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NODAL ANATOMY OF SOME HITHERTO UNSTUDIED EUPHORBIACEAE

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Nodal anatomy of twenty-six species belonging to twenty-one genera of the family Euphorbiaceae have been studied. The present study revealed trilacunar, three traced; one lacunar, one traced and pentalacunar, five traced condition in the family. However, the latter two conditions are noted only in two species. Obviously, the trilacunar, three traced condition is more prevalent and hence thought basic for the family Euphorbiaceae. The association of stipules, reduction or amplification of nodal vasculature are pertinently discussed.

Keywords : Euphorbiaceae; Nodal organization.

Introduction

Nodal anatomical study have been carried out in the family Euphorbiaceae in past[1-6]. The present authors also extended observations on similar line on eleven euphorbiaceous species[7]. However, some more taxa have been investigated which forms the subject matter of this communication.

Materials and Methods

The plants collected from various places, like Nakane Dam (Dhule District, Maharashtra), Peint, Harsul Forest (Nasik District, Maharashtra), Radhanagari, Dajipur Forest (Kolhapur District, Maharashtra), Ootakamund Government Botanical Garden (Ootakamund, Tamil Nadu), were preserved in 70 % alcohol. Healthy herbarium materials from S I N U Botanical Herbarium Singapore, Rancho Santa Ana Botanic Garden Claremont (U. S. A.) and preserved plant material from Auckland War Memorial Museum Auckland (New Zealand) were obtained.

Herbarium materials whenever used were first boiled in water for 5 – 10 minutes. Few drops of acetic acid were added to soften and to help recovery of tissue to natural state, with a gap of few minutes after boiling, the materials were washed in water and kept ready for next stage of operation.

Results and Discussion

1) *Acalypha indica* Linn.: Leaves are alternate and stipulate. The stem-axis contain a ring of vascular tissue (Fig.1). A median vascular trace departs a little earlier, however, a lateral traces do so a little latter (Fig.2). The stipules do not receive vascular supply from the laterals. They are minute and non-vascularised. Thus, the nodes are trilacunar, three trace.

2) *Agrostistachys indica* Dalz.: Leaves are alternate and exstipulate. A continuous ring of vascular tissue extend in the stem-axis (Fig.3). The two lateral traces on either side emerge first (Fig.4). The median trace departs higher up. It is prominent (Fig.5). The lateral traces, however, split in their upward course (Fig.6). All the traces extend into the petiole. The nodes are trilacunar, three trace.

3) *Aporosa lindleyana* (Wight) Baillon : Leaves are alternate and stipulate. The stem-axis contains a continuous ring of vascular tissue (Fig.7). The lateral as well as median trace departs simultaneously (Fig.8). The laterals do not bear vascular tissue for the stipules. The stipules are thus evascular. The laterals in their upward course divide (Fig.9). All the traces, the median and the laterals extend into the petiole. The nodes are trilacunar three trace.

4) *Baliospermum axillare* (Wight) Baillon: Leaves are alternate and stipulate. Stipules are described as biglandular at base in taxonomic accounts. A continuous vascular cylinder extend in the stem-axis (Fig.10). It is the median trace that emerged first from it (Fig.11). The lateral traces on either side departs a little higher up (Fig.12). The lateral traces in their upward course however do not send vascular supply towards the biglandular stipules (Fig.13). The laterals and median trace extend into the petiole. The node is trilacunar, three trace.

5) *Bridelia retusa* Spreng: Leaves are alternate and stipulate. A continuous ring of vascular tissue extend in the stem-axis (Fig.14). The median trace departs first (Fig. 15). The lateral do so a little farther up (Fig.16). The stipules do not receive vascular supply from the laterals. They are evascular. The laterals as well as the median trace extend into the petiole. The petiole is slightly three-pronged (Fig.17). The nodes are thus trilacunar, three traced.

