololoo*1*oo*lllloollol 10.0
 I71. oool*oolool*loloollllooloolooloolll*oololool*oo*lllloollol 10.0
 I72. loool*ol*olo*ollloooloolloooloolll*olloloo*1*oo*llllooll** 10.0
 486. ooooooooo*ooo*ooloololoololooloolloolllooloo*olo**1*oo*llllooll** 10.0

479.	I,2,3 /	*/ 2 /I	/ 2 4/I	4,5,6/I	/I	/ 3/ 3/
480.	3,4/	4/ 2 /I	/ 2 4/I	4 6/I	/I	/ 3/ 3/
7.	2,3 /	*/ 2 /	4/I,2 4/	4,5,6/I	/I	/ 2 /I,2,3/
56.	3,4/	*/ 2 /I	/I,2,3 /I	4 6/I	/I	/ 2,3/ */
57.	4/	*/ 2 /I	/ 3 /I	4 6/I	/I	/ 3/ */
58.	4/	*/ 2,3/I	/ 3 /I	4 6/I	/I	/ 3/ */
59.	3,4/	*/ 2 /I	/ 3 /I	4,5,6/I	/I	/ 3/ */
204.	2 /	*/ 2 / 2	/I,2 4/	4 6/	3/I	/ */I,2,3/
205.	3 /	3 / 2 / 2	/I,2 4/	4 6/I	/I	/ 2,3/ 2 /
206.	2,3 /	3 / 2 / 2	/I,2, 4/	4 /I	/I	/ 2,3/ 2 /
207.	3 /	3 / 2 / 2	/I,2 4/	4 6/I	/I	/ 2,3/I /
208.	3,4/	3 / 2 / 2	/ */	4 /I	/I	/ 2,3/ 2 /
209.	3 /	*/ 2 / 2	/I,2 4/	4 6/	3/I	/ */ 2,3/
210.	2,3 /	*/ 2 / 2	/I,2 4/	4 6/ 2	/I	/ */ 3/
211.	2 /	*/ 2 / 2	/I,2 4/	4 /I	/I	/ 2,3/ 2,3/
409.	I,2 /I	/I,2 /I,2	/I,2 4/I	4 6/I	/I	/ 2 /I /
410.	3 /	*/I /I,2	/ 2 4/I	4 /I	/I	/ 3/I /
411.	I,2,3 /I	/ 2,3/I,2	/I,2, 4/I	4 6/I	/I	/ 2 / 2 /
412.	I,2,3 /	*/I,2 /I,2	/ 2 4/I	4 /I	/I	/ 3/I /
413.	I,2 /	*/I /I,2	/ 2 4/I	4 6/I	/I	/ 2 /I /
414.	I,2 /	*/ 2 /I,2	/ 2 4/I	4 /I	/I	/ 2 /I /
415.	2,3 /	*/I /I,2	/I,2 4/I	4 6/I	/I	/ 2 /I /
416.	I,2 /	*/ 2 /I,2	/ 2 4/I	4 6/I	/I	/ 3/ 3/
417.	2 /	*/ 2 /I,2	/ 2 4/I	4 6/I	/I	/ 2 /I /
419.	I,2 /	*/ 2 /I,2	/I,2 4/I	4 6/I	/I	/ 3/ 3/
420.	I,2 /	*/ 2 /I,2	/ 2 4/I	4 6/I	/I	/ 2 /I /
421.	2,3 /	*/ 2 /I,2	/I,2 4/I	4 /I	/I	/ 2 /I /
422.	I /	*/ 2 /I,2	/ 2 4/I	4 6/I	/I	/ 3/ 3/
423.	I,2,3 /	*/I,2 /I,2	/I,2 4/I	4 6/I	/I	/ 2 /I /
425.	I,2 /	*/ 2 /I,2	/ 2 4/I	4 6/I	/I	/ 3/ 3/
426.	I,2 /	*/I /I,2	/I,2 4/I	4,5,6/I	/I	/ 2 /I /
427.	I,2,3 /	*/ 2 /I,2	/I,2 4/I	4 6/I	/I	/ 2 /I /
428.	I,2,3 /	*/I,2 /I,2	/ 2 4/I	4 6/I	/I	/ 3/ 3/

Group 9.

494.	3 /	*/ 2 / 3 /I	4/	5 /	3/I,2 /	*/ */
495.	3 /	*/ 2 / 3 /I	4/	*/	3/ 2 /	*/ */
496.	3 /	*/ 2 / 3 /I	4/	*/	3/ 2 /	*/ */
502.	4/	*/ 2 /I	/I,2,3 /	6/I	/ 2,3/	3/ 3/
503.	3 /I	4/ 2 /I	/ 2 4/	6/I	/I /	3/ 3/
513.	2,3 /	*/I / 3 /	*/I	/	3/I /	*/ 2 /
I66.	3 /	*/I /I	/ 2 4/	6/I	/I /	2 / */
I68.	3 /	*/ 3/I	/ */I	4 6/I	/I /	2,3/I /
I69.	3 /	3 /I /I	3 / 2 4/	4 6/I,2	/I /	*/ */
I70.	3 /	*/I /I	/ 2 4/I	5,6/I	/I /	3/ 3/
I71.	3 /	*/I /I	/ 2,3,4/I	4 6/I	/I /I	3/ 3/
I72.	3 /	3 /I / 3 /	2 4/I	4 6/	3/I /	*/ 3/
486.	3 /	*/I /I	/I 4/I	/I	/I /	2 /I /

3/I	/I,2	/I	/	2	/I	/	*/	2	/	2	/I	/
3/I	/I,2	/I	/	2	/I	/	*/I	/	2,3/I	/	/	/
3/	3/ 2	/I	/	2	/	3/	*/I	/	2,3/	*/	/	/
3/I	/I	/	3	/	2	/	3/	*/I	/	2	/I	/
3/I	/I	/	3	/	2	/	3/	*/I	/	2	/I	/
3/I	/I	/	3	/	3	/	3/I	/	*/	2	/I	/
3/I	/I	/	3	/	2	/	3/	*/I	/	2	/I	/
3/I	/I	/	*/	3	/	3/I	/	*/	2	/I	/	/
3/I	/I	/	*/	3	/	3/I	/	*/	2	/I	/	/
3/I	/I	/	*/	3	/	3/I	/	*/	2	/I	/	/
3/I	/I	/	*/	3	/	3/I	/	*/	2	/I	/	/
3/I	/I,2	/	*/	3	/	3/I	/	*/	2	/I	/	/
3/I	/I	/	*/	3	/	3/I	/	*/	2	/I	/	/
3/I	/I,2	/	*/	3	/	3/I	/	*/	2	/I	/	/
3/I	/I	/	*/	3	/	3/I	/	*/	2	/I	/	/
3/I	/	2	/I	/	2	/	3/	*/I	/	2	/I	/
3/I	/I,2	/I	/	2	/	3/	*/I	/	2	/I	/	/
3/I	/I,2	/I	/	2	/	3/	*/I	/	2	/I	/	/
3/I	/	2	/I	/	2	/	3/	*/I	/	2	/I	/
3/I	/I,2	/I	/	2	/	3/	*/I	/	2	/I	/	/
3/I	/I,2	/I	/	2	/	3/	*/I	/	2	/I	/	/
3/I	/	2	/I	/	2	/	3/	*/I	/	2	/I	/
3/I	/	2	/I	/	2	/	3/	*/I	/	2	/I	/
3/I	/I,2	/I	/	2	/	3/	*/I	/	2	/I	/	/
3/I	/	2	/I	/	2	/	3/	*/I	/	2	/I	/
3/I	/	2	/I	/	2	/	3/	*/I	/	2	/I	/
3/I	/I	/I	/	2	/	3/	*/I	/	2	/I	/	/
3/I	/	2	/I	/	2	/	3/	*/I	/	2	/I	/
3/I	/I,2	/I	/	2	/	3/	*/I	/	2	/I	/	/
3/I	/	2	/I	/	2	/	3/	*/I	/	2	/I	/
3/I	/I	/I	/	2	/	3/	*/I	/	2	/I	/	/
3/I	/	2	/I	/	2	/	3/	*/I	/	2,3/I	/	/
3/I	/I,2	/I	/	2	/	3/	*/I	/	2	/I	/	/

I,2,3/	2	/I	/I,2	5/	3	/I	/	2	/	*/I	/	*/
2	/	*/I	/I	/	3	/I	/	2	/	*/I	/	*/
3/	*/I	/	4	/	3	/I	/	2	/	*/I	/	*/
I	3/ 2	/I,2	/I,2	/	2	/	2	/	*/	3/ 2	/I	3,4
	3/I	/ 2	/I,2	/	2	/	2	/	*/	2	/	3,4
	*/	*/I	/ 2	/	3	/	2,3/	2	/	*/	*/	*/
	3/I	/	3	/I	/I	/	/	*/I	/	2	/	4
	3/	3/	3	/I,2	/I	/	3/	*/I	/	2	/	4
	3/I	/	3	/I	/I	/	3/	*/I	/	2	/	4
I	/I	/	3	/I,2	/I	/	3/	*/I	/	2	/	4
	3/I	/	3	/I	/I	/	3/	*/I	/	2	/	4
	3/I	/	3	/I	/I	/	3/	*/I	/	2	/	4
	3/ 2	/I	/I	/I,2	4/I	/	/	*/	3/ 2	/	3	/

429. 00000000010*0001000***11110000111100001000*11*00*11*0011011 9.0
430. 10001*000010*100100000000001010001101100001000011*00*11*10111* 10.0
431. 0000**01*0100000100000000001*000101000001100011*00*11*10011011 9.0
432. 00001*00100000100*0**01100001101100001000011*00*11*0001010 10.0
434. 00001*00001000001000000000111000111100001000*11*00*11*10001011 9.0
435. 00000100101000001000*0**001*000101100001000*11*00*11*00011* 9.0
436. 00000101*0100000100*00010001*000101100001000*11*00*11*00111* 9.0
437. 1000**01*01000001000***1111000011100001000*11*00*11*0011011 10.0
438. 10001*001010000010000100000101000110101*001000011*00*11110111* 10.0

Group 10.

