

TAXONOMIC REVISION OF THE GENUS *OPHIORRHIZA* L. (RUBIACEAE) IN INDIAN SUBCONTINENT

D.B. DEB AND D. C. MONDAL *

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A B S T R A C T

The present study on the taxonomic revision of *OPHIORRHIZA* L. (Rubiaceae) in Indian subcontinent was carried out on the basis of specimens extant in the Indian Herbaria and some received on loan from several foreign herbaria. 47 species and 9 extra typical varieties are described with original citations, synonymy, typification, distribution, phenology and ecology. 4 species and 1 variety proposed as new have been described earlier. 4 varietal combinations have been made and published. One newly described species is reduced here to the status of a variety. For identification of taxa two sections and a dichotomous key are given.

INTRODUCTION

The term 'OPHIORRHIZA' is derived from the greek terms 'Ophis' a snake and 'rhiza', a root alluded to healing properties in snake bite in Indian subcontinent particularly *O. mungos* L. and *O. japonica* Bl. (G. Don 1834).

Linnaeus described the genus *OPHIORRHIZA* (as *OPHIORHIZA*) in *Flora Zeylanica* (Linnaeus 1747) and included in *Materia Medica* (1749), *Species Plantarum*

(1753) and *Genera Plantarum* (1754).

Sp. Pl. (Linnaeus 1753) included 2 species. *O. mitreola* based on Houston's genus *MITRA* (*MITREOLA* of *Hortus Cliffortianus*) is now usually recognized as a species of *MITREOLA* L. ex Schaeffer. In *Gen.Pl.* Linnaeus (1754) published *OPHIORRHIZA* with altered spelling. However, the spelling has uniformly been corrected to *OPHIORRHIZA*. David Don (1825) placed the genus in the Rubiaceae being followed by all subsequent workers.

J. D. Hooker (1880), *Fl. Brit. India* described the genus *OPHIORRHIZA* L. with 31 species and 10 varieties. Subsequently,

*Present address: Department of Agriculture,
University of Santiniketan, Sriniketan, Birbhum
Dist, West Bengal.

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W. G. Craib (1911), J. S. Gamble (1919, 1920), S. T. Dunn (1920) and C. E. C. Fischer (1938, 1939, 1940) described 11 more species mostly on determination of the specimens extant in the herbarium. In the meantime Trimen (1895) and D. Chatterjee (1939) discussed on endemism of the genus. Accumulation of material in herbaria for over a century after Hooker's work necessitated a taxonomic revision of the genus in the Indian subcontinent. The study was completed in 1984, when one of the authors (D.C. Mondal) submitted on it a thesis for Ph.D. degree of the University of Calcutta, that was soon awarded. Unfortunately the circumstances stood beyond control all these years to process the work in the form of a paper for publication. However, 4 new species and one new variety postulated have been published. Other workers also published several new taxa.

The paper presents 47 species and 9 extra typical varieties with original citations, synonymy, typification, distribution, phenological and ecological observations. One newly described species is reduced here to the status of a variety.

Watt (1891), Dey (1896), Kirtikar & Basu (1935), Chopra *et al.* (1956), Agarwal & Dhar (1959) compiled the economic importance and chemical composition of roots, stems and leaves of *O. mungo* L.

The authors described partially and illustrated the following threatened and endangered plants in Nair & Sastry (1987,

1988) Red Data Book of Indian Plants Vols. I & II. : 1. *Ophiorrhiza barnesii*, 2. *O. brunonis*, 3. *O. caudata*, 4. *O. incarnata*, 5. *O. pycarensis*, 6. *O. wattii*, 7. *O. gracilis*, 8. *O. griffithii*, 9. *O. hispida*, 10. *O. lurida*, 11. *O. radicans*, 12. *O. subcapitata* and 13. *O. tingens*.

Very little work has been done on anatomy, cytology, palynology, embryology etc. Chromosome numbers as $n = 11$ was reported for *O. harrisiana* Heyne and *O. mungos* L. by Love (1976) and Mathew & Philip (1979) respectively. Corner (1976) observed that endosperm formation in the family is nuclear but cellular in OPHIORRHIZA (particularly *O. mungos*) and TARENNA. Mathew & Philip (*l.c.*) reported exceptional type of pollen development in *O. mungos*.

MATERIAL AND METHODS

The present investigation is based mostly on herbarium specimens collected from Indian subcontinent as accumulated in different Indian and foreign herbaria.

Qualitative and quantitative characters of each and every specimen, as far as possible, have been carefully studied so as to check any variation or difference that may occur. Acronyms of the herbaria following Index Herbariorum have been mentioned against each specimen cited. Taxonomic ranks and nomenclature of taxa of all levels have been scrutinized and studied. Correct names and synonyms as per International Code of Botanical

Nomenclature (ed. 1983) have been given. Type specimens have been examined in most cases and indicated with the exclamation marks after the acronyms of the herbaria where there are extant. In case of nonavailability of the type, microfiche or photographs have been consulted. Dichotomous key has been prepared for identification of taxa of all levels. Data on the flower colour, flowering and fruiting time, ecology, altitude and uses etc. of the species have been gathered from the collector's observations and from the literature. A note regarding some points of taxonomic or other interest has been given wherever necessary.

MORPHOLOGICAL CHARACTERS

Habit : The species of *OPHIORRHIZA* vary in habit from creeping herbs to small shrubs up to 3 m high, growing in humid regions at varying altitudes. Most of them are erect, suffrutescent, some are prostrate, and a few creeping.

Indumentum : The hairs are of three types (Fig:1). They are up to 1 mm long, straight, uniseriate and of 6-20 cells, commonly found on stem, leaf, inflorescence and hypanthium. Hairs on lower surfaces of leaves are comparatively longer with lesser number of longer cells. The basal cell is broader and the apical cell very narrow and often pointed. In the second type the hair is very short, consisting of 2-3 cells, somewhat bent and the apical cell is not pointed. Sometimes

both multicellular straight hairs and unicellular bent hairs occur on the nerves beneath the leaves as in *O. ochroleuca*. In the third type the hair is elongated and unicellular, with subparallel or undulate walls, present inside the corolla tube. The hairs are without any crystal and never glandular or bulbous.

Raphides : Needle like crystals clustered in ellipsoid sacs called raphides are present in stems, leaves, floral parts and capsules. Raphides are found in the outer tissues of the leaf and petiole of *O. treutleri*, calyx lobes of *O. pectinata*, corolla and calyx lobes of *O. pykarensis*, ovary, placenta and capsule of *O. codyensis*, *O. caudipetala*, *O. grandiflora*, *O. mungos*, *O. tingens*, *O. villosa* and *O. wallichii*; calyx lobes, ovary, placenta and disc of *O. fasciculata*.

Leaves and stipules : The leaves are often unequal in opposite pair, petiolate, stipulate, entire and membranous. They vary greatly in size and shape e.g. the lamina of *O. glechomaefolia* are 0.6-1.8 cm long, whereas in *O. ochroleuca* they are 3.5-22.5 cm long. The shape varies from elliptic to lanceolate, sometimes ovate-orbicular as in *O. pauciflora* or ovate-cordate as in *O. radicans* and *O. glechomaefolia*. Usually the leaves are acute to acuminate at apex, sometimes obtuse as in *O. radicans*. They are acute to attenuate at base. In *O. radicans* and *O. glechomaefolia* the leaf base is somewhat rounded or cordate. The lower surface of

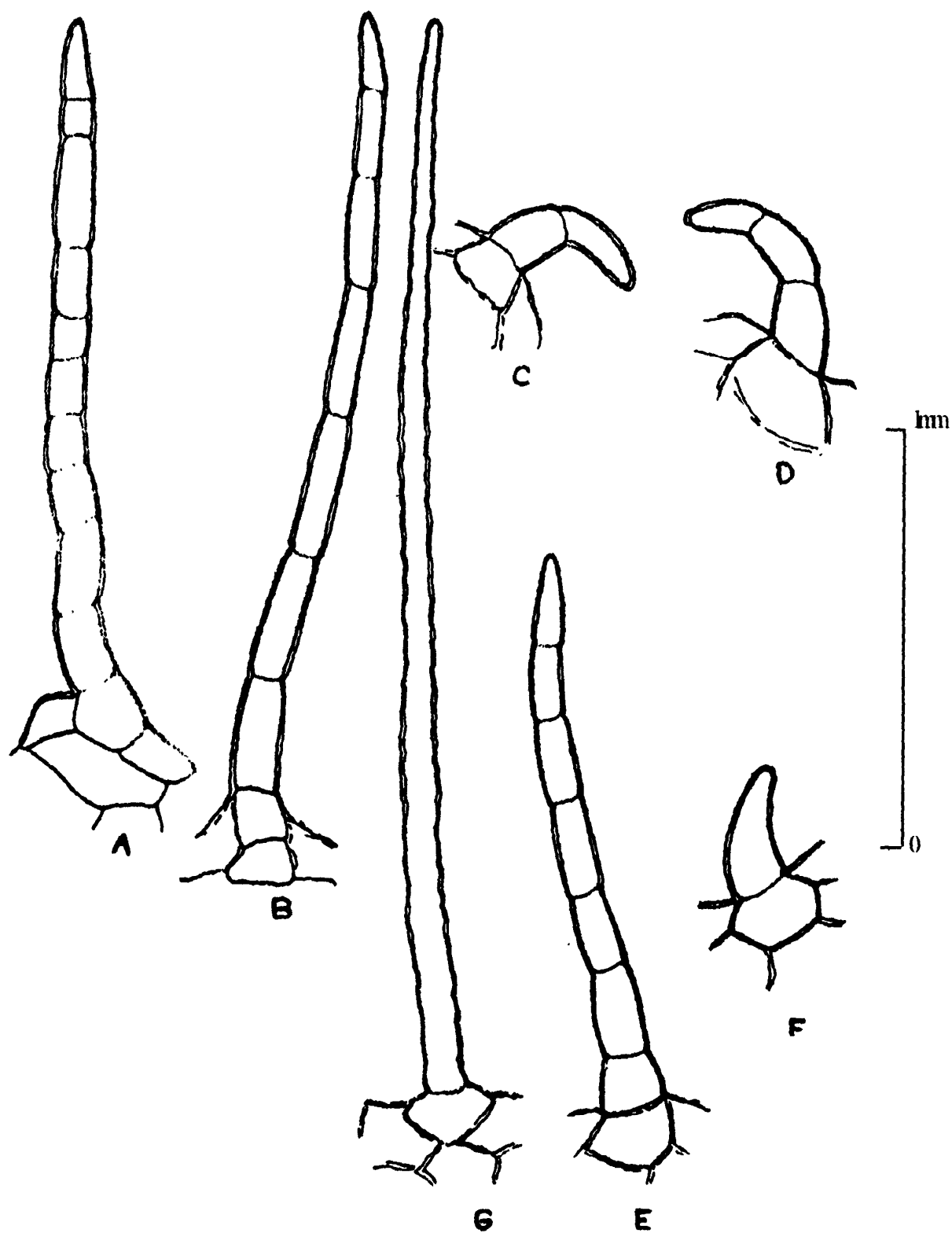


Fig. 1. Hair types of OPHIORRHIZA (figs A-G) : A. petiole hair of *O. hirsutula*; B. calyx hair of *O. hispida*.
 C and D. stem hairs of *O. incarnata* and *O. munnarensis*; E. hair of corolla inside of *O. subcapitata*;
 F and G. multicellular straight hair and unicellular curved hair of stem of *O. ochroleuca*.

the leaf is gradually pale on drying, but reddish in *O. succirubra* and *O. tingens*. Lateral nerves vary from 3 to 19 on either side of the midrib. In *O. lacei* and *O. lurida* the nerves are very close set in relation to size of the leaves. In *O. heterostyla* the nerves are distant though the leaves are moderately long.

