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STEMONACEAE AND PENTASTEMONACEAE; WITH MISCELLANEOUS NOTES ON MEMBERS OF BOTH FAMILIES

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SUMMARY

With field observations in situ, and extended study of recently collected copious FAA-conserved material of *Pentastemona sumatrana*, it became evident that *Pentastemona* represents a family of its own, Pentastemonaceae, beside Stemonaceae. The discriminating characters are discussed and additional notes on the growth habit, inflorescences, and flowers of *Pentastemona*, which appear possibly to be polygamous, are given. For the genus *Stemona* two new combinations are proposed, and some notes on cultivated living plants are presented.

INTRODUCTION

Stemonaceae is a small monocotyledonous family with three small genera, viz. *Croomia* (SE North America and Japan), *Stemona* (Southeast Asia through Malesia to N Australia) and *Stichoneuron* (Southeast Asia, including the Malay Peninsula). During the preparation of the treatment of this family for Flora Malesiana, partly based on the considerations by Van Steenis (1982), it appeared that the surprisingly 5-merous genus *Pentastemona* (Central West and North Sumatra) can best be regarded as representing a family of its own, Pentastemonaceae, as was already suggested by Dahlgren et al. (1985). This segregation is evident on several macromorphological grounds, e.g. by a different general habit and construction of the plant and a different flower morphology, but it is corroborated also by new research on the pollen grains (Van der Ham, 1991, present issue), as well as by flower ontogeny (W.A. van Heel, Blumea, 1992, in preparation) and seed structure (F. Bouman, Blumea, 1992, in preparation).

Earlier (Nakai, 1937; Airy Shaw, 1973) the genera *Croomia* and *Stichoneuron* were placed in a separate family Croomiaceae, beside the monotypic Stemonaceae. But, although these genera appear mutually more closely related, this separation seems less evident and – pending more information – I will, in Flora Malesiana, keep *Stichoneuron* and *Stemona* in one family, Stemonaceae.

When publishing the new genus *Pentastemona*, with two species, *P. egregia* and *P. sumatrana*, Van Steenis had adequate material at hand in the form of good newly made collections, including spirit-material of *P. egregia* (*Meijer 17010*), but a number of interesting data remained unknown until still more collections and observations were made recently for both species, in the field as well as during cultivation in European greenhouses.

During a recent visit to Indonesia, living plants of *Stemona* could be examined in the National Botanic Garden (Kebun Raya), at Bogor, and this yielded some facts of interest which otherwise might have escaped due attention and which therefore are published in the present paper, precursory to the Flora Malesiana treatment. In addition, some new combinations in Stemonaceae are made, as a result of the ongoing taxonomic research.

For the general taxonomy and descriptions of genera and species, including the complicated flower architecture in both families, I refer to Van Steenis (1982) and the literature cited by him, to Van Heel (Blumea, 1992, in prep.), and to the forthcoming family treatments in Flora Malesiana (Duyfjes, 1992).

STEMONACEAE VERSUS PENTASTEMONACEAE

Stemonaceae

The main characters shared by the three genera, discriminating the family against Pentastemonaceae (only genus *Pentastemona*) are the following:

Growth habit and roots – Long-lived plants with perennial subterranean rootstock, often with scale-leaves, and with sympodial growth; roots strong, sometimes tuberous (*Stemona*); leafy stem(s) erect, restrictedly branched or unbranched, inflorescences axillary to the foliage leaves, the whole shoots dying off after the fertile season, not viviparous; plants mostly (always?) of seasonal climate.

Leaves – Foliage leaves distichous or opposite, rarely verticillate (*Stemona* in China, Japan); petiole narrowly attached to the stem, not sheathing, pulvinate at base in *Stemona*; scale leaves present on rootstocks.

Inflorescences – Flowers solitary or ± fasciculate or mostly in peduncled, short, raceme-like cincinnae, never branched (never compound), usually withering together with the whole leafy stem.

Flowers – Hermaphroditic, rarely (*Stichoneuron*) probably functionally unisexual with some dimorphism; perianth 4-merous, tepals free, in two whorls of 2; stamens 4, in two whorls of 2, filamentous, connective narrow or broad, or with conspicuous appendage; ovary superior or semi-inferior (*Stichoneuron*); ovules few or many, anatropous or semi-anatropous, placenta basal (*Stemona*) or apical; pedicel articulated.

