Occurrence and significance of cystoliths in Acanthaceae

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KEYWORDS
Cystolith , Taxonomy, Acanthaceae

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Introduction
It is doubtful that most of the taxonomic evidence is usually drawn from exomorphology of plants. This is so because of easily visible and convenient nature. Moreover, there is high degree of coincidence between the expressed phenotypic characters and the genotype of the taxon. Generally, micromorphological features are overlooked during routine taxonomic investigations. It is only when the exomorphic characters are felt inadequate, the micromorphological ones are employed for the said purpose. Use of microscopic features in plant classification has a long history. Directly visible chemical criteria are used in taxonomy. For example starch grains (Reichert, 1913: Takeoka, 1962), raphides (Gulliver, 1866; Gibbs, 1963; Tomlinsom, 1962: Jaccard and Frey, 1928 : Kharchenko, 1928), silica (Tomlinsin, 1961), gypsum (Brunswick, 1920), etc. have been conveniently employed in taxonomy. Crystals of calcium oxalate, so called cystoliths or lithocysts, have also similar significance. The present authors investigated foliar anatomical features of some Acanthaceae, of which cystoliths form a slender segment. Their observation along with a general review is being communicated in this contribution.

Materials and Methods
The plants were collected from various places like Tropical Botanic Garden and Research Institute, Palode, Thiruvanthapuram District (Kerala); Malbar Botanical Garden, Kozhikode (Kerala); Munnar, Idukki District (Kerala); Forest Research Institute, Pooch, Trichur (Kerala); Calicut University, Botanical Garden, Kozhikode (Kerala); Lal Bag Garden, Bangalore (Karnataka); Government Botanic Garden, Ootacamund (Tamilnadu) and Charanmal, District Dhule (Maharashtra). They were preserved in F.A.A. solution. The chemical method was followed for the separation of peels. Diluted nitric acid and chromic acid (5-10%) were used in different proportions. In some cases, Three Acid Treatment (TAT Method) was followed (Ramayya and Vanaja, 1979). Epidermal peels were stained in safranin (1%). They were and mounted in glycerin and cellular sketches were drawn using prism type of camera lucida. They were inked by using Camligraph or Rotring isographs technical pens with 0.1, 0.2, 0.3 points.

Results and Discussion
Cystoliths are silicified bodies with cellulose skeleton or occasionally not encrusted. They are generally found in laminar epidermis, petiolar epidermis and ground tissue. They exhibit different shapes, sizes and even colors. In some taxa, both ends of cystoliths are obtuse or acute, whereas in others one of the ends of cystolith are either obtuse or acute. They observed either single or double. This communication reviewed their occurrence in the family and highlighted their taxonomic significance.

www.currentbotany.org
ISSN: 2220-4822
ends are tapering in Strobilanthus anamallaicus (Fig.51), Stenosiphonion russellianum (Fig.48) and Pachystachys lutea (Fig.38). Both ends are rounded or obtuse in Andrographis alata (Fig.1), A. elongata (Fig.2), A. macrobotrys (Fig.3), A. stellalata (Fig.4-5), A. wightiana (Fig.6), Barleria prattensis (Fig. 7-8), Beloperone comosa (Fig. 10), B. nemorosa (Fig. 12), B. plumaginifolia (Fig. 14), B. punctata, Fittonia gigantea (Fig. 17), Goldfussia anysophylla (Fig.18-19), Hygrophila schuli (Fig. 21-22), Justicia carnea (Fig. 24), J. trinervia (Fig. 25-26), Mackenzia integerrifolia (Fig. 32), Pseuderanthemum malabaricum (Fig. 50-51). Abaxially one end is obtuse, however, in Strobilanthes ends rounded or obtuse. In Stenosiphonium russellianum (Fig. 48) and Pachystachys lutea (Fig.40-41), Stenosiphonium parviflorum (Fig. 46), S. russelii (Fig.49), Strobilanthus anamallaicus (Fig.50), S. asperrimus (Fig.52), S. barbatus (Fig.53-54), S. benzaccordinis (Fig.55-56), S. cinereus (Fig.57), S. glanduloso (Fig.58) and S. lupinus (Fig. 63). However, in some cases like Barleria pratensis (Fig. 7-8), Beloperone comosa (Fig. 9-10), B. nemorosa (Fig. 11-12), B. plumaginifolia (Fig.13-14), Mackenzia integerrifolia (Fig. 31-32), Perianthum malabaricum (Fig. 49-51), Stenosiphonion parviflorum (Fig. 46-47), Strobilanthus citates (Fig.57-58), and S. lupinus (Fig. 63-64). Adaxially cystoliths show one end tapering and other end obtuse but abaxially cystoliths show both ends rounded or obtuse. In Stenosiphonion russellianum (Fig. 48-49) adaxially cystoliths show both ends tapering, while abaxially one end is obtuse. However, in Strobilanthus anamallaicus (Fig. 50-51) abaxially cystoliths show both ends tapering, while adaxially one end is obtuse. In Pachystachys lutea adaxially cystoliths are tapering at both ends.