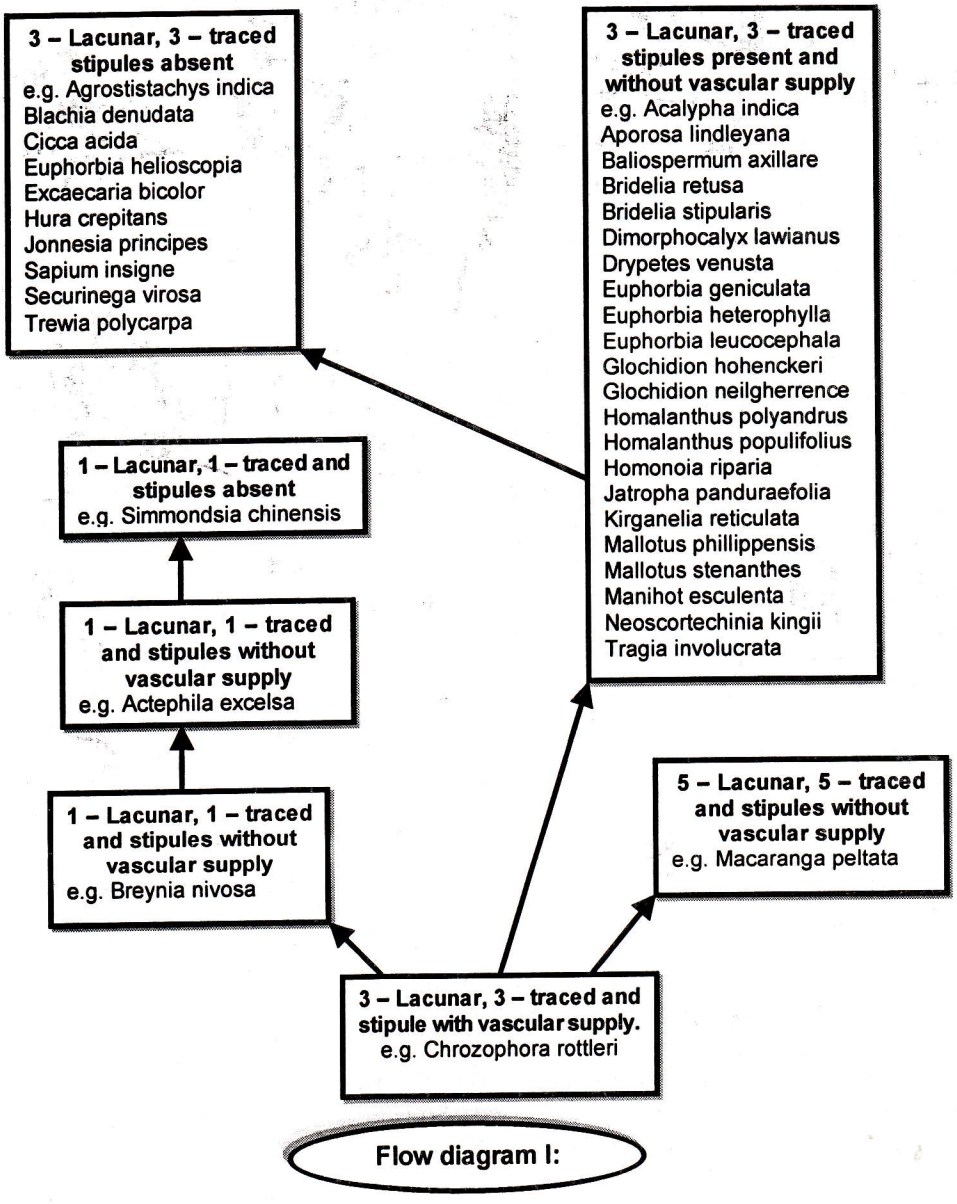
6) *Bridelia stipularis* Blume: Leaves are alternate and stipulate. The stem – axis contains a continuous vascular cylinder (Fig.18.). The median and lateral traces emerge

more or less simultaneously from it (Fig.19.). All these traces extend upwards and enter into the petiole (Fig.20 - 21.). The stipules do not receive vascular supply from the lateral traces. Thus they are non-vascular. The nodes are thus trilacunar, three trace.