Fruit and seed – Fruit superior or semi-inferior, a thin-walled 2-valved capsule; seeds without sarcotesta; arillode various.

Pollen – Conspicuously distinct from that of Pentastemonaceae; see there.

Anatomy – Distinct from Pentastemonaceae; see there.

Pentastemonaceae (only genus *Pentastemona*)

The characters discriminating with Stemonaceae are:

Growth habit and roots – Whole plant juicy, living for few to several years, consisting of a prostrate or slightly ascending supraterraneous, unbranched, green, juicy-fleshy stem of monopodial growth, creeping towards the light over sloping or vertical substrate (i.e., over rocks or partly in shallow humus soil in *P. egregia*, epilithic

in *P. sumatrana*), loosely attached with slender adventitious roots (stem up-growing in pot cultures in greenhouses); stem bearing foliage leaves only (no scale leaves), with the inflorescences sub-axillary (see the notes), the latter usually viviparous in *P. sumatrana*; plants of shady habitat of everwet tropics.

Leaves – Plants with foliage leaves only; these dispersed, the petioles shortly sheathing at the base, broadly attached to the stem and leaving ring-shaped scars after decay; petiole without pulvinus.

Inflorescences – Essentially compound, peduncled, of racemose structure, withering or rotting away after flowering or fruiting; in *P. sumatrana* usually viviparous at the top, in *P. egregia* few-flowered simple racemes through reduction; see further under the notes.

Flowers – Wholly or partly functionally unisexual, with some dimorphism, in *P. sumatrana* monoecious or polygamous, in *P. egregia* probably dioecious or polygamous; flowers predominantly 5-merous: tepals in one whorl, almost free or partially united into a tube, lobes imbricate; stamens in one whorl, ± sessile, the connectives together with the top of the hypanthium and ovary grown into a complicated, strange, swollen, disk-like structure, leaving five pouches in which each two thecae of adjacent anthers are situated; ovary inferior, distinctly fringed-ribbed with 5 long ribs alternating with 5 shorter ones, placentas 3, parietal, with many anatropous ovules; pedicel not articulated.

Fruit and seed – Fruit inferior, very distinctly (coarsely fringed-)ribbed, berry-like, containing many seeds embedded in their juicy sarcotesta-like hyaline exotestas; arillode conspicuous, inflated; see further under the discussion.

Pollen – According to Van der Ham (1991, this issue) the pollen morphology fully endorses the separation of Pentastemonaceae as distinct from Stemonaceae: within Stemonaceae pollen of *Pentastemona* is most deviating; it is inaperturate and shares several special features with pollen of other distinct families, but the closest relatives of *Pentastemona* as for palynology have as yet not been traced.

Anatomy – The anatomy of *Pentastemona* has not been studied in detail, but from the preliminary observations by Baas (in Van Steenis, 1982) we may summarize that the leaves contain crystals in the form of styloids and raphides and that this combination is suggestive of Stemonaceae as well as of *Dioscorea*, but also that the stomata are different: tetracytic or tetracytic to cyclocytic in *Pentastemona*, as against anomocytic in Stemonaceae (*Croomia*).

In the literature the hairs of Stemonaceae are described as simple, uniseriate, but those of *Pentastemona* are coarse, much broadened (dilated) and multiseriate towards the base; moreover, the fringes on the ribs or wings on the ovary and fruit of *P. egregia* are singularly conspicuously antler-like branched.

DISCUSSION AND CONCLUSION

With the description of the new genus *Pentastemona*, Van Steenis (1982: 157) presented a survey of the affinities between the three existing genera in Stemonaceae and the new genus, at the same time listing the unique characters for each genus; all

illustrated in the diagram given by him in his figure 2g. From his list and diagram it appears that *Pentastemona* has the largest number of unique characters, namely eight, viz. 1) 5-merous flowers, in three cycles; 2) mostly compound inflorescences; 3) anthers sessile; 4) leaf-base sheathing; 5) no leafy stem proper; 6) ovary inferior, as is the fruit, winged in *P. sumatrana*; 7) ovules in 3 parietal zones; 8) pollen inaperturate.

Supposedly important characters which, according to Van Steenis, *Pentastemona* shares with other single genera in Stemonaceae are, with *Stichoneuron*: the suprabasal lateral nerves, the thecae of the anthers separated by a broad connective, and the uniseriate hairs; and with *Stemona*: the numerous ovules and seeds, and stamens inserted on a shallow ring-like staminal tube.

