

STUDIES IN MALESIAN PANDANACEAE

XIII. NEW AND NOTEWORTHY PANDANACEAE FROM PAPUASIA

By B. C. STONE*

Abstract

New localities for *Sararanga sinuosa* are recorded, all from the Admiralty Islands, from where the genus has now been introduced into cultivation for the first time.

Critical notes are provided concerning the placement of a number of species into sections of *Pandanus*. New sections described are sectio *Karuka* typified by *P. brosimos* Merr. & Perry, sectio *Paralophostigma* typified by *P. limbatus* Merr. & Perry, sectio *Perrya* typified by *P. archboldianus* Merr. & Perry, sectio *Metamaysops* typified by *P. brachyphyllus* Merr. & Perry, sectio *Megastigma* typified by *P. rex* B. C. Stone, and sectio *Excavata* based on *P. antaresensis* St. John. New species described are *P. columbiformis* (Papua) in sectio *Lophostigma* (Brongn.) Warb., *P. clarkei* (NE. New Guinea) in sectio *Paralophostigma*, *P. galorei* (W. New Guinea) in sectio *Metamaysops*, *P. croceus* (Admiralty Is.) in sectio *Maysops* St. John, *P. navicularis* (New Ireland) in sectio *Bryantia* (Gaud.) Warb., and *P. rex* (Papua) in sectio *Megastigma*. First accounts are given of staminate inflorescences in *P. brosimos* (sectio *Karuka*), *P. antaresensis* St. John (sectio *Excavata*), and *P. leiophyllus* Martelli (sectio *Involuta* St. John).

INTRODUCTION

During the past several years it has been my privilege to have received some interesting and excellent specimens of *Pandanus* from New Guinea, collected by Nancy Bowers and by William C. Clarke, the latter then a student of geography who did his field work in the highlands in and near Simbai Valley, the former an anthropologist then at Duke University, who worked in the Western Highlands. Their notes and photographs facilitated study of the collections and in many cases are worth reporting. Collections from the Kaugel Valley, Simbai Valley, and Yakitapara Valley, all with very detailed notes, were sent to me by Dr. Bowers. These are a valuable source of information, especially concerning vernacular names.

Besides these collections, specimens for determination have from time to time been sent from the Lae Herbarium and a few of these are reported on here.

Through the courtesy of J. S. Womersley, Chief of the Division of Botany, Department of Forests, Papua New Guinea, I was enabled to spend nearly five months in New Guinea in the first half of 1971. Provided with full logistic support, I was able to explore and collect Pandanaceae in a variety of localities both on the mainland and in the Admiralty Islands.

In the course of this work a number of important new discoveries were made, bearing on the systematics and the known distribution of the Pandanaceae. In the following notes the more important ones are described, including six new species of *Pandanus*, four from New Guinea, and two from the Bismarck Archipelago.

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1. Genus SARARANGA Hemsl.

1. *Sararanga sinuosa* Hemsl. in J. Linn. Soc. Bot. 30: 216, t. 11. 1894.

BISMARCK ARCHIPELAGO: Admiralty Islands: SW. Manus Island, lower slopes of Mt. Dremse, above Wili River, alt. 500 ft, old tree 50 ft tall, trunk 9 in. DBH., fruits green, 24.vi.1971, *Stone & Streimann* 10444 = LAE 53744 (LAE); Los Negros Island, junction of coast road and Naval road, limestone soil, alt. 10 ft, beside a small watercourse, in disturbed secondary forest, fruits ripe, dark magenta-red, 18.vi.1971, *Stone & Streimann* 10299 = LAE 53599 (LAE; further specimens to be distributed).

In my revision of the genus (Stone 1961), the distribution of *S. sinuosa* was given with several localities in the Solomon Islands (New Georgia, Santa Ysabel, Malaita, Florida, Buka) and in then Netherlands New Guinea, now West Irian (Hollandia District, Cycloop Mts.). With the above-noted discovery of the species in the Admiralty Islands an intermediate station is now known; but it is still of much interest that the species apparently does not occur in east New Guinea.

Seeds of LAE 53599 and seedlings from the same tree were brought into cultivation at the Lae Botanic Gardens. This is believed to be the first time the genus has been successfully introduced.

2. Genus PANDANUS L.

In the most recent publications on New Guinea *Pandanus* (Merrill and Perry 1939, 1940; Kanehira 1941; St. John 1960) which deal with considerable numbers of species or with generic sections, there are several species attributed to sectio *Hombronia*, others to sectio *Lophostigma* or sectio *Bryantia*, and one rather tentatively to sectio *Rykia*. A review of these species has shown the need to alter several of these dispositions and also to create for certain species new sectional or subsectional taxa to accommodate them. A number of such cases is discussed below and a number of new species is described, whereas some names are reduced to synonyms. Some vernacular names and some localities of earlier species are also reported.

1. Sect. *Lophostigma* (Brongn.) Warb.

1. *Pandanus columbiformis* B. C. Stone, sp. nov.

Figs. 1-3

Arbor erecta usque 15-16 m alta, sursum subdichotomo-ramificans, trunco basi radicibus aeriis elongatis usque 5.7 m longis conum angustum formantibus instructo. Cortex radicis spina 5×2 mm gerens. *Folia* sublinearia usque 220×7.5 cm, apice breviter acute acuminata, basi canaliculata 6 cm lata, marginibus serrulato-denticulatis, basi dentibus 1 mm longis et 1-5 mm sese separatis, medio dentibus c. 1 mm longis et 2-3 mm sese separatis, ad apicem dentibus c. 0.5 mm longis et 0.5-1 mm sese separatis; costa media dorso ad basin inermis, paullo carinata; in parte apicali serrulato-denticulata dentibus c. 0.5 mm longis et 0.5-1 mm sese separatis. Foliorum pagina inferior glaucescens canalicula media excepta, dense atque minute longitudinaliter venata venis tenuibus c. 150. Plicae bini apicales ventrales sparse denticulatae. *Inflorescentia feminea* tantum nota, cephalium solitarium terminale conico-trigono-

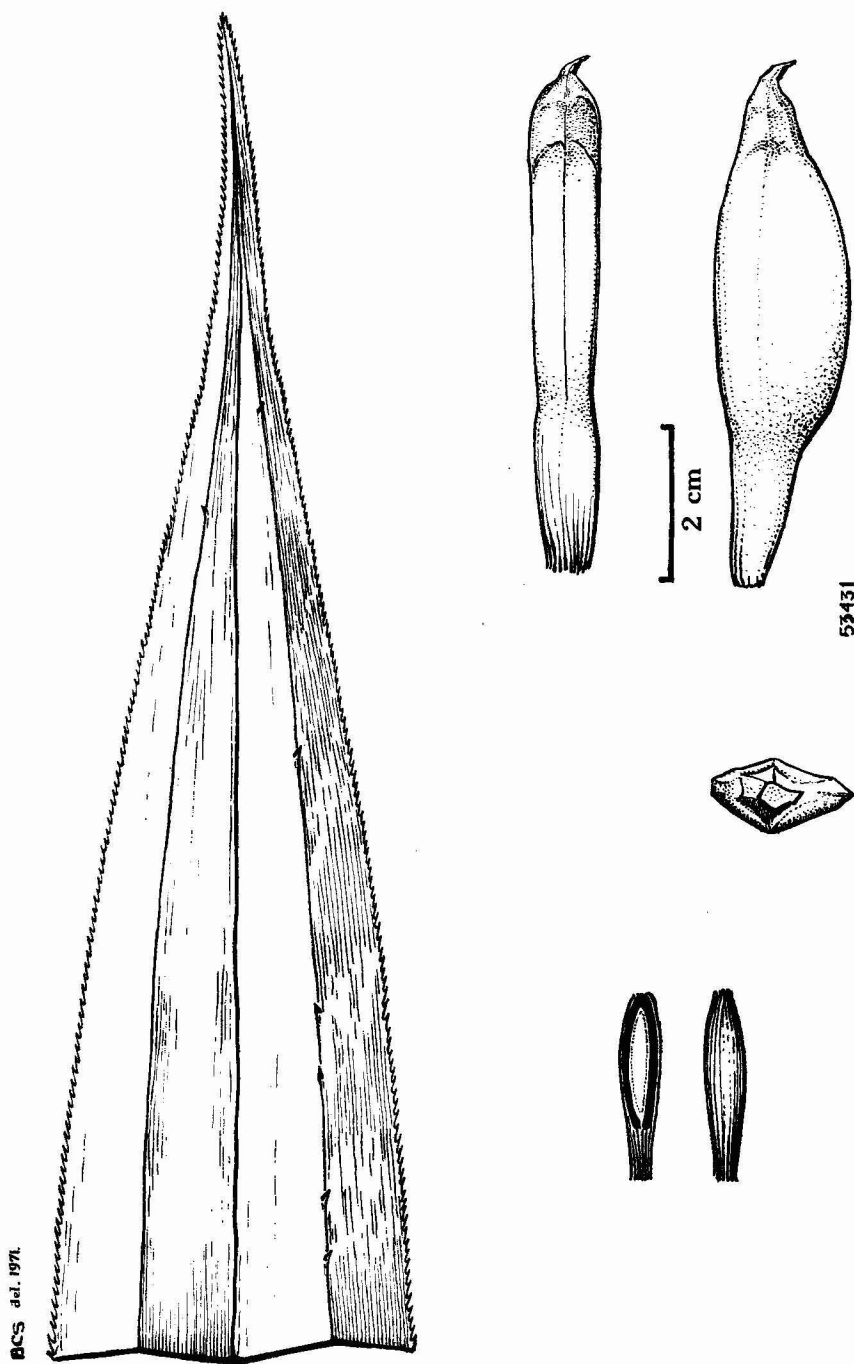


Fig. 1.—*Pandanus columbiformis*. Leaf apex, adaxial surface (left); isolated drupes in profile and top view (upper right); seed and fibrous-covered endocarp of drupe in profile and longitudinal section (lower right). After holotype.

ovoideum, maturitate 28–33 cm longum, 18–20 cm latum, pedunculatum, spathis persistentibus ovato-navicularibus 25 × 15 cm vestitum, e drupis c. 3000 compositum. *Drupae* 1-loculae, maturitate 6–6.5 cm longae, lateraliter compressae, 1 cm latae, 2 cm crassae, apice purpurato-brunneae, pericarpio (pileo excepto) carnosio aurantiaco. Pileus hexagonus pyramidatus, c. 1 cm longus, sursum in stylum antrorsum 2–4 mm longum et latum productus, medio constrictus. Stylus truncatus vel oblique vel irregulariter denticulatus. Stigma infra rostrum situm. Endocarpium basale tenue, anguste filiforme, c. 14 × 3–4 mm. *Semen* unicum endospermio albo.

PAPUA: Gulf District: Vailala East, in swamp forest near Iori Village, alt. c. 20 ft, 30.iv.1971, Stone 10131 = LAE 53431 (LAE, holotype; isotypes to be distributed).

This handsome species, known only from the type, is most closely related to *Pandanus concinnus* Merr. & Perry, which occurs near the Idenburg River in West Irian at about 1800 m altitude. It differs clearly from that species in the broader leaves, the larger cephalia, and the larger drupes which are almost twice as long and have longer seeds. Another related species is *P. atropurpureus* Merr. & Perry, also of the Idenburg River area, which has longer styles, a more distinct pileus, and narrower cephalia. Despite these differences the near affinity of the three species is manifest. Outside New Guinea the closest relatives appear to be *P. viscidus* (Brongn.) Solms and *P. oblongus* (Panch. ex Brongn.) Solms, both of New Caledonia.

The specific epithet *columbiformis* (from columba, dove) is given because the ripe drupes somewhat resemble pigeons, or more specifically, the pileus of each drupe is reminiscent of the head of a pigeon and its beak. The fruits of this pandan are, according to my informants, eaten by cassowaries and cuscus.

2. *Pandanus atropurpureus* Merr. & Perry, J. Arnold Arbor. 21: 173, pl. 1 figs. 9–11. 1940.

Merrill and Perry when describing this species doubtfully assigned it to sectio *Rykia*, remarking: “On account of the unusually long projecting tip of the style ... we are inclined to associate *P. atropurpureus* with the sectio *Rykia* rather than with *Lophostigma*, although the latter is the section to which a great many species of the Papuan region belong. In doing so, nevertheless, we point out the similarity in shape of the heads of the drupes of *P. lamprocephalus*, *P. concinnus*, and this species. As a matter of fact the entire structure of the drupe of *P. concinnus* closely approaches that of *P. atropurpureus*, although the two plants themselves are vastly different in gross aspect.” The judgment of the two authors, here as elsewhere, was excellent and their decision, apparently reluctant, to assign the species to sectio *Rykia* was probably due to an unwillingness to evaluate critically the sections in question in what was a regionally oriented paper. The species is easily accommodated in sectio *Lophostigma*, with which it agrees in the entire structure of the drupe, and the elongation of the style, though unusual, is not by itself a reason to exclude it from that section.

This reallocation excludes the sectio *Rykia* from the island of New Guinea. Indeed, its easternmost occurrence appears to be in the Philippines (where it is represented by, e.g. *P. apoensis* and *P. calamianensis*). Otherwise, the section is predominantly one of south-east Asia, Sumatra, Borneo, and Java. It appears not to occur in the Celebes, although a related section (*Rykiopsis*) is found there.

It might be added here that *Pandanus faviger* Backer also appears to be a member of sectio *Lophostigma*; this is found in East Java, Bali, and perhaps on some mountain peaks in the other Lesser Sunda Islands.