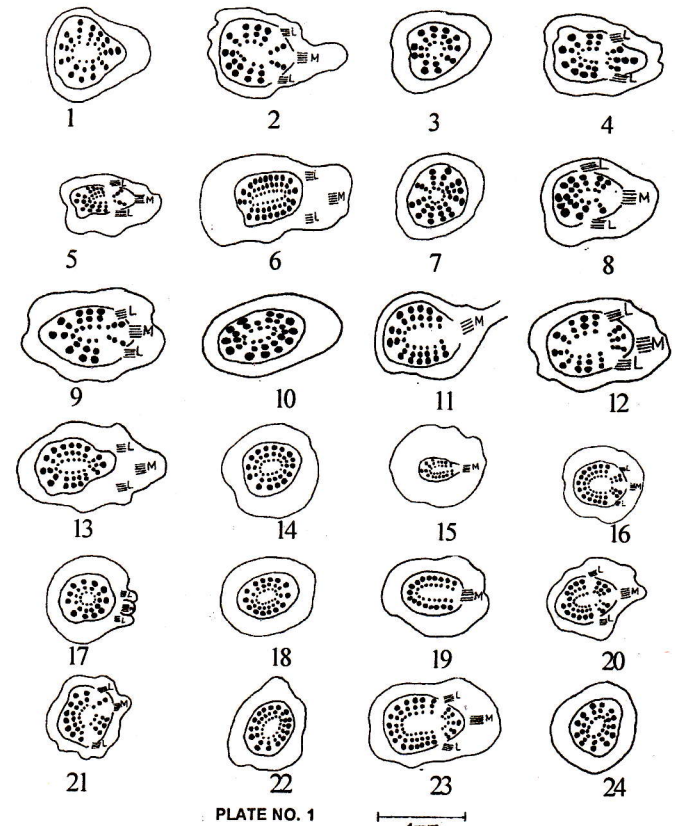
7) *Cicca acida* Merr.: Leaves are alternate and exstipulate. The stem-axis contains a continuous ring of vascular tissue (Fig.22). The laterals as well as the median trace emerge simultaneously from it (Fig.23). They extend upwards into the petiole (Fig.23). The nodes are three lacunar, three trace.

8) *Dimorphocalyx lawianus* Hook: Leaves are alternate and stipulate. The stem- axis contains a continuous vascular cylinder (Fig.24). The median trace departs first (Fig.25). The lateral traces emerges, however, little farther up (Fig.26). The median and lateral traces extend into the petiole (Fig.27). The stipules do not receive vascular supply from the lateral traces. Thus, they are non-vascular. The nodes are three lacunar, three trace.

9) *Drypetes venusta* (Wight) Pax. & Hoffm: Leaves are alternate and stipulate. The vascular supply of stem-axis contains a continuous vascular cylinder (Fig.28). It is the median trace that departs first from it (Fig.29). The lateral traces depart a little farther up (Fig.30). They do not bear vascular supply to the stipules. Stipules are evascular. The nodes are three lacunar, three trace.



