

BALANOPHORACEAE (B. Hansen, Copenhagen)

Herbaceous, fleshy root parasites, destitute of chlorophyll and roots, with yellowish white to yellow, brown, orange to red or rose pink colours. At point of contact with host root a cylindrical or subspherical, branched or unbranched solid tuber develops. Stem appearing from the tuber endogenously or exogenously, leafless or with scaly leaves. *Inflorescence* spadix-like with unisexual flowers, ♂, ♀, or ♀♂, in the Mal. *spp.* unbranched. ♂ *Flowers* pedicellate or sessile, supported by bracts or not, 2–6-merous. Tepals 2–6 in one series, free from each other. Stamens 2–4(–?), opposite the tepals, united into a syndandrium. ♀ *Flowers* apparently not supported by bracts, with or without a minutely 2-lobed perianth adnate to the ovary. Styles 2 or 1. *Ovary* with 1 embryo, apparently without a cavity. Embryo very small, embedded in a more or less well developed endosperm.

Distribution. About 45 species in 18 genera in the tropics and subtropics of the world. As to our present knowledge 7 genera are exclusively South American, 4 genera are exclusively African, 2 are Asian, 1 is from Madagascar, 1 from New Zealand, and 1 from New Caledonia. Two genera have remarkable distributions, viz *Langsdorffia* with 3 species, 1 in South America, 1 in Madagascar and 1 in New Guinea, and *Balanophora* with 15 species from tropical Africa to Tahiti and Marquesas, one of the species covering almost the entire area (see *B. abbreviata*).

Ecology. Mostly in mountain forests parasitizing trees, rarely herbs. No particular host-affinity could be demonstrated within *Balanophora*, which is known to parasitize at least 74 host species belonging to 35 families. *B. fungosa* parasitizes at least 25 species.

Dispersal. Factual information is very scarce. RIDLEY (Disp. 1930, 39) observed in Christmas I. and P. Aur in Johore that 'in preserving specimens' (of the monoecious *B. abbreviata*) '... the minute fruits drifted away on the high breezes, like the pollen of a conifer. They were produced in great abundance on the little plant and borne on short stalks. The plants, which were very scanty, grew in open woods or between high rocks.' He also observed that this species is widely distributed in Oceanic islands, occurring from Madagascar and the Comores as far east as the Marquesas Is.

Diospores are indeed very light: the average weight of those of *B. fungosa ssp. indica* are 0.007 mg, that is only four times heavier than the lightest orchid seed.

However, RIDLEY correctly pointed out that 'the other species grow in dense forest in wet spots, their fruits are not so small and are apparently diffused mainly by rain-wash. These are quite absent from other islands.' This is not quite true; they do occur in islands, not only in those of the Malesian archipelago, but *B. fungosa ssp. fungosa* occurs also in the Solomons, New Caledonia, New Hebrides, and Fiji, while *B. wilderi* is confined to Rarotonga and Rapa Is.

For these others, and the species of the genera *Rhopalocnemis*, *Exorhopala*, and *Langsdorffia*, which all grow in the depth of dense everwet rain-forest, dispersal by wind is excluded while dispersal by rain-wash can only be very local and is insufficient to explain the large to almost world-wide ranges of the *Rhopalocnemis* affinity and *Langsdorffia* respectively. They grow on the forest floor and often do emerge only very little from the litter. Their spadices decay gradually and rot away, as was observed in *Rhopalocnemis* (fig. 2).

It has been advanced by KONINGSBERGER (Java, Zool. en Biol. 1915, 425, 614) that in the Javanese mountain forest pigs feed on tubers of *Balanophora*, but this appears obviously to be a loose assumption or a misinterpretation of their digging activity, as DOCTERS VAN LEEUWEN with his immense experience and acute observation denied it (Verh. Kon. Ak. Wet. A'dam, sect. II, 31, 1933, 71).

VAN STEENIS (Mt. Fl. Java, 1972, pl. 5–1) has advanced that dispersal of these forest floor parasites takes place, similarly as in *Rafflesiaceae*, epizoically by game, mainly by ungulates, but possibly also by other animals, large and small.

The dioecism which prevails in several species, makes dispersal over long distances still more problematic, similarly as in *Rafflesiaceae* in which species and genera show large, or even immense disjunctions. It is clear that these disjunct ranges are testimony of the great age of these parasite families and that the range histories reflect extinction and a chequered history going back to a dim past.

About the life-span of viable seed nothing is known unfortunately. Also about the way of infecting the host plant and its first life-stages no factual data are available. In *Rafflesia* it has been shown experimentally that infection can only take place on wounded roots or stems. This may be true for these *Balanophoraceae*. The solving of the secret of Balanophoraceous infection is one of the many goals of future tropical research.

Pollination. Again very few observations have been reported. Various insects have been observed visiting male flowers of *Balanophora fungosa ssp. indica* (HANSEN). In *Balanophora papuana* the male flowers open in being touched (FORMAN). Inflorescences of *Balanophora reflexa* smell from fox in the morning (CORNER) and could possibly thus attract *Diptera* or *Hymenoptera*.

VAN STEENIS (Hand. 6th Ned. Ind. Natuurwet. Congr. 1931, 1932, 470) observed that the supporting hairs of the female flowers in *Rhopalocnemis* excreted nectar, but no insect visitors were observed by him or VAN DER PIJL. GOVINDAPA & SHIVAMURTHY (Ann. Bot. 39, 1975, 977) found bees collecting pollen of *Balanophora abbreviata* and its ♀ flowers producing a sugary liquid.

Pollen morphology. The pollen of the *Balanophora* species has recently been described by me in detail (Dansk Bot. Ark. 28, 1972, 31–36). This genus proved to be eurypalynous with the grains spherical or slightly ellipsoid, equatorial diam. 13–31 μ , polar axis 12–31 μ , non aperturate, triporate or polypan-toporate with up to 12 apertures, exine granular from numerous conical, obtuse or apiculate bodies 0.4–0.8 μ high. In *Langsdorffia* the pollen is (3–) 4 (–5)-porate, exine more or less granular. Tricolpate grains have been found in *Rhopalocnemis* and *Exorhopala*.

Anatomy & morphology. In several species seed setting is by apogamy or parthenogenesis, as has been studied in Java or based on Javanese material by TREUB in *Balanophora elongata* (Ann. Jard. Bot. Btzg 15, 1898, 1–23, pl. 1–8), LOTSY in *B. fungosa* ssp. *indica* var. *globosa* (*ibid.* 16, 1899, 174–185, t. 16–19) and ERNST (Festschr. Eröffn. neuen Inst. f. Allg. Bot. Zürich, 1914, 145–176, 2 tab.). The same has been found in *Rhopalocnemis* by LOTSY (Ann. Jard. Bot. Btzg 17, 1901, 73–101, t. 3–14) and ERNST (Flora 106, 1913, 129–159, 2 Taf.).

FAGERLIND (Svensk Bot. Tidskr. 32, 1938, 139–159; *ibid.* 39, 1945, 65–82) made it clear, however, that these authors were mostly wrong in their interpretation and concluded that normal sexual reproduction occurs in most *Balanophoraceae*. Within the genus *Balanophora* agamospermy was found only in *B. fungosa* ssp. *indica* var. *globosa* and in *B. japonica*.

FAGERLIND's papers have shed doubt on the use of the terms 'ovary cell', 'ovule' and 'pendulous' nature of the latter, as there seems to be no cavity in the ovary. I have consequently abandoned these terms and restricted myself to speak of an embryo consisting of a few cells which is embedded in the tissue of the ovary.

VON GUTTENBERG (Planta 34, 1945, 193–220) studied the anatomy of *Balanophora* material he collected in Sumatra and came to the conclusion that the tubers of *Balanophora* should be interpreted as root tubers. It should be realized, however, that the tuber contains also fused root tissue of the host. Compare fig. 5.

A detailed, comprehensive review of the knowledge concerning the anatomy of *Balanophora* is given by FAGERLIND (Kungl. Svenska Vet. Akad. Handl. 25, 3, 1948, 1–72), where also important original observations are reported. HARMS (in E. & P. Nat. Pfl. Fam. ed. 2, 16b, 1935, 296–339) has summarized the knowledge concerning *Balanophora* as well as of other genera. Further METCALFE & CHALK (Anat. Dic. 2, 1950, 1205) should be consulted and my thesis on *Balanophora* (Dansk Bot. Ark. 28, 1972, 19–30). FAGERLIND has in a series of papers: Svensk Bot. Tidskr. 32 (1938) 139–159 and *ibid.* 39 (1945) 197–210; Ark. Bot. Stockh. 29A, 7 (1938) 1–15; Bot. Not. 4 (1945) 330–350, reviewed and given much new evidence concerning floral morphology and anatomy of several genera. The latest review by KUJIT (The biology of parasitic flowering plants, 1969, 118–135) deals with most aspects of the biology of *Balanophoraceae*.

Chromosomes. Because of their small size countings are very difficult in *Balanophora*. I have surveyed data and added some myself (Dansk Bot. Ark. 28, 1972, 37–38) in which *n* numbers are found to be *c.* 16 or *c.* 18, and 2*n c.* 36 for *Balanophora abbreviata*, 56 and 94–112 for *B. japonica*. DARLINGTON & WYLLIE (1955) listed for *Cynomorium* *n* = 12 and for *Helosis* and *Thonningia* both *n* = 18.

Phytochemistry. Candles are prepared from species of *Balanophora* and *Langsdorffia*; their tissues contain large amounts of a wax-like substance called balanophorin. Balanophorin from *Balanophora fungosa* ssp. *indica* var. *globosa* (JUNGH.) HANSEN (err. *B. 'bulbosa'* JUNGH.) and *B. elongata* BL. consists mainly of β -amyrin palmitate which is accompanied by small amounts of rubber. *B. japonica* MAKINO is used to prepare a bird-lime; it contains esters of β -amyrin and taraxasterol and probably appreciable amounts of rubber too. Several observations as well as some medicinal uses indicate that *Balanophoraceae* are rich in phenolic and tannin-like substances. Recent investigations with two species shed some light on the nature of these constituents. Large amounts of coniferin were isolated from a *Balanophora* species used in Thai medicine as an antiasmatic; at the same time 0.3% of β -amyrin acetate was obtained (V. PODIMUANG *et al.* Chem. Pharm. Bull. Tokyo 19, 1971, 207). From rhizomes of *Lophophytum leandri* EICHL. WEINGES *et al.* isolated polymeric proanthocyanins (= condensed tannins), eriodictyol (a flavanon), taxifolin (a flavanonol), (–)-epicatechin and glycosides of eriodictyol, naringenin, quercetin and epicatechin (Phytochemistry 10, 1971, 829). These recent observations confirm the presence of condensed tannins and their building stones (catechins) in the family. However, trihydroxylated constituents (myricetin, gallic acid, gallo-catechins) were not yet detected in *Balanophoraceae*. Chemical knowledge of the taxon is still too scanty for a balanced chemosystematic evaluation. The patterns of phenolic and triterpene constituents seem to agree rather well with the often accepted santalalean relationships (see TAKHTAJAN, Flowering plants, origin and dispersal, 1969). It should be remembered, however, that most species have not yet been investigated hitherto and that fatty acids with acetylene linkages seem to be lacking in the family (H. H. HATT *et al.* Austr. J. Chem. 20, 1967, 2285; *Balanophora fungosa* FORST.). For additional references see: HEGNAUER, Chemotaxonomie der Pflanzen 3 (1964). — R. HEGNAUER.

Taxonomy. In his masterly monograph (Trans. Linn. Soc. Lond. 22, 1856, 1–68) HOOKER *f.* treated 12 genera, as delimited today, and 28 species. VAN TIEGHEM, Ann. Sc. Nat. Bot. IX, 6 (1907) 125–260

treated as two families, viz *Balanophoraceae* and *Langsdorffiaceae*, what is now known as *subfam. Balanophoroideae*; he enumerated 51 species. In my recent revision of *Balanophora* (Dansk Bot. Ark. 28, 1972, 1-188) I reduced the number of species to 15. In *Langsdorffia* there seem to be 3 and in *Thonningia* only 1 species, which makes a total of 19 species today within *subfam. Balanophoroideae*.

Uses. *Balanophora elongata* contains large amounts of wax in the tubers and has been used on Java for making torches. Outside the Malesian area there are reports from Thailand and Japan on making bird-lime from the wax of *Balanophora* tubers.

Note. Good material of *Rhopalocnemis* and *Exorhopala* is extremely scarce and it has been necessary to some extent to rely upon observations published by botanists, who studied fresh material (JUNGHUHN, VAN STEENIS, RIDLEY). Regarding *Langsdorffia papuana* nothing can be added to the careful observations made by GEESINK.

