

**Zeitschrift:** Candollea : journal international de botanique systématique = international journal of systematic botany  
**Herausgeber:** Conservatoire et Jardin botaniques de la Ville de Genève  
**Band:** 54 (1999)  
**Heft:** 1

**Artikel:** The genus Pandanus (Pandanaceae) in Madagascar : part 3  
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**DOI:** <https://doi.org/10.5169/seals-879384>

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# The genus *Pandanus* (Pandanaceae) in Madagascar (part 3)

KIM-LANG HUYNH

## RÉSUMÉ

HUYNH, K.-L. (1999). Le genre *Pandanus* (Pandanaceae) à Madagascar (3<sup>e</sup> partie). *Candollea* 54: 145-170. En anglais, résumés français et anglais.

Douze espèces nouvelles de *Pandanus* sect. *Souleyetia* de Madagascar sont décrites: *P. ambohitantelensis*, *P. arenicola*, *P. bemarahensis*, *P. cuneatus*, *P. flagellibracteatus*, *P. isalicus*, *P. latistigmaticus*, *P. majungensis*, *P. manongarivensis*, *P. membranaceus*, *P. tolanarensis*, *P. tubulatus*. Une clé des espèces malgaches actuellement connues de la section est proposée.

## ABSTRACT

HUYNH, K.-L. (1999). The genus *Pandanus* (Pandanaceae) in Madagascar (part 3). *Candollea* 54: 145-170. In English, French and English abstracts.

Twelve new species of *Pandanus* sect. *Souleyetia* from Madagascar are described: *P. ambohitantelensis*, *P. arenicola*, *P. bemarahensis*, *P. cuneatus*, *P. flagellibracteatus*, *P. isalicus*, *P. latistigmaticus*, *P. majungensis*, *P. manongarivensis*, *P. membranaceus*, *P. tolanarensis*, *P. tubulatus*. A key to the species of the section known at present in Madagascar is tentatively proposed.

**KEY-WORDS:** Madagascar – Pandanaceae – *Pandanus* sect. *Souleyetia* – Taxonomy.

## Introduction

*Pandanus* sect. *Souleyetia* (Gaudich.) Kurz, as seen in STONE (1970: 594), comprises those African species which have 1-celled drupes with reniform stigmas and on which the pileus is generally the same length as the lower seeded portion, or 2-3 times shorter in some species. It is mostly confined to Madagascar.

In his revision of the genus *Pandanus* in Madagascar, STONE (1970) included 11 species in sect. *Souleyetia*: *P. dyckioides* (incl. *P. angustifolius*), *P. freycinetioides*, *P. leptopodus*, *P. longipes*, *P. neoleptopodus*, *P. oligocarpus*, *P. oligocephalus*, *P. punctulatus*, *P. stellatus*, *P. subglobosus*, and *P. tsaratananensis*. A key was also given (STONE, 1970: 594-595): this was the first time that a key to the Madagascan species of the section was proposed. *P. pristis*, at first included in sect. *Mammillarisia* (STONE, 1971), was later moved to sect. *Souleyetia* by STONE (1974, 1975). Another species, *P. microcephalus*, had previously been placed in this section by BAKER (1886) and Pichi-Sermolli (in MARTELLI & PICHIS-SERMOLLI, 1951: 63). Thus, some 13 species of sect. *Souleyetia* were known to exist in Madagascar. These were roughly found in the north-eastern part of the island – viz. north of the line passing by Besalamy (about 16°45'S 44°29'E) on the West coasts, where *P. stellatus* was found, and Vohipeno (about 22°22'S 47°51'E) on the East coasts, where *P. punctulatus* was found (see Fig. 1), while apparently only a few collections of the section have been made from the south-western part. Recently

a large number of specimens of sect. *Souleyetia* was collected from both parts of Madagascar, revealing the existence of several unknown species. Thus, sect. *Souleyetia* is rich in species, actually the richest section in this respect on the island.

This can be explained. In fact, sect. *Souleyetia* has a very variable morphology. Probably it is the section which has the most variable morphology in Madagascar, considering its leaves (size, shape, dentation, texture, vagina length and aspect, etc.), infructescences (one or several syncarps), peduncles (from about 1.6 cm to 26 cm long or longer), syncarps (size, shape, drupe numbers), and its drupes in particular (size, shape, ratio between the free part and connate part, structure as seen on the drupe axial section: length and position of the endocarp in the drupe, shape and position of the seed locule, etc.).

In addition, given the generally feeble capacity of dispersal of the genus *Pandanus* (essentially by rivers occasionally by sea streams for most species), and in particular the abundantly mountainous relief of Madagascar that does not favour dispersal, most species in this island have a limited distribution. Thus, *P. vandamii* (sect. *Mammillarisia*) for example was observed in the Manongarivo Massif area only, and *P. pristis* (sect. *Souleyetia*) was not found elsewhere except in the Ankarana Massif. Likewise, sect. *Foullioya* was confined to the eastern part of the island (HUYNH, 1998). Only some species were known to have a  $\pm$  wide distribution: for example *P. pygmaeus* (sect. *Foullioya*) and *P. dauphinensis* (sect. *Dauphinensia*); nevertheless both were observed in the eastern part only.

Moreover, the Western Region of Madagascar (as defined in HUMBERT, 1955: 445-446, plate map) has quite different climatic conditions from the Eastern Region, resulting in two "fundamentally different Floras". This climatic contrast certainly contributes to the endemism of *Pandanus* species in the island.

Given this limited distribution of *Pandanus* species in Madagascar, whenever a tentative identification of these plants in a section (for example sect. *Souleyetia*) is made, a distribution map of those species which were known should be established. This will make it possible to know which species have been found in the same or close areas in order to compare the plants with them. In fact, it appears hardly possible that a plant collected for example in Montagne d'Ambre, in the northern end of the island, would be a species found, say, around Tôlanaro, in the southern end, and vice versa. And to date, no species found in the western part of Madagascar appeared to exist also in the eastern part, and vice versa. Take an example: when Phillipson 1974 (*P. latistigmaticus*), from Montagne d'Ambre, was tentatively identified in the present study, it was first compared with those species of sect. *Souleyetia* which were described from the northern part of the island, viz. *P. pristis* (Ankarana Massif), *P. tsaratananensis* (Tsaratanana Massif), and *P. longipes* (Manongarivo Massif) (Fig. 1). The comparison revealed that it belonged to none of these species. It was therefore not surprising that a subsequent comparison with those species existing in the other areas gave a similar result.

The present paper describes unknown species of sect. *Souleyetia* recently found in Madagascar. In order to facilitate their recognition, a key to the species of the section known at present in the island will be tentatively proposed.

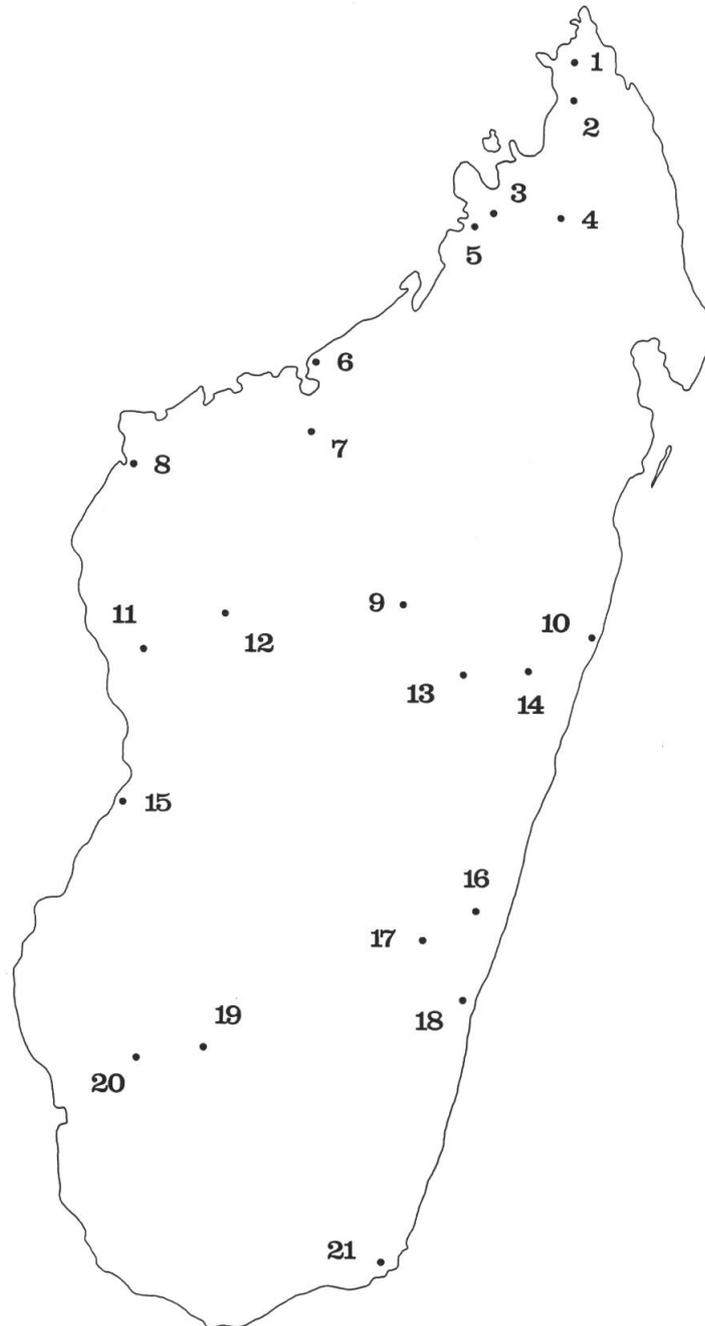


Fig. 1. – Distribution of species of *Pandanus* sect. *Souleyetia* in Madagascar: – **1:** *P. latistigmaticus*. **2:** *P. pristis*. **3:** *P. manongarivensis*. **4:** *P. tsaratananensis*. **5:** *P. longipes*. **6:** *P. subglobosus*. **7:** *P. oligocarpus*. **8:** *P. stellatus*. **9:** *P. ambohitantelensis*. **10:** *P. neoleptopodus*. **11:** *P. bemarahensis*, *P. membranaceus*. **12:** *P. majungensis*. **13:** *P. dyckiioides*. **14:** *P. leptopodus*. **15:** *P. flagellibracteatus*. **16:** *P. freycinetioides*. **17:** *P. cuneatus*. **18:** *P. punctulatus*. **19:** *P. isalicus*. **20:** *P. arenicola*. **21:** *P. tolanarensis*, *P. tubulatus*. – **Note:** for *P. dyckiioides*, it is the location of Dorr 3717; for *P. freycinetioides*, that of Guillaumet 2037 (see STONE, 1970: 600); for the other species, that of their types; most of the locations are approximative.

### Observations

#### *Tentative key to the species of sect. Souleyetia in Madagascar*

1. Syncarps solitary ..... 2
- 1a. Syncarps spicate. .... 19
2. Leaves 4 cm wide; marginal prickles exceptionally stout, up to 8-10 mm long  
..... *P. pristis* B. C. Stone
- 2a. Leaves 0.7-2.5 cm wide; marginal prickles at most 4-5 mm long ..... 3
3. Stigmas exceptionally large, up to 8 mm wide ..... *1. P. latistigmaticus* Huynh
- 3a. Stigmas at most 4 mm wide, generally 1-2 mm ..... 4
4. Syncarp with 6-20 drupes ..... 5
- 4a. Syncarp with 40 or more drupes ..... 11
5. Transverse ambitus of the drupes at lower 1/3 or lower ..... *P. oligocarpus* Martelli
- 5a. Transverse ambitus of the drupes at middle or higher ..... 6
6. Transverse ambitus of the drupes at the base of the free part. Syncarp with 6 drupes, or 18-20 drupes ..... 7
- 6a. Transverse ambitus of the drupes above the base of the free part. Syncarp with 12 drupes  
..... 10
7. Syncarp with 6 drupes ..... *P. subglobosus* St. John
- 7a. Syncarp with 18-20 drupes ..... 8
8. Leaves 25-30 cm long, chartaceous, subamplexicaul. Drupes 25 mm long  
..... *P. stellatus* Martelli
- 8a. Leaves 52-100 cm long, coriaceous, amplexicaul. Drupes 18 mm long ..... 9
9. Leaves 52-57 cm long; vagina 1-1.5 cm long. Drupes with transverse ambitus above middle; seed locule with centre median ..... *2. P. flagellibracteatus* Huynh
- 9a. Leaves 90-100 cm long; vagina 4-5 cm long. Drupes with transverse ambitus at middle; seed locule with centre clearly inframedian ..... *3. P. arenicola* Huynh
10. Supraambital part of the drupes always wider than long. Leaves revolute in a short basal part. Peduncle 1.6-2 cm long ..... *4. P. membranaceus* Huynh
- 10a. Supraambital part of the drupes longer than wide, sometimes as wide as long but never wider than long. Leaves revolute from above the vagina to the apex. Peduncle 3.5-4 cm long  
..... *5. P. bemarkahensis* Huynh
11. Leaves 40-60 × 0.7-0.9 cm ..... *P. dyckioides* Baker
- 11a. Leaves wider ..... 12
12. Leaves abruptly attenuate in the apical part, subcuspidate ..... 13
- 12a. Leaves gradually attenuate in the apical part, not subcuspidate ..... 14
13. Syncarp with 120-130 drupes. Peduncle about 14 cm long ..... *P. punctulatus* Martelli
- 13a. Syncarp with 50-60 drupes. Peduncle almost nil ..... *P. microcephalus* Baker
14. Syncarp globose/subglobose ..... 15
- 14a. Syncarp oblong/ovoid ..... 17

