NOTES ON THE GENUS AMORPHOPHALLUS (ARACEAE) – 5
AMORPHOPHALLUS KONKANENSIS, A NEW SPECIES FROM INDIA,
AND TAXONOMIC REFLECTIONS ON
AMORPHOPHALLUS SECTION RHAPHIOPHALLUS

W.L.A. HETTERScheid2, 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

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., rhachises 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 cylindric, 0.8–1.7 cm long, flowers congested; male zone cylindric, 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.
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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. suteponsis 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, Szecuwan). 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'.

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<tr>
<th>species</th>
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<tr>
<td><em>A. bonaccordensis</em> Sivad. &amp; Mohanan</td>
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<td><em>A. hohenackeri</em> (Schott) Engl.</td>
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<td><em>A. konkanensis</em> Hett., Yadav &amp; Patil</td>
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<td><em>A. longiconnectivus</em> Bogner</td>
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<td><em>A. margaritifer</em> (Roxb.) Kunth</td>
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<td><em>A. mysorensis</em> Barnes &amp; Fischer</td>
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<td><em>A. nicolsonianus</em> Sivad.</td>
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<td><em>A. sylvaticus</em> (Roxb.) Kunth</td>
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<td>*A. 'group yunnanensis'</td>
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<td>*A. 'group krausei'</td>
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**Characters:**

1a: appendix present  
   b: appendix absent or stub  

2a: neuter organs flattened  
   b: neuter organs globose  

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 (Hetterscheid, 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. margaritifer* (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. margaritifer*. 
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. margaritifer* and *A. longiconnectivus* (northern India) both lacking an appendix or the appendix being reduced to a mere stub. This character of both *A. margaritifer* 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. margaritifer*, 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. margaritifer* 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 Hetterscheid (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. margaritifer 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.

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REFERENCES