KEY TO THE GENERA

1. Stem of inflorescence leafless. Young inflorescences with a closed cover of spirally arranged, polygonate, peltate scales, which are caducous in anthesis. Styles 2.
2. Stem of inflorescence more or less scaly, originating endogenously from a more or less spherical tuber forming a sheath round the base of the stem; perianth of male flowers tubular, lobes 4 or inconspicuous. 1. *Rhopalocnemis*
2. Stem of inflorescence without scales, apparently originating exogenously from an elongated tuber, no sheath observed; perianth of male flowers conspicuously 4-lobed. 2. *Exorhopala*
1. Stem of inflorescence with leaves, the upper ones covering the young inflorescence; the latter without such scales. Style 1.
3. Leaves (in Mal.) up to 30, wide, rounded, or blunt. Flowers arranged on a globular to elongate axis. Tubers with surface fine granular to coarsely warted, scattered stellate warts mostly present. Female flowers free from each other, intermixed with club-shaped spadicles. Tuber with wax. 3. *Balanophora*
3. Leaves very many (80-100), linear, very acute. Flowers arranged on the flattish, thickened apex of the stem. Tubers with surface densely pubescent, never granular or warted. Female flowers apparently adnate to each other, spadicles absent. Tuber starchy 4. *Langsdorffia*

1. RHOPALOCNEMIS

JUNGH. Nov. Act. Ac. Caes. Leop.-Car. 18, Suppl. 1 (1841) 213; GOEPP. *ibid.* 22, 1 (1847) 148, t. 11-15; HOOK. *f.* Trans. Linn. Soc. 22 (1856) 31, 52, t. 12; EICHL. in DC. Prod. 17 (1873) 138; HOOK. *f.* in B. & H. Gen. Pl. 3 (1880) 238; ENGL. in E. & P. Nat. Pfl. Fam. 3, 1 (1889) 259; LOTSY, Ann. Jard. Bot. Btzg 17 (1901) 75; STEEN. Hand. 6th Ned. Ind. Natuurwet. Congr. 1931 (1932) 470; HARMS in E. & P. Nat. Pfl. Fam. ed. 2, 16b (1935) 323, f. 163. — *Phaeocordylis* GRIFF. Trans. Linn. Soc. 20 (1846) 100. — *Lytogomphus* JUNGH. ex GOEPP. Nov. Act. Ac. Caes. Leop.-Car. 22, 1 (1847) 122, *nom. nud.* — Fig. 1-5.

Diocious or monoecious plant. A large basal tuber develops at the point of contact with the host root; surface of tuber irregularly corrugated; tuber starchy. *Inflorescence-bearing stem* breaking through the outer tissues of the tuber, which in turn forms a conspicuous, by tearing irregularly lobed sheath around the base of the stem. Stem leafless or with spirally arranged, slightly recurved warty scales. *Inflorescences* spadix-like, unisexual or bisexual, at first covered by the flattened, marginally cohering tops of polygonate, peltate scales (fig. 3); central area of scale often developing a wart or a slightly recurved structure much resembling the scales on lower part of stem; scales caducous in flakes at anthesis. ♂ *Flowers* with a tubular perianth splitting irregularly or apparently in 4 lobes. Stamens forming a columnar synandrium with the anthers united into a head containing 20-30 thecae in 2-3 layers. ♀ *Flowers* with perianth adnate to the ovary and forming 2 low crests at the top of the ovary, one anterior and one posterior, alternating with the caducous styles. Stigma conspicuous, capitate. *Ovary* slightly compressed in anterior-posterior direction.

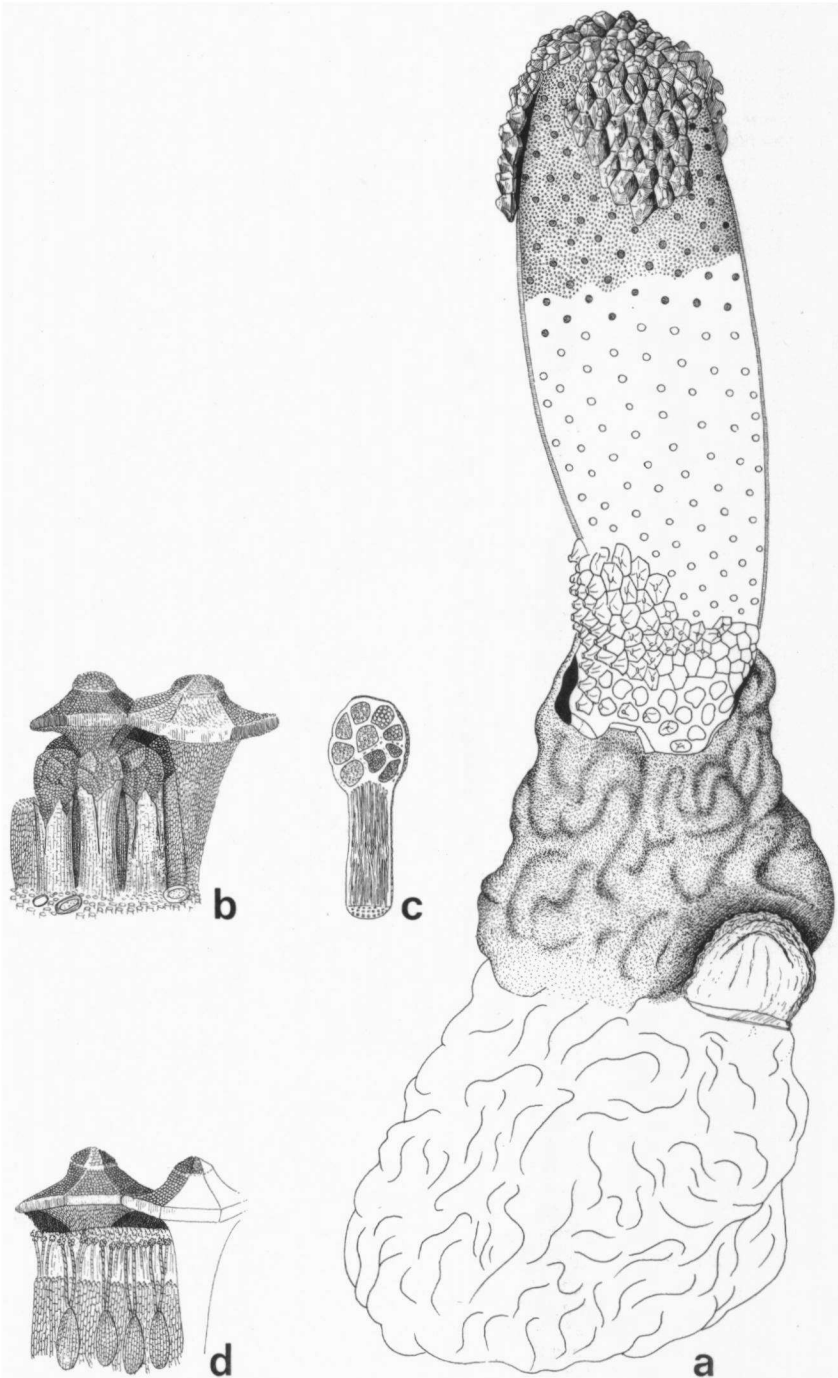


Fig. 1. *Rhopalocnemis phalloides* JUNGH. *a.* Habit, peltate scales shed in major part of ♀ inflorescence, each leaving a circular scar, $\times \frac{2}{3}$, *b.* section of inflorescence showing ♂ flowers covered by peltate scales, $\times 5$, *c.* LS of stamen, $\times 9$, *d.* section of inflorescence showing ♀ flowers surrounded by supporting hairs and still covered by peltate scales, $\times 5$ (after GOEPPERT, 1847).

Distr. Monotypic. E. Himalaya, Indo-China, in *Malesia*: Sumatra, Java, Celebes, and Central Moluccas (Buru). Fig. 6.

Note. The closest taxonomic relatives within *subfam. Helosidoideae* are *Exorhopala* in Malaya and *Ditepalanthus* in Madagascar (cf. HANSEN, Bot. Tidsskr. 69, 1974, 58-59).



Fig. 2. *Rhopalocnemis phalloides* JUNGH. in mossy forest on Mt Kemiri, Losir Mts, N. Sumatra, c. 2500 m altitude. Left a spadix in course of throwing off the scales, 2 ♀ spadices in full anthesis, right 3 old ones in decay, all from an enormous tuber (Photogr. VAN STEENIS, 1937).

1. *Rhopalocnemis phalloides* JUNGH. Nov. Act. Ac. Caes. Leop.-Car. 18, Suppl. 1 (1841) 215; GOEPP. *ibid.* 22, 1 (1847) 149, t. 11-15; HOOK. *f.* Trans. Linn. Soc. 22 (1856) 31, 52, t. 12; MIQ. Fl. Ind. Bat. 2 (1859) 1066; EICHL. in DC. Prod. 17 (1873) 138; HOOK. *f.* Fl. Br. Ind. 5 (1886) 239; ENGL. in E. & P. Nat. Pfl. Fam. 3, 1 (1889) 260, f. 165A-E; LOTSY, Ann. Jard. Bot. Btzg 17 (1901) 76-101, t. 3-14; KOORD. Exk. Fl. Java 2 (1912) 173; JACOBSON, Trop. Natuur 6 (1917) 138, f. 10; STEEN. Bull. Jard. Bot. Btzg III, 13 (1934) 176; Trop. Natuur 23 (1934) 49, f. 7; HARMS in E. & P. Nat. Pfl. Fam. ed. 2, 16b (1935) 323, f. 163; KANJILAL *et al.* Fl.

Assam 4 (1940) 133; BACK. & BAKH. *f.* Fl. Java 2 (1965) 79; CORNER & WATAN. Ill. Trop. Pl. (1969) 78; STEEN. Mt. Fl. Java (1972) pl. 5-3; HANSEN, Bot. Tidsskr. 67 (1972) 146, f. 1 (map). — *Phaeocordylis areolata* GRIFF. Trans. Linn. Soc. 20 (1846) 101, t. 8, f. 1-14. — *Lytogomphus stilbiferus* JUNGH. ex GOEPP. Nov. Act. Ac. Caes. Leop.-Car. 22, 1 (1847) 121, *nom. nud.* — Fig. 1-5.

Monoecious or dioecious plants (inflorescences bisexual or unisexual respectively) with yellowish to brownish colours. Total length from contact with host root to top of inflorescence 15-25 cm. Tubers 6-21 cm \varnothing and 6-13 cm long with a strong-



Fig. 3. *Rhopalocnemis phalloides* JUNGH. Two rugose tubers producing three young spadicis still fully covered with scales, one ♀ mature (white). Mt Tangkuban Prahau, W. Java (Photogr. KUYPERS, coll. ARENS).

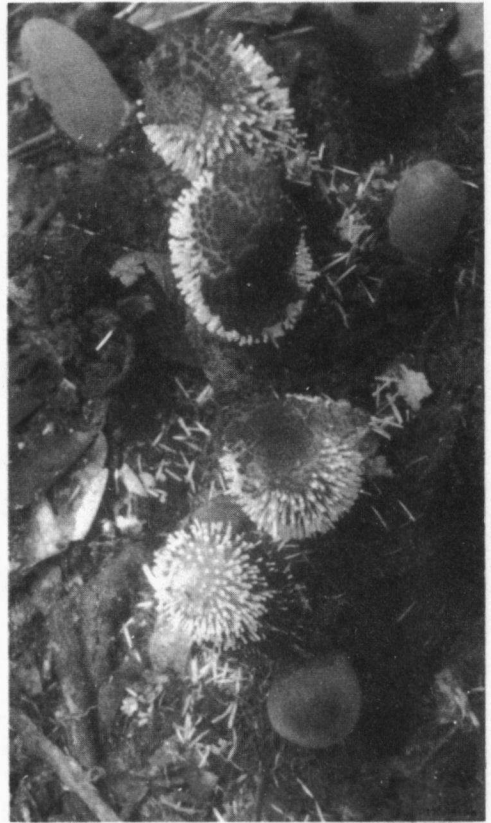


Fig. 4. *Rhopalocnemis phalloides* JUNGH. from above. ♂ Spadicis showing cream stamens, partly dropped; scales at apex are not yet shed all; 3 mature ♀ spadicis. Telaga Warna near Puntjak, Mt Gedeh, W. Java, 1400 m (Photogr. VAN STEENIS)

ly irregularly corrugated surface. Sheath around stem 1–5 cm long, irregularly lobed. *Inflorescence-bearing stem* 2–10 cm long, 2–5 cm \varnothing , with or without spirally arranged, slightly recurved, warty scales. *Inflorescence* 7–20 cm long, 3–7½ cm \varnothing . Top part of scales ½ cm \varnothing , in central part often developing a recurved structure much resembling the scales on lower part of stem. *Flowers* sessile, surrounded by numerous supporting hairs, which produce nectar. ♂ Specimens always with ♂ flowers in lower part of inflorescence.

Distr. E. Himalaya, Indo-China, in *Malesia*: Sumatra, Java, Celebes, and Moluccas (Buru). Fig. 6.

Ecol. Mountain forests, 1000–2700 m. Parasitizing roots of various woody plants: *Ficus fistulosa* REINW. ex BL. (*Morac.*), *Quercus pruinosa* BL., *Quercus* sp. (*Fagac.*) *Macaranga tanarius* (L.) M.A. (*Euph.*), *Albizia lophantha* (WILLD.) BTH. (*Leg.*), rarely supraterraneous stems: unknown liana (JUNGHUHN), *Ficus* sp. (*Morac.*), *Schima wallichii* (DC.) KORTH. ssp. *noronhae* (REINW. ex BL.) BLOEMB. (*Theac.*).

Note. Readily distinguished from *Exorhopala* by its yellowish to brownish colours, large, thick tubers, and endogenously originating stems.

