

DICHOTOMOUS VENATION AND ANASTOMOSIS IN THE COROLLA OF AN ORCHID—*HABENARIA DENTATA* (SW.) SCHLTR.

BY K. SUBRAMANYAM, F.A.Sc. AND N. C. NAIR

(*Botanical Survey of India, Calcutta*)

Received September 5, 1973

ABSTRACT

The lip of the corolla in *Habenaria dentata* (Sw.) Schltr. is tripartite. The lateral lobes show dichotomously branched veins. While the majority of the vein-endings are related to crenulation in the corolla and terminate at the tip, others end blindly. Usually each crenulation receives one vein. In exceptional cases two veins enter a crenulation. Cases of veins ending beneath an incision (sinus) separating two crenulations have been observed. Sinus vein dichotomies are present. Nine types of anastomoses are described. In Type I, two branches of a single vein-dichotomy remain united. Type II is characterized by the union of adjacent branches of two vein dichotomies and their separation. Type III is similar to Type II but the branches do not separate after confluence. In Type IV an arcuate vein unites with the branch of contiguous vein dichotomy and then separates. Type V is similar to Type IV but the fused branches do not separate. Type VI is formed by the union of the outer branch of a second order vein-dichotomy and the outer branch of a first order vein-dichotomy. In Type VII one outer branch each of two adjacent second order vein-dichotomies unite and separate. Type VIII is similar to Type VII but the branches do not separate after confluence. In Type IX the outer branch of a third order vein-dichotomy and the outer branch of a second order vein-dichotomy unite and separate after a short area of confluence. Cases of vein-approximations also have been observed.

INTRODUCTION

THOUGH the open dichotomous type of venation is comparatively very rare in the leaves of angiosperms, it is frequently met with in the perianth, particularly of monocotyledons (Hammen, 1948). Gluck's (1919) monograph and the papers of Arnott and Tucker (1963) and Hiepko (1965) give several references to dichotomous venation in perianth parts. Petals, suggested Foster (1966,

p. 599), "may provide important clues to the evolutionary development of venation patterns in angiosperms".

Studies on vein anastomosis have not received adequate attention in the past. Examples of petal venation with anastomoses are provided by Kausmann (1941). Arnott (1959) studied anastomoses in the leaves of *Ginkgo biloba* Linn. *Kingdonia uniflora* Balfour f. et W. W. Smith and *Circaeaster agrestis* Maxim. were studied by Foster (1959, 1963, 1966, 1968). Accounts of anastomoses in the petals of *Ranunculus* were provided by Arnott and Tucker (1963, 1964) and Banerji and Mukerji (1970). Subramanyam (1969) observed three types of anastomoses in the leaves of *Utricularia*. Banerji (1972) discussed the significance of vein unions in certain fossils with reference to petal venation in *Ranunculus diffusus*. Recently vein anastomoses in the leaves of *Adiantum incisum* Forsk. and *Pteris vittata* Linn. were studied by Nair and Das (1973 a, b).

The purpose of this paper is to present some observations on a study of the morphology and venation pattern in the petals of *Habenaria dentata* (Sw.) Schltr.

MATERIALS AND METHODS

Habenaria dentata, a native of China, has recently been reported by Arora (1973) from Thal, Pithoragarh, Kumaon, India. The present observations are based on his collections (C. M. Arora 41307) deposited in the herbarium of the Botanical Survey of India, Northern Circle, Dehra Dun (BSD). In all, nine flowers were present on the sheets. These were examined under a stereomicroscope and the following observations were made. Another set of three unmounted flowers were soaked in 5% sodium hydroxide for 48 hours and then cleared in chloral hydrate for observation.

OBSERVATIONS

Of the three petals in a flower the antero-lateral ones are triangular, very small and do not show any special feature of interest in their venation pattern. The lip or the labellum, posterior in position, is large and continuous with the base of the column. It is 3-partite, crenulate apically with the lateral lobes larger than the strap-shaped, 3-nerved, middle lobe. Figures 1 and 2 illustrate the form and total venation pattern of the lip. At the base of each lateral lobe can be seen four prominent veins. These repeatedly branch dichotomously in a more or less symmetrical fashion and end in the margin. The main vein lying close to the middle lobe gives out a branch

to the median lobe which in turn becomes the lateral vein of the central lobe. The central vein of the middle lobe is independent. The vein-endings or ultimate terminations of the veins in the lateral lobes were observed to be variable in the distal region.