Also, his list and diagram illustrate the mutually close affinity of *Croomia* and *Stichoneuron*.

When advocating the inclusion of *Pentastemona* in Stemonaceae Van Steenis argues (l.c.: 157, 158) that, instead of emphasizing the differences, one rather should look for "the characters which hold the four genera together, viz., the morphological and anatomical vegetative characters, the anatropous ovules, the one-celled ovary, and the striking similarity in the peculiar seed structure, exactly matching in all four genera, whatever they may differ in placentation."

The present study, however, shows that these binding features are less strong than as supposed by Van Steenis, at the same time allowing for many more 'unique' characters in the genus *Pentastemona*.

Regarding the chromosomes[1] we now know that for *Pentastemona* these do not fully agree with those of Stemonaceae. They are:

Stemona japonica: 2n = 14 (according to Suzuka & Koriba, 1949).
Stichoneuron caudatum: 2n = 18, size 2–4 μm.
Croomia pauciflora: 2n = 24, size 1–1.5 μm.
Pentastemona egregia: 2n = 14, size 3–5 μm.
(Dahlgren et al., 1985, mentions x = 7 for the family).

But there is more. As can be seen from the descriptions of growth habit and roots, etc., as given by me above, the morphological and anatomical vegetative characters appear completely at variance with those reported by Van Steenis. Also, the supposedly "striking similarity in the seed structure, exactly matching all four genera" cannot be maintained, as will be clear from the presence of a distinct, proportionally thick sarcotesta (or better: a watery hyaline sarcotesta-like layer being the exotesta) in both species of *Pentastemona*, already mentioned by Van Steenis for *P. egregia*, but omitted from his list of unique characters.

Further studies on the seed will be published by Bouman (Blumea, 1992, in prep.), with which he will conclude that the seed of *Pentastemona* is essentially different from that of *Stemona* and *Stichoneuron*.

1) I am indebted to Mrs. Gitte Petersen, Copenhagen, to allow me to publish her data, which were kindly communicated by Mr. J. Bogner, Munich. The chromosome numbers were counted by Mrs. Petersen on roottips of material grown in the botanic gardens at Munich.

The remaining arguments for binding the four genera together are now: the finely trabeculate tertiary venation and the one-celled ovary with anatropous[2] ovules. Although these three are heavy characters in itself, they occur in several more families, and in my opinion they better serve for assuming a mutual relationship of the genera in a wider sense, rather than that these genera should be merged into one single family.

A family description valid for all genera would be ridiculously complicated, repeatedly stressing an aberrant condition for *Pentastemona*. Therefore, I must conclude to accept only this option: *Pentastemona* represents a family of its own, Pentastemonaceae.

MISCELLANEOUS NOTES

Stemonaceae: genus Stemona

Nomenclature – During the research for the taxonomic treatment of Stemonaceae for Flora Malesiana it appeared that the following two new combinations should be made:

Stemona tuberosa Lour. var. **ternatensis** (J.J. Smith) Duyfjes, *comb. nov.*

Stemona moluccana (Blume) Wright var. *ternatensis* J.J. Smith, Bull. Jard. Bot. Buitenzorg III, 6 (1924) 73. — Type: *Beguin 1682*, Moluccas, Ternate (BO, holo).

Stemona lucida (R. Br.) Duyfjes, *comb. nov.*

Dioscorea lucida R. Br., Prod. Fl. Nov. Holl. (1810) 295. — Type: *Banks & Solander s.n.*, Endeavour River, Queensland; the left-hand specimen (BM, holo).

Observations on growth habit, flowers, and fruit – In the National Botanic Garden (Kebun Raya) at Bogor, Indonesia, two species of *Stemona* are cultivated, and some observations on the living plants could be made. Most likely both species grow there already from far before the war (1940), or possibly some specimens are offspring by seed or runners from the mother rootstocks. It concerns:

Stemona tuberosa Lour. var. *ternatensis* – The several plants of this taxon in the garden originate from Ternate (N Moluccas). They apparently consist of large clumps of tuberous roots, from the centre emitting each growing season several shoots which

