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EFFECTS OF NUMERICAL METHODS, QUANTITY AND COMPOSITION OF CHARACTERS ON THE CLASSIFICATION OF THE ANGRAECOID OF NIGERIA AND CAMEROON.

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ABSTRACT: Numerical taxonomic study of 100 angraecoid orchid species was undertaken. Four basic data matrices of 100 OTUs by 86, 63, 37 and 18 characters were generated and analyzed by two ordination methods (PCA and DCA) and one clustering method (CS). Characters from different aspects of the orchids produced similar results while data based solely on characters of the flower differed. There were both consistency and agreement among the methods and different subsets of characters. There are indications that either the quantity of characters available or the type of method applied does not determine the outcome of numerical taxonomy. The three groupings that emerged from the study compared well with existing traditional classification by both Summerhayes and Arends.

INTRODUCTION

The formulation of characters is unlikely to affect the result of numerical taxonomy. Clifford and Lavarack (1974) pointed OTU that in the Orchidaceace, different sets of characters, for example, floral, fruiting and vegetative characters, can lead to different classifications. Davies and Heywood (1963) pointed OTU that classifications produced from different sets of characters for the sane OTUs are incongruent. Bascomb (1989) observed that, with such a wide range of dendrograms produced from the same set of data one is bound to ask which method should be used. Hoft *et al.* (1999) compared research interests and appropriate methods of analysis: DCA explores associations between variables: PCA is concerned with variances among variables while CS provides information about similarity and dissimilarity in variables or group of variables. Borantaski and Davis (1979) and Funk, and Brooks (1990), observed that the Systematists' null hypothesis is the assumption that as more and more characters were sampled, no consistent pattern of interrelationship will emerge.

In spite of the vast literature on automated classification, the question of what number of characters is adequate has not been resolved. Sneath and Sokal (1973) proposed the use of not less than 60 characters and if at all feasible, considerably more characters should be employed, although this recommendation cannot be justified on either empirical or theoretical grounds. Effects of changes in character sets upon within group phenetic distance have not received much attention.

Glimartin (1976), Watson, William and Lance (1967) used less than 40 characters in the classification of Ericales. Moses (1967) and Seigal (1965) cited the use of 130 and 146 characters. Steykal (1968) advised but when working with organisms, at least 1,000 characters must be used.

Clifford and Larvack (1974) observed that while there has been considerable research on the effects of the use of different classificatory strategies on the same set of data , less attention has been devoted to the use of different subsets of the data. According to Rolf (1964), indicating the class membership of each point in ordination makes useful comparisons of classifications. If the scatter of points in the same class were found to be close to one another and not mixed, some degree of agreement would have been indicated. Glimartin (1969) observed that distance matrices resulting from Numerical Taxonomy analyses can provide an estimate of a taxon's variability with regard to a particular set of characters; and that the differences in character-states (phenetic distance) between OTU within the same taxon can yield a novel and useful estimate of intra-taxon variability and that these estimates of variability with various taxonomic groups can help to indicate their respective evolutionary ages. It is the aim of this study to analyze the relationships among the genera of the angraecoid orchids of Nigeria using different numerical methods to analyze different numbers of characters, composed from different aspects of the orchids with a view to generating information on their effects on the angraecoid orchids classification.

MATERIALS AND METHODS

The 100 angraecoid orchid specimens (OTUs) used in this study were obtained from three sources:

a.) the herbaria, consulted ones included, IFE, FHI, UCI/UCH (abbreviations are according to Holmgren, (1990);
b.) orchid material conserved in the Orchidarium of the Biological Gardens, Obafemi Awolowo University and
c.) field collections in forest reserves in Nigeria and Cameroon.

For each species, 10 specimens were examined and studied. It was ensured that data were scored from various aspects of the orchids: leaf, stem and flowers, infructescences and ecology. The measurements of morphological features such as leaf length and stems length were made using the measuring rule graduated in 1mm division.

From 37, 63 and 86 characters all have hazy margins and hardly with any cores, phonograms from 18 characters has a strong core typified by OTUs lying between 73 and 80

For all measured quantities the states corresponds to two major levels of discontinuity.

Four basic data matrices involving 86 characters and subsets of them (63, 37 and 18 characters) were composed for use in the analysis. While other subsets are from various aspects of the orchids, the subset of 63 characters contained only floral attributes. The data matrices were then exposed to two ordination methods. Detrended Correspondence Analysis (DCA) and Principal Component Analysis (PCA) and one clustering method, Centroid Sorting (CS) for comparative purposes. A.J. Morton, of the University of London, Imperial College modified all programmes at Silwood Park and run on the CDC 6600 System of the University.

RESULTS

A list of the angraecoid orchids of Nigeria is provided in Table 1 while Table 2 details OTU the composition of the characters scored for each OTU. Summary of the groupings obtained under the different methods and subsets of characters are shown in Table 3. The ordination diagrams of the PCA and DCA are depicted by Figures 1-8. while the phenograms from the CS are shown in figure 9-12. The grouping together of related taxa (OTUs) arrived at by using ordination methods of PCA and DCA together with the cluster analysis of Centroid Sorting (CS) are delimited into groups A, B and C. numerical groupings were then compared with existing classifications of the angraecoids.

Effects of the numerical methods on the grouping of taxa

The groupings produced by the ordination methods of PCA (Figs. 1-4) and DCA (Figs. 5-8) consist roughly of the same OTUs as compared in able 3. Although components I and II normally express maximum variance in ordination, good separation of OTUs into coherent groupings were observed between components III and I of both PCA and DCA (Figs. 4 and 6). Grouping produced by DCA (Fig. 5-8) become more compact, and hence more coherent for larger number of characters than for smaller numbers, whereas PCA and CS groupings are less compact with larger number of characters than with smaller sets. While inter-stand distance or proximity value between adjacent OTU's increased with increasing number of characters in PCA ordination, the same set of characters produced progressive reduction in inter-stand distance in DCA, thus making the OTUs to be close. But overall, the structure of the groupings remained preserved, as there were no appreciable distortions.

Effects of varying the number of characters on the grouping of taxa.