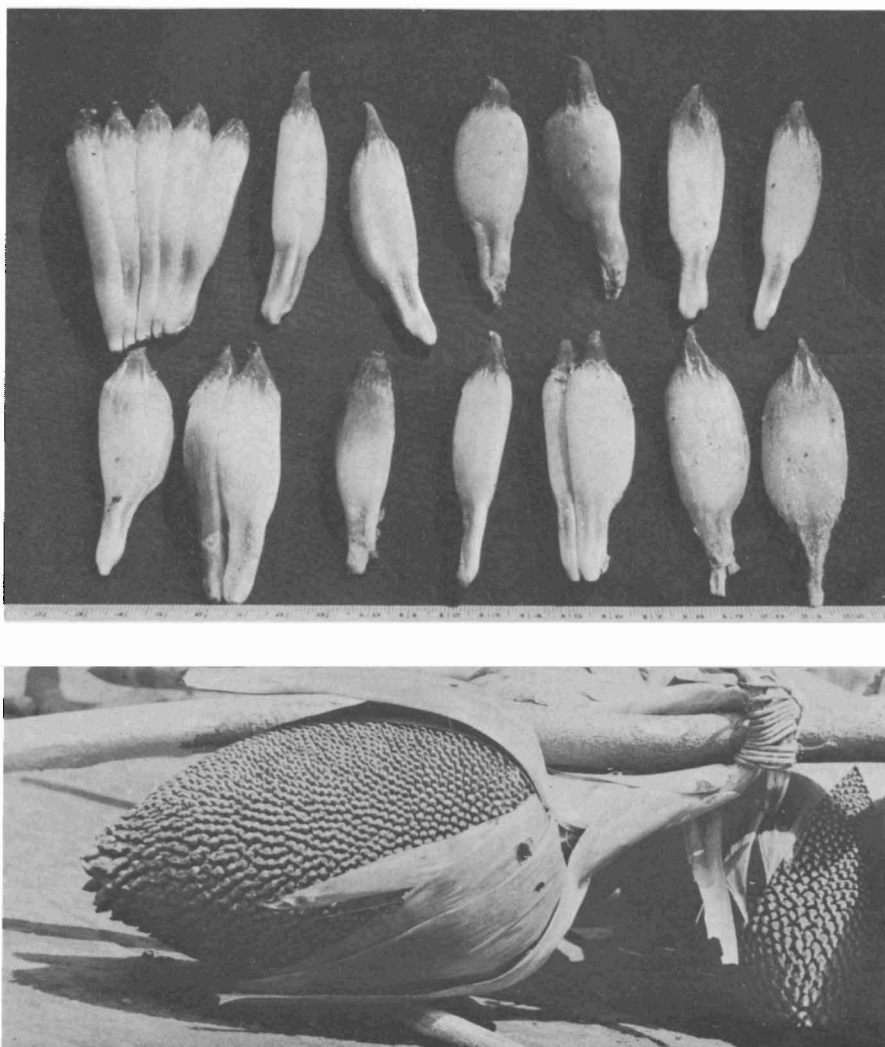


Fig. 2.—*Pandanus columbiformis*. Above: isolated drupes. Below: cephalium. Holotype.

2. Sect. **Karuka** B. C. Stone, sect. nov.

Drupae uniloculares ultime separatae; stigma erectum, adaxiale; placenta adaxialis; endocarpium uniloculare semini albo esculento; pericarpium album vel pallide luteum. Phalanges masculi paucistaminati staminibus plerumque 5, 6, vel 7 ad apicem columnae umbellatim dispositis, sessilibus filamentis obsoletis, antheris valde elongatis et longe caudiculatis; apex columnae procurrens (habitu pistillodii) vel nullus. Arbores, ultime pauciramosae; folia aliquantum magna pro genere, ea

plantarum adularum plicis binis lateralibus adaxialibus apicalibus inermibus, ea plantarum juvenilium plicis plene spinuloso-denticulatis. Radices aëriæ nunquam divaricatae, semper subverticales.



Fig. 3.—*Pandanus columbiformis*. Young, unbranched tree, in situ.

Type Species.—*Pandanus brosimos* Merr. & Perry.

P. brosimos and *P. julianettii* Martelli together form the group of plants known as “karuka” in New Guinea pidgin.* The section also includes *P. carrii* St. John and is restricted to New Guinea. These plants are high-altitude species found mostly above 1500 m and up to about 3000 m altitude; in rare cases they may occur as low as 900 m. They constitute an extremely important food crop and are exploited, maintained, and planted by various Highlands tribes. The edible seeds, usually prepared by smoke-drying, provide a source of edible oil and fat and perhaps some protein. Unfortunately no nutritional analysis has yet been carried out.

In placing this new section close to sectio *Lophostigma*, I am relying on vegetative characters of leaves and aerial roots as well as on the usual features of drupe structure and stigmatic form and position. The staminate characters of *P. brosimos*, and hence of the new section, are herein described for the first time. Unfortunately no direct comparison can be made with sectio *Lophostigma* since there appears to be no knowledge of the staminate plants and their floral structure for *P. viscidus* (Brongn.) Solms and *P. oblongus* (Panch. ex Brongn.) Solms, the type species and its closest relative of that section.

Hitherto, the “karuka” pandans have been grouped with *Pandanus conoideus* Lamk. (*Bryantia butyrophora* Webb ex Gaud. is synonymous) and its relatives in sectio *Bryantia* on the basis of their stigma position, the presence of simple drupes, and the orientation of the placenta. They have also been included with these and various other species in sectio *Microstigma* Kurz, as extended by St. John (1960). The “marita” pandans, to use another common name in New Guinea pidgin, which form a group including *P. conoideus* and a few closely related species such as *P. ruber* St. John, therefore equivalent to sectio *Bryantia* sensu stricto, differ widely from the “karuka” pandans in vegetative features, in details of the drupe and stigmas, in the disposition of the stamens and the occurrence of the staminate spike, and in certain anatomical features of the leaves, as shown in Table 1.

3. *Pandanus julianettii* Martelli in Webbia 2: 433. 1907.

NORTH-EAST NEW GUINEA: Bismarck Mts., alt. 5000–7000 ft, *Clarke* 90 (BISH).

PAPUA: Gailala subdistrict: Tapini, alt. 5100 ft, tree 80 ft tall, 30.x.1959, *K. J. White* NGF 10707 (LAE).

NGF 10707 has fruits which match perfectly those illustrated by Merrill and Perry (1939, pl. 2 fig. 8) from *Brass* 5461, Bella Vista, Central Division.

Clarke has noted with his collection: “Native name *amule*. A high-elevation wild pandan ... (but) the nut utilized for food. Fruit on 35 in. stalk, pale green, 9 in. long, 6 lb weight, uncured; nuts 1–2 in. long; innermost bracts boat-shaped, 9 in. long, not waxy; yellow-green at base, darker green at tip; outermost bracts 52 in. long. Trunk and proproots have only widely scattered blunt spines. Leaves: longest 7 ft 4 in. ... green with a touch of yellow on lower foot; top darker than lower surface; not waxy.”

* It is noteworthy that there is a vernacular name for *Pandanus* in Malagasy, “karaka”, which is extraordinarily similar to “karuka”. Is this merely coincidental?

TABLE 1
CONTRASTS BETWEEN SECTIO *BRYANTIA* AND SECTIO *KARUKA*

Sectio <i>Bryantia</i>	Character state	Sectio <i>Karuka</i>
Solitary, terminal, unusually elongated	Staminal spadix	Branched, each branch (spica) bracteate, comp. shorter
About 6 stamens joined by filaments to form a compressed tube; filaments very short but evident; apiculus short	Staminal phalanx and anthers	About 6 stamens without evident filaments, anthers basally attached to top of a much elongated stemonophore and with a long apiculus
None noted so far	? Pistillode	Occasionally present as a subulate extension of the stemonophore apex
Normally denticulate in seedlings and juveniles as well as adult plants	Apical-ventral pleats of leaves	Denticulate in seedlings and juveniles, smooth in adult plants
Continuous	Leaf palisade tissue	Discontinuous*
Continuous	Leaf lacunar tissue	Discontinuous*
Commonly red or yellow; oily	Drupe pericarp	Commonly whitish; not (or not very) oily
Often black; usually ± circular-reniform	Stigma	Often brownish; usually ovate
Elongate-cylindric or long-ellipsoid	Female cephalium	Subglobose to broadly ovoid
Often widely divaricate, prickly, often more than 2 m long	Aerial propoots	Rather closely appressed to trunk, smooth, mostly less than 2 m long*

* Also true in sectio *Lophostigma*.

4. *Pandanus brosimos* Merr. & Perry in J. Arnold. Arbor. 21: 171, pl. 1 figs. 12-15. 1940.

Figs. 4, 5

NORTH-EAST NEW GUINEA: Western Highlands: upper Kaugel Valley (foothills of Mt. Giluwe), Alipe Mandaka, alt. 8200 ft, in forest "island" a few hundred feet below present main forest fringe (tree c. 80 ft tall; 8 in. diam., propoots 10 ft long; fruit not quite mature), 26.iv.1962, *Bowers* 36 (KLU, LAE); 1.v.1962, *Bowers* 37, 38 (LAE); upper Kaugel Valley, alt. 7400-9000 ft, 1963, *Bowers* 192, 193, 194 (Feb.-Mar.), 206, 208, 211 (June-July) (BISH, LAE); slopes of Mt. Hagen, c. 5 miles above Tomba, alt. 8600 ft in extensive forest rich in *Pandanus*, 11.vii.1971, *Stone & Trenorden* 10504, 10505, 10506, 10507 = LAE 53804, 53805, 53806, 53807 (LAE; further specimens to be distributed).

Of the collections cited, LAE 53804 bore a well-developed but not ripe fruiting head; 53805 was a sterile adult thought to be a male tree by our native guides; 53806 and 53807 were juvenile and young juvenile plants respectively.

Staminate inflorescence terminal, c. 13-17-bracteate (not including the lowest transitional foliaceous bracts); bracts dull white, brown when dry, fleshy-coriaceous, ovate-lanceolate, navicular, up to 45-50 cm long and 12-16 cm wide, acute-acuminate,

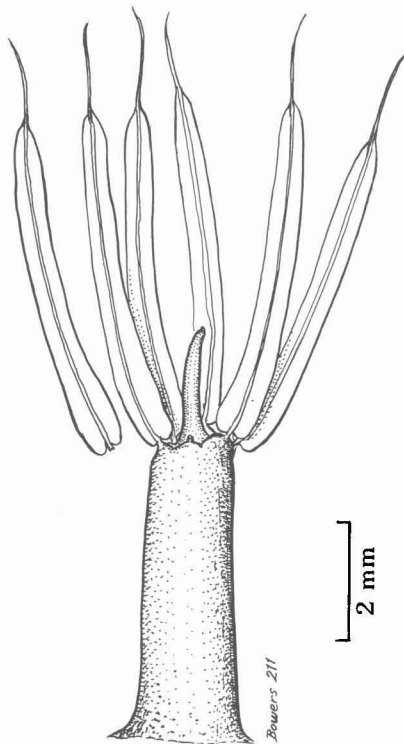
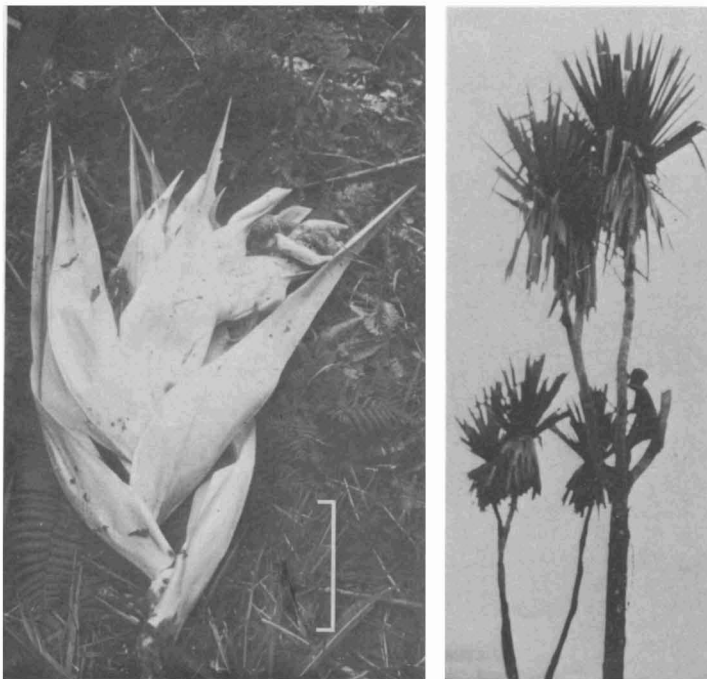


Fig. 4.—*Pandanus brosimos*.
Staminate inflorescence
(scale = 15 cm): staminate
tree. Details of stamen
structure and phalanges.
Photos by Nancy Bowers.