The stipules are interpetiolar, varying greatly in size, shape and persistence. They can be recognized into 3 groups : (1) Stipules are setaceous to linear with broad membranaceous base in most of the species; (2) They are large and membranaceous in *O. calcarata*, *O. eriantha*, *O. grandiflora*, *O. griffithii*, *O. subcapitata*, etc. (3) they are minute, coriaceous, deltoid or triquetrous in *O. mungos*, *O. pykarensis*, *O. wallichii*, etc. The stipules are very large, broadly ovate, with many converging nerves in *O. codyensis* and are the largest in Indian species. Seemann (1866) considered the stipular apex as an important taxonomic character, but it is not so with respect to Indian species. The stipular apex is quite variable in *O. mussaendiformis* where it is ensiform and entire or 2-3 fid even in the same specimen. (Fig.2)

Inflorescence and flowers : Inflorescence is usually terminal cymes with helicoid branches. It is both terminal and axillary in *O. brunonis*, *O. hirsutula*, *O. oppositiflora*, etc. In a few species it is only axillary as in *O. barberi*, *O. barnesii*, *O. codyensis*, etc. In some species the inflorescence is corymbose

cyme as in *O. tingens*, *O. grandiflora*, *O. roxburghiana*, etc. In *O. barberi* it is scorpioid cyme and very spreading with deciduous, scattered bracts and bracteoles. In *O. subcapitata* and *O. villosa* it is somewhat subumbellate or subcapitate cyme, very condensed. In *O. villosa* bracts and bracteoles are absent whereas in *O. subcapitata* the base of inflorescence is encircled by a whorl of bracts. In *O. caudata*, *O. hispida*, *O. incarnata*, *O. munnarensis* and *O. pectinata* the branches being more reduced, form a capitate cyme which is concealed by a number of well developed, persistent bracts. (Fig.3)

The length of peduncle is also variable, as for example, 1-6 cm long in *O. nutans*, *O. thomsonii*, etc. and 1-8 cm long in *O. fasciculata*. Sometimes it becomes elongated with the maturity of fruits as in *O. barnesii*, *O. candipetala*, etc. The peduncle is short in *O. heterostyla*, *O. hispida*, *O. wattii*, etc. and is not elongating with the maturity of fruits. It is usually erect but sometimes deflexed as in *O. nutans* or drooping at first then erect as in *O. succirubra*.

The flowers are usually secund on the branches of axillary or terminal dichotomous, trichotomous, corymbose or capitate cymes. The flower is pentamerous, with 2 carpels and inferior ovary, gamosepalous calyx, gamopetalous corolla, epipetalous stamens and style with usually 2-lobed stigma. The flower varies from 3.5

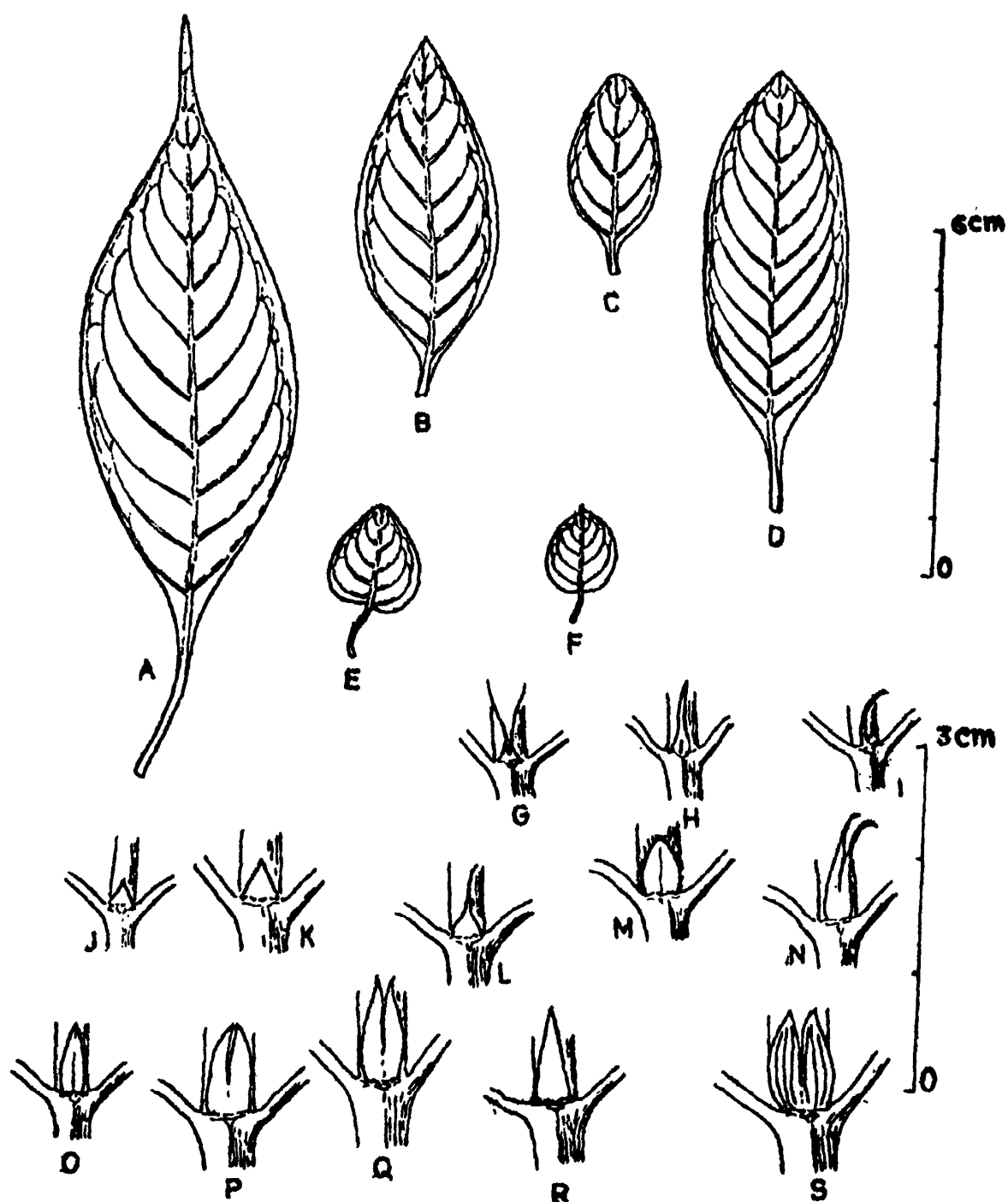


Fig.2. Lamina types of OPHIORRHIZA (figs. A-F) :

A. *O. rosea* (elliptic-lanceolate, acuminate); B. *O. hispida* (ovate-lanceolate, acute); C. *O. pauciflora* (ovate-obtuse); D. *O. lurida* (elliptic-oblong, acute); E. *O. radicans* (ovate-cordate, obtuse); F. *O. glechomaefolia* (ovate-orbicular, apiculate). Stipule types of OPHIORRHIZA (figs G-S); G. *O. rugosa* (filiform from triangular base, bifid); H. *O. lurida* (linear with broad base); I. *O. pallida* (setaceous); J. *O. pykarensis* (triangular, acuminate); K. *O. mungos* (triangular, acute); L. *O. rosea* (ovate with long apex); M. *O. subcapitata* (ovate); N. *O. mussaendiformis* (ensiform, 2-fid); O. *O. grandiflora* (narrowly lanceolate); P. *O. roxburghiana* (ovate-oblong, bifid); Q. *O. eriantha* (lanceolate, bifid); R. *O. hirsutula* (subulate); S. *O. codyensis* (broadly ovate).

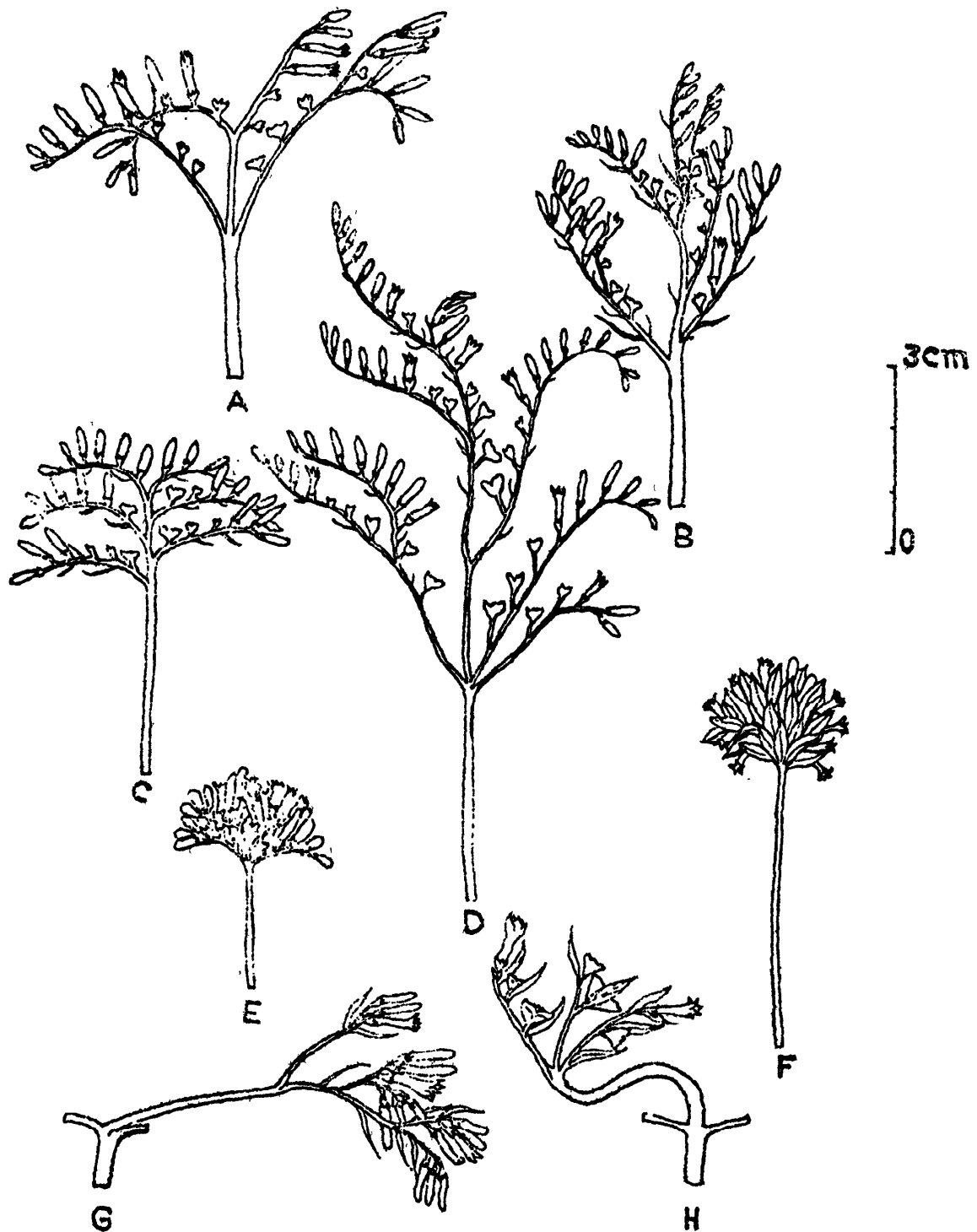


Fig. 3. Inflorescence types of *OPHIORRHIZA* (figs. A-H) :
 A. *O. ochroleuca*; B. *O. rosea*; C. *O. lacei*; D. *O. barberi*; E. *O. villosa*;
 F. *O. pectinata*; G. *O. nutans*; H. *O. succirubra*.

mm to 40 mm in length varying sometimes in the same species, as in *O. brunonis* 6.5 mm to 17.25 mm, in *O. grandiflora* 20 mm to 40mm, in *O. roxburghiana* 23 mm to 40 mm.