The groupings produced by using different numbers of characters are listed in Table 3. The locations of the OTUs in the hyperspace of the PCA (Figs. 1-4) and DCA (Figs. 5-8) changed with each set of characters. Indeed, no single OTU, maintained the same position when subjected to two different sets of characters. The highest variance of 42.2% mwas extracted from the first three component axes when 18 characters were used, and then 29.2%; 23.8% and 20.7%, for 37, 63 and 86 characters respectively Phenograms resulting from CS (Figs. 9-12) also showed branching at increasing phenon levels of 0.2, 1.1, 1.2, and 1.3, for 18, 37, 63 and 86 characters respectively. While phenograms obtained with any core, phenogram from 18 characters has a strong core typified by OTUs lying between 78 and 80. Again, the structure of group A, B and C remained reasonably preserved from one set of characters to the other, but the subset of 63 characters consistently deviated from other subsets.

Table 2: Qualitative and Quantitative Characters from different aspects of the Orchids

Source of character	Stem	Leaves	Inflore-scence	Infrute-scences	Flowers	Ecology	Total
Qualitative	2	9	2	-	13	-	26
Quantitative	2	5	3	4	41	5	60
Total	4	14	5	4	54	5	86
%	5	16	5	5	62	6	

Characters composed from a combination of various aspects of the orchids such as the leaf, stem, infructescences and ecology produced similar groupings when subjected to different methods. But groupings resulting from solely the characters of the flower consistently produced no grouping similar to what the combinations of characters from various aspects of the orchid yielded, even when methods changed. Table 3 illustrates the consistency of the floral characters in not producing comparable classification under different methods.

DISCUSSION

In the study of interrelationship among the genera of angraecoid orchids, neither was the outcome influenced fundamentally by the numerical techniques employed nor the quantity of characters available for analysis. The similarly observed in inter-stand distances of the OTUs groupings arising from PCA and CS was not unexpected since both methods aim at providing information among variables whereas DCA is concerned with association between variable (Hoft *et al,* 1999).

However, the composition of taxonomic characters, especially using the characters of the flower or reproductive attributes alone affected the resulting grouping of genera which is consistent with the view of Clifford and Larvarack (1974) and Davis and Heywood (1971). The consistent failure of the floral attributes to produce ant coherent grouping of genera comparable to those obtained from other sets of characters illustrates this point. This suggests the complexity of similarity relationship of the reproductive attributes of the angraecoid orchids. Clifford and Lavarack (1974) in their study of the genera of Neottid orchids of Australia, observed that floral parts are liable to strong selection pressure originating from various aspects of their reproductive biology, and this is in agreement with the position of Davis and Heywood (1963). This may mean that certain genes are only active at specific times during the development of the reproductive structures, and besides, it could also be a reflection of different adaptation patterns and evolutionary rates for those genes (Sneath and Sokal, 1973).

That increase in the number of characters also caused corresponding increases in the proximity values of OTUs analyzed by both PCA and CS, is in agreement with the observation of Hoft *et al* (1999) pointing OTU some similarity in the two methods. But DCA took an exception to this observation by exhibiting reduction in phenetic distance among contiguous OTUs. This suggests that a generalized statement as made by Borantaski and Davis (1979) and Funks and Brooks (1990) is therefore not wholly true. Although the occurrence of smaller variances being associated with large numbers of characters, exhibited by PCA and DCA methods suggests dilution of important taxonomic characters by the less important ones, it is not sufficiently strong to upset the structure of the groupings, and hence, the integrity of the groupings remain preserved among characters and methods.

The variations observed among the methods and the number of characters do not constitute any fundamental difference since the results were in general agreement with known classifications of the angraecoid genera, for instance, Summerhayes (1966), Arends (1986) and Senghas (1986). In spite of the slight variations, each group retained its integrity from method to method. Some intrinsic properties of the methods such as the differences in the matrices of correlation may have accounted for the variations.

The type of method does not determine the outcome of numerical classification and the number of characters used but may be influenced by the nature of characters. This gives an indication that different phenetic groupings of the same group of plants could give rise to different phyletic classifications. This observation agrees with the observation of Clifford and Larvack (1974) that different sets of characters, for example, floral characters can lead to different classifications. It is therefore important for taxonomists employing numerical techniques to ensure that characters are selected from as many aspects of the orchids as possible rather than obtaining the whole lot of characters from a particular organ of the plant.

Table 1: A Systematic list of the angraecoid orchids of Nigeria and Cameroun used in this study