2) Curiously enough Airy Shaw (1973), Dahlgren et al. (1985) and Mabberley (1987) describe the ovules of *Stemona* as orthotropous. Swamy (1964) describes the ovules of *Stemona* as of 'anatropous condition', although in his figures 19 and 27, e.g., the funicle is drawn as not laterally fused with the ovary. My own observations in fresh material of *Stemona tuberosa* conclude to anatropous ovules. I also note here the curious incomprehensibility in figure 47 of *Croomia pauciflora* in Dahlgren et al. (1985; copied from Takhtajan, 1982), in which sub C the ovules are correctly depicted as apically attached, but sub F and G the ripe seeds are drawn as provided with a long funicle and as basally attached.

grow high up, twining around the strong persisting died-off shoots of the foregoing season, up to heights of at least 12 m. The first-produced leaves of a shoot are distichous-alternate, but the phyllotaxis soon becomes opposite, perhaps not decussate. Several up-growing main shoots (which are not or only occasionally branched) are twining (to the left) around each other. They produce copious foliage, and, at various heights in the plant but mostly to the tops of the shoots, inflorescences are produced in the axil of one of the two opposite leaves. The aspect of the mature plants is reminiscent of wild-growing *Humulus lupulus* (Cannabidaceae) in Europe. The inflorescences are stalked and several-flowered; each flower bud, just before maturity, has grown large, c. 4 cm long, and is in an erect position. They open in anthesis with curving the upper half of the tepals outward-downward. They are pale dirty green and purplish striped outside, but the tepals inside, towards the centre of the flower, and most of the stamens are dark purplish; pollen is creamy-white, the ovary and stigma pale greenish. These carrion-coloured flowers produce a strong carrion smell, already noticed by Beguin in 1922 (see J.J. Smith, 1924). In the garden at Bogor, regularly a few small glossy flies, c. 2.5 mm long, were seen landing on and entering the flowers, but actual carrying away of pollen by the flies was not observed. One fly was catched and identified as a member of the family Longhaeidae.[3]

In the garden fruit was apparently easily set; these grow to c. 5 cm length, are greenish yellow, and become pendent with weight. Ripe fruit was not present at the time, but copious young plants, apparently of different generations and soon forming tuberous roots, were seen scattered around in the shady lawn; some were taken alive for the Botanic Gardens at L and M.

Stemona javanica – This species is quite extensively described by Backer (Backer & Bakhuizen van den Brink Jr, 1968). The single plant in the botanic garden at Bogor was recorded as originating from Java. It is roughly of the same growth-habit as *S. tuberosa,* but in the garden it grew much lower, with twining shoots only c. 3 m long, into a bushy plant of c. 1 m tall, possibly due to lack of support in its vicinity. The leaves remain distichous alternate all over the adult plant, which was flowering incidentally, and quite close to the ground. The flowers were produced axillary, single or a few together, but only one grown large and flowering at a time; they resemble those of *S. tuberosa* but are much smaller, in mature bud c. 1.5 cm long only, and wholly purple-black. They disperse the same carrion smell, and were visited by the same flies as those seen with *S. tuberosa.* Fruit was not present.

The leaves of both taxa, growing side by side, are remarkably similar; only a faint difference in intensity of the green colour (lighter) and a slightly smaller size in *S. javanica* could be observed.

The petiole, in both species, showed a distinct pulvinus or joint, c. 0.5 cm long and of a pale green colour, in the basal part, a feature which could be seen later on in dried material as well (drying blackish), and also in earlier collected herbarium specimens of all or most species of the genus. The presence of a joint in the petiole of *S. javanica* was recorded by Backer (Backer & Bakhuizen van den Brink Jr, 1968), but I found it nowhere mentioned in other publications on *Stemona.*

3) I thank Mr. P. Beuk of the Natural History Museum, Leiden, for his expertise.

Pentastemonaceae: Pentastemona egregia and P. sumatrana

Although with the original description of the genus *Pentastemona* by Van Steenis (1982) complete herbarium specimens of both species were at hand, several additional facts about these juicy plants could only later on be observed on the living plants in situ or on material preserved in spirit, after collectors became aware of the singularity of the new genus. Thus, there is the spirit material of *P. egregia* collected by Meijer (*Meijer 17010,* seen by Van Steenis only just before publishing his treatment of the genus), and later collections by J. Bogner (at present in the living state in the botanic gardens at M and L), and several more herbarium collections and photographs by Japanese collectors, mainly M. Hotta; all are from a restricted area in central W Sumatra. Of *P. sumatrana* the author made new additional collections, including spirit material, in 1985, on a site at the mouth of the Sebelin River, where it flows into the Middle Alas, not far away from the type-locality at Moara Bengkong; both in N Sumatra.