The Probable Course of Evolution of Nodal Structure in Euphorbiaceae (*Sensu lato*)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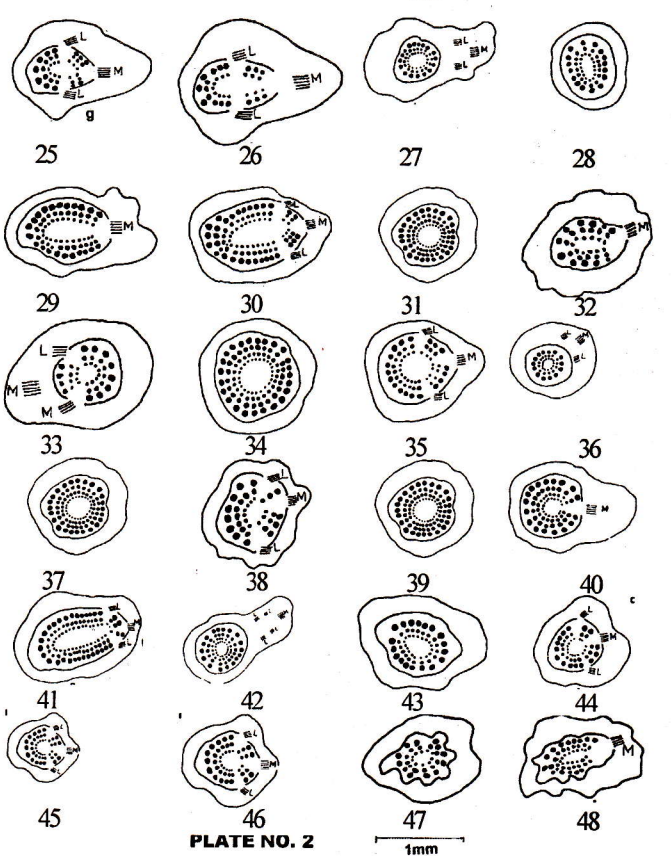
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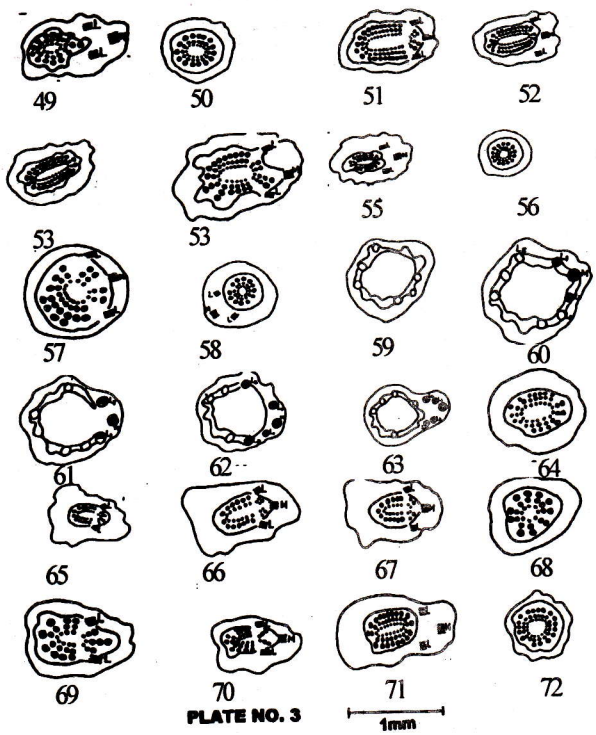

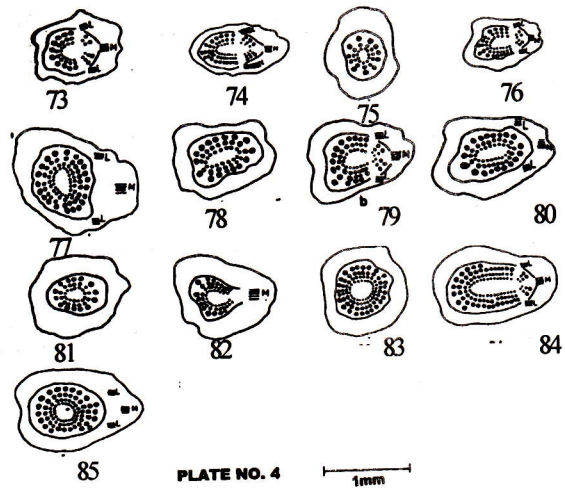

Abbrevations

M - Median Trace.

L - Lateral Trace.