106. 00001*0010101000011**0***11000001101000010100001*00*111001000* 6.0
107. 00000100101010000110*1***11000001101000010100001*00*110001000* 6.0
108. 0000010010101000111**0***11000001101000010100001*00*111001000* 6.0
109. 0000010010101000011**0***11000001101000010100001*00*111101000* 6.0
110. 0000010010101000011**0***11000001101000010100001*00*111001000* 6.0
111. 1000010010100000010**0***11000001101000010100001*00*110001000* 6.0
112. 0000000000100000010**0***1100000*101000010100001*00*111001000* 10.0
113. 00000101*010000010**1***11000001101000010100001*00*111001000* 6.0
114. 0000**00000100000010**0***11000001101000010100001*00*111001000* 6.0
115. 00001*00101010000100**0***11000001101000010100001*00*110001000* 6.0
116. 10001*01*010*0000100100000100000*101000010100001*00*111001000* 6.0
117. 00000000101000000100*0***11000001101000000100001*00*111001000* 6.0
118. 00001*0010100000010*0000001000001101000000100001*00*111001000* 6.0
119. 00001*00101000000100**0***11000001101000000100001*00*110101000* 6.0
120. 0000000010101000011*00000011000001101000000100001*00*111001000* 6.0
121. 0000000010100000010**0***11000001101000000100001*00*111001000* 6.0
122. 00001*0000*110000010**0***0100000*0010000010100001*00*110001000* 10.0
123. 00001*0000100000010**0***01000001101000010100001*00*111001000* 6.0
124. 0000000000100000010*0000001000001101000010100001*00*111101000* 6.0
125. 00000101*0101000010*1000011000001101000010100001*00*111001000* 6.0
126. 10101*0010101000010*0000101000001101000010100001*00*111001000* 6.0
127. 000000001*100000010**0***11000001101000010100001*00*111001000* 10.0
128. 0000000001010*000010**0***11000001101000010100001*00*111001000* 9.0
129. 00000000010*10000010**1***01000001101000010100001*00*111001000* 6.0
130. 0000**01*0100000010**0***01000001101000010100001*00*111001000* 6.0
131. 00001*0010*100000010*000100100000011000010100001*00*111001000* 6.0
132. 1000**01*010*000010*000000100000011000010100001*00*111001000* 6.0
133. 00001*01*0101000011*1001001000001101000010100001*00*111001000* 6.0
134. 0000010010100000011**0***01000001101000010100001*00*111001000* 7.0
135. 0000010010100000010**1***01000001101000010100001*00*111001000* 6.0
136. 00000101*0101000010**0***11000001101000010100001*00*110001000* 6.0
137. 100000001010*000010**0***11000001101000010100001*00*111001000* 9.0
221. 0000010010100000010**0***11010001111000000000000*111001100* 7.0

60. 10001*101010*000010*0001111010000111100*0*100*01*00*1110010010 8.0
78. 1000**01*0101*****1**0***1110000100110000000010*1*00*1110011011 9.0
511. 00001*00001000000100*0**01100000101100000000011*0111100001010 10.0
512. 00001*01*01010000100*0**01100001101100000000011*0111100101010 10.0

429.	3,4/	*/I	/I	/ 2	4/	4	6/I	/I	/	3/ 2	/
430.	3,4/I	/I	/I	/ 2	4/	4,5,6/I	/I	/	3/ 2	/	
431.	I 3 /	*/I	/I,2	/ 2	4/	4	6/I	/I	/	3/ 2	/
432.	I,2 /	*/I	/I,2	/ 2	4/	4	6/I	/I	/	3/ 2	/
434.	I,2,3 /	*/I	/I	/ 2	4/	4,5,6/I	/I	/	3/ 2	/	
435.	I,2 /	*/I	/I	/ 2	4/	4,5,6/I	/I	/	3/ 2	/	
436.	I 3 /	*/I	/I	/	*/	4	6/I	/I	/	2,3/ 2	/
437.	I,2,3 /	4/I	/I	4/	*/	4	6/I	/I	/	3/ 2	/
438.	I,2,3,4/I,2	/I	/I,2	/ 2	4/	4,5,6/I	/I	/	3/ 2	/	

Group IO.

Group 10.											
I06.	I,2	/	*/I	/I,2	/I	4/	4,5,6/	3/I	/	*/	*/
I07.	2	/	*/I	/I,2	/I	4/	4,5,6/	3/I	/	*/	*/
I08.	I,2	/	*/I	/I,2	/I	4/	4,5,6/	3/I	/	*/	*/
I09.	2	/	*/	*/I,2	/I	4/	4,5,6/	3/I	/	*/	*/
I10.	I,2	/	*/	*/I,2	/I	4/	4,5,6/	3/I	/	*/	*/
I11.	I,2	/I	/	2	/I,2	/I	4/	4,5,6/	3/I	3/	*/
I12.	2	/	*/I,2	/I,2	/I	4/	4,5,6/	3/	2	/	*/
I13.	I,2	/	*/I,2	/I,2	/I	4/	4,5,6/	3/I	/	*/	*/
I14.	I,2	/	*/	2	/I,2	/I	4/	4,5,6/	3/	3/	*/
I15.	I,2,3	/	*/I	/I,2	/I	4/	4,5,6/	3/I	3/	*/	*/
I16.	3	/	4/I	/I,2	/I	4/	4,5,6/	3/	2	/	*/
I17.	2	/	*/I	/I,2	/I	4/	4,5,6/	3/I	3/	*/	*/
I18.	I,2,3	/	*/I	/I,2	/I	4/	4,5,6/	3/I,2,3/		*/	*/
I19.	I,2,3	/	*/I	/I,2	/I	4/	4,5,6/	3/I,2,3/		*/	*/
I20.	I,2,3	/	*/I	/I,2	/I	4/	4,5,6/	3/	3/	*/	*/
I21.	I,2,3	/	*/I	/I,2	/I	4/	4,5,6/	3/I	/	*/	*/
I22.	2	/	*/I	/I,2	/I	4/	4,5,6/	3/	2	/	*/
I23.	I,2	/	*/I	/I,2	/I	4/	4,5,6/	3/	3/	*/	*/
I24.	I,2,3	/	*/I	/I,2	/I	4/	4,5,6/	3/I	/	*/	*/
I25.	2,3	/	*/I	/I,2	/I	4/	4,5,6/	3/	3/	*/	*/
I26.	I,2,3,4/		3,4/I	/I,2	/I	4/	4,5,6/	3/I,2,3/		*/	*/
I27.	I,2,3	/	*/I	/I,2	/I	4/	4,5,6/	3/	3/	*/	*/
I28.	3	/	*/I	/I,2	/I	4/	4,5,6/	3/	3/	*/	*/
I29.	I,2	/	*/I,2	/I,2	/I	4/	4,5,6/	3/I	/	*/	*/
I30.	2,3	/	*/I,2	/I,2	/I	4/	4,5,6/	3/I	/	*/	*/
I31.	2,3	/	*/	2	/I,2	/I	4/	4,5,6/	3/I	/	*/
I32.	3	/	4/I	/I,2	/I	4/	4,5,6/	3/I	/	*/	*/
I33.	I,2,3	/	*/I	/I,2	/I	4/	4,5,6/	3/I	/	*/	*/
I34.	I,2	/	*/I	/I,2	/I	4/	4,5,6/	3/I,2	/	*/	*/
I35.	I,2	/	*/I	/I,2	/I	4/	4,5,6/	3/I	/	*/	*/
I36.	2	/	*/	*/I,2	/I	4/	4,5,6/	3/I	3/	*/	*/
I37.	3	/	2	/I	/I,2	/I	4/	4,5,6/	3/	3/	*/
22I.	I,2	/	*/	2	/	4/	2	4/	4,5,6/I	/I	/
60.	3	/I	3	/	2	/I	/	2,3	/I	/	3/
78.	2	/I		/	*/	*/	*/	*/	2,3/I	/	*/
5I1.	2	/	*/I,2,3/I		/I	4/	4	6/I	/I	/	2
5I2.	2	/	*/	*/I	/I	4/	4	6/I	/I	/	3/I

3/I,2	/I,2	/	*/	2	/	3/	*/I	/	2,3/	4	/	
3/	2	/I	/	*/	2	/	3/	*/I	/	2,3/	4	/
3/	2	/I	/	*/	2	/	3/	*/I	/	2,3/	4	/
3/I	/I	/	*/	2	/	3/	*/I	/	2,3/	4	/	
3/	2	/I	/	*/	2	/	3/	*/I	/	2,3/	4	/
3/	2	/I	/	*/	2	/	3/	*/I	/	2,3/	4	/
3/	2	/I	/	*/	2	/	3/	*/I	/	2,3/	4	/
3/	2	/I	/	*/	2	/	3/	*/I	/	2,3/	4	/
3/	2	/I,2	/	*/	2	/	3/	*/I	/	2,3/	4	/
3/	2	/I	/	*/	2	/	3/	*/I	/	2,3/	4	/

3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/	2	/I	/I	3	/	3	/I	/	2	/	*/	2	/	2	/
3/I	/	2	/I	/	2	/	2	/	*/	2	/	2	/I	/	/
3/I	/I	/	3	/	2	/	3/	*/I	/	2	/I	/	/	/	/
3/	2	/I	/	*/	2	/	3/	*/I	/	2	/	4	/	/	/
3/	3/I	/I,2	/	3	/	3/	4/	*/	2,3/	3	/	/	/	/	/
3/I	/I	/I,2	/	3	/	3/	4/	*/	2,3/	3	/	/	/	/	/

459.	ooooolllolloloolooloo**o***olooooooloolloooooooool*oo*llloolloll	2.0
460.	oooo**lololooooooooo**o***olooooooloolloooooooool*oo*llloolloll	2.0
461.	ooooo*oooooooooolooloo*l***olooooooloolloooooooool*oo*lllololloll	2.0
462.	ooooolllollolooooooooo**o***olooooooloolloooooooool*oo*llloolloll	2.0
463.	oooo**lololooooooooo**o***llooooooloolloooooooool*oo*llloolloll	2.0
464.	ooooooooolo*llloollol*o***olooooooloolloooooooool*oo*llloolloll	2.0
465.	ooooo*oolloooooooooool*l***olooooooloolloooooooool*oo*llloolloll	2.0
466.	ooooolllollolooooooooo**o***olooooooloolloooooooool*oo*llloolloll	2.0
467.	ooooolllollolooooooooool*l***olooooooloolloooooooool*oo*llloolloll	2.0
468.	ooooolllollolooooooooo**o***olooooooloolloooooooool*oo*llloolloll	2.0
469.	oooo**lololooooooooo**o***olooooooloolloooooooool*oo*llloolloll	2.0
470.	ooooooloolooloolooloo**o***olooooooloolloooooooool*oo*llloolloll	2.0
471.	oooo**oolo*lloooooool*o***olooooooloolloooooooool*oo*llloolloll	2.0

Group II.