The majority of the marginal vein-endings terminated in each crenulation. Variations from this were frequent. Sometimes a crenulation received two vein-endings; in Fig. 1 there are eight such crenulations and in Fig. 2 there are seven. Invariably the two vein-endings in a crenulation were derived from branches of adjacent vein-dichotomies. This rule was violated in one case (Fig. 2) where the endings were branches of the same dichotomy.

A second variation was that the vein-endings did not extend up to the marginal crenulations. Such vein-endings which were unrelated to the crenulation can be termed as blind vein-endings in a more or less the same sense as Foster (1959) used for *Circaeaster*. Some of the blind vein-endings were more or less parallel with the lateral margin of the lip. Others were central in position. The number of blind vein-endings in a lip was found to be variable. In Fig. 1, there are 71 vein-endings of which three are blind endings and in Fig. 2, of the 99 vein-endings, seven end blindly. The blind vein-endings may be long or short, branched or unbranched.

In several cases the veins ended beneath an incision which separated two crenulations. In Figs. 1 and 2 there are 11 and 5 such sinus vein-endings respectively. In one case one of the major veins ended close below a sinus which separates the middle lobe and the lateral lobe (Fig. 2).

Another deviation was the presence of crenulations without vein-endings. The sinus vein-endings were usually near such non-vascularized crenulations.

Veins dichotomizing below sinuses were very common. Veins branching likewise are termed sinus-vein-dichotomy by Foster and Arnott (1960). The veinlets derived from a sinus-vein-dichotomy diverge into adjacent crenulations.

Vein-approximations (Foster, 1966) representing intermediate stages between open dichotomous venation and anastomoses were observed (Figs. 1, 2). These approximations were mostly in the median or central portion of the lateral lobes. The vein-approximation in the right lobe of Fig. 2 where two veins derived from a single dichotomy converged may be considered as

intermediate between open dichotomous venation and Type I anastomosis described below (Types A and B of Arnott, 1959). In all the other vein-approximations the veins coming together represented branches of two vein dichotomies.