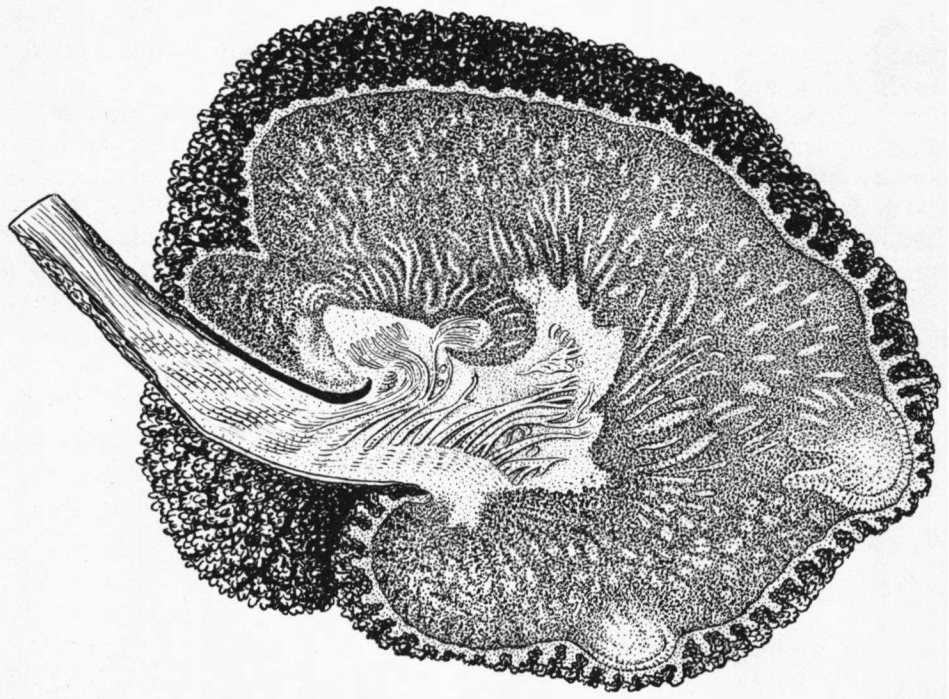


Fig. 5. *Rhopalocnemis phalloides* JUNGH. Cross-section through a tuber and attached root showing fusion of tissues. Mt Papandajan, W. Java (Coll. VAN STEENIS).

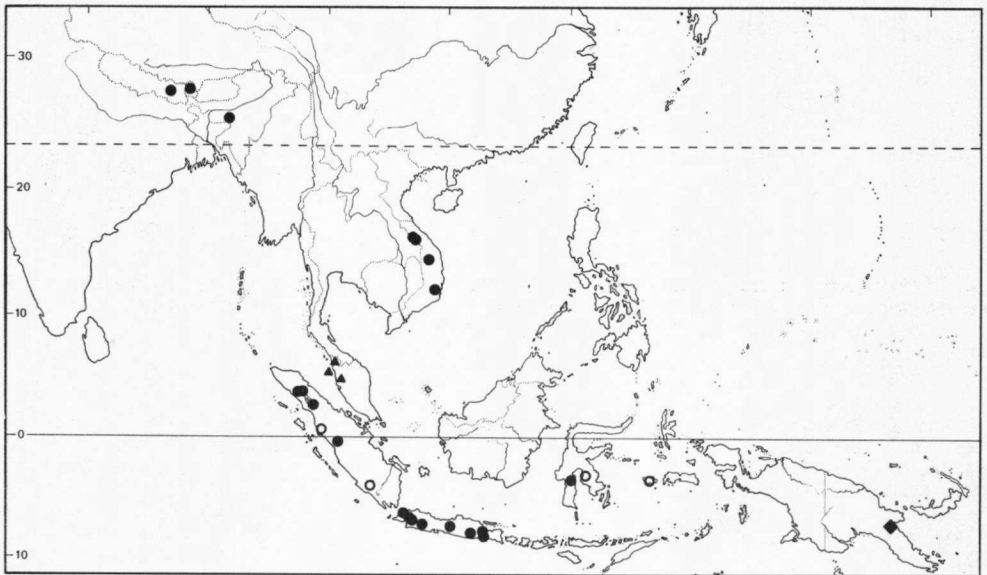


Fig. 6. Range of *Rhopalocnemis phalloides* JUNGH. (● specimens studied, ○ from literature), *Exorhopala ruficeps* (RIDL.) STEEN. (▲), and *Langsdorffia papuana* GEESINK (■).

2. EXORHOPALA

STEEN. Hand. 6th Ned. Ind. Natuurwet. Congr. 1931 (1932) 470; HARMS in E. & P. Nat. Pfl. Fam. ed. 2, 16b (1935) 324. — Fig. 7.

Point of contact with host plant (roots?) not known. *Inflorescence-bearing stem* leafless, appearing exogenously from elongated, horizontal tubers; no sheath observed. *Inflorescences* spadix-like, unisexual, at first covered by the conical top parts of marginally cohering peltate bracts. Bracts caducous on anthesis. Flowers mixed with numerous hairs. ♂ *Flowers* with a 4-lobed, short-tubular perianth. Stamens forming a columnar synandrium with the 4 anthers united into an elongated, ellipsoid head, which thus contains 8 linear cells (thecae). ♀ *Flowers* with compressed ovaries bearing 2 styles with very small capitate stigmas.

Distr. Monotypic. *Malesia*: Penang and Malay Peninsula. Fig. 6.
Note. Undoubtedly belonging in *Balanophoraceae-Helosidoideae*.

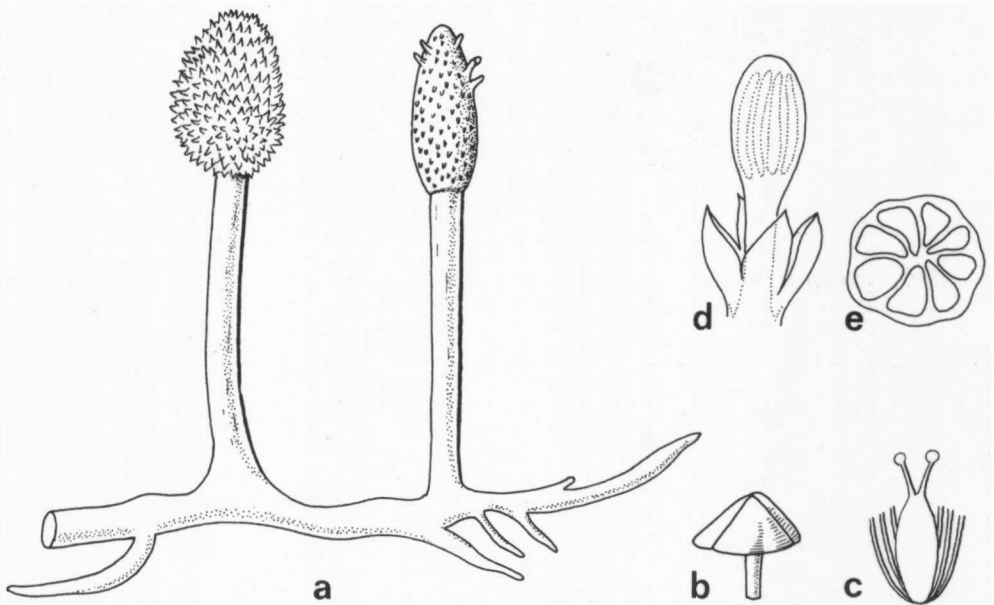


Fig. 7. *Exorhopala ruficeps* (RIDL.) STEEN. a. Habit, the inflorescence to the left still with peltate scales present, nat. size, b. peltate scale, $\times 5$, c. ♀ flower with supporting hairs, $\times 7$, d. ♂ flower, $\times 15$, e. CS of synandrium, $\times 25$ (a-c after RIDLEY, 1924, d-e after FAGERLIND, 1938).

1. *Exorhopala ruficeps* (RIDL.) STEEN. Hand. 6th Ned. Ind. Natuurwet. Congr. 1931 (1932) 470; HARMS in E. & P. Nat. Pfl. Fam. ed. 2, 16b (1935) 324; HANSEN, Bot. Tidsskr. 67 (1972) 147, f. 1 (map). — *Rhopalocnemis ruficeps* RIDL. Kew Bull. (1914) 188; Fl. Mal. Pen. 3 (1924) 176, f. 150. — Fig. 7.

Dioecious plant (inflorescences unisexual) with yellow to orange brown or rose colours. Basal organs not sufficiently known. *Inflorescence-*

-bearing stem appearing from an elongated, horizontal tuber at least 15 cm long and $\frac{1}{2}$ cm wide. Stem naked, 4–10 cm long, $\frac{3}{4}$ cm \varnothing , yellow. *Inflorescence* 3–5 (–10) cm long, 2–3 cm \varnothing incl. of bracts, rose pink, covered by the conical top parts of marginally cohering, peltate bracts. Bracts bright red, with top part $\frac{1}{2}$ cm long and 0.4 cm wide at base, caducous on anthesis. ♂ *Flowers* 2 mm long. ♀ *Flowers*: stigmas very small, head-like.

Distr. *Malesia*: Penang (Penara Bukit) and Malay Peninsula (Perak: Thaiping Hills), very rarely collected. Fig. 6.

Ecol. Dense forest, 100–1200 m. Contact with host plant not known.

Note. Distinguished from *Rhopalocnemis* by its yellowish-reddish colours, horizontally spreading tubers, and exogenous origin of the spadices.

3. BALANOPHORA

J. R. & G. FORST. Char. Gen. Pl. (1776) 99; BL. En. Pl. Jav. (1827) 86; JUNGH. Nov. Act. Ac. Caes. Leop.-Car. 18, Suppl. 1 (1841) 201–228, t. 1–2; GOEPP. *ibid.* 18, 1 (1842) 231–272, t. 1–3; MIQ. Fl. Ind. Bat. 2 (1859) 1064; EICHL. in DC. Prod. 17 (1873) 143; HOOK. *f.* in B. & H. Gen. Pl. 3 (1880) 235; BOERL. Handl. 3, 1 (1900) 183; TIEGH. Ann. Sc. Nat. Bot. IX, 6 (1907) 144; HARMS in E. & P. Nat. Pfl. Fam. ed. 2, 16b (1935) 329, f. 166–168; HANSEN, Dansk Bot. Ark. 28 (1972) 84, a complete monograph, 188 pp. — *Cynopsole* ENDL. Gen. Pl. (1836) 74. — *Acroblastum* SOLAND. [*Primitiae florum insularum oceani pacifici 310, 311 in sched.*] ex SEEM. Fl. Vit. (1866) 100. — *Balaniella* TIEGH. Ann. Sc. Nat. Bot. IX, 6 (1907) 144. — Fig. 8–24.

Stems emitted from basal tubers. Total length of parasite incl. of tuber 2–30 cm. Tubers mostly in a mass 1–25 cm \varnothing , branching from the base, containing wax (balanophorine) in varying amounts. Single tubers 1–6 cm long and 1–6 cm wide, ovoid, ellipsoid, or obovoid, sometimes almost cylindrical or spherical. In a few species the tubers are repeatedly branched with elongated, cylindrical branches, thus forming an entangled mass 10–30 cm \varnothing . Surface of tubers fine-granular to coarsely tessellate, with or without stellate warts. Stem appearing from a greater or smaller pit at the apical part of each single tuber. Leaves 2–40, broad-based, whorled, opposite, distichous or spirally arranged. Inflorescence spadix-like, terminating the stem. Flowers unisexual, pedicellate or not. δ Inflorescences racemose or spicate, 1–18 cm long and $\frac{1}{2}$ –7 cm wide in anthesis. φ Inflorescences spicate, ovoid, ellipsoid, obovoid, or spherical, $\frac{1}{2}$ –7 by $\frac{1}{2}$ –8 $\frac{1}{2}$ cm, number of flowers estimated in one inflorescence 10^5 – 10^7 according to size. δ Flowers mostly subtended by short, truncate bracts. In φ inflorescences the bracts are transformed to more or less club-shaped spadices $\frac{1}{2}$ –2 $\frac{1}{2}$ mm long, surrounded by φ flowers; in some species φ flowers are also situated on the lower, narrow part of each spadicle. Species monoecious as well as dioecious. Monoecious species have bisexual inflorescences with the δ flowers intermixed with the φ flowers or in a zone below and/or above the φ part. δ Flowers with a perianth of 3, 4–5 or 6, in exceptional cases up to 14, tepals, actinomorphic or bisymmetric to zygomorphic on account of lateral elongation. Tepals ovate to lanceolate, acute or almost square and truncate. Stamens forming a more or less elongated synandrium. Anthers 4–5 or numbers indeterminable, cells longitudinally dehiscent, sometimes transversally divided into smaller locelli. Anthers opposite to tepals when few in number. φ Flowers without a perianth. Ovary 0.2–0.7 mm long and 0.15–0.4 mm wide. Style $\frac{1}{2}$ –1 $\frac{1}{2}$ mm long, apparently stigmatoid at and near apex, where pollen grains are often found attached. Fruit indehiscent, nut-like. Embryo few-celled, embedded in a small endosperm. Diaspore: fruit with or without parts of pedicel and style attached.

