

## FLORAL BIOLOGY OF *BLYXA OCTANDRA* (ROXB.) PLANCHON EX THWAITES (HYDROCHARITACEAE)

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### ABSTRACT

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*Blyxa octandra* (Roxb.) Planchon ex Thwaites is a dioecious aquatic plant. In the male flower the pollen is deposited on the adaxial surfaces of the petals whilst it is in bud. The petals elongate and spread, thus presenting the pollen to pollinating insects. The female flower only superficially resembles the male; the petals are much smaller and the stigmas are spreading and petal-like. The attractive function of the petals in the male is, therefore, transferred to the stigmas in the female. Between 09.30 and 10.00 h the petals in the male and the stigmas in the female exude water-like droplets. The flowers are visited by various Diptera and Odonata who transfer pollen on their feet. By midday the flowers dry out and wither.

### INTRODUCTION

The Hydrocharitaceae are notable for having extraordinary pollination mechanisms. The most significant publications are cited by Sculthorpe (1967) and Cook et al. (1974). The work of Ernst-Schwarzenbach (1945, 1953) is particularly noteworthy, seldom cited and often misinterpreted. The genus *Blyxa* has been almost completely ignored. The remarks of Lakshmanan (1961) on the floral biology of *Blyxa octandra* (Roxb.) Planchon ex Thwaites are incorrect and from the evidence published it seems likely that the species studied was the bisexual *B. aubertii* m. Richard.

*Blyxa octandra* is geographically widespread in India, but somewhat localised in occurrence and by no means common. The population studied was in a temporary pool on laterite located near the sports stadium on the campus of the University of Calicut (11°07' N, 75°53' E), Malappuram District, Kerala, India. Field observations were made from 9 October–14 November 1979, and cultivated plants were also studied. *Blyxa octandra* is an aquatic plant with linear leaves arranged in a rosette. The leaves are obligately submerged and cannot withstand drying out. The pool is more or less

flat-bottomed with a maximum depth of ca. 40 cm. The substrate is flat laterite covered by a thin layer of mobile mud. The water is eutrophic, being frequently visited by water buffalo. The buffalo often uproot the vegetation but the free-floating plants of *Blyxa* continue to flower and set seed. The detached male plants usually float upside down with their roots uppermost, but even in this state they flower freely. The dominant plant in the pool is *B. octandra*; the associated species are *Rotala malampuzhensis* R.V. Nair ex C.D.K. Cook — a local endemic, *Fimbristylis littoralis* Gaud. and *Dopatrium junceum* F. Ham.

*Blyxa octandra* is strictly dioecious and no trace of functional bisexuality was found; there are three-lobed pistillodia in the male flowers. The male plants were in an overwhelming majority; as the plants have branching root-stocks and grow in clumps, the exact ratios are difficult to establish without destroying the population. The authors estimated at least ten males to one female, but the ratio could be as high as 16/1. The female plants are usually somewhat larger and more robust than the males. The male and female flowers of *B. octandra* look superficially alike, and presumably also appear to be so to pollinating insects. However, from a morphological point of view they are very different in structure. Like other Hydrocharitaceae, the flower buds of *B. octandra* develop within a closed spathe. The spathe remains submerged in water and, shortly before anthesis, the pedicels or hypanthia elongate and the flowers open above the surface of the water.

#### THE MALE FLOWER

The male spathe contains up to ca. 22 male flowers. During the flowering period one flower from each spathe opens each day. Male plants have up to, but usually less than, ten flowering spathes. The process of anthesis takes place relatively quickly. At 06.00 h, just as the first morning light comes, the flower buds lie flat on the surface of the water. By 07.00 h the flower buds are erect and raised about 1.5–2 cm above the surface of the water. At this time the three petals burst through the top of the sepal tube. The three sepals are not conjoined, but remain tubular during anthesis. The petals are lightly stuck together at the distal ends by interlocking papillate cells (rather like a zip fastener). The petals remain closed together and elongate as a closed column (Fig. 1a). Between 07.00 and about 09.00 h the petals elongate from ca. 5 to 15 mm in length. This elongation is accomplished by the longitudinal stretching of the petal cells; Fig. 1c and 1d show the cells before and after elongation, respectively.