54.	100000100010*000010*000111111000111100*0*100*01*00*1110010010	8.0
55.	1000**100010*000010*000111111000111100*0*100*01*00*1110010010	8.0
I67.	000000000010*****0*00001010000100111*0010100*1*00*1110001011	10.0
2I4.	1000001*0*1*00001000001010001*001100*01000111*10*01*00011**	8.0
329.	1001*11*0*10000101110001111*1000101001000110100*010000100*	*
33I.	000010011001000010**0***0111010100110100100011010*010000100*	*
537.	00000111*0*111000100*0***0111000101010000100001*0110100101010	2.0
540.	00000101*0001000010000001010001110110**0*000111*00*1110001010	10.0

459.	2	/	*/I	/I	/I	/I	5	/	3/I	/	*/	*/
460.	I	/	*/I	/I	/I	/I	5	/	3/I	3/	*/	*/
461.	I,2	/	*/I	/I	/I	4/I	5	/	3/I	/	*/	*/
462.	I,2	/	*/I	/I	/I	4/I	5	/	3/I	3/	*/	*/
463.	I	/	*/I	/I	/I	4/I	5	/	3/I	/	*/	*/
464.	2	/	*/I	/	3	/I	4/I	5	/	3/I	/	*/
465.	I,2	/	*/I	/	3	/I	/I	5	/	3/I,2	/	*/
466.	2	/	*/I	/I	/I	/I	5	/	3/I	/	*/	*/
467.	2	/	*/I	/I	/I	3	/I	5	/	3/I	3/	*/
468.	2	/	*/I	/I	/I	4/I	5,6/	3/I	/	*/	*/	*/
469.	I,2	/	*/I	/I	/I	/I	5	/	3/I	/	*/	*/
470.	2	/	*/I	/I	/I	4/I	5	/	3/I,2	/	*/	*/
471.	2	/	*/I	/I	/I	/I	5	/	3/I	/	*/	*/

Group II.

54.	3	/	2	/	2	/I	3	/	3	/I	4,5,6/I	/I	/	3/	*/
55.	3	/	2	/	2	/I	/	3	/I	4	6/I	/I	/	3/	*/
167.	3	/	*/I	/	*/	*/	*/	*/	*/	*/	*/	/I	/	3/	*/
214.	3	/I	/I	/	*/	*/	5	/I	/	2	/	3/I	/	3/I	/
329.	2,3	/I,2	/	2	/I	/I	3	/I	3	/I	/I	/I	/I	/	2
331.	I,2	/	*/I	/I	/I	3	/I	3	/I	3	/I	/I	/I	/I	/
537.	I,2	/	*/I	/	3	/I	3	/	4	6/I	/I	/I	/I	/I	/
540.	I,2,3	/	*/I	/	2	4/I	4/	4	6/I	/I	3/	3/I	/	3/I	/

I	/	2	/I	/I	5/	2	/I	/	*/	3/	2	/	4	/
I	/	2	/I	/I	5/	2	/I	/	*/	3/	2	/	4	/
I	/	2	/I	/I	5/	2	/I	/	*/	3/	2	/	4	/
I	/	2	/I	/I	5/	2	/I	/	*/	3/	2	/	4	/
I	/	2	/I	/I	5/	2	/I	/	*/	3/	2	/	4	/
I	/I		/I	/I	5/	2	/I	/	*/	3/	2	/	4	/
I	/I,2		/I	/I	5/	2	/I	/	*/	3/	2	/	4	/
I	/	2	/I	/I	5/	2	/I	/	*/	3/	2	/	4	/
I	/	2	/I	/I	5/	2	/I	/	*/	3/	2	/	4	/
I	/	2	/I	/I	5/	2	/I	/	*/	3/	2	/	4	/
I	/	2	/I	/I	5/	2	/I	/	*/	3/	2	/	4	/
I	/	2	/I	/I	5/	2	/I	/	*/	3/	2	/	4	/
I	/I		/I	/I	5/	2	/I	/	*/	3/	2	/	4	/
I	/I		/I	/I	5/	2	/I	/	*/	3/	2	/	4	/

	3/I	/I	/	3	/	2	/	3/	*/I	/	2	/I	/	
	3/I	/I	/	3	/	2	/	3/	*/I	/	2	/I	/	
I	/I	/	3	/I	/I		/	3/	*/I	/	2	/	4	/
I,2	/	2	/I	/I	5/	3	/	2	/	3	/	*/	2	/
	*/	*/	4/	4	/I		/I	/	3	/	*/	2	/I	/
I	/I	/	4/	4	/I		/I	/	2	/	*/	2	/I	/
I	/	3/	3	/I	5/I		/I,2,3/		*/I	/	2	/	2	/
	3/I	/I	/I	5/	2		/I,2,3/		*/I	/	2,3/I		/	/

Appendix 3. Comparative observations recorded for 543 genera of Dicotyledons as coded for analyses under INFO and ASOC. The serial numbers refer to the genera in Appendix 1. They are grouped at the 1,000 (26 group) level for INFO as shown in Diagrams II and III. Description of the characters is given in Table 3. The first state is scored as 1 the second as 0.

Group I.

1. 11101001001000101110001100110111001001011110001100100000010100000010110001100010001
2. 01110011000000011001100001100110111001001010111100010010000110100000010110001100001001
3. 011100100000000100011100011011101110010011101111000100000000010100000010110001100001001
4. 0011101000000001000110001101110111001001010111000100100000010100000010110001100001001
5. 0111101100000001000110001111110111001001000111000100000000010100000010110001100001001
6. 00111010000000010001100011011101110010010101110001001000011010000001011000110001001
7. 0111001000000001100110001111110111000110101111000100000000010001100010111001100001001
8. 0111001100000001000110001101110111000111001111000100000000010100000010110001100001001
54. 11010110000101000011010011111100010010011001111000100010001010010010010100111100001001
55. 110101100001000000110100111111000100100110011110001000010001010010010010100111100001001
56. 0101011010010000001100001101110001001001100101100010000110001010010001010011110000001
57. 01010111000010000011000011011100010010011001111000100001000101001000101001110000001
58. 0100000000010000001100001101110001001001100111100010000100010010110000010011100000101
59. 0101011101001000001100001101110001001001100111100010000100010100100010100111000001001
60. 1101110100001000001101001101110001001001100111100010000100010100100010100111000001001
533. 1100101000001000100110000110101000100100110010110001000010000101011000010100011101001110
217. 0010100100001100000110000110111010100100101011110001000000000110100010000100111100001001
218. 001000110000110000011000011011101010010010101111000100000000011010001000010011110000110
219. 0011100100001101000110000110111010100100101011110001000000000110100010000100111101001100
220. 0111001000000001000110000110111010100100101011110001000000000110100010000100111100001100
221. 0010100100000001000110100011011101010010010101111000100000000110100010000100111100001100
222. 0111000100000001000110000110111010100100101011110001000000000110100010000100111100001100
223. 0111000100000001000110000110111010100100101011110001000000000110100010000100111100001100
224. 0111000100000001000110000110111010100100101011110001000000000110100010000100111100001100
225. 01010100000110000011000111011010100100101011110001000000000110100010000100111100001100
226. 0111101000000001000110000110111010100100101011110001000000000110100010000100111100001100
227. 0111101100000001000110000110111010100100101011110001000000000110100010000100111100001100
228. 1011100100000001000110000110111010100100101011110001000000000110100010000100111100001100
229. 0011101100000001000110000110111010100100101011110001000000000110100010000100111100001100
230. 0111101100001100000110000110111010100100101011110001000000000110100010000100111100001001
231. 0101010000000001000110000110111010100100101011110001000000000110100010000100111100001100
472. 010110010000100000110000110111000100100110110001000000000010100000010110011110000101
473. 010010110000100000110000110111000100100110111100010000000001010000010110011110000101
474. 110110110000100000110000110011000100100110111100010000000001010000100010011110000101
475. 11011010000010000011000011011100010010011011110001000000000101000000010110011110000101

476. o111oool1oooooool1oooo1lool1looollool1lo1111loool1oooooool1lo1oooo1oooo1lool1111oooo1lool
 477. 1lo1lool1oooooool1oooo1loool1lool1lool1lool1lo1111loool1lool1loool1lo1oooo1oooo1lool1111oooo1lool
 478. ool1lool1oooo1oooooool1oooo1lool1lool1lool1lo1111loool1oooooool1lo1oooo1oooo1lool1111oooo1lool
 479. o111lool1oooo1oooooool1oooo1lool1lool1lool1lo1111loool1lool1loool1lo1oooo1oooo1lool1111oooo1lool
 480. 1lo1111lo1lool1oooo1loool1lo11lool1lool1lo1111loool1oooooool1lo1oooooool1lo1lool1111oooo1lool
 418. o111lool1oooo1lo1lool1loool1lool1lool1lool1lo1111loool1lool1loool1lo1oooooool1lo1oooooool1lo1lool1111oooo1lool
 424. o1o1lool1loool1lo1lool1loool1lool1lool1lool1lo1111loool1lool1loool1lo1oooooool1lo1oooooool1lo1lool1111oooo1lool

Group 2.