1. *Aerangis arachnopus* (Rchb. F.) Schltr.
   (= Angraecum arachnopus)
2. *A. biloba* (Lindl.) Schltr.
   (=Angraecum biloba)
3. *A. calantha* (Schltr.) Schltr.
   (=calanthus)
4. *A. collum-cygni* Summerb.
5. *A. gracillima* (Kraenzl.) Schltr.
   (= Angraecum gracillima)
   (= A. Stellisera)
   (= A. collumn-cygni)
6. *A. kotschyana* (Rchb. F.) Schltr.
   (= Angraecum stella)
7. *A. gravenreuthii* (Kraezl.) Schltr.
   (= Angraecum stella)
   (= Aeranthes gravenrethii)
   (= Mystacidium gravenreuthii)
8. *A. rhodostica* (Kraenzl.) Schltr.
9. *A. stelligera* Summerh.
10. *Ancistrorhynchus capitata* (Lindl.) Summerh.
11. *A. cephalotes* (Rchb. F.) Summerh.
    (= Listrostachys cepholotes)
    (= Cephalangraecum glomeratum)
12. *A. clandestinus* (Lindl.) Schltr.
    (= A. recurvus)
    (= A. clandestinum)
    (= Angraecum brunneo-maculatum)
    (= Ancistrorhynchus brunnea-maculatum)
13. *A. metteniae* (Kraenzl.) Summerh.
    (= Listrostachys metteniae)
    (=L. brannii)
    (= Cephalangraecum brannii)
14. *Angraecopsis parviflora* (Thou.) Schltr.
    (= Mystacidium parviflorum)
15. *Ancistrorhynchus recurvus* Finet.
    (= A. clandestinus)
16. *A. schumannii* (Kraenzl.) Summerh.
    (= Angraecum schumannii)
    (= Mystacidium schumannii)
    (= Phormangis schumannii)
17. *A. serratus* Summerh.
    (= Listrostachys brannii)
18. *A. straussii* (Schltr. Schltr.)
    (= Angraecum straussii)
    (= Cephalangraecum staussii)
19. *Angraecopsis elliptical* Summerh.
20. *A. ischnopus* (Schltr.) Schltr.
    (= Angraecum ischnopus)
21. *A. tridens* (Lindl.) Schltr.)
    (A. tridens)
    (Mystacidium tridens)
    (Angraecum occidentale)
22. *Angraecum angustum* (Rolfe) Summerh.
    (= Mystacidium angustum)
23. *A. aporoides* Summerh.
    (= Angraecum distichum var. gradifolium)
24. *A. anguistipetalum* Rendle
25. *A. birrimense* Rolfe
26. *A. chevalieri* Summerh.
27. *A. distichum* Lindl.
    (= Mystacidium distichum)
28. *A. egertonii* Rendle
29. *A. eichleranum* Kraenzl.
30. *A. infundibulare* Lindl.
    (= Mystacidium infundibulare)
31. *A. multinominatum* Rendle
    (= Mystacidium clavatum)
32. *A. podochiloides* Schltr.
    (= Monixus aporum)
33. *A. pungens* Schltr.
34. *A. pyriforme* Summerh.
    (= A. multinominatum)
35. *A. sacciferum* Lindl.
36. *A. subulatum* Lindl.
    (= Listrostachys subulantum)
37. *A. reygaertii* (Kraenzl.)
38. *Bolusiella batesii* (Rolfe) Schltr.
    (= Listrostachys batesii)
39. *B. iridifolia* (Rolfe) Schltr
    (= Listrostachys iridifolia)
40. *B. talbotii* (Rendle) Summerh.
    (= Angraecum talbotii)
41. *Calyptrochilum christyanum* (Rchb. F.) Summerh.
    (= Limordorum emerginatum)
    (= Angraecum imbricatum)
42. *C. emerginatum* (SW.) Schltr.
    (= Limordorum emerginatum)
43. *Chamaeangis ichneumonea* (Lindl.) Schltr.
    (= Angraecum ichneumonea)
44. *C. lanceolata* Summerh.
45. *C. odoratissima* (Rchb. F.) Schltr.
    (= Angraecum odoratissima)
46. *C. vesicata* (Lindl.) Schltr.
    (= Angraecum vesicata)
47. *Cyrtorchis arcuata sub.* Sp. *Variabilis* Summerh.
48. *C. aschersonii* (Kraenzl.) Schltr.
    (= Angraecum aschersonii)

49. *C. chailluana* (Hook. F.) Schltr.
(= Angraecum chailluanum)
(= Listrostachys chailluanum)
50. *C. cyanifolia* Sanford
51. *C. hamata* (Rolfe) Schltr.
(= Listrostachys hamata)
52. *C. monteiroae* (Rchb. F.) Schltr.
(= Listrostachys monteiroae)
53. *C. ringens* (Rchb.) F. Summerh.
(= Listrostachys ringens
(= L. Hookeri)
(= L. bistorta)
54. *Diaphanantho bidens* (SW.) Schltr.
(= Limodorum bidens)
55. *D. bueae* (Schltr.) Schltr.
(= Angraecum bueae)
56. *D. curvata* (Rolfe) Summerh.
(= Angraecum curvatum)
57. *D. dorotheae* (Rendle) Summerh.
(= Angraecum dorotheae)
(= Rangaeris dorotheae)
58. *Rhipidoglossum densiflorum* (Summerh.) Summerh.
59. *Diaphananth fragrantissima* (Rolfe. F.) Schltr.
60. *Rhipidoglossum kamerunensis* (Schltr.) Schltr.
61. *R. longicalar* (Summerh.) Summerh.
62. *R. obanensis* (Rendle) Summerh.
63. *Diaphananthe pellucida* (Lindl.) Schltr. Var. Pellacida
(= Angraecum pellucidum)
(= Listrostachys pellucida)
64. *D. plehniana* (Schltr.) Schltr.
(= Angraecum plehinianum)
65. *D. polyanthus* (Kraenzl.) Schltr.
(= Mystacidium polyanthus)
(= Sarcorhynchus polydactyla)
(= S. saccolaboides)
66. *Rhipidoglossum polydactyla* (Kraenzl.) Summerh.
(= Listrostachys polydactyle)
(= Crassangis polydactyla)
67. *R. pulchellum* Summerh. Var. *geniculata* Summerh.
68. *Diaphananthe quintassii* (Rolfe) Schltr.
69. *Rhipidoglossum rutilum* (Rchb. F.) Summerh.
(= Diaphananthe rutila)
(= Aeranthus rutilum)
(= Mystacidium rutilum)
70. *Dinklageella liberica* Mans.
71. *Eurychone rothschildiana* (C'Brien) Schltr.
(= Angraecum rothschildianum)
72. *Listrostachys pertusa* (Lindl.) Rchb. F.)
73. *Chaulidon buntingii* Summerh.
74. *Microcoelia caespitosa* (Rolfe) Summerh.
(= M. coria)
(= Angraecum caesapitosum)
(= A. andersonii)
75. *M. microglossa* Summerh.
(= M. microptela)
76. *M. koehleri* (Schltr.) Summerh.
(= Angraecum koehleri)
77. *M. konduensis* (De Wild.) Summerh.
78. *M. macrorhynchia* (Schltr.) Summerh.
(= Angraecum macrorhychium)
(= Encheridium macrorhychium)
79. *M. sanfordii* L. Jonsson.
80. *M. stolzii* (Schltr.) Summerh.
81. *Rangaeri brachyceras* (Summerh.) Summerh.)
(= Aerangis brachyceras)
(= R. bilongi caudata)
82. *R. longicaudata* (Rolfe) Summerh.
(= Listrostachys longicaudatum)
83. *R. muscicola* (Rchb. F.) Summerh.
(= Aeranthus muscicola)
(= Listrostachys muscicola)
84. *R. rhipsalisocia* (Rchb. F.) Summerh.
(= Angraecum batesii)
(= Angraecum rhipsalisocium)
(= Listrostachys rhisalisocium)
(= L. colarum)
85. *R. trilobata* Summerh.
86. *Plectrolminthus caudatas* (Lindl.) Summerh.
(= Angraecum caudatum)
(= Listrostochys caudata)
(= Leptocentrum caudatum)
87. *Podangis dactyloceras* (Rchb. F.) Schltr.
88. *Solenangis clavata* (Rolfe) Schltr.
(= Angraecum clavatum)
89. *S. scandens* (Schltr.) Schltr.
(= Angraecum scandens)
90. *Tridactyle anthomaniaca* (Rchb. F.) Summerh.
(= Listrostachys anthomaniaca)
(= Angraecum lepidotum)
(= T. lepidota)
91. *T. bicaudata* (Lindl.) Schltr.
(= Angraecum bicaudatum)