Occurrence of cystoliths in the Acanthaceae have been repeatedly reported by various workers. Solereder (1908) mentioned double cystoliths in Glossoschis durechellii (Barleriae). The genus Lasiocladus has also double cystoliths. They are fusiform in shape e.g. Petalidium barleriodes and Sautieria deceseae (Ruelliae). They are elongated with either equal or pointed or rounded at one end (Fig. 15-18). They have different shapes and sizes. They occur as simple, double, triple or even joined together forming chains and aggregates of varying shapes. The shape, as stated earlier, are round, oval, oblong, conical, arc-shaped, bean-shaped or bent sharply like T-, Y-, or V-shaped. The elongated cystoliths may be spindles or spiny-shaped with both ends blunt or obtuse, one end blunt and other pointed, or both ends pointed. These features can be conveniently employed in taxonomic distinctions. They can be used in such considerations either exclusively or in conjunction with other endomorphic or exomorphic features of plants. Metcalfe and Chalk (1950) gave a systematic account of cystoliths in the family Acanthaceae. They categorized them into seven different groups based on the features noted above. Accordingly, some particular groups of genera can be recognized containing distinct groups. Ahmad (1975) extended similar observations in some species of Lepidagathis and Barleria. He noted solitary cystoliths in Lepidagathis, whereas they are usually double in the species of Barleria. The condition in Barleria is confirmed by Shendage and Yadav (2009) while studying 22 species and two varieties of the genus Barleria. Ahmad (1975) although pointed out absence of cystoliths in the subfamily Thunbergioideae, Kumar and Paliwal (1975) observed their presence in one of the species of Thunbergia viz., Thunbergia laevis. This appears to be an exceptional case.

Taxonomic and Significance

Occurrence of cystoliths in the vegetative parts is considered characteristic for the family Acanthaceae. Even their presence is also marked out in some taxonomic accounts (Hutchinson, 1969: 1973: Cronquist, 1988: Rendle, 1959, etc.). It has received attention of many plant anatomists (cf. Metcalfe and Chalk, 1950; Solereder, 1908: Ahmad, 1975: 1976: 1979; Kumar and Paliwal, 1975: Karlstrom, 1979, 1980: Do, Anima, 1986a, b). The earlier and present accounts revealed different features of cystoliths. They have different shapes and sizes. They occur as simple, double, triple or even joined together forming chains and aggregates of varying shapes. The shape, as stated earlier, are round, oval, oblong, conical, arc-shaped, bean-shaped or bent sharply like T-, Y-, or V-shaped. The elongated cystoliths may be spindles or spiny-shaped with both ends blunt or obtuse, one end blunt and other pointed, or both ends pointed. These features can be conveniently employed in taxonomic distinctions. They can be used in such considerations either exclusively or in conjunction with other endomorphic or exomorphic features of plants. Metcalfe and Chalk (1950) gave a systematic account of cystoliths in the family Acanthaceae. They categorized them into seven different groups based on the features noted above. Accordingly, some particular groups of genera can be recognized containing distinct groups. Ahmad (1975) extended similar observations in some species of Lepidagathis and Barleria. He noted solitary cystoliths in Lepidagathis, whereas they are usually double in the species of Barleria. The condition in Barleria is confirmed by Shendage and Yadav (2009) while studying 22 species and two varieties of the genus Barleria. Ahmad (1975) although pointed out absence of cystoliths in the subfamily Thunbergioideae, Kumar and Paliwal (1975), however, observed their presence in one of the species of Thunbergia viz., Thunbergia laevis. This appears to be an exceptional case.

Acknowledgements

The authors are grateful to Dr. E.S. Santoshchukumar, Department of Botany, Tropical Botanical Garden and Research Institute, Palode (Kerala) 1 Dr. A.K. Pradeen, Dept. of Botany, University of Calicut, Kozikode (Kerala) for collection and identification of some plant materials. They are thankful to Dr. Muktesh Kumar, Botany Division, Kerala Forest Research Institute, Peechi, Trichur (Kerala), Mr. Kulloli Shreshhail K. Junior Research fellow, Tropical Botanical Garden and Research Institute, Palode (Kerala), for authorizes of Government Botanical Garden, Ootacamund (Tamilnadu), Lalbag Garden, Bangalore.
(Karnataka), Malbar Botanical Garden, Kozikode (Kerala) for their help in collection of plant materials. Junior author (AMP) thankful to his colleague Mr. C. R. Patil for his help during botanical outings. He heart fully thanks Honorable Kakasaheb Vasantrao More, the Chairman, and also the Principal of his college for laboratory facilities and inspirations.

Fig: 1-30 Cystoliths in surface view

Fig: 31-52 Cystoliths in surface view
Fig. 53-64 Cystoliths in surface view


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*Original not consulted.*