204. ool1oool1oooo1oooooool1oooo1111lo1lo11lool1lool1lool1loool1oooooool1lool1lo1oooo1lool1111oooo1lool
 205. 1lo1lool1oooooool1lool1loool1lo11lool1lool1lool1lo1111loool1oooooool1lool1lo1oooo1lool1111oooo1lool
 206. 1111lool1oooooool1oooooool1lool1lool1lool1lool1lool1loool1oooooool1lool1lo1oooo1lool1111oooo1lool
 207. 1lo1lool1oooooool1lool1loool11111lo1lool1lool1lool1loool1oooooool1lool1lo1oooo1lool1111oooo1lool
 208. 1loool1loool1loool1loool1lool1lool1lool1lool1lool1loool1oooooool1lool1lo1oooo1lool1111oooo1lool
 209. o1o1lo1lo1lool1loool1loool1111lool1lool1lool1lool1loool1oooooool1lool1lo1oooo1lool1111oooo1lool
 210. o1111lool1oooooool1oooo1lool1lool1lool1lool1lool1loool1oooooool1lool1lo1oooo1lool1111oooo1lool
 211. ool1lool1lool1lool1lool1lool1lool1lool1lool1lool1loool1oooooool1lool1lo1oooo1lool1111oooo1lool
 409. 1o1lool1oooooool1oooooool1loool1lool1lo1lo1lool1lool1lool1lool1lool1loool1oooooool1lool1lool1lool1lool1lool1lool
 410. o1oooo1lool1loool1loool1loool1lool1lool1lool1lool1lo1111loool1oooooool1lool1lool1lool1lool1lool1lool
 411. 11111lo1lool1loool1loool1loool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 412. o1lo1lo1loool1loool1loool1loool1lool1lo1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 413. ool1oool1lool1111loool1loool1lool1lo1lool1lool1lool1lo1111loool1oooooool1lool1lool1lool1lool1lool1lool
 414. ool1oooo1loool1loool1loool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 415. o1lo1lo1lool1111loool1loool1lool1lo1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 416. ool1oooo1lool1loool1loool1loool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 417. ool1o1lo1loool1loool1loool1loool1lool1lo1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 419. ool11lool1lool1loool1loool1loool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 420. ool1lool1loool1loool1loool1loool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 421. o1111lo1lool1loool1loool1loool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 422. ool1oooo1loool1loool1loool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 423. o1lo1lool1loool1loool1loool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 425. ool1lool1loool1loool1loool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 426. ool1o1lo1lool1111loool1loool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 427. o1111lool1lool1loool1loool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool
 428. o1loool1loool1loool1loool1loool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool1lool

Group 3.

I06. 0011100100111100001101110010001001011101000100010001000100011101001000
I07. 00101001001111000011011111001000100010110010100010001010001000100010010010001000
I08. 0010100100111100001111110010001000101100101000100010100010001000100010011101001000
I09. 001010010010110000110110110010001000101100101000100010100010001000100010011101001000
I10. 00101001001011000011011011001000100010110010100010001010001010001000100010011101001000
I11. 1010100100011000011010011000000100010110010100010001010001000100010001000100110010001000
I12. 00110100001100001101001100000010001011001010001000101000100010001000100010011101001000
I13. 00101011010011000011010111001000100010110010100010001010001010001000100010011101001000
I14. 00101010000110000110101100000010001011001010001000101000100010001000100010011101001000
I15. 0111100100111100001101001100000010001011001010001000101000100010001000100110010001000
I16. 11011011001110000110100100000010001011001010001000101000100010001000100010011101001000
I17. 0011001000111000011010011000000100010110010100010001000100010001000100010011101001000
I18. 011110010011100001101001000000100010110010100010001000100010001000100010011101001000
I19. 01111001001110000110100110000001000101100101000100010001000100010001000100110010001000
I20. 0111001001111000011011011000000100010110010100010001000100010001000100010011101001000
I21. 0111001000111000011010011001000100010110010100010001000100010001000100010011101001000
I22. 0011101001111000011010010000001000101100101000100010001000100010001000100110010001000
I23. 001110100011100001101001000000100010110010100010001000100010001000100010011101001000
I24. 0111001001111000011010010001000100010110010100010001000100010001000100010011101001000
I25. 0110101001111000011010011000000100010110010100010001000100010001000100010011101001000
I26. 11111001001111000011010011000000100010110010100010001000100010001000100010011101001000
I27. 0111001100111000011010011000000100010110010100010001000100010001000100010011101001000
I28. 0101001000111000011010011000000100010110010100010001000100010001000100010011101001000
I29. 00110010100110000110101010001000100010110010100010001000100010001000100010011101001000
I30. 011001100011000011010010001000100010110010100010001000100010001000100010011101001000
I31. 01111001010110000110100100010001000101100101000100010001000100010001000100110010001000
I32. 110001100011000011010010001000100010110010100010001000100010001000100010011101001000
I33. 01111011001110000110110010001000100010110010100010001000100010001000100010011101001000
I34. 0010100100111000011011001000000100010110010100010001000100010001000100010011101001000
I35. 00101001001110000110101010001000100010110010100010001000100010001000100010011101001000
I36. 001010110010110000110100110000001000101100101000100010001000100010001000100110010001000
I37. 1101001000111000011010011000000100010110010100010001000100010001000100010011101001000

Group 4.

33. ololoolooooollolooooollllooloollllloololooooollloololllooooooolloooooololoolloooooollloollloooloolool
34. llolooloooooololoolllllooloollllloololooooollloololllooooooolloooooololoolloooooollloollloooloollo
35. llolloloooooololooooollllooloolollloololooooollloololllooooooolloooooololoolloooooollloollloooloollo
36. llolooloooooololooooollllooloololllloololooooollloololllooooooolloooooololoolloooooollloollloooloollo
37. lloloolooooooloooooolllllooloololllloololooooollloololllooooooolloooooololoolloooooollloollloooloollo
38. ololooloooooololooooollllooloololllloololooooollloololllooooooolloooooololoolloooooollloollloooloolllo
39. lloloolooooooloooooolllllooloololllloololooooollloololllooooooolloooooololoolloooooollloollloooloollo
40. ololoolooooooloooooolllllooloololllloololooooollloololllooooooolloooooololoolloooooollloolllooololllll
46. lolololooooooloooooollloloololllloololooooolllooloooooololoollooollooololoolloooooollloollloooloollo
47. oolooooooloooooolloooooolllooloololllloololooooolllooloooooololoollooollooololoolloooooollloolllooollo
48. lllllooloooooolloooooolllooloolllllloololooooolllooloooooololoollooollooololoolloooooollloolllooollo
49. llolloloooooolloooooolllooloololllloololooooolllooloooooololoollooollooololoolloooooollloolllooollo
50. llolooloooooolloooloollooloololllloololooooolllooloooooololoollooolloolllooolloooooollloolllooollo
51. llllloolooooooloooooollooloololllloololooooolllooloooooololoollooollooololoolloooooollloolllooollo
52. lloloolooooooloooooollooloololllloololooooolllooloooooollooollooollooololoolloooooollloolllooollo
53. oolooooooloooooolloooooolllooloololllloololooooolllooloooooololoollooollooololoolloooooollloolllooollo
3I6. llolloloooooolloooooolllooloololllloololooooolllooloooooolloolllooollooollooolloooooollloolllooollo
3I7. llolloloooooolloooooolllooloololllloololooooollloololoooooolloolllooollooollooolloooooollloolllooollo
3I8. llolloloooooolloooooolllooloololllloololooooollloololoooooolloolllooollooollooolloooooollloolllooollo

Group 5.

6I. oollloolllooollooooooolloooooolollloololoollooollooollooollooooooololoolloooooolllooollooooooollooo
62. oolololooooolllooooooolloooooolollloololoollooollooollooollooooooololoolloooooolllooollooooooollooo
63. ollloolooooolllooooooolloooooolollloololoollooollooollooollooooooololoolloooooolllooollooooooollooo
64. oolololooooolllooooooolloooooolollloololoollooollooollooollooooooololoolloooooolllooollooooooollooo
65. ollloolooooolllooooooolloooooolollloololoollooollooollooollooooooololoolloooooolllooollooooooollooo
66. ollllollooollooooooolloooooolollloololoollooollooollooollooooooololoolloooooolllooollooooooollooo
67. oololoolooooolllooooooolloooooolollloololoollooollooollooollooooooololoolloooooolllooollooooooollooo
68. lloloolooooolllooooooolloooooolollloololoollooollooollooollooooooololoolloooooolllooollooooooollllo
404. olollolooooollloooooolllooollooollllloololoollooollooollooollooooooollooooooololoollooooooollooo
405. ololoolooooolllooollooollooolloollloololoollooollooollooollooooooollooooooololoollooooooollooo
406. ololoolooooollloooooolllooollooollllloolllooollooollooollooollooooooollooooooololoollooooooollooo
407. ololoolooooollloooooolllooollooollllloolllooollooollooollooollooooooollooooooololoollooooooollooo
408. ololoolooooollloooooolllooollooollllloololoollooollooollooollooooooollooooooololoollooooooollooo

Group IO.

82. 001110100100100100001010001111111000010111000011000100000000001001010001000110000001001101
83. 001100100000100100001010001011111000010111000011000100000000001001010001000110000001000101
84. 001100100000000100001010001111111000001110000110001000000000001001010001000110000001001101
85. 00101010100010000000101000111111100001011100001100010000000000101001010001000110000001000101
86. 001100100000000110001010001111111000001110000110001000000000001001010001000110000001000101
88. 001010100010000100011010001111111000001110000110001000000000001001010001000110000001001101
89. 001010101000000100011010001011111001010011000011000100000000001001010001000110000001000101
90. 00101010000010010000101000111111100001001100001100010000000000101001010001000110000001001101
497. 01010010000111000000100010101001010000111001011000110000000011001010001001110110100000110
498. 010100110001110000001000101000001010010011001011000110000000011001010001001110110100000110
499. 010100100001110000001000101001001000011011001011000110000000011001010001001110110100000110
511. 001110100000100000011010001101101010000111001011000110000000011001010001001111110001000101
512. 001110110010100000011010001101101010010011001011000110000000011001010001001111110001010101

Group II.