15. Drupes  $12 \times 7-8$  mm, free by  $2/3$ . Syncarp 3.5 cm long . . . *P. longipes* Perrier ex Martelli
- 15a. Drupes 28-38 mm long, free by  $1/4-1/3$ . Syncarp 7-8 cm long . . . . .16
16. Drupes 35-38 mm long; stigma 3 mm stipitate. Leaf pleats unarmed  
 . . . . .6. *P. manongarivensis* Huynh
- 16a. Drupes 28 mm long; stigma sessile. Leaf pleats armed . . . . .7. *P. majungensis* Huynh
17. Leaves  $35-40 \times 1.4-1.5$  cm; vagina alveolate at the adaxial face  
 . . . . .*P. tsaratananensis* Martelli
- 17a. Leaves longer; vagina not alveolate at the adaxial face . . . . .18
18. Drupes  $17 \times 5$  mm, free by  $1/4$ ; seed locule with centre clearly inframedian. Syncarp with 600-700 drupes. Leaf marginal prickles to 0.9 cm apart . . . . .8. *P. isalicus* Huynh
- 18a. Drupes  $27 \times 17$  mm, free by  $1/2$ ; seed locule with centre median. Syncarp with about 40 drupes. Leaf marginal prickles to 4 cm apart . . . . .9. *P. ambohitantelensis* Huynh
19. Drupes  $6 \times 3$  mm. Infructescence with 7-9 syncarps . . . *P. freycinetioides* (Gaudich.) Kurz
- 19a. Drupes 13 mm long or longer. Infructescence with at most 4 syncarps . . . . .20
20. Syncarps with 20-30 drupes. Drupes 13 mm long . . . . .*P. oligocephalus* Baker
- 20a. Syncarps with 50-80 drupes. Drupes 17 mm long or longer . . . . .21
21. Leaves gradually attenuate in the apical part . . . . .22
- 21a. Leaves abruptly attenuate in the apical part, subcuspidate . . . . .24
22. Drupes dome-shaped; pileus with convex faces. Leaves  $115-130 \times 2.5-2.8$  cm. Drupes to  $18 \times 6$  mm; upper mesocarp distinct laterally . . . . .*P. neoleptopus* Pic. Serm.
- 22a. Drupes flask-shaped; pileus with concave faces . . . . .23
23. Drupes to  $18 \times 11$  mm; upper mesocarp distinct laterally. Leaves  $80-85 \times 1-1.4$  cm  
 . . . . .10. *P. cuneatus* Huynh
- 23a. Drupes to  $18 \times 6$  mm; upper mesocarp nil laterally. Leaves  $80-110 \times 1.5-1.8$  cm  
 . . . . .*P. leptopus* Martelli
24. Endocarpic apical walls of the seed locule 5 mm high in axis. Seed locule with apex at  $4/10$  of the drupe, base at  $9/10$ , and centre clearly inframedian. Leaf pleats unarmed  
 . . . . .11. *P. tolanarensis* Huynh
- 24a. Endocarpic apical walls of the seed locule 2 mm high in axis. Seed locule with apex at  $2/10$  of the drupe, base at  $6/10$ , and centre slightly suprasedian. Leaf pleats armed  
 . . . . .12. *P. tubulatus* Huynh

**1. *Pandanus latistigmaticus* Huynh, spec. nova** (sect. *Souleyetia*)

*Arbor. Folia infra infructescentiam 60-65 cm longa 1.7 cm lata in medio 1.3 cm supra vaginam, oblongo-lanceolata, e medio ad apicem sensim attenuata, 10 cm vel plus flagellata, e 1/4 infera vaginam versus sensim attenuata, in basi amplexicaulia; lamina in sicco submembranacea, dense striata inter venas longitudinales in pagina adaxiali, hic illic leviter revoluta (i.e. in marginibus solum); plicis inermibus, leviter visibilibus in dimidio infero; venis longitudinalibus distinctis in pagina abaxiali minus vel invisibilibus in adaxiali; venis transversalibus utrinque indistinctis, hic illic subvisibilibus praecipue in pagina abaxiali; denticulis marginalibus e 2-3 cm supra basim ad apicem praesentibus, antrorsis, raro perpendicularibus, in tertia infera ad 4 mm longis 15 mm inter se separatis, in media ad 3 mm longis 7-8 mm inter se separatis, in supera brevioribus creberrimisque; denticulis costalibus praesentibus in dimidio supero, generaliter paulo creberrimis quam marginalibus proximis, inferne 3-plo superne 2-plo vel minus brevioribus apice aequae longis; vagina 2 cm longa 2.5-3 cm lata, partis basalis laminae simili in aspectu,*

*utrinque omnino longitudinaliter nervata non nitida non alveolata. Infructescentia monosyncarpica; syncarpio globoso, circa 6 cm diametenti, circa 45 drupis praedito; pedunculo 6-9 cm longo 1 cm crasso in apice deorsum versus attenuato, recto, leviter trigono. Drupae circa 3 cm longae 2 cm latae 1.5 cm crassae, in 1/4 supera liberae; stigmatibus unicus, latissimis, 6-8 × 4-5 mm, reniformibus, horizontalibus, 2-3 mm peltatis, sessilibus, atrobrunneissimis; pileo late pyramidalis, circa 8 mm alto, leviter angulato, dense longitudinaliter striato inter angulos; endocarpio circa 24 mm alto in axe, apice prope basim stigmatis basi ad circa 6 mm supra basim drupae, parte supra loculum seminale circa 4-5 mm alta, rotundate pyramidalis, solida; loculo seminali ellipsoideo, circa 15 × 7 mm, apice ad circa 5 mm infra basim stigmatis basi circa 6 mm supra basim drupae, centro leviter supramediano; mesocarpio supero subnullo in apice sed perspicuo in partibus lateralibus, abundanter medullosa fibrosoque; mesocarpio infero medullosa, abundanter fibroso. – Fig. 2-6 and 49.*

**Typus:** Phillipson 1974 (holo MO!); Madagascar, province of Antsiranana, National Park of Ambohitra (Montagne d'Ambre), along road in park, 12°31'S 49°10'E, alt. 900 m, 28 June 1987; well-branched tree in forest, leaves dark green, glossy, arched, stems spiny, male flowers in a pendant panicle about 150 mm long with about 8 branches, flowers and bracts white except for the brown anthers, lower bracts with leaf-like apical "patian", upper with green apiculus, young infructescence green with grey bloom.

*P. latistigmaticus* is the northernmost species of sect. *Souleyetia* which was found in Madagascar (Fig. 1). It is unique in the section in that its stigmas are exceptionally large, up to 8 mm wide. In fact, when the drupes are observed, the readily prominent feature is the stigmas. In the other species, the stigmas are generally 1-2 mm wide, at most 4 mm. Apparently there are no species very closely related to *P. latistigmaticus*. This may be compared with *P. pristis*, from the Ankarana Massif (about 12°54'S 49°07'E), and the closest in distribution (Fig. 1). This latter species differs essentially from *P. latistigmaticus* in that: its leaves are 30-40 cm long and 4 cm wide, and abruptly attenuate in the apical part; in particular the marginal prickles of the leaves are exceptionally stout, up to 8-10 mm long, a feature not observed in any other known species of sect. *Souleyetia*; its drupes are 18-21 × 12 mm.

## 2. *Pandanus flagellibracteatus* Huynh, spec. nova (sect. *Souleyetia*)

*Arbor parva. Folia infra infructescentiam 52-57 cm longa 1.3 cm lata in medio, e tertia supra ad apicem sensim attenuata, 10 cm vel plus flagellata, prope vaginam dilatata, in basi amplexicaulia; lamina in sicco coriacea, e basi fere ad apicem valde revoluta; plicis inermibus, canaliculatis; venis longitudinalibus fere omnibus distinctis in pagina abaxiali, minus vel obscuris in adaxiali; venis transversalibus utrinque invisibilibus; denticulis marginalibus e 1-1.5 cm supra basim ad apicem praesentibus, antrorsis, in dimidio infero ad 2-3 mm longis 7-15 mm (vel plus) inter se separatis, sursum versus brevioribus creberrimisque; denticulis costalibus praesentibus in 3/4 superis, magis separatis brevibusque quam marginalibus proximis; vagina 1-1.5 cm longa 2.8-3 cm lata, partis basalis laminae simili in aspectu, utrinque omnino longitudinaliter nervata non nitida non alveolata. Infructescentia monosyncarpica; syncarpio globoso, circa 4 cm diametenti, 20 drupis praedito; pedunculo circa 7.5 cm longo 6 mm crasso in apice deorsum versus attenuato, recto, acute trigono, multinervato inter angulos. Drupae circa 1.8 cm longae 1.2-1.7 cm latae 1.2-1.5 cm crassae, in 4/10 superis liberae; stigmatibus unicus, circa 2 × 1.5 mm, reniformibus, horizontalibus, subsessilibus vel 1 mm stipitatis; pileo circa 8 mm alto, late pyramidalis, semper plus lato quam alto, leviter vel obscure angulato, dense subtiliter longitudinaliter striato inter angulos; endocarpio circa 15 mm alto in axe, apice prope basim stigmatis, basi ad 3 mm supra basim drupae, parte supra loculum seminale circa 5 mm alta, late deltoidea, acuta, solida; loculo seminali subsphaerico, 7-8 mm diametenti, apice ad circa 6 mm infra basim stigmatis basi circa 5 mm supra basim drupae, centro mediano; mesocarpio supero nullo in apice sed lato in partibus lateralibus, copiose medullosa fibrosoque; mesocarpio infero parce medullosa sed copiose fibroso. – Fig. 7-10 and 56.*

**Typus:** *Cremers 3507* (holo P!); Madagascar, North of Morondava, 29 August 1974; small tree.

Morondava is at about 20°17'S 44°17'E.

*P. flagellibracteatus* is named in reference to the lowermost bract of its infructescence. This bract is at about 1.5 cm below the syncarp (Fig. 56); it is leaf-like, about 28 cm long and 1 cm wide at the vagina (this about 5 cm long), above which it is very narrow, almost entirely flagelliform, and strongly revolute; the margins and midrib are armed almost from the base to the apex. The floral bracts at the base of the syncarp are about 1.5-2 cm long and 1 cm wide.

*P. flagellibracteatus* appears closest to *P. arenicola*, also found in the western part (Fig. 1). They are similar in that they have strongly revolute leaves, syncarps with 18-20 drupes, and drupes about 18 mm long and with subspherical seed-locules (Fig. 10 and 14). This latter species differs essentially from *P. flagellibracteatus* in that: the transverse ambitus of its drupes is at middle (Fig. 13); the centre of its seed locule is clearly inframedian (Fig. 14); its peduncle is about 13 cm long; in particular, its leaves are 90-100 cm long, with vagina 4-5 cm long.

### 3. *Pandanus arenicola* Huynh, **spec. nova** (sect. *Souleyetia*)

*Arbor 4-5 m alta. Folia infra infructescentiam 90-100 cm longa 1.3-1.5 cm lata in medio, e tertia supra ad apicem sensim attenuata, 10-15 cm flagellata, in basi amplexicaulia; lamina in sicco brunnea vel viridula, coriacea, fere ad basim flagelli valde revoluta, basi utrinque tessellata; plicis inermibus, leviter visibilibus; venis longitudinalibus densis, utrinque distinctis; venis transversalibus visibilibus in partibus tessellatis; denticulis marginalibus e 5-6 cm supra basim ad apicem praesentibus, antrorsis, in parte basali ad 2-3 mm longis sursum versus creberrimis; denticulis costalibus in circiter dimidio supero praesentibus, inferne magis separatis brevibus quam marginalibus proximis, superne ± aequae longis separatisque; vagina 4-5 cm longa 3-3.5 cm lata, nitida in basi praecipue in pagina abaxiali, pro parte maxima perspicue longitudinaliter nervata in pagina abaxiali partim leviterque in adaxiali, utrinque non alveolata. Infructescencia monosyncarpica; syncarpio globoso, circa 4 cm diametenti, 18 drupis praedito; pedunculo 12-13 cm longo 8 mm crasso in apice deorsum versus attenuato, recto, acute trigono, multinervato inter angulos. Drupae circa 1.8 cm longae 1.5 cm latae 1.3 cm crassae, in 1/2 supra liberae; stigmatibus unicus, raro 2, circa 2 × 1.5 mm, reniformibus, horizontalibus, sessilibus vel 1 mm stipitatis; pileo circa 8 mm alto, late tholiformi vel late pyramidali, semper plus lato quam alto, subtiliter vel obscure longitudinaliter striato inter angulos; endocarpio circa 14 mm alto in axe, apice prope basim stigmatis, basi ad 3 mm supra basim drupae, parte supra loculum seminale circa 5 mm alta, late deltoidea, solida; loculo seminale subsphaerico, circa 9 mm diametenti, apice ad circa 7 mm infra basim stigmatis basi circa 2-3 mm supra basim drupae, centro perspicue inframediano; mesocarpio supero nullo in apice sed distincto in partibus lateralibus, medullosa fibroso; mesocarpio infero fibroso. – Fig. 11-14 and 57.*

**Typus:** *Dorr 4173* (with *Barnett, Rakotozafy, Cheek & Razafimalala*) (holo MO!); Madagascar, forest of Zombitsy, National Reserve 7, 10.1 km NE of Sakaraha, 22°55'S 44°32'E, 26 March 1985; dry forest on white sand; branching plant, 4-5 m tall, fruit a single cephalia at stem tip.

