A new species of Parartocarpus Baillon (Moraceae)

by

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P. microcarpus sp. nov. is described as a montane species from Sarawak and Sabah, as the most leptocaul species of the genus able to fruit with small 1 (–2) seeded syncarps. Four species are recognised, namely *P. bracteatus, P. forbesii, P. microcarpus,* and *P. venenosus.*

Parartocarpus has been revised by Jarrett (1959, 1960), who reduced ten specific names to *P. bracteatus* (King) Becc. and *P. venenosus* (Zoll. et Mor.) Becc. For the second she introduced four subspecific names, but the complexity calls for enquiry. I take this up with a new species *P. microcarpus.* My attention was drawn to it by the field-note attached to the collection S. 33074 from Sarawak, which had been filed under *P. venenosus.* It recorded the plant as a treelet c. 3m high. I have seen many trees of *P. bracteatus* and *P. venenosus* and have never observed such precocious maturity. They do not fruit until c. 12m high, when the trunk is becoming massive; ultimately they reach 30–45m. They are among the easiest trees to recognise in the primary forest where they grow. The pale cylindric trunk, rarely with short imperfect buttresses, has strongly pustulate and greyish white bark, often tinged brownish or yellowish, with faint hoop-marks and copious latex. Actually they are often first encountered by stumbling on the massive superficial roots with similar pustulate bark. From these stout roots, which spread widely, many smaller laterals proceed from the underside deeply and perpendicularly into the soil; thus uprooted trunks and stumps in recent clearings can also be recognised. I observed that in the peat-swamps of Singapore and Johore big trees of *P. venenosus* ssp. *forbesii* (King) Jarrett occurred at the rate of 2–4 per hectare.

As I had never seen such small fruiting trees as S. 33074, I examined in detail the duplicate sent to me and found that what appeared to be inflorescences at anthesis (capitula 2–3cm wide) were in fact fully grown syncarps with a nearly mature seed; the cotyledons had not entirely filled the testa. More remarkable, however, were two facts; the syncarps were bisexual and the anthers were introrse. *Parartocarpus,* like most other Moraceae, has extorse anthers; they are introrse, so far as known, merely in *Antiaris, Antiaropsis,* and *Ficus* (Corner 1962). I found the same peculiarities in the duplicate of S. 28676, sent to me, but the field-note gave this as a large tree c. 26m high. As this material was scant, I borrowed through Mr Paul Chai the original sheets from the Kuching Forest Herbarium. He kindly sent me two more sheets which also gave the tree as 25–30m high. The four collections agreed in the thin twigs (3–5mm thick), small glabrous leaves, small bisexual syncarps (of which I dissected eight), flat facets to the tepals, the 1(–2?) fertile seeds, absence of any central core to the syncarp, introrse anthers, and short thick deflexed involucral bracts. In *P. bracteatus* and *P. venenosus* the syncarps are much larger (7–20cm wide), many-seeded, with a distinct core (3–4cm thick), and usually unisexual. Their twigs are relatively stout (5–9mm thick) and their leaves larger with more lateral veins (8–15 pairs) and distinct transverse intercostals (3–5 in *P. venenosus,* up to 11 in *P. bracteatus*), though the smaller leaf of *P. venenosus* ssp. *forbesii* (1–2 intercostals) approaches that

of *P. microcarpus* (Figures 1, 2). The leaves are also figured by Jarrett (1960, figure 21).

Having found these morphological agreements between the four collections, I asked that the field-note on S. 33074 should be checked. It transpires that there was an error. The tree was c. 23m high and 1.6m in girth (70ft., 4ft. girth, not the 10ft. treelet of 4in. girth as given on the label). This error has been productive. *P. microcarpus* is the most leptocaul species able to fruit with exceptionally small syncarps, and this faculty may enable it to begin fruiting early in the life of the tree. The species comes nearest in leaf, perhaps also in seed, to *P. venenosus* ssp. *forbesii* (Malaya, Sumatra, Borneo), but differs in the non-spinous, small and bisexual syncarps, the thick deflexed involucral bracts, the introrse anthers, and the montane habitat.