I38. 11110010010100101001010000101111101000101100101100010000000011101000010000101000000001110
I39. 11101001010100101001110100010111101000101100111100010000000001101000010000101000010001101
I40. 11000010000101101001110000101111101000101100101100010000000001100101110001001000000001110
I41. 01110010000101101001110000101111101000101100101100010000000001101000010000010010000001101
I42. 0111001001010010100111010001011110100010110010110001000000000100100001000001000000001100
I43. 111010010101001010011101001111111010001011001111000100000000111010000100001010000001001101
I44. 11110011010100101001110000111111101000101100111100010000000001101000010000101000000001101
504. 001110010000010000001100001100101000000101000011000100000000011100010000101011000100001001
505. 001110010011010000001100001100101000000101000011000100000000011100010000101011000100001001
522. 0100100101001000101110110010010010100110000110001001010000110100001001000100001000010001001
535. 0010100111110100000010010000101111000010011000001000000001100000000101110000100001001
540. 011010110111010000110100010010010100100001001100010010000011101001000010110011110000101
482. 0111101000100100100000001110101000010011000011000100001000010010011000000011001001000101
483. 00110011001001001000000001110001000010011001011000100001000010010011000000011001001000101
514. 0010100101101000000110100010001010010100011000010000100001100101100000011001000101101
515. 00111001011110000001101000110010100001001110011000010000100101000010001100100101101
520. 0111100111110110000010000111111110000011110000110001000110000110001110000010110000100101
521. 011111011001000000010000011111110000011110000110001001010000111000100001010100000101101
537. 0010101101110010100110100011111110000011100010100010010100000110001000010001101001000101

489. o1111o11loolol111o11looloooolol111111looooolol1looloooolool1loolololooool11lo1111loooloooolololooooloolol
542. o11lool1lool1111looooololololooool1111looooolooool1loolol1loooloooolooooloololoooolooooloooolooooloolol

Group I2.

I45. ool1lool1lool1olooooloololoooolool111loool1looolooool11loool1loooooloooolololool1loooool1111loool1looooolool
I46. ool1lool1lool1olooooloololoooolool111loool1looolooool11loool1loooooloooolololool1loooool1111loool1looooolool
I47. o11looolool1olooooloololoooolool111loool1looolooool11loool1loooooloooolololool1loooool1111loool1looooolool
I48. ool1loooloolololooooloololoooolool111loool1looolooool11loool1loooooloooolololool1loooool1111loool1looooolool
I49. oololol11ol11olooooloololoooolool111loool1looolooool11loool1loooooloooolololool1loooool1111loool1looooolool
I50. o111loooloolololooooloololoooolool111loool1looolooool11loool1loooooloooolololool1loooool1111loool1looooolool
I51. ool1lool1lool1olooooloololoooolool111loool1looolooool11loool1loooooloooolololool1loooool1111loool1looooolool
I52. ool1loooloolololooooloololoooolool111loool1looolooool11loool1loooooloooolololool1loooool1111loool1looooolool
I53. o11lool1looolololooooloololoooolool111loool1looolooool11loool1loooooloooolololool1loooool1111loool1looooolool
I54. oolooool1looolololooooloololoooolool111loool1looolooool11loool1loooooloooolololool1loooool1111loool1looooolool
I55. ool11ol1looolololooooloololoooolool111loool1looolooool11loool1loooooloooolololool1loooool1111loool1looooolool
I56. o11lool1lool1olooooloolololoooolool111loool1looolooool11loool1loooooloooolololool1loooool1111loool1looooolool
I57. o11loooloooolololooooloololoooolool111loool1looolooool11loool1loooooloooolololool1loooool1111loool1looooolool

Group I3.

69. 11looooolooooloolooooloololooooloolololooool1looooolool1loool1looooolooooloolol1loooooloololoooolooooloolol
70. o11looooolooooloolooooloololooooloolololooool1looooolool1loool1loooooloololol1loooooloololoooolooooloolol
71. o11looooolooooloolooooloololooooloolololooool1looooolool1loool1loooooloololol1loooooloololoooolooooloolol
72. ollooooolooooloolooooloololooooloolololooool1looooolool1loool1loooooloololol1loooooloololoooolooooloolol
73. 11oolololooooloolooooloololooooloolololooool1looooolool1loool1loooooloololol1loooooloololoooolooooloolol
74. 11looooolooooloolooooloololooooloolololooool1looooolool1loool1loooooloololol1loooooloololoooolooooloolol
307. ololoollooooolloooooloolloool1looololoolololoooollooooolool1looolool11loool1loooloolloooooloollooollooooollooo
308. ololoollooooolloooooloolloool1looololoolololoooollooolool1looolool11loool1loooloollooollooollooollooolloool
309. ololoollooooolloooooloollooololololololoololoollooollooolool11loool1loooloollooollooollooollooollooolloool
310. ololoollooollooolloooooloolloool1looololoolololoooollooollooollooolloool11loool111ol1looolloool1looollooolloool
311. 11oloollooooollooollooollooololololololoollooollooollooolloool1loool1loool1looolloool1looollooollooolloool
312. ololoollooooolloooooloollooololololololoollooollooollooolloool1loool1loool1looollooollooollooollooollooolloool
313. ololoollooooollooollooollooololololololoollooollooollooolloool1loool1loool1looollooollooollooollooollooolloool
314. ololoollooooolloooooloolloool111oloollooollooollooollooollooolloool1loool1looollooollooollooollooollooolloool
315. ololoollooooolloooooloolloool1looollooollooollooollooollooolloool1looolloool1looollooollooollooollooollooolloool

Group I4.

267. 110010100000100000100000100110100001001100000100000011000011000100000100010000000101010
 268. 11010010100000101000100000100110100001001100000000000011000100000100010000000101000
 269. 01010011100000100000100000101101000010011000101000000011000111000100000100010000000101010
 270. 110100111000001010001000001001101000010011000101000000001000111000100000100011000000101000
 484. 0100001010010010001110000010011010000011101001100000001100011000100000101010000010000000
 485. 0100001010010010001110000010011010000011101001100000001100011000100000101010000010000000
 501. 0101000110010010101010000010011110001100100100111000100000001110010000010101101000001010

Group I5.

481. 11010010100110000110100000110111110001001001001100000001000011011111000010110000100000010
 531. 0101110100011000100010101010111110011000100001100010001100001000101010001001100010000010
 527. 010110100100101100101000101111000110000010001000001000001010000100001000010011000110001101
 534. 0101001110011000010010101011011110000100100010100010100010100011000010111000100010110
 536. 01010010000100100000110010100100010100000010000010001011000010001000100010000000010111
 543. 010100110001001010000000011110000011000101001100000100111001010001100010010001000000010
 487. 01010010000001001101000001011010000100000100010110100010000100010000010010001000101010011110
 488. 01010010000001011001000001111011000010000010001111010001000011110100010001001010100001110
 528. 00110011010110000001101100010010000010000101011100000101100000010001100010001010011111
 538. 001010010101100000010110001011110001100000100110000100010001000100010001000100010011111
 529. 111110110101100011000100011100010100000101000001000100010001110001000010100010001000101
 530. 11110011111100001101101011101000010100000100000100010001000100011100010000101000100010001
 490. 01010010010100101010100001000100010000000100110100010001000100000100001000011000100001010
 491. 010100100101001011101000010100010000000100110100010011000100010000010000100001100000001010
 492. 0101001001010010111010000101000100000001001100010011000100010000010000100001100010001010
 493. 010100100101001011101000010100010000000100110100010011000100010000010000100001100010001010
 I88. 010100011001001001000101000100000100010001001101000001000011000101100000101100000001110
 I89. 01010011100100100100010110101000001101000101001110000110001011000001011000000011101
 I90. 0101000110010010000010000010110100010001001101010001000011000101100000001100000001110
 I91. 01010001100100100000100000101010101000010001001101010001000011000101100000001100000001101
 I92. 0101001110010100000010000101101100001001101001101000100000110001011000001001100000000110
 I93. 0101001110010110000010000101101100001000010011010000010000110001011000001011000000010101
 I94. 01010011110100100000100001101111000110100010011010000011000011000101100000001110
 I95. 01010001100100100100000100011000100001000110101000101000011000101100000101100000001110
 525. 010010111001001001000001000001000001000001000110001100010000110001011000001000000010001001

Group I6.

26. 0101101000010010101010000010111010010100001001101000101101001010000010000010001100011110
27. 11010010000100100010100000110111010010100001001101000101100001010000010000010001100001110
28. 1101001000010010001010000011011101001100000100110100010110000101000001000100100011000110
29. 01010010000100100010100000110111010011000001001101000101100001010000010001001000110000110
30. 1101001000010010001010000010111010010100001001101000101101001110000100001001000110000110
31. 1101001000010010001010000010111010011000001001101000101100001010001100001001000110000110
32. 010100100001001000101000001101110100101000010011010001011000010100011000000001000110000110

Group I7.

I58. lololoololollllooolllllloolllooollooolloollloollloolllooolloollloolllooollooollooollo
I59. lololoololollllooolllllloolllooollooolloollloollloolllooolloollloolllooollooollooollo
I60. lololoololollllooollllllooollooollooolloollloollloolllooolloollloolllooollooollooollo
I61. lololoololollllooollllllooollooollooolloollloollloolllooolloollloolllooollooollooollo
I62. lololoololollllooollllllooollooollooolloollloollloolllooolloollloolllooollooollooollo
I63. llooolololollllooollllllooollooollooolloollloollloolllooolloollloolllooollooollooollo
I64. lololoololollllooollllllooollooollooolloollloollloolllooolloollloolllooollooollooollo
I65. lololoololollllooollllllooollooollooolloollloollloolllooolloollloolllooollooollooollo
296. lllllooolollllooolloollloolllooollooolloollloolllooollooolloolllooollooollooollooollo
297. lllllooolollllooolloollloolllooollooolloollloolllooollooolloolllooollooollooollooollo
298. lllllooolollllooolloollloolllooollooolloollloolllooollooolloolllooollooollooollooollo
299. lllllooolollllooolloollloolllooollooolloollloolllooollooolloolllooollooollooollooollo
300. lllllooolollllooolloollloolllooollooolloollloolllooollooolloolllooollooollooollooollo
326. lololoololollllooolloollloolllooolloollloolllooolloollloolllooollooollooollooollooollo
327. oololoolollllooolloollloolllooolloollloolllooollooolloolllooollooollooollooollooollooollo
328. oololololollllooolloollloolllooolloollloolllooollooolloolllooollooollooollooollooollooollo
329. lllllllllooollooolloollloolllooollooolloolllooollooollooollooollooollooollooollooollooollooollo
330. oololoolollllooolloollloolllooolloollloolllooollooolloolllooollooollooollooollooollooollooollooollo
331. oololoollllllllooolloollloolllooolloollloolllooollooollooollooollooollooollooollooollooollooollooollo
332. oololololollllooolloollloolllooolloollloolllooollooollooollooollooollooollooollooollooollooollooollo
333. oololoololollllooolloollloolllooolloollloolllooollooollooollooollooollooollooollooollooollooollooollo

Group 18.