*P. arenicola* is the southernmost species of sect. *Souleyetia* which was found in the western part of Madagascar (Fig. 1). It appears closest to *P. flagellibracteatus*, also found in the western part. The two species differ essentially in their drupes and leaves (see under *P. flagellibracteatus*).

### 4. *Pandanus membranaceus* Huynh, **spec. nova** (sect. *Souleyetia*)

*Arbor 5-6 m alta, ± lianescenti, radicibus gralliformibus suffulta. Folia infra infructescentiam 30-36 cm longa 6-9 mm lata in medio 5-6 mm supra vaginam, anguste lanceolata, e medio*

*ad apicem sensim attenuata, prope vaginam leviter attenuata, in basi amplexicaulia; lamina in sicco atroviridula, membranacea flexuosa, prope basim revoluta, dense striata inter venas longitudinales in pagina adaxiali; plicis inermibus, superne visibilibus; venis longitudinalibus utrinque distinctis sed plus in pagina abaxiali, transversalibus indistinctis; denticulis marginalibus e circa 1 cm supra basim ad apicem praesentibus, antrorsis, in tertia infera valde acutis, ad 4 mm longis 18-20 mm inter se separatis, sursum versus brevioribus creberrimisque; denticulis costalibus praesentibus in circiter dimidio supero, plerumque paulo creberrimis quam marginalibus proximis, inferne manifeste brevioribus, superne  $\pm$  aequae longis; vagina circa 1 cm longa 1.5 cm lata, utrinque omnino longitudinaliter nervata non nitida non alveolata, marginibus 1.5 mm latis, tenuis. Infructescentia monosyncarpica; syncarpio globoso, circa 3 cm diametenti, 12 drupis praedito; pedunculo 1.6-2 cm longo 2.5-3 mm crasso in apice deorsum versus attenuato, recto, leviter trigono, leviter nervato inter angulos. Drupae 1.4-1.5 cm longae 1-1.3 cm latae 0.9-1.2 cm crassae, in 2/3 superis liberae; stigmatibus unicis, circa  $1.5 \times 1$  mm, reniformibus, horizontalibus, 1-1.5 mm stipitatis; pileo circa 1 cm alto, obscure vel leviter angulato, dense longitudinaliter striato inter angulos, basi perspicue infra ambitum posita; parte supraambitali circa 0.8 cm alta, late pyramidalis, semper perspicue plus lata quam alta; parte connata circa 3/4 partis infraambitalis occupanti; endocarpio circa 10 mm alto in axe, apice prope basim stigmatibus basi ad 3 mm supra basim drupae, parte supra loculum seminale circa 4 mm alta, deltoidea, solida; loculo seminali subsphaerico, circa  $6 \times 6$  mm, apice ad circa 5-6 mm infra basim stigmatibus basi circa 3 mm supra basim drupae, centro leviter inframediano; mesocarpio supero nullo in apice sed perspicuo in partibus lateralibus, copiose medullosa fibrosoque; mesocarpio infero medullosa fibroso. – Fig. 15-18 and 52.*

**Typus:** Villiers, Klackenberg & Badré 4833 (holo P!, iso MO!); Madagascar, 14 km East of Antsalova, 18 March 1993; underwood; tree 5 m tall, stem  $\pm$  lianescent, white, spiny, fruits green.

Antsalova (locality) is at about 18°40'S 44°38'E.

*Other material:* Labat 2649 (with Dupuy & Couté) (G! MO! P!); Madagascar, Mahajunga, Antsalova, Ambinda, Andranopasasa, RN 9 Tsingy of Bemaraha, 18°42'28"S 44°42'58"E, 1 March 1995; tropical caducifoliolate forest, with thin covering brown soil on karst; tree 5-6 m tall, almost lianescent, stem and branches spiny and abundantly branched, with proproots, fruit small, smooth; vernacular name Fandra (Sakalava lang.).

On the infructescence of Villiers, Klackenberg & Badré 4833, the lowermost bract is about 20 cm long and 1.5 cm wide at the vagina (this about 5 cm long), above which it is very gradually attenuate to the apex where it forms a flagellum about 10 cm long; the margins are armed from about 2 cm above the base to the apex; the midrib is armed from about 4 cm above the base. The intermediate bract, above the lowermost bract, is about 4.5 cm long. The floral bracts, at the base of the syncarp, are boat-shaped and about 1-1.5 cm long.

*P. membranaceus* is named in reference to its membranaceous leaves. It is noticeable in sect. *Souleyetia* in that: its drupes are almost as wide as long, and the base of the pileus is clearly below the transverse ambitus of the drupe (Fig. 17); its peduncle is very short, not exceeding 2 cm in length; its syncarp comprises only 12 drupes. These features contribute to facilitate its recognition. It appears most closely related to *P. bemarahensis*, found nearby. They are similar in that they have a syncarp with 12 drupes, on which the base of the pileus is clearly below the transverse ambitus. This latter species differs essentially from *P. membranaceus* in that: its leaves are revolute from above the vagina to the apex; its peduncle is 3.5-4 cm long; in particular on its drupes, the part that is above the transverse ambitus is generally longer than wide (Fig. 21 and 50), sometimes as wide as long but never wider than long.

##### 5. *Pandanus bemarahensis* Huynh, spec. nova (sect. *Souleyetia*)

*Folia infra infructescentiam 45-50 cm longa 7-8 mm lata in medio, e tertia infera ad apicem sensim attenuata, 9-10 cm flagellata, prope vaginam perspicue attenuata, in basi amplexicaulia; lamina in sicco membranacea/submembranacea, e basi ad basim flagelli valde revoluta,*

*dense striata inter venas longitudinales in pagina adaxiali; plicis inermibus, in parte supera visibilibus; venis longitudinalibus distinctis in pagina abaxiali, vix visibilibus in adaxiali; venis transversalibus visibilibus in parte infera paginae abaxialis; denticulis marginalibus e circa 2 cm supra basim ad apicem praesentibus, antrorsis, in 1/4 infera ad 3 mm longis 20 mm inter se separatis, sursum versus brevioribus creberrimisque; denticulis costalibus praesentibus in 1/3-1/2 supera, inferne plerumque 2-plo brevioribus et minus separatis quam marginalibus proximis, superne ± aequae longis separatisque; vagina 1.5-2 cm longa 1.5 cm lata, utrinque omnino longitudinaliter nervata non nitida non alveolata. Infructescentia monosyncarpica; syncarpio globoso, circa 4 cm diametenti, 12 drupis praedito; pedunculo 3.5-4 cm longo 5 mm crasso in apice deorsum versus attenuato, recto. Drupae circa 1.8 cm longae 1.2 cm latae 1 cm crassae, in 7/10 superis liberae; stigmatibus unicis, circa 1 × 1 mm, reniformibus, horizontalibus, subsessilibus; pileo circa 1.3 cm alto, obscure vel leviter angulato, dense longitudinaliter striato inter angulos; parte supraambitali oblongo-pyramidalis, circa 0.9 cm alta, perspicue plus alta quam lata, interdum tam alta quam lata sed nunquam plus lata quam alta; parte connata circa 1/2 partis infraambitalis occupanti; endocarpio circa 12 mm alto in axe, apice prope basim stigmatum, basi ad 5 mm supra basim drupae, parte supra loculum seminale circa 5 mm alta, solida, superne spiniformi-deltaeidea; loculo seminale ellipsoideo, circa 8 × 5 mm, apice ad circa 6 mm infra basim stigmatum, centro leviter inframediano; mesocarpio supero subnullo in apice sed perspicuo in partibus lateralibus, copiose medullosa fibrosoque; mesocarpio infero fibroso. – Fig. 19-22 and 50.*

**Typus:** *Cremers 3799-bis* (holo P!); Madagascar, Tsingy of Bemaraha (East of Antsalova), 3 February 1975; young plant 1.5 m tall, unbranched.

The collector field-noted that this specimen was the same species as *Cremers 3799*. It was not possible to investigate this latter specimen in the present study.

Antsalova (locality) is at about 18°40'S 44°38'E. Tsingy of Bemaraha is a vast natural reserve of about 1520 sq. km, whose central position is at about 18°40'S 44°47'E. "Tsingys" are natural reserves not far from the West coasts of Madagascar; they harbour narrow mazes of limestone peaks; these rows of peaks sharpened by the wind and the rain are called "tsingy" because they give a "tsing" sound when they are tapped with a hand; rare are those who dare venture on or among their razor-sharp edges (NOËL & BOURDIAL, 1997).

*P. bemarahensis* is remarkable in sect. *Souleyetia* in that it has drupes free by 7/10 (Fig. 21) and a syncarp with only 12 drupes. These features contribute to facilitate its recognition. It appears most closely related to *P. membranaceus*, found nearby. The two species differ essentially in their drupes and leaves (see under *P. membranaceus*).

## 6. *Pandanus manongarivensis* Huynh, **spec. nova** (sect. *Souleyetia*)

*Arbor circa 11 m alta. Folia circa 73 cm longa 2.5 cm lata in medio 3 cm lata supra vaginam, 4-5 cm caudata, e medio ad apicem sensim attenuata, prope vaginam leviter dilatata, in basi amplexicaulia; lamina in sicco subcoriacea, utrinque pro parte maxima tessellata, in pagina adaxiali inferne leviter alveolata; plicis inermibus, distinctis, pro parte maxima canaliculatis; denticulis marginalibus e 2-2.5 cm supra basim ad apicem praesentibus, antrorsis, in dimidio infero ad 3 mm longis 2.8 cm inter se separatis, sursum versus brevioribus creberrimisque; denticulis costalibus praesentibus in circiter dimidio supero, antrorsis, perspicue brevioribus et paulo magis separatis quam marginalibus proximis; vagina 2-2.5 cm longa 3.5 cm lata, utrinque subnitida et partim longitudinaliter nervata, in pagina adaxiali superne leviter alveolata. Infructescentia monosyncarpica; syncarpio globoso, circa 6.5 cm diametenti, circa 60 drupis praedito; pedunculo circa 15 cm longo, 12 mm crasso in apice 6 mm medio deorsum versus attenuato, recto, trigono, dense nervato inter angulos. Drupae circa 3.5 cm longae 1.5-1.9 cm latae 1.2-1.5 cm crassae, in circa 1/3 supera liberae; stigmatibus unicis, interdum 2 et aggregatis, circa 2 × 1.5 mm, reniformibus, horizontalibus, circa 3 mm stipitatis; pileo pyramidalis, circa 8-9 mm alto, laevi, leviter angulato sed angulis fere ad basim stigmatum visibilibus; endocarpio*

circa 20 mm alto in axe, apice prope basim stigmatis, basi ad circa 12 mm supra basim drupae, parte supra loculum seminale circa 5-6 mm alta, solida, apice deltoidea basi subcylindrica, in drupis 2-stigmaticis superne separata; loculo seminali ellipsoideo, circa 10 × 3-4 mm, apice ad 7-8 mm infra basim stigmatis basi circa 16 mm supra basim drupae, centro perspicue supramediano; mesocarpio supero subnullo in apice sed perspicuo in partibus lateralibus, fibroso, copiose meduloso; mesocarpio infero parce meduloso sed copiose fibroso. – Fig. 23-26 and 54.

**Typus:** *Gautier & Chatelain LG.2648* (holo NEU!, iso G!); Madagascar, Special Reserve of Manongarivo, Besinkara, 14°04'S 48°17'E, 300 m below Ambalafary, alt. 350 m, 13 May 1995; young secondary forest; tree 11 m tall; vernacular name Maitsokely.

*Other material:* *Gautier, Messmer & D'Amico LG.3207* (G!, NEU!); Madagascar, Besinkara, below Ambalafary on route to Anabotoaka, 14°04'S 48°17'E, alt. 200 m, 29 August 1997; evergreen wet forest; tree 9 m tall, 7 cm thick, fruits green.

On the infructescence of *Gautier & Chatelain LG.2648*, the lowermost bract is at about 5 cm below the syncarp; it is leaf-like, about 31 cm long and 2.4 cm wide at the vagina (this about 4.5 cm long), above which it is linear lanceolate, gradually attenuate to the apex; the margins are armed almost from the base to the apex, the midrib from about 4.5 cm above the base. The subsequently upper bract partially preserved is at about 2 cm below the syncarp. The floral bracts, at the base of the syncarp, are up to 3 cm long and 2.6 cm wide, boat-shaped, with margins armed from the base to the apex, and midrib armed from the middle.

On *Gautier, Messmer & D'Amico LG.3207*, the syncarp is about 8 cm long and 8 cm wide. The drupes are 35-38 mm long. The peduncle is ± straight, and about 20 cm long, 1 cm thick at apex, from which it tapers to the base; it bears only one bract, at about 4 cm below the syncarp. Photos taken in situ show short stilt-roots and a stem with sparse small prickles.

*P. manongarivensis* is the only known species in sect. *Souleyetia* which has drupes up to 35-38 mm long and stigmas 3 mm stipitate (Fig. 25). In the other species, the drupes are shorter, and to date the stigmas were known as being sessile or at most 1-1.5 mm stipitate.

Apparently there are no species very closely related to *P. manongarivensis*. This latter may be compared with *P. longipes*, from Maromandia (about 14°12'S 48°05'E), and the closest in distribution (Fig. 1). This latter species differs from *P. manongarivensis* especially in that: its drupes are 12 mm long and 7-8 mm wide, and free by 2/3; its syncarp is 3.5 cm long.