92. *T. obuduensis* sanford
93. *T. brevicalcarata* Summerh.
94. *T. crassifolia* Summerh.
95. *T. muriculata* (Rendle) Schltr.
(= *Angraecum muriculatum)*
96. *T. gentilii* (De Wild.) Schltr.
(= *Angraecum gentilii)*
97. *T. lagosensis* (Rolfe) Schltr.
(= *Angraecum lagosense)*
98. *T. oblongifolia* Summerh.
99. *T. tridentata* (Harv.) Schltr.
100. *T. tridaclytes* (Rolfe) Schltr.
(= *Angraecum tridacyltes)*
(= *Aeranthus deistelianus)*
(= *Mystacidium ledermanianum)*

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Table 3: Grouping of OTU's according to the method of analysis and number of characters

		Grouping of OTU's according to method of analysis		
No of characters		**CS**	**PCA**	**DCA**
18	A	25,22,24,26,27,31,32,33, 34,36,37.41,42,70,45,54, 55,90,92,94,88,58,85	22,23,24,25,26,29,30,31, 36,27,28,34,41,42,54,88, 89,90,92,94,95,97,99,98, 70	22,24,26,27,28,29,30, 31,33,34,36,41,42,70, 88,89,90,94,95,97,98, 99
	B	73,74,75,76,77,78,79,80	73,74,75,76,77,78,79, 80	73,74,75,76,77,78,79,80
	C	1,2,3,4,5,6,7,8,9,10,11,12,13 ,14,15,16,17,17,18,19, 38,39,40,43,45,46,47,61, 62,66,67,69,68,71,72.81, 82,83,84,16,20,21,49,50, 51,52,53,60,57,63,64,65, 23,28,29,30,35,48,87,91, 93,96,99,100	1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15,16,17,18,19, 20,21,37,38,39,40,43,44, 45,46,47,48,49,50,51,53, 54,55,57,59,63,64,65,68, 56,58,60,61,62,67,69,71, 72, 81,83,84	1,2,3,4,5,6,7,8,9,10,11,12,13,14,1 5,16,17,18, 19,20,21,37,40,42,43, 44,45,46,47,48,49,50, 51,52,53,55,57,59,63, 64,65,68,56,58,60,61, 62,66,69,70,72,81,82, 83,84,85,86,87,91,93, 96,97,99,100
37	A	22,23,24,25,29,30,32,33,27, 36,41,85,64	22,23,24,25,26,27,28, 29,30,31,32,33,36,41, 42,90,92,94,95,88,89, 70	22,23,24,25,26,27,29, 30,31,32,33,36,41,92, 94,89
	B	73,74,75,76,77,78,79,80	73,74,75,76,77,78,79, 80	73,74,75,76,77,78,79,80
	C	1,2,3,4,6,8,9,10,14,18, 37,38,46,47,48,49,50,51,52, 53,57,59,63,56,58,60,62,70, 71,72,81,82,83,84,85,90,91, 92,96,94,95,97,98,99,100	1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15,16,17,18,19, 20,21,38,39,40,43,44,45, 46,47,48,49,50,51,52,53, 54,55,58,57,59,63,64,65, 68,56,60,61,62,66,69,70, 71, 72,81,82,83,84,85,86, 87,91,93,96,97,98,100	1,2,3,4,5,6,7,8,9,10,11,12,13,15,1 6,17,18,14, 19,21,39,40,42,43,44, 45,46,47,48,49,50,51, 52,54,55,57,59,63,64, 65,68,56,58,60,61,62, 66,69,70,71,72,81,82, 83,84,85,86,87,88,91, 93,95,96,97,98,99, 100
63	A	-	-	-
	B	-	-	-
	C	-	-	-
	A	23,24,25,27,28,29,30,32,34, 33,36,92,93,98,95, 100,85,15	22,23,24,25,26,27,28, 29,30,32,35,36,41,42, 54,90,92,94,96,97,98, 100,88,89,70	22,23,24,25,26,27,28, 31,32,33,34,35,36,70, 88,89,90,92,94,95,96, 97,99,100,41
	B	73,74,75,76,77,78,79,80	73,74,75,76,77,78,79, 80	73,74,75,76,77,78,79, 80
	C	1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15,16,18,19,20,21, 26, 35,37,38,39,40,43,44,46,47, 48,49,50,51,52,53	1,2,3.4,5,6,7,8,9,10, 11,12,13,14,15,16,17, 18,19,20,21,26,35,37, 38,39,40,43,44,46,47, 48,49,50,51,53,63,55, 57,59,64,55,68,58,60, 61,62,69,70,71,72,81, 82,83,84,85,54,56,58, 67,86,87,88,89,90,91, 93,95,97,98,99	1,2,3,4,5,6,7,8,9,10, 11,12,15,16,17,18,14, 19,20,21,37,38,39,40, 41,42,43,44,45,46,47, 48,49,50,51,52,53,54, 55,57,59,63,64,65,56, 60,61,62,66,67,69,71, 72,81,82,83,84,85,86, 87,91,93,98