Bracts and bracteoles : Presence or absence of bracts and bracteoles was considered by Schumann (1891) to be of considerable importance in defining species groups within the genus. Bracts are present in most of the species but completely lacking in *O. mungos*, *O. trichocarpa* and *O. villosa*. In some species the bracts are poorly developed, minute, subulate and scattered, falling off before the maturity of fruits as in *O. ochroleuca*, *O. oppositiflora*, *O. rosea*, *O. rugosa*, etc. In *O. eriantha*, *O. grandiflora*, *O. hirsutula* and *O. roxburghiana* the bracts are linear, slender, and often with pubescent margin and midvein. They are usually persistent. In some species they are well-developed, glabrous or pubescent or rarely ciliate with prominent midvein and persistent. They are lanceolate in *O. fasciculata*, *O. lurida*, *O. thomsonii*, *O. treutleri*, etc. and oblong-lanceolate in *O. caudata*, *O. incarnata*, *O. pectinata*, etc.

Calyx : The calyx consists of five lobes above the hypanthium. They are small, deltoid, subulate, ovate or lanceolate. Small triangular, deltoid to ovate calyx lobes are of common occurrence. In *O. brunonis*, *O. eriantha*, *O. pectinata*, *O. radicans*, *O. thomsonii*, *O. trichocarpa* and *O. wallichii*

the calyx lobes are subulate. In *O. repens*, *O. glechomaefolia*, *O. hirsutula*, *O. nicobarica*, *O. pallida* and *O. roxburghiana* the calyx lobes are lanceolate to linear-lanceolate. In *O. hispida* they are ovate to ovate-lanceolate. The lobes are usually shorter than or as long as hypanthium. In *O. glechomaefolia*, *O. nicobarica*, *O. pallida*, *O. radicans* and *O. roxburghiana* the lobes are longer than hypanthium.

Hypanthium is usually as long as ovary and fused with ovary wall. It is usually obovoid and often ribbed.

Corolla : The corolla is white to pinkish-white in most of the species. But in some species it is variable in colour. In *O. fasciculata*, *O. oppositiflora*, *O. wallichii* corolla is white and purple, in *O. caudipetala* and *O. mungos* white, pinkish-white, greenish-yellow or sometimes rosy. In *O. ochroleuca* it is yellow-orange or brownish chocolate. In *O. pykarensis* the corolla is pale-blue. The form of corolla also varies. In most cases the corolla is narrowly infundibuliform. Sometimes it is somewhat salver-shaped as in *O. heterostyla* and *O. nepalensis*, occasionally cylindrical as in *O. ochroleuca*, broadly infundibuliform in *O. eriantha*, *O. grandiflora* and *O. roxburghiana*. Generally the corolla tube is several times longer than lobes but the tube and lobes are equal in *O. nepalensis*. The lobes are half as long as the tube in *O. heterostyla*. The

tube is bulbous at base and constricted at middle in *O. borii*. In *O. heterostyla* the tube is bulbous at base in one form and cylindric in the other form. The interior of the corolla is usually villous with a ring of hairs, ± 1 mm long. But in a few species, the interior is glabrous as in *O. gracilis*, *O. lurida*, *O. pallida* and *O. succirubra*. The position of the villous ring within the corolla varies greatly depending on the position of the stamens. The exterior of the corolla varies from glabrous to hirsute. Usually they are glabrous. They are villous in *O. eriantha* and *O. mussaendiformis*, hispid in *O. glechomaefolia* and *O. hispida*, hirsute in *O. hirsutula* and *O. treutleri*. In *O. grandiflora* the corolla tube is pubescent outside only along the veins towards the base.

The corolla lobes are usually ovate to ovate-lanceolate with straight acute apex. They are ovate-oblong in *O. fasciculata*, *O. tingens*, *O. tirunelvelica* and *O. wattii*, linear-oblong to linear in *O. heterostyla* and *O. nepalensis*. In some species the apices of the lobes are inwardly curved and keeled at the back as in *O. borii*, *O. mussaendiformis*, *O. nicobarica*, *O. wattii*, etc. In *O. repens* and *O. ochroleuca* the lobes are ovate, erect with a short or long, recurved spur at the back. In *O. griffithii* and *O. pallida* the lobes are winged at the back, it is extended to the base of corolla in *O. griffithii*. In *O. caudipetala* the lobes are ovate to ovate-lanceolate with acute

inwardly curved apex and a glandular coloured horn at the back. (Fig.4)

Androecium : Five stamens are adnate to the corolla tube at various levels. In heterostylous species, especially in *O. heterostyla*, *O. incarnata*, *O. nutans* and *O. pauciflora*, the stamens are adnate at the middle of the corolla tube in one form and slightly above the base in the other form. Filaments vary greatly. They are shorter than or equal to or longer than the anther. In the heterostylous species, especially in *O. heterostyla* and *O. nicobarica*, in one form the filament is shorter and in the other form it is longer than the anther. (Fig.5)

The anthers are linear-oblong, 2-lobed, dorsifixed slightly above the base and longitudinally dehiscent.

Pollen grain : The pollen grain is isopolar, radiosymmetric, tricolporate as well as rarely tetra-colporate as in *O. hirsutula*, *O. nutans*, *O. rugosa* var. *decumbens*, *O. tingens* and *O. treutleri* where 80% grains are tri-colporate and 20% tetra-colporate ; oblate-spheroidal to prolate-spheroidal, suboblate in some species like *O. barberi*, *O. barnesii*, *O. caudipetala*, *O. eriantha*, *O. roxburghiana*, etc., subprolate in *O. fasciculata*, angular in polar out line or semi-circular as in *O. oppositiflora*, *O. pykarensis* and *O. roxburghiana* (Fig.7). The polar axis is 24-46 μm long and the equatorial axis is 26-50 μm long; both axes are often equal in *O. calcarata* and *O. ochroleuca* when the grain

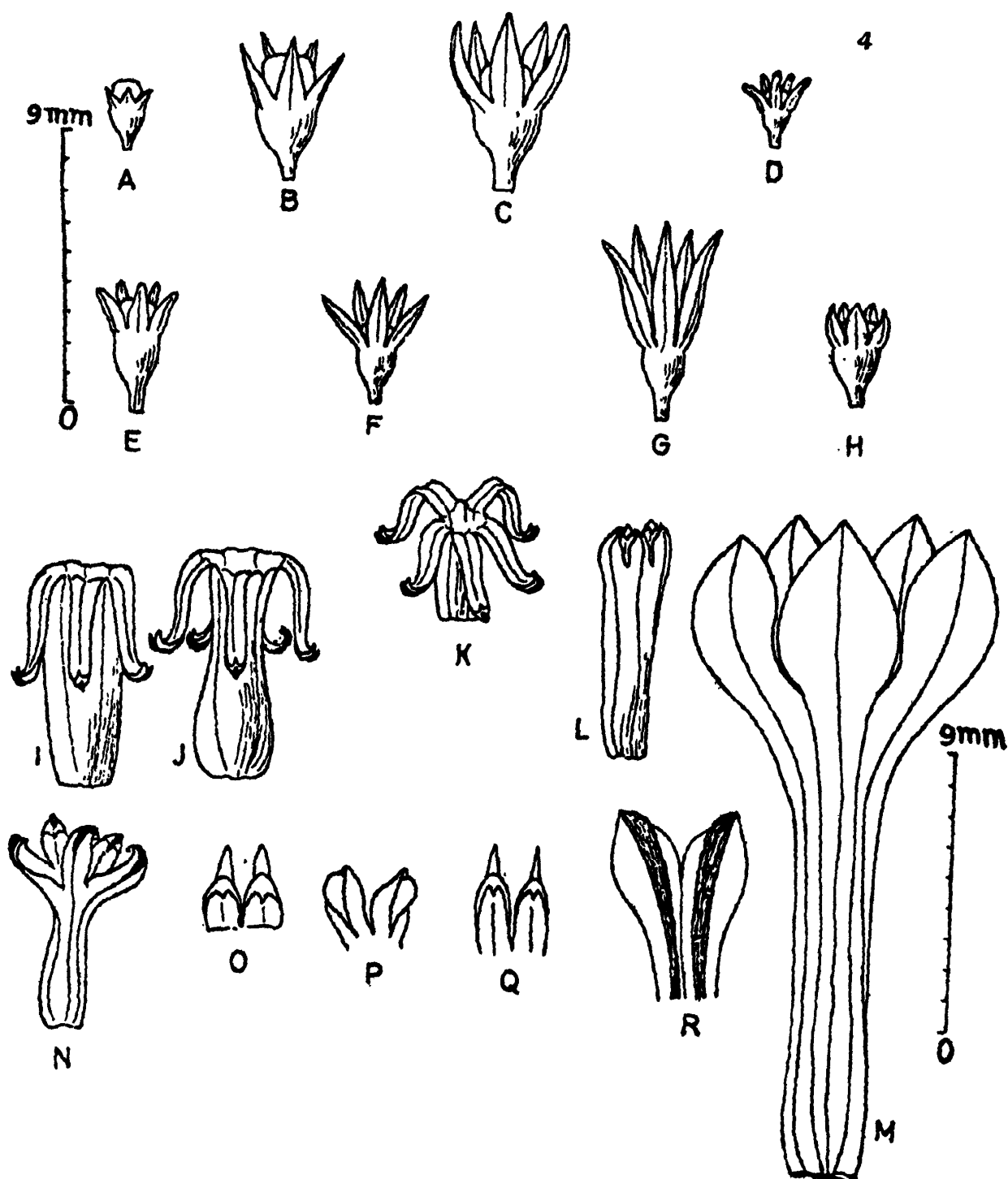


Fig.4. Calyx types of OPHIORRHIZA (figs. A-H) :

- A. *O. mungos* (calyx lobes triangular); B. *O. eriantha* (calyx lobes subulate); C. *O. roxburghiana* (calyx lobes lanceolate); D. *O. pallida* (calyx lobes linear-lanceolate, obtuse); E. *O. hirsutula* (calyx lobes lanceolate, obtuse); F. *O. glechomaefolia* (calyx lobes linear-lanceolate); G. *O. nicobarica* (calyx lobes linear-lanceolate); Corolla types of OPHIORRHIZA (figs. I - R): I and J. *O. heterostyla*; K. *O. nepalensis*; L. *O. ochroleuca*; M. *O. roxburghiana*; N. *O. borii*; O. *O. calcarata* (corolla lobes spurred); P. *O. pallida* (corolla lobes winged); Q. *O. caudipetala* (corolla lobes horned); R. *O. griffithii* (corolla winged).