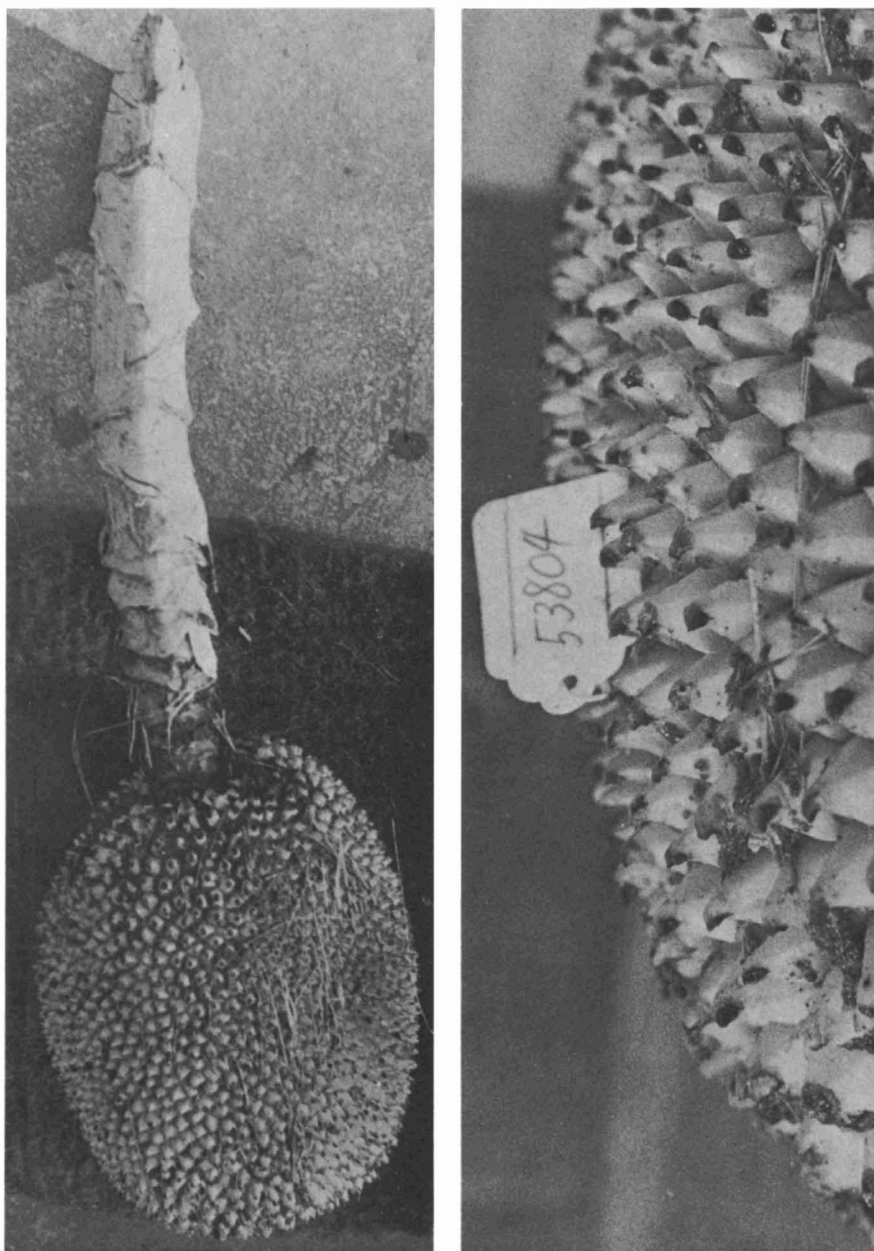


Fig. 5.—*Pandanus brosimos*. Whole cephalium, bracts removed (left); close-up view of drupe apices.
LAE 53804.

margins denticulate, midrib dorsally denticulate distally, coarsely lineate-venulose. Spikes 7-9(-11), *c.* 24 cm long, *c.* 3 cm broad, composed of numerous staminal phalanges. Each phalange consists of a short column (stemonophore) 3.5-5.5 mm long, 0.7-1.5 mm wide, with 5-7 anthers attached directly (with scarcely evident or obsolete filaments) in a clearly ringlike manner at the apex of the column which is occasionally prolonged into a short subulate process (possibly a pistillode) 1 mm long. Anthers much elongated, 4.5 mm long, *c.* 0.3 mm wide, probably white; apex prolonged into a slender caudiculiform apiculation *c.* 1.5 mm long. Pollen not present (based entirely on Bowers 211; Fig. 4).

The following notes on vernacular names and cultivars have been supplied by Nancy Bowers (in litt. 1963, 1964).

In the Kaugel Valley, the indigenous people distinguish two types of edible pandans. The first type, called "wapuneme", is "bush" pandans with edible seeds; the matrix in which the seeds are embedded, i.e. the mesocarp, is also edible. The second type (no doubt the cultivars), called "umbumu", is "place" (village) pandans; the seeds are not edible, rather the fruits are sterile (but the lower mesocarp is edible); the plants are propagated by cuttings. There exist many varieties, some with the same "sub-type" names as those under wapuneme. Wapuneme pandans may reach a height of 24-28 m and can be found as high as 3050 m on Mt. Giluwe. Umbumu seldom are found over 12 m high. The wapuneme all appear to be *Pandanus brosimos* Merrill & Perry, if this is distinct from *P. julianettii* Martelli.

Notes from Bowers 36: native name (Medlpa, Kaugel dialect): *am(u) wapuneme ekeki*; *am(u)* is a general word for *Pandanus*; *wapunem(e)* means "bush" or wild *Pandanus* as opposed to "farm" or cultivated *ekeki*, this particular kind. Leaves are sewed together to make rain capes. Trunk is split to make containers for firewood which are placed in house above fireplace (it prevents roof from being ruined by soot). This particular variety is thought inferior because it is very difficult to separate husk from the nut. The tree would be spared if people were cutting bush in which it occurred; a seedling found in a bad location might be transplanted to a better one, but no attempt would be made to raise it in the garden area some 180 m below.

3. Sect. *Paralophostigma* B. C. Stone, sect. nov.

Sectio Lophostigmatis simillima, differt carpellis transverse seriatis in phalanges connatis, pileis liberis, stigmatibus verticali.

Type Species.—*Pandanus limbatus* Merr. & Perry.

This section, including also *P. balenii* Martelli and *P. clarkei* B. C. Stone, is presently known only from New Guinea.

5. *Pandanus clarkei* B. C. Stone, sp. nov.

Figs. 6, 7

Arbor parva erecta simplex trunco usque 6-7 m alto apicem versus *c.* 6 cm diametro, cortice irregulariter brevi-spinoso, cicatricibus foliorum 3-5 mm distantibus. *Folia* oblongo-linearum, *c.* 200-225 cm longa, 7.5-9.5 cm lata, apice abrupte et valde inequaliter rotundato-acuminato, uno latere valde rotundato, altero latere subacuminato;

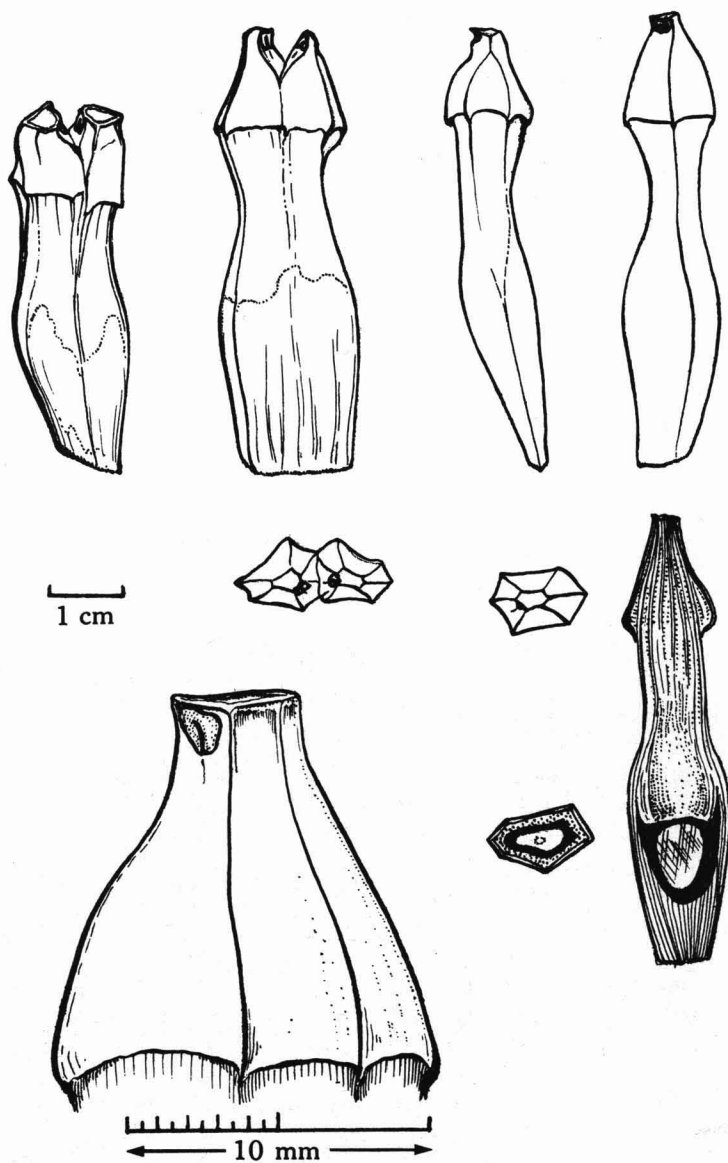


Fig. 6.—*Pandanus clarkei*. Drupes in profile, showing 1- and 2-celled examples (above); longitudinal and transverse sections, showing endocarp (lower right); enlarged view of pileus with stigma (lower left). After holotype.

marginibus parvidenticulatis, basi dentibus 1×1 mm et 2–5 mm sese separatis, medio dentibus antrorsis appressis 0.5 mm longis, 15–20 mm sese separatis, apice dentibus 0.75 mm longis, 2–5 mm sese separatis; plicis binis ventralibus apicem versus paucidenticulatis, dentibus 0.75 mm longis, 10–25 mm sese separatis. Costa media basi et medio inermis, apicem versus per spatiam brevem (c. 30 cm) denticulata, dentibus c. 0.75 mm longis et 2–5 mm sese separatis; paginae ambae striatae nervis longitudinalibus c. 88, 1 mm sese separatis. *Inflorescentia feminea* (tantum nota) terminalis, solitaria, pedunculo 10+ cm longo, 2.5+ cm crasso, apice incrassato, cephalio trigonopyramidato, c. 20 cm longo, receptaculo c. 15×12 cm. *Drupae* simplices vel, ad basin cephalii, in phalangibus 2–3-natis, 5–6 cm longae, 12–14 mm latae (vel duplo), pileo anguste pyramidato truncato, vertice, plano depresso, stigmate laterali irregulariter ovato erecto 1.5–2 mm longo. Mesocarpium superum carnosum, fibrosum, medullosum, basi supra endocarpium cavernosum. Mesocarpium inferum fibrosum. Endocarpium subbasale, 14 mm longum, apice rimosum, pariete 0.5–1.5 mm crasso, loculo $8-9 \times 6$ mm. *Semen* album. Pericarpium in vivo aurantiaceo-rubrum.

NORTH-EAST NEW GUINEA: Bismarck Mts., old secondary forest, alt. 3500 ft, nom. vernac. "tramnowa", 25.v.1965, *Clarke* 108 (KLU, holotype; L, LAE).

This species resembles *P. balenii*, but the endocarp is more nearly basal, and there are probably more simple drupes than phalanges in a cephalium. In the type and only specimen known, unfortunately, only the lower part of the receptacle retained its drupes; about half of these were simple, the rest 2- or sometimes 3-celled. The only other similar species is *P. limbatus*. Both these species were previously included in sectio *Hombrovia*. With its curious leaf-apices, this new species appears unique; although the strongly asymmetrical tips could conceivably be caused by an abnormality in growth, all the leaves preserved in the specimen are alike in this regard and the collector noted the character as apparently the norm.

It is a pleasure to dedicate this species to the collector, William C. Clarke, now of the Department of Biogeography, Australian National University.

4. Sect. *Perrya* B. C. Stone, sect. nov.

Sectio Maysopsis et sectio Lophostigmatis simillima differt endocarpio basilari, pileo integro rotundato apice non annulato nec fossulato.

Type Species.—*Pandanus archboldianus* Merr. & Perry.

This section, which also includes *P. galeatus* St. John, *P. vinkii* St. John, and *P. aggregatus* Merr. & Perry, is apparently restricted to New Guinea. It is dedicated to Dr. Lily M. Perry of the Arnold Arboretum, whose work in collaboration with E. D. Merrill on the Pandanaceae of the Brass collections has proved to be exemplary.

Merrill and Perry placed their two species *P. archboldianus* and *P. aggregatus* in sectio *Lophostigma*. Further study of these two species indicates a close relationship to such species as *P. beccarii*, *P. microdontus*, etc., of sectio *Maysops*. They are closer to the other species of *Maysops* than to *P. concinnus* or other species of sectio *Lophostigma*, but are distinct enough from all of these to form a new section.

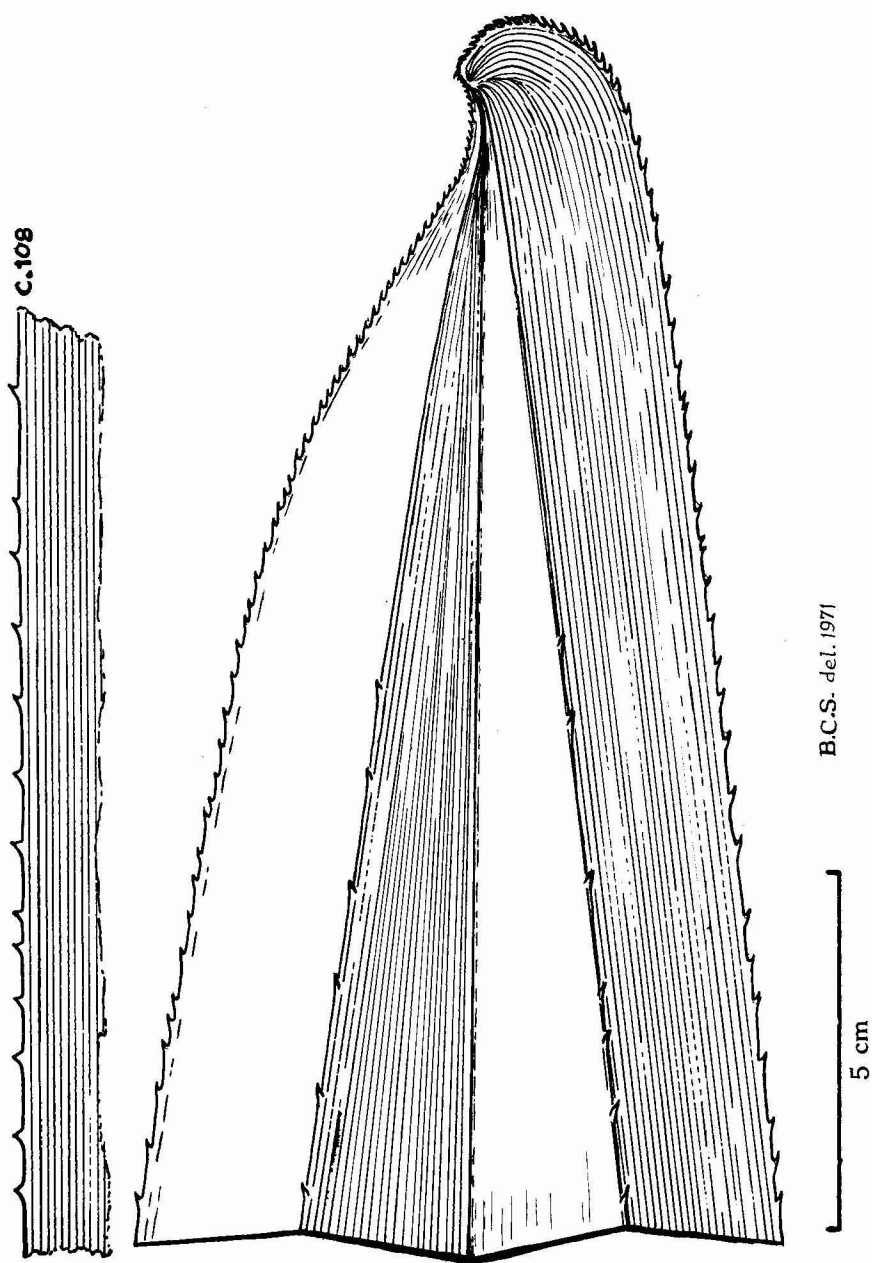


Fig. 7.—*Pandanus clarkei*. Leaf margin from middle part of leaf (left). Leaf apex, adaxial surface (right). After holotype.