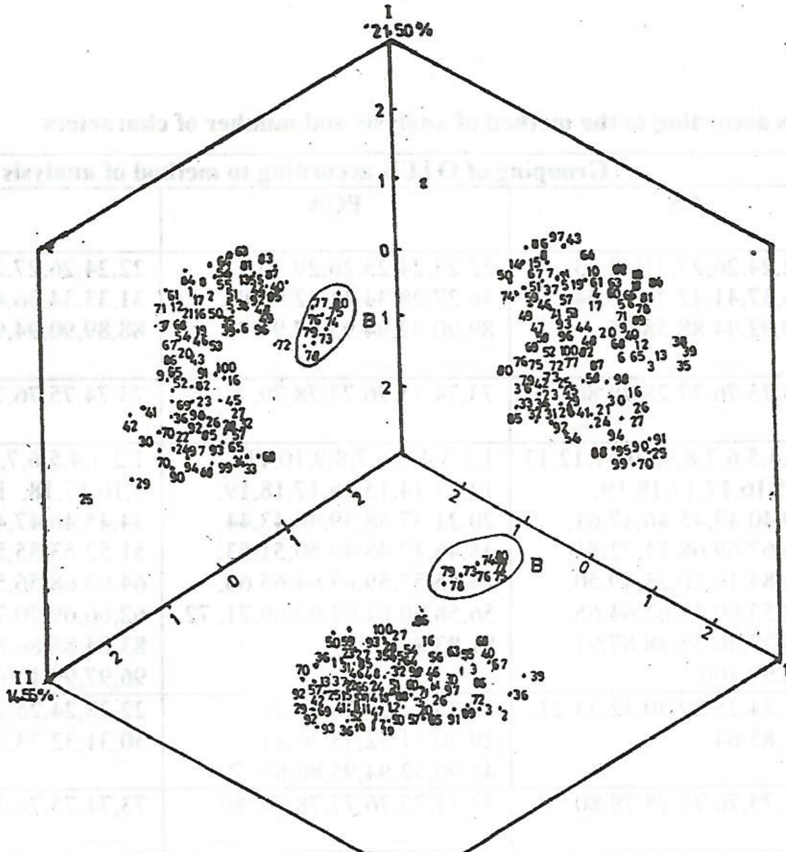

Figure 1: Three dimensional ordination based on components I, II and III employing 18 characters. Numbers represent the species as shown in Table 1.

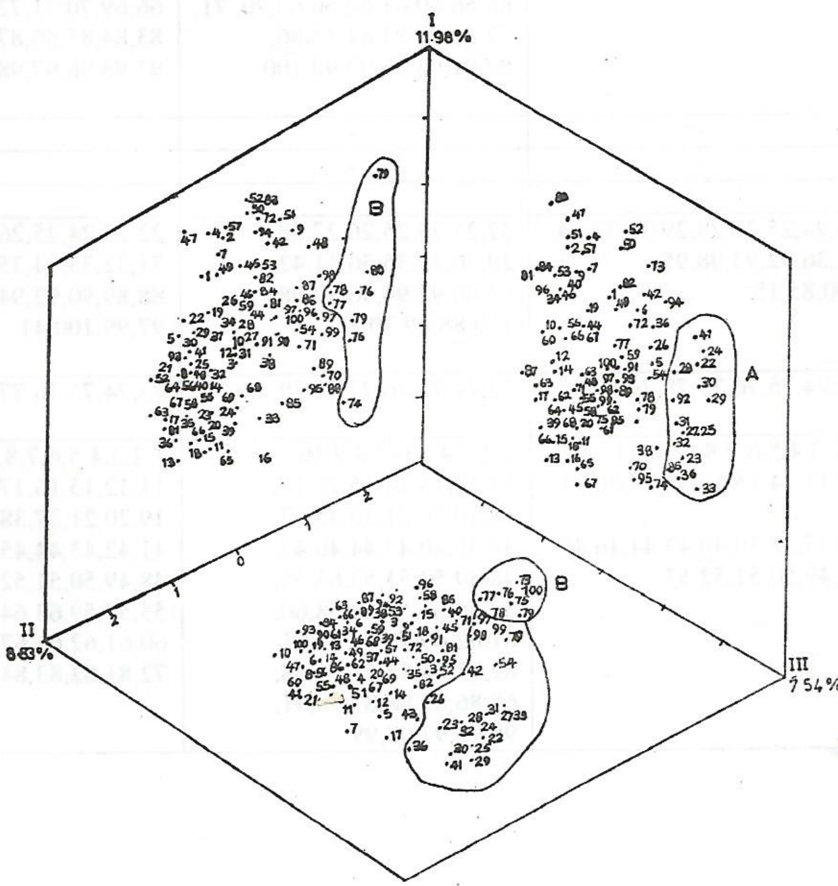

Figure 2: Three dimensional ordination based on components I, II and III employing 37 characters.

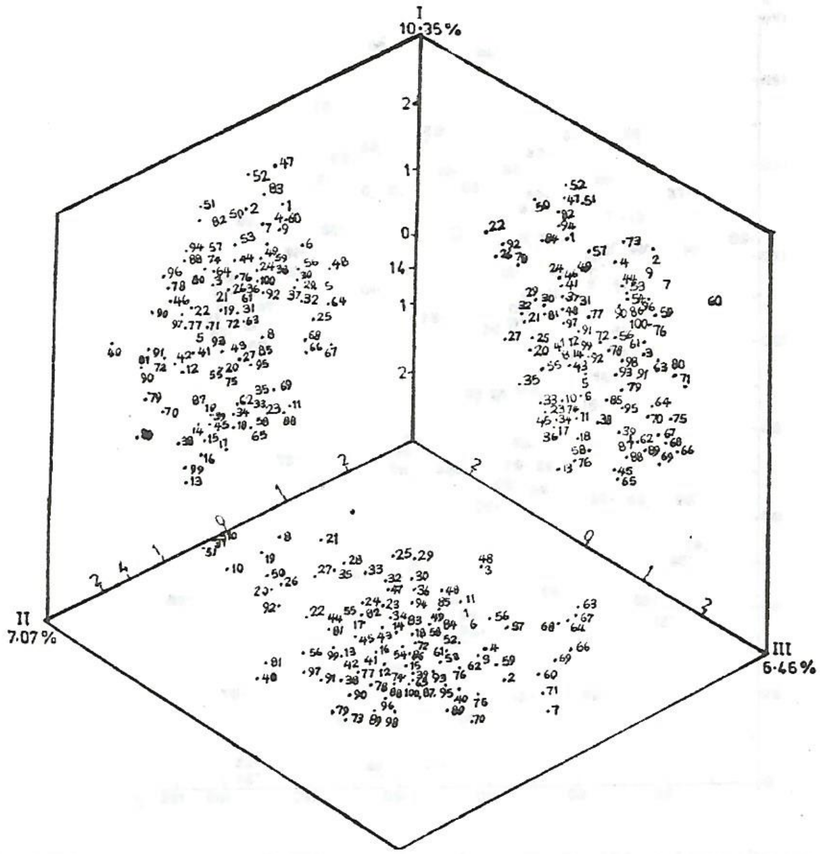

Figure 3: Three dimensional ordination based on components I, II and III employing 63 characters. Numbers represent the species as shown in Table 1.