The bisexual syncarp is puzzling. At first I thought that the capitula were strongly protogynous because the male flowers had included anthers, as if to become exsert while the seed was forming. At anthesis of the female flowers the anthers were 3–4mm long and well-formed with the loculi filled with apparently mature pollen-grains. In the nearly ripe syncarps the anthers were shrunken (1.5–2.5mm long), more or less empty, and without sign of elongation of the filament. The collections S. 28676 and S. 33074 had capitula at anthesis and various stages in development on to mature syncarps, but there were no exsert anthers as typical of the genus (Figure 3). Two explanations offer themselves, which field-study must resolve. Either there are only bisexual capitula from which the anthers are never exsert, and the pollen must be extruded somehow from the male loculus; or there are both male and functionally female capitula, in which case the male have yet to be discovered, perhaps on different trees. The second possibility happens occasionally in *P. venenosus* ssp. *forbesii*, a few syncarps of which have such male loculi with included and shrunken but extrorse anthers, and it was habitual in two trees of *Treculia africana* which grew in the Singapore Botanic Garden; all the syncarps of these trees were bisexual, very strongly protogynous, with the anthers slowly exsert, and productive of many viable seeds. Like *Parartocarpus* in general and *Artocarpus, Treculia* is said to be monoecious with unisexual capitula.

Parartocarpus microcarpus sp. nov. Figure 1.

Arbor –30m alta. Folia parva glabra, venulis intercostalibus transversis nullis. Capitula 15mm lata, bisexualia; bracteis involucri 3–4(–5) deflexis, dense puberulis. Syncarpia parva, 2.5–3cm lata, seminibus 1(–2) praedita; bracteolis tepalisque planis, non spinosis. Semina epistomio sclerotico deficientia. Borneo (Sarawak, Sabah) in silvis montanis 1000–1800m alt. Typus:— S. 28676 (Herbarium, Forest Department, Sarawak).

Tree –30m high, bole –2m in girth; bark whitish, lenticellate; latex white. Leaves spirally arranged. Twigs 3–5mm thick, appressedly puberulous with whitish hairs 0.1–0.3mm long, soon glabrous. Stipules 2–3.5mm long, closely puberulous, caducous. Lamina 3–10 x 1.6–4cm, narrowly obovate to lanceolate-elliptic, subacute, base tapered, coriaceous, entire, glabrous except for sparse whitish hairs –0.5mm long on the underside of the midrib, drying brown; lateral veins 6–8(–9) pairs, raised on both sides of the lamina, without transverse intercostal veins (rarely 1); reticulum not or scarcely raised; petiole 18–35 x 1–1.5mm.

Capitula c. 15mm wide at anthesis of the female flowers, bisexual, solitary, axillary, globose, minutely facetted with flat or slightly convex tepals arranged mostly in pairs or threes (rarely fours) with the outer end 1.5–2.5mm wide, sometimes with a slight central point, the free parts 0.5mm high; involucre of