5. Sect. *Hombronia* (Gaud.) Warb.

The following New Guinea species hitherto have been considered as members of sectio *Hombronia*: *P. balenii* Martelli; *P. hystrix* Martelli; *P. penicillus* Martelli; *P. boemiensis* Kaneh.; *P. orculiformis* Kaneh.; *P. brachyphyllus* Merr. & Perry; and *P. limbatus* Merr. & Perry. The major character used in deciding whether to include a species in this section has been whether the carpels of the phalanges are arranged in transverse series. Examination of other features, however, reveals that reliance on this single character is not satisfactory. Close comparison of the above-named species with *P. dubius* Spreng. and *P. compressus* Martelli, the type species and its closest relative, emphasizes the distinctness and homogeneity of sectio *Hombronia* and, at the same time, the diversity and heterogeneity of the group of species mentioned. A reallocation of four of these species is suggested here which, it is felt, more adequately indicates their true relationships. *P. balenii* and *P. limbatus* are accommodated in sectio *Paralophostigma*, *P. brachyphyllus* in sectio *Metamaysops*, and *P. penicillus* in sectio *Megastigma*.

6. Sect. *Metamaysops* B. C. Stone, sect. nov.

Sectio *Maysopsis* simillima, differt drupis connatis in phalangibus (1-)2-7-loculatis.

Type Species.—*Pandanus brachyphyllus* Merr. & Perry.

A second species, *P. galorei* B. C. Stone, is included in this section. Each of the two species is essentially a "compound *Maysops*", and the relationship to this section is particularly shown by the thick fusiform inner fibres of the apical mesocarp, the minute lateral stigmas, the solitary cephalium, and the leaf morphology. In its syncarpous or phalangiote fruits, however, the section differs from sectio *Maysops*; it is endemic to New Guinea, and the only localities known to date are in West Irian.

Merrill and Perry placed *P. brachyphyllus* in sectio *Hombronia*, but with the remark that this species "is very distinct from the other known Papuan members" of this section. Their indication that it suggests *P. aggregatus* was astute.

6. *Pandanus galorei* B. C. Stone, sp. nov.

Fig. 8

Arbor pauciramosa usque 13 m alta. *Folia* atroviridia, usque 2 m longa, 10.5 cm lata, linearia, coriacea, apice breviter acuminata, marginibus denticulatis, basi dentibus antrorsis c. 2 mm longis et 2-6 mm sese separatis, medio dentibus appressioribus c. 1.5 mm longis et 8-15 mm sese separatis, apicem versus dentibus minoribus c. 0.5-0.6 mm longis et 1-2 mm sese separatis; costa media, apicem versus parvidenticulata. *Cephalium* solitarium terminale pendulum magnum e phalangibus plurimis compositum, phalangibus 4-7-carpidiatis, c. 6 cm longis, 10-16 mm latis, plerumque compressis, clavatis, apice late rotundato-subtruncato, pileo indistincto c. 4 mm alto leniter anguloso, stylis terminalibus valde confertis subuniseriatim vel subcirculariter dispositis pro maxima parte sursum directis, interdum aliquot retrorsis, c. 1-1.5 mm longis, appianatis, acutis vel obtusis, vel subsagittatis, stigmate c. 1 mm lato, vadoso. Mesocarpium superum grosse fibrosum fibris fusiformibus fere 1 mm diametro, inferum incurvatum demum supra orthotropium. Endocarpium (immaturum) infra medium positum c. 2 cm longum. Cetera ignota.

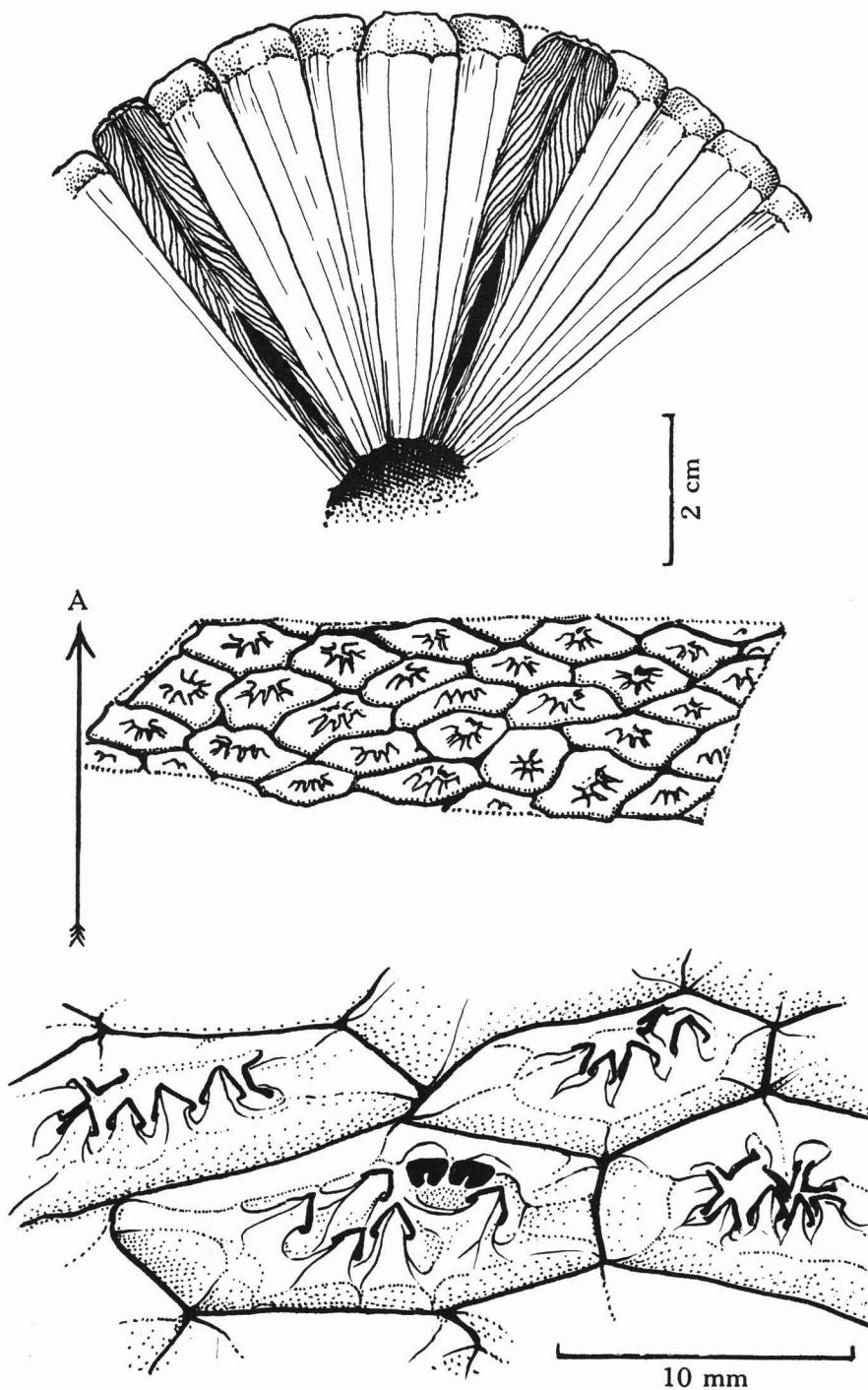


Fig. 8.—*Pandanus galorei*. Portion of syncarp showing phalanges in lateral view (above) and top view (centre). Enlarged detail top view to show style and stigma arrangement. Arrow A indicates direction of syncarp apex. After holotype.

WEST NEW GUINEA: Okwalimkam, lat. 5°2'S., long. 140°55'E., alt. c. 4000 ft, in lower montane forest, tree branching into three at 30 ft, and reaching 40 ft tall, leaves dark green, c. 5–6 ft long, fruit immature, fawn-red; 21.vi.1967, *Ridsdale & Galore* NGF 33192 (LAE, holotype).

This species is very much like *P. brachyphyllus* but differs in the somewhat longer phalanges that are formed of a larger number of carpels, mostly 4–7 per phalange. The immature fruit in the type specimen has no well-formed endocarps. The fusiform fibres, which angle inward from just above the middle of the phalange, then gently curve upward again to continue to the apex, are very characteristic, and their presence appears to confirm the relationship of these species to sectio *Maysops* which, however, has 1-celled drupes usually with subtruncate pilei having a marginal rim and a turret-like central style surrounded by a fossa.

This species is dedicated to Michael Galore, now keeper of the Lae Herbarium and one of the first Papuan botanists, an excellent collector and a good field companion.

7. Sect. *Maysops* St. John

7. *Pandanus croceus* B. C. Stone, sp. nov.

Figs. 9–11

Arbor erecta usque 15 m alta, ramis paucis brevibus dichotomis, trunco basi radicibus aeriis usque 2 m longis, c. 5 cm diametro, sparse tuberculatis, instructo. Cortex trunci griseus sublaevis. *Folia* sublinearia, in speciminibus juvenilibus usque 400 cm longa et 12 cm lata, in plantis adultis c. 200–300 cm longa et 7–10 cm lata, apice attenuata acuta, pagina inferiori glaucescenti; marginibus serrulato-denticulatis, basi dentibus parvis antrorsis congestis rectis vel curvulatis c. 1 mm longis, et 1–1.5 mm sese separatis; medio dentibus appressioribus acicularibus 1.5 mm sese separatis; ad apicem, dentibus vix 1 mm longis 1–1.5 mm sese separatis; costa media dorso ad basin inermis 20–30 cm supra vaginam denticulata dentibus rectis c. 0.5 mm longis, 1–3 mm sese separatis; apicem versus dentibus 1–2 mm sese separatis. *Inflorescentia feminea* terminalis, solitaria, cephalio elongato trigono, anguste cylindraceo-conoideo, maturitate flavo-croceo, 28–41 cm longo, 8.5–13 cm diametro, pedunculo 28–36 cm longo et 4–5 cm diametro; bracteis exterioribus purpureo-glaucis, bracteis interioribus corallinis. *Drupae* 1-loculatae, maturitate c. 13 mm longae, 4–5 mm latae, 5–6-gonae, flavidae, in vivo firme carnosae, pileo plano c. 1 mm alto, stylo turiformi centro obscure concavo 5–6-angulato, c. 1 mm lato; stigmatate leniter bilobo nigro. Mesocarpium carnosum-fibrosum. Endocarpium centrale ellipsoideum c. 6 mm longum, pariete osseo c. 0.5 mm crasso. *Semen* ellipsoideum c. 4.5–4.9 mm longum et 2 mm latum. *Inflorescentia mascula* terminalis pendula bracteata; spadix ramosa, spicis c. 9 axillaribus; bracteis anguste ovato-navicularibus apice acutis, corallinis vel exterioribus purpureo-glaucis, marginibus atque in costa serrulatis; spicae usque 18 cm longae et 2–2.5 cm latae, staminibus liberis, filamentis albo basi late bulbiformi, ad apicem abrupte contracto et angustissime producto, antheris aurantiacis oblongis 2.75 mm longis, apice minute apiculatis, apicula 0.4 mm longo acuto albo.

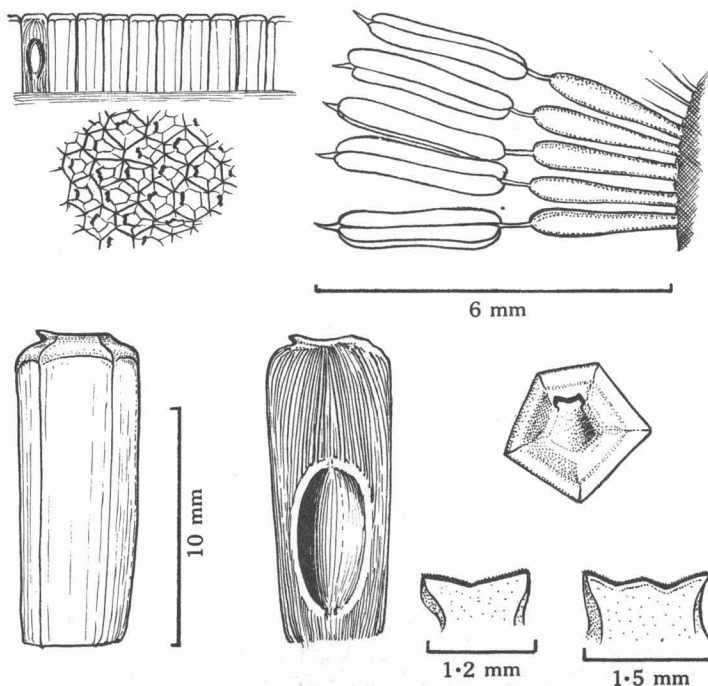


Fig. 9.—*Pandanus croceus*. Drupes in profile, longitudinal section, and top views, with enlarged views of stigma from above (left and beneath); stamens (upper right). Drupes after LAE 53594; stamens after LAE 53695.