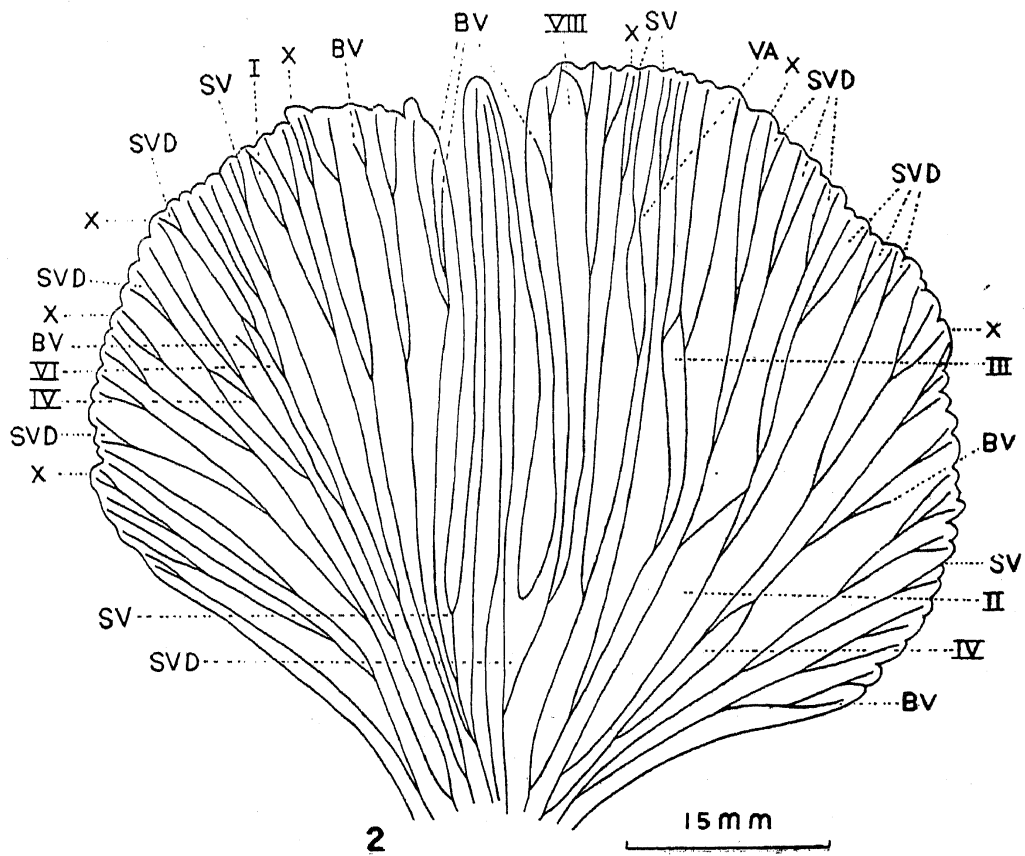
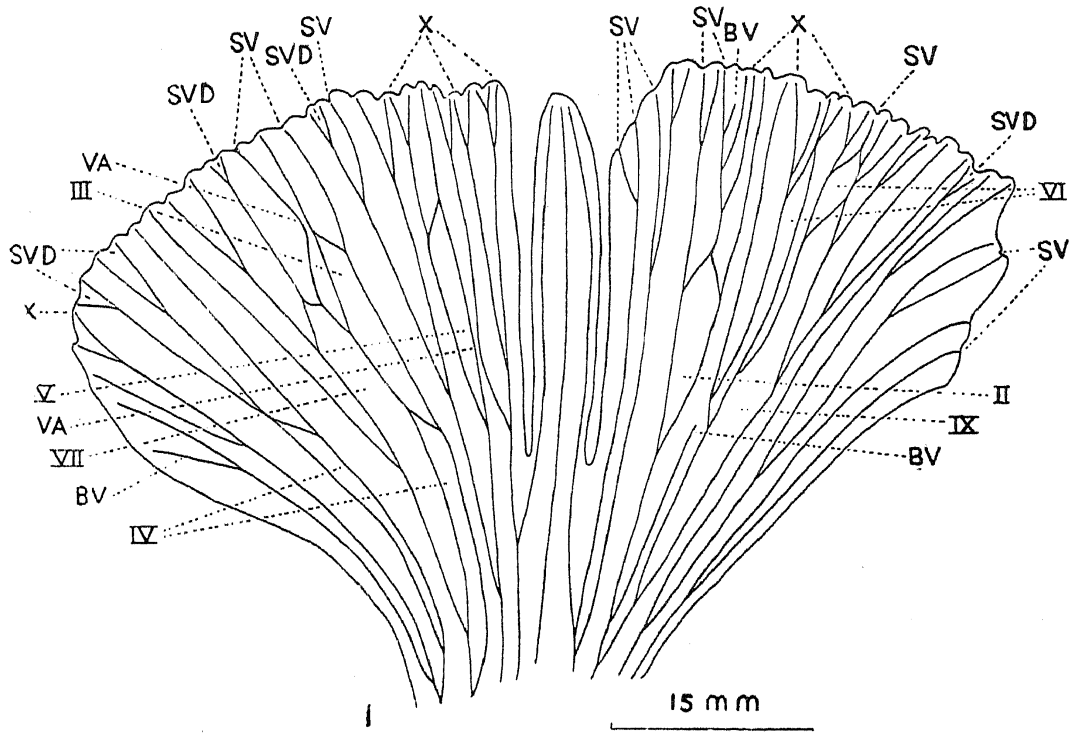
Vein-unions of different types were common in the material studied. In all the 12 lips examined, there were anastomoses. Several anastomoses could be observed even in a single lip (Figs. 1, 2). In all, nine types of anastomoses (Figs. 3-11) were recognized in the present study and these are described below:

Type I.—Here an areole is created by the union of the two branches of a single vein dichotomy, *i.e.*, one vein dichotomises and the branches reunite again to form a vein which terminates at the distal margin of the petal (Figs. 2, 3). This type is confined to the leaf margin. In *Ginkgo biloba* (Arnott, 1959) and *Adiantum incisum* (Nair and Das, 1973 *a*) also they are predominantly marginal. Type I anastomosis is similar to A type of anastomosis in *Ginkgo biloba* (Arnott, 1959) and Type II anastomosis in *Adiantum incisum* (Nair and Das, 1973 *a*).