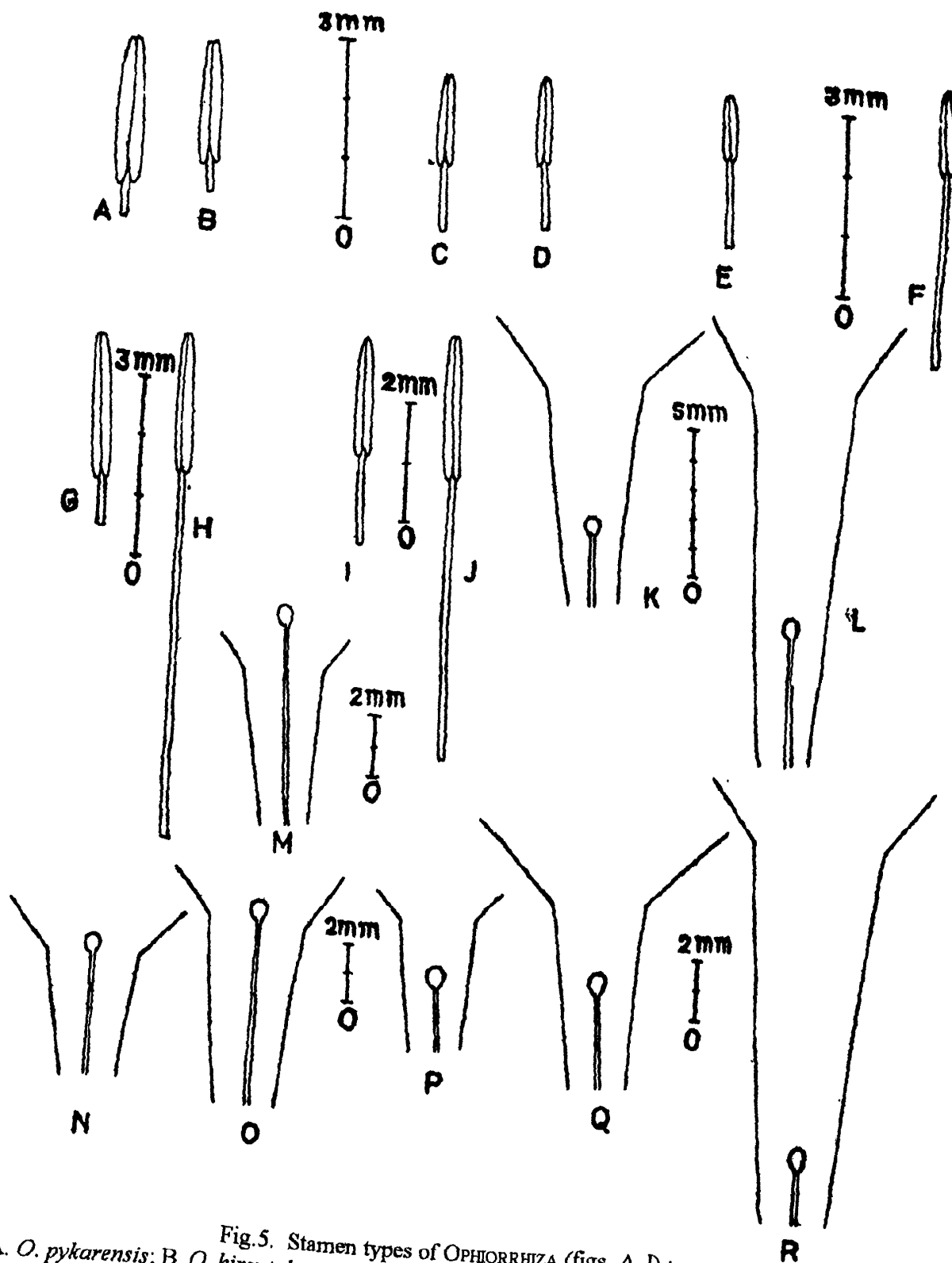


Fig. 5. Stamen types of *OPHIORRHIZA* (figs. A-J) :
 A. *O. pykarensis*; B. *O. hirsutula*; C. *O. thomsonii*; D. *O. pallida*; E. *O. lurida*; F. *O. nepalensis*;
 G and H. *O. nicobarica*; I and J. *O. heterostyla*.
 Style types of *OPHIORRHIZA* (K - R): K. *O. barnesii*; L. *O. waltii*; M. *O. borlii*; N. *O. thomsonii*;
 O. *O. codyensis*; P. *O. subcapitata*; Q. *O. tirunelvelica*; R. *O. fasciculata*.

is essentially spheroidal. There is a general correlation between anther size and pollen size. The smallest anthers have the smallest and numerous pollens whereas the largest anther has the largest but few pollens. But between the two extremes the correlation does not seem to be particularly strong or interesting, as for example, the large anther (2.5-3.5 mm long) of *O. grandiflora* (flowers 20-40 mm long) does not bear the large pollen rather it bears medium sized pollen ($29 \times 33 \mu\text{m}$) and moderately small anther (1.5 mm long) of *O. munnarensis* (flowers 8.5-10.5 mm long) bears large pollen being $46 \times 43 \mu\text{m}$. Apertures are provided with colpi which are tapering to acute or obtuse ends, 20-46 μm long, 3-8 μm wide (weakly developed in *O. barnesii*) and ora which are usually circular in outline (oblongate in *O. caudata*, *O. caudipetala*, *O. grandiflora*, *O. griffithii* and *O. rugosa* var. *merguensis*), 3.5-9 μm in diameter. The larger ora occur in *O. caudata* and *O. caudipetala* and the smaller in *O. pallida*. The exine is 2 μm thick. The grains are rugulo-reticulate.

Gynoecium : The ovary is small, obovoid to subglobose or sometimes turbinate and often conspicuously ribbed, two loculed with many ovules in club shaped axile placenta attached below the middle of the dissepiment and gradually occupying more basal position with the maturity of fruit. The ovary is crowned by disc of two semicircular glandular lobes which encircle the base of style but is free from it.

The styles are variable in length. In some species they are as long as corolla tube as in *O. codyensis*, *O. lacei*, etc. or half as long as in *O. nepalensis*, *O. roxburghiana*, etc. or one-third of corolla tube as in *O. barnesii*, *O. caudata*, etc. The styles are very short with respect to corolla tube in *O. fasciculata* and *O. grandiflora*. In *O. borii* the style is very long and the stigma is exserted.

The stigma is variable in shape and size. In most of the species they are 2-lobed and the lobes are lanceolate to linear-lanceolate. In *O. borii*, *O. hirsutula*, *O. oppositiflora*, *O. pallida*, *O. subcapitata* and *O. villosa* the lobes are ovate. In *O. nicobarica* and *O. pectinata* (both species are heterostylous) the lobes are ovate and linear-lanceolate. In long-styled flower of *O. nicobarica* the lobes are ovate and pubescent whereas in short-styled flowers, they are linear-lanceolate and glabrous. In long-styled flower of *O. pectinata* the lobes are linear-lanceolate and glabrous, whereas in short-styled ones they are ovate and pubescent. In *O. barberi*, *O. codyensis*, *O. heterostyla* and *O. tirunelvelica* the stigma is slightly divided at the top but a demarcating line is continuous up to the base. In *O. nutans* the stigma of both long and short-styled flowers are somewhat clavate and not divided at all but the demarcating line is visible. In *O. glechomaefolia* the stigma is clavate and the demarcating line is not visible.

Heterostyly : In some heterostylous species (*O. nicobarica*, *O. pectinata*, and



Fig.6. Pollen types of *OPHIORRHIZA* (figs. A-N) : ($\times 800$) A. tricolporate (*O. treutleri*); B. tricolporate (*O. nutans*); C. tetracolporate (*O. nutans*); D. tricolporate (*O. tingens*); E. tetracolporate (*O. tingens*); F. suboblate (*O. eriantha*); G. suboblate, ora circular & margin of ora smooth (*O. roxburghiana*), H. subprolate (*O. fasciculata*); I. semicircular (*O. pykarensis*); J. both the axes are nearly equal (*O. calcarata*), K. grain is spherical (*O. ochroleusa*); L. ora longate (*O. caudata*); M. margin of ora rough (*O. calcarata*); N. Ornamentation rugulo-reticulate (*O. nutans*).

O. tingens) the styles are as long as or half as long as corolla tube. In *O. tingens* both short and long styles are pubescent. In long-styled flower, the filaments are short (0.5-1.5 mm) and adnate to the middle of corolla tube, and anthers are quite inserted whereas in short-styled flowers the stamens are adnate slightly above the base of corolla, filaments long (3-3.5 mm) and anthers slightly exserted. The hairy ring is more or less at the middle of corolla in long-styled and at the throat in short-styled flowers i.e., more or less around the anthers in both the flowers. The stigma is quite 2-lobed in both. In *O. pectinata* long style is pubescent and short one glabrous. The attachment of stamens is slightly above the base in long-styled flowers, filaments short (0.5-0.75 mm) and anthers included. The filaments are attached at the middle of corolla in short-styled flowers where filaments are long (2.5-2.75 mm) and anthers slightly exserted. Villous ring of hairs is at the middle just at the insertion of filaments in short-styled and at the throat in long-styled ones. Stigma is 2-lobed; lobes linear and warty in short-styled, ovate and pubescent in long-styled flowers. In *O. nicobarica* both long and short styles are glabrous. The stamens are adnate slightly above the base of corolla and the hairy ring is at the constriction of corolla in both long-styled and short-styled flowers. In short-styled one the filaments are long (5.5-6.5 mm), stigma lobes long, linear and in long-styled flowers the filaments are short (1.5-3.5 mm), stigma lobes short, ovate-lanceolate

and the anthers are always included. In *O. caudipetala* the styles are either as long as corolla tube, pubescent, the stamens being adnate at or below the middle of corolla tube or one-third as long as corolla tube and glabrous, when the stamens are adnate above the middle of corolla tube. In *O. wallichii* the corolla tube is much longer with respect to lobes. The styles are either two-third or one-third of corolla tube. When short, the stamens are adnate to the throat of corolla with villous ring of hairs just above the anthers. In long-styled flower the stamens are adnate to the middle of corolla and villous ring of hairs is above the anthers. The length of filament is same in both long and short-styled flowers. The corolla of *O. repens* is also much longer. The styles are as long as or one-sixth of corolla tube, both are glabrous. The position of stamens in both long-styled and short-styled flowers is more or less at the middle of corolla tube. The length of filament and the position of hairy ring are also same. In *O. nutans* and *O. treutleri* the styles are three-fourth or one-fourth of corolla tube. In *O. nutans* the stamens are adnate slightly above the base of corolla in long-styled flowers where the anthers are included. In short-styled flowers, the stamens are adnate above the middle of corolla and the anthers are slightly exserted. The length of filaments and anthers, shape and size of stigma are similar. The corolla in both long and short-styled flowers are villous throughout inside except at the base. In *O. treutleri* the position of stamens is at