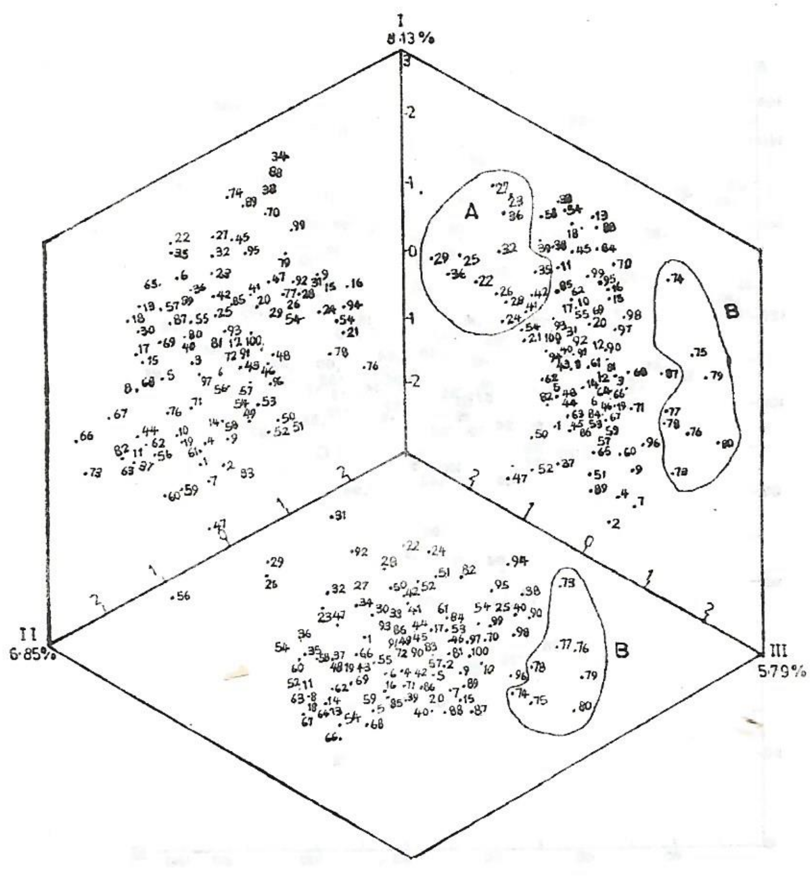

Figure 4: Three dimensional ordination based on components I, II and III employing 86 characters.

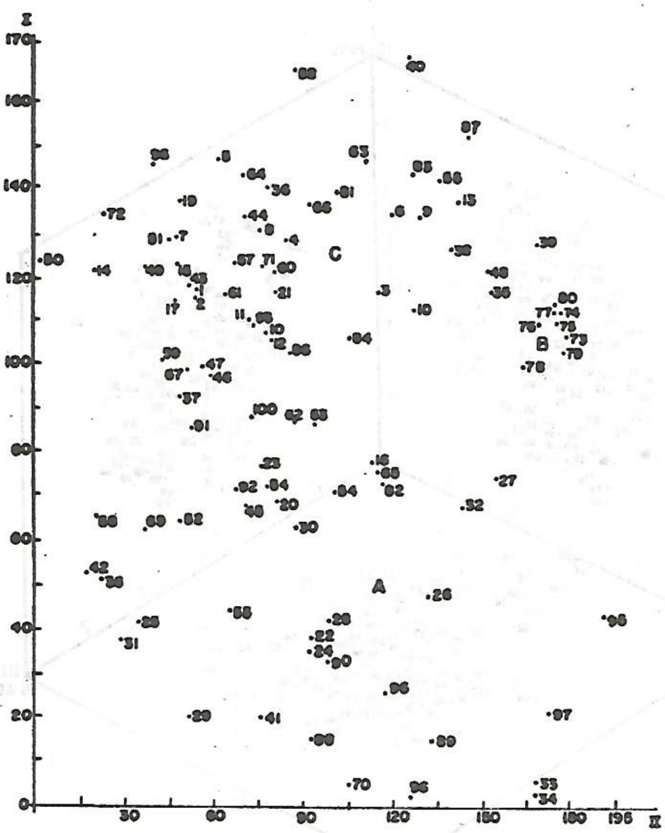

Figure 5: Scatter diagram of axes I and II of species from Detrended Correspondence Analysis based on 18 characters. Numbers represent the species as shown in Table 1.

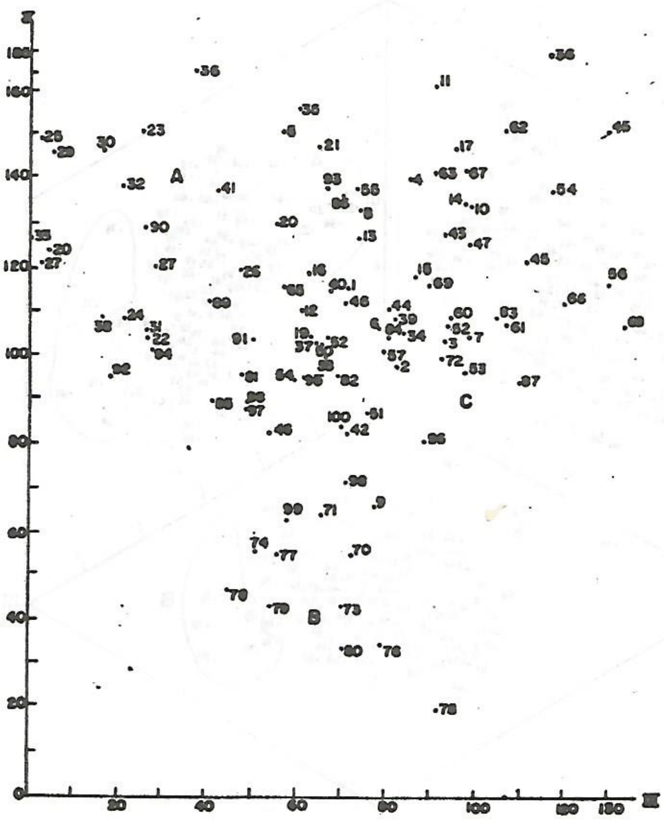

Figure 6: Scatter diagram of axes I and II of species from Detrended Correspondence Analysis based on