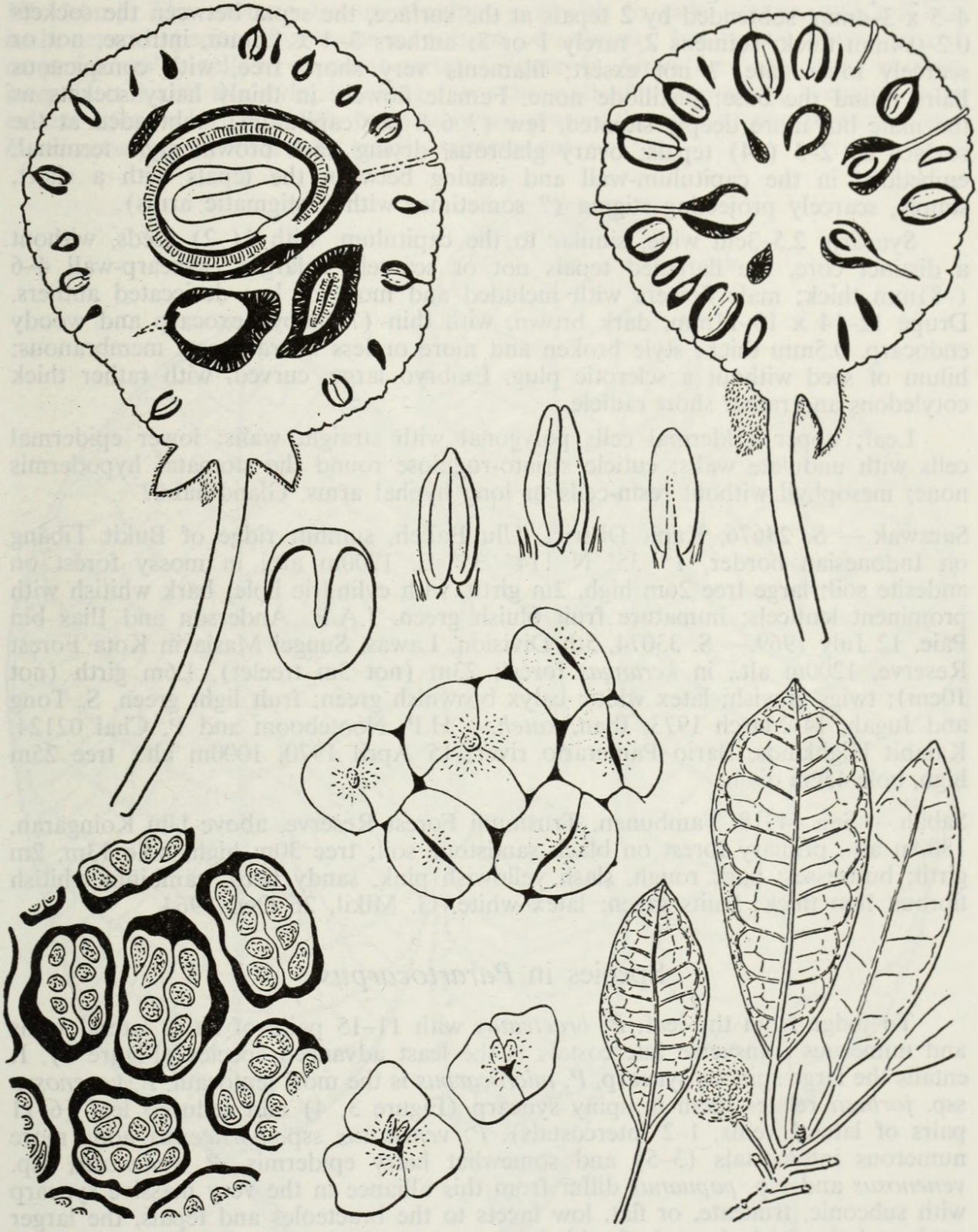

Figure 1. *Parartocarpus microcarpus.* Capitula shortly after anthesis of the female flowers (S. 33074) and fully grown (S. 28676), x 2. Twig and leaves, x ½. Embroy in radicle view, x 3. Stamens, x 5. Male flowers in t.s., x 10. Facets of perianths, the lower two apparently with bifid stigmata (S. 28676), x 6.

3–4 (–5) short, thick, closely puberulous, triangular, more or less deflexed bracts 3–4 x 3–5mm, 2–2.5mm thick, free or shortly joined; peduncle 14–25 x 1.5–2mm, thinly puberulous, glabrescent. Male flowers abundant, in hairy sockets 4–5 x 3–4mm, subtended by 2 tepals at the surface, the septa between the sockets 0.2–0.4mm thick; stamens 2, rarely 1 or 3; anthers 3–4 x 1.5mm, introrse, not or scarcely mucronate, ? not exsert; filaments very short, free, with conspicuous hairs round the base; pistillode none. Female flowers in thinly hairy sockets as the male but more deeply situated, few (? 6–8 per capitulum), subtended at the surface by 2–3 (–4) tepals; ovary glabrous, drying dark brown; style terminal, embedded in the capitulum-wall and issuing between the tepals with a short, simple, scarcely projecting stigma (? sometimes with 2 stigmatic arms).

Syncarp. 2.5–3cm wide, similar to the capitulum, with 1(–2) seeds, without a distinct core, the flattened tepals not or scarcely enlarged; syncarp-wall 4–6 (–8)mm thick; male flowers with included and more or less desiccated anthers. Drupe 12–14 x 10–11mm, dark brown, with thin (? pulpy) exocarp and woody endocarp. 0.5mm thick; style broken and more or less lateral; testa membranous; hilum of seed without a sclerotic plug. Embryo large, curved, with rather thick cotyledons and rather short radicle.