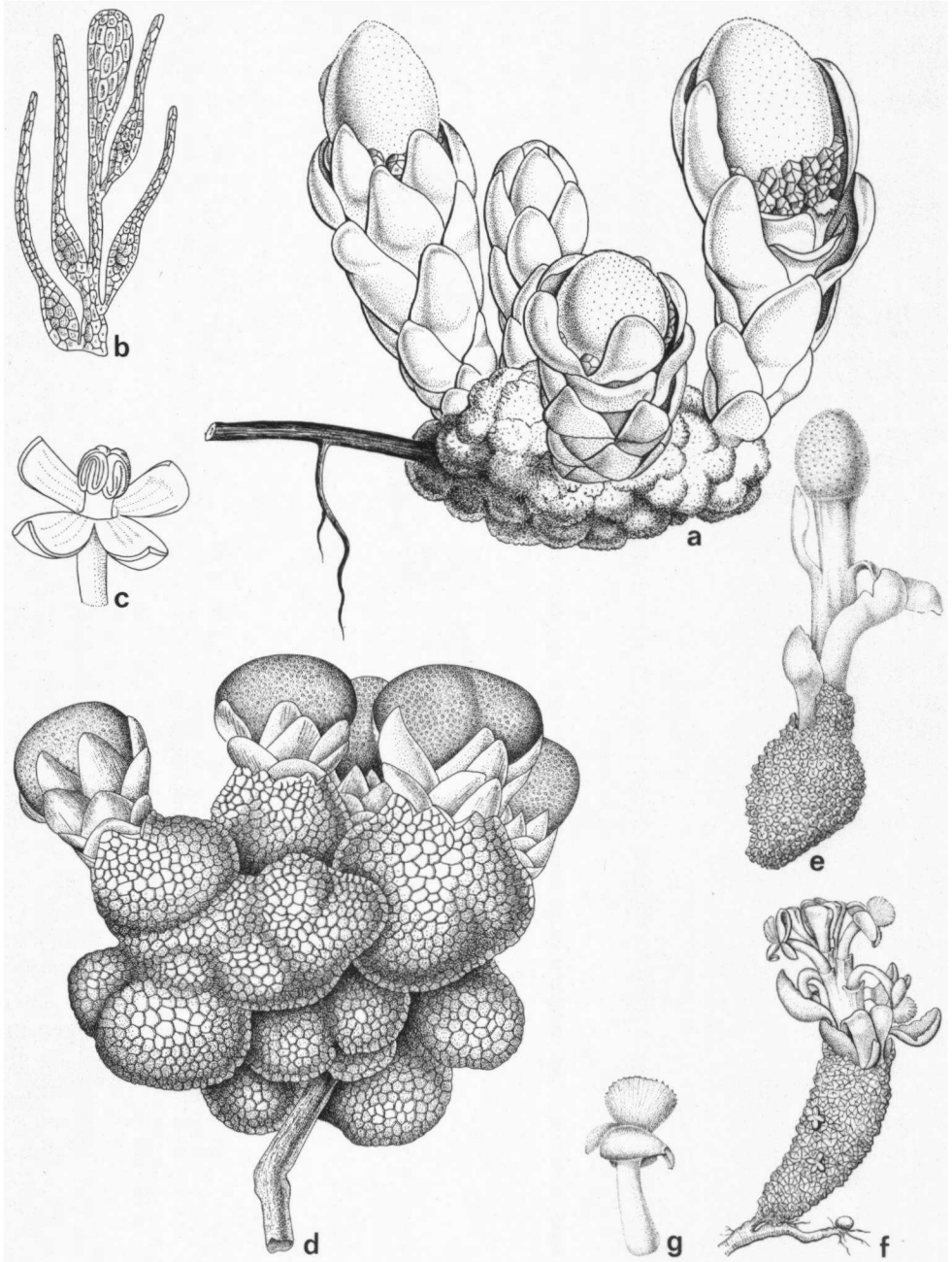


Fig. 8. *Balanophora fungosa* J. R. & G. FORST. *ssp. fungosa*. a. Habit, $\times \frac{2}{3}$, b. spadicle with 4 ♀ flowers, $\times 33$, c. ♂ flowers, $\times 3$. — *B. fungosa* *ssp. indica* (ARN.) HANSEN var. *globosa* (JUNGH.) HANSEN. d. Habit, $\times \frac{2}{3}$. — *B. reflexa* BECC. e. ♀ Specimen, habit, $\times \frac{2}{3}$, f. ♂ specimen, habit, $\times \frac{2}{3}$, g. ♂ flower, $\times 1\frac{1}{3}$ (a-c after HOOKER f., 1856, d after JUNGHUHN, 1841, e-g after BECCARI, 1869).

Distr. About 15 species in temperate to tropical Asia, throughout *Malesia*, Pacific islands, tropical Australia, Comores, Madagascar, and tropical Africa (Congo).

Ecol. Parasitizing roots, rarely supraterranean stems, of woody, rarely herbaceous, dicotyledonous species, in exceptional cases *Bambusa* and even *Pinus*.

Vern. *Prut*, S, a generic name, followed by the name of the host, e.g. *prut tjantigi*, *Balanophora* on *Vaccinium*, etc.

Notes. In no case have unisexual inflorescences of both sexes been observed to appear from one tuber. However, careful examination is necessary, when two seeds have germinated close to each other on the same root-tip, one producing a male plant, the other a female plant: such a case was observed in *B. fungosa* ssp. *indica*.

Dwarf specimens parasitizing extremely tiny roots were observed in *B. fungosa* ssp. *indica*. They probably occur in other species too, but are easily overlooked.

KEY TO THE SPECIES, SUBSPECIES, AND VARIETIES

1. Female and male flowers in the same inflorescence.
2. Leaves distichous. Male flowers sessile, bisymmetric or zygomorphic 6. *B. abbreviata*
2. Leaves spirally arranged, rarely subopposite. Male flowers pedicellate, actinomorphic. 1. *B. fungosa*
1. Female and male flowers in different inflorescences.
3. Male specimens only. (Note: flowers at proximal and distal parts of inflorescence often not typically developed.)
4. Male flowers actinomorphic, 4- or 5-merous, rarely 3- or 6-merous. Tepals all lanceolate, acute. 1. *B. fungosa* ssp. *indica*
4. Male flowers bisymmetric or zygomorphic, 4-merous, rarely 5- or 7-14-merous. Lateral tepals narrow, acute, median tepals wide, truncate.
5. Pedicels 14-18 mm, during anthesis much reflexed. Lateral tepals extremely narrow and acute, median tepals very wide, square, truncate. Synandrium completely compressed in anterior-posterior direction (Borneo, Malaya). 5. *B. reflexa*
5. Pedicels absent or at most up to 6 mm.
6. Leaves always distichous 7. *B. latisejala*
6. Leaves spirally arranged or opposite, decussate.
7. Leaves spirally arranged, gradually increasing in size upwards on the stem, the upper ones elliptic, concealing inflorescence during anthesis. Tuber elongated and regularly branched. 2. *B. elongata*
7. Leaves opposite, decussate.
8. Leaves 6-8 pairs, gradually increasing in size upwards on the stem, the uppermost ones almost orbicular in outline, cucullate, completely concealing the inflorescence during anthesis. Tuber spherical, not branched (Borneo) 4. *B. lowii*
8. Leaves 2-4 (-5) pairs, all of nearly the same size; in case of 4 leaves only, the two pairs often very close to each other, apparently whorled, patent during anthesis. Tubers branched (3-12 branches) with slightly elongated parts 3. *B. papuana*
3. Female specimens only. (Note: in some cases difficult to key out properly.)
9. Leaves whorled or opposite and decussate.
10. Leaves 4, distinct, apparently whorled at the upper part of the stem 3. *B. papuana*
10. Leaves opposite and decussate.
11. Leaves gradually increasing in size upwards on the stem; the uppermost leaves almost orbicular, cucullate, concealing the flowering inflorescence 4. *B. lowii*
11. Leaves almost equal in size except for the lowermost 1-3 pairs 3. *B. papuana*
9. Leaves distichous or spirally arranged.
12. Leaves distichous 7. *B. latisejala*
12. Leaves spirally arranged.
13. Spadicles without flowers in lower part. (Note: easily observed with handlens on cross-section of inflorescence.) (Borneo and Malaya only) 5. *B. reflexa*
13. Spadicles with flowers in lower part.
14. Upper leaves not covering the flowering inflorescence. 1. *B. fungosa* ssp. *indica* var. *indica*
14. Upper leaves totally or partially covering the flowering inflorescence.
15. Stem elongated, slender. Female inflorescence ellipsoid. Tubers elongated and repeatedly branched 2. *B. elongata* var. *elongata*
15. Stem very short and stout. Tubers not elongated.
16. Female inflorescence subspherical-ellipsoid. Leaves coarsely longitudinally striate (Java only). 2. *B. elongata* var. *ungeriana*
16. Female inflorescence subspherical, markedly depressed. Leaves smooth (Java only). 1. *B. fungosa* ssp. *indica* var. *globosa*

1. *Balanophora fungosa* J. R. & G. FORST. Char. Gen. Pl. (1776) 99, t. 50; MERR. En. Philip. 2 (1923) 118; HANSEN, Dansk Bot. Ark. 28 (1972) 93, f. 19. — *B. micholitzii* RIDL. J. Str. Br. R. As. Soc. 39 (1903) 207; *ibid.* 45 (1906) 219. — Fig. 8–11.

ssp. fungosa. — Fig. 8a–c.

Monoecious plant (inflorescences bisexual), pale yellow, yellow to orange yellow or yellowish brown, sometimes with pinkish tinges. Length from fusion with host root to top of inflorescence 6–12 cm. Tubers single or in a mass 10–15 cm wide, branching from the base. Single tuber subspherical or depressed, c. $1\frac{1}{2}$ by $2\frac{1}{2}$ cm. Surface granular with stellate warts. Stem $2\frac{1}{2}$ –11 cm. Leaves 15–30, spirally arranged, rarely subopposite, imbricate, 2–3 by $1\frac{1}{2}$ –2 cm, obtuse, slightly cucullate. ♂ Flowers 2–20, in a zone $\frac{1}{2}$ –1 cm high just below ♀ part of inflorescence, 4–5-merous, actinomorphic, subtended by short (1–2 mm), truncate, rudimentary bracts. Pedicels 3–7 mm. Tepals ovate-elliptic, acute. Synandrium ovoid-ellipsoid, slightly compressed in anterior-posterior direction. Anthers 4–5, horseshoe-shaped. ♀ Part of inflorescence (1–) $1\frac{3}{4}$ – $2\frac{1}{4}$ (– $3\frac{1}{2}$) cm long and ($\frac{1}{4}$ –) $1\frac{1}{2}$ – $2\frac{1}{4}$ (– $3\frac{1}{2}$) cm wide, subspherical to short ovoid. Spadicles (1110–) 1130 (–1150) μ long, long-obconical or with a lower, cylindrical part about 100 μ wide and an upper, obconical part 170–240 μ wide. ♀ Flowers on main axis of inflorescence and a few also in lower part of the spadicles. Largest ♀ flowers with pistils c. 1250 μ long, ovary about 400 μ long.

Distr. Upper Burma (Manipur), Ryu Kyu Is. (Iriomote), Micronesia (Marianas); in *Malesia*: Philippines (Luzon, Palawan), E. Java, Celebes, E. New Guinea; also in the Solomon Is., N. Queensland (Cape York Peninsula), New Caledonia, New Hebrides, and Fiji. Fig. 9.

Ecol. From about sea-level to 1000 m, in dense primary forest or rain-forest regrowth. Flowering all year round, but 52 % of all dated specimens are from June–July. Parasitizing various forest trees; hosts recorded: *Diospyros maritima* BL. (*Eben.*), *Macaranga tanarius* (L.) M.A. (*Euph.*), *Hibiscus tiliaceus* L. (*Malv.*), *Ficus austrocaledonica* BUR., *F. prolixa* FORST., *F. schlechteri* WARB. (*Morac.*), *Eucalyptus* sp. (*Myrt.*), *Linociera* sp. (*Oleac.*), *Citrus* sp. (*Rutac.*), *Vitex cofassus* REINW. ex BL. (*Verb.*).

Note. Distinguished from *B. abbreviata* by its leaves never being distichous and by its longer pedicels of the male flowers.

ssp. indica (ARN.) HANSEN, Dansk Bot. Ark. 28 (1972) 100, f. 20, 21. — *Langsdorffia indica* ARN. Ann. Nat. Hist. 2 (1838) 37. — *B. indica* (ARN.) GRIFF. Trans. Linn. Soc. 20 (1846) 95. — *B. elongata* (non BL.) HOOK. f. Trans. Linn. Soc. 22 (1856) 30, 45 p.p. *quoad specimina* WIGHT, GARDNER & THWAITES. — *B. decurrens* FAWC. Trans. Linn. Soc. Bot. II, 2 (1886) 243, t. 33, f. 1–4; ELMER, Leaf. Philip. Bot. 5 (1913) 1659; MERR. En. Philip. 2 (1923) 118. — *B. dioica* (non R.Br. ex ROYLE) RIDL. J. Str. Br. R. As. Soc. 59 (1911) 165. — Fig. 10.