### 7. *Pandanus majungensis* Huynh, *spec. nova* (sect. *Souleyetia*)

*Arbor 4-6 m alta, radicibus gralliformibus suffulta. Folia 100-105 cm longa 1.8-2 cm lata in medio, lanceolata, 2 cm caudata, e tertia supera ad apicem sensim attenuata, prope vaginam perleviter attenuata; lamina in sicco subcoriacea; plicis in circa 5 cm sparsim armatis, distinctis, fere e basi ad apicem canaliculatis, superne in circa 2 cm sese appositis; venis longitudinalibus utrinque distinctis sed magis in pagina abaxiali; venis transversalibus utrinque indistinctis sed subvisibilibus in basi; denticulis marginalibus e circa 8 cm supra basim ad apicem praesentibus, antrorsis, in tertia infera ad 2 mm longis 1-2.5 cm inter se separatis, sursum versus perspicue brevioribus creberrimisque; denticulis costalibus praesentibus in dimidio supero, antrorsis, plerumque tam separatis quam marginalibus proximis, inferne perspicue brevioribus superne aequae longis; vagina 6-7 cm longa 3.5 cm lata, nitida non longitudinaliter nervata in pagina abaxiali igitur partis basalis laminae dissimili in aspectu, non nitida (vel subnitida) leviter longitudinaliter nervata leviter alveolata in pagina adaxiali. Infructescentia monosyncarpica; syncarpio globoso/subgloboso, circa 7.5 cm longo 7 cm lato, circa 55 drupis praedito; pedunculo circa 15 cm longo, 8 mm crasso in apice deorsum versus attenuato, trigono, leviter nervato inter angulos. Drupae circa 2.8 cm longae (1-) 1.5-2 (-2.3) cm latae 1-1.5 cm crassae, in circa 1/3 supera liberae; stigmatibus unicus, circa 3 × 1.5 mm, reniformibus, horizontalibus, sessilibus; pileo late pyramidalis, circa 5 mm alto, dimidium superum partis liberae obtegenti, non vel obscure angulato, dense longitudinaliter striato inter angulos; endocarpio circa 18 mm alto in axe, apice prope basim stigmatis basi ad circa 9 mm supra basim drupae, parte supra loculum semi-*

*nalem rotundate pyramidali, cava, ± uniformiter crassa; loculo seminali ellipsoideo, circa 9 × 5 mm, apice ad circa 6 mm infra basim stigmati basi prope medium; mesocarpio supero subnullo in apice sed perspicuo in partibus lateralibus, copiose medullosa fibrosoque; mesocarpio infero medullosa, copiose fibroso.* – Fig. 31-34 and 55.

**Typus:** *Dorr 3488* (with *Barnett, Rakotozafy & Rajemisa*) (holo MO!); Madagascar, province of Majunga, ca. 16 km North West of Ambohitsaratelo-Bebao (North West of Tsiroanomandidy), alt. ca. 1100 m, 11 January 1985; in forest, common in this valley; tree 4-6 m tall with spines on trunk and proproots, fruit dark green, solitary, drupes with a single large style.

*Other material:* *Dorr 3475* (with *Barnett, Rakotozafy & Rajemisa*) (MO!); Madagascar, province of Majunga, ca. 16 km North West of Ambohitsaratelo-Bebao (North West of Tsiroanomandidy), alt. ca. 1100 m, 11 January 1985; in forest, common in this valley; tree 4-6 m tall with spines on trunk and proproots, fruit dark green, solitary, drupes with a single large style.

It was deduced from Dr. L. J. Dorr's collecting itinerary that both *Dorr 3488* and *3475* were collected at about 18°16'S 45°30'E.

*P. majungensis* is apparently the only species in sect. *Souleyetia* which has a monosyncarpic infructescence and leaves with armed pleats. In the other species that have these infructescences, the leaves were to date known as having unarmed pleats.

Apparently there are no species very closely related to *P. majungensis*. This may be compared with *P. longipes*, a species also found in the western part of Madagascar but much further north, near Maromandia (about 14°12'S 48°05'E). They are similar in that they have globose/subglobose syncarps and leaves gradually attenuate in the apical part. This latter species differs essentially from *P. majungensis* in that: its drupes are 12 mm long and 7-8 mm wide, and free by 2/3; its syncarp is 3.5 cm long; its leaves are about 70 cm long.

#### 8. *Pandanus isalicus* Huynh, **spec. nova** (sect. *Souleyetia*)

*Arbor 15-20 m alta, radicibus gralliformibus suffulta. Folia infra infructescentiam circa 95 cm longa 2.2 cm lata in medio 2.6-2.8 cm supra vaginam, e circa 1/3 supera ad apicem sensim attenuata, 8 cm vel plus caudata/subflagellata, prope vaginam leviter dilatata, in basi amplexicaulia; lamina in sicco coriacea, revoluta praecipue in parte media; plicis inermibus, pro parte maxima canaliculatis; venis longitudinalibus utrinque distinctis, transversalibus invisibilibus; denticulis marginalibus e circa 8 cm supra basim ad apicem praesentibus, antrorsis, raro retrorsis, inferis obliquis divergentibus ad 2-3 mm longis 5-9 mm inter se separatis, superis parallelis vel applicatis brevioribus creberrimis; denticulis costalibus e 18-20 cm supra basim ad apicem praesentibus, ad circa 8 cm supra basim interdum cum 1-3 abortivis, brevioribus sed ± tam separatis quam marginalibus proximis; vagina circa 8 cm longa 6 cm lata, laevi subnitidaque prope costam mediam sed longitudinaliter nervata prope margines in pagina abaxiali, superne laevi subnitidaque sed inferne longitudinaliter nervata in adaxiali. Infructescentia monosyncarpica; pedunculo circa 26 cm longo, 12 mm crasso in apice deorsum versus attenuato, trigono, in tertia supera leviter curvato; syncarpio oblongo-ovoideo, circa 8 cm longo 4.3 cm lato, 600-700 drupis praedito. Drupae 15-17 mm longae 5 mm latae 4 mm crassae, plerumque in 1/4 supera liberae, latissimae crassissimae in apice syncarpium; stigmatibus unicus, interdum 2, circa 1-1.5 × 1 mm, reniformibus, horizontalibus, sessilibus; pileo circa 4 mm alto, pyramidali vel anguste pyramidali, prominente angulato, profunde valleculato inter angulos; endocarpio circa 11 mm alto in axe, apice ad 2-3 mm infra basim stigmati, basi prope basim drupae, parte supra loculum seminalem circa 5 mm alta, deltoidea, solida; loculo seminali oblongo-ellipsoideo, circa 7 × 2 mm, apice ad medium, centro prope 1/4 inferam; mesocarpio supero ± distincto in partibus lateralibus apiceque, parce medullosa, uno strato fibrarum verticalium crassissimarum (0.6-0.7 mm) usque ad basim extensarum praedito; mesocarpio infero parce medullosa fibrosoque.* – Fig. 27-30 and 51.

**Typus:** *Bernardi 11280-bis* (holo P!, iso G!); Madagascar, Isalo Mts, alt. 900 m, 7 November 1967; "in altis sabulosis planisque Isalo, a rupibus ruiniformibus circumdatis".

*Other material: Bernardi 11280* (G! P!); Madagascar, Isalo Mts, alt. 900 m, 7 November 1967; “in altis sabulosis planisque Isalo, a rupibus ruiniformibus circumdatis”; tree 15-20 m tall, with proproots (this is a staminate plant of *Bernardi 11280-bis*). *Humbert 11703* (P!); Madagascar, Vohipolaka Mt, north of Betroka, alt. 1300 m, November 1933; brooklet; tree 4-6 m tall (pistillate and staminate plants).

Isalo Mts has its central position at about 22°49'S 45°13'E. Betroka (locality) is at about 23°16'S 46°06'E.

On *Bernardi 11280*, the staminate inflorescence is about 27 cm long, and bears about 12 spikes up to 7.5 cm long and 1.4-1.5 cm wide. The staminate flowers comprise 5-7 stamens arranged umbellately or subumbellately at the apex of a column about 4-5 mm long; the filaments are 1-1.5 mm long; the anthers are about 1.5 mm long and shortly mucronate. The peduncle is about 15 cm long and 1 cm thick at apex, from which it narrows to the base where it is about 2.5 mm thick; it is slightly curved in the middle, and bears a bract in the middle. This is the basal bract. It is about 60 cm long; the vagina is about 10 cm long and 5 cm wide; the margins and midrib are armed from about 9 cm above the base to the apex. The subsequently upper bract, the intermediate bract, is close to the basal spike; it is about 45 cm long; the vagina is about 9 cm long and 5 cm wide; the margins and midrib are armed from about 8 cm above the base to the apex. On both bracts, the prickles are all antrorse and entirely white or whitish (by contrast, the prickles on the leaves of the pistillate plants are dark brown at tip). For the floral bracts, the lower are 11-20 cm long, with cauda 2-10 cm long, the upper are boat-shaped, up to 9 cm long, and with a short acumen.

Apparently there are no species very closely related to *P. isalicus*. This appears unusual in sect. *Souleyetia* in that it has a syncarp with very numerous drupes (600-700), and a seed locule located in the lower half of the drupe (Fig. 30). With regard to the second feature, *P. isalicus* may be compared with *P. tolanarensis* (Fig. 46), a species found at about 24°58'S 46°58'E, near Tôlanaro. This latter species differs essentially from *P. isalicus* in that: its syncarps are globose (Fig. 59) and have about 80 drupes; its pileus occupies more than one half of the drupes; in particular its infructescence is polysyncarpic (Fig. 59) and its leaves are abruptly attenuate in the apical part (Fig. 44).

### 9. *Pandanus ambohitantelensis* Huynh, spec. nova (sect. *Souleyetia*)

*Arbor circa 4 m alta. Folia infra infructescentiam circa 60 cm longa 1.4-1.7 cm lata in medio, e tertia infera ad apicem sensim attenuata, circa 3 cm caudata, medio vaginam versus leviter attenuata, in basi amplexicaulia; lamina in sicco submembranacea, valde revoluta in tertia infera, utrinque partim tessellata; plicis inermibus, in parte supera visibilibus; venis longitudinalibus distinctis in pagina abaxiali, minus in adaxiali; venis transversalibus visibilibus in partibus tessellatis; denticulis marginalibus e 3.5-4 cm supra basim ad apicem praesentibus, antrorsis, ad 3-4 cm inter se separatis, in tertia infera ad 4-5 mm longis sursum versus multo brevioribus; denticulis costalibus praesentibus in tertia supera, circa 2-plo brevioribus et plerumque minus separatis quam marginalibus proximis; vagina 3-3.5 cm longa 2.5 cm lata, partis basalis laminae simili in aspectu, utrinque omnino longitudinaliter nervata non nitida non alveolata. Infructescentia monosyncarpica; syncarpio ovoideo, circa 8 cm longo 5.5 cm lato, circa 40 drupis praedito; pedunculo circa 7.5 cm longo 7 mm crasso in apice deorsum versus attenuato, recto, trigono, dense longitudinaliter nervato. Drupae circa 2.7 cm longae 1.7 cm latae 1.5 cm crassae, in 1/2 supera liberae; stigmatibus unicus, circa 4 × 3 mm, reniformibus, horizontalibus, subsessilibus; pileo 1.3-1.4 cm alto, pyramidalis vel late pyramidalis, obscure vel leviter angulato, dense longitudinaliter striato inter angulos; endocarpio circa 20 mm alto in axe, apice ad 1.5 mm infra basim stigmatis basi ad 5-6 mm supra basim drupae, parte supra loculum seminalem circa 5 mm alta, subdeltoidea, solida; loculo seminali ellipsoideo, circa 11 × 5 mm, apice ad circa 7 mm infra basim stigmatis basi 8-9 mm supra basim drupae, centro mediano; mesocarpio supero subnullo in apice sed perspicuo in partibus lateralibus, fibroso, copiose medullosa; mesocarpio infero medullosa, copiose fibroso. — Fig. 35-38 and 58.*

**Typus:** *Schatz, Razafimandimbison, Malcomber & Rakotomalala 3577* (holo MO!, iso P!); Madagascar, Special Reserve Ambohitantely, 18°10'42"S 47°17'00"E, alt. 1530 m, 23-24 November 1993; much branched small tree to 4 m tall, leaves dark green, fruit medium green.

*Other material:* *Schatz, Razafimandimbison, Malcomber & Rakotomalala 3578* (MO! P!); Madagascar, Special Reserve Ambohitantely, 18°10'42"S 47°17'00"E, alt. 1530 m, 23-24 November 1993; much branched small tree to 4 m tall, leaves dark green, bracts white, stamens white.

The staminate plant of *P. ambohitantelensis* (*Schatz, Razafimandimbison, Malcomber & Rakotomalala 3578*) shows leaves up to 30-32 cm long and 0.8-1 cm wide in the middle, thus narrower and shorter than those of the pistillate plant (*Schatz, Razafimandimbison, Malcomber & Rakotomalala 3577*). The inflorescence is about 7 cm long and sustained by a peduncle about 6 cm long. It comprises 8-10 staminate spikes 2-3 cm long and 1-1.5 cm wide, each of which is borne by a bract. The lowermost bract preserved is at about 1 cm below the basal spike; it is about 18 cm long; the vagina is about 3 cm long and 2 cm wide; the lamina is leaf-like, narrowly ensiform, subulate; the margins and midrib are armed from about 4 cm above the base to the apex; the marginal prickles are longer than the costal prickles. The bract of the basal spike is about 15 cm long; the vagina is about 2 cm long and 1.4 cm wide; the lamina is leaf-like, narrowly ensiform, subulate. The bract of the subsequently upper spike is about 12 cm long; the vagina is about 2 cm long and 1.2 cm wide; the lamina is leaf-like, narrowly ensiform, subulate. The bract of the subsequently upper spike is about 5 cm long 1.4 cm wide, boat-shaped, caudate along 1.5 cm. The bracts of the uppermost spikes are 2-3 cm long and boat-shaped, with margins and midribs minutely armed. The stamens are shortly mucronate, and arranged umbellately or subumbellately on the columns as also observed in the other species of the section whose staminate flowers had been observed.