In August 1991 the author could visit both localities with *P. sumatrana* again, and although the weather was rainy, some field observations could be made and photographs, good flowering herbarium and FAA-material could be secured. Moreover, living plants were taken, and introduced in the botanic gardens at BO, L, and M.

From all these later collections I have compiled the following notes, partly repeating what is already said above concerning the 'discriminating characters' for *Pentastemona.*

Habitat and growth habit – From the herbarium labels and the close study of a number of published (Meijer & Bogner, 1982, 1983; Hotta, 1989) and unpublished photographs (incl. those by W. Meijer, accompanying the collection *Meijer 17010*), and the plants of *P. egregia* grown in the greenhouse, and from my own observations in situ (with photographs) of *P. sumatrana* (fig. 1), it is clear that both species of *Pentastemona* are very juicy; they grow on steep sloping or even vertical bottom, epilithic for *P. sumatrana,* and for *P. egregia* epilithic or in shallow humus soil or gravelly soil; both species in moist, very shady situations.

The stem is unbranched, green, always above the soil, and it usually grows in a 'creeping' way ± vertically up towards the light. It carries only foliage leaves which are dispersed, spreading, with the more or less glossy blades orientated towards the light (see plate 7, lower left, in Hotta, 1989). Plants may grow either solitary on vertical faces of rocks or fallen rock blocks of presumably basaltic sort, or they may form dense stands on rock-faces (see the photograph in Meijer & Bogner, 1983). The localities of *P. sumatrana* are at an altitude of 50–80 m above sea level, those of *P. egregia* in central W Sumatra at 350–650 m. The areas of both species seem to be very restricted.

The juicy, finger-thick, creeping, supra-terraneous stem loosely clings to the substrate with a restricted number of slender adventitious roots which may be copiously branched towards the end. The inflorescences emerge apparently from the axils of the lower foliage leaves, but, because the petiole is sheathing and broadly inserted on the stem it is easily overlooked that actually they are inserted beside the true centre of the leaf axil, i.e. pseudo-axillary.

Fig. 1. Black-and-white reproduction of a colour-flash photograph of a plant of *P. sumatrana* in situ, growing on a very shady rock block (same population as *de Wilde & de Wilde-Duyfjes 21399*); × 0.3. Note small viviparous plantlet at top of inflorescence in upper left corner.

Most likely both species are monoecious or polygamous, *P. egregia* possibly is dioecious; see explanation further on.

Pentastemona sumatrana is viviparous from the apical part of the inflorescences; *P. egregia* easily grows young plants from (portions of) detached leaves, as seen in *Meijer 17010,* or when placed on humid soil in the greenhouse (see also the photograph in Meijer & Bogner, 1983).

Inflorescences and vivipary – The pseudo-axillary inflorescences are usually simple in *P. egregia* and compound in *P. sumatrana.* However, in *P. egregia* sometimes a bifid branched inflorescence is formed, and comparison with the compound inflorescences of *P. sumatrana* shows that those of *P. egregia* can be thought as derived from the former by reduction. As also the perianth in *P. egregia* is basally fused into a tube, as against perianth-lobes almost free in *P. sumatrana,* the latter species possibly can be regarded as being more primitive.

The inflorescences of both species are schematically depicted in figure 2c–f, and can briefly be described as follows:

In *P. sumatrana* the inflorescences are long-peduncled, more or less upright, later on curving downward, about as long as the leaves, and hence the flowering portion of the inflorescence is among or just below the leaf blades, in the periphery of the plant (see schematic habit, fig. 2a). The inflorescence consists of the long juicy peduncle which proceeds towards the top into the flowering portion, with along the main axis 1–4 rather spaced flower-bearing side branches, apparently in a spiral disposition. These lateral flower-bearing branches are short, up to a few cm long, unbranched, and few- to many-flowered. They obviously are simple racemes, with the flowers produced in an indeterminate way, in a spiral disposition. The lateral flowering racemes and the flowers are axillary to the bracts, those sustaining the racemes are largest, c. 1 cm long, and are inserted on the peduncle (or main axis) or somewhat displaced onto the basal part of the matching lateral racemes (fig. 2c). Most flowers fall off after anthesis, leaving an axillary scar or mostly the greater portion of the pedicel, because apparently there is no fixed place of abscission or joint. There are no bracteoles.