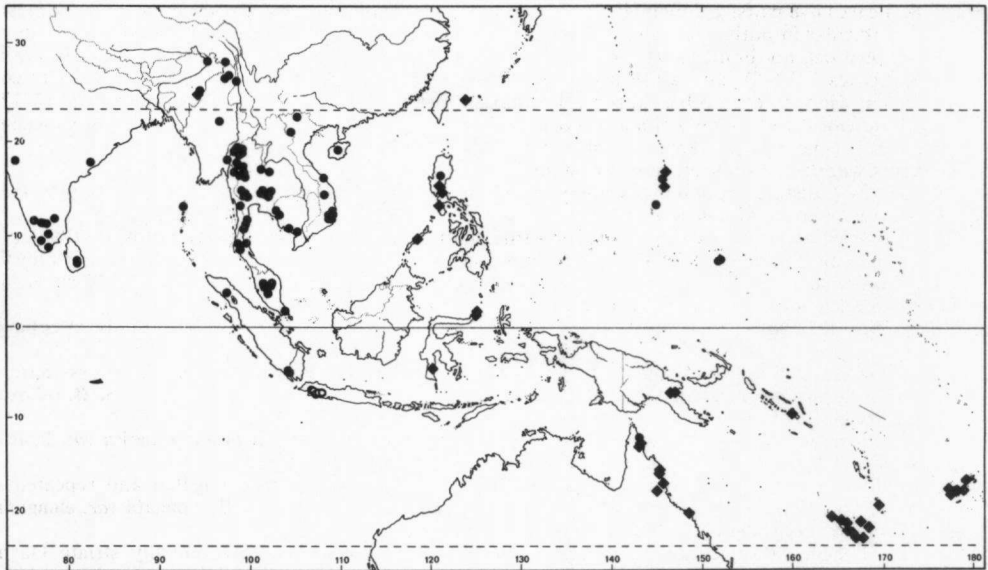


Fig. 9. Range of *Balanophora fungosa* J. R. & G. FORST. *ssp. fungosa* (■; add. E. Java), *ssp. indica* (ARN.) HANSEN var. *indica* (●), and *ssp. indica* (ARN.) HANSEN var. *globosa* (JUNGH.) HANSEN (○).

var. indica. — Fig. 10.

Dioecious plant, yellow to orange-yellow or pink. Length from fusion with host root to top of inflorescence $1\frac{1}{4}$ –22 cm. *Tubers* single or in a mass more or less branched from the base. Single tuber subspherical, $\frac{1}{2}$ – $5\frac{1}{2}$ cm wide and slightly shorter. Surface coarsely tessellate to fine granular, with stellate warts. Stem more or less elongated. *Leaves* 10–20, spirally arranged, imbricate, up to 3 by 2 cm, obtuse, slightly cucullate. ♂ *Inflorescence* ($\frac{3}{4}$ –) 2–7 (–12) cm long and ($1\frac{1}{4}$ –) 2–6 (–7) cm wide with expanded flowers, ovoid to ellipsoid.



Fig. 10. *Balanophora fungosa* ssp. *indica* var. *indica* in N. Thailand, Doi Inthanon, 1750 m (Photogr. H. P. NOOTEBOOM).

Pedicles 7–10 mm. ♂ *Flowers* subtended by truncate bracts 5 mm long and 4 mm wide, (3–) 4–5 (–6)-merous, actinomorphic. Tepals 3–7 by 1– $2\frac{1}{2}$ mm, elliptic-lanceolate, acute. Synandrium with fertile part slightly compressed, $2\frac{1}{2}$ –5 mm long, anterior-posterior width 2 mm, lateral width $3\frac{1}{2}$ mm, often slightly obconical. Anthers (3–) 4–5 (–6), horseshoe-shaped. ♀ *Inflorescence* ($\frac{1}{2}$ –) 1–6 (– $7\frac{1}{4}$) cm long and ($\frac{1}{2}$ –) 1–4 (– $8\frac{1}{2}$) cm wide, depressed-ellipsoid, subspherical or obovoid. Spadices (1270–) 1770 (–1960) μ long with a cylindrical lower part about 200–300 μ wide and an obovoid, obtuse or truncate top part about 600–900 μ long and 400–600 μ wide. ♀ *Flowers* on main axis of inflorescence as well as on cylindrical part of spadices. Largest ♀ flowers with pistils (1380–) 1700 (–1920) μ long, ovaries (240–) 340 (–500) μ long and 150–350 μ wide.

Distr. Indian and Indo-Chinese subcontinents, Yunnan, Hainan; in *Malesia*: Malaya, Sumatra, Philippines (Luzon, once), also in Micronesia

(Carolines, Marianas), N. Queensland (Cape York Peninsula, once). Fig. 9.

Ecol. Evergreen forest, (150–) 500–2600 m. Flowering all year round; in *Malesia*, the Pacific islands, and Australia 85 % of all collections are from June–Nov. Parasitizing various trees and climbers. Hosts recorded: *Carissa carandas* L. (*Apoc.*), *Ilex wightiana* WALL. ex WIGHT (*Aquif.*), *Euonymus crenulatus* WALL. (*Celastr.*), *Acacia melanoxylon* R. BR., *Albizia lophantha* (WILLD.) BTH., *Milletia* sp., *Pithecellobium* sp. (*Leg.*), *Ficus* sp. (*Morac.*), *Barringtonia asiatica* (L.) KURZ (*Lecyth.*), *Syzygium cumini* (L.) SKEELS (*Myrt.*), *Cissus* sp., *Tetrastigma* sp. (*Vitac.*).

var. globosa (JUNGH.) HANSEN, Dansk Bot. Ark. 28 (1972) 109, f. 24; STEEN. Mt. Fl. Java (1972) pl. 5–2. — *B. globosa* JUNGH. Nov. Act. Ac. Caes. Leop.-Car. 18, Suppl. 1 (1841) 210, t. 2; MIQ. Fl. Ind. Bat. 2 (1859) 1065; EICHL. in DC. Prod. 17 (1873) 146; KOORD. Exk. Fl. Java 2 (1912) 177, f. 39; STEEN. Trop. Natuur 23 (1934) 49; BACK. & BAKH. f. Fl. Java 2 (1965) 79; CORNER & WATAN. Ill. Trop. Pl. (1969) 74. — *B. gigantea* WALL. [Cat. (1832) n. 7249] ex FAWC. Trans. Linn. Soc. Bot. II, 2 (1886) 235, t. 33; RIDL. Fl. Mal. Pen. 3 (1924) 174. — *B. ramosa* FAWC. Trans. Linn. Soc. Bot. II, 2 (1886) 236, t. 34. — *Balaniella globosa* (JUNGH.) TIEGH. Ann. Sc. Nat. Bot. IX, 6 (1907) 181. — *Balaniella ramosa* (FAWC.) TIEGH. l.c. 181. — *Balaniella junghuehnii* TIEGH. l.c. 185. — Fig. 8d, 11.

Dioecious plant; only ♀ inflorescences observed. Length 8–10 cm from fusion with host root to top of inflorescence. Mass of tubers 8–10 cm \varnothing ; single tuber about 3 cm \varnothing , but often indistinct. Surface



Fig. 11. *Balanophora fungosa* ssp. *indica* var. *globosa* in Tjibodas, Mt Gedeh, W. Java, 1500 m, Aug. 1913 (Photogr. KOORDERS).

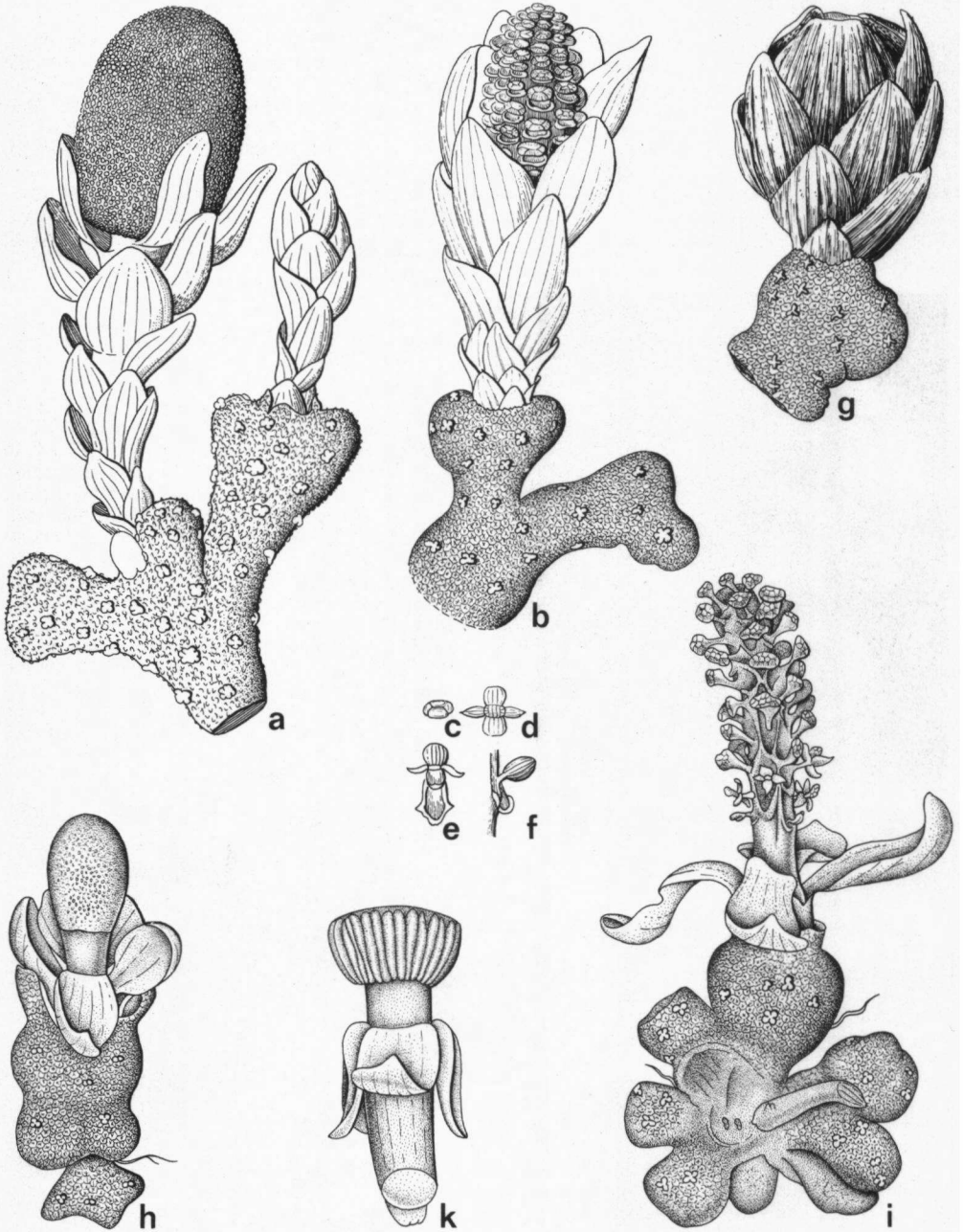


Fig. 12. *Balanophora elongata* BL. var. *elongata*. a. ♀ Specimen, habit, b. ♂ specimen, habit, c. ♂ flower in bud, d. ♂ flower fully open, seen from above, e. ditto, anterior view, f. ditto, lateral view, tepals removed. — *B. elongata* var. *ungeriana* (VAL.) HANSEN. g. Habit. — *B. papuana* SCHLTR. h. ♀ Specimen, habit, i. ♂ specimen, habit, k. ♂ flower, anterior view; a-i $\times \frac{2}{3}$, k $\times 3$ (a-f after JUNGHUHN, 1841, g after VALETON, 1912, h-k after VALETON, 1913).

coarsely tessellate with polygonate 'fields' 5–7 mm \varnothing . Stellate warts not distinct. Stem short and stout, 1–2 cm long only. *Leaves* 10–12, spirally arranged, imbricate, closely appressed to the stem and lower part of inflorescence, partly covering up to $\frac{2}{3}$ of flowering inflorescence. ♀ *Inflorescence* $2\frac{1}{2}$ – $2\frac{3}{4}$ by $3\frac{1}{2}$ –4 cm, depressed, flat-ellipsoid. Spadicles up to 2100–2500 μ long with a cylindrical lower part 200–450 μ wide and an ovoid-obovoid, obtuse or truncate top part up to 600–900 μ wide. ♀ *Flowers* on main axis of inflorescence as well as on lower part of spadicles. Largest flowers with pistils 1700–1800 μ long, ovaries 300–350 μ long and 260–280 μ wide. ♂ *Inflorescences* not observed. Plant apomictic.

Distr. Malesia: West Java only (Mt Salak east to Priangan Mts). Fig. 9.

Ecol. Evergreen forests at 1500–2000 m. Parasitizing forest trees; *Schima wallichii* (DC.) KORTH. *ssp. noronhae* (REINW. ex BL.) BLOEMB. (*Theac.*) has been recorded as host plant.

2. *Balanophora elongata* BL. En. Pl. Jav. 1 (1827) 87; MIQ. Fl. Ind. Bat. 2 (1859) 1065; Illustr. (1871) 105; EICHL. in DC. Prod. 17 (1873) 147; KOORD. Exk. Fl. Java 2 (1912) 176, f. 38; Atlas 4 (1925) t. 869, 870; Fl. Tjibodas 2 (1923) 52, *incl. var. macropanicis* VAL. ms. ex KOORD. l.c. 55; STEEN. Trop. Natuur 23 (1934) 49, f. 1, 2, 8; BACK. & BAKH. f. Fl. Java 2 (1965) 79; CORNER & WATAN. Ill. Trop. Pl. (1969) 72; STEEN. Mt. Fl. Java (1972) pl. 5–1a/b; HANSEN, Dansk Bot. Ark. 28 (1972) 114, f. 26, 27. — *B. dioica* (non R. BR. ex ROYLE) UNGER, Ann. Wien. Mus. Naturgesch. 2 (1837) 26, t. 2, f. 1, 2. — *B. maxima* JUNGH. Nov. Act. Ac. Caes. Leop.-Car. 18, Suppl. 1 (1841) 209, t. 1; MIQ. Fl. Ind. Bat. 2 (1859) 1065. — *B. elongata* var. *maxima* (JUNGH.) HOOK. f. Trans. Linn. Soc. 22 (1856) 45. — *B. forbesii* FAWC. Trans. Linn. Soc. Bot. II, 2 (1886) 236, t. 33, f. 8–10. — *B. multibrachiata* FAWC. l.c. 236, t. 34. — *Cynopsole elongata* (BL.) ENDL. ex JACKS. Ind. Kew. 1, 1 (1895) 688. — *Balaniella elongata* (BL.) TIEGH. Ann. Sc. Nat. Bot. IX, 6 (1907) 181. — *Balaniella maxima* (JUNGH.) TIEGH. l.c. — *Balaniella forbesii* (FAWC.) TIEGH. l.c. — *Balaniella multibrachiata* (FAWC.) TIEGH. l.c. — Fig. 12–16.

var. elongata. — Fig. 12a–f, 13–16.