301. o1o1oo1111oo11ooo1o111oo1o1o1oooo1oo11ooo11ooo1ooo11oo1ooo1ooo11ooo1ooo1ooo
302. o1o1oo1o1oo11ooo1oo11oo1o1o1oooo1oo1ooo1oo11ooo11ooo1ooo11oo1ooo1ooo11ooo1ooo1oo

303. 01110010110111000011001001010000010000100011000110001000111001000010001100001000000
304. 11010011110110001101100100101000100000110001100011000100011001000010001100001000100
305. 010010011101100000011001001010000101000010001100011000100011001000010001100001000110
306. 01000101001100000011000010100000100000010011000110001000110010000100011100001000000
516. 01011001110111000001100001011000101000010001100011000000010000001000110100001000100
517. 01001001110010000101100100101100001000010001100011000000010000001000100100001000000
518. 00101011110001000001100001011001001000010001100011000000010000001000100100001000100
519. 00111001110010000011001001011001001000010001100011000000010000001000100100001000100
506. 010000010011000000101000101110100100001010001000100100000010010001000001000010001100
507. 110100100010010010110100010110010010000101000100010010000001001000100001000010001100
508. 011010101011100000110100010111010010000101001100010010000001001000100001000010001100
509. 111110111011010100110100010110010010000100011000100100000010010001000001000010001100
510. 001110111011100000110100010110010010000100011000100100000010010001000001000010001100
340. 001010011111100000110000110000101000101000110001000100010100000100000000000000000000000
341. 011101111011100000010000110000100100000010011000100001000010001000010000000000000000000
342. 0101101110011000100010100011101010000100100100110001000010001111010000010001000010001010
343. 01001001100110000001000011101010000100100100110001000010001111110000010000000000000000000
344. 001011011011101000011010011001001001001001100010000100001010000010000000000000000000000
347. 01001001100110001000100001010101000010010010011000100001000111100100000100010000010001010
348. 011011011111100000110100011101010000100100110001000010000101000001000000000000000000000
349. 001111011011100000010100010000010010000001001100010000100001001110001000000000000000000
350. 010010011001100010011000001100010000100100100110001000010000100010001000000000000000000
351. 1101110110011000100110100011001010000100100110001000010000101000001000000000000000000
352. 1111101110110000101101000110010100001001001100010000100001010000100000000000000000000
353. 010011010001100010001000001000001100010110010011000100001000010100011000000000000000000

Group 19.

```

19. 01010100001100000001000001001001000010011000111000100101000111001000100001000000010001000
20. 0100111000011000000010000010010010001001100011100010010100011100100001000001000010001010
21. 010101000011000010010000010010010000100110000110001001010001110010001000100000000001010
22. 0100011000011000000010000010010010001101100011100010010100011100100100011100000000001010
23. 110111110001100010011000001001001000100110000110001001010001110010001000001100010001010
24. 010000100001100000001000001001001000100110000110001001010001110010000100000000010001010
25. 0100111000011000000010000010010011000010110001110001001010001111000000010000000000001010
212. 1101010000111000000101000100110100000101100001100010000100001100100001000100000000001110

```

2I3. 110100100000110000001010001011001000001011000011000010001000011001000010010000000000000110
 2I4. 1101001101011100000010100010010000010010000110001000101000111001000010011000010000000110
 2I5. 11010011010111000000101000100100000100100001100000001000011001000010010000000000000110
 2I6. 0101001000011100000010101010110010000010110000110001011010000110010000100100000000000001110

Group 20.

4I. 01101101110100101000101000100000000001101100001100010001000001110100010000100100001110
 42. 010100111101001001000101010000000000010110000110001000010000110000010001100100001110
 43. 11010111110100100000101000100000000000101100001100010000100001110000010000100100001110
 44. 0101011010010010110000101010000000000101100001100010001000011000001000100100001110
 45. 1101011111010010010010101010000000001010110000110001000010000110000010011100100001110
 494. 01001010010000100000100000101000000001011001011001110101000011001000100010001100000110
 495. 01010010010000100000000000100000000000010000110011000010000110010001000100001100001110
 496. 0101001001000010000000000101000001000001001011101001000011001000100010001100001110
 500. 110100100000010000010100010110001010000110000010001100010000000100010000110000010000100
 5I3. 011110100001001010001000001010001010000110010110000100010001100101010000100001100000100
 526. 1111001011010001011010101000001000011100110001100010000110010001000101010001000000110
 345. 010100101001001001101000011000101100010111000110001000010000100010000000000000000000000000000
 346. 010100101001100011110000110001011010100111001010001000010000100010000000000000000000000000000
 486. 0101001101011000001010001010011010100010110010110011000001000111010001000000111001001110
 502. 010010100001000100000001001000001101001101011010110001000011010000010001000111101100100
 503. 110111100000100001010000001111100010010010101011000110011000011010000100001000111001100010
 523. 010010011001100010111000101010001000000100001000100000000011010000010100000000000000000000000
 524. 010110011001100011111000101010001000000110100110000100000000011100100001001100001000000000000
 532. 0100101100001000100110001010101000000100100001100011000000001101000001000100000000001110
 54I. 010010011001100000111010101000100000100001100001100011000000001010000010000100000000000000000

Group 2I.

3I9 010100010001001001101010001001100101000001001000010001000010000000110000010001001
 320. 0101001100010000100100100110011001010000010010000010001000010000000110000010001001
 32I. 01010001000100001010100110011001010000010010000010001000010000000110000010001001
 322. 01010010000100000010100010000010100000100100000010001000010000000110000010001000
 323. 01010010000100000010100011011001010000010010000001000100001000000100000100001001010
 324. 01010010000100000010100110011001010000010010000001000100001000000110000010001000
 325. 010100110001000000101000100110010100000100100000010001000010000001000001000010001001

294. ololllllooollooooooioooooooloolloooooolllllloooooilooooloollllooolllllooolloooooolololllooolloooooollol
 295. olololllooollooooooioooooooloolloooooollolloooooollolloooooooloolloooooollololooooollololllooolloooooool
 384. ololollloooooioooooollloooooollolloooooooloolloooooolllooolloooooioooooollloooooooolololllooolloooooolll
 385. ololoollooollooooooioooooollolollolooooooloolloooooolllooollooolloooooollloooooooolololllooolloooooool
 386. ololoollooollooooooioooooooloolloooooooloolloooooolllooollooolloooooollololoooooolololllooolloooooool
 387. ololollllooollooooooioooooollolollolooooooloolloooooolllooollooolloooooolllooooooolololllooolloooooollol
 388. ololollllooollooooooioooooollolollolooooooloolloooooolllooollooolloooooolllooollooooooolololllooooooololol
 389. oloolllllooolloooooollolollolooooollolllolooooollollloloolloooooooloolloooooollloooooooolololllooolloooooool
 390. oloolloooooiooooooioooooooloolloooooollolloooooollolloooooolllooollooolloooooollloooooooolololllooolloooooool
 391. ololollllooollooooooioooooollolloooooollolllloooooollolllloooooolllooolloooooioooooolllooollooooooolloooooollol
 392. ololollllooollooooooioooooooloolloooooooloolloooooolllooolloooooioooooollololooooollollllooollooooooololol
 393. oloollllooollooooooioooooollolollloooooolloloolooooolllooolloooooioooooollloooooooolololllooolloooooollol
 394. olllllllooolloooooololoooooololllolooooooloolloooooolllooolloooooioooooolllooollooooooolololllooolloooooollol

Group 24.

277. ololoolooloolloooooollolllloooooololololooooooloolloooooolllooollooollooooooollolollloooooololollloooooooolool
 278. llolooloolooloolloooooollolllloooooollolololooooooloolloooooolllooollooollooooooolllooolloooooololollloooooooolool
 279. ololoolloooloollllllllloooooololololooooooloolloooooolllooollooooooooloollooolloooooolololllooooooolool
 280. ololoolloooloolloooooollolllloooooooloolloooooolllooolllllooollooollooooooolllooolloooooololollloooooooolool
 281. ololoolloooloolllollllloooooololololooooooloolloooooolllooollooooooooloollooolloooooololollloooooooolool
 282. ololoolooloolloooooollolllloooooollolololooooooloolloooooolllooolllllooollooollooooooolllooolloooooololollloooooooloolll
 283. ololoolloooloolloooooollolllloooooololololooooooloolloooooolllooolllllooollooollooooooolllooolloooooololollloooooooolool
 284. llolooloolooloolllollllloooooololololooooooloolloooooolllooolllllooollooollooooooolllooolloooooololollloooooooolool
 285. ololoolloooloollllllllloooooololololooooooloolloooooolllooollooollooooooollooolloooooololollloooooooolool
 286. ololoolloooloolloooooollolllloooooooloolloooooolllooolllllooollooollooooooolllooolloooooololollloooooooolool
 287. ololoolooloolloooooollolllloooooololololooooooloolloooooolllooollooollooooooolllooolloooooololollloooooooolool
 288. olllloooloolloooooollolllloooooollolololooooooloolloooooolllooollooooooooloolloooooololollloooooooolool
 289. ololoolloooloolllollllloooooololololooooooloolloooooolllooollooooooooloolloooooolololllooooooolool
 290. lloloolooloolloooooollolllloooooollolololooooooloolloooooolllooollooollooooooolllooolloooooololollloooooooolool

Group 25.