In most inflorescences the uppermost bract, at the very top of the main axis, is somewhat enlarged and the terminal growing point then proliferates, producing a young plant in a viviparous way. This viviparous plant, while still attached to the parent plant, may reach quite a big size, with (1 or) 2–4 normal shaped, rosulate, closely set leaves, with blades up to 5 cm long, and with some adventitious roots developed from the node-like thickened main stem. It is likely that, after the stalk of the inflorescence has curved down either by the load of the young plant or by developed fruits or both, or by decay, the young plant becomes loose and may get grip on the substrate, giving rise to new individual plants. Opening of the mature berry-like fruit, or germinating seed has not been seen.

There is another strange fact concerning the inflorescences: in the axils of the bracts carrying the lateral racemes there is, beside the raceme, an extra flower or the scar of its pedicel. This flower is similar to the other flowers of the lateral raceme, but it does not have a supporting bract; it is strictly axillary or slightly (up to 1.5 mm) shifted up along the side branch, and apparently it is always in the abaxial position. Schematically, this is for *P. sumatrana* as depicted in figure 2c.

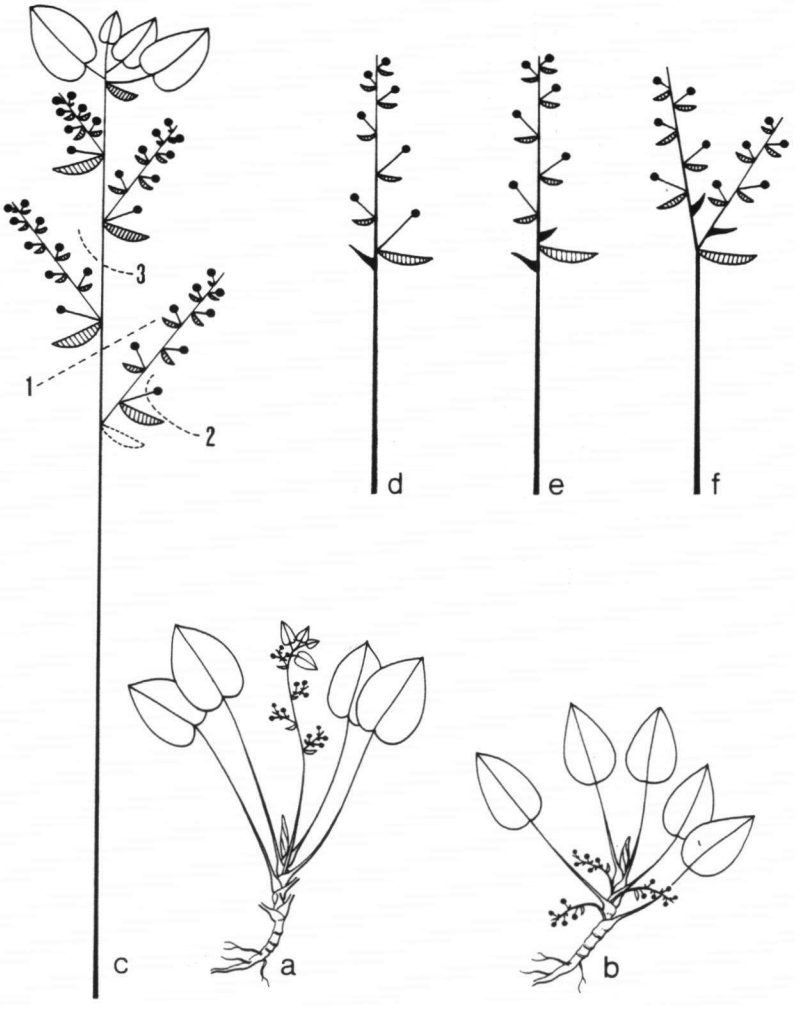

Fig. 2. *Pentastemona*. – a. Schematic growth habit of *P. sumatrana*; note inflorescences with terminal proliferation; b. ditto of *P. egregia*; c. diagram of the compound inflorescence of *P. sumatrana*; d–f. ditto of *P. egregia*, sterile appendages solid black.

I cannot think of a simple morphological explanation of this peculiar situation of two superposed strongly differing axes in the axil of one supporting bract. Because bracts and/or branches show tendencies of being replaced, or fused, in the inflorescence locally, and because the inflorescence itself possibly is not truly axillary to the foliage leaf, it seems likely that a complicated shifting of bracts or fusion of axes is involved, which only can be elucidated by a specialist studying a large amount of living and alcohol material.