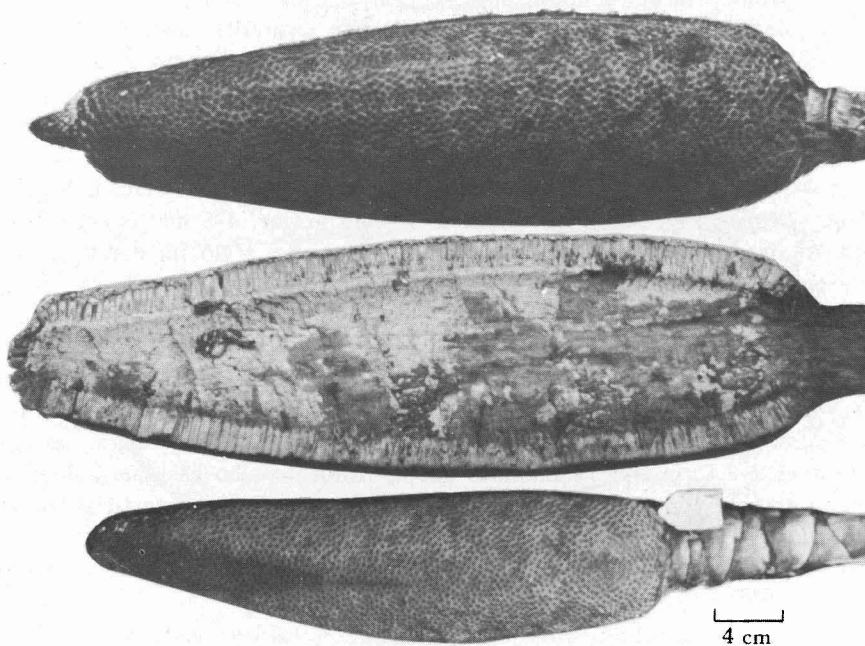


Fig. 10.—*Pandanus croceus*. Cephalia: centre view shows longitudinal section. Top and centre LAE 53590, bottom LAE 53694.

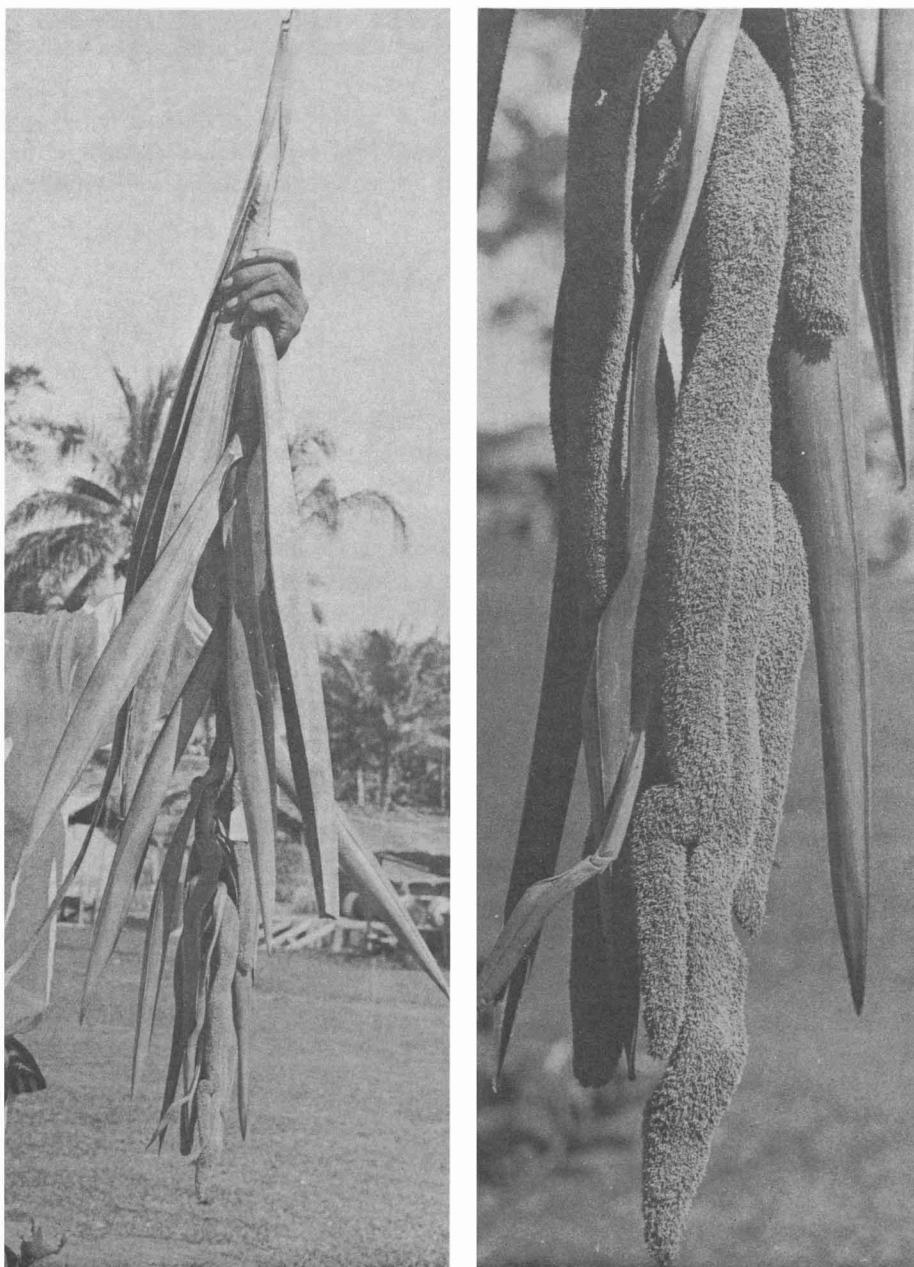


Fig. 11.—*Pandanus croceus*. Staminate inflorescence (left) and close-up view of spikes (right).
LAE 53695.

ADMIRALTY ISLANDS: Manus Island, hills above Lorengau, coral limestone soil, alt. 150 ft, 18.vi.1971, *Stone* 10290 = LAE 53590 (pistillate: LAE holotype); alt. 100 ft, *Stone* 10294 = LAE 53594 (staminate: LAE); SW. Manus Island, near Kabuli Village, alt. 50 ft, swamp forest, 22.vi.1971, *Stone* 10394 = LAE 53694 (pistillate: LAE), *Stone* 10395 = LAE 53695 (staminate: LAE).

This is a clear-cut and distinctive species of sectio *Maysops*. It is fairly common all over Manus Island on both the limestone and other soils, from near sea-level to about 490 m altitude. Its yellow, very small drupes yet large leaves and cephalium are notable and distinguishing characters.

8. Sect. *Bryantia* (Gaud.) Warb.

8. *Pandanus navicularis* B. C. Stone, sp. nov.

Fig. 12

Arbor 5 m alta, trunco erecto radicibus aëriis 1.5 m longis instructo. *Folia* usque 150 cm longa, 6–11 cm lata, linearia coriacea infra subglauca, apice abrupte rotundato-acuminato subcaudato cucullato ad instar prorae naviculæ formato, marginibus denticulatis, basi dentibus rectis deltoideis c. 1 mm longis et 2–4 mm sese separatis, medio integris vel sparsissime denticulatis, apice dentibus brevioribus adpressisque, plicis binis ventralibus apicem versus antrorse spinulosis, spinulis c. 0.5 mm longis et 5–15 mm sese separatis, costa media dorso ad basin et medio laevi, apicem versus denticulata dentibus e carina prominulenti assurgentibus, 0.5 mm longis et 5–15 mm sese separatis. *Inflorescentia feminea* terminalis solitaria suberecta, syncarpio rubro ovoideo-elliptico usque 25.5 cm longo et basin versus 9 cm lato, pedunculo 25 cm longo, 2.5–3 cm crasso, apice incrassato triquetro, bracteis ignotis. *Drupae* compressae, in sicco c. 30 × 8 mm, obovatae truncatae, stigmatibus plano terminatae. Pileus c. 14–15 mm longus inconspicuus, in parte apicali 5 mm longa in vivo subcarnosus, stigmate centrali depresso. Stigma in vivo brunneum suberosum pentagonum vel hexagonum planum c. 5 × 3 mm, sutura ventrali indistincta. Epicarpium carnosum rubrum. Mesocarpium superum fibroso-medullosum inferum fibrosum. Endocarpium leviter subcentralium fusiforme c. 13 × 6 mm uniloculare, pariete atrobrunneo osseo c. 1 mm crasso, loculo c. 9.5 × 3 mm. *Semen* unicum c. 9 × 3 mm, endospermio albo.

NEW IRELAND: Namatanai subdistrict: Danfu River area, c. 8 miles inland, riverside forest in steep limestone valley, 18.ii.1970, *Yakas Lelean* NGF 46147 (LAE, holotype; K).

This very distinctive species apparently pertains to sectio *Bryantia* although the size of the stigmas is rather large and the leaf apex shape somewhat unusual. But in the unilocular drupes, the ventrally grooved stigma, and the denticulate apical ventral pleats of the leaf it conforms reasonably well with the diagnostic features of sectio *Bryantia*. It would be most interesting to study the staminate inflorescence of this species, but the male tree remains unknown.

9. Sect. *Megastigma* B. C. Stone, sect. nov.

Drupae uniloculares, separatae, magnae; stylus et pileus nullus; stigma magnum, planum, suberosum, cordatum, cardioideum; placenta adaxialis; mesocarpium supra spongioso-medullosum; endocarpium subcentrale vel subbasale crassum, uniloculatum.

Type Species.—*Pandanus rex* B. C. Stone.

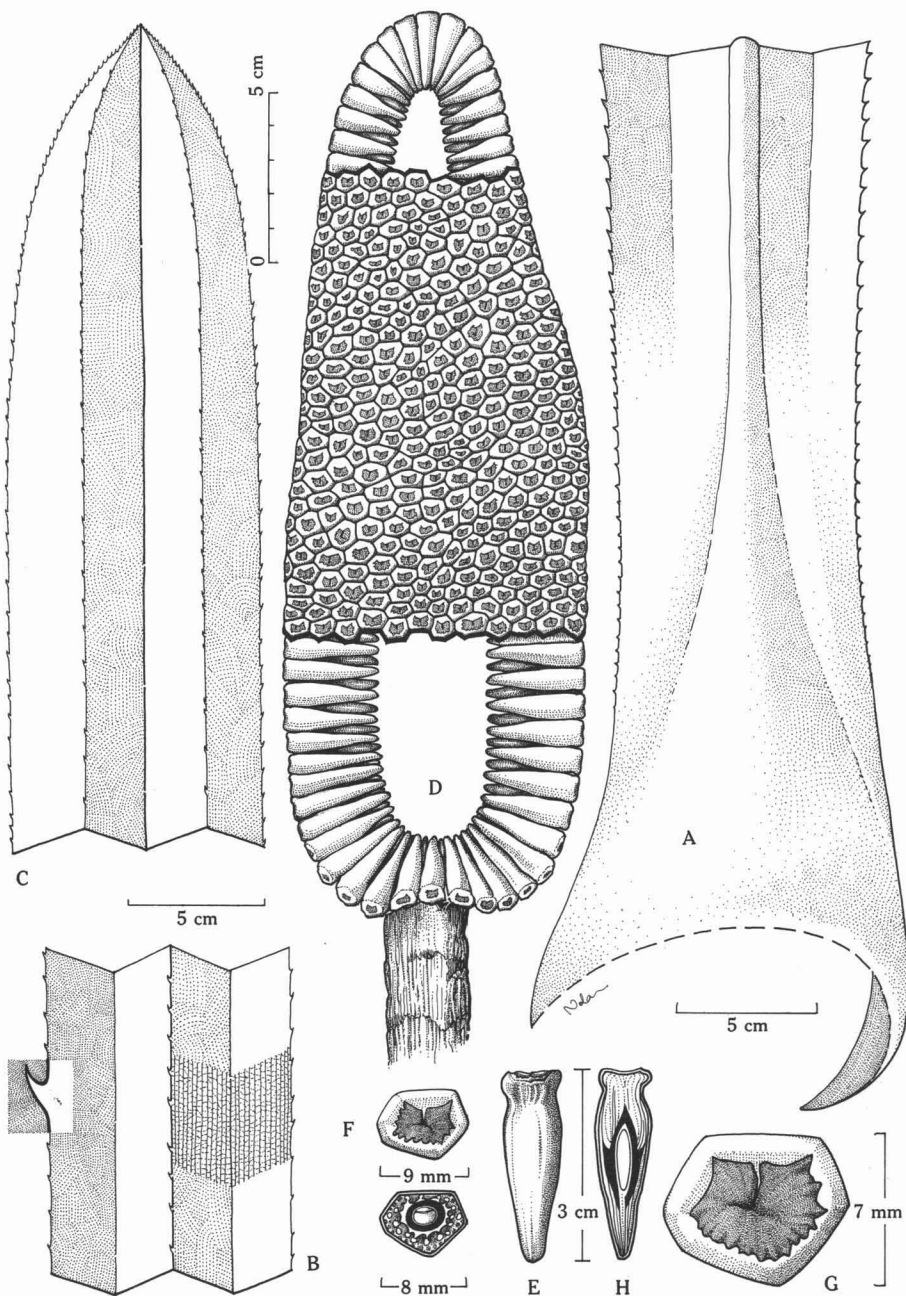


Fig. 12.—*Pandanus navicularis*. A, leaf base, abaxial surface; B, leaf segment from middle of leaf, abaxial surface, with enlarged view of prickle; C, leaf apex, adaxial surface; D, cephalium (some drupes removed); E, drupe in profile; F, drupe, top view, showing stigma; G, stigma, top view, much enlarged; H, drupe in longitudinal section. After holotype.

