

NOTES ON THE GENUS AMORPHOPHALLUS (ARACEAE) – 5¹
AMORPHOPHALLUS KONKANENSIS, A NEW SPECIES FROM INDIA,
AND TAXONOMIC REFLECTIONS ON
AMORPHOPHALLUS SECTION RHAPHIOPHALLUS

W.L.A. HETTERSCHIED², S.R. YADAV³, & K.S. PATIL⁴

SUMMARY

A new species of *Amorphophallus* sect. *Rhaphiophallus* (Schott) Engl. from SW India is described. The monophyly of and character evolution in sect. *Rhaphiophallus* is discussed.

DESCRIPTION

***Amorphophallus konkanensis* Hett., Yadav & Patil, *spec. nov.* — Fig. 1**

Ab *A. mysorensis* Barnes et Fischer in floribus neutris semicomplanatis, placentatione basali, et ab *A. sylvatico* (Roxb.) Kunth in dimensionibus maioribus, spatha fusca, placentatione basali differt. — Typus: K.S. Patil 4687-A (CAL holo), India, Maneri, Sindhudurg District, 15-v-1992. Paratypes: K.S. Patil 4687-B (BLAT), 4687-C (L), both same data as holotype.

Tuberous herb. *Tuber* globose or depressed globose, 3–8 cm in diam., 3–4.5 cm high, producing short, rhizomatous offsets. *Leaf* solitary; petiole smooth, 29–88 cm long, 0.6–1.5 cm in diam., brown or greenish brown, mottled pinkish and with whitish stripes; *lamina* 40–96 cm in diam., rachises winged, except for the most proximal parts; *leaflets* lanceolate, acuminate, 4–19 cm long, 1–4 cm in diam. *Inflorescence* long-peduncled; *peduncle* as petiole, 25–55 cm long, 0.3–1 cm in diam.; spathe erect, ovate, acute, not constricted, limb poorly differentiated from base, 3.3–8.5 cm long, 2.3–7 cm in diam., outside dirty pinkish with a brownish hue and faint brownish spots, veins dark purplish brown, inside maroon, base within dark maroon, longitudinally ridged. *Spadix* stipitate, up to twice as long as spathe, 9.5–16 cm long; *stipe* c. 0.5 cm long, green; *female zone* cylindrical, 0.8–1.7 cm long, flowers congested; *male zone* cylindrical, 1.8–3.1 cm long, flowers slightly distant; staminodial zone between female and male zone 0.6–1.5 cm long, staminodes congested;

- 1) The first three papers in this series were published in, respectively, *Blumea* 36 (1991) 467–475 and 39, the present issue, pages 237–281 and 283–287; No. 4 (by C.I. Peng) will be published in *Bot. Bull. Acad. Sinica*, 1995.
- 2) Chrysanterstraat 28, 1214 BM Hilversum, The Netherlands.
- 3) Department of Botany, Goa University, Taleigao Plateau, P.O. Bambolim Complex, Goa 404 203, India.
- 4) Department of Botany, Shivaji University, Kolhapur 416 004, Maharashtra State, India.