Leaf; upper epidermal cells polygonal with straight walls; lower epidermal cells with undulate walls; cuticle striato-rugulose round the stomata; hypodermis none; mesophyll without resin-cells or long hyphal arms. Gland-hairs?

Sarawak.— S. 28676, Kapit District, Ulu Balleh, summit ridge of Bukit Tibang on Indonesian border, 1° 35′ N 114° 35′ E, 1700m alt., in mossy forest on andesite soil; large tree 26m high, 2m girth, with cylindric bole; bark whitish with prominent lenticels; immature fruit bluish green. J.A.R. Anderson and Ilias bin Paie, 12 July 1969.— S. 33074, 5th Division, Lawas, Sungei Masia in Kota Forest Reserve, 1200m alt., in *kerangas* forest; 23m (not 3m treelet), 1.6m girth (not 10cm); twigs greyish; latex white; calyx brownish green; fruit light green. S. Tong and Jugah, 14 March 1973. Iban, *kateh*.— H.P. Nooteboom and P. Chai 02124, Kalabit Highlands, Bario Pamerario river, 15 April 1970, 1000m alt.; tree 25m high, bole 45cm diam.

Sabah.— San 44318, Tambunan, Trusmudi Forest Reserve, above Ulu Koingaran, 1800m alt., primary forest on black sandstone soil; tree 30m high, bole 13m, 2m girth; buttresses; bark rough, slash yellowish pink, sandy hard, cambium whitish fibrous 1cm thick; fruits green; latex white. G. Mikil, 26 Oct. 1964.

Species in *Parartocarpus*

To judge from the leaf, *P. bracteatus* with 11–15 pairs of hairy lateral veins and numerous transverse intercostals is the least advanced species (Figure 2). It entails the large spinous syncarp. *P. microcarpus* is the most leptocaul. *P. venenosus* ssp. *forbesii* relates them in spiny syncarp (Figure 3, 4) and reduced leaf (6–11 pairs of lateral veins, 1–2 intercostals). *P. venenosus* ssp. *borneensis* adds more numerous intercostals (3–5) and somewhat hairy epidermis. *P. venenosus* ssp. *venenosus* and ssp. *papuanus* differ from this alliance in the very massive syncarp with subconic, truncate, or flat, low facets to the bracteoles and tepals, the larger seed, and the fairly large leaf with lax venation (6–15 pairs of lateral veins, 3–5 intercostals). *P. microcarpus*, though with the flat facets of ssp. *venenosus*, is vegetatively closer to ssp. *forbesii*, and this alliance seems to be proved by the seed.

In *P. bracteatus* and *P. venenosus*, except ssp. *forbesii*, the seed has a thick sclerotic plug in the hilum (Figure 4). This is absent from *P. microcarpus* and from some collections of ssp. *forbesii* (Figure 4), though perhaps not all (Jarrett 1959, figure 2e). The plug develops early, even before the sclerotic endocarp. The

seeds are largest in *P. venenosus* ssp. *venenosus* and ssp. *papuanus* (20–35 x 16–28mm across the endocarp), smaller in *P. bracteatus,* ssp. *forbesii,* and spp. *borneensis* (c. 15 x 12mm), and slightly less, perhaps, in *P. microcarpus* (12–14 x 10–11mm). The exocarp becomes pulpy, yellowish to pale orange, and aril-like as in several species of *Artocarpus* subgen. *Artocarpus,* but it has a layer of red or purple pulpy cells in its outer cortex (Figure 4). Growth of the drupe is often inequilateral and the style, breaking from the wall of the syncarp, becomes more or less lateral (Jarrett 1960), but this is not always the case in ssp. *papuanus* and *P. microcarpus* where it may remain subterminal.