*P. ambohitantelensis* appears unusual in sect. *Souleyetia* in that the marginal prickles of its leaves are generally remote (to 4 cm apart) and stout (to 4-5 mm long) (Fig. 35 and 36). Apparently there are no species very closely related to *P. ambohitantelensis*. This may be compared with *P. dyckioides*, close in distribution (Fig. 1). This latter species differs essentially from *P. ambohitantelensis* in that: its leaves are 40-60 cm long and 7-9 mm wide; its drupe is free by about 1/3, and the endocarp extends down to about the lower 1/3, as seen in *Dorr 3717* (MO!), a plant of *P. dyckioides* collected on 8 February 1985 at about 18°55'S 47°56'E.

#### 10. *Pandanus cuneatus* Huynh, **spec. nova** (sect. *Souleyetia*)

*Arbor circa 7 m alta, radicibus gralliformibus suffulta. Folia infra infructescentiam 80-85 cm longa 1-1.4 cm lata in medio, e tertia supera ad apicem sensim attenuata, prope vaginam perleviter dilatata, in basi amplexicaulia; lamina in sicco coriacea, utrinque brunneola atroviridula et tessellata in parte infera, striata inter venas longitudinales in pagina adaxiali; plicis armatis in 20-22 cm, in parte supera distinctis, ad 4-5 cm infra apicem convergentibus, superne sese appositis; venis longitudinalibus visibilibus sed non prominentibus in pagina abaxiali minus vel invisibilibus in adaxiali; venis transversalibus visibilibus in partibus tessellatis; denticulis marginalibus e 6-7 cm supra basim ad apicem praesentibus, antrorsis, inferne 0.5-0.8 mm longis et 5-8 mm inter se separatis, sursum versus paulo brevioribus creberrimis; denticulis costalibus praesentibus in 1/4-1/2 supera, brevioribus sed tam separatis quam marginalibus proximis; vagina 6-7 cm longa 3 cm lata, utrinque non nitida, omnino longitudinaliter nervata (nervis acutis in 1/4 infera caeterum leviter visibilibus) in pagina abaxiali, longitudinaliter nervata in 1/4 infera caeterum dense alveolata in adaxiali. Infructescentia 3 syncarpiis praedita; rhachidi inter syncarpium summum et infimum circa 2 cm longa ± recta; syncarpiis globosis, circa 4 cm diametentibus, circa 50 drupis praeditis, sessilibus; pedunculo circa 15 cm longo, 7-8 mm crasso in apice deorsum versus attenuato, recto, trigono, dense longitudinaliter nervato, leviter acuto in angulis. Drupae lageniformes, 17-18 mm longae 9-11 mm latae 8-9 mm crassae, in 1/2 supera liberae; stigmatibus unicis, raro 2, circa 2 × 1.3 mm, reniformibus, horizontalibus, sessilibus; pileo pyramidalis, circa 8 mm alto, acute alato in angulis, generaliter sulcato/valleculato inter*

*angulos; parte connata cuneata; endocarpio circa 12 mm alto in axe, apice prope basim stigmati bisi ad 5 mm supra basim drupae, parte supra loculum seminale circa 4 mm alta, spiniformi, solida; loculo seminali ellipsoideo, circa 7 × 3 mm, apice ad circa 5 mm infra basim stigmati bisi circa 6 mm supra basim drupae, centro mediano; mesocarpio supero subnullo in apice sed distincto in partibus lateralibus, medullosa fibrosoque; mesocarpio infero fibroso. – Fig. 39-42 and 53.*

**Typus:** *Nicoll 131* (holo MO!); Madagascar, Ranomafana, 50 km East of Fianarantsoa on Mananjary road, across R. Namorona from Ambatolahy, 21°45'S 47°28'E, alt. 950 m, 4 November 1986; mid-altitude hill forest with *Weinmannia*, *Tambourissa*, *Psidium* invasion, canopy 15-20 m; stilt-rooted screw pine about 7 m tall with slender trunk, 10 cm in diameter at base, branching in spiral pattern, fruits dark green.

*Other material:* *Beverley Lewis 848* (= with *Raharimalala*, *Rahajaso*, *Randriambololona* & *McDonagh*) (MO! P!); Madagascar, Andringitra, ca 43 km South of Ambalavao, Andringitra Reserve, junction of the Sahanivoraky and Sahavatoy Rivers, 22°13'40"S 47°00'13"E, alt. 810 m, 22-29 November 1993; tree to 2 m high, in riverine forest, fruits green.

*P. cuneatus* is named in reference to the connate part of its drupes (Fig. 41). Its closest relationship appears to be with *P. leptopodus*, from Ambatovolo (about 18°53'S 48°34'E) and Analamazaotra (about 18°56'S 48°25'E). Actually, they are similar in that they have leaves gradually attenuate in the apical part and pilei with concave faces, besides polysyncarpic infructescences. This latter species differs essentially from *P. cuneatus* in that: its drupes are to 18 × 6 mm, thus of the same length but only about half as wide; its upper mesocarp is almost nil at apex, and in particular nil laterally (MARTELLI & PICHI-SERMOLLI, 1951: 72, Fig. 11-e) which is a rare feature and was corroborated by several recent collections of *P. leptopodus*, for example *McPherson & Van der Werff 16556* (MO!), *Malcomber 1044* (MO! P!), *Schatz & Seigler 1410* (MO! P!).

Another close relative is *P. neoleptopodus*, from Tampina (about 18°31'S 49°17'E), on the East coasts. They are similar in that they have polysyncarpic infructescences, leaves gradually attenuate in the apical part, and drupes with the upper mesocarp distinct laterally. This latter species differs essentially from *P. cuneatus* in that: its drupes are to 18 × 6 mm, thus of the same length but only about half as wide; its pileus is formed of convex faces; its endocarp apex is remote from the stigma base given that its upper mesocarp is distinct at the apex (MARTELLI & PICHI-SERMOLLI, 1951: 78, Fig. 11-l); in particular its leaves are 115-130 cm long and 2.5-2.8 cm wide.

### 11. *Pandanus tolanarensis* Huynh, *spec. nova* (sect. *Souleyetia*)

*Arbor 3-4 m alta. Folia infra infructescentiam 60-65 cm longa 2.5-3 cm lata in medio 2.2-2.4 cm supra vaginam, superne abrupte attenuata, subcuspidata, circa 4 cm caudata, in basi amplexicaulia; lamina in sicco subcoriacea, viridula vel brunnea/atroviridula, utrinque fere omnino tessellata; plicis inermibus, e basi laminae ad basim caudae visibilibus, canaliculatis in dimidio infero; venis longitudinalibus distinctis in pagina abaxiali minus vel invisibilibus in adaxiali; venis transversalibus utrinque visibilibus; denticulis marginalibus e 4-5 cm supra basim ad apicem praesentibus, antrorsis sed inferne interdum perpendicularibus vel leviter retrorsis, in parte basali ad 2.5 mm longis 1.2 cm inter se separatis, sursum versus abrupte brevioribus/minutis creberrimis; denticulis costalibus generaliter praesentibus in parte supera tantum, plerumque leviter magis separatis quam marginalibus proximis, inferne generaliter brevioribus superne ± aequilongis; vagina 4-5 cm longa 3.5 cm lata, utrinque non nitida, in pagina abaxiali inferne longitudinaliter nervata superne tessellata, in adaxiali fere omnino leviter alveolata. Infructescentia 4 syncarpiis praedita; rhachidi inter syncarpium summum et infimum circa 2 cm longa ± recta; syncarpiis globosis, ad 4 cm diametentibus, circa 80 drupis praeditis, sessilibus; pedunculo circa 15 cm longo, 1 cm crasso in apice deorsum versus attenuato, recto, acute trigono, multisulcato inter angulos. Drupae 19-20 mm longae 8 mm latae 5 mm crassae, parte libera leviter longiore quam connata; stigmatibus unicis, interdum 2, parvis, reniformibus,*

*horizontalibus, sessilibus; pileo anguste pyramidali, saepe leviter curvato in apice, acute angulato, leviter concavo inter angulos, superne punctulato pustuliusculo; endocarpio circa 13 mm alto in axe, apice prope basim stigmati basi ad 2-3 mm supra basim drupae, parte supra loculum seminale circa 5 mm alta, deltoidea, solida; loculo seminali ellipsoideo, 10 × 4-5 mm, apice ad circa 6-7 mm infra basim stigmati basi circa 1-2 mm supra basim drupae, centro perspicue inframediano; mesocarpio supero subnullo, meduloso in apice, fibroso in partibus lateralibus; mesocarpio infero fibroso. – Fig. 43-46 and 59.*

**Typus:** *McPherson, Dumetz & Rabevohitra 14888* (holo MO!, iso P!); Madagascar, Fort Dauphin (Tôlanaro) Region, North of town along trail following pipes back to town's water source, 24°58'S 46°58'E, alt. 100-200 m, 25 January 1990; forest called Lakandava; tree 3.5 m tall, branching layered, fruit green.

*Other material:* *Service forestier 26474 SF* (P!); Madagascar: Marosiky (near Imonty), 18 February 1967; vernacular name Fandra (Antanosy lang.). Imonty (locality) is at about 24°49'S 46°42'E.

Whitish and slightly prominent dots are observed on the upper part of the pileus of *P. tolanarensis*. When observed under the microscope, the epicarp of the pileus showed numerous stomates in the upper part, but none in the lower part; each stomate was at the centre of a small and slightly prominent pustule. This seems to be a characteristic of *P. tolanarensis*, and also of *P. tubulatus* (see below).

On the infructescence of *McPherson, Dumetz & Rabevohitra 14888*, the first bract from the apex of the peduncle is at about 2.5 cm below the basal syncarp, and is separated from this by three nodes; it is leaf-like, and about 13 cm long and 2.6 cm wide at the vagina (this about 2 cm long), above which it narrows to the apex into a cauda about 5 cm long; the margins are armed almost from the base to the apex, the midrib from the base. The second bract, at the subsequent node, is about 2.5 cm below the first bract; it is leaf-like, and about 24.5 cm long and 2 cm wide at the vagina (this about 7 cm long), above which it also narrows to the apex into a cauda about 5 cm long; the margins are armed almost from the base to the apex, the midrib likewise armed, or only in the upper part. The third bract, at the subsequent node, is about 9 cm below the second bract and 1 cm above the base of the peduncle; it is more leaf-like, and about 37 cm long and 2.3 cm wide at the vagina (this about 9 cm long), above which it also narrows to the apex into a cauda about 5 cm long; the margins are armed from about 7 cm above the base to the apex, the midrib from about 11 cm above the base. No floral bracts were preserved.

*P. tolanarensis* and *P. tubulatus* (see below) are the southernmost species of sect. *Souleyetia* which were found in the eastern part of Madagascar (Fig. 1). They are most closely related, but can be distinguished by their drupes and leaves (see under *P. tubulatus*).

## 12. *Pandanus tubulatus* Huynh, **spec. nova** (sect. *Souleyetia*)

*Arbor circa 4 m alta. Folia ab illis P. tolanarensis haud distincta praeter plicas in brevi spatio (circa 2 cm) armatas. Infructescentia 4 syncarpiis praedita; rhachidi inter syncarpium summum et infimum circa 2 cm longa et ± recta; syncarpiis globosis, ad 3.5-4 cm diametentibus, sessilibus, circa 75 drupis praeditis; pedunculo circa 21 cm longo, 1 cm crasso in apice deorsum versus attenuato, recto, trigono, superne subalato, inferne dense longitudinaliter nervato. Drupae circa 17 mm longae 5-6 mm latae 4-5 mm crassae, parte libera leviter longiore quam connata; stigmatibus unicis, interdum 2, parvis, reniformibus, horizontalibus, sessilibus; pileo anguste pyramidali, interdum leviter curvato in apice, acute angulato, leviter concavo inter angulos, superne punctulato pustuliusculo; endocarpio circa 12 mm alto in axe, apice prope basim stigmati basi ad 4 mm supra basim drupae, parte supra loculum seminale circa 2 mm alta, subrotundata, ± uniformiter incrassata; loculo seminali anguste elongato, circa 9 × 2 mm, apice ad circa 3 mm infra basim stigmati basi circa 6 mm supra basim drupae, centro leviter supramediano; mesocarpio supero subnullo, meduloso in apice, fibroso in partibus lateralibus; mesocarpio infero non meduloso, intra non fibroso. – Fig. 47, 48 and 60.*

**Typus:** *Malcomber, Hemingway & Compton 1534* (holo MO!); Madagascar, North West of Tôlanaro (Fort Dauphin), Réserve Intégrale no. XI, Andohahela, parcelle 1, forest bordering Andohahela River, 27°36'S 49°34'E, alt. 200-500 m, 17-19 May 1992; canopy circa 25 m; tree 4 m tall on rocks, leaves dark green, syncarps medium green.