This new section, including also *P. schoddei* St. John and *P. patina* Martelli of Ponape, has been established to accommodate species that formally might have been included in sectio *Bryantia* but nonetheless seemed anomalous there. Unfortunately, no staminate plants are yet known for any of the species cited. The unusually large and often somewhat cardioid stigmas (see Figs. 15, 16) are strikingly different from the small, ovate to subcircular stigmas prevalent in the more "classical" species of sectio *Bryantia*. That there is a relationship between the two sections, however, seems very probable, especially considering that the ventral pleats of the leaf apex in the species of sectio *Megastigma* are also denticulate. But staminate characters must be evaluated for any reasonably final disposition.

9. *Pandanus rex* B. C. Stone, sp. nov.

Fig. 13

Arbor alta, trunco basi breviter (c. 1.8 m) prostrato demum erecto, c. 8 m alto radicibus gralliformibus nullis. *Folia* magna usque 6 m longa et 18 cm lata, percoriacea apice longe attenuata, marginibus serratodentatis, plicis binis ventralibus usque ad apicem minute antrorse spinulosis. *Infructescentia* subpendula ovoidea, circuitu 120 cm, pedunculo c. 81 cm longo. *Drupae* giganteae pro genere, 14–15.5 cm longae et 5.7 cm latae, pentagonae vel hexagonae, in dimidio basilari rubrae, in dimidio apicali atrogrieco-brunneae, stigmate magno plano suberoso terminatae. Stigma c. 12 × 9 mm ad 2 mm crassum brunneum, sutura c. 5 mm longa. Epicarpium firme membranaceum. Mesocarpium apicale firme medullosum, fibris longitudinalibus percursis, inferum fibrosum. Endocarpium osseum multipertusum subcentrale, in parte centrali late fusiforme, in parte peripherali processibus irregularibus verticalibus munitum, c. 60 mm longum et 35–42 mm latum, loculo singulo 45 × 14 mm. *Semen* unicum.

PAPUA: Gulf District: Vailala River, NE. of Ihu, alt. 40 ft, alluvial plains, 20.iii.1966, *Royal Pullen* 6595 (LAE, holotype).

This species is known only from the type; it is evidently quite similar to *P. penicillus* Martelli, but with much larger drupes and more massive endocarp. Although I searched for this species in the vicinity of Ihu in April 1971, I was unable to locate it again. The Ihu region is unusually rich in *Pandanus*, with at least 12 and possibly 14 species known to occur there.

10. *Pandanus schoddei* St. John in Contr. Herb. Aust. 3: 5. 1974.

Fig. 14

SOLOMON ISLANDS: Bougainville: Lake Loloru crater, south rim, alt. 5000 ft, in stunted cloud forest, 26.viii.1964, *Craven* (& *Schodde*) 347 (CANB, holotype; LAE); same locality (6°30'S., 155°38'E.), "very common but not on exposed ridges", *Lavarack & Ridsdale* NGF 31464 (LAE).

This species, just described, appears to be related to *P. rex* and is here placed in the same section. It differs in the much more massive endocarp which is situated in the basal half of the drupe and lacks the bowl-like margins, in the somewhat shorter more depressed free pilear portion of the drupe apex, in the somewhat simpler form of the stigma without the "double-coil" pattern, in the smaller and more crowded teeth of the leaf margins and midrib, and in the habitat.

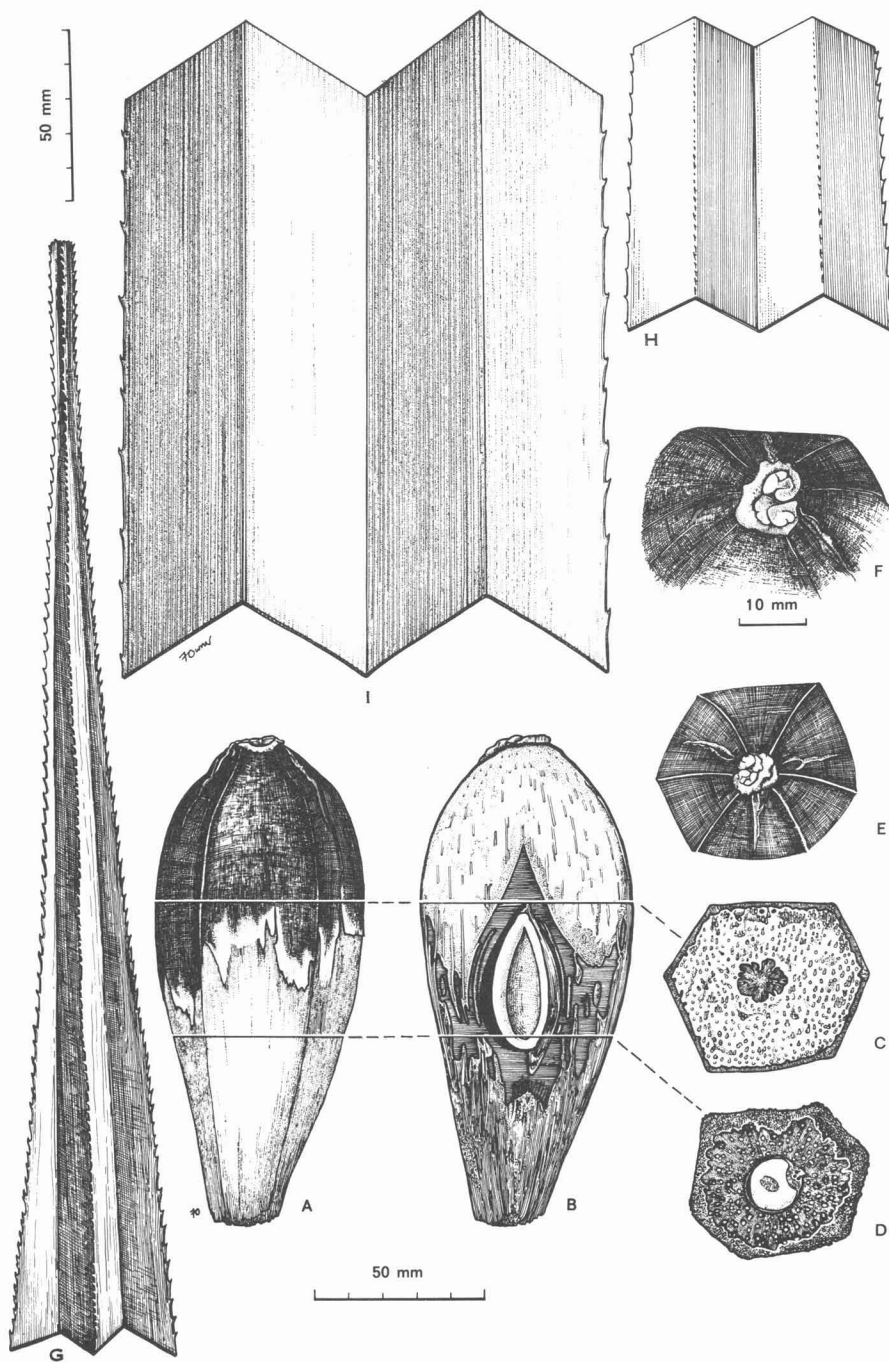


Fig. 13.—*Pandanus rex*. A, profile of drupe; B, longitudinal section; C, D, transverse sections at two levels, through upper mesocarp (C) and through endocarp (D); E, top view; F, stigma, top view. Details of leaf: G, apex (ultimate tip broken off) abaxial surface; H, apical segment, adaxial surface; I, segment from lower middle adaxial surface. After holotype.

The position, orientation, and form of the stigma serve to relate this species with *P. rex* and *P. patina* and thus allow it to be assigned to the new sectio *Megastigma*.

Discovery of male flowering specimens in this section is now a prime desideratum. It may be postulated that the sectio *Megastigma* is most closely related to sectio *Lophostigma*, on the basis of available evidence.

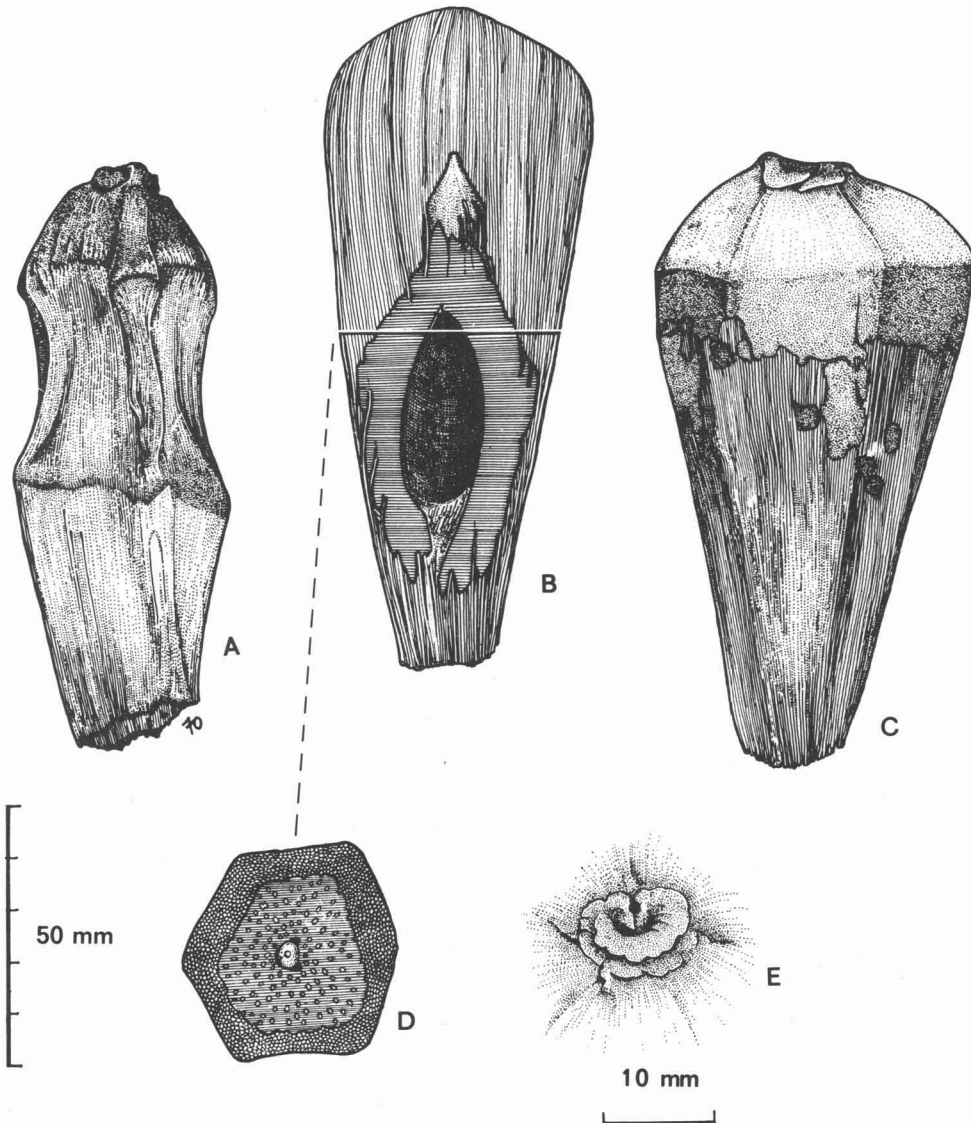


Fig. 14.—*Pandanus schoddei*. A, profile of slightly immature (shrunken) drupe, after NGF 31464; B, longitudinal section; C, profile of drupe, after isotype; D, transverse section through endocarp; E, enlarged view of stigma.

10. Sect. **Excavata** B. C. Stone, sect. nov.

Sectio *Pandani* affinis, differt apicibus phalangium feminearum excavatis, apicibus carpidorum subplanis, stigmatibus centripetalibus verticalibus; phalangibus masculis pluristaminatis filamentis basi valde connatis columnam crassissimam formantibus. Arbores vastae.

Type Species.—*Pandanus antaresensis* St. John.

This is a monotypic section, based on a very characteristic species of the New Guinea highlands. While clearly related to sectio *Pandanus*, this section appears adequately distinct by the following characters: truncate, crowded carpel apices, with vertical or nearly vertical centripetally arranged stigmas, forming a distinctly concave and only shallowly sulcate surface of the phalange apex; and the structure of the staminate phalanges, in which the column (stemonophore) is scarcely evident but is represented by a broad amalgamation of the basal halves (or more) of the constituent filaments of each phalanx, numbering about 9 to 11 (cf. Fig. 18). The description of the staminate flowers is based on the following collections: *Bowers* 766 (LAE) and *Stone* LAE 53546 (LAE).

11. ***Pandanus antaresensis*** St. John in *Pacif. Sci.* 27: 58, figs. 307–309. 1973.

P. bowersae St. John in *Contr. Herb. Aust.* 3: 1, fig. 1. 1974, syn. nov.

Figs. 15–19

WEST NEW GUINEA: Star Mts: Mt. Antares, 1 km E. of junction of Bon and Minam rivers, primary forest, alt. 1500 m, 4.vii.1959, *Kalkman* 4367 (L, holotype of *P. antaresensis*; SING).