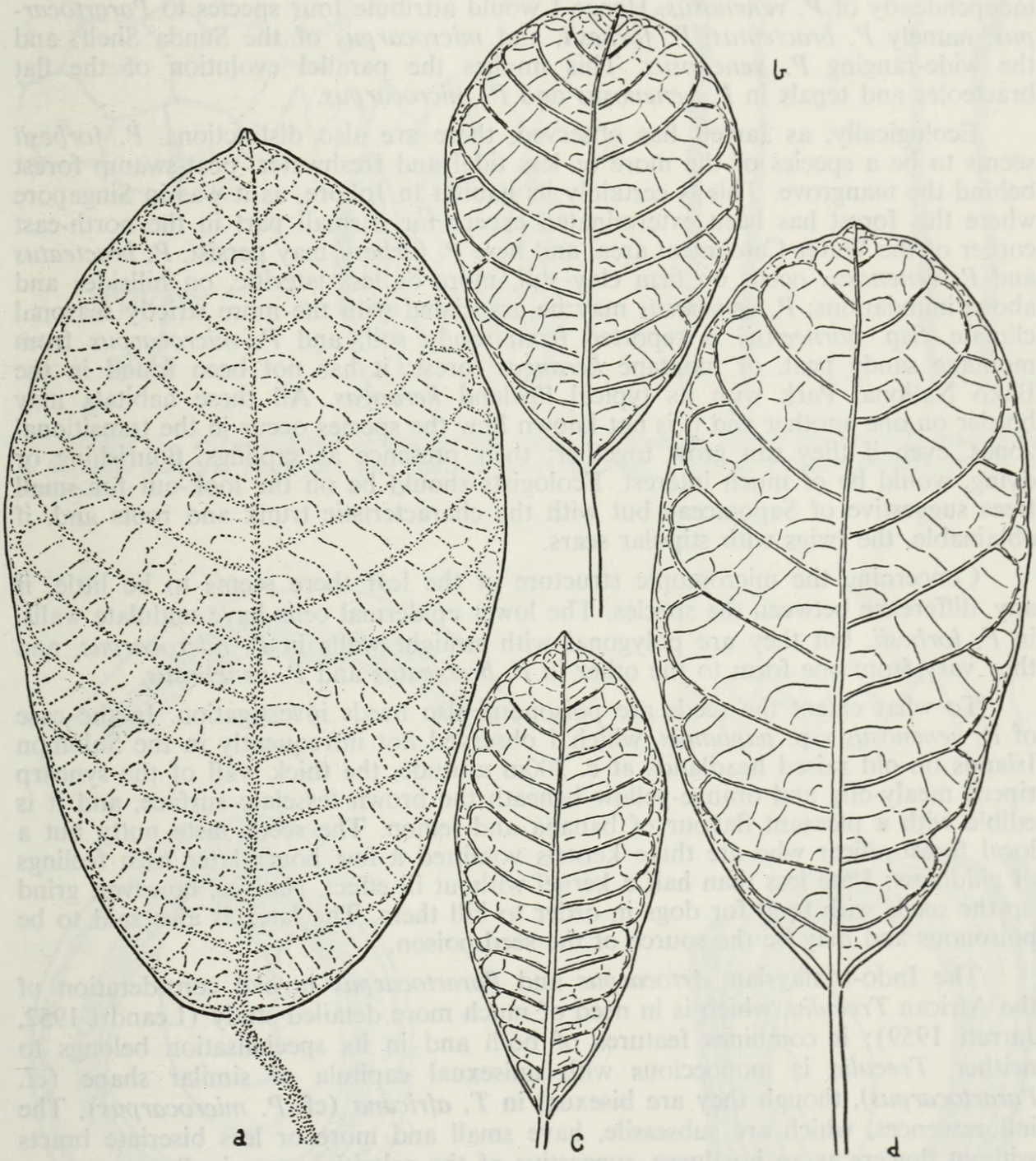

Figure 2. Leaves of *Parartocarpus bracteatus* (a), *P. venenosus* ssp. *borneensis* (b), ssp. *forbesii* (c), and ssp. *papuarus* (d), x ½.

Geographically, according to Jarrett (1960), *Parartocarpus* occupies the lowland forests of south-east Asia on the Sunda Shelf, except for *P. venenosus* ssp. *papuanus* the distribution of which is easterly from Celebes and the Philippines to the Solomon Islands. With this exception, all species and subspecies occur in Borneo, where ssp. *borneensis* is endemic, and Java has only ssp. *venenosus*. The one record of ssp. *venenosus* from Borneo, however, is problematic and based on the type of *P. beccarianus*, which may need enquiry. Certainly the main distribution of ssp. *venenosus* and ssp. *papuanus* is different from that of the remainder of the genus. When morphological characters are added, I incline to regard ssp. *forbesii* and ssp. *borneensis* as a distinct species connected with the ancestry of *P. bracteatus* independently of *P. venenosus*. Hence I would attribute four species to *Parartocarpus*, namely *P. bracteatus*, *P. forbesii*, and *microcarpus* of the Sunda Shelf, and the wide-ranging *P. venenosus*. This implies the parallel evolution of the flat bracteoles and tepals in *P. venenosus* and *P. microcarpus*.