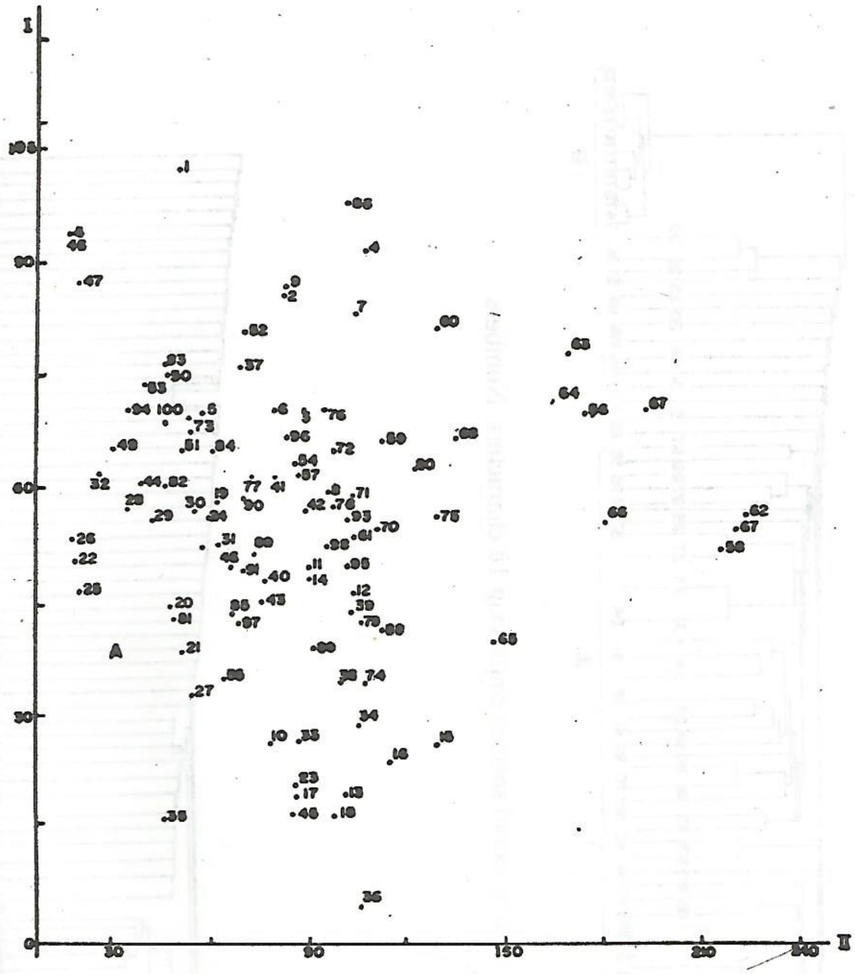

Figure 7: Scatter diagram of axes I and II of species from Detrended Correspondence Analysis based on 63 characters. Numbers represent the species as shown in Table 1.

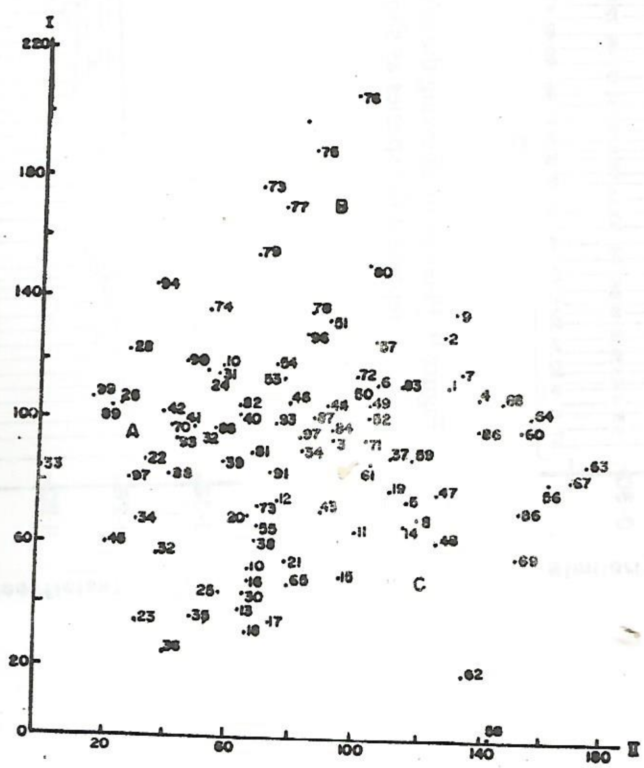

Figure 8: Scatter diagram of axes I and II of species from Detrended Correspondence Analysis based

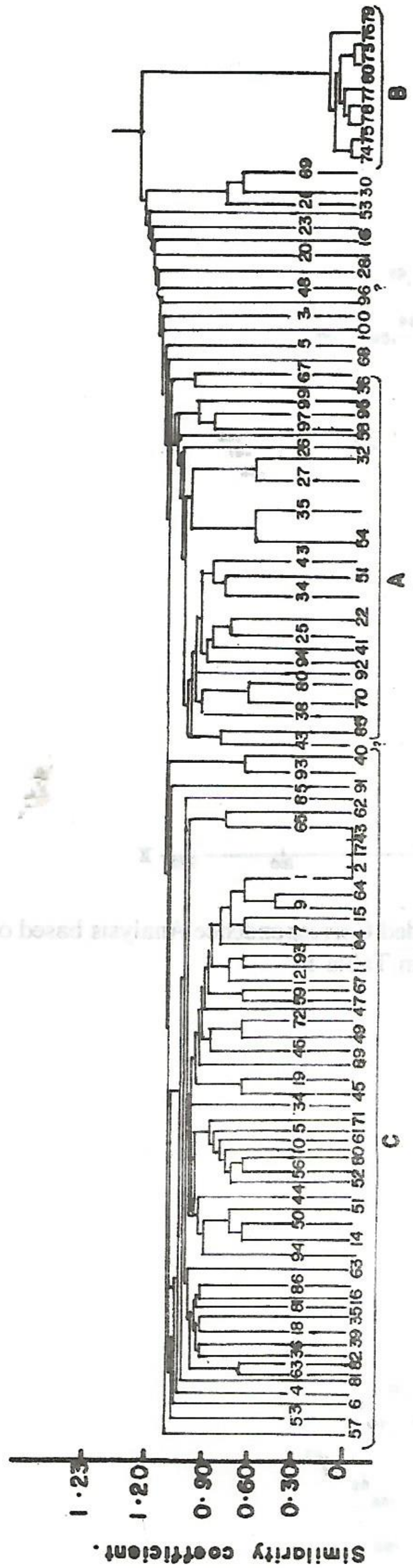

Figure 9: Phenogram showing the relationships of angroecoid species employing 18 characters. Numbers represent the species as shown in Table 1.