In *P. egregia* the inflorescences are mostly simple, or rarely 2-branched. They are much shorter than those of *P. sumatrana,* and develop from the axils (but actually from beside the true centre) of the lower foliage leave-blades, and hence the flowering part of the plant is below the leafs, rather towards the centre of the plant (fig. 2b; see also Hotta, 1989: plate 7, lower left).

In the species description of *P. egregia* given by Van Steenis (1982), he mentions a small appendage in the inflorescence, as appears from the following quoting (l.c.: 162): "Peduncle glabrous, 2–3 cm long, somewhat flattened, with one filiform, sometimes downward curved setaceous appendage, c. 1.5 mm long below the lowest bract." However, he pays no further attention to this, except that it seems to be depicted in his figure 2f (l.c.: 153), but described and drawn in the wrong position. Actually, the said appendage appears as a slightly up-curved thorn-shaped projection, 1.5–2 mm long, of the same tissue structure as the peduncle, and situated at (about) the same level or slightly below and subopposite or perpendicular to the lowest bract, which is c. 1 cm long. This is schematically depicted for a simple inflorescence of *P. egregia* in figure 2d. In the rare 2-branched inflorescences of *P. egregia* there appear to be two such horn-like appendages, as depicted in figure 2e, f.

When the schematic figures of the inflorescences of *P. egregia* (fig. 2d–f) are compared with that of *P. sumatrana* (fig. 2c), it will be clear that the former can easily be thought as being homologous with the latter through reduction to the small appendage of the parts of the inflorescence of figure 2c (*P. sumatrana*) above the broken lines, for instance at 1, 1 and 2, or 2 and 3 respectively. The inflorescences of *P. egregia* agree exactly with what can be expected, namely that all the flowers or pedicel-scars are subtended by a bract, also the lowermost.

Flowers: morphology, shape, and sex – As alluded to already in various ways, the flower morphology of *Pentastemona* is highly distinctive, and I may refer to the brief descriptions presented by Van Steenis (1982) and those to be given by me in Flora Malesiana (in prep.), whereas Van Heel (Blumea, 1992, in prep.) will publish an article on the ontogeny and comparative morphology of the flowers within Stemonaceae including *Pentastemona.*

Van Steenis (1982) described the flowers of *Pentastemona* as uniformly hermaphroditic, but closer study of herbarium material and photographs (see above) of *P. egregia,* and especially living plants and spirit material of *P. sumatrana,* convinced me that in both species different types of flowers are present. Apparently it rather concerns polygamy; all flowers seem superficially hermaphroditic, provided with ovary and anthers, and all considerably resemble each other. Actually, however, all or at least the majority of the flowers are either functionally female or male, and likely there are also intermediates with only a reduced ability of one of the sexes, and truly hermaphroditic ones as well.

In *P. sumatrana* this is quite evident: in the young stages, before anthesis, all flower buds closely resemble each other, but at opening, there are small but marked differences, the fully male ones have the perianth more or less urceolate, at the base broad and abruptly tapering into a short-conical hypanthium which contains a reduced ovarial part inside with only deformed abortive ovules; the pedicel is relatively long and slender; the tepals (which are free in all flower types) are sub-erect and some-