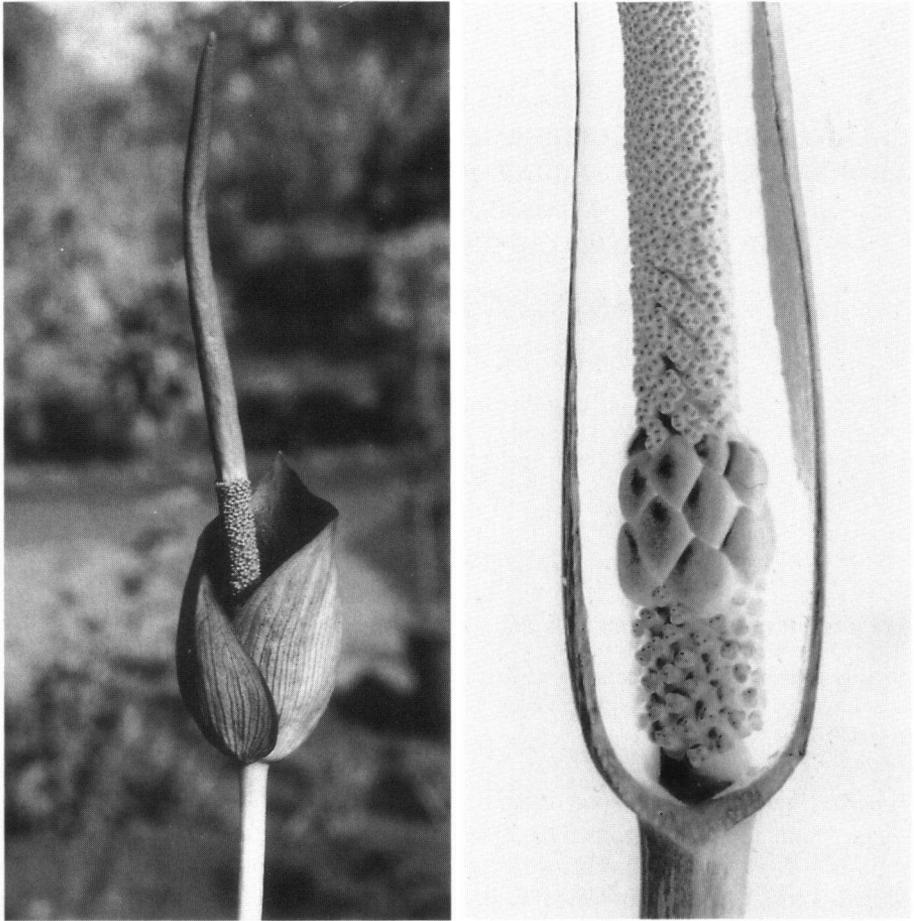


Fig. 1. — a, b: *Amorphophallus konkanensis* Hett., Yadav & Patil; a: inflorescence, c. $\times 0.7$; b: lower half of spadix, c. $\times 1.7$.

appendix elongate conic, apex blunt, 5.5–13 cm long, 0.5–1 cm in diam., dirty olive green. *Ovaries* depressed-globose, diamond-shaped in cross section, 2–3 mm in diam., 0.8–1 mm high, pale green, near the top becoming purplish, 3- or 4-locular, one basal ovule per locule; *style* short, cylindric or conic, 0.2–0.5 mm long, 1 mm in diam. (base), purplish; *stigma* large, subcircular or slightly irregular in cross section, 2 mm in diam., 0.7–1 mm high, verruculate, pale yellow, 3- or 4-lobed, lobes very shallowly conical or rounded, obtuse, separated by shallow grooves. *Male flowers* consisting of 4–6 stamens; *stamens* 1 mm long; *filaments* 0.2–0.3 mm long, entirely connate; *anthers* truncate, 0.7–0.8 mm long, 1–1.5 mm in diam., irregular in cross section, thecae whitish, connective brownish, pores apical, elongate, reniform or straight. *Pollen* psilate. *Staminodes* ovate or rhomboid in cross section,

slightly convex, 3–6 × 2.5–4 mm, 1–3 mm high, whitish or with a faint purplish hue. *Berries* pink at maturity, 2–4-seeded; seeds subglobose, 0.3–0.5 cm long, 0.2–0.35 cm in diam. $2n = 26$.

Etymology – The species epithet refers to the Konkan region in the south-western part of Maharashtra State, where this species is found.

Distribution – India, SW Maharashtra State (Konkan region).

Habitat & Ecology – Common throughout the Konkan forest on laterite soils, near bushes. Fl. April–May; fr. May–June.

NOTES ON MONOPHYLY AND CHARACTER EVOLUTION

Amorphophallus konkanensis is clearly a member of *Amorphophallus* sect. *Rhaphiophallus* (Schott) Engl. (Engler, 1911) (emend. Sivadasan, 1989), possessing the characteristic spathe-shape and staminodes. The general morphology and colour-pattern of *A. konkanensis* are very similar to *A. mysorensis* Barnes & Fischer from the state of Mysore (India), from which it differs markedly in the semi-flattened staminodes (vs. globose in *A. mysorensis*) and the basal placentation (vs. axillary halfway up the length of the locule in *A. mysorensis*). Three other species of sect. *Rhaphiophallus* possess similarly flattened staminodes as in *A. konkanensis*, viz. *A. bonaccordensis* Sivad. & Mohanan, *A. hohenackeri* (Schott) Engl. and *A. sylvaticus* (Roxb.) Kunth, all from southern India. Of these, *A. sylvaticus* has an axile placentation as in *A. mysorensis* and much smaller dimensions, whereas *A. bonaccordensis* and *A. hohenackeri* differ in having much broader leaflets, very long, thin stolons and the spadix equal to or shorter than the spathe.