Dioecious plant, red-yellow to coral-red or red-brown. *Tubers* repeatedly branched, single branches elongated, cylindrical, c. 3–8 by 1.2–1.4 cm, those producing an inflorescence slightly obconical, c. $1\frac{1}{2}$ –2 cm wide in distal part. Surface granular to fine tessellate, with scattered stellate warts. Stem various, in ♂ specimens 1–20 cm long, shorter in ♀ specimens, $\frac{1}{2}$ – $\frac{3}{4}$ cm \varnothing . *Leaves* 7–20, spirally arranged, imbricate, gradually increasing in size upwards, elliptic, obtuse, 1– $4\frac{1}{2}$ by $\frac{3}{4}$ – $2\frac{1}{4}$ cm, colour red-yellow to red or dark red-brown, rarely butter yellow. In wet, translucent material 6–12 longitudinal nerves are seen, in dry material the leaves are faintly longitudinally striate. Upper leaves appressed to and partly concealing the

flowering inflorescences or slightly reflexed in advanced stages. ♂ *Inflorescence* 3–5 cm long, rarely longer. Bracts 1–5 mm long, 5–6 mm wide, truncate. Pedicels 3–7 mm long. ♂ *Flowers* 4 (–5)-merous, bisymmetric or zygomorphic. Lateral tepals narrow, acute, 4– $4\frac{1}{2}$ by $1\frac{1}{2}$ –2 mm, median tepals wide, truncate, 4– $4\frac{1}{2}$ by 3 mm. *Synandrium* with fertile part 2 mm long, slightly compressed, lateral width $2\frac{1}{2}$ –4 mm, anterior-posterior width $1\frac{1}{2}$ –2 mm. Anthers apparently straight, locules running from base to top of synandrium, longitudinally opening. Number of locules various, 20–30. ♀ *Inflorescence* ellipsoid-subsppherical, 3–4 cm by $1\frac{3}{4}$ –3 cm. Spadicles (880–) 985 (–1190) μ long, with a lower, cylindrical part 100–130 μ wide and an upper, ellipsoid, ovoid or obovoid part about 350–500 μ long and 270–340 μ wide. ♀ *Flowers* on main axis of inflorescence as well as on lower part of spadicles. Largest flowers with pistils (1250–) 1270 (–1300) μ long. Ovaries ellipsoid 270–300 μ by 160–180 μ .



Fig. 13 & 14. *Balanophora elongata* BL. var. *elongata*. Young ♂ spadices (above), after two weeks just coming into anthesis (below), showing slow development. Tjibodas, Mt Gedeh, W. Java, 1500 m (Photogr. VAN STEENIS).

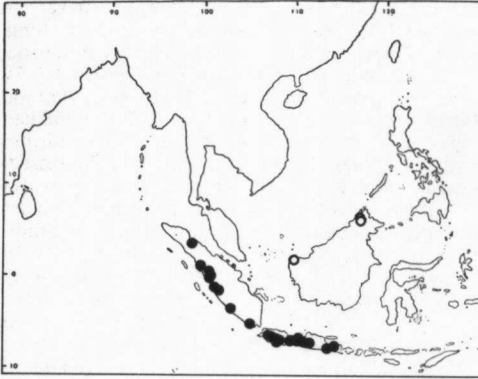


Fig. 15. Range of *Balanophora elongata* BL. (●) and *B. lowii* Hook. f. (○).



Fig. 16. *Balanophora elongata* BL. var. *elongata*. Two ♀ spadices (left upper corner and lower down) and four ♂ ones. Kandang Badak, Mt Gedeh, W. Java, 2400 m (Photogr. VAN STEENIS).

Distr. *Malesia*: Sumatra and Java (most abundant in West Java). Fig. 15.

Ecol. Evergreen forest at 1000–3000 m. Parasitizing various trees and shrubs; hosts recorded: *Strobilanthes* sp. (*Acanth.*), *Macropanax dispermus* (BL.) O.K., *Schefflera aromatica* (BL.) HARMS (*Aral.*), *Rhododendron retusum* (BL.) BENN., *Vaccinium laurifolium* (BL.) MIQ., *V. lucidum* (BL.)

MIQ. (*Eric.*), *Albizia lophantha* (WILLD.) BTH. (*Leg.*), *Ficus lepicarpa* BL., *F. ribes* REINW. ex BL., *F. septica* BURM. f., *F. villosa* BL., and *Ficus* sp. (*Morac.*), *Girardinia heterophylla* (VAHL) DECNE (*Urtic.*). Flowering all year round, but 80% of all dated specimens studied were collected in March to September.

Uses. The tubers contain wax, often in great quantity, and are used in West Java (notably Tjibodas and on Mt Gedeh) for making torches, cf. ULTÉE (Hand. 3rd Ned. Ind. Natuurwet. Congr. 1924, 1925, 275–276).

Note. Easily distinguished from *B. papuana* in the leaves being spirally arranged.

var. *ungeriana* (VAL.) HANSEN, Dansk Bot. Ark. 28 (1972) 120, f. 28. — *B. ungeriana* VAL. Ic. Bog. 4 (1912) 95, t. 330; STEEN. Trop. Natuur 23 (1934) 49; BACK. & BAKH. f. Fl. Java 2 (1965) 80. — Fig. 12g.

Tubers not elongated, branches short obconical. Leaves coarsely longitudinally striate.

Distr. *Malesia*: West Java (Mts Salak and Gedeh), 1400–1600 m.

Note. Male plants never seen. The tubers contain but little wax. Parasitizing various species of *Ficus*, e.g. *F. lepicarpa* BL., *F. septica* BURM. f., *F. ribes* REINW. ex BL., and *F. villosa* BL. (*Morac.*).

3. *Balanophora papuana* SCHLTR, Bot. Jahrb. 50 (15 April 1913) 68, f. 1; MERR. & PERRY, J. Arn. Arb. 23 (1942) 383; HANSEN, Dansk Bot. Ark. 28 (1972) 121, f. 29, 30. — *B. elongata* (non BL.) STAPP, Trans. Linn. Soc. Bot. II, 4 (1894) 223. — *B. incarnata* ELMER, Leaf. Philip. Bot. 5 (13 June 1913) 1661; MERR. En. Philip. 2 (1923) 118. — *B. oosterzeeana* VAL. Nova Guinea 8 (Sept. 1913) 919, t. 161; RIDL. Trans. Linn. Soc. Bot. II, 9 (1916) 147; H. J. LAM, Nat. Tijd. N. I. 88 (1928) 277, 294; *ibid.* 89 (1929) 131; MERR. & PERRY, J. Arn. Arb. 29 (1948) 152. — *B. celebica* WARB. Die Pflanzenwelt 1 (1913) 517, f. 168B, *nom. nud.*; CORNER & WATAN. Ill. Trop. Pl. (1969) 71. — *B. decurrens* (non FAWC.) MERR. Philip. J. Sc. 1 (1906) Suppl. 51. — *B. multibrachiata* (non FAWC.) BURK. & HOLTT. Gard. Bull. S. S. 3 (1923) 72; RIDL. Fl. Mal. Pen. 3 (1924) 174; BURK. & HEND. Gard. Bull. S. S. 4 (1928) 315; MERR. Contr. Arn. Arb. 8 (1934) 54, p.p.; HEND. Mal. Nat. J. 6 (1951) 458, f. 413. — *Balaniella papuana* (SCHLTR) HOSOKAWA, J. Jap. Bot. 13 (1937) 202. — Fig. 12h–j, 17.

Dioecious plant, yellow to orange-yellow or red. Length from fusion with host root to top of inflorescences 3–15 cm. Tubers in a mass, 14–24 cm \varnothing , branching from the base into 3–12 single tubers; single tubers (1–) 2–5 (–6) cm by (1–) 1½–3 (–4) cm; surface tessellate being covered by polygonate 'fields' 1–2 mm across, with scattered stellate warts. Stem with 2–4 (–5) pairs of opposite, decussate, obovate yellow to red leaves, which are patent during anthesis. In a New Guinea specimen preserved in alcohol the leaves are 3¼ by 2½ cm with 7–11 longitudinal nerves. New Guinea and



Fig. 17. *Balanophora papuana* SCHLTR at upper Lai River, Wabag, E. New Guinea (HOOGLAND & SCHODDE 7712).

Celebes material has 4, rarely 5 leaves inserted at nearly the same level, thus appearing verticillate. In Philippine material 2-3 leaf pairs are observed, and in Borneo, Malaya, and Sumatra material 2-4 (-5) pairs. If more than 2 pairs of leaves present, the pairs are usually somewhat spaced on the stem. The leaves are always nearly of the same size. ♂ *Inflorescence* $2\frac{1}{2}$ -5 by $1\frac{1}{2}$ -3 cm with expanded flowers. Bracts rudimentary, at most 1 mm long. Pedicels 2-7 mm long. *Flowers* often in conspicuous vertical rows, bisymmetric or zygomorphic on account of lateral elongation, 4 (-5)-merous. Median tepals wide and truncate, $4\frac{1}{2}$ by $3\frac{1}{2}$ mm. Lateral tepals narrow and acute, $4\frac{1}{2}$ by 1 mm. Synandrium with fertile part often slightly obconical, laterally elongated, e.g. length 3 mm, anterior-posterior width 3 mm and lateral width 7 mm. Anther cells parallel, running from base to top of synandrium, longitudinally opening. ♀ *Inflorescence* obovoid, ($\frac{3}{4}$ -) $1\frac{1}{2}$ -3 (-4) by ($\frac{1}{2}$ -) $1-2\frac{1}{2}$ (-3) cm. Spadices (900-) 1000 (-1200) μ long with a cylindrical lower part about 600 μ long and 100 μ wide and an obconical upper part about 400 μ long and 200-300 μ wide. ♀ *Flowers* chiefly on main axis of inflorescence but always a few also on lower part of spadices. Largest flowers with pistils c. 1150 μ , ovaries c. 180 μ long and 140 μ wide.

Distr. Malesia: Malaya, NW. Borneo (Mts Murud, Kinabalu), Celebes, Philippines (Luzon, Mindoro, Mindanao), and New Guinea. Fig. 18.

Ecol. Evergreen mountain forests at (300-) 1000-2000 m. Parasitizing roots of forest trees. Hosts recorded: *Macaranga* sp. (*Euph.*), *Ficus* sp. (*Morac.*). Flowering all the year round, 66% of dated collections from June-Nov.

Note. Distinguished from *B. lowii* by the fewer leaves which are nearly equal in size and not concealing the flowering inflorescence, from *B. elongata* by the leaves being opposite and almost equal.

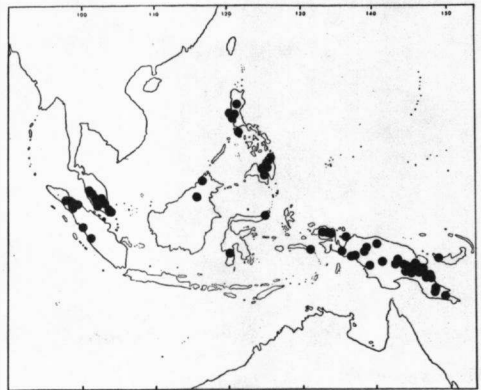


Fig. 18. Range of *Balanophora papuana* SCHLTR.



Fig. 19. *Balanophora lowii* HOOK. f. at Mesilau River, Mt Kinabalu, N. Borneo (Photogr. CORNER).

4. *Balanophora lowii* HOOK. f. Trans. Linn. Soc. 22 (1859) 426, t. 75; EICHL. in DC. Prod. 17 (1873) 148; HANSEN, Dansk Bot. Ark. 28 (1972) 127, f. 31, 32. — *Balaniella lowii* (HOOK. f.) TIEGH. Ann. Sc. Nat. Bot. IX, 6 (1907) 181. — Fig. 19.