The collecting site of this specimen is certainly not 27°36'S 49°34'E. This point is much further south from Madagascar and on the Indian Ocean, the southernmost point of the island being at about 25°36'S 45°10'E. The Andohahela Reserve has its central position at about 24°44'S 46°44'E.

*P. tubulatus* is named in reference to its narrowly elongated, tubular seed-locule (Fig. 48). It is most closely related to *P. tolanarensis*. Actually, they resemble each other in the aspect of their infructescence, syncarp, and drupe. Also, in both species the upper mesocarp is almost nil. Their leaves are little different, apparently differing only in that the pleats are armed in the first species but not in the second. Furthermore, both are close in distribution, being found from only about 60 km. However, their drupes are very different, considering in particular the height of the endocarpic apical walls of their seed locules, and the position of the centre of these. In *P. tubulatus*: the drupes are 5-6 mm wide; the seed locule is narrowly elongated, and about  $9 \times 2$  mm; the endocarpic apical walls of the seed locule are 2 mm high in axis; the apex of the seed locule is at about 2/10 of the drupe, the base at about 6/10, and the centre a little above the middle (Fig. 47 and 48). In *P. tolanarensis*: the drupes are wider (compare Fig. 45 and 59 with Fig. 47 and 60); the seed locule is ellipsoid, and about  $10 \times 4-5$  mm; the endocarpic apical walls of the seed locule are 5 mm high in axis; the apex of the seed locule is at about 4/10 of the drupe, the base at about 9/10, and the centre at about 7/10 thus clearly below the middle (Fig. 45 and 46). This difference in drupe structure was invariably observed using several drupes for either species. It suggests that *P. tubulatus* would be better given the status of a distinct species, although to some extent it may be considered as a form of *P. tolanarensis*. This is an example of the utility of the drupe structure in distinguishing between close species in *Pandanus*.

Also, by their upper mesocarp almost nil, besides their polysyncarpic infructescences, both *P. tubulatus* and *P. tolanarensis* appear close to *P. leptopodus*. This latter species differs from *P. tubulatus* and *P. tolanarensis* in several characters, in particular its leaves, which are gradually attenuate in the apical part, and 80-110 cm long and 1.5-1.8 cm wide.

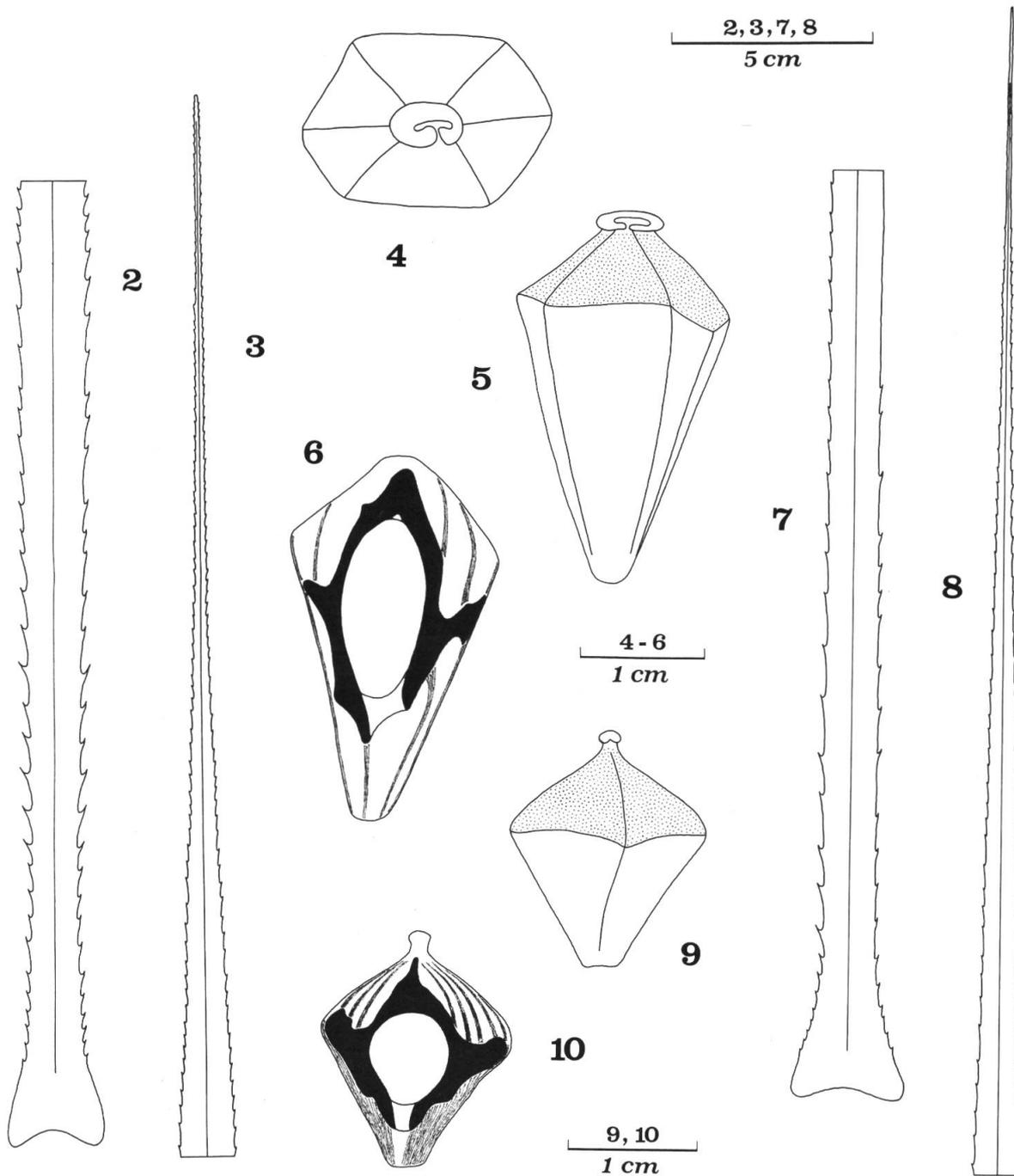


Fig. 2-10. – *Pandanus latistigmaticus* (2-6: Phillipson 1974, holotype), and *P. flagellibracteatus* (7-10: Cremers 3507, holotype): – 2, 7: Lower part of leaves flattened horizontally, viewed by the adaxial face. 3, 8: Upper part of leaves flattened horizontally, viewed by the adaxial face. 4: Drupe in apical view. 5, 9: Drupes in lateral view (dotted: pileus and free part). 6, 10: Drupes in axial section (black: endocarp).

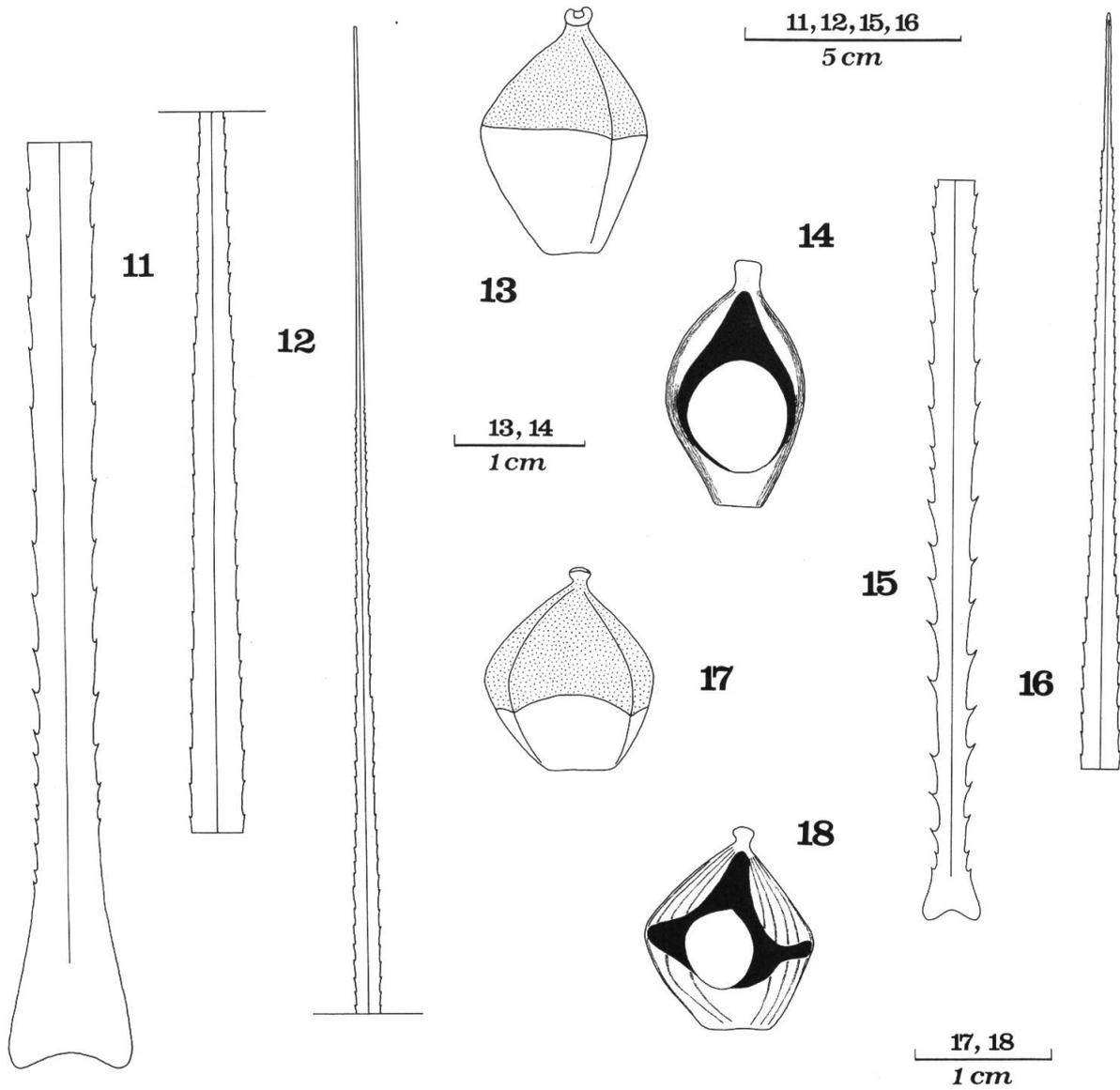


Fig. 11-18. – *Pandanus arenicola* (11-14: Dorr 4173, holotype), and *P. membranaceus* (15-18: Villiers *et al.* 4833, holotype): – **11, 15**: Lower part of leaves flattened horizontally, viewed by the adaxial face. **12, 16**: Upper part of leaves flattened horizontally, viewed by the adaxial face. **13, 17**: Drupes in lateral view (dotted: pileus and free part). **14, 18**: Drupes in axial section (black: endocarp).

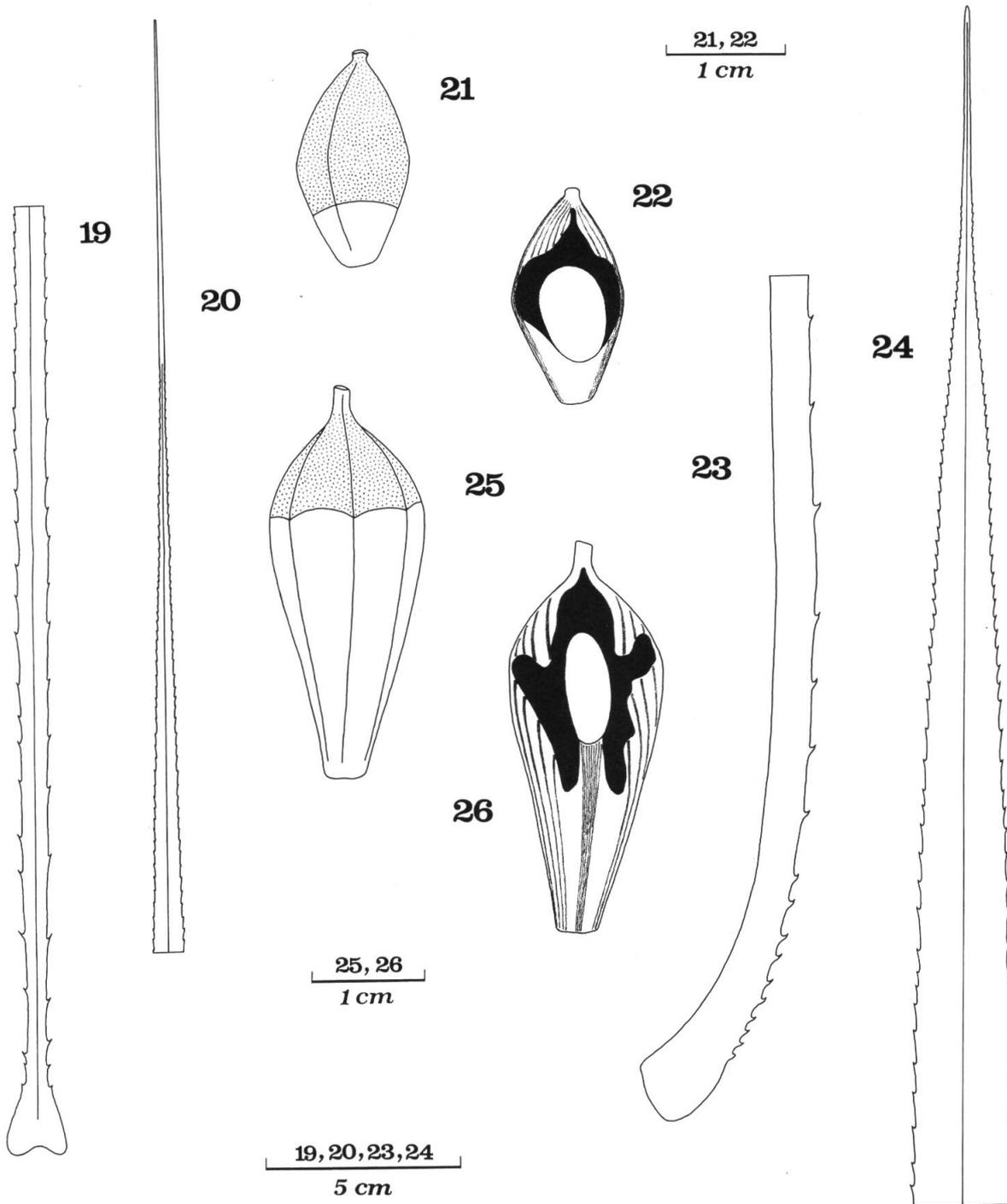


Fig. 19-26. – *Pandanus bemarahensis* (19-22: *Cremers 3799-bis*, holotype), and *P. manongarivensis* (23-26: *Gautier & Chatelain LG. 2648*, holotype): – 19: Lower part of leaf flattened horizontally, viewed by the adaxial face. 20, 24: Upper part of leaves flattened horizontally, viewed by the adaxial face. 21, 25: Drupes in lateral view (dotted: pileus and free part). 22, 26: Drupes in axial section (black: endocarp). 23: Lower part of leaf folded along midnerve which is on left.