Section *Rhaphiophallus*, as here understood, contains eight species which are separated as a group by Sivadasan (1989) within *Amorphophallus* on the basis of the large, flattened or globose neuter organs between the male and female zones. However, contrary to Sivadasan's statement that only species of sect. *Rhaphiophallus* possesses such neuter organs, there are three more published species with similar structures not belonging to this section, viz. *A. krausei* Engl. [syn. *A. sutepensis* Gagnep., *A. ximengensis* H. Li, from northern Burma, northern Thailand, China (Yunnan)], *A. saraburiensis* Gagnep. (central Thailand) and *A. albus* P.Y. Liu & J.F.Chen (China, Szechuan). An additional two new species (*A. atroviridis* Hett., Thailand and *A. salmoneus* Hett. [Philippines (Palawan)]), published in the present issue, also share this character. As a consequence, this character cannot be used a priori to distinguish sect. *Rhaphiophallus* from the remainder of *Amorphophallus*, without considering the distribution of this and other characters of the section in other species of the genus (see Table 1 on the next page).

The axile position halfway up the length of the placenta of the ovules in three species of sect. *Rhaphiophallus* is unique in the genus but this does not suffice to support the monophyly of the entire section. The same holds for the globose staminodes, which are also only found in three species of the section. There remains the stipitate spadix, a fairly rare character in the genus. It is also found in a number of Himalayan-Indo-chinese species, e.g. *A. yunnanensis* Engl. (syn. *A. kerrii* Gagnep.) from Thailand,

Table 1. Character distribution in *Amorphophallus* sect. *Rhaphiophallus* compared to *A.* 'group *yunnanensis*' and *A.* 'group *krausei*'.

species	characters:	1	2	3	4	5
<i>A. bonaccordensis</i> Sivad. & Mohanan		a	a	a	a	b
<i>A. hohenackeri</i> (Schott) Engl.		a	a	a	a	b
<i>A. konkanensis</i> Hett., Yadav & Patil		a	a	a	a	b
<i>A. longiconnectivus</i> Bogner		b	?	?	?	b
<i>A. margaritifera</i> (Roxb.) Kunth		b	b	a	a	b
<i>A. mysorensis</i> Barnes & Fischer		a	b	b	a	b
<i>A. nicolsonianus</i> Sivad.		a	b	b	a	b
<i>A. sylvaticus</i> (Roxb.) Kunth		a	a	b	a	b
<i>A.</i> 'group <i>yunnanensis</i> '		a	—	b	b	b
<i>A.</i> 'group <i>krausei</i> '		a	a	a	a	a
Characters: 1a: appendix present		4a: neuter organs present				
b: appendix absent or stub		b: neuter organs absent				
2a: neuter organs flattened		5a: spadix sessile				
b: neuter organs globose		b: spadix stipitate				
3a: placentation basal						
b: placentation axile etc. (see text)						

Laos, China (Yunnan) and N Vietnam, *A. corrugatus* N.E. Brown from northern Burma and northern Thailand, *A. kachinensis* Engl. & Gehrm. (syn. *A. bannaensis* H. Li) from north-east India, northern Burma, northern Thailand, China (Yunnan) and Laos. If this character is an apomorphy, linking these species to sect. *Rhaphiophallus*, the species of the latter section would still come out as a monophyletic group on the basis of the staminodes. All other species with staminodes have sessile spadices, so, even in that frame, sect. *Rhaphiophallus* would probably still separate as a monophyletic group. The spathe-shape of all eight species is also quite rare in the genus and occurs only in species which show no other relevant similarities to species of sect. *Rhaphiophallus* and are therefore considered not to belong to it (e. g. *A. elliottii* N.E. Brown, *A. interruptus* Engl. & Gehrm.). On the basis of these speculations and awaiting a phylogenetic analysis of the entire genus (Hettterscheid, in prep.), it seems fair to consider sect. *Rhaphiophallus* monophyletic. This provides the opportunity to discuss comparatively some characters of its species. The position of *A. longiconnectivus* Bogner (ined.) in sect. *Rhaphiophallus* is uncertain at the moment because of difficulties in interpreting some characters of the only known specimen. Even its status as species in relation to its nearest morphological ally *A. margaritifera* (Roxb.) Kunth is under discussion. A preliminary cladistic analysis of sect. *Rhaphiophallus* using all possible alternative states of some characters of *A. longiconnectivus* and entering it as a separate species, indicate it is the sister species of *A. margaritifera*.