Ecologically, as Jarrett has observed, there are also distinctions. *P. forbesii* seems to be a species of the more or less tidal and freshwater, peat-swamp forest behind the mangrove. This is certainly its habitat in Johore, as it was in Singapore where this forest has been exterminated except for a small part in the north-east corner of the Water Catchment area, and here *P. forbesii* may persist. *P. bracteatus* and *P. venenosus* occur on firm clay soil, more or less lateritic, on hillsides and above inundations; *P. venenosus* may be associated with the more strictly seasonal climate. Ssp. *borneensis* is reported from sandy soil, and *P. microcarpus* from montane sandy peat, or montane *kerangas* forest; it has not been found in the Bako National Park with its typical lowland *kerangas*. All these habitats may border on one another and it is not known how the species occur in the transitional zones, even if they can grow together; their presence as saplings, flourishing or dying, would be of much interest. Ecologists should be on the look-out for small trees suggestive of Sapotaceae but with the characteristic trunk and roots and, if obtainable, the twigs with stipular scars.

Concerning the microscopic structure of the leaf there seems to be little, if any, difference between the species. The lower epidermal cells have undulate walls. in *P. forbesii*, but they are polygonal with straight walls in *P. microcarpus*, and they vary from one form to the other in *P. bracteatus* and *P. venenosus*.

To what extent the seeds are poisonous also needs investigation. In the case of *P. venenosus* ssp. *papuanus*, which I observed not infrequently in the Solomon Islands on old raised headlands at c. 300m altitude, the thick wall of the syncarp ripens mealy-oily and orange-yellow beneath the brown tesselate surface, and it is edible with a pleasant flavour of banana and lemon. The seeds taste nutty but a local forest-officer who ate three kernels vomitted a few hours later with feelings of giddiness; I ate less than half a kernel without ill effect. Natives, however, grind up the seeds with food for dogs in order to kill them. The latex is also said to be poisonous and may be the source of the seed-poison.

The Indo-Malaysian *Artocarpus* and *Parartocarpus* invoke consideration of the African *Treculia*, which is in need of much more detailed study (Leandri 1952, Jarrett 1959); it combines features of both and in its specialisation belongs to neither. *Treculia* is monoecious with unisexual capitula of similar shape (cf. *Parartocarpus)*, though they are bisexual in *T. africana* (cf. *P. microcarpus*). The inflorescences, which are subsessile, have small and more or less biseriate bracts without flowers as an involucre, suggestive of the primitive state in *Parartocarpus*. They are covered with many free bracteoles with peltate heads (cf. *Artocarpus*) or they have spicately ramified extremities. The male flowers have a thin tubular perianth with 2–4 teeth at the end (cf. *Artocarpus*), but they enclose 3–4 extrorse stamens (cf. *Parartocarpus*) with short anthers and free filaments; there may be a minute pistillode. The female flower has no perianth or it may consist of three