NORTH-EAST NEW GUINEA: West Sepik District: Suongot near Telefomin, alt. 5500 ft, 10.i.1965, *Henty* NGF 20880 (LAE). Western Highlands District: Kebaika, upper Kaugel Valley, alt. 7000 ft, v.1963, *Bowers* 201 (LAE, isotype of *P. bowersae*); Yakitapara Valley, Porgera, Laiagam, alt. 7700 ft, 13.vi.1969, *Bowers* 765 (LAE); same locality, 21.vi.1969, *Bowers* 766 (LAE, staminate), 767 (LAE, pistillate). Eastern Highlands District: Okapa subdistrict, near Wonatabe, alt. 6000 ft, 19.v.1967, *Womersley & Coode* NGF 24958 (LAE); Waresevieti, Okapa-Purosa Rd., alt. 6000 ft, 26.v.1971, *Stone et al.* LAE 53534 (LAE); Okapa-Kainantu, alt. 5000 ft, 26.v.1971, *Stone et al.* LAE 53546 (LAE, staminate). PAPUA: Western District: Kawol, alt. 5500 ft, 2.iv.1965, *Craig* 29 (LAE).

11. Sect. **Marginata** St. John12. ***Pandanus meniscostigma*** Merr. & Perry in *J. Arnold Arbor.* 20: 171, pl. 2 fig. 2. 1939.

P. marginatus St. John in *Pacif. Sci.* 22: 520, fig. 275. 1968, *typ. sect.*

Sectio *Marginata*, created by St. John, to accommodate his new species *P. marginatus* seems reasonably distinctive on the basis of its rather curious stigmatic structure. However, the species *P. marginatus* is apparently the same as *P. meniscostigma* earlier described by Merrill and Perry and assigned by them to sectio *Bryantia*. The section is here considered to be monotypic and is now known to occur at several localities in Papua and in the D'Entrecasteaux Islands on Goodenough Island. Unfortunately, the male plants have not yet been discovered.

The relation of the section seems to be with sectio *Bryantia*, on the basis of stigma form and the adaxial placentation.

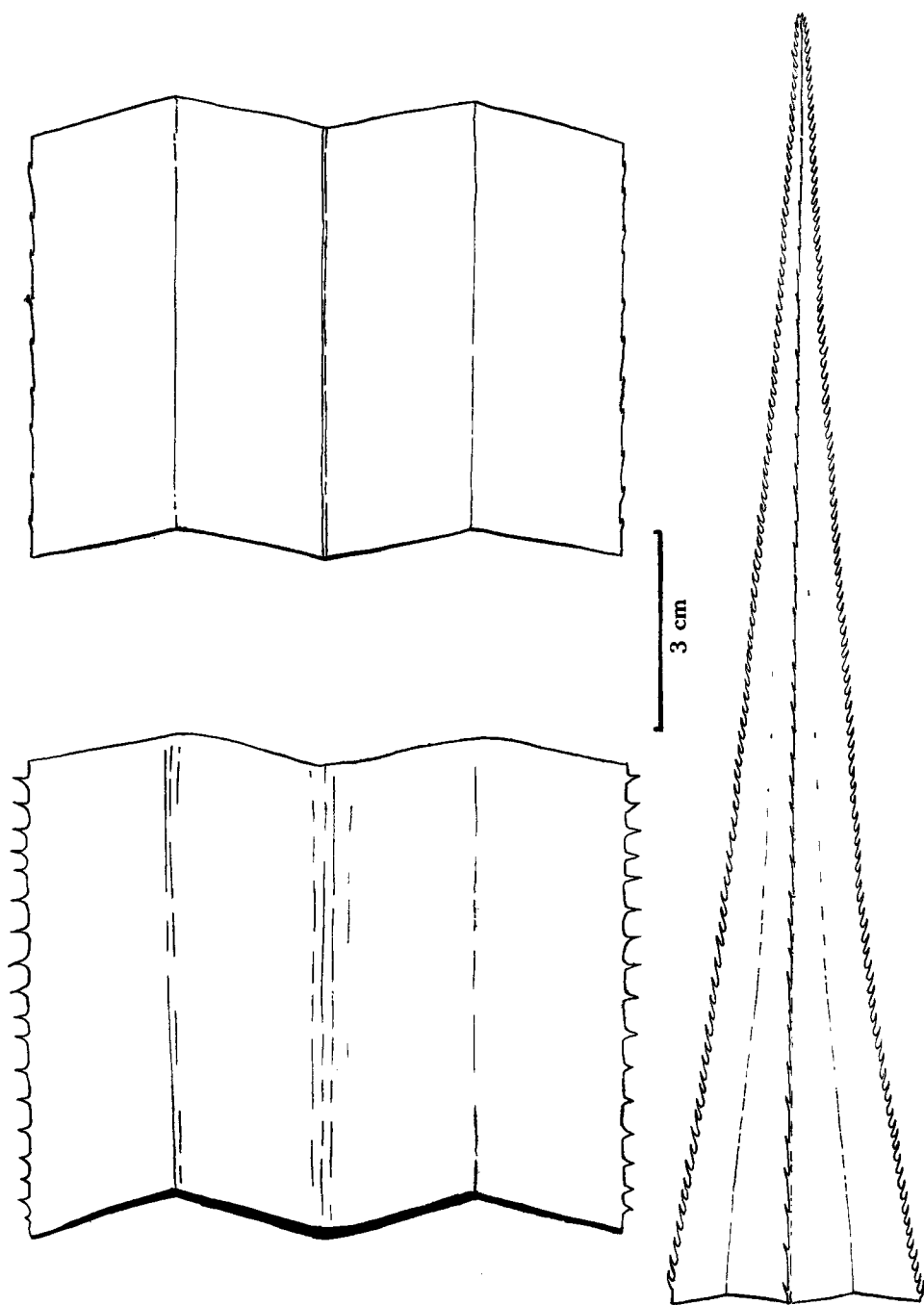


Fig. 15.—*Pandanus antaresensis*. Leaf apex, abaxial surface (right); leaf segment from middle (left, above); leaf segment from near base (left, below), both abaxial surface. After Bowers 765.

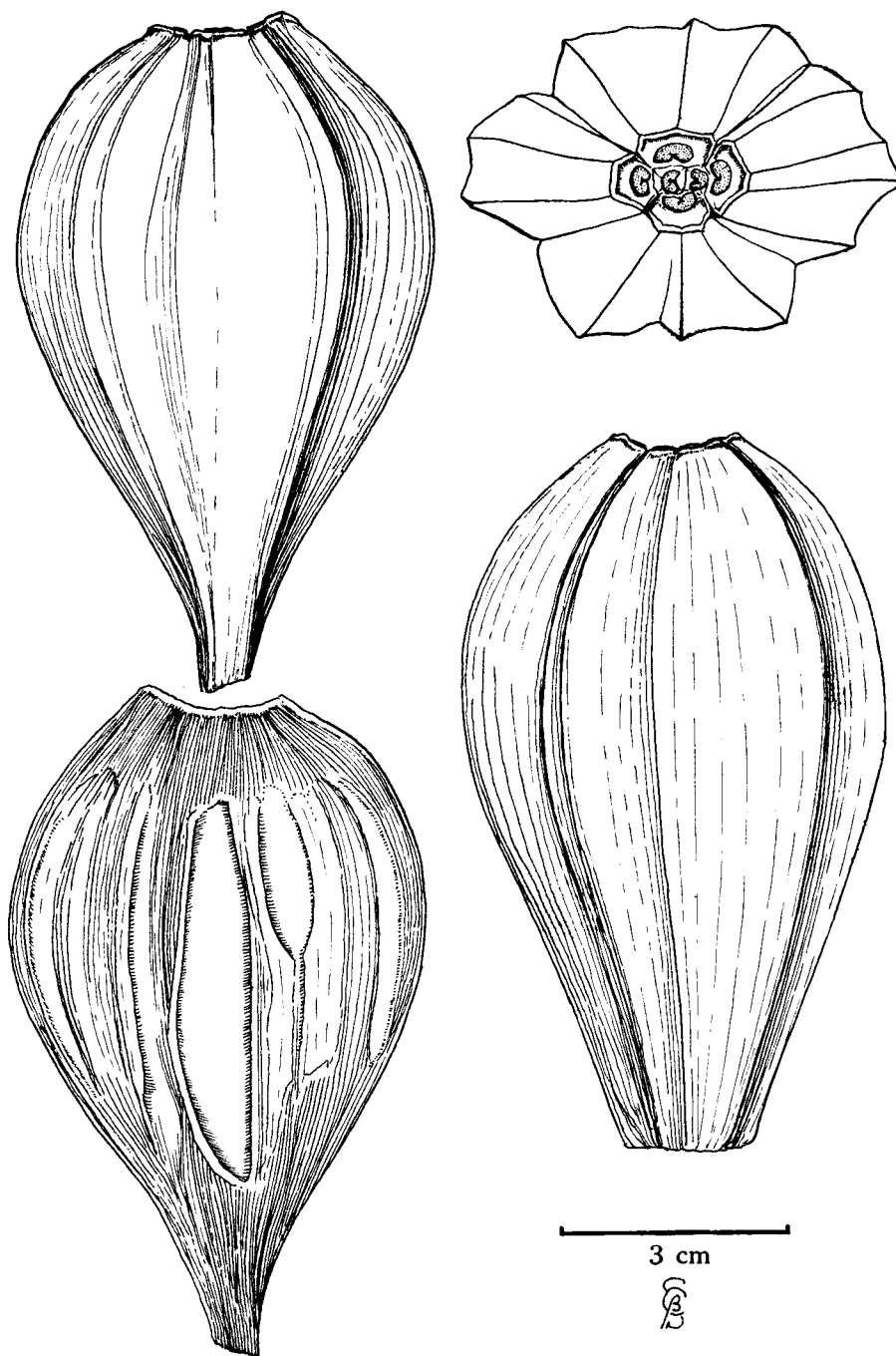


Fig. 16.—*Pandanus antaresensis*. Phalanges in profile, top view, and longitudinal section. After Craig 29.

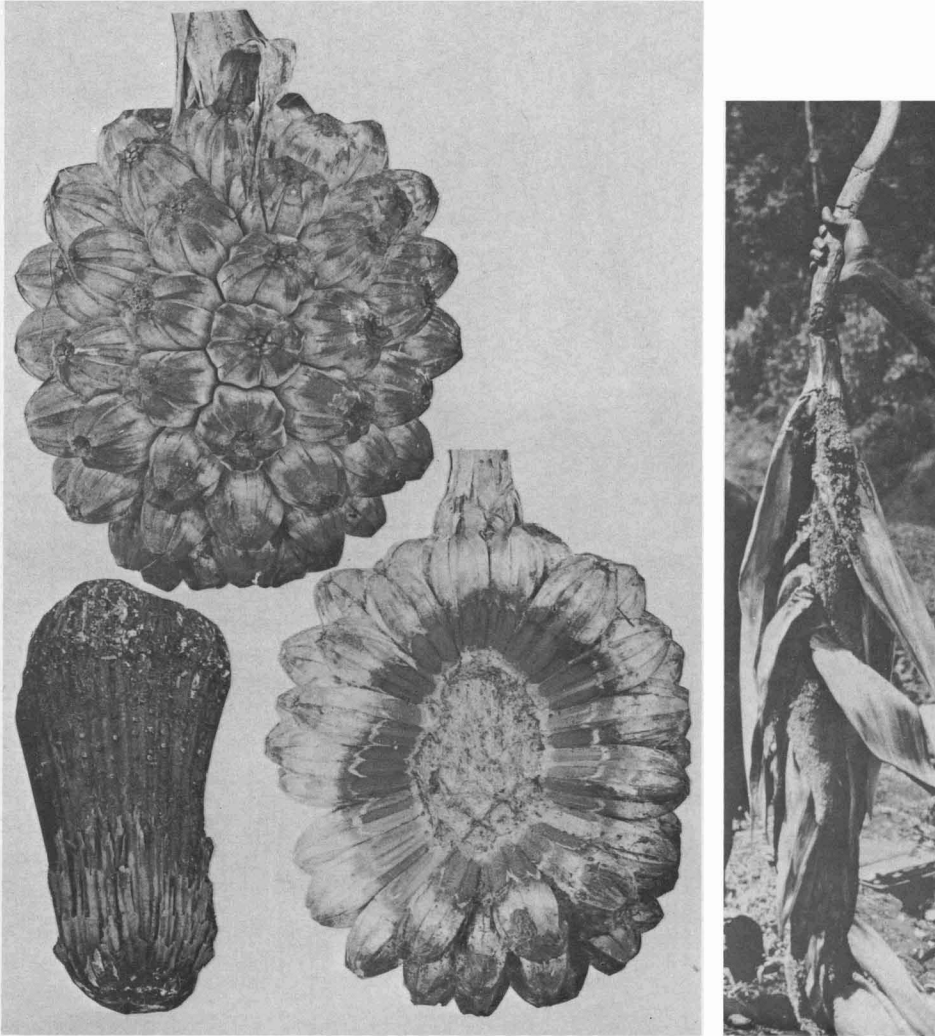


Fig. 17.—*Pandanus antaresensis*. Cephalium in profile and longitudinal section, and apex of prop-root showing large rootcap. LAE 53534. At right, staminate inflorescence. Bowers 766.