Dioecious plant, yellow to red. Length from fusion with host root to top of upper leaves about 9 cm. Tubers always single in the material studied, spherical, $1\frac{1}{2}$ – $2\frac{1}{2}$ cm \varnothing , surface granular with scattered to numerous stellate warts. Leaves 12–16, deep pink, opposite, decussate, gradually increasing in size upwards, the basal ones being small and bract-like, while the upper 2–3 pairs are ovate to almost orbicular, $2\frac{1}{2}$ – $4\frac{1}{4}$ by $2\frac{1}{2}$ –4 cm. In wet material 8–14 longitudinal nerves are easily observed; the nerves are forking in the middle part of the lamina. The upper 2–3 pairs of leaves conceal the flowering inflorescence completely. ♂ Inflorescence subspherical-ellipsoid, $2\frac{1}{2}$ – $2\frac{3}{4}$ by $2\frac{1}{2}$ cm. Bracts 2 mm long and 5 mm wide, truncate or almost rudimentary. Pedicels 6–7 mm long. ♂ Flowers bisymmetric or zygomorphic through lateral elongation, 4 (–5)-merous. Median tepals 5 mm by 4 mm, truncate. Lateral tepals 5 by $2\frac{1}{2}$ –3 mm, acute. Synandrium with fertile part slightly laterally elongated, 3 mm long, anterior-posterior width $3\frac{1}{2}$ mm, lateral width 5 mm. Anther cells parallel, running from base to top of synandrium, longitudinally opening. ♀ Inflorescence ellipsoid, $3\frac{1}{4}$ by $2\frac{1}{4}$ cm. Spadices 1100–1500 μ long, with a cylindrical lower part c. 180–230 μ wide and an obovoid to truncate upper part, 320–380 μ wide. Largest flowers with pistils 1450–1750 μ long, ovaries 240–320 μ long, ellipsoid.

Distr. *Malesia*: Borneo (Mt Kinabalu; Sarawak: Poi Range, G. Berumpit). Fig. 15.

Ecol. Collected in evergreen forests at 1000–3000 m. Parasitizing roots as well as supraterranean stem parts. Host(s) not yet recorded. Season probably all year round, but more records are needed.

Note. Distinguished from *B. papuana* by its higher number of leaves and by the leaves being gradually increasing in size upwards on the stem, from *B. elongata* by its opposite leaves.

5. *Balanophora reflexa* BECC. Att. Soc. Ital. Sc. Nat. 11 (1868) 198; Nuov. Giorn. Bot. Ital. 1 (1869) 65, t. 2–4; EICHL. in DC. Prod. 17 (1873) 148; BECC. Wanderings (1904) 128, 164; VAL. Nova Guinea 8 (1913) 920; HANSEN, Dansk Bot. Ark. 28 (1972) 130, f. 33, 34. — *Balaniella reflexa* (BECC.) TIEGH. Ann. Sc. Nat. Bot. IX, 6 (1907) 182. — *B. fasciculigera* SUESSENG. & HEINE, Mitt. Bot. Staatssamml. Münch. 2 (1950) 57; HEINE in Fedde, Rep. 54 (1951) 226. — Fig. 8e–g, 20.

Dioecious plants, rich orange to red or dark red. Length from fusion with host root to top of inflorescence in ♂ plants (4–) 5–10 (–11) cm, in ♀ plants (6–) 7–10 (–23) cm. Tubers several together in a mass branching from the base into single tubers. Single tubers elongated, cylindrical or ovoid-ellipsoid-obovoid, (2–) 3–6 (–14) cm long and



Fig. 20. *Balanophora reflexa* BECC. at Balleh River, Bt Tikang, Sarawak (Photogr. J. A. R. ANDERSON).

($1\frac{1}{2}$ -) 2-4 (- $4\frac{1}{2}$) cm wide. Surface coarsely tessellate. Leaves 3-8, spirally arranged, length 2- $3\frac{1}{2}$ cm, width $1\frac{1}{2}$ - $2\frac{1}{4}$ cm. ♂ Inflorescence $1\frac{3}{4}$ - $2\frac{1}{2}$ cm long. Bracts various: upper bracts entire, truncate, 3-4 mm long, lower bracts divided to the base into 4-6 (-7) teeth, each about 1-2 by $\frac{1}{2}$ mm. Pedicels of lowermost flowers (1-) $1\frac{1}{2}$ - $1\frac{3}{4}$ (-2) cm, compressed, 3 by 2 mm in cross-section, before anthesis pointing upwards and closely appressed to the axis of the inflorescence, during and after anthesis strongly reflexed. Flowers 7-9 or more. Buds much compressed, length ($3\frac{3}{4}$ -) 5-6 (-7) mm, lateral width ($4\frac{1}{2}$ -) 6-8 (-9) mm, anterior-posterior width ($2\frac{1}{2}$ -) 3 (- $3\frac{1}{2}$) mm. ♂ Flowers 4-merous, bisymmetric or zygomorphic on account of lateral elongation. Median tepals 2, wide, almost square, truncate. Lateral tepals 2, narrow, lanceolate, acute. Synandrium with fertile part much compressed, almost fan-shaped. Anther cells parallel, running from base to top of synandrium. ♀ Inflorescence spherical or ellipsoid-obovoid, (1-) $1\frac{1}{2}$ -3 (-5) by ($\frac{3}{4}$ -) 1-2 (-3) cm. Spadicles (800-) 1000 (-1200) μ long, long-obconical with top part rounded, about 100 μ wide at base and 250-270 μ wide at top. ♀ Flowers on main axis of inflorescence only. Largest flowers about 1150 μ long, ovaries about 270 μ long.

Distr. *Malesia*: Borneo (Sarawak, W. Borneo, Mt Kinabalu) and Malaya (Pahang, one collection). Fig. 24.

Ecol. In evergreen forest on roots of trees at altitudes from 300-3000 m. Host recorded: *Elastostema* sp. (*Urtic.*), parasite appearing on supra-terrestrial stem parts of host. Flowering all year round.

Note. Distinguished from all other species by the long, reflexed pedicels and the extremely compressed, almost sharp-edged, fan-shaped synandria. Flowering specimens sometimes smelling strongly of fox (CORNER on label).

6. *Balanophora abbreviata* BL. En. Pl. Jav. 1 (1827) 87; MIQ. Fl. Ind. Bat. 2 (1859) 1065; EICHL. in DC. Prod. 17 (1873) 148; F.-VILL. & NAVES, Nov. App. Blanco Fl. Filip. ed. 3, 1 (1880) 185; KOORD. Exk. Fl. Java 2 (1912) 176, f. 37; STEEN. Arch. Hydrobiol. Suppl. 11 (1932) 301; Trop. Natuur 23 (1934) 49; BACK. & BAKH. f. Fl. Java 2 (1965) 79; HANSEN, Dansk Bot. Ark. 28 (1972) 134, f. 32. — *B. alutacea* JUNGH. Nov. Act. Ac. Caes. Leop.-Car. 18, Suppl. 1 (1841) 205; MIQ. Fl. Ind. Bat. 2 (1859)



Fig. 21. *Balanophora abbreviata* BL. in limestone cave, Castle Hill, Cape Vogel Peninsula, NE. New Guinea (Photogr. HOOGLAND 4334).

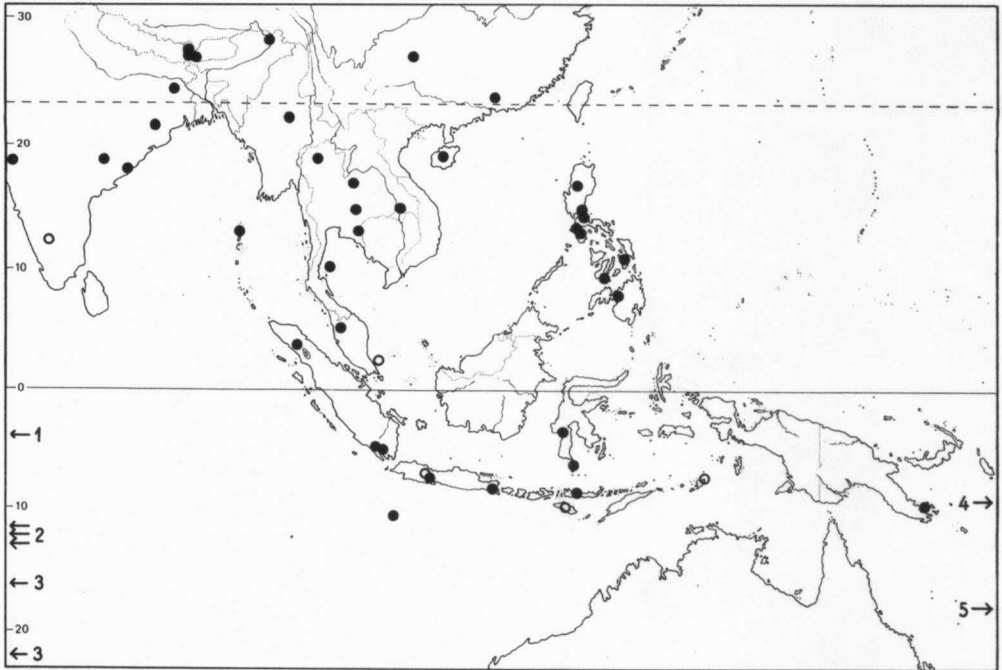


Fig. 22. Range of *Balanophora abbreviata* BL. (● specimens studied, ○ from literature). Occurrence outside map: 1. Africa (Congo), 2. Comores, 3. Madagascar, 4. Marquesas, 5. Tahiti.

1064; ELMER, *Leaflet. Philip. Bot.* 5 (1913) 1659. — *B. zollingeri* FAWC. *Trans. Linn. Soc. Bot.* II, 2 (1886) 234, t. 34. — *B. micrantha* WARB. in Perkins, *Fragm. Fl. Philip.* (1905) 169; ELMER, *Leaflet. Philip. Bot.* 5 (1913) 1659; MERR. *En. Philip.* 2 (1923) 118. — *B. insularis* RIDL. *J. Str. Br. R. As. Soc.* 45 (1906) 218; *Fl. Mal. Pen.* 3 (1924) 175. — *B. trimera* TIEGH. *Ann. Sc. Nat. Bot.* IX, 6 (1907) 148. — *Balaniella abbreviata* (BL.) TIEGH. *l.c.* 181. — *Balaniella alutacea* (JUNGH.) TIEGH. *l.c.* 181. — *B. fawcettii* ELMER, *Leaflet. Philip. Bot.* 5 (1913) 1659. — *B. subglobosa* ELMER, *l.c.* 1660; MERR. *En. Philip.* 2 (1923) 118. — *Acroblastum fawcettii* (ELMER) SETCH. *Un. Cal. Publ. Bot.* 19 (1935) 146. — *Acroblastum insulare* (RIDL.) SETCH. *l.c.* 147. — *Acroblastum subglobosum* (ELMER) SETCH. *l.c.* 147. — *B. sarasinorum* WARB. ex HARMS in E. & P. *Nat. Pfl. Fam. ed. 2*, 16b (1935) 333, *nom. nud.* — Fig. 21.

Monoecious plants (inflorescences bisexual), creamy-white to pale yellow. Length from fusion with host root to top of inflorescence (3–) 5–10 (–15) cm. Tubers single, or several together in a mass, branching from the base. Single tubers obconical, narrow at base, broadening near top to (1–) 1.7 (–2) cm, length (1–) 2½ (–3½) cm. Surface fine granular, with or without scattered stellate warts. Leaves 3–7, distichous, evenly spaced, slightly imbricate 1–2 by ¾–1½ cm, ovate, obtuse or emarginate. ♂ Flowers 10–20, in a zone ½–2 cm high below ♀ part of inflorescence (Hainan material

with a few (3–8) ♂ flowers also at top of the ♀ part). Pedicels extremely short, c. 1 mm, or flowers sessile. ♂ Flower (3–) 4–5 (–8)-merous, bisymmetric or slightly to conspicuously zygomorphic on account of lateral elongation. A 4-merous flower will have 2 narrow, ovate, acute lateral tepals, and 2 wide, truncate, almost square median tepals. Length of tepals 1½–2 mm. Synandrium with fertile part about 1 mm long, slightly compressed, lateral width 1½–2 mm, anterior-posterior width ½–¾ mm. Anthers divided into 16–20 parallel loculi, running from base to top of synandrium, or the loculi may be transversally divided into smaller locelli. ♀ Inflorescence ovoid, (1–) 1½ (–2½) by (1½–) 1 (–2¼) cm. Spadicles 850–1000 μ long with a lower cylindrical part 140–180 μ wide, and an upper, obconical, truncate, part 400–500 μ wide. ♀ Flowers on main axis of inflorescence as well as on lower part of spadicles. Largest flowers with pistils 950–1100 μ long, ovaries ovoid to ellipsoid, 300–450 μ by 175–250 μ.

Distr. Africa (Congo), Comores, Madagascar, SW. China, Hainan, Indian and Indo-Chinese subcontinents, Andamans, throughout Malesia (but very scattered and not yet known from Borneo and the Moluccas), and in the Pacific (Tahiti, Marquesas). Fig. 22.

Ecol. From about sea-level to 1000 m, mostly in evergreen forests. Flowering season in Malesia May–Jan. Hosts recorded: *Tetrameles nudiflora* R. BR. (*Datisc.*), *Hibiscus tiliaceus* L. (*Malv.*), *Ficus*

baroni BAKER, *F. cocculifolia* BAKER ssp. *sakalavarum* BAKER, *F. tinctoria* L. f. (Morac.).

Note. Distinguished from *B. fungosa* ssp. *fungosa* by its distichous leaves and by the pedicels of ♂ flowers being very short or absent. Flowering specimens may occur 3 m high above the soil in *Ficus* specimens (RANT in sched.).