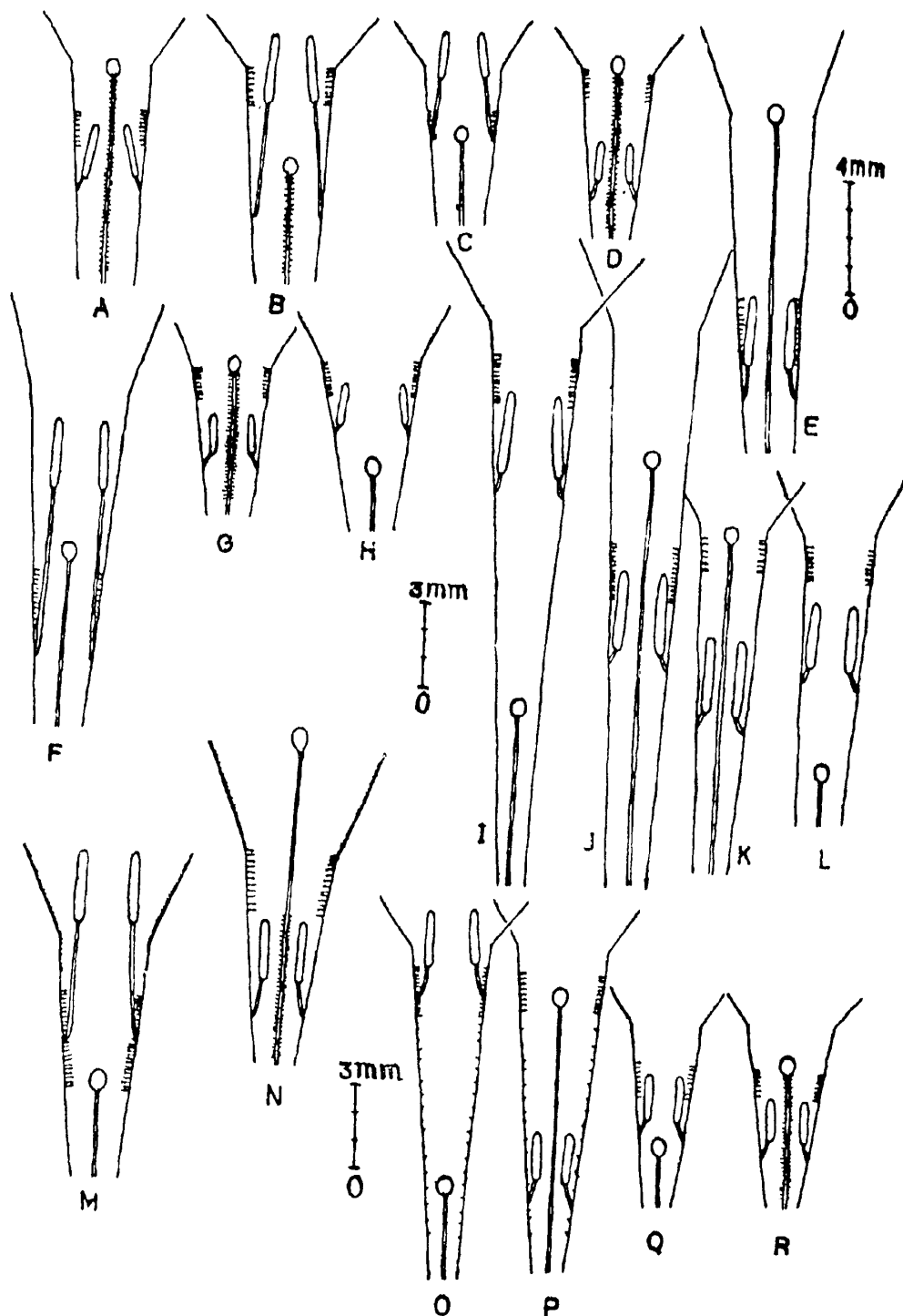


Fig. 7. Heterostyly of *OPHIORRHIZA* (figs. A-R) : A and B. *O. tingens* (style as long as or half as long as corolla tube); C and D. *O. pectinata* (style as long as or half as long as corolla tube); E and F. *O. nicobarica* (style as long as or half as long as corolla tube); G and H. *O. caudipetala* (style as long as or 1/3rd as long as corolla tube); I and J. *O. wallichii* (style 2/3rd or 1/3rd of corolla tube); K and L. *O. calcarata* (style as long as or 1/6th of corolla tube); M and N. *O. heterostyla* (style as long as or 1/3rd of corolla); O and P. *O. nutans* (style 3/4th or 1/4th corolla tube); Q & R. *O. treutleri* (style 3/4th or 1/4th of corolla tube).

the middle or slightly below in both long and short styled flowers. The length of filament, shape and size of stigma and position of hairy ring are similar in both, and the longer style is pubescent whereas the shorter one is glabrous. In *O. incarnata* both long and short styles are glabrous. The filaments are adnate slightly above the base of corolla in short-styled flower where the anthers are inserted, and in long-styled flower the filaments are adnate to the middle of corolla where the anthers are slightly exerted. The length of filament and anther, shape and size of stigma are same and the position of hairy ring is at the insertion of filaments in both long and short-styled flowers. In *O. heterostyla* the styles are as long as or one-third of corolla. In long-styled flower, the corolla base is somewhat bulbous and the villous ring is at the throat, the insertion of filaments is slightly above the base of corolla, filaments short (0.75-2 mm), anthers included, style pubescent towards the base, stigma slightly exerted. In short-styled flower, the corolla is without any bulbous base, villous ring at the throat is somewhat broad and extending up to the middle of corolla tube, the insertion of filaments is at the middle of corolla, filaments long (4-5 mm), anthers exerted, style glabrous with included stigma.

In strict sense a species is true heterostylous when its flowers contain styles of different length, the style and stamens of the same flower mature simultaneously, position of the stamens,

length of filament and corolla in both long- and short-styled flowers are same.

However, of heterostylous species of *OPHIORRHIZA* some are true heterostylous and others not. In *O. oppositiflora* the flowers of some specimens show protandry where the style is somewhat coiling with immatured stigma below the stamens and the anthesis is already there. In other specimens the style is elongated holding the stigma at the level of anthers and the stigma is quite matured, 2-lobed and capable of capturing pollen.

The heterostyly in *O. caudipetala*, *O. nicobarica*, *O. nutans*, *O. pectinata*, *O. tingens* and *O. wallichii* seems to be not true as each of them is lacking in at least one of the characters of true heterostyly. The heterostyly in *O. repens*, *O. incarnata* and *O. treutleri* seems to be true as they possess all the characters of true heterostyly. Sometimes both short and long styles with stigma have been found to persist in the immatured fruits of *O. heterostyla* in the different inflorescence of the same specimen. This seems to be true heterostyly though the position of stamens and length of filaments of short-styled and long-styled flowers are different.

Fruit : The fruit of *OPHIORRHIZA* is very characteristic. It is a dry papery, loculicidally dehiscent, 2-locular (sometimes two locules are unequal), many seeded capsule which is laterally flattened. They are compressed in such a way that the

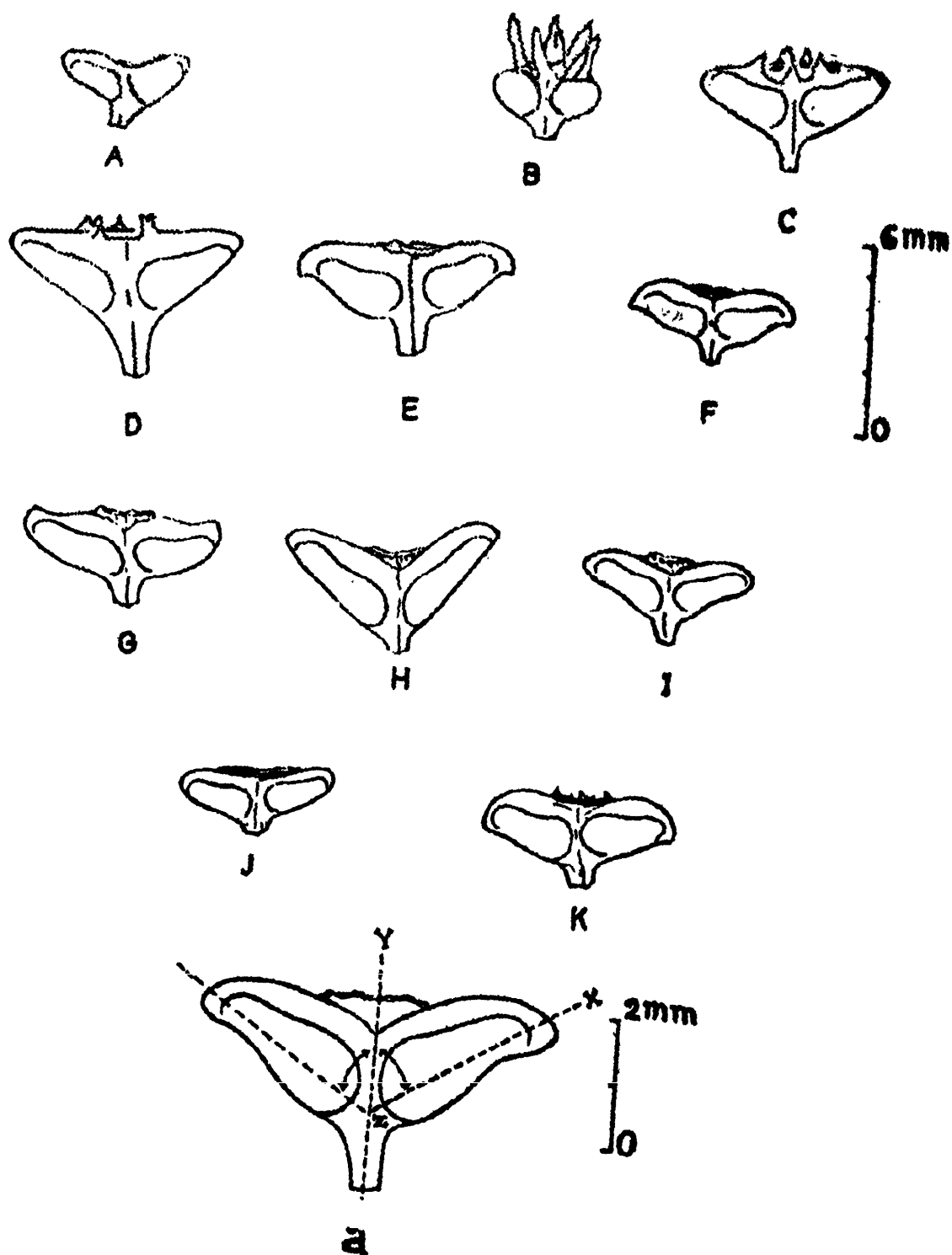


Fig. 8. Fruit types *OPHIORRHIZA* ; A. *O. barberi*; B. *O. glechomaefolia*; C. *O. roxburghiana*; D. *O. calcarata*; E. *O. hirsutula*; F. *O. ochroleuca*; G. *O. pectinata*; H. *O. nutans*; I. *O. codyensis*; J. *O. villosa*; K. *O. treutleri*.
a. angle of divergence.

longest axis is perpendicular to the dissepiment. The capsule is crowned by the dried nectarial lips and sometimes by the persistent calyx lobes. Such capsules are often more than twice as broad as long in which the inflated locules are somewhat fusiform and the apex of the fruit is depressed as a result it looks like obcordate as found in *O. barberi*, *O. barnesii*, *O. nutans*, etc. The capsule of *O. glechomaefolia* is not so compressed, rather subglobose and slightly broader than long with persistent calyx lobes. In a few species the apex of capsule is not depressed as a result it looks like somewhat triangular in outline as in *O. brunonis*, *O. repens*, *O. fasciculata*, *O. roxburghiana*, *O. tirunelvetica* etc. The locules are ovate-oblong. The apices of the locules in most of the species are straight as in *O. repens*. In some species they are arcuately patent (slightly curved outward) as in *O. eriantha*, *O. grandiflora*, *O. hirsutula*, *O. nepalensis*, *O. ochroleuca*, etc., and to some extent erecto-curved (slightly curved inward) in *O. pectinata*. The capsule dehisces loculicidally by a narrow slit on the top.