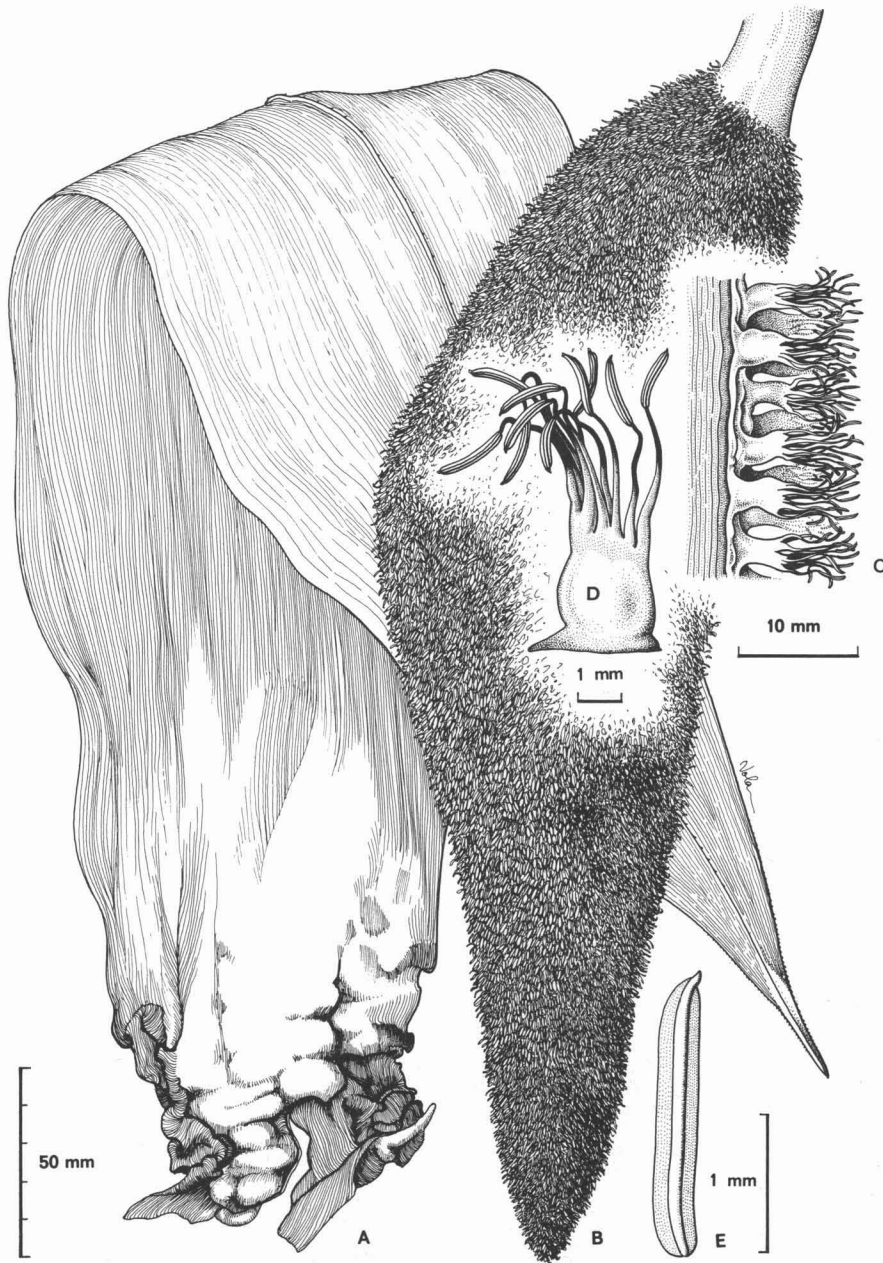


Fig. 18.—*Pandanus antaresensis*. Details of staminate inflorescence: *A*, single bract; *B*, single spadix; *C*, segment of spadix showing staminal phalanges; *D*, single staminal phalange, much enlarged; *E*, single anther. After Bowers 766.

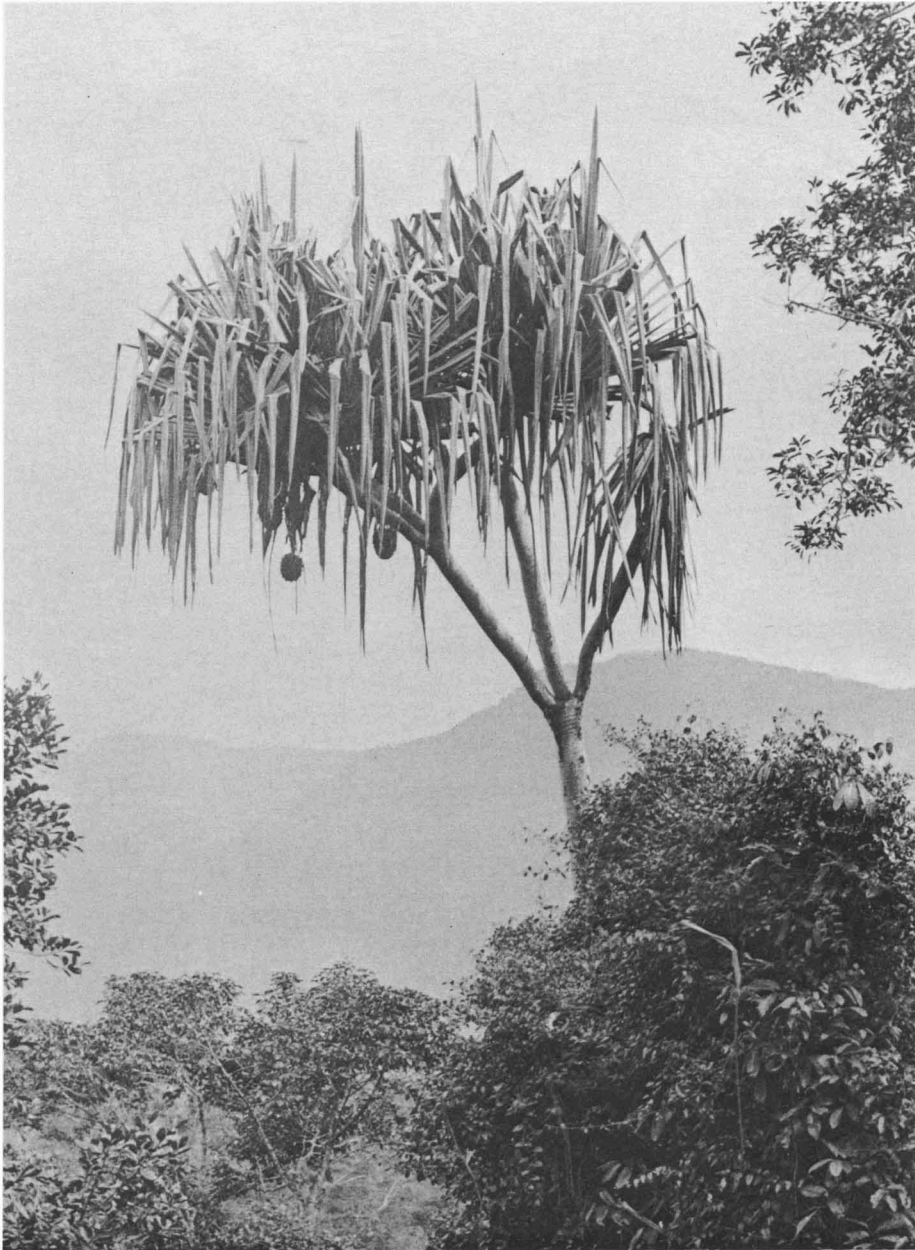


Fig. 19.—*Pandanus antaresensis*. A large pistillate tree in the Eastern Highlands, New Guinea.
LAE 53534.

12. Sect. *Involuta* St. John

This section, like the previous one, seems related to sectio *Bryantia*. It is regarded here as monotypic and is confined to New Guinea and the Papuan Islands.

13. *Pandanus leiophyllus* Martelli, *Webbia* 4(1): 21, 54, 95, 100, Pl. 17. 1913, nomen nudum; *ibid.* 4(2): 422. 1914 (as "*lejophyllus*").

Figs. 20, 21

P. involutus St. John in *Pacif. Sci.* 22: 532, fig. 279. 1968, *typ. sect.*

P. involutus was distinguished on the basis of some dimensions of the drupes, the extent and number of stylar invaginations, leaf width, and number of veins, but although they are real differences between specimens they do not appear to be significant at the specific level. The more striking character of the "hornlike lateral processes" ascending from the pileus of the drupe seems (on examination of the specimen cited below) to be an artefact brought about by drying of the cephalium, followed by shrinkage and separation of the drupes. The less mature the fruit is the

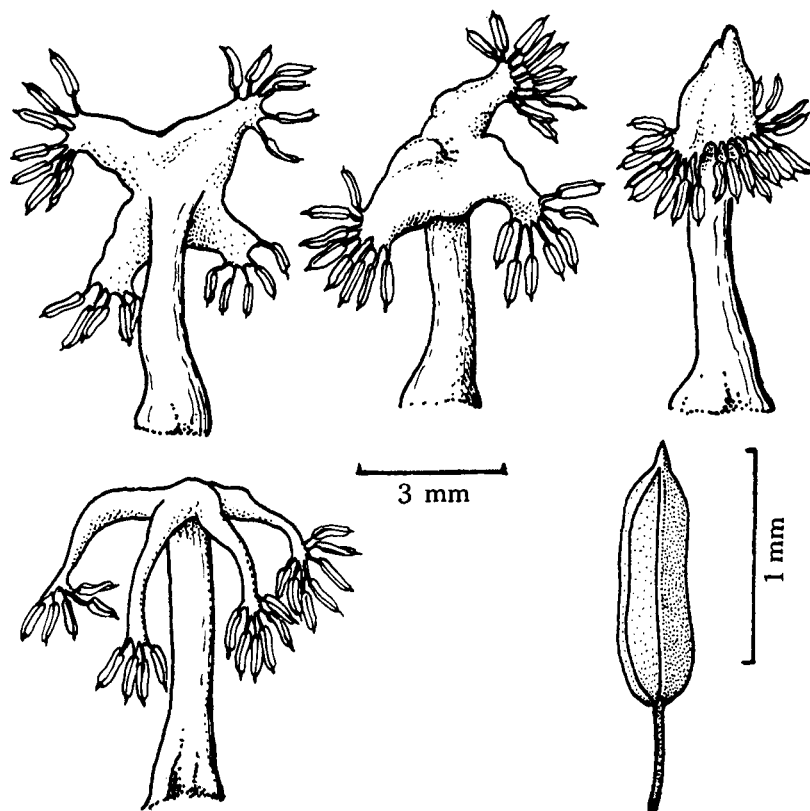


Fig. 20.—*Pandanus leiophyllus*. Staminal phalanges, showing several forms. A single anther enlarged (lower right). After LAE 53557.



Fig. 21.—*Pandanus leiophyllus*. Staminate inflorescence, intact on its leafy branch. LAE 53557.

more likely these processes will be found, which turn out to be small strips of adjacent pilei which have torn free. The other features mentioned in St. John's discussion appear to be functions of age of the specimen when collected (the type of Martelli's species, *van Balen* 2, seems slightly less than fully ripe). But even in Martelli's description and illustrations the "hornlike lateral processes" are shown not to occur on every drupe; in the apical view of drupes (his Table 17, Fig. 6) and the profile of a drupe (his Fig. 7) no such processes are depicted. The presence of such structures, therefore, whatever their nature, does not appear to be regular and reliable. On the whole it seems preferable to retain *P. leiophyllus* so as to include the plants identified as *P. involutus*. The habitat and ecology of all specimens known is similar, in lowland forest.

NORTH-EAST NEW GUINEA: Morobe District: Lae, mouth of Markham River, swamp forest, 10.vi.1971, *Stone* 10257 = LAE 53557 (LAE).

The recent collection of a male plant permits the description and illustration of the characters of the staminate inflorescence, which may now be added to the diagnosis of the section.

Staminate inflorescence terminal, $\pm$ pendulous, about 20 cm long, the *c.* 21 white bracts closely enveloping the spikes, broadly ovate-navicular, somewhat firm fleshy, the outer (lower) ones with attenuate foliaceous apices, and obvious rounded denticulate auricle-like marginal lobes at the base, margins elsewhere and dorsal mid-rib finely denticulate. Spikes short-lanceoloid, composed of numerous crowded staminal phalanges. Phalanges with a columnar stemonophore, 5-6 mm long, 1 mm thick, divided at the apex into 3-5, *c.* 2-3 mm long, 0.5-1.5 mm thick, tapered arms each bearing a terminal cluster of 5-10 very short-filamented stamens; filaments filiform, 0.3-0.5 mm long; anthers about 1.1-1.2 mm long, briefly apiculate. Some phalanges with the arms concrescent into a central subconic projection prolonged above the level of the filament insertions (based entirely on LAE 53557; Fig. 13).

13. Sect. *Acrostigma* Kurz, subsect. *Dimissistyli* B. C. Stone

14. *Pandanus danckelmannianus* K. Sch. in K. Sch. & Hollr. Fl. K. Wilhelms Land, 18. 1889.

NORTH-EAST NEW GUINEA: Morobe District: 1 mile SE. of Wau, lat. 7°20'S., long. 146°45'E., alt. 3500 ft, creek bed with rain-forest remnants, 7.vii.1958, *K. J. White* NGF 10162 (LAE, SING); Bismarck Mts., N. slope, Sipapi, alt. 3800 ft, old secondary bush, 7.vi.1965, *Clarke* 126 (LAE, KLU).

Both these specimens fit well into Schumann's species. There is now a rather large number of specimens, reports, and observations of this species establishing its range from New Guinea through the Bismarck Archipelago into the Solomon Islands.

Collectors' notes are as follows: (White) tree 15 ft tall, 4 in. diam., no propoots; leaves 9 ft long, 4 in. wide; fruit globular, nearly sessile, 9 in. diam., scarlet turning brown. (Clarke) specimens 20-25 ft tall (said by native informants not to grow taller); propoots very small, close to the ground, unbranched; leaves

to 12 ft long, 3 in. wide (as measured across the channel; if flattened, then 4½ in. wide); all spines point to leaf tip; leaf under surface here and there with a bluish haze; fruit orange to red; no bracts (i.e. fallen); pendent on "stem" (peduncle) about 6-7 in. long, globular, 7½ in. diam., slightly flattened at apex; drupes to 2½ in. long; spiniform style $\frac{3}{8}$ in. long.

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