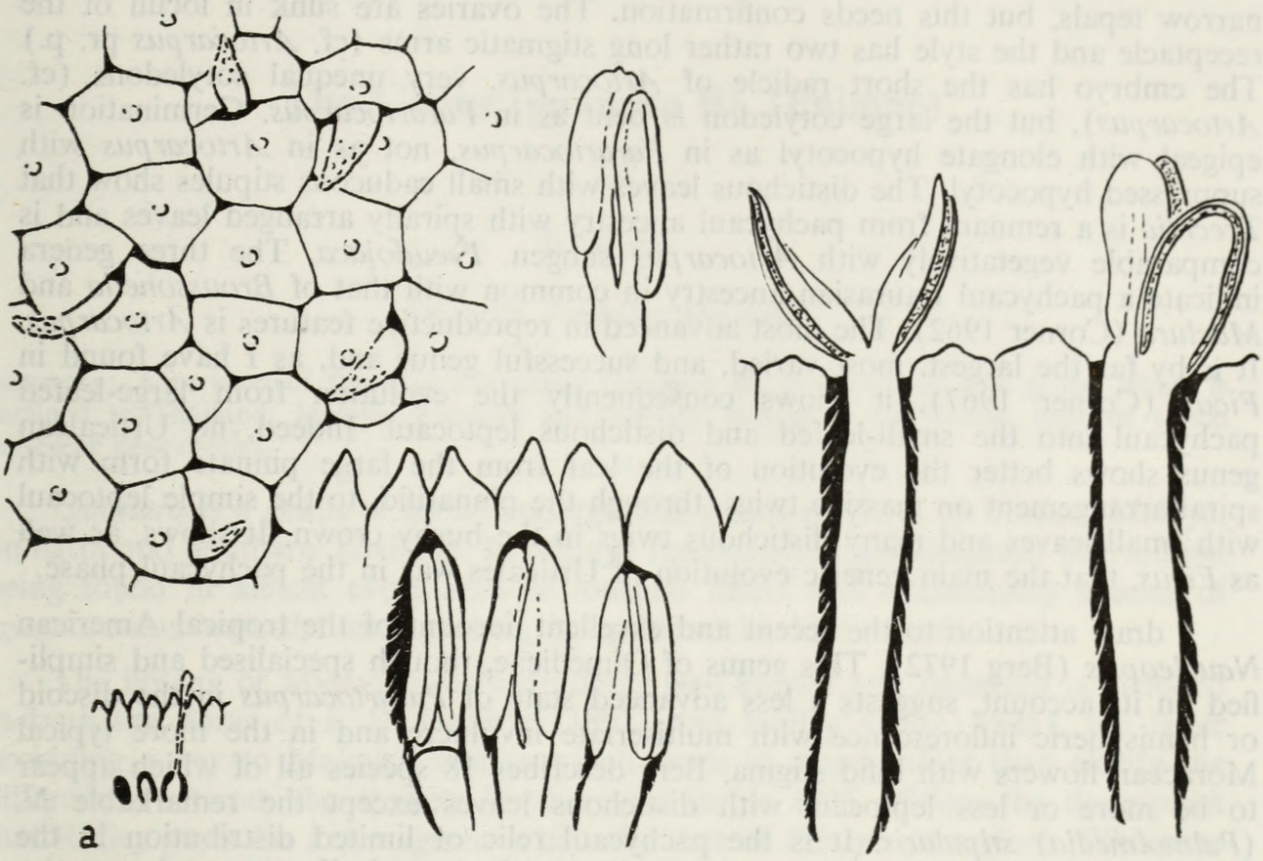

Figure 3. *Parartocarpus venenosus* ssp. *forbesii.* Facets of female flowers with bracteoles, x 6. Male flowers, immature and mature, and stamens, x 10. *a.* Female flowers in l.s. at anthesis, x 2.