Seeds : The ovules are unitegmic and anatropous. As a consequence seeds are exotestal. The exotesta is one cell in thickness. The endotesta gets crushed in matured seeds. The seeds are 45-132 in each locule but not always equal in number in two locules. They are angular, the longest axis being 0.2-1 mm and the shortest axis 0.2-

0.75 mm. The surface is smooth and brown. The exotesta is areolate, areoles alveolate. The wall of areole is usually thick but in *O. munnarensis* it is very thin. The wall possesses a number of reflecting tubercles (pits) either on the wall or on the areole in *O. munnarensis* or sometimes on both areole and wall as in *O. nicobarica*. In *O. mussaendiformis* the pits are very small and highly reflecting. In *O. tirunelvetica* the pits are modified into large, pointed projections. In *O. eriantha* the wall of areole possesses branched projections. In *O. ochroleuca*, *O. pauciflora*, *O. treutleri* and *O. trichocarpa* the wall of areole is without pits or ornamentation. In *O. pallida* the areoles are without any definite shape. (Fig.9)

TAXONOMY

Bremekamp (1952 : 21) segregated the genera OPHIORRHIZA, SPIRADICLIS and VIRECTARIA from the Hedyotideae to constitute the tribe Ophiorrhizeae and treated in his Urophyllodeae. He believed that the first two genera are closer to one another, while the third one did not have similar leaves, stipules, inflorescence and flowers as the other two.

Verdcourt (1958) discovered raphides in OPHIORRHIZA and SPIRADICLIS and placed them in the Ophiorrhizeae under Rubioideae. He excluded VIRECTARIA from this tribe for the absence of raphides and other characteristics. Darwin (1976) based on a revision of the pacific species of OPHIORRHIZA suggested inclusion of this genus in the Hedyotideae again, which has

PLATE - 9

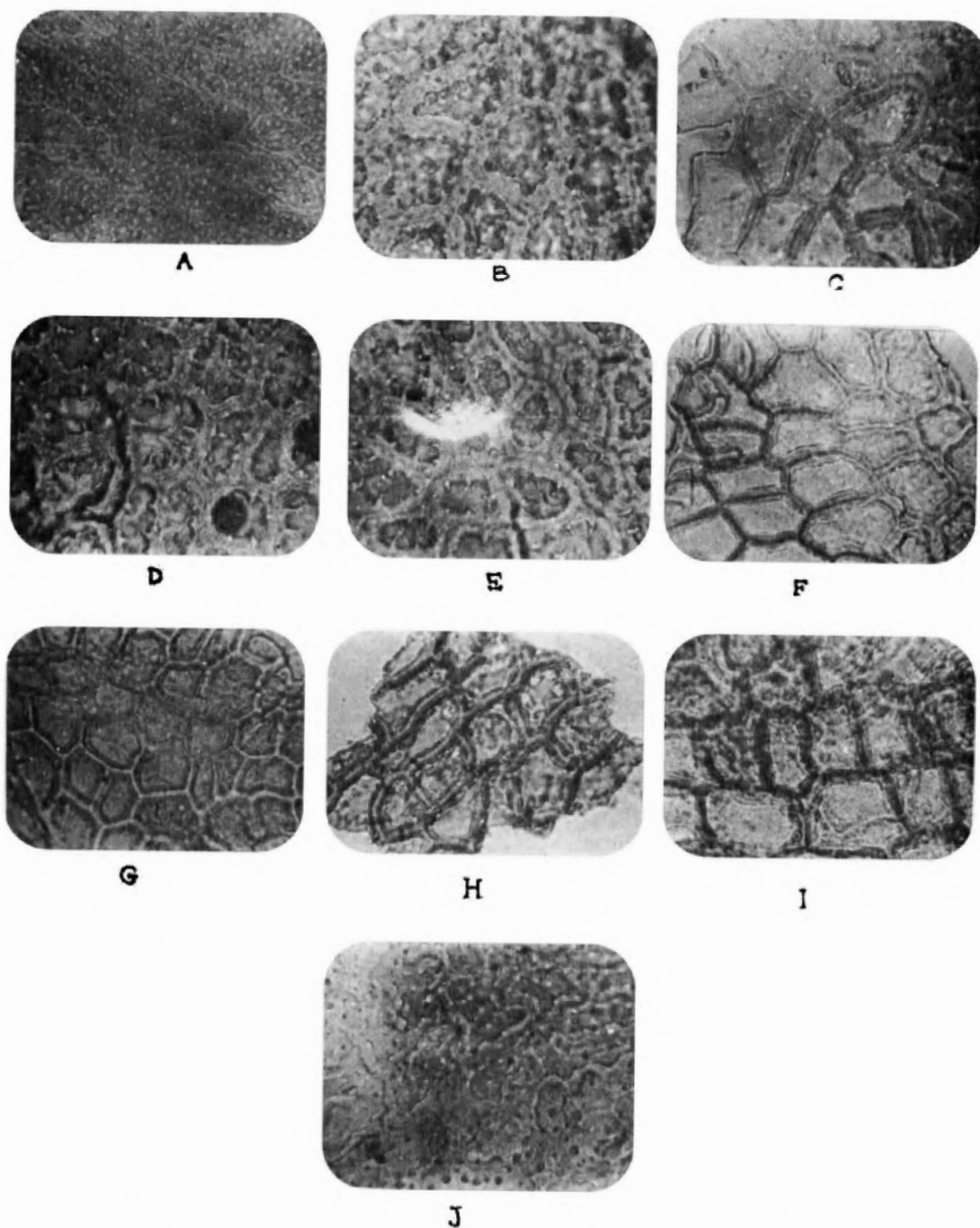


Fig. 9. Testa types of *OPHIORRHIZA* (A-J) ($\times 320$) : A. *O. munnarensis*; B. *O. nicobarica*; C. *O. mussaendiformis*; D. *O. tirunelvelica*; E. *O. criantha*; F. *O. ochroleuca*; G. *O. pauciflora*; H. *O. treutleri*; I. *O. trichocarpa*; J. *O. pallida*.

been accepted by Robbrecht (1988, 1993).

With the recognition of the tribe Ophiorrhizeae, the genus *Polyura* H.k.f. which does not appear to have received any attention, deserves to be placed in this tribe. This genus is closely allied to the two genera of this tribe in vegetative characters namely, habit, leaves, stipules etc., and also in terminal peduncle bearing paniculate, inflorescence, form, size and structure of the flower, bilocular ovary, multiovulate median placenta and minute angular seeds but differing in structure of the fruit that is unique in *Ophiorrhiza*, while allied to that of *Spiradiclis* in small subglobose capsule dehiscing initially loculicidally and then septicidally.

2. OPHIORRHIZEAE Bremek. ex Verdc.

Herbs or undershrubs; hairs septate. Stipules interpetiolar, filiform or subulate or fimbriate. Raphides present in various parts. Inflorescence mostly terminal rarely axillary. Flowers frequently heterostylous. Corolla tube narrow, lobes valvate. Pollen colporate. Ovary 2-locular; ovules many on median axile placenta. Capsule laterally flattened or ribbed, globose or subglobose or obconic loculicidally or septicidally dehiscent, along the calyx. Exotesta cells with thick verrucose walls.

Key to the tribe

- 1a. Fruit a capsule broadly didymously obcordate, of two compressed spreading lobes, loculicidal above the calyx ... 1 *OPHIORRHIZA*
- 1b. Fruit a capsule, not as above ... 2
- 2a. Capsule subglobose or obconic loculicidal

and septicidal, strongly ribbed; flowers along one side of the branches of a dichotomous axillary or terminal spicate or paniculate cyme ... 3 *SPIRADICLIS*

- 2b. Capsule sub-globose, septicidal; flowers crowded along one side of the short alternating, recurved distant branches of a terminal panicle ... 2 *POLYURA*

The Genus *OPHIORRHIZA* L.

OPHIORRHIZA L. (Fl. Zeyl. no. 402. 239. 1747; Mat. med. 79. t. I. 1749) Sp. Pl. 1 : 150. 1753; Gen. Pl. 74. 1754 ; Syst. Nat. 920. 1759 ; Burman f. Fl. Ind. 42. 1768; Gaertn. Fruct. 1: 264. t. 55. 1788 ; Juss. Gen. Pl. 143. 1789; R. Brown, Prodr. 1: 450. 1810; Roxb. Fl. Ind. 2: 546. 1824 & 1 : 702. 1832; D. Don, Prodr. 135. 1825; Bl. Bijdr. 977. 1826; Gaudich. in Freycin, Voy. Bot. t. 97. 1829; DC. Prodr. 4: 415. 1830; G. Don, Gen. Syst. Gard. Bot. 3: 522. 1834; Wt. & Arn. Prodr. 405. 1834; Endl. Gen. Pl. 550. 1838; Walp. Rep. 2: 502. 1843; Ann. Bot. Syst. 1: 376. 1848; Wt. Icon. 3: 4. 1848; Gray, Proc. Amer. Acad. 4: 311. 1859; Miq. Fl. Ind. Bat. 2: 166. 1861; Benth. Fl. Hongk. 147. 1861; Thw. Enum. Fl. Zeyl. 139. 1864; Benth. Fl. Austral. 3: 407. 1867; Miq. Ann. Mus. Lugd. Bat. 4: 230. 1869; Hook. f. in Benth. & Hook. f. Gen. Pl. 2: 63. 1873 & Fl. Brit. Ind. 3: 77. 1880; Schumann in Engler & Prantl. Nat. Pflanzenfam. IV. 4: 29. 1891; Hance in Trimen, Fl. Ceylon 2: 320. 1895; Prain, Beng. Pl. 1: 410. 1903; Duthie, Fl. Upper Gang. Pl. 1: 384. 1903; Cooke, Fl. Pres. Bomb. 1: 596. 1903; Rao, Fl. Pl. Travanc. 207. 1914; Fyson, Fl. Nilgiri & Pulney

Hill tops 1:191. 1915; Gamble, Fl. Pres. Madras 607. 1921; Haines, Bot. Bih. Orissa 443. 1922; Ridley, Fl. Malay Penin. 2L 40. 1923; Kanjilal *et al.* Fl. Assam 3: 42. 1939; Kitam. in Fauna Fl. Nep. Himal. 231. 1955; Bakh. f. in Backer & Bakh. f. Fl. Java 2: 291. 1965; Hara, Fl. E. Himal. 313. 1966; Gandhi in Saldanha *et al.* Fl. Hassan District 587. 1976; Babu, Herbaceous Fl. Dehra Dun 228. 1977; Hara in Hara & Williams, Enum. Nepal Fl. 2: 206. 1979; Balakr. Fl. Jowai 1: 247. 1981; Deb, Fl. Tripura state 2: 73. 1983.