7. *Balanophora latisejala* (TIEGH.) LECOMTE, Fl. Gén. I.-C. 5 (1915) 228; HANSEN, Dansk Bot. Ark. 28 (1972) 140, f. 37, 38. — *Balaniella latisejala* TIEGH; Ann. Sc. Nat. Bot. IX, 6 (1907) 184. — *B. truncata* RIDL. J. Linn. Soc. Bot. 41 (1913) 296; Fl. Mal. Pen. 3 (1924) 174; BURK. & HEND. Gard. Bull. S. S. 3 (1925) 419; CALDER et al. Rec. Bot. Surv. India 11 (1926) 16; HEND. Gard. Bull. S. S. 4 (1927) 102. — *B. multibrachiata* (non FAWC.) HEND. J. Mal. Br. R. As. Soc. 5 (1927) 266; MERR. Contr. Arn. Arb. 8 (1934) 54 p.p. — Fig. 23.

Dioecious plants (inflorescences unisexual), yellowish white to yellow or grey. Length from fusion with host root to top of inflorescence 10–25 cm. Tubers in a mass, branching from the base. Single tuber subspherical-ellipsoid, 2–4¹/₄ by 1³/₄–2¹/₂ cm. Surface of tubers fine granular with few to numerous stellate warts. Stem mostly long and slender, ³/₄–1¹/₄ cm ø below inflorescence.

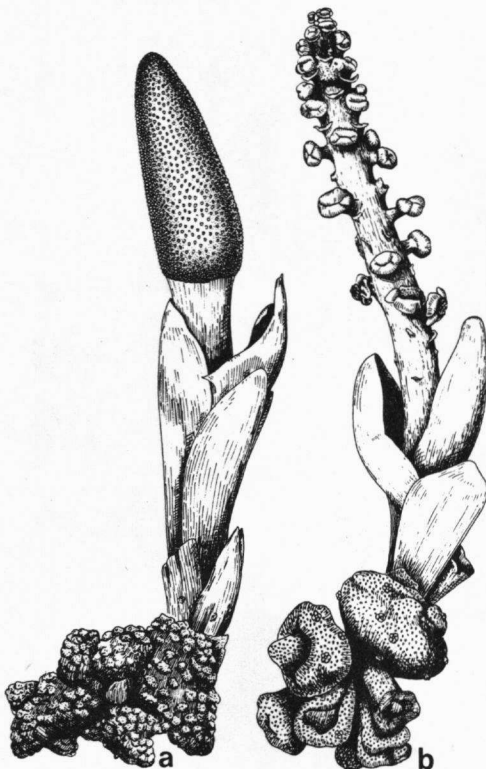


Fig. 23. *Balanophora latisejala* (TIEGH.) LEC. left, ♂ right (after HANSEN, 1972, 141–142, fig. 37–38), both × ³/₄.

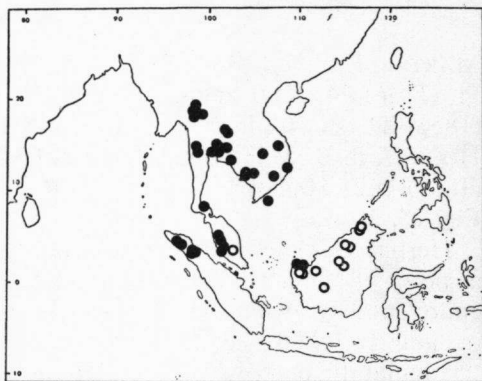


Fig. 24. Range of *Balanophora reflexa* BECC. (○) and *B. latisejala* (TIEGH.) LEC. (●).

Leaves 3–4 (–6), well spaced, distichous, patent. ♂ Inflorescence long-ellipsoid, 5–9 cm long and 1¹/₂–2¹/₂ cm wide with flowers expanded. Bracts truncate, c. 3 mm long and 5 mm wide, sometimes with the middle part reduced and thus appearing like two teeth. Pedicels (1¹/₂–) 2–3 (–6) mm long. ♂ Flowers bisymmetric or zygomorphic on account of lateral elongation and correspondingly compressed in anterior-posterior direction, 4–5 (–9–14)-merous. A normally developed 4-merous flower will have two narrow, ovate, acute lateral tepals 3–3¹/₂ by 1¹/₂–2 mm and two wide, nearly square, truncate median tepals 3–3¹/₂ by 3–4 mm. In a 5-merous flower the upper median tepal is normally split into two. Higher numbers of tepals may be caused by further splitting up of median tepals or simply by fusion of neighbouring flowers. Synandrium with fertile part laterally elongated, somewhat compressed in anterior-posterior direction. Anther cells 16–20 or more, parallel, always running from base to top of synandrium, opening longitudinally. ♀ Inflorescence (1–) 4–6 (–7) cm long and (1¹/₂–) 1–1¹/₂ (–2) cm wide, long-ellipsoid or almost cylindrical with obtuse top part. Spadicles (730–) 1050 (–1270) μ long, lower part cylindrical, c. 100 μ wide, upper part obovoid, 300–600 μ wide, about ¹/₃ of total length of spadicle. ♀ Flowers on main axis of inflorescence as well as on spadicles, the largest flowers being those on the main axis. Largest flowers with pistils (845–) 1070 (–1300) μ long. Ovaries ovoid, (300–) 360 (–400) μ long.

Distr. Indo-China, Thailand, in *Malesia*: Malaya, N. Sumatra, Borneo (Sarawak, twice). Fig. 24.

Ecol. In various kinds of forest, from 1200–1700 m. Flowering season in Malaya, Sumatra, and Borneo probably all year round, but more records are necessary. Parasitizing various trees and climbers. Hosts recorded: *Gymnema* sp. (Ascl.), *Bambusa* sp. (?) (Gram.), *Ficus religiosa* L. (Morac.), *Sterculia* sp. (Sterc.), *Tetrastigma* sp. (Vitac.).

Note. Distinguished from *B. polyandra* in the anther cells not being transversally divided into smaller locelli.

4. LANGSDORFFIA

MART. in Eschw. J. Bras. 2 (1818) 179; Nov. Gen. Sp. Pl. 3 (1832) 182; ENDL. Gen. Pl. (1836) 74; KLOTZSCH, Linnaea 20 (1847) 460; HOOK. f. Trans. Linn. Soc. 22 (1856) 29; EICHL. in Mart. Fl. Bras. 4, 2 (1869) 9; in DC. Prod. 17 (1873) 140; HOOK. f. in B. & H. Gen. Pl. 3 (1880) 236; ENGL. in E. & P. Nat. Pfl. Fam. 3, 1 (1889) 262; HARMS in E. & P. Nat. Pfl. Fam. ed. 2, 16b (1935) 335, f. 169. — Fig. 25, 26.

Herbaceous, fleshy parasites. *Tubers* elongated, cylindrical, somewhat swollen at point of contact with the host root, more or less hairy. *Inflorescences* appearing endogenously from the cylindrical parts of tubers, basally surrounded by an irregularly lobed sheath. *Stem* in lower part with numerous spirally arranged, triangular to narrowly triangular, pergamentaceous, acute scales, exceeding the flowers; flower-bearing apex of stem flattish or slightly convex. *Inflorescences* unisexual with trimerous, pedicellate ♂ flowers or with very numerous ♀ flowers apparently laterally connate in their lower parts, having a short tubular perianth and one style.

Distr. 3 spp., one in Madagascar (*L. malagastica* (FAWC.) HANSEN, Bot. Tidsskr. 69, 1974, 59), one in Malesia (New Guinea), and one in Central and tropical South America (*L. hypogaea* MART.). Fig. 6.

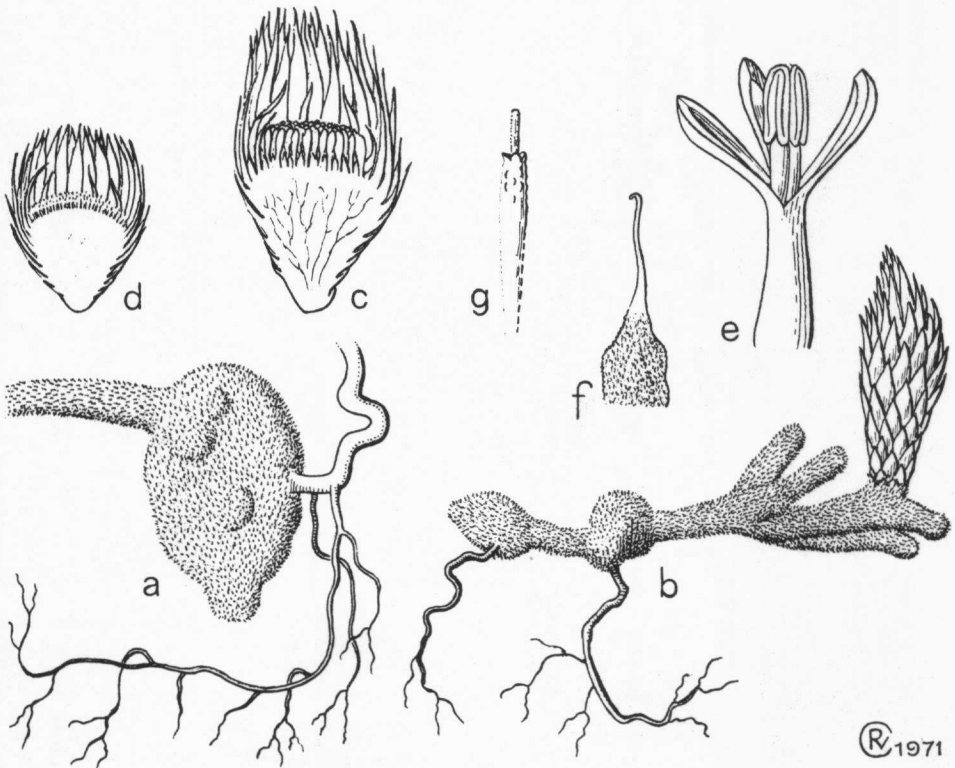


Fig. 25. *Langsdorffia papuana* GEESINK. a. Swollen part of tuber with part of root of the host, b. tuber with young inflorescence, c. LS through a nearly full-grown ♂ capitulum, d. ditto, ♀ capitulum, all $\times \frac{1}{2}$, e. ♂ flower, f. reduced scale between ♂ flowers, both $\times 3$, g. ♀ flower, $\times 6$ (after GEESINK, 1972).

1. *Langsdorffia papuana* GEESINK, Acta Bot. Neerl. 21 (1972) 104, f. 1 — *Langsdorffieae* indet.: WOMERSLEY & STREIMANN, Proc. Papua & New Guinea Sci. Soc. 22 (1970) 31–34. — Fig. 25, 26.

Yellowish to reddish parasites with unisexual inflorescences. *Tuber* cylindrical, c. 1 cm \varnothing , swollen up to 3 cm \varnothing at the point of contact with host root, densely patently hairy, less so at swollen parts. *Inflorescences* surrounded at base by a 5–8-lobed sheath. Inflorescence-bearing stem obconical, $2\frac{1}{2}$ –5 cm long, in upper part 3–5 cm \varnothing , in lower part c. 1 cm \varnothing , with numerous adpressed, pergamentaceous, imbricate, scaly leaves. *Leaves* creamy stramineous to reddish with brown tips, lower ones triangular $\frac{1}{2}$ by $\frac{1}{2}$ cm, upper ones narrowly triangular, up to 5 by 1 cm. ♂ *Inflorescence* carrying among the flowers reduced, reddish scales with a papillose base. ♂ *Flowers* 1 cm by 3 mm when not expanded, creamy yellow. Pedicels $\frac{3}{4}$ cm. Tepals (2–) 3, elliptic, boat-shaped, valvate, c. $\frac{3}{4}$ cm by 3 mm. Stamens (2–) 3, epitepalous, filaments united into a tube c. $2\frac{1}{2}$ mm long. Anthers with their connectives united up to $\frac{1}{3}$ of their length, ovate-elliptic, emarginate at the base, rounded at apex, c. 4 by 2 mm, 2-celled and horseshoe-shaped with the bend upwards. ♀ *Flowers* inserted very close to each other, apparently laterally connate in lower parts. Style up to halfway surrounded by a tubular, apically shortly 4–6-lobed perianth up to 1.3 by 0.4 mm; exerted part of the style c. 1.3 by 0.2 mm, surface cells somewhat swollen. Ovary apparently without cavity. The diaspore consists of embryo + endosperm surrounded by 2–3 layers of sclereid cells and is dispersed upon the decay of the infructescence.

Distr. *Malesia*: E. New Guinea. Fig. 6.

Ecol. Parasitizing roots of *Vaccinium* sp. (*Eric.*), *Eugenia* sp., *Metrosideros eugenioides* (SCHLTR) STEEN. (*Myrt.*) and *Meliosma pinnata* (ROXB.) WALP. (*Sab.*). Upper part of flowering heads appears above humus layer in *Nothofagus* forest at 1500 m.



Fig. 26. *Langsdorffia papuana* GEESINK. New Yamap, Head of Baime Creek, Wau Subdistr., E. New Guinea ($7^{\circ} 08' S$, $146^{\circ} 46' E$), 1500 m, two spadices, one in bud (above, 4 cm wide), one in anthesis (below) (Photogr. STREIMANN, NGF 44461).

Doubtful

Cynomorium philippinense BLANCO, Fl. Filip. (1837) 665; ed. 2 (1845) 464; ed. 3, 3 (1879) 72; MERR. Sp. Blanc. (1918) 134; En. Philip. 2 (1928) 119.

This is a *Balanophora*. According to the description it is a monoecious plant, and might belong to *B. fungosa*, but the imperfect description makes identification uncertain.