Despite their superficial simplicity, the petals are very complex in structure. The adaxial surface of each petal has three furrows and a central mound with rows of pointed, protruding cells. The outlines of the petals follow, and almost fit into, the anthers, as illustrated by Fig. 1g and 1h. There are nine stamens, and in spite of the specific epithet 'octandra', these are arranged in three whorls of three. The anther walls are very thin. It has not been possible to determine whether the anthers burst of their own accord or whether

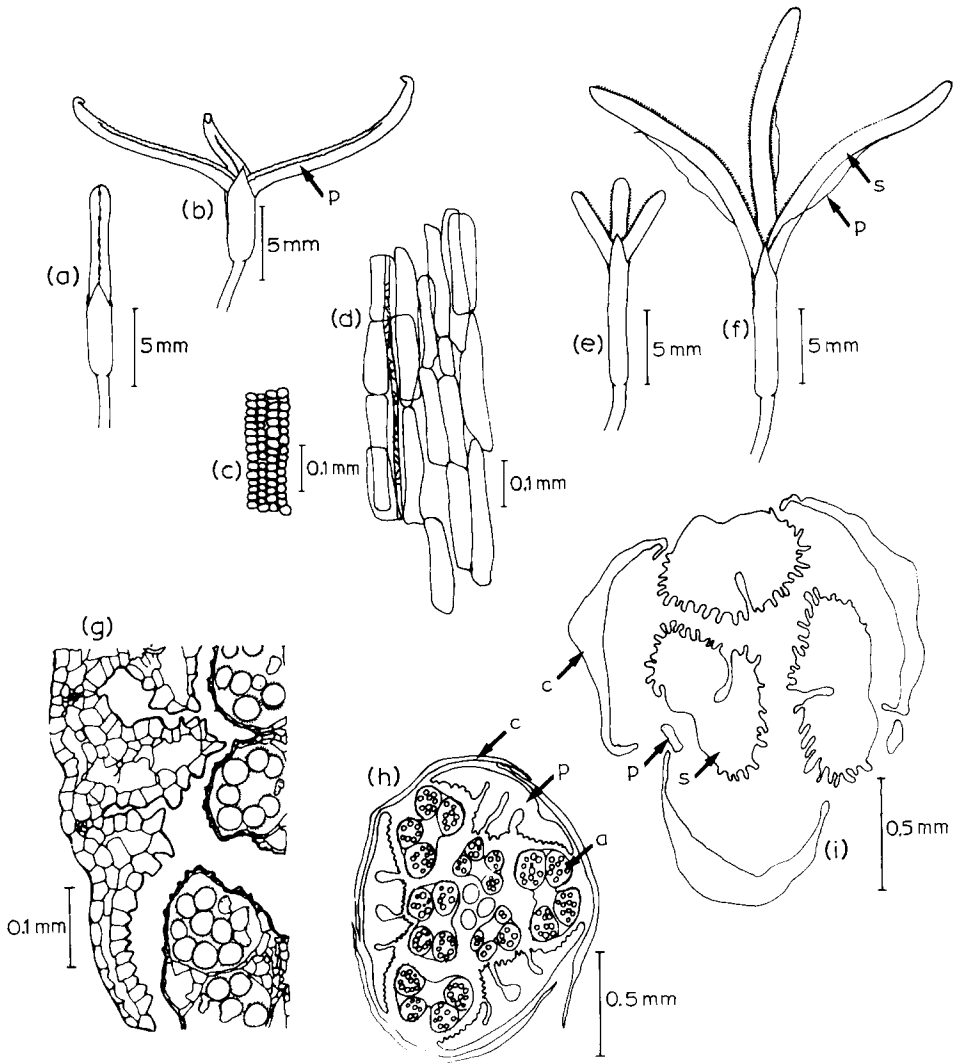


Fig. 1a-i. *Blyxa octandra*: (a) male flower with emerging column of petals; (b) male flower at pollen presentation stage; (c) cells of petal before elongation; (d) cells of petal after elongation; (e) female flower with stigmas emerging from the calyx; (f) female flower at pollen transfer stage (note filamentous petals); (g) transverse section of part of male flower showing petal and stamens; (h) transverse section of a male flower in bud (the three objects in the centre are stamen filaments); (i) transverse section of a female flower at top of calyx (a = anther, c = calyx, p = petal, s = stigma).

they are ripped open by the elongating petal column. However, it is certain that the petals remove the pollen from the anthers and that the pollen grains become fairly evenly distributed on the adaxial surfaces of the petals. The pollen grains are spherical and covered with small spines.