Herbs, annual or perennial, rarely undershrubs, 5 cm to 3m tall; stems erect, prostrate, decumbent or creeping, herbaceous, rarely suffrutescent, pubescent or glabrous. Leaves opposite, decussate, petiolate or rarely sessile, often unequal in pair, 0.6-25 × 0.5-10 cm, elliptic, elliptic-lanceolate, elliptic-oblong, ovate, ovate-lanceolate or rarely orbicular, obtuse or cordate at base, glabrous or scattered hairy above, usually pubescent, sometimes glabrous on the nerves beneath; lateral nerves 3-19 on either side, subopposite; petioles 0.3-3.5 cm long; stipules persistent or caducous, 1.5-18 mm long, usually narrow, linear-lanceolate from a broad base, sometimes broadly ovate-oblong, or ovate-lanceolate, rarely triangular, rotund or cuspidate, entire or bifid, glabrous. Inflorescence axillary and terminal cymes, 0.5-1 cm across, branches spicate; peduncles 0.5-10 cm long, sometimes elongated in fruits. Bracts and bracteoles absent or small,

linear-lanceolate, falling away before the maturation of fruits or large, linear-oblong to oblong-lanceolate and persistent, pubescent or glabrous. Flowers on the branches of peduncles, more or less pedicellate, rarely sessile, 3.5mm-40 mm long, bisexual, 5-merous, white, pink, purple, greenish, creamy or brownish-chocolate, sometimes sweetly fragrant. Hypanthium 0.5-2.25 × 0.4-2.5 mm, ovoid or turbinate. Calyx lobes 0.3-5 × 0.2-2 mm, triangular to subulate or ovate to lanceolate, acute or obtuse. Corolla 2.75-38 mm long, usually infundibuliform, often swollen at base, sometimes constricted at middle; lobes valvate in buds, 0.75-9 × 0.5-5 mm, usually ovate to ovate-lanceolate, sometimes winged or spurred at back. Stamens 5, adnate at different levels in the corolla tube, inserted or exerted; filaments short or long, raising the anthers above the throat; anthers 2-lobed, linear-oblong, dorsifixed, introrse, dehiscent longitudinally; pollen usually tricolporate, rarely both tri and tetra-colporate, oblate-spheroidal to prolate-spheroidal, sometimes suboblate, angular in polar outline (quadrangular in tetracolporate grains) or semicircular, polar axis 21-46 µm long, equatorial axis 26-50 µm long; colpi 20-46 µm long, 3-8 µm wide, tapering to acute or obtuse ends; ora usually circular, 3.5-9 µm in diameter, rarely elongate; exine about 2 µm thick, rugulo-reticulate. Ovary 2-loculed, many-ovuled; placenta oblong or clavate, ascending from the dissepiment near the bottom of each cell. Style filiform,

encircled by a large 2-lobed disc at base; stigma usually 2-lobed, sometimes seemingly clavate by coherence of the lobes or capitate. Capsules strongly laterally compressed with a thickened belt at middle, obcordate, much broader than height, internally divided into 2-locules by a transverse partition, loculicidal, opening between the remains of 2 fleshy nectarial lips or by a transverse slit round the apex. Seeds numerous, minute, angular; testa areolate, areoles alveolate, wall of the areole usually thick, rarely thin; embryo straight.

Type : *O. mungos*. L.

Abundance and distribution : About 150 species extending from Sri Lanka and Eastern India and north-eastwards to China, Formosa, Japan and Micronesia and south-eastwards through Myanmar, Thailand, Malay, Java, Sumatra, Borneo and Fiji to the Society Islands. A few species Australian and Polynesian. According to Van Balgooy (1971) the genus attained greatest diversity in New Guinea and south-eastern Asia. New Guinea is probably its centre of origin.

In India the genus is distributed in Peninsular India mainly in Anamalai hills, Nilgiri hills, Palni hills and Tirunelveli hills, north-eastern Himalaya from Nepal, Tibet and Bhutan to Arunachal Pradesh, Meghalaya and all other states of eastern India. Nilgiri hills, Sikkim and Khasi hills are rich in number of species. One species *O. fasciculata* is distributed all over these

areas extending over to western Himalaya up to Mussoorie. The genus occurs from \pm 5 to 3000 m above m.s.l. Two species, namely, *O. mungos* and *O. rugosa* are distributed throughout India. The genus is scarce in western India. Most of the species of north-east India have closer affinity with those of south-east Asia. Peninsular Indian species have lesser affinity with others but they themselves have closer affinity.

Uses : As medicine, dye and food.

The roots of *O. mungos* L. and *O. japonica* Bl. ex DC. are said to have healing properties in snake bite (G. Don 1834, Drury 1864, Baillon 1881). The roots of *O. mungos* L. are also said to be useful in the treatment of cancer. A decoction of roots, leaves and bark is given as stomachic. The leaves are used for dressing ulcers. The bruised roots are used as an application to the various forms of cutaneous eruptions. The leaves are said to possess alterative properties and the flowers are prescribed as a stimulant and cardiac tonic in rheumatism and diseases of the heart. The roots are used in the Punjab Himalaya and Trans-Indus region as a red dye for wool. In Nepal, the roots are boiled with oil and used as a dye for the hair (Watt 1891).

The fruits of *O. fasciculata* D. Don are edible among the people of Koppu to Geling, Siang district, Arunachal Pradesh.

INFRAGENERIC CLASSIFICATION

Hooker (1880) arranged the species of OPHIORRHIZA in three groups on the basis of

presence or absence of bracteoles, their shape and duration and corolla length but did not give formal names to the groups. Schumann (1891) arranged the species in two Reihe (Series): EBRACTEOLATAE K. Schum. and BRACTEOLATAE K. Schum. on the basis of presence or absence of bracts, their duration, shape of calyx and stipules. Darwin (1976) considered this classification as "unlikely to be natural. Such taxa based on a single character are notoriously unsound". Within what appear to be otherwise homogenous species he (l.c.) "has found specimens with well developed inflorescence bracts and others in which bracts are absent" We did not find such cases. But we agree with him that infrageneric distinction on the basis of a single character is not natural. At the same time, all our efforts to classify the species in groups on the basis of 2 or more characters, failed. Hence we refrain from infrageneric classification and propose a general key to all the species at our disposal.

Key to the species

- 1a. Bracts and bracteoles absent; stipules minute or very small, with one or two long narrow apices ...2
- 1b. Bracts and bracteoles present; stipules long with acute apex ...4
- 2a. Leaves narrowly ovate; calyx lobes ovate; capsule hispid or pubescent ...3
- 2b. Leaves elliptic or elliptic-lanceolate; calyx lobes triangular to subulate; capsule glabrous ...21. *O. mungos*
- 3a. Inflorescence subcapitate cymes; corolla tube 5-angular, lobes keeled at back; capsule hispid ...45. *O. villosa*
- 3b. Inflorescence dichotomously branched cyme; corolla tube terete, lobes not keeled; capsule pubescent ...44. *O. trichocarpa*
- 4a. Bracts and bracteoles minute, falling away before maturity of capsule ...5
- 4b. Bracts and bracteoles long, linear or broadly lanceolate to oblong-lanceolate, persistent : ...9
- 5a. Corolla lobes slightly curved inward at apex and keeled or spurred at back ...6
- 5b. Corolla lobes straight at apex, not keeled or spurred at back ...12
- 6a. Peduncle less than 2.5 cm long, not elongating with the maturity of fruits (except *O. tingens* and *O. oppositiflora*) ...7
- 6b. Peduncle more than 2.5 cm long and elongating with the maturity of fruits 14
- 7a. Corolla lobes about half or as long as tube .8
- 7b. Corolla lobes one-third as long as tube or less ...15
- 8a. Leaves narrowly lanceolate, caudate acuminate at apex, acute at base; calyx lobes triangular to subulate; corolla lobes shorter than tube ...15. *O. heterostyla*
- 8b. Leaves broadly lanceolate, shortly acuminate at apex, attenuate at base; calyx lobes ovate; corolla lobes about as long as tube ...24. *O. nepalensis*
- 9a. Corolla broadly infundibuliform, lobes much spreading (except *O. brunonis* and *O. hirsutula*) :
- 9b. Corolla narrowly infundibuliform, lobes not spreading (except *O. repens*, *O. fasciculata*, *O. griffithii* and *O. nutans*) ...17
- 10a. Leaves ovate to ovate-lanceolate ...11
- 10b. Leaves elliptic to elliptic-lanceolate ...20
- 11a. Stem glabrous or puberulous; calyx

- lobes subulate; corolla lobes about 1/4th of tube ...4. *O. brunonis*
- 11b. Stem rusty pubescent; calyx lobes lanceolate, obtuse; corolla lobes 1/6th of tube ...16. *O. hirsutula*
- 12a. Corolla lobes 1/3rd of tube; calyx lobes ovate to ovate-lanceolate :
- 12b. Corolla lobes 1/5th of tube; calyx lobes triangular ...22
- 13a. Plant glabrous; leaves broadly elliptic-lanceolate; flowers in axillary scorpioid cymes; pedicels 2-4 mm long; style as long as corolla tube ...1. *O. barberi*
- 13b. Plant pubescent; leaves narrowly elliptic-lanceolate or linear-lanceolate; flowers in dichotomous cymes; pedicels 0.7-1 mm long; style shorter than corolla tube ...42. *O. tirunelvelica*
- 14a. Lateral nerves pubescent beneath; inflorescence contracted; corolla lobes shortly keeled at back ...37. *O. rugosa*
- 14b. Lateral nerves glabrous beneath; inflorescence spreading; corolla lobes with a short dorsal spur below the top ...27. *O. ochroleuca*
- 15a. Stipules deciduous ...16
- 15b. Stipules persistent ...23
- 16a. Stem glabrous; leaves elliptic-lanceolate; calyx lobes subulate; corolla glabrous outside ...46. *O. wallichii*
- 16b. Stem pubescent; leaves ovate-lanceolate; calyx lobes ovate; corolla puberulous outside ...32. *O. pykarensis*
- 17a. Flowers in capitate or subcapitate cyme, contracted ...18
- 17b. Flowers in corymbose, helicoid or fascicled cyme ...26
- 18a. Stem somewhat woody at base, glabrous ...19
- 18b. Stem herbaceous, hairy ...30
- 19a. Leaves broad; calyx lobes subulate; corolla tube constricted at base and throat, lobes lanceolate, keeled at back ...31. *O. pectinata*
- 19b. Leaves narrow; petioles 0.5-1.5 cm long; calyx lobes ovate-lanceolate; 1-1.6 mm long; corolla tube cylindric, lobes ovate, not keeled ...5. *O. caudata*
- 20a. Stem densely pubescent above; corolla pubescent or villous outside all over, lobes 1/2 - 1/3rd of tube ...21
- 20b. Stem glabrous; corolla pubescent outside along the veins at base, lobes about 1/5th of tube ...13. *O. grandiflora*
- 21a. Leaf nerves distant; calyx lobes lanceolate; stamens adnate to the corolla at base or slightly above; style half as long as corolla ...36. *O. roxburghiana*
- 21b. Leaf nerves closer; calyx lobes subulate; stamens adnate to middle of corolla tube; style 1/4th as long as corolla ...9. *O. eriantha*
- 22a. Tender shoots glabrous; petioles 1-2.25 cm long; stipules subulate; flowers subsessile; style much shorter than corolla tube ...12. *O. gracilis*
- 22b. Tender shoots hairy; petioles 2.5-5 cm long; stipules ovate; flowers pedicellate; style almost as long as corolla tube ...35. *O. rajsea*
- 23a. Erect herbs; leaves ovate to ovate-lanceolate with more than 7 lateral nerves on either side; calyx lobes ovate-lanceolate ...24
- 23b. Creeping herbs; leaves ovate-orbicular with 3-5 lateral nerves on either side; calyx lobes subulate ...33. *O. radicans*
- 24a. Petioles more than 1 cm long; flowers in corymbose cymes; capsule glabrous ...25
- 24b. Petioles up to 1 cm long; flowers in helicoid cymes; capsule pubescent ...3. *O. borii*
- 25a. Leaves pale or reddish beneath; inflorescence spreading; peduncles stout; calyx lobes acute ...41. *O. tingens*
- 25b. Leaves greenish beneath; inflorescence not spreading; peduncles slender; calyx lobes obtuse ...28. *O. oppositiflora*