Legends for Figures

Fig. 1 - 2. *Acalypha indica*, **Fig. 3 - 6.** *Agrostistachys indica*, **Fig. 7 - 9.** *Aporosa lindleyana*, **Fig. 10 - 13.** *Baliospermum axillare*, **Fig. 14 - 17.** *Bridelia retusa*, **Fig. 18 - 21.** *Bridelia stipularis*, **Fig. 22 - 23.** *Cicca acida*, **Fig. 24 – 27.** *Dimophocalyx lawianus*, **Fig. 28 - 30.** *Drypetes venusta*, **Fig. 31 -33.** *Euphorbia geniculata*, **Fig. 34 - 36.** *Euphorbia helioscopia*, **Fig. 37 - 38.** *Euphorbia heterophylla*, **Fig. 39 - 42.** *Homalanthus polyandrus*, **Fig. 43 – 46.** *Homalanthus populifolius*, **Fig. 47 - 49.** *Homonoia riparia*, **Fig.50 – 52.** *Hura crepitans*, **Fig. 53 – 55.** *Jatropha panduraefolia*, **Fig. 56 - 58.** *Jonnesia principes*, **Fig. 59 – 63.** *Macaranga peltata*, **Fig. 64 - 67.** *Mallotus phillippensis*, **Fig. 68 – 71.** *Mallotus stenanthes*, **Fig. 72 - 74 .** *Manihot esculenta*, **Fig. 75 - 77.** *Neoscortechinia kingii*, **Fig. 78 - 80.** *Sapium insigne*, **Fig. 81 – 82.** *Simmondsia chinensis*, **Fig. 83 – 85.** *Trewia polycarpa*.

11) *Euphorbia geniculata* Linn. : Leaves are alternate and exstipulate. The vascular tissue of the stem – axis contains a continuous ring of vascular tissue (Fig.31). The laterals and the median trace depart simultaneously (Fig. 32). They extend upwards into the petiole (Fig. 33). The nodes are trilacunar, three trace.

12) *Euphorbia helioscopia* Linn. : Leaves are alternate and exstipulate. The stem axis contains a continuous ring of vascular tissue (Fig.34). All the three traces – a median and two laterals, departs simultaneously from it (Fig.35). They extend upwards into the petiole (Fig.36). The nodes are trilacunar, three trace.

13) *Euphorbia heterophylla* Linn.: Leaves are alternate and exstipulate. A continuous ring of vascular tissue extend in the stem – axis (Fig.37). The laterals as well as median trace emerge simultaneously (Fig.38). They extend upwards into the petiole. The nodes are trilacunar three trace.

14) *Homalanthus polyandrous* Cheesem. : Leaves are alternate and stipulate. The stem – axis contains a continuous ring of vascular tissue (Fig. 39). The median trace departs first from it (Fig.40). The lateral traces departs little higher up (Fig. 41). They do not bear vascular supply to the stipules. The stipules are non - vascular. However, they split in their upward course towards the petiole (Figs. 41 –42). The nodes are trilacunar, three trace.

15) *Homalanthus populifolius* Graham. : Leaves are alternate and stipulate. The stem – axis contains a continuous ring of vascular tissue (Fig. 43). The median trace departs first from it (Fig. 44). The lateral traces departs little higher up (Fig. 45). They do not bear vascular supply to the stipules. The stipules are nonvascular. However, they splits in their upward course towards the petiole (Figs. 45 –46). The nodes are trilacunar, three trace.

16.) *Homonoia riparia* Lour : Leaves are alternate and stipulate. The stem-axis contains a continuous ring of vascular tissue (Fig. 47). The median trace departs first from it (Fig. 48). The Lateral traces emerge little higher up (Fig.48). All the three traces extend in the petiole. The stipules however do not receive vascular supply from the lateral traces (Fig. 49) and thus are evascular. The nodes are trilacunar, three trace.

17) *Hura crepitans* Linn. : Leaves are alternate and exstipulate. A continuous ring of vascular tissue is present in the stem – axis (Fig.50). The lateral as well as median trace departs more or less simultaneously from it (Fig.51). All the three traces – two laterals and median one, continue in the petiole in their upward course (Fig. 52). The nodes are trilacunar, three trace.