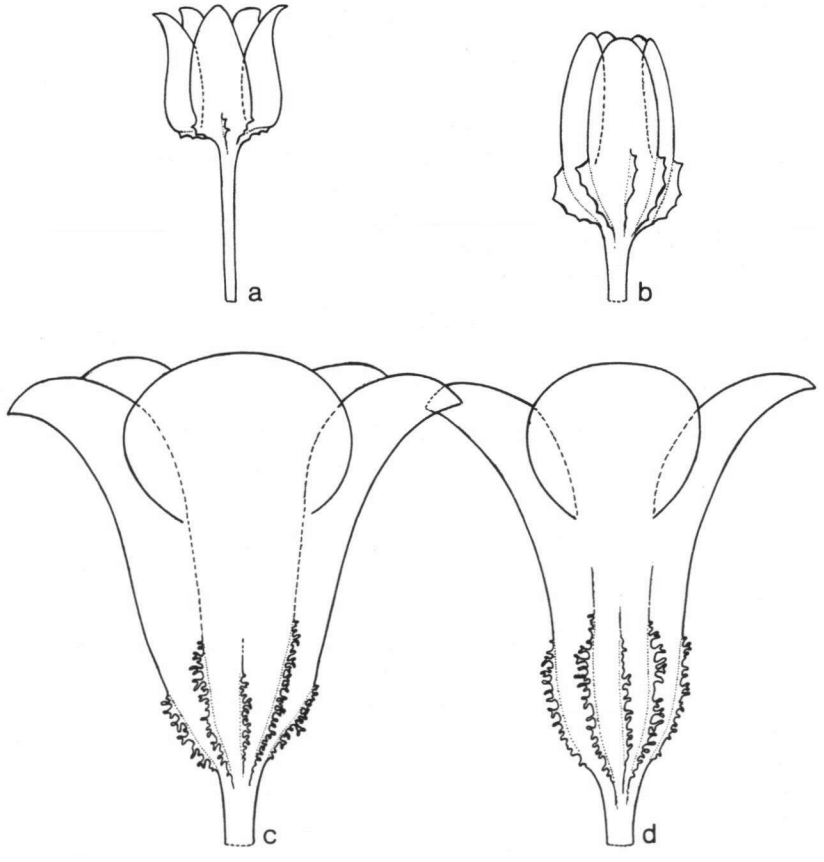

Fig. 3. *Pentastemona*, lateral views of mature flowers – a, b. *P. sumatrana*, male and female flower respectively; c, d. *P. egregia*, ditto; all × 4 (a, b: *de Wilde & de Wilde-Duyfjes 21399*; c: *Bogner 1724*; d: *Meijer 17010*).

what out-curved towards the top (fig. 3a). The anthers have copious pollen which is early shed after anthesis. Then the flower soon drops, usually breaking away at the transition of hypanthium to pedicel, the latter long remaining in the axil of its sustaining bract. Female flowers have a slightly larger, i.e. longer conical part; the tepals open only to an upright position and do not curve outward; the pedicel usually is shorter; the disk with anther-pouches is somewhat lower, with smaller thecae containing presumably less and largely sterile pollen; the ovary with many well-developed ovules soon develops into the berry-like fruit with persistent perianth. Presumably, there are also flowers in which only a part of the ovules is well-developed and fertile, of a similar outward appearance as fully female ones, and possibly these should be regarded as hermaphroditic. Finally, all or part of these hermaphroditic flowers may be markedly protandrous.

Whether the male flowers have a fixed disposition in the lateral racemes is not clear; once I saw that the very first flower (that in which the bract is lacking, see above) had developed into a fruit, but fruits were frequently seen formed higher up in the raceme as well.

In *P. egregia,* the flowers are much larger than in *P. sumatrana,* with the perianth fused for about halfway into a tube. I have the impression that of *P. egregia* the plants, possibly in small populations, are dioecious. But maybe here too the flowers are only partially functionally unisexual, or profoundly protandrous, in such a way that after the release of pollen the ovary rapidly matures; more field observations are needed to confirm this. The herbarium collections give only limited information, mainly because the juicy flowers dry into a very filmy inaccessible state. The material *Meijer 17010,* with photographs in L, seems to represent plants with only or mainly female flowers; *Bogner 1724,* cultivated in the greenhouses in Munich, with vegetatively propagated offspring in Leiden, and all or most of the plants collected by Hotta and others (see also the photograph in Hotta, 1989) seem largely male; in these plants the ovarial part is relatively small and the corolla relatively wide (see fig. 3c). The Leiden plants, however, seem to produce only a limited amount of pollen, which soon disappears after anthesis; fruit-setting has never occurred, neither in Munich nor in Leiden.

Fruit and seed – The fruit of both species of *Pentastemona* can best be described as a berry. The thinly but distinctly ribbed pericarp is of juicy tissue, as is the whole plant, and the ovules grow into a conspicuous mass of jelly-like watery substance, formed by the exotestas, containing the seeds, as can easily be seen in the somewhat translucent fruit of FAA-pickled material. It is unknown how the fruit releases its seed, how the seed is dispersed and germinates. A comparative study on the seeds of Stemonaceae and *Pentastemona* will be published by F. Bouman (Blumea, 1992, in prep.). The sagging of the inflorescence to the ground, as well as the shape and consistence of the fruit is somewhat reminiscent to that of *Tacca* species.

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