173. ollllooollloloolloooooollloooloollllloolloloooooololoollllloollloooooooollooolloooooooloollooollooooooolol
 174. lloloolooloolloooooooloolllllooolloooooollloooooooloollooooooooloolloooooooloolloooooooloollooooooollllo
 175. ololoolooloolloooooooloolllllooolloooooollloooooooloollooooooooloolloooooooloolloooooooloollooooooolllol
 176. ololooloolooloollooollooollllloollloooooollloooooooloollooooooooloolloooooooloolloooooooloollooooooolllol

177. 11010011110100101011110100101100110000011001001100000100000011001000001000110010000101
 178. 0111001010000010110110110010110000010000010000110111000000001001000001001100100000101
 179. 011100111101001000011001001011001011001100100101010000000011010100000100110010000101
 180. 010100111101001000011101001011001000001110001100000100000000100100000100110010000101
 181. 010100111101001010111001101011001010000111001100100000000110101000001001100100000101
 182. 01001011110100101011110110111100100100000010011001000000001001000001001100100000101
 183. 011100111101001010111001101011001001000110001100100000000101001000001001100100000101
 184. 11110010100101010110110100001111011001000011000010101000000001110011000010011000000101
 185. 010100101001001000001001001011001001000010001101001000000011101000001001100100000111
 186. 0111001010010010000011010010110000010000010001101001000000011001000001001100100000101
 187. 0101001010010010010110000010110110010000100100110010000000001001000001001100100000101
 271. 011100111101100000111000001011001000001100100100110000010111100100001011000010000101
 272. 01110011110110000011100000101100100000110010010010010010111100100001011000010000101
 273. 011110011101100000111000001011001000001100100100110000010111100100001011000010000101
 274. 00111001110110000011100000111110010000011001001001100000101111000000001011000010000101
 275. 01110011110110000011100000111110010000011001001001100000101111000000001011000010000101
 276. 01111001110110000011100000111110010000011001001001100000101111000000001011000010000101
 439. 010100011001100000011000001011100100000111010001010000100011110100000100111000010000101
 440. 010100111001100000011000001011001000001110000010100010010010001110010000101111000010000101
 441. 011100011001100000011000001011001000001110000010100010001110000000100111000010000101
 442. 010100011001000000110000010111001010000110001110010000100011100110000101111000010000101
 443. 011100011001000000110000010111001000011100000101000010001110000000100111000010000101
 444. 0101111110011000000110000010010001010001101000101000100001110010000101111000010000101
 445. 010100101001100000011000001111100100000111010001010100010001110010000100111000010000101
 453. 01000010110110000001100000101110010000011001001100000001000111000000010111000010000101
 453. 01110001100110000001100000111110100000111010011000000010001111011000010111000010000101
 455. 01011011110110000001100000101110101000110010011000000010001111011000010111000010000101
 456. 01000010110110000001100000101110010000011001001100000001000111000000010111000010000101
 457. 0100100111011000000110000010111010000011001001100000001000111000000010111000010000101
 458. 01110001110110000001100000101111010100011101001100000001000111101000010111000010000101
 395. 0101010100011000000110000010110010001001100011001000010001100110000101110010000101

Group 26.

232. 0101010010010010100100000010010001100101010010001000100101010010001011000000110010001001
 233. 11010100100100101001000000100100011001010100011000110010011100001001011000000110010000000

[illegible]

Appendix 4. The species of Leguminosae considered in the analysis of hardwoods. The serial numbers refer to those on Diagram VIII. The citations are from Brazier and Franklin (1961), those genera marked * being identical with others (the number indicated by the figures in parentheses) listed in the above mentioned work.

MIMOSOIDEAE.

1. *Acacia aneura* F.v.Muell.
2. *Acacia melanoxylon* R.Br.
3. *Acacia mollissima* Willd.
4. **Albizia adianthifolia* (Schum.) W.F.Wight. (3).
5. *Amblygonocarpus andongensis* (Welw. ex Oliv.) Exell and Torre.
6. *Anadenanthera macrocarpa* (Benth.) Brenan.
7. *Cylicodiscus gabunensis* Harms.
8. *Lysiloma latisiliqua* (L.) Benth.
9. *Newtonia buchanani* (Bak.) Gilb. and Bout.
10. *Piptadeniastrum africanum* (Hook.f.) Brenan.
11. *Plathymania reticulata* Benth.
12. *Prosopis africana* (Guill. and Perr.) Taub.
13. *Samanea saman* (Jacq.) Merr.
14. *Xylocarpa xylocarpa* (Roxb.) Taub.

CAESALPINIOIDEAE.

15. **Afzelia africana* Sm. (3).
16. *Amburana cearensis* (Fr. Allem.) A.C.Sm.
17. *Baikiaea plurijuga* Harms.
18. **Berlinia bracteosa* Benth.(3).
19. **Brachystegia eurycoma* Harms (2).
20. *Burkea africana* Hook.
21. *Caesalpinia echinata* Lam.
22. *Caesalpinia granadillo* Pitt.
23. **Copaifera mildbraedii* Harms (3).
24. *Cynometra alexandrii* C.H.Wright.
25. **Daniellia kleinei* Pierre ex A.Chev. (3).
26. *Daniellia oliveri* (Rolfe) Hutch. and Dalz.
27. *Dicorynia paraensis* Benth.
28. *Distemonanthus benthamianus* Baill.
29. **Eperua falcata* Aubl. (1).
30. *Erythrophleum africanum* (Welw. ex Benth.) Harms.
31. *Erythrophleum guineense* G.Don.
32. *Guibourtia arnoldiana* (De Wild. and Th. Dur.) Leonard.
33. *Guibourtia coleosperma* (Benth.) Leonard.
34. **Guibourtia demeusei* (Harms) Leonard.(2).
35. *Haematoxylon campechianum* L.
36. *Hymenaea courbaril* L.
37. **Intsia bijuga* (Colebr.) O.Kuntze. (1).
38. *Koompassia excelsa* Taub.
39. *Koompassia malaccensis* Maing. ex Benth.
40. **Microberlinia* spp. (3).
41. **Mora excelsa* Benth. (1).
42. *Oxystigma oxyphyllum* (Harms) Leonard.
43. *Peltogyne porphyrocardia* Gris.
44. *Peltogyne pubescens* Benth.
45. *Prioria copaifera* Gris.
46. *Pseudosindora palustris* Sym.
47. **Sindora coriacea* Frain (5).
48. *Swartzia madagascariensis* Desv.
49. *Trachylobium verrucosum* (Gaertn.) Oliv.

PAPILIONOIDEAE.

50. *Afrormosia angolensis* (Baker) Harms.
51. *Afrormosia elata* Harms.
52. *Andira inermis* (Sw.) H.B.K.
53. *Baphia nitida* Lodd.
54. *Baphia pubescens* Hook.f.
55. *Bowdichia nitida* Benth.
56. *Brya ebenus* DC.
57. *Castanospermum australe* A.Cunn.
58. **Centrolobium ochroxylon* Rose (I).
59. *Dalbergia cearensis* Ducke.
60. *Dalbergia frutescens* (Vell) Britt. var. *tomentosa* (Vog.) Standl.
61. *Dalbergia latifolia* Roxb.
62. *Dalbergia melanoxylon* Guill. and Perr.
63. *Dalbergia nigra* Fr. Allem.
64. *Dalbergia oliveri* Gamb.
65. *Dalbergia retusa* Hemsl.
66. *Dalbergia sissoo* Roxb.
67. *Dalbergia stevensonii* Standl.
68. **Diploptropis purpurea* (Rich.) Amsh. (2).
69. *Gossweilerodendron balsamiferum* (Verm) Harms.
70. *Haplormosia monophylla* Harms.
71. *Laburnum anagyroides* Medic.
72. **Millettia laurentii* De Wild. (I).
73. **Myrocarpus fastigiatus* Fr. Allem. (I).
74. *Myroxylon balsamum* (L.) Harms.
75. **Pterocarpus angolensis* DC. (I).
76. **Pterocarpus dalbergioides* Roxb. (2).
77. *Pterocarpus soyauxii* Taub.
78. *Robinia pseudoacacia* L.
79. *Vouacapoua americana* Aubl.

Appendix 5. Anatomical data on 113 species of conifers as coded for INFO. Description of the characters is given in Table 24. The first state is scored as 1 the second as 0. The specific citations are from Dallimore and Jackson (1966), and the serial numbers represent the species in the computer type-out (Appendix 6).

39. *Glyptostrobus lineatus* (Poiret) Druce.
40. *Juniperus lucayana* Britt.
41. *J. procera* Hochst.
42. *J. virginiana* L.
43. *Keteleeria davidiana* (Bertr.) Beissn.
44. *Larix decidua* Mill.
45. *L. kaempferi* (Lamb.) Carr.
46. *L. laricina* (Du Roi) K.Koch.
47. *L. occidentalis* Nutt.
48. *L. russica* (Endl.) Sab. ex Trautv.
49. *Libocedrus bidwillii* Hook.f.
50. *Calocedrus decurrens* (Torr.) Florin.
51. *Pilgerodendron uviferum* (D.Don) Florin.
52. *Phyllocladus asplenifolius* (Labill.) Hook.f.
53. *P. trichomanoides* D.Don.
54. *Picea abies* (L.) Karst.
55. *P. engelmannii* Engel.
56. *P. glauca* (Moench) Voss.
57. *P. jezoensis* (S. & Z.) Carr.
58. *P. mariana* (Mill.) B.S.P.
59. *P. obovata* Ledeb.
60. *P. rubens* Sarg.
61. *P. sitchensis* (Bong.) Carr.
62. *Pinus banksiana* Lamb.
63. *P. canariensis* C.Smith.
64. *P. caribaea* Morlet.
65. *P. cembra* L.
66. *P. contorta* Dougl.
67. *P. echinata* Mill.
68. *P. halepensis* Mill.
69. *P. koraiensis* S. & Z.
70. *P. lambertiana* Dougl.
71. *P. leucodermis* Ant.
72. *P. monticola* Dougl ex D.Don.
73. *P. nigra* Arn.
74. *P. palustris* Mill.
75. *P. patula* Schlecht and Cham.
76. *P. pinaster* Ait.