At 09.00 h or shortly afterwards the distal portions of the petals become detached and the petals start to spread, exposing the pollen deposited on their adaxial surfaces. At this stage the white petals are covered with pollen and from a distance actually appear to be yellow. By 09.30–10.00 h the petals have spread (Fig. 1b), and at this stage, small drops of fluid appear on their adaxial surfaces. The pollen-transfer stage is reached. The pollen presentation procedure is illustrated diagrammatically in Fig. 2. After midday the flowers start to wither and by late afternoon no erect male flowers are to be seen.

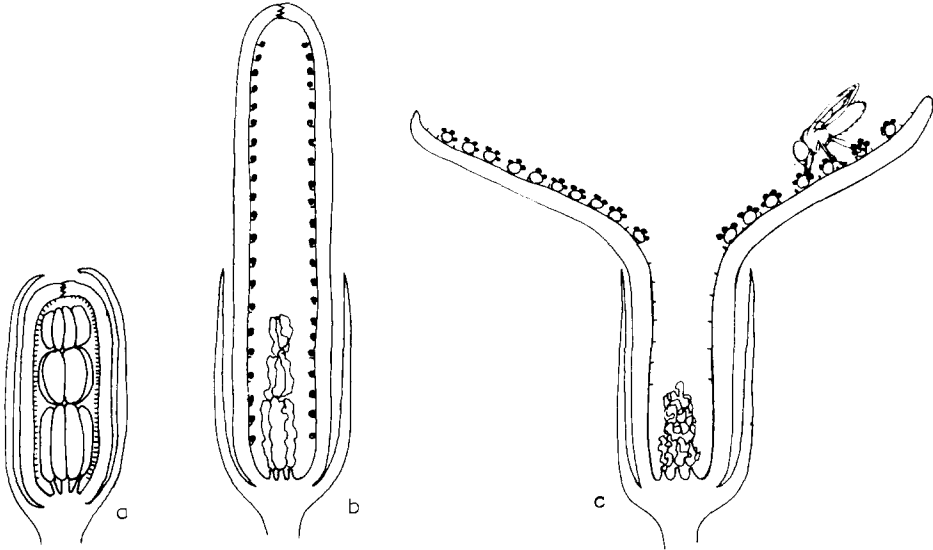


Fig. 2. Diagrammatic representation of pollen presentation in the male flower of *Blyxa octandra*: (a) flower bud, anthers closed; (b) petal column elongating, pollen deposited on adaxial surface of petals; (c) petals spread, pollen on fluid droplets, visiting fly. (Not to scale.)

#### THE FEMALE FLOWER

The female spathe contains one, or very rarely two, flowers. A vigorously growing plant may develop a female flower from each spathe every second day. The process of anthesis is less regular and much slower than in the male. The female superficially resembles the male but is morphologically rather different. The 'pedicel' is morphologically a tubular hypanthium and the ovaries are inferior, remaining submerged and enclosed within the spathe. The calyx has three free segments that remain tubular during anthesis; it looks very much like that of the male but is usually almost twice as long. The petals are fine and filamentous; sometimes they stick to the stigmas and are pulled out of the calyx tube (Figs. 1f, 3 and 6), or they may remain within the calyx tube. The petals appear to be vestigial organs that play no role in pollination. No traces of stamens or staminodia were found in female flowers.

The stigmas are white and resemble the petals of the male flowers. On the adaxial surface they are papillate and have a single adaxial furrow (Fig. 1i). Unlike the petals of the male flowers the stigmas are not joined distally. During the process of elongation they spread as soon as they break through the apex of the calyx tube (Fig. 1e). The elongation of the styles is slower and less regular than that of the petals in the male flowers; often the stretching takes place overnight. Nevertheless, by 09.30–10.00 h they are elongated and assume a position similar to that of the petals of the male (Fig. 1f). At this stage small droplets of fluid appear on the surfaces of the stigmas. These droplets have no smell or taste, they do not appear to be viscous and readily evaporate leaving no visible traces. They have not been chemically analysed but to all intent they appear to be only water. The two genera of Hydrocharitaceae examined by Heslop-Harrison and Shivanna (1977) have dry stigmas.