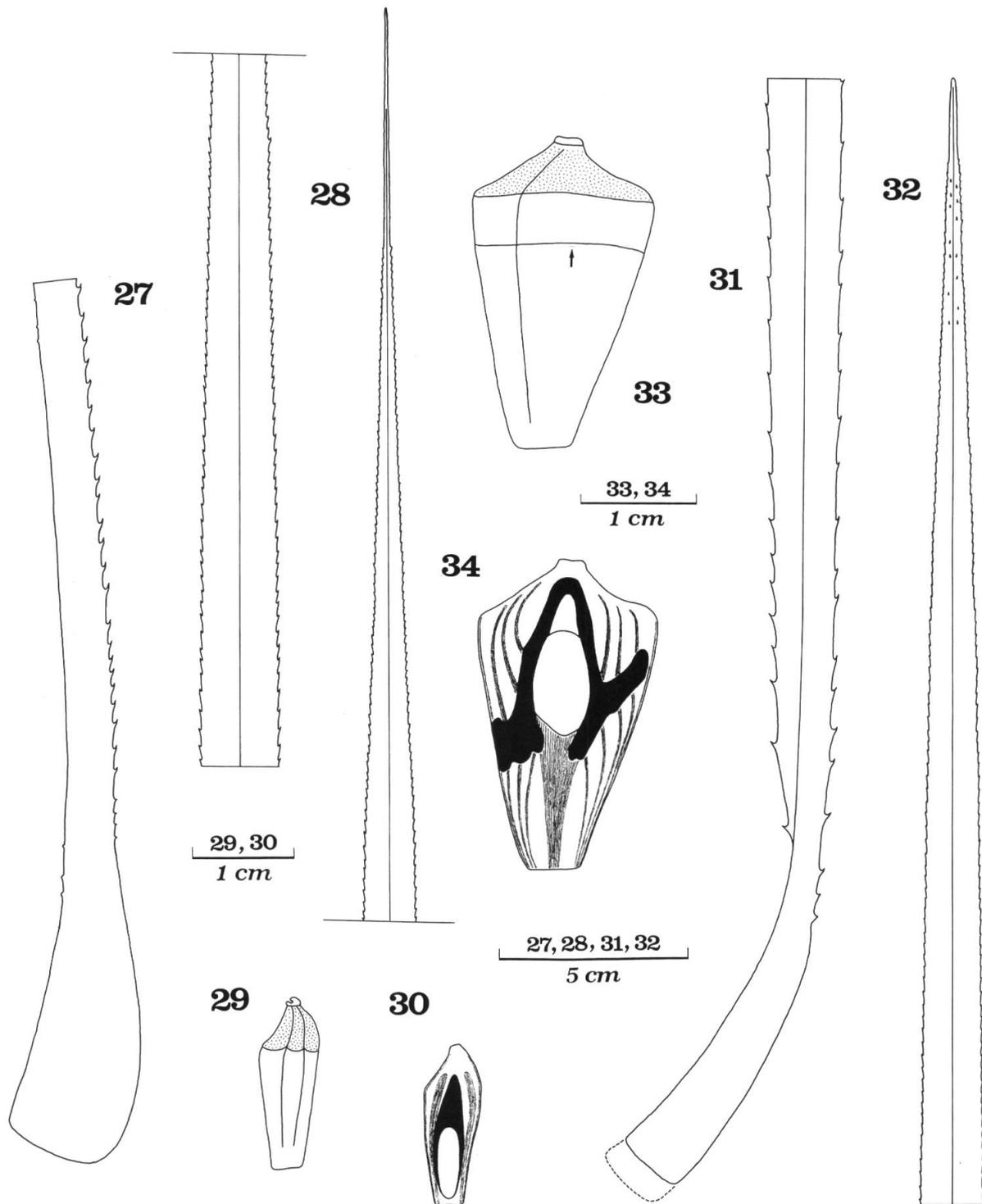


Fig. 27-34. – *Pandanus isalicus* (27-30: *Bernardi 11280-bis*, holotype), and *P. majungensis* (31-34: *Dorr 3488*, holotype):  
 – 27: Lower part of leaf, folded along midnerve which is on left. 28, 32: Upper part of leaves flattened horizontally, viewed by the adaxial face. 29: Drupe in lateral view (dotted: pileus and free part). 30, 34: Drupes in axial section (black: endocarp). 31: Lower part of leaf, the supravaginal part flattened horizontally viewed by the abaxial face, the vaginal part folded along midnerve which is on left. 33: Drupe in lateral view (dotted: pileus; arrowed: lower limit of free part).

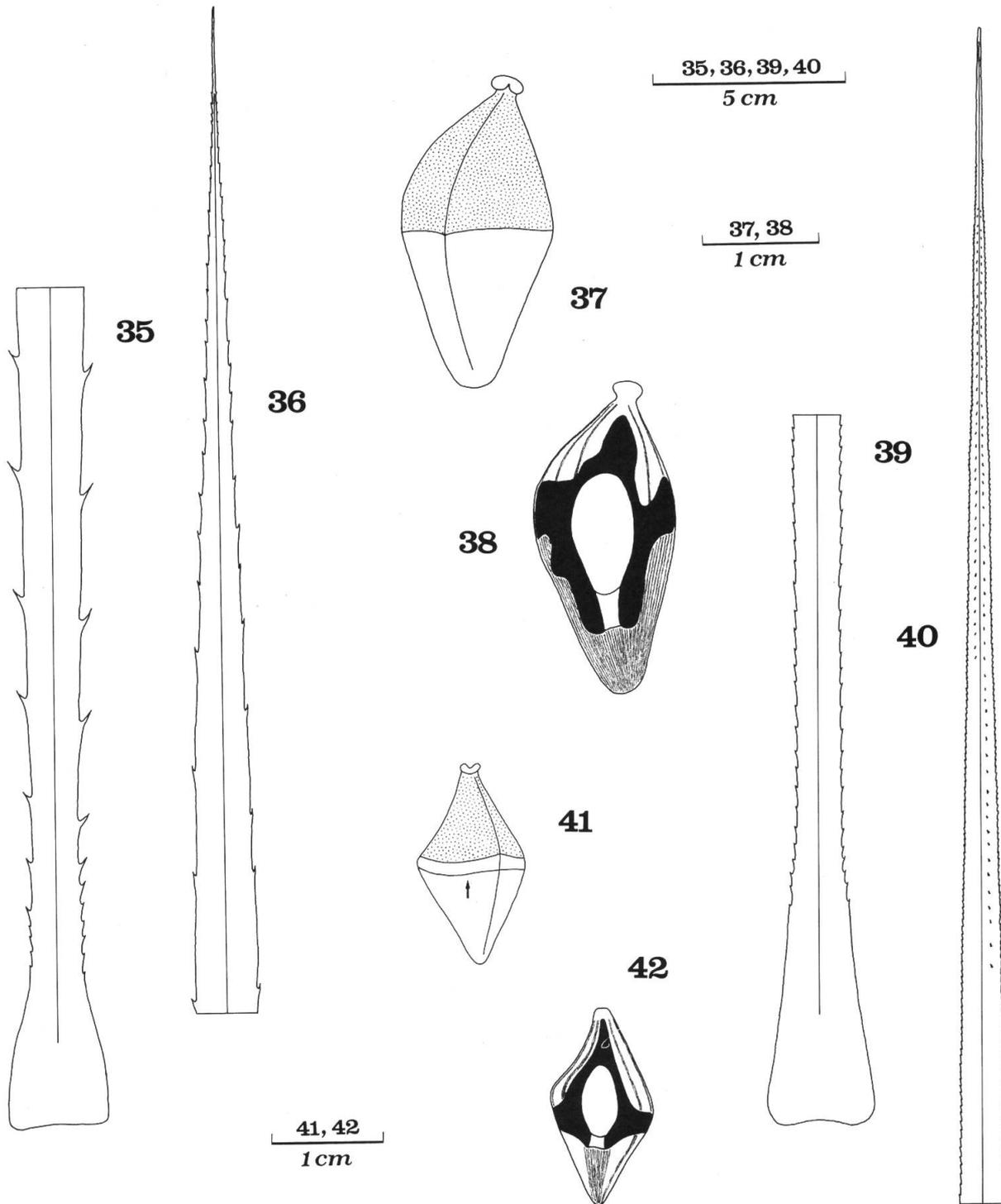


Fig. 35-42. – *Pandanus ambohitantelensis* (35-38: Schatz et al. 3577, holotype), and *P. cuneatus* (39-42: Nicoll 131, holotype): – 35, 39: Lower part of leaves flattened horizontally, viewed by the adaxial face. 36, 40: Upper part of leaves flattened horizontally, viewed by the adaxial face. 37: Drupe in lateral view (dotted: pileus and free part). 38, 42: Drupes in axial section (black: endocarp). 41: Drupe in lateral view (dotted: pileus; arrowed: lower limit of free part).

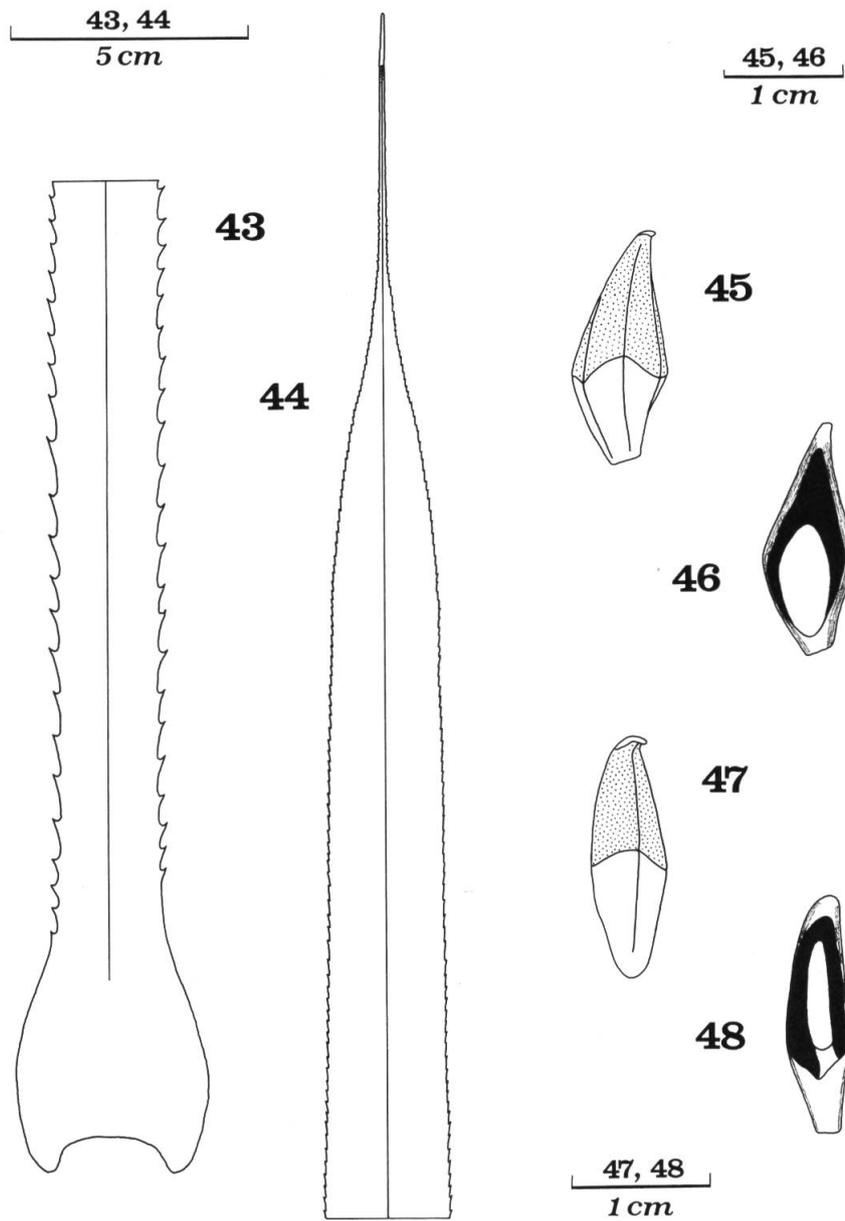


Fig. 43-48. – *Pandanus tolanarensis* (43-46: *McPherson et al. 14888*, holotype), and *P. tubulatus* (47, 48: *Malcomber et al. 1534*, holotype): – 43, 44: Lower and upper part of leaf flattened horizontally, viewed by the adaxial face. 45, 47: Drupes in lateral view (dotted: pileus and free part). 46, 48: Drupes in axial section (black: endocarp).

