CHAPTER - V

CLADISTIC ANALYSIS

CHAPTER - 5

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5.1 Introduction

Cladistics is a method by which the organisms are ranked entirely on the basis of recency of common descent, that is on the basis of sequence of dichotomies in the inferred phylogeny. It aims at decreasing the amount of subjectivity and intuition. Cladistics, in strict sense, does not allow the existance of polyphyletic groups or an existing taxon to be ancestral to any other existing taxon. The cases of parallelism, convergence, divergence and the hybridization cannot be represented in a cladistic treatment. The polarity of characters as well as the selection of out-groups are mostly left to the judgement of the taxonomists, thus increasing the subjectivity. Of the many cladograms theoretically possible, the one which is most paraimonious is selected preferably by a computer. Cronquist (1987) while thoroughly criticising the cladism, calls for restraint on the indiscriminate usage of the method in deducing phylogeny. He suggests exercising a rational consideration in the selection of characters and advises to prepare the cladogram manually on the basis of wagner's ground plan-divergence method (Wagner, 1980).

In the present work, 29 genera belonging to the family Euphorbiaceae have been subjected to a cladistic treatment using characters selected from morphology, anatomy and chemistry.

5.2 Methods

In the present work, 17 characters from morphology, anatomy and chemistry have been used for the construction of a cladogram. Polarity of the morphological and anatomical characters is assessed following Cronquist (1968), Hutchinson (1948) and T Takhtajan (1980). For the chemical characters the known biosynthetic pathways and correlation studies were used to determine polarity. The selected characters and their plesiomorphic and apomorphic states are represented in Table-15. The distribution of these characters in the taxa studied is represented in Table-16. An advanced (apomorphic) character is given the score-1 while the primitive (plesiomorphic) character is given the score-0.

Wagner's bulls eye chart, consisting of a number of concentric semicircles having a common base point, is prepared in which each semicircle represents a single evolutionary state. These semicircles are given numbers 1,2,3 etc. The total number of apomorphic characters corresponds to the total number of semicircles. The score of a taxon (i.e. the total number of apomorphic characters of a taxon) gives the extent of advancement that taxon attained and the corresponding semicircle in which it is to be placed.

The hypothetical ancestor having all the plesiomorphic characters, forms the ground plan. The construction of cladogram strictly follows the pattern of the formation of dichotomous keys of identification found in a flora. The length of the branch represents the total number of common characters of that group. Branching occurs at the point where some members of this group acquire additional advanced characters. From this node two branches diverge, one with the acquired characters and the other without them. Further branching occurs with the acquisition of more characters. The most advanced taxon occupies the farthest semicircle and that taxon with least advanced characters occupies the lowest semicircle.

The polarity of all the 17 characters taken is well established. The advanced character is given the score-1 and primitive character-0.

5.3. Discussion

The family as a whole shows dominance of primitive characters. Macaranga and Acalypha with a score of 9 show the highest level of advancement followed by Mallotus, Sebastiania, Drypetes and Excoecaria with a score of 8 each. The dichotomy occurs below the first semicircle due to the elimination of flavonols in one group and this leads to the formation of two groups A (without flavonols) and B (with flavonols). There are 8 genera in group A with H. Hevea occupying the 5th level,

Trewia, Chrozophora and Hura at 6th level, Jatropha 7th, Mallotus 8th, Macaranga and Acalypha at the 9th level of advancement.

The group A proceeds to level three due to their two apomorphic characters viz. the introduction of flavones and the elimination of proanthocyanins (characters 2 & 4). Of the 8 genera of this group 6 show methoxylated flavones (character 3) and form a branch diverging from the other branch containing Hevea and Hura which could not achieve any methoxylation in flavones. In the second branch Hevea reaches the level of 5 and since Hura has all the characters of Hevea, the former is derived from the latter. From the dichotomy at level 3, the first branch proceeds further due to their methoxyflavones to level four where it further divides to two, the former with unisexual and bisexual flowers (character 15) and the latter with bisexual flowers only. The unisexual flowers and the loss of tannins in the group takes this branch two circles ahead of level six which is the evolutionary level achieved by Trewia. The two remaining plants of this group Mallotus and Macaranga evolve together but the former diverges from the latter by acquiring dioecious flowers. From the branch which produces only bisexual flowers, Chrozophora diverges to the level six due to the acquisition of syringic acid and the other branch terminates in Acalypha through Jatropha at level 7.