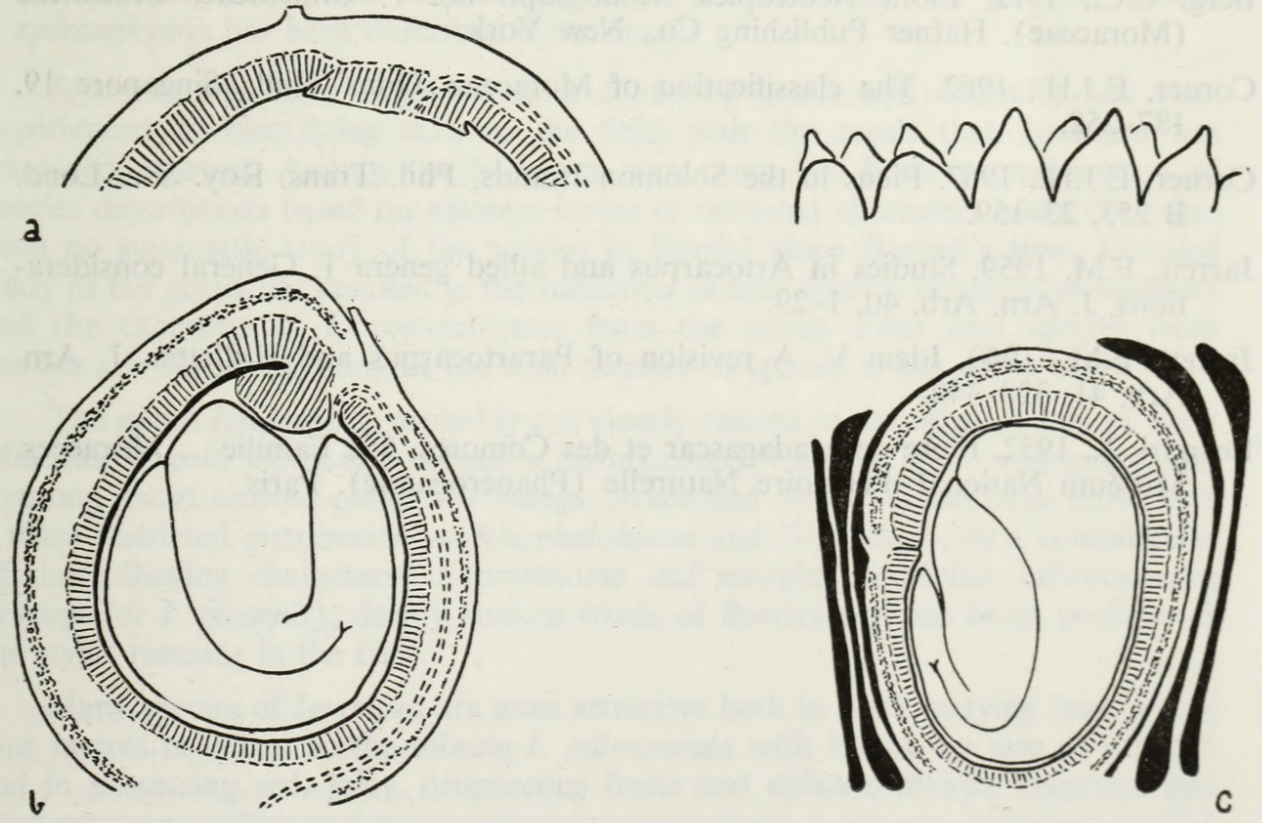

Figure 4. Drupes of *Parartocarpus* in l.s., x 3. *P. venenosus* ssp. *papuanus* (a, with hilum of seed only), ssp. *forbesii* (c, with syncarp-wall), and *P. bracteatus* (b). Endocarp striated; v.b. with broken lines; layer of red pulpy cells of exocarp speckled.

narrow tepals, but this needs confirmation. The ovaries are sunk in loculi of the receptacle and the style has two rather long stigmatic arms (cf. *Artocarpus* pr. p.) The embryo has the short radicle of *Artocarpus*, very unequal cotyledons (cf. *Artocarpus*), but the large cotyledon is bent as in *Parartocarpus*. Germination is epigeal with elongate hypocotyl as in *Parartocarpus*, not as in *Artocarpus* with suppressed hypocotyl. The distichous leaves with small caducous stipules show that *Treculia* is a remnant from pachycaul ancestry with spirally arranged leaves and is comparable vegetatively with *Artocarpus* subgen. *Pseudojaca*. The three genera indicate a pachycaul Laurasian ancestry in common with that of *Broussonetia* and *Maclura* (Corner 1962). The most advanced in reproductive features is *Artocarpus*. It is by far the largest, most varied, and successful genus and, as I have found in *Ficus* (Corner 1967), it shows consequently the evolution from large-leafed pachycaul into the small-leafed and distichous leptocaul. Indeed, no Urticalean genus shows better the evolution of the leaf from the large pinnate form with spiral arrangement on massive twigs, through the pinnatifid, to the simple leptocaul with small leaves and many distichous twigs in the bushy crown. It shows, as well as *Ficus*, that the main generic evolution of Urticales was in the pachycaul phase.

I draw attention to the recent and excellent account of the tropical American *Naucleopsis* (Berg 1972). This genus of Olmedieae, though specialised and simplified on its account, suggests a less advanced state of *Parartocarpus* in the discoid or hemispheric inflorescence with multiseriate involucre and in the more typical Moracean flowers with bifid stigma. Berg describes 18 species all of which appear to be more or less leptocaul with distichous leaves except the remarkable *N.* (*Palmolmedia*) *stipularis*. It is the pachycaul relic of limited distribution in the Amazon Basin with large leaves and persistent stipules spirally arranged on twigs 7–20mm thick. The ancestry of *Naucleopsis* must link with that of Artocarpeae.

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