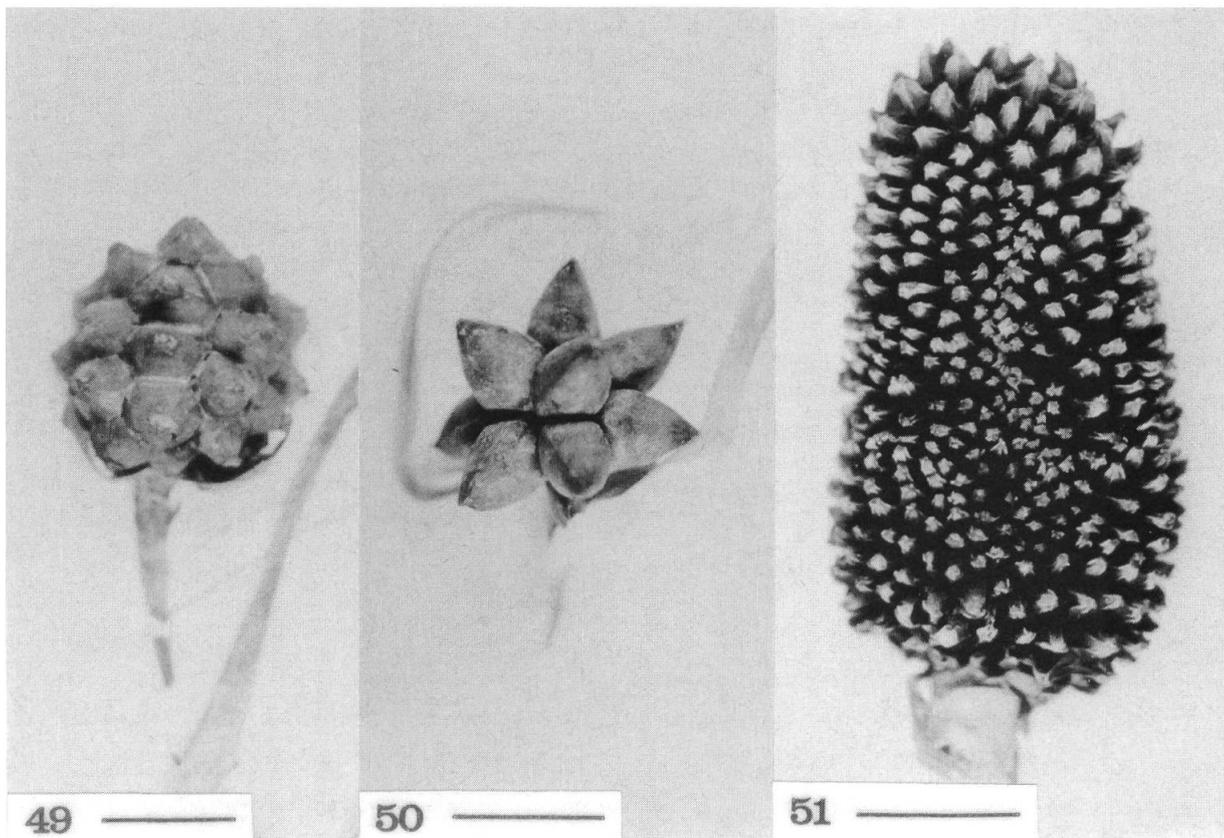


Fig. 49-51. – Inflorescences of *Pandanus* sect. *Souleyetia*: – **49**: *P. latistigmaticus* (Phillipson 1974, holotype); scale bar = 3 cm. **50**: *P. bemarahensis* (Cremers 3799-bis, holotype); scale bar = 2 cm. **51**: *P. isalicus* (Bernardi 11280-bis, holotype); scale bar = 2 cm.

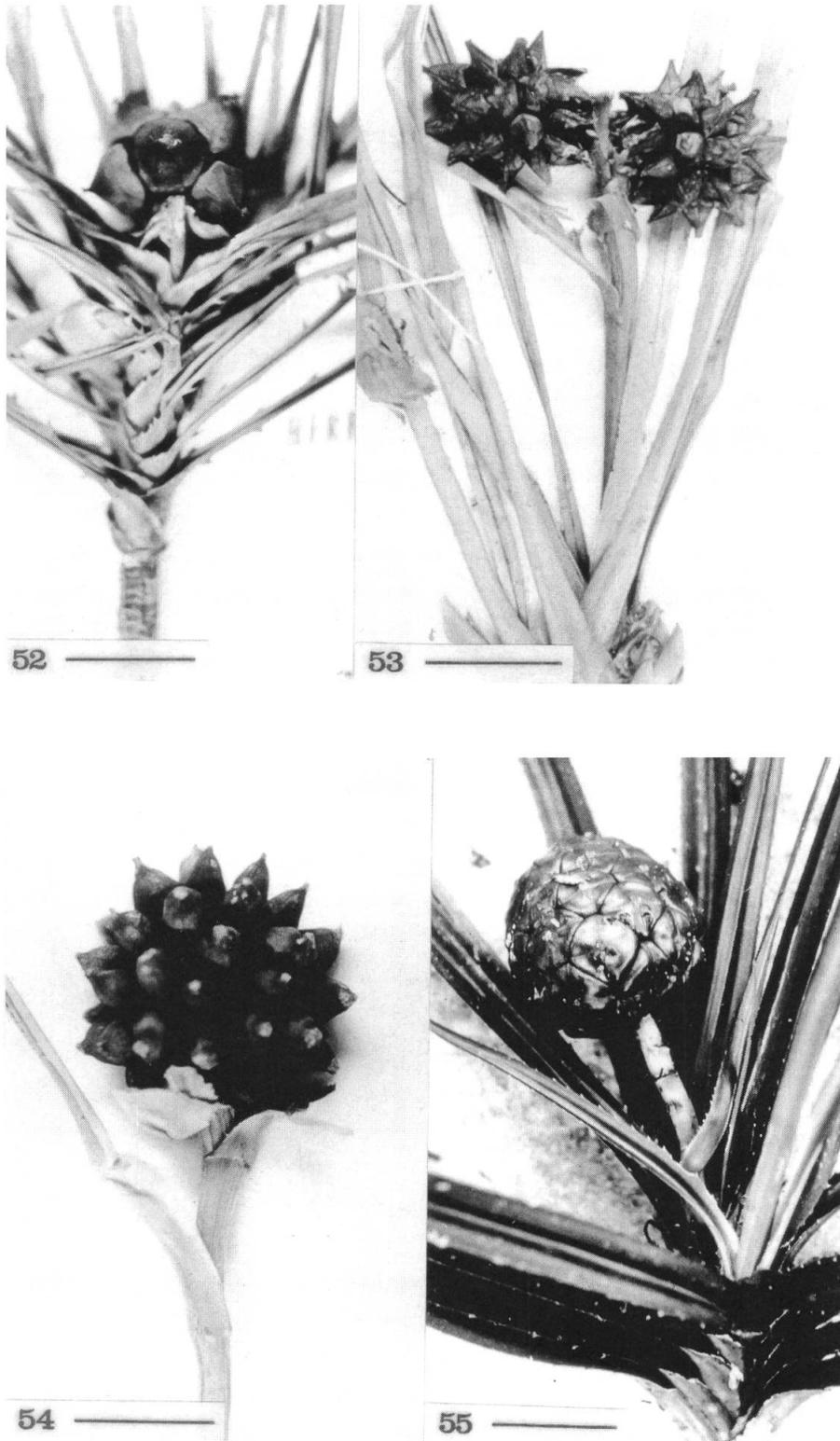


Fig. 52-53. – Infructescences of *Pandanus* sect. *Souleyetia*: – **52**: *P. membranaceus* (Villiers *et al.* 4833, holotype); scale bar = 2 cm. **53**: *P. cuneatus* (Nicoll 131, holotype); scale bar = 3 cm.

Fig. 54-55. – Infructescences of *Pandanus* sect. *Souleyetia*: – **54**: *P. manongarivensis* (Gautier & Chatelain LG 2648, holotype); scale bar = 3 cm. **55**: *P. majungensis* (Dorr 3475 or 3488) (photo in situ L. J. Dorr); scale bar = 5 cm.

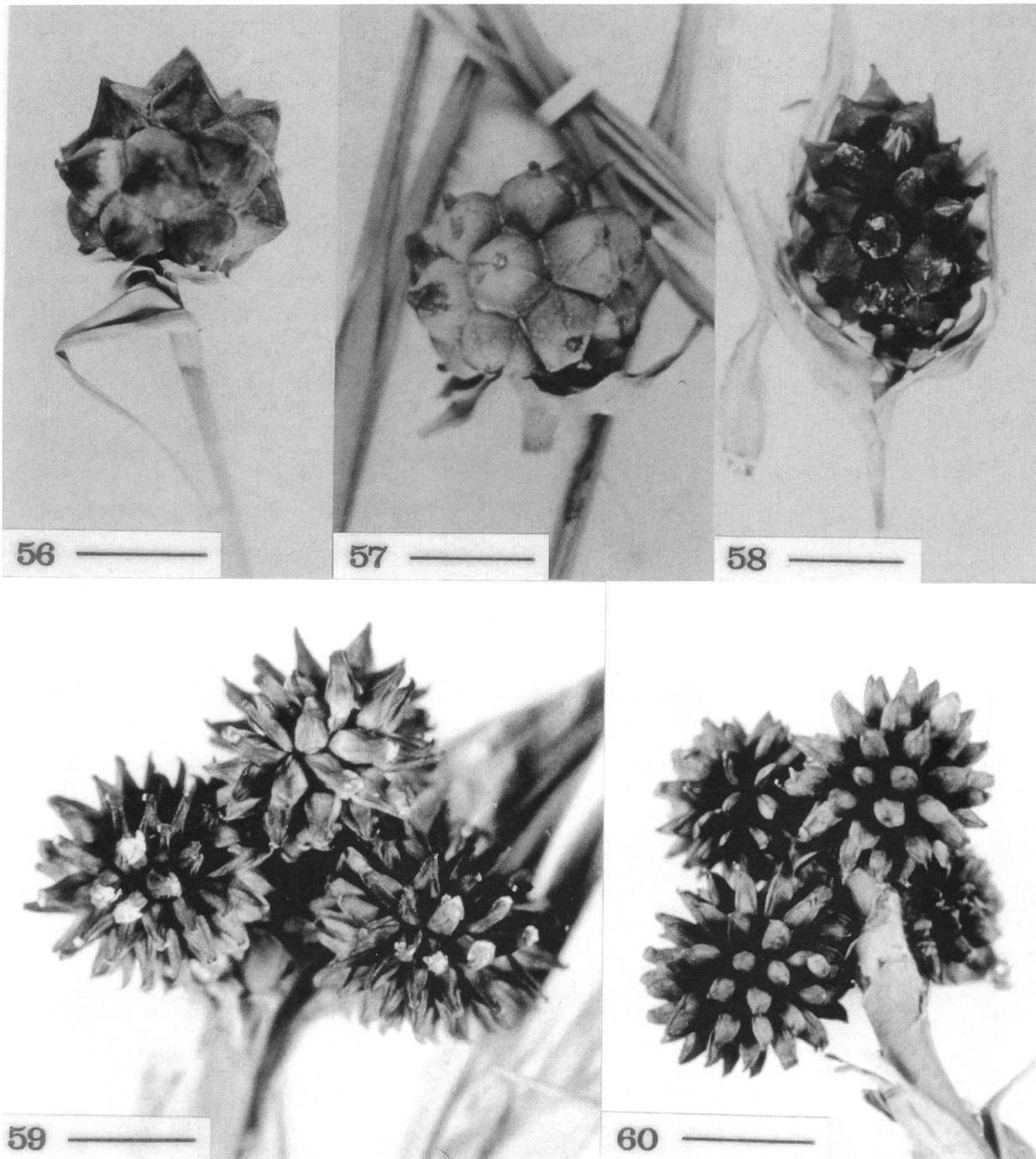


Fig. 56-60. – Inflorescences of *Pandanus* sect. *Souleyetia*: – **56:** *P. flagellibracteatus* (Cremers 3507, holotype); scale bar = 2 cm. **57:** *P. arenicola* (Dorr 4173, holotype); scale bar = 2 cm. **58:** *P. ambohitantelensis* (Schatz et al. 3577, holotype); scale bar = 3 cm. **59:** *P. tolanarensis* (McPherson et al. 14888, holotype); scale bar = 2 cm. **60:** *P. tubulatus* (Malcomber et al. 1534, holotype); scale bar = 2 cm.

## ACKNOWLEDGEMENTS

The author is deeply indebted to the Missouri Botanical Garden, St. Louis (MO!), the Laboratoire de Phanérogamie, Muséum National d'Histoire Naturelle, Paris (P!), and the Conservatoire et Jardin botaniques, Genève (G!), for the loan of materials. Part of the Grant No. 31-45707.95 of the Swiss National Science Foundation was used.

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