18) *Jatropha panduraefolia* Andr. : Leaves are alternate and stipulate. The stem – axis contains a ring of continuous vascular tissue (Fig. 53). The lateral traces and the median departs simultaneously from it (Fig. 54). All the three traces extend upwards in the petiole. The lateral traces do not provide vascular supply to the stipules (Fig. 54 –55). The stipules are evascular. The nodes are thus trilacunar, three trace.

19) *Jonnesia principes* Vella.: Leaves are alternate and exstipulate. A continuous ring of vascular tissue is present in the stem – axis (Fig. 56). The three traces – two laterals and a median one emerge simultaneously from it. (Fig. 57). The laterals as well as the median one continue in the petiole in their upward course (Fig. 58). The nodes are thus trilacunar, three trace.

20) *Macaranga peltata* Muell. - Arg.: Leaves are alternate and stipulate. The stem axis contains a wavy ring of continuous vascular tissue (Fig. 59). Five traces are resolved upwards but below the nodal region. They ultimately represent as – the median trace and two others on each side representing lateral traces - L1, L2 (Fig.60). The median trace and the adjacent lateral trace (L1) departs slightly early and extends upwards (Fig. 61). Afterwards the remaining lateral traces (L2) emerge from the vascular ring and then extend upwards (Fig. 62). Thus all the five traces – the median one and total four lateral traces continue in the petiole (Fig. 63). The stipules do not receive vascular supply. The nodes are pentalacunar, five trace.

21) *Mallotus phillippensis* (Lamk.) Muell.–Arg.: Leaves are alternate and stipulate. A continuous ring of vascular tissue present in the stem – axis (Fig. 64). The lateral on either side emerge first from it (Fig. 65). The median trace resolves little upward (Fig.67). The median as well as lateral traces continue in the petiole (Fig. 66, 67). The stipule do not receive vascular supply from laterals (Fig. 66, 67). They are non- vascular. The nodes are trilacunar, three trace.

22) *Mallotus stenanthes* Muell. – Arg.: Leaves are alternate and stipulate. A continuous ring of vascular tissue present in the stem –axis (Fig. 68). The laterals on either side emerge first from it (Fig. 69). The median trace resolves little upward (Fig 70). The median as well as lateral traces continue in the petiole (Fig. 70 –71). The stipule do not receive vascular supply from laterals (Fig.70 –71). They are non-vascular. The nodes are trilacunar, three trace.

23) *Manihot esculenta* Crantz.: Leaves are alternate and stipulate. The stem – axis contains a continuous vascular cylinder (Fig. 72). The two lateral traces and median one departs simultaneously (Fig. 73). They continue upward course in the petiole (Fig. 73–74). The lateral traces do not provide vascular supply to the stipules, thus stipules are evascular. The nodes are trilacunar, three traced.

24) *Neoscortechinia kingii* Hook. f.: Leaves are alternate and stipulate. The stem – axis contains a continuous ring of vascular tissue (Fig. 75). The lateral as well as median trace departs more or less simultaneously (Fig. 76). The lateral traces do not bear vascular supply to the stipules (Fig. 76 –77). The stipules are evascular. All the three trace

continue in the petiole upwards (Fig. 77). The nodes are thus trilacunar, three trace.

25) *Sapium insigne* Benth.: Leaves are alternate and exstipulate. The stem – axis contains a continuous ring of vascular tissue (Fig. 78). It is the median trace that departs first from it (Fig. 79). The lateral traces departs a little higher up (Fig. 80). All these continues in their upward course into the petiole. The nodes are trilacunar, three trace.

26) *Simmondsia chinensis* (Link.) C. K. Schneid.: Leaves are alternate and exstipulate. The stem – axis contains a continuous ring (Fig. 81). A solitary prominent trace departs from it (Fig. 82) which continues in the petiole in its upwards course. The nodes are unilacunar, one trace.

27) *Trewia polycarpa* Benth : Leaves are opposite as well as subopposite and exstipulate. The stem axis contains a continuous ring of vascular tissue (Fig.83.). median and two lateral traces departs simultaneously (Fig. 84). They continue upwards in the petiole (Fig. 85). The nodes are trilacunar, three trace.