Type II.—The salient features of this type of anastomosis are that adjacent branches of two vein-dichotomies unite and separate afterwards. The area of confluence may be short or long (Figs. 1, 2, 4). The separated branches usually extend to the margin of the lobe without branching. But, in one case one of the separated branches was found to dichotomise repeatedly twice (Fig. 1). In another case each of the branches dichotomized once (Fig. 2). This type of anastomosis is confined to the basal and central regions of the lobes of the lip. Type II anastomosis is similar to Type D anastomosis in the leaves of *Ginkgo* (Arnott, 1959) and petals of *Ranunculus repens* (Arnott and Tucker, 1963), Type I anastomosis in *Circaea* (Foster, 1966), and Type III anastomosis in *Adiantum* (Nair and Das, 1973 *a*). This type of anastomosis is also known in the petals of *Ranunculus sceleratus* (Banerji and Mukerji, 1970).

Type III.—This type of anastomosis is similar to Type II anastomosis described above but the united branches do not separate after confluence (Figs. 1, 2, 5). This type is similar to Type II anastomosis of Foster (1966), and Type IV of Nair and Das (1973 *a*).

Type IV.—In this type an arcuate vein unites with the branch of a contiguous vein-dichotomy and then separates (Fig. 6). The region of confluence may be short (Fig. 1) or long (Fig. 2). This type is distinct from



FIGS. 1-2

Types II and III described above in which union occurs between two of the branches of a pair of adjacent vein-dichotomies. Type IV is similar to Type IV anastomosis in *Circaeaster* (Foster, 1968) and Type VI anastomosis in *Adiantum* (Nair and Das, 1973 a).

Type V.—This type of anastomosis is similar to type IV described above but the arcuate vein and the branch of vein-dichotomy do not separate after confluence (Figs. 1, 7). This type is similar to Type V in *Circaeaster* (Foster, 1968) and Type VII in *Adiantum* (Nair and Das, 1973 a).

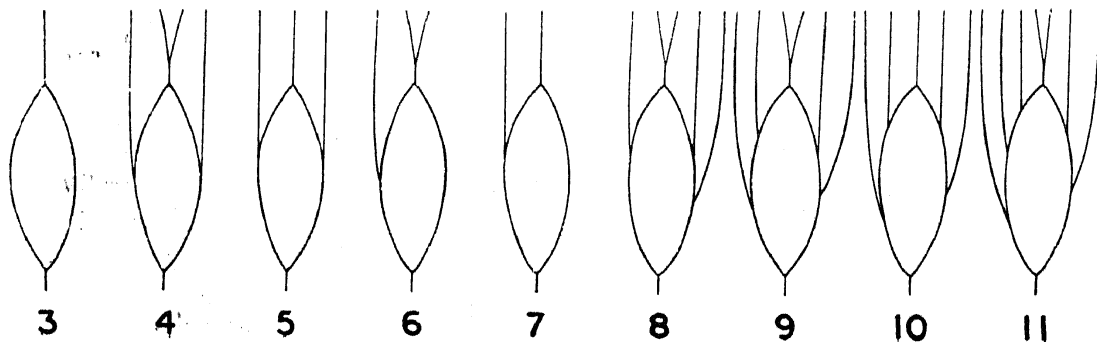
Type VI.—In this type an areole is formed by the union of the outer branch of a second order vein dichotomy and the outer branch of a first order vein-dichotomy (Figs. 1, 2, 8).

Type VII.—This type is characterized by the union of one outer branch each of two adjacent second order vein-dichotomies and their separation after a very short area of confluence (Figs. 1, 9).

Type VIII.—This type is similar to Type VII but after union the two branches do not separate or if the confluent vein dichotomises, it does so only at the margin of the lobe whereby the area of confluence remains very long (Figs. 2, 10).

Type IX.—In this type of anastomosis the outer branch of a third order vein-dichotomy and the outer branch of a second order vein-dichotomy unite and after a short area of confluence they separate again (Figs. 1, 11).

As far as we are aware, Types VI to IX are not reported in any of the plants where open dichotomous venation is met with.



FIGS. 3-11

DISCUSSION

While any detailed consideration of the phylogenetic aspect of the anastomosis described here requires the study of a very large number of petals, certain other deductions can be made from the data already available.

It is controversial whether the open dichotomous type of venation is primitive or not. Troll (1938) and Chrtek, (1962, 1963) are of the view that anastomosed venation is primitive than open dichotomous venation. A similar opinion is held by Wagner (1952) in the case of ferns. Hammen (1948), and Foster and Arnott (1960) on the other hand think that dichotomous venation is primitive. This view has been supported by Arnott and Tucker (1963, 1964) and Banerji and Mukerji (1970). The fact that open dichotomous venation occurs only on one of the petals and that too on the most specialized labellum of *Habenaria dentata* (present study) and *Orchis morie* (Hammen, 1948) may tempt one to conclude that it is a specialized feature. But, following the line of arguments advanced by Arnott and Tucker (1963, 1964) our study lends support to the view that the open dichotomous venation is primitive.