The group B which is characterised by the flavonols, divides into two branches at level 1 resulting in a branch B_1,

which contain plants having lesser number of fertile stamens (less than 10- character 13) and the other B_2 with more than 10 fertile stamens. The former branch (stamens less than 10) proceeds to level 2 where a dichotomy occurs due to the elimination of proanthocyanins in some members and retention of these compounds in the former. The branch with proanthocyanins contains Cicca, Bridelia and Pedilanthus. Bridelia diverges early from the other two and the Pedilanthus is derived from Cicca. The other group without proanthocyanins reaches the level 3 where Sapium is placed. From this point two branches arise one which eliminates syringic acid and the other retains it. The former branch evolves further where Emblica is placed at level four. From Emblica, Kirganelia evolves on one side and Breynia on the other side. Breynia gives rise to Euphorbia, Manihot and Phyllanthus. The origin of Sebastiania and Drypetes is traced (doubtfully) to Phyllanthus. The second branch possessing syringic acid branches into three branches leading to Cleistanthus, Tragia and Aporosa. Excoecaria is derived from Tragia. The branch containing plants characterised by many stamens divides further into two branches. The former line ends in a dichotomy of Ricinus and Baliospermum and the latter to Dalechampia and Croton. Securinega is derived from Dalechampia.

When a comparison of the cladogram is made with that of the existing classifications, it shows the greatest similarity with the system of Bentham and Hooker. A total number of 17

genera have been studied from the Crotoneae of Bentham and Hooker, out of which 8 are in group A. Out of the remaining nine (9) four are in group B_2 and 5 in group B_1. Thus the tribe Crotoneae of Bentham and Hooker is distributed in 3 different groups of the cladistic system. Tribe Euphorbieae and Phyllantheae of Bentham and Hooker forms a single group (group B_1) in the cladistic arrangement. Except the genus Securinega, all other genera of the tribe Phyllantheae in Bentham and Hooker come under the group B_1 along with the tribe Euphorbieae.

Euphorbia and Pedilanthus have the same level of advancement but not a recent common ancestry. The similarities between these genera appear to be a case of convergence in evolution. Trewia, Mallotus and Macaranga which have been put in subtribe Acalypheae have also come closely on the cladogram.

Websters, Acalyphoideae is also close to group A in which out of the 8 genera studied 5 come under group A in the cladogram. Similarly Webster's Euphorbioideae, all members except Hura are grouped under group B_1 in the cladogram.

Group A	Group B_1
1. Trewia	1. Bridelia
2. Mallotus	2. Cleistanthus
3. Macaranga	3. Phyllanthus
4. Acalypha	4. Drypetes

Group A

5. Jatropha
6. Chrozophora
7. Hura
8. Hevea

Group B_1

5. Breynia
6. Aporosa
7. Emblica
8. Kirganelia
9. Cicca
10. Sapium
11. Manihot
12. Tragia
13. Baccaeria
14. Sebastiania
15. Euphorbia
16. Pedilanthus

Group B_2

1. Croton
2. Dalechampia
3. Securinega
4. Anliospermum
5. Ricinus

Table - I5 Showing the characters and their apomorphic and plesiomorphic states

Sr.No.	Characters	Plesiomorphic Score = 0	Apomorphic Score = 1
1	Flavonoids	Present	Absent
2	Flavones	Absent	Present
3	Methoxylated flavones	Absent	Present
4	Proanthocyanins	Present	Absent
5	Iridoids	Absent	Present
6	Tannins	Present	Absent
7	Syringic acid	Present	Absent
8	Woody habit	Present	Absent
9	Distribution of sexes	Monoecious	Dioecious
10	Carpels	Pentacarpellary	Tricarpellary
11	Leaves	Simple	Compounds
12	Ranunculaceous stomata	Present	Absent
13	No. of fertile stamens	Ten	Less than 10
14	No. of styles	Three	One
15	Inflorescence	Racemose	Cymose
16	Flavonols	Present	Absent
17	Inflorescence or cyathia like	Absent	Present