The earlier study by the authors[7] revealed a trilacunar, three traced condition more prevalent, whereas unilacunar, one trace is noted in few euphorbiaceous taxa. They also reached to a conclusion that the trilacunar, three traced condition is basic for the family. The present attempt includes nodal anatomical information of mature nodes of unstudied twenty-six species belonging to twenty-one genera of the Euphorbiaceae. Majority of taxa show trilacunar, three traced condition. An unilacunar, one trace condition is observed in *Simmondsia chinensis*. It is also to be noted that in *Macaranga peltata* the nodes are pentalacunar, five traced. which appears a derived condition in relation to the larger size of the leaves. Likewise, the reduction of vascular supply to the leaves in case of *Simmondsia chinensis* can be conceived into relation to the size of leaves. Thakur and Patil[7], reached to a similar conclusion in their earlier communication on some euphorbiaceous taxa.

The trilacunar, three traced is usually associated with the stipulate condition in majority of species except *Agrostistachys indica*, *Cicca acida*, *Euphorbia helioscopia*, *Euphorbia heterophylla*, *Hura crepitans*, *Sapium insigne* and *Trewia polycarpa* of the present account. It is also generally thought that the leaves with unilacunar nodes are exstipulate[8]. The taxon viz., *Simmondsia chinensis* have unilacunar nodes but associated with stipulate condition of leaves e.g. *Actephila excelsa* and *Breynia nivosa*. The stipules are non-vascular in *Actephila exelsa* and *Simmondsia chinensis*, whereas they are vascularised in *Breynia nivosa*. It appears that trilacunar nodes, vascularised stipules and stipulate leaves appear evolved in three different ways. First, only the stipules are lost and their corresponding laterals are not suppressed. Second, both the stipules and their corresponding laterals are suppressed totally culminating into unilacunar nodes with exstipulate condition. Third, sometimes only the corresponding laterals are lost, and the stipules are still present. This is also noted in some Rubiaceae[9] and celastralean taxa[10]. Obviously, the unilacunar condition appears a later attainment. The conclusions deducted from the earlier account (*cf.* Thakur and Patil[7]) and the present one are represented in the flow diagram – I.

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References

1. Sinnott E W 1914, Investigations on the phylogeny of the angiosperms I.The anatomy of the node as an aid in the classification of the angiosperms. *Amer.J.Bot.* **1** 303-322.
2. Von Veh R 1928, Beitrage Kenntnis der Anisophyllum Euphorbiaceen und einige vergleichnde und entwicklungs schicht liche Untersuchungen uber die Druse des Cyathiums. *Ann.Jard.Bot.Buiten.* **38** 131-143.
3. Reynolds 1942, Development of the nodes in *Ricinus communis. Bot.Gaz.* **104** 167-170.
4. Sharma R 1972, Trends of specialization in the Euphorbiaceae I. The node. In: Biology of the Land Plants 78 - 89(Ed.V.Puri, Y.S.Murty, P.K.Gupta, and D.Banerjee) Sarita Prakashan, Meerut, India.
5. Patil D A 1988, Nodal anatomy of seedlings of some Euphorbiaceae IBC **5** 141-143.
6. Singh A 1992, Studies in Euphorbiaceae I. Trends of specialization in nodal Vasculature. *J. Indian Bot. Soc.* **51** 350-355.
7. Thakur and Patil 2002, Nodal Vasculature in some Euphorbiaceae. *Swami Botanical J. Bot.* **19** 59 – 62.
8. Sinnot E W and Bailey I W 1914, Investigations on the phylogeny of the angiosperms 3:Nodal anatomy and the morphology of the stipules *Amer.J.Bot.***1** 144-459.
9. Majumdar G P and Pal P K 1988, The stipules of the Rubiaceae: A Review. *Tran. Bose Res. Inst.* **22** 57 - 68
10. Shisode S B and Patil D A 2000, Nodal anatomical studies in some Celastrales. *J. Swamy Bot.* Cl. **22** 57 - 68