#### POLLEN TRANSFER

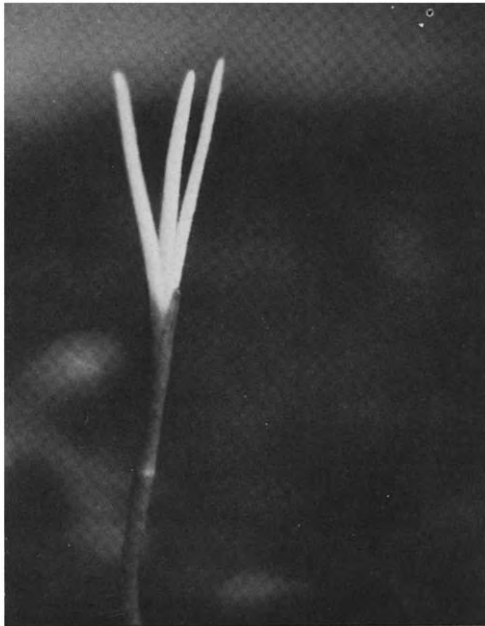
At about 09.30–10.00 h the male and female flowers are 1.5–2.0 cm above the surface of the water. The males have three spreading petals, which are wet and covered with yellow pollen grains on the adaxial surfaces. The females have three spreading petal-like stigmas and are also wet on the adaxial surfaces (Fig. 3–5). When wet, the flowers were visited regularly by



Fig. 3. *Blyxa octandra*. Plants taken out of water: left, female flower showing filamentous petals; right, a male plant.



**Fig. 4. Female flower, droplets 'just visible' on petaloid stigma.**



**Fig. 5. Female flower, droplets almost invisible.**

muscid flies which could be seen to taste the droplets with their labella. Several species of flies visited the flowers, mostly blowflies (Calliphoridae) and houseflies (Muscidae). The flies did not appear to be especially attracted by the flowers, because buffalo dung, buffalo and the observing botanists were also being visited by the same insects. The flies regularly flew from flower to flower and transferred pollen carried on their feet. Pollen was not seen to be consumed and syrphid flies were not observed on the flowers.

Between 10.00 and 12.00 h, the density of the yellow pollen on the petals of the males had become so low that the petals appeared to be white; at the same time, the stigmas had become well covered with pollen grains. The papillae on the stigmas are larger than those on the petals and seem better adapted to hold the pollen (Fig. 1i). After midday the male flowers withered and the stigmas dried out (Fig. 6). The pollen transfer takes place from about 09.30 to 12.00 h.

Damselflies (Zygoptera) and dragonflies (Anisoptera) frequently use *Blyxa octandra* flowers as resting places and no doubt they play a role in pollen transfer. One was temporarily caught in a spider's web and, after escaping, *Blyxa* pollen was left on the web. As the droplets on the petals of the male flowers dry out, some pollen falls onto the surface of the water. No mechanism by which this floating pollen could be transferred to stigmas was apparent. The stigmas stay above the water surface for at least 24 h and only fall into the water when they wither.



Fig. 6. Plants in situ: centre, female flower with one petal visible; right, male flower with petals withering.

## DISCUSSION

The genus *Blyxa* has about eight species, two of which have bisexual flowers and are strongly autogamous (pollen is deposited directly on to the stigmas which have laterally arranged papillae). The other six species are dioecious. From herbarium studies, it seems likely that all the dioecious species have the same pollen presentation mechanism. In two African species, *Blyxa radicans* Ridley and *Blyxa hexandra* C.D.K. Cook et R. Löönd, the petals of the male flowers appear to remain distally joined during pollen transfer; no field observations on these species have been published.

Among flowering plants the presentation of pollen on the petals is uncommon. Although pollen may be found on the petals of some plants (*Hypocoum*, *Papaver*, *Magnolia*, *Viola*), a mechanism similar to the stylar presentation of the Campanulaceae—Compositae but group transferring pollen to petals is probably unique to the dioecious species of *Blyxa*.

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