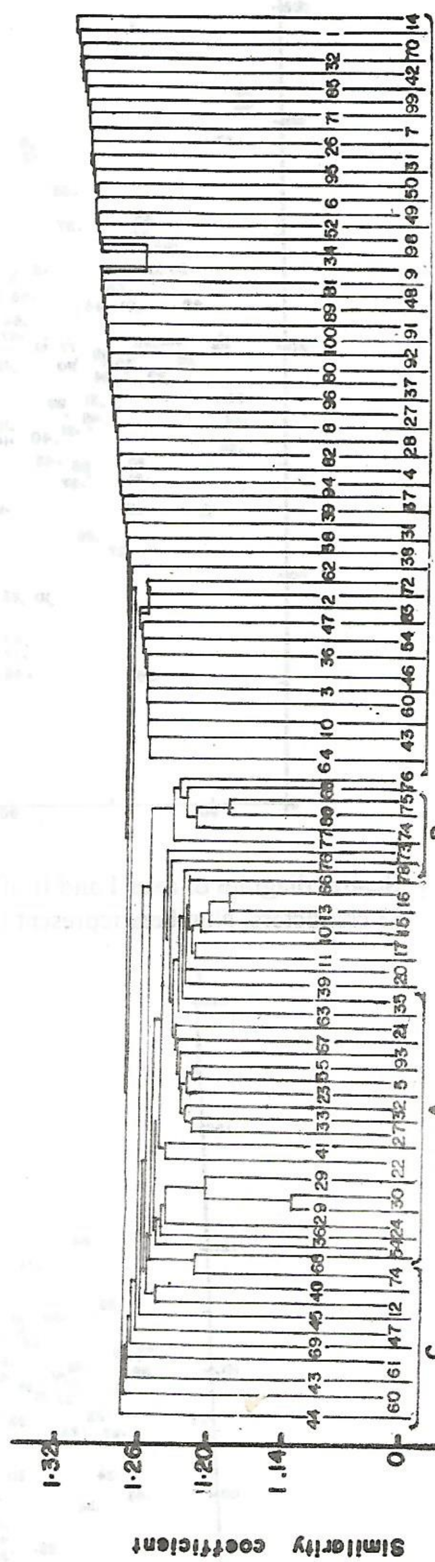

Figure 10: Phenogram showing the relationships of angroecoid species employing 37 characters. Numbers represent the species as shown in Table 1.

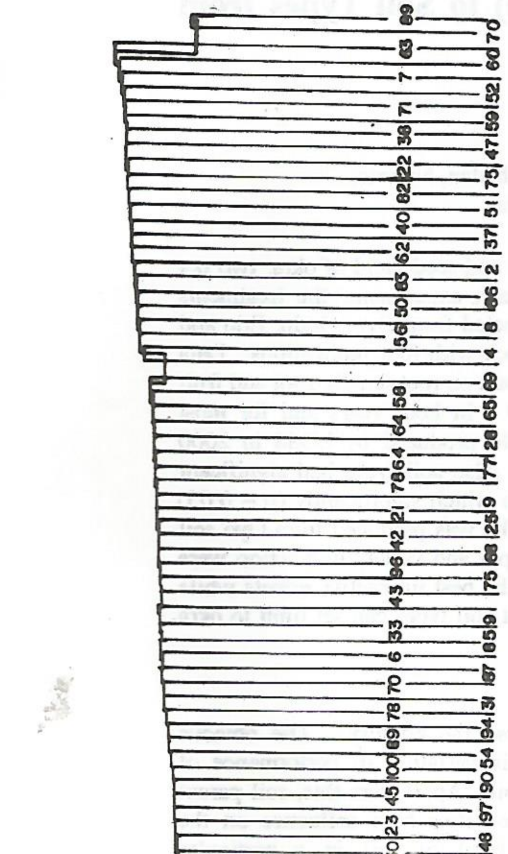

Figure 1 Phenogram showing the relationships of angroecoid species employing 63 characters. Numbers represent the species as shown in Table 1

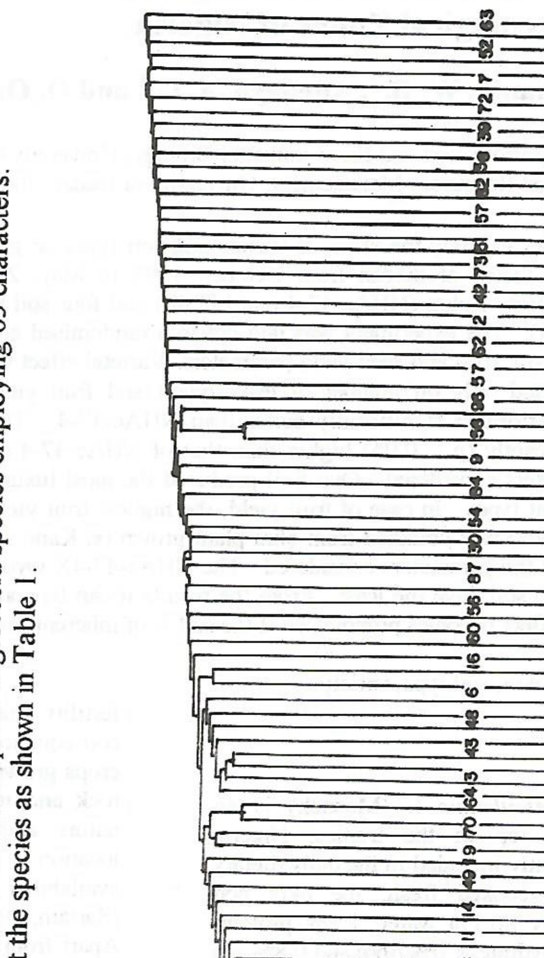

Figure 12: Phenogram showing the relationships of angroecoid species employing 86 characters. Numbers represent the species as shown in Table 1.