77. *Pinus pinea* L.
78. *P. ponderosa* Dougl.
79. *P. radiata* D.Don.
80. *P. resinosa* Ait.
81. *P. strobus* L.
82. *P. sylvestris* L.
83. *P. taeda* L.
84. *Podocarpus salignus* D.Don.
85. *P. dacrydioides* A.Rich.
86. *P. falcatus* R.Br.
87. *P. ferrugineus* D.Don.
88. *P. gracilior* Pilg.
89. *P. henkelii* Stapf.
90. *P. latifolius* (Thbg.) R.Br.
91. *P. milanjanus* Rendle.
92. *P. spicatus* R.Br.
93. *P. totara* D.Don ex Lamb.
94. *P. usambarensis* Pilg.
95. *Pseudolarix amabilis* (Nels.) Rehd.
96. *Pseudotsuga menziesii* (Mirb.) Franco.
97. *Saxegothea conspicua* Ldl.
98. *Sciadopitys verticillata* (Thbg.) S. & Z.
99. *Sequoia sempervirens* (D.Don) Endl.
100. *Taiwania cryptomerioides* Hayata.
101. *Taxodium distichum* (L.) Rich.
102. *Taxus baccata* L.
103. *Tetraclinis articulata* (Vahl) Mast.
104. *Thuja occidentalis* L.
105. *T. orientalis* L.
106. *T. plicata* D.Don.
107. *T. standishii* (Gord.) Carr.
108. *Thujopsis dolabrata* (L.f.) S. & Z.
109. *Torreya nucifera* S. & Z.
110. *Tsuga canadensis* (L.) Carr.
111. *T. heterophylla* (Raf.) Sarg.
112. *Widdringtonia juniperoides* (L.) Endl.
113. *W. whytei* Rendle.

010100000000000000010011100001100010000
 0101001000000000001110100001100010000
 01010000000000000001100000011100010000
 011100000000000000011101010000100010000
 0101000000000000000100001110000100010000
 011100000000000000011101010000100010000
 0111000010000000001110100001100010000
 1000000000001000000100010000000000000
 110000010000100001000100101110000000000
 1000000000001000011000011000000000000
 1100000000001000011000001000000000000
 1000000100001000011000001100000000000
 1000000000001000011000001000000000000
 1000000000001000011000001100000000000
 1100001000000000001100010010000000000
 1100000000001000011000001000000000000
 1000000000001000011000001000000000000
 0000000100010010000111000100000000010
 01100001010001010001110100010001000
 1100000000000001000010000000000000000
 0101100000000000001100010000000000000
 0100000100000010000000000100000000000
 010000000000000100010100010000000001
 010111001000000100001000110000000001
 010000000100000000010001000000000000
 110000000001000011000010000000000000
 00000000000100000001100010000000001
 010100000000010000001000100000000001
 010110001000000100001000110000000001
 010100000000000100001000010000000001
 00000000000001000010000100000000000
 010100000100000000010001000000000000
 000000010000010100011100100000000000
 000000010000010100011101110000000000
 100110000000100001100000100000000000
 1001100010000100001100000100000000000

Appendix 6. The computer type-out used for plotting the INFO hierarchy in Diagram IX. Figures 1-113 represent the species in Appendix 5; each group is followed by its gain and content (the latter used as the scale in Diagram IX), the right-hand column indicating the size of the group.

2001	1	+	2	2001	0.0000	0.0000	2
2003	7	+	5	2002	0.0000	0.0000	3
2004	+	+	8	2003	0.0000	0.0000	2
2005	+	+	9	2004	0.0000	0.0000	3
2005	+	+	10	2005	0.0000	0.0000	4
2005	+	+	11	2006	0.0000	0.0000	5
14	+	+	99	2007	0.0000	0.0000	2
15	+	+	86	2008	0.0000	0.0000	2
2008	+	+	90	2009	0.0000	0.0000	3
19	+	+	20	2010	0.0000	0.0000	2
31	+	+	32	2011	0.0000	0.0000	2
34	+	+	93	2012	0.0000	0.0000	2
39	+	+	108	2013	0.0000	0.0000	2
2014	+	+	45	2014	0.0000	0.0000	2
52	+	+	47	2015	0.0000	0.0000	2
2014	+	+	53	2016	0.0000	0.0000	2
54	+	+	55	2017	0.0000	0.0000	2
2017	+	+	56	2018	0.0000	0.0000	3
2019	+	+	57	2019	0.0000	0.0000	4
2019	+	+	58	2020	0.0000	0.0000	5
2020	+	+	59	2021	0.0000	0.0000	6
60	+	+	61	2022	0.0000	0.0000	2
62	+	+	76	2023	0.0000	0.0000	2
64	+	+	67	2024	0.0000	0.0000	2
2024	+	+	74	2025	0.0000	0.0000	3
2025	+	+	83	2026	0.0000	0.0000	4
65	+	+	70	2027	0.0000	0.0000	2
2027	+	+	72	2028	0.0000	0.0000	3
2028	+	+	81	2029	0.0000	0.0000	4
66	+	+	78	2030	0.0000	0.0000	2
73	+	+	80	2031	0.0000	0.0000	2
2031	+	+	82	2032	0.0000	0.0000	3
91	+	+	94	2033	0.0000	0.0000	2
3	+	+	4	2034	1.3862	1.3862	2
13	+	+	37	2035	1.3862	1.3862	2
16	+	+	17	2036	1.3862	1.3862	2
24	+	+	51	2037	1.3862	1.3862	2
26	+	+	107	2038	1.3862	1.3862	2
40	+	+	42	2039	1.3862	1.3862	2
68	+	+	77	2040	1.3862	1.3862	2
101	+	+	106	2041	1.3862	1.3862	2
102	+	+	109	2042	1.3862	1.3862	2
112	+	+	113	2043	1.3862	1.3862	2
2002	+	+	95	2044	2.2494	2.2494	4
2009	+	+	88	2045	2.2494	2.2494	4
2015	+	+	46	2046	2.2494	2.2494	4
2036	+	+	49	2047	2.4327	3.8189	3
2039	+	+	50	2048	2.4327	3.8189	3
2029	+	+	69	2049	2.5020	2.5020	5
2006	+	+	6	2050	2.7033	2.7033	6
2045	+	+	89	2051	2.7545	5.0040	5
18	+	+	29	2052	2.7724	2.7724	2
2012	+	+	2033	2053	2.7727	2.7727	4
63	+	+	71	2054	2.7724	2.7724	2
87	+	+	103	2055	2.7724	2.7724	2
110	+	+	111	2056	2.7724	2.7724	2

2054	+	79	2057	2.9559	5.7284	
2037	+	2011	2058	3.6359	5.0221	4
2007	+	27	2059	3.8189	3.8189	3
2023	+	2026	2060	3.8190	3.8190	6
21	+	36	2061	4.1586	4.1586	2
22	+	100	2062	4.1586	4.1586	2
25	+	28	2063	4.1586	4.1586	2
30	+	41	2064	4.1586	4.1586	2
2021	+	2022	2065	4.4985	4.4985	8
2063	+	2052	2066	5.3626	12.2937	4
2061	+	97	2067	5.3887	9.5474	3
33	+	98	2068	5.5449	5.5449	2
2044	+	2034	2069	5.5900	9.2257	6
35	+	2016	2070	5.7284	5.7284	3
2050	+	12	2071	5.9083	8.6116	7
2042	+	105	2072	6.2517	7.6379	3
2055	+	92	2073	6.7749	9.5474	3
23	+	104	2074	6.9311	6.9311	2
84	+	85	2075	6.9311	6.9311	2
2057	+	75	2076	7.0885	12.8170	4
2056	+	2041	2077	7.2718	10.0443	4
2035	+	2062	2078	7.2720	12.8170	4
2058	+	2064	2079	7.6830	16.8638	6
2046	+	48	2080	7.7586	10.0080	5
2068	+	2070	2081	7.9671	19.2405	5
2067	+	2013	2082	8.0543	17.6017	5
2078	+	38	2083	8.1499	20.9669	5
2051	+	2053	2084	9.4525	17.2292	9
2060	+	2030	2085	10.7229	14.5419	8
2083	+	2048	2086	10.8677	35.6536	8
2047	+	2066	2087	11.7515	27.8642	7
2069	+	43	2088	12.1851	21.4108	7
96	+	2056	2089	12.5034	15.2758	3
2086	+	2079	2090	14.3186	66.8361	14
2075	+	2043	2091	14.5439	22.8613	4
2059	+	2077	2092	15.3180	29.1813	7
2085	+	2032	2093	15.9915	30.5335	11
2091	+	2087	2094	16.5846	67.3102	11
2084	+	2073	2095	17.5766	44.3533	12
2074	+	2072	2096	18.1323	32.7014	5
2076	+	2040	2097	19.0527	33.2560	6
2096	+	2082	2098	24.0895	74.3927	10
2088	+	2089	2099	29.8069	66.4937	10
2095	+	2081	2100	31.2290	94.8229	17
2098	+	2090	2101	33.7972	175.0261	24
2097	+	2093	2102	34.7831	98.5727	17
2099	+	2010	2103	39.2440	105.7377	12
2080	+	2065	2104	40.1602	54.6668	13
2100	+	2071	2105	40.8477	144.2823	24
2092	+	2101	2106	41.3288	245.5363	31
2105	+	2094	2107	48.2153	259.8079	35
2102	+	2049	2108	65.8250	166.8997	22
2103	+	2104	2109	98.1887	258.5933	25
2106	+	2107	2110	163.6937	669.0380	66
2109	+	2108	2111	281.1626	706.6558	47
2111	+	2110	2112	384.5778	1760.2717	113