A geographic trend has been suggested (pers. comm. J. Bogner, Munich, Germany) in this section of a reduction of the appendix in species going from South to North India but this trend is broken by the occurrence of *A. konkanensis* north of the distribution of *A. mysorensis*. This latter species shows a marked variation in the appendix-length which has been interpreted as being intermediate between the situation in, on the one hand, *A. sylvaticus* and *A. nicolsonianus* Sivad. (respectively S and SW India) possessing a long appendix and, on the other hand, *A. margaritififer* and *A. longiconnectivus* (northern India) both lacking an appendix or the appendix being reduced to a mere stub. This character of both *A. margaritififer* and *A. longiconnectivus* must be considered a derived character within the framework of sect. *Rhaphiophallus*, since it occurs in species of a monophyletic 'subunit' of sect. *Rhaphiophallus* made up of all species with globose staminodes (a unique character in Araceae!). The lack of a naked appendix may be the result of two alternative evolutionary pathways, one being the differentiation of fertile male flowers on the appendix, the other being an actual suppression of the appendix. Two clues point to the latter alternative. First, *A. mysorensis* shows marked variation in appendix-length, whereby the appendix may be 'reduced' to a mere short stub. At least one specimen is known of *A. margaritififer*, showing a similar stub. Second, in all species of the group with globose staminodes which possess an appendix the male zone reaches to the top of the spathe. In both *A. margaritififer* and *A. longiconnectivus* this situation is similar. If, on a non-suppressed appendix male flowers would have differentiated, this would have resulted in a very long male zone reaching far beyond the spathe, as for the 'male zone + appendix' of the other species. Therefore it is concluded that the lack of a naked appendix in both species discussed resulted from a suppression of the entire appendix. The other explanation (male flowers differentiated on the appendix) is considered by Hettterscheid (in prep.) to be the cause of the lack of a smooth appendix in *A. coudercii* (Bogner) Bogner (Laos & Vietnam) and may also explain the staminodial appendix in *A. napalensis* (Wall.) Bogner & Mayo (Bhutan, Nepal, N India) and *A. sumawongii* (Bogner) Bogner & Mayo (Thailand).

The interpretation of the sterile structures between male and female zones as staminodes is based on observations of serial homology between the male flowers and the sterile structures. The development of this type of staminode may have occurred more than once in *Amorphophallus*. They are also found in a group of mainly Himalayan-Indochinese species (see above) and in *A. atroviridis* Hett., a member of a group of long-tubered species (see the description in the present issue, page 245). The phylogenetic interrelationships of these groups are unclear at the moment, so any speculation on the amount of homoplasy in the occurrence of these staminodes in the genus is futile. However, morphological investigation by the first author into all species possessing such staminodes indicates that they are derived in a similar manner from the male flowers (assuming that in all these cases the presence of staminodes is a derived character). In a number of these species the filaments of at least the lower male flowers are entirely connate and the resulting column ('cushion' in Sivadasan et al., 1994) is often enlarged in the lowermost flowers. Flowers morphologically intermediate between the latter and the staminodes are often found and they indicate that the transition is brought about by a reduction of the thecae, leaving only the col-

umn and the connective-tissue as the actual staminode. In the group of long-tubered species this same derivation can be based by invoking topographic homology. In all species of this group the column in the lowermost male flowers is extremely large, reducing the anthers to mere stubs on top of it and often pushing them apart, thereby resembling the staminodial condition. The transition to staminodes in this group is then 'completed' in one of its species, viz. *A. atroviridis*.

Variation in the sculpture of the pollen wall in sect. *Rhaphiophallus* is remarkable being psilate (*A. konkanensis*, *A. margaritifera* and *A. mysorensis*), finely verrucate (*A. sylvaticus*) or striate (*A. nicolsonianus*). Palynological investigations (Van der Ham & Hetterscheid, in prep.) show that this variation is much wider than in other monophyletic species groups in *Amorphophallus*.

ACKNOWLEDGEMENTS

Thanks are due to Dr. Jin Murata (Botanic Garden, University of Tokyo) and V.T. Chougule (principal of Smt.K.W. College, Sangli) for encouragement, to Dr. S.M. Patil (head, Department of Botany, Shivaji University) for providing necessary facilities, Dr. M. Sivadasan (Department of Botany, Calicut University) for valuable comments, Dr. A. Hay (Sydney) and Mr. P.C. Boyce (Kew) for correcting the manuscript, Dr. J.F. Veldkamp (L) for providing the Latin diagnosis, and Dr. R.W.J.M. van der Ham (L) for providing the pollen data.

REFERENCES

- Engler, A. 1911. Araceae–Lasioideae. In: A. Engler (ed.), Das Pflanzenreich IV.23C, Heft 48. Leipzig.
- Sivadasan, M. 1989. *Amorphophallus nicolsonianus* (Araceae), a new species from India, and a note on *A. sect. Synantherias*. *Willdenowia* 18: 435–440.
- Sivadasan, M., N. Mohanan & G. Rajkumar. 1994. *Amorphophallus bonaccordensis*, a new species of Araceae from India. *Blumea* 39: 295–299 (this issue).