Table -16. The distribution of the various characters in 29 genera of the Euphorbiaceae

Sr.No.	Name of the Genera	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
1	Breynia	-	-	-	+	-	+	+	+	-	+	-	-	+	-	-	-	-	6
2	Manihot	-	-	-	+	-	+	+	+	-	+	+	-	+	-	-	-	-	7
3	Drypetes	-	-	-	+	-	+	+	+	+	-	-	-	+	-	+	-	-	7
4	Kirganelia	+	-	-	+	-	-	+	+	-	-	-	-	+	-	-	-	-	5
5	Emblica	-	-	-	+	-	-	+	-	-	+	-	-	+	-	-	-	-	4
6	Aporosa	-	-	-	+	-	+	-		+	+	-	-	+	-	-	-	-	5
7	Excoecaria	-	+	+	+	-	+	-	+	-	+	-	-	+	-	+	-	-	8
8	Tragia	-	-	-	+	-	+	-	+	-	+	-	-	+	-	-	-	-	5
9	Cleistanthus	-	-	-		-	+	-	-	-	+	-	-	+	-	-	-	-	4
10	Phyllanthus	-	-	-	+	-	+	+	+	-	+	+	-	+	-	-	-	-	7
11	Sebastiania	+	-	-	+	-	+	+	+	-	+	-	-	+	-	-	-	-	7
12	Sapium	-	-	-	+	-	+	-	-	-	-	-	-	+	-	-	-	-	3
13	Pedilanthus	-	-	-	-	+	+	+	+	-	+	-	-	+	-	-	-	+	7
14	Bridelia	-	-	-	-	-	+	-	+	-	+	-	-	+	-	+	-	-	5
15	Euphorbia	-	-	-	+	-	+	+	+	-	+	-	-	+	-	-	-	+	7
16	Cicca	-	-	-	-	-	+	+	-	-	+	+	-	+	-	-	-	-	5

Table -16 (Contd.)

Sr.No.	Name of the Genera	Characters 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
17	Securinega	-	-	-	+	+	+	+	-	-	+	-	-	-	-	+	-	-	6
18	Dalechampia	-	-	-	+	-	+	+	+	-	+	-	-	-	-	-	-	+	6
19	Croton	-	-	-	+	+	+	+	-	-	+	-	-	-	-	-	-	-	5
20	Ricinus	+	-	-	+	-	+	+	+	-	+	-	-	-	-	-	-	-	6
21	Heliospermum	+	-	-	+	-	-	-	+	+	+	-	+	-	-	+	-	-	7
22	Acalypha	-	+	+	+	-	+	+	+	-	+	-	-	+	-	-	+	-	9
23	Mallotus	-	+	+	+	-	+	-	-	+	+	-	-	-	-	+	+	-	8
24	Trewia	-	+	+	+	-	+	-	-	-	-	-	-	-	-	+	+	-	6
25	Hevea	-	+	-	+	-	+	-	-	-	+	+	-	-	-	-	+	-	6
26	Hura	-	+	-	+	-	+	+	-	-	+	-	-	-	-	-	+	-	6
27	Jatropha	-	+	+	+	-	+	+	-	-	+	-	-	-	-	-	+	-	7
28	Macaranga	-	+	+	+	-	+	+	-	+	-	-	-	+	-	-	+	-	8
29	Chrozophora	-	+	+	+	-	-	-	+	-	+	-	-	-	-	-	+	-	6