As a corollary, another question that arises is that if the open dichotomous venation is primitive, how can one account for its presence in one of the most highly evolved families, Orchidaceae and that too, only in the specialized lip or the labellum? Marsden and Bailey (1955) pointed out that no taxonomic group is conspicuously the most primitive or advanced in all structural features. As emphasized by Subramanyam (1969) and Subramanyam and Nair (1972), the presence of an open dichotomous venation in only one of the specialized petals of *Habenaria* and that too, in the lateral lobes only can be explained by the process of mosaic evolution termed heterobathmy by Takhtajan (1966). According to this, the side by side existence of different degrees of evolutionary advancement in different parts of one and the same plant, due to simultaneous operation of different modes and rates of evolution on different parts of the organism, is possible. Consequently, a very primitive feature can exist in a highly advanced family.

ACKNOWLEDGEMENTS

We are thankful to Mr. C. M. Arora and Dr. M. A. Rau of the Northern Circle of the Botanical Survey of India, Dehra Dun, for lending the material for our study.

REFERENCES

- Arnott, H. J. ... *Amer. Jour. Bot.*, 1959, 46, 405-11.
 ——— and Tucker, S. C. .. *Ibid.*, 1963, 50, 821-30.
 ——— .. *Bot. Gaz.*, 1964, 125, 13-26.
 Arora, C. M. .. *Bull. bot. Surv. India*, 1974, 13 (in press).
 Banerji, M. L. .. *All India Symposium on Biology of the Land Plants, Meerut, 1972* (Abstract).
 ——— and Mukerji, M. .. *Castanea*, 1970, 35, 157-161.
 *Chrtack, J. .. *Novitates Bot. Horti. Bot. Univ. Carolinae Pragensis*, 1962, pp. 3-10.
 * ——— .. *Acta Horti. Bot. Pragensis*, 1963, 13-29.
 Foster, A. S. .. *Notes Roy. Bot. Gard. Edinb.*, 1959, 23, 1-12.
 ——— .. *Jour. Arn. Arb.*, 1963, 44, 299-321.
 ——— .. *Amer. Jour. Bot.*, 1966, 53, 588-99.
 ——— .. *Jour. Arn. Arb.*, 1968, 49, 52-67.
 ——— and Arnott, H. J. .. *Amer. Jour. Bot.*, 1960, 75, 684-98.
 Gluck, H. .. *Blatt und Blumenmorphologische studies*, Jena, 1919.
 Hammen, L. van Der. .. *Blumea*, 1948, 6, 290-301.
 Hiepko, P. .. *Bot. Jahrb.*, 1965, 84, 359-508.
 Kaussmann, B. .. *Bot. Arch.*, 1941, 42, 503-72.
 Marsden, M. P. F. and Bailey, I. W. .. *Jour. Arn. Arb.*, 1965, 36, 1-50.
 Nair, N. C. and Anjali Das .. *Bull. bot. Surv. India*, 1973a (in press).
 ——— .. *Jour. Arn. Arb.*, 1973b (in press).
 Subramanyam, K. .. 11th Int. bot. Congr. Seattle, Wash. (Abstra.), 1969, p 212.
 ——— and Nair, N. C. .. *All-India Symp. on Biol. Land Plants, Meerut, 1972* (in press).
 Takhtajan, A. .. *Systema et Phylogenia Magnoliophytorum. Leningrad*, 1966.
 Troll, W. .. *Vergleichende Morphologie der hoheren Pflanzen. Erster Bd. Zweiter Teil 1, Lieferung, Berlin*, 1938.
 Wagner, W. H. .. *Amer. Jour. Bot.*, 1952, 39, 578-92.

* Not seen in original.

EXPLANATION OF TEXT-FIGURES

FIGS. 1-2. Venation pattern in the lip of *Habenaria dentata*. (BV, Blind vein; SV, Sinus vein; SVD, Sinus-vein-dichotomy; VA, Vein-approximation; X, Serration with two vein-endings; I-IX, the 9 types of anastomosis depicted in Figs. 3-11 (Figures drawn from C.M. Arora 41307).

FIGS. 3-11. Diagrammatic representation of the 9 types of anastomoses found in the lip of *Habenaria dentata*.