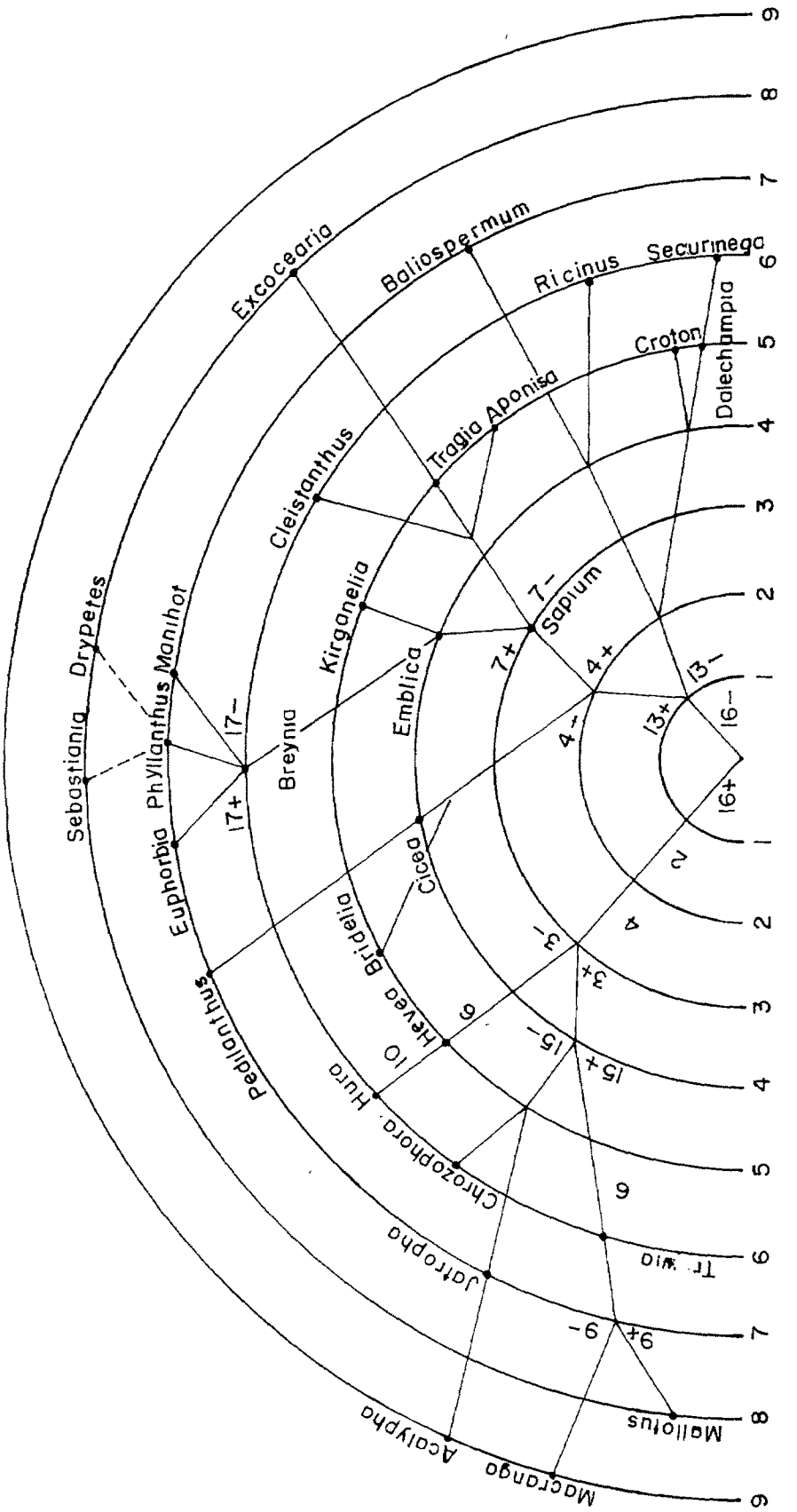

Fig.5. A CLADISTIC ANALYSIS OF 29 GENERA BELONGING TO THE FAMILY EUPHORBIACEAE.