- 26a. Stipules lanceolate, ovate, oblong or subulate ...27
- 26b. Stipules narrowly linear with somewhat broad base ...39
- 27a. Corolla lobes keeled, winged or spurred at back ...28
- 27b. Corolla lobes not keeled ...32
- 28a. Calyx lobes triangular ...29
- 28b. Calyx lobes ovate to ovate-lanceolate ...35
- 29a. Leaves elliptic to elliptic-lanceolate, purple beneath on drying; corolla lobes shortly keeled at back ...39. *O. succirubra*
- 29b. Leaves broadly elliptic, pale greenish on drying; corolla lobes winged at back ...14. *O. griffithii*
- 30a. Corolla lobes ovate-lanceolate or ovate-oblong; stamens adnate to throat of corolla ...31
- 30b. Corolla lobes broadly ovate; stamens adnate to corolla at or near the middle ...36
- 31a. Leaves hispid; bracts and bracteoles acute at apex; capsule hispid ...17. *O. hispida*
- 31b. Leaves hirsute; bracts and bracteoles obtuse at apex; capsule glabrous ...38. *O. subcapitata*
- 32a. Calyx lobes ovate or ovate-lanceolate ...33
- 32b. Calyx lobes triangular to subulate ...37
- 33a. Petioles usually long, peduncles long, elongating in fruits; bracts and bracteoles frequent ...34
- 33b. Petioles usually short, peduncles short, not elongating in fruits; bracts and bracteoles few, scattered ...7. *O. chandrosekharanii*
- 34a. Corolla lobes broadly ovate-oblong; stamens adnate to base of corolla tube; style about 1/10th of corolla tube; capsule pubescent ...10. *O. fasciculata*
- 34b. Corolla lobes ovate; stamens adnate to middle of corolla tube; style about 1/4th of corolla tube; capsule glabrous ...2. *O. barnesii*
- 35a. Peduncle deflexed; corolla lobes ovate-lanceolate, shortly keeled at back; capsule hispid ...26. *O. nutans*
- 35b. Peduncle erect, corolla lobes ovate, with long, recurved hispid spur at back; capsule pubescent ...34. *O. repens*
- 36a. Leaves narrowly elliptic, glabrous above; calyx lobes ovate-lanceolate ...18. *O. incarnata*
- 36b. Leaves elliptic-lanceolate with ciliate margin, scabrid above; calyx lobes triangular ...22. *O. munnarensis*
- 37a. Stem very short, ascending from rooting horizontal base, herbaceous; leaves elliptic-oblong or ovate-lanceolate ...19. *O. lacei*
- 37b. Stem long, erect, woody; leaves ovate-lanceolate ...38
- 38a. Stipule with many converging nerves; corolla glabrous outside; stamen adnate slightly above the base of corolla; capsule glabrous ...8. *O. codyensis*
- 38b. Stipule with single nerves; corolla hirsute outside; stamens adnate to middle of corolla; capsule pubescent ...43. *O. treutleri*
- 39a. Corolla lobes keeled, horned or winged at back ...40
- 39b. Corolla lobes not keeled, horned or winged ...45
- 40a. Calyx lobes ovate-lanceolate or subulate ...41
- 40b. Calyx lobes linear or ensiform ...43
- 41a. Stem erect; stem, leaves above, corolla outside and capsule hairy ...42
- 41b. Stem creeping at base; stem, leaves above, corolla outside and capsule glabrous ...40. *O. thomsonii*
- 42a. Leaves ovate-elliptic; corolla lobes strongly keeled at back; stigma clavate ...23. *O. mussaendiformis*
- 42b. Leaves ovate-lanceolate; corolla lobes horned at back; stigma 2-lobed, lobes ovate-

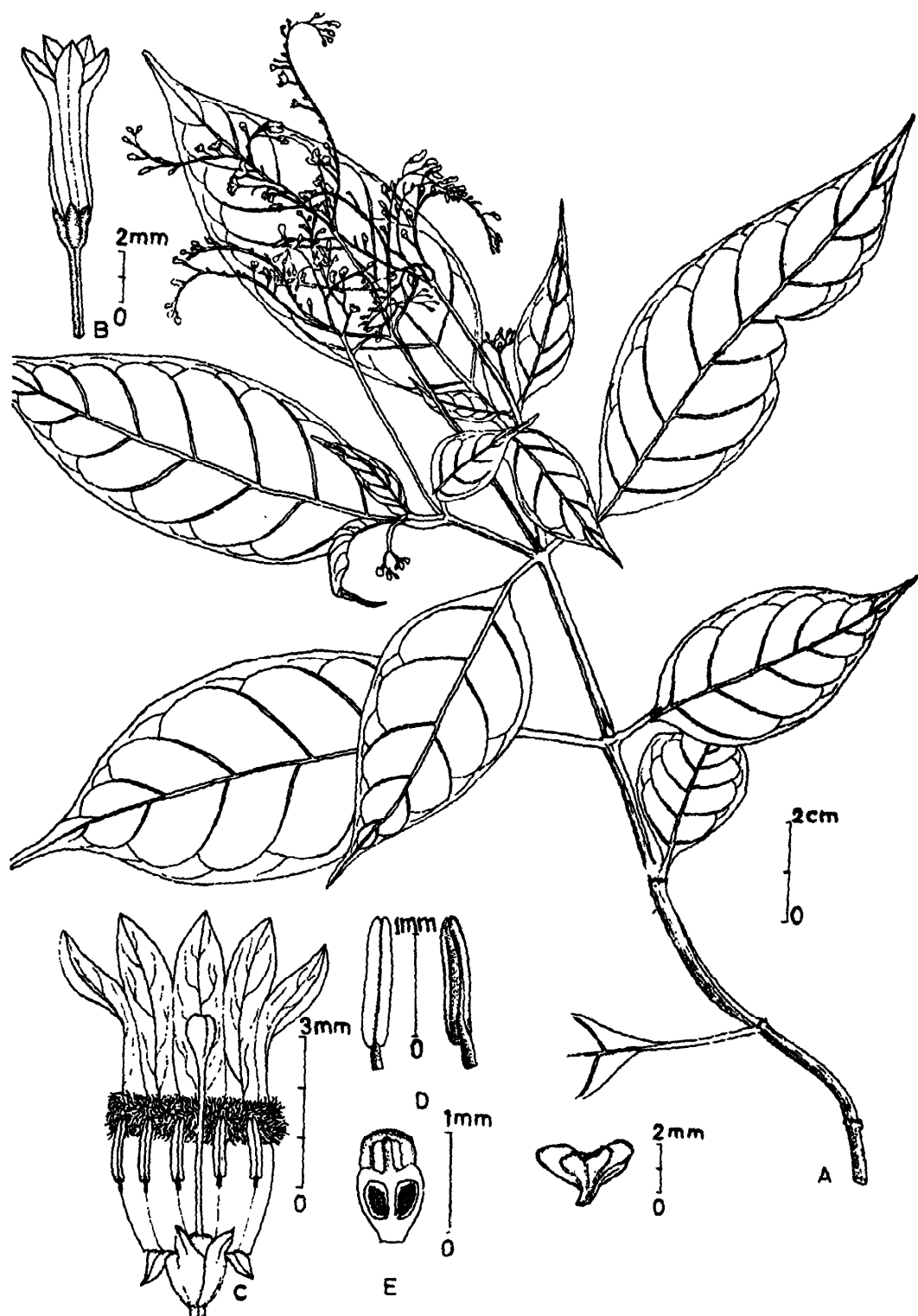
- lanceolate ...6. *O. caudipetala*
- 43a. Stem pubescent or tomentose; leaves ovate or ovate-lanceolate style half or as long as corolla tube ...44
- 43b. Stem glabrous; leaves elliptic or elliptic-lanceolate; style 1/4th to 1/3rd of corolla tube ...47. *O. wattii*
- 44a. Corolla tube cylindric, lobes winged at back; capsule glabrous ...29. *O. pallida*
- 44b. Corolla tube constricted slightly above the base, lobes reflexed and keeled at back; capsule pubescent ...25. *O. nicobarica*
- 45a. Stem creeping; leaves ovate or ovate-orbicular; capsule hairy ...46
- 45b. Stem very short, ascending with copiously rooting base; leaves elliptic-oblong or ovate; capsule glabrous, sometimes puberulous ...20. *O. lurida*
- 46a. Leaves glabrous or with scattered hairs above; calyx lobes ovate-lanceolate; corolla glabrous outside ...30. *O. pauciflora*
- 46b. Leaf hispid above; calyx lobes linear-lanceolate; corolla hispid outside ...11. *O. glechomaefolia*
1. **O. barberi** Gamble in Kew Bull. 1919: 406. 1919 (*Type* : Anamalai Hills, Paralai, 15th October 1901, *C.A. Barber* 3793 MH! selected as the lectotype; Travancore Hills, Mankulam, about 1000 m, May 1915, *Venkoba Rao* 3143K! Para); Gamble Fl. Pres. Madras 607, 1921; Fyson in Journ. Indian Bot. 2: 210. 1921. (Fig.10)

Herbs, 35-50 cm tall ; stem erect, branching, terete at base, glabrous. Leaves 4-16 × 2-5 cm, elliptic to elliptic-lanceolate, caudate-acuminate at apex, attenuate at base, glabrous, pale beneath; lateral nerves 5-9 on either side; petioles

1-2.5 cm long, slender, glabrous; stipules persistent, 5-8 mm long, ovate with broad base and long apex, entire, glandular, glabrous. Inflorescence axillary scorpioid cyme, 3-6 cm across, branches spreading, glabrous; peduncles 2-5 cm long, slender, glabrous. Flowers 6-8 mm long, white ; pedicels 2-4 mm long, slender, nearly filiform, glabrous; bracts and bracteoles similar, caducous, minute, glabrous; pedicels 2-4 mm long, slender, nearly filiform, glabrous. Hypanthium 0.75-1.2 × 0.7-1 mm, obovoid, glabrous. Calyx lobes 0.6-0.8 × 0.5-0.6 mm, ovate-lanceolate, acute, glabrous. Corolla 5.25-6.8 mm long, infundibuliform, glabrous outside with a villous ring at the middle of tube inside; lobes 1.25-1.5 × 0.8-1 mm, ovate, acute, spreading. Stamens adnate to the base of corolla or slightly above, inserted; filaments 0.5-0.6 mm long; anthers 1.2-1.3 mm long, narrowly oblong. Ovary 0.6-1 × 0.6-0.8 mm, obovoid; disc 0.4-0.5 mm high; style 4-5 mm long, slender, glabrous; stigma 2-lobed, 0.7-0.8 × 0.5-0.6 mm, lobes rounded to obovate, glabrous. Capsules 1.5-2 × 4-5 mm, glabrous, locules ovate-oblong with straight tip. Seeds 0.35 - 0.4 × 0.3 - 0.4 mm, 4-8 angular, glabrous, brown ; wall of the areole thick with a number of tubercles hooded over the areolar space.

Fl. & Fr. : May- September.

Pollen : Suboblate, angular in polar outline, polar axis (P) × equatorial axis (E) = 18 - (21) 24 × 27-(27)-28 μ m, 3-colporate, colpi 21-23 × 4 μ m, tapering to

Fig.10. *O. barberi* Gamble

A. habit; B. flower; C. flower split open; D. stamen; E. l.s. of ovary; F. fruiting.

acute ends; ora circular, 4 μ m in diameter; sexine 1.25 μ m, nexine 0.25 μ m, rugulo-reticulate; lumina 0.5-1 μ m, muri 0.5 μ m.

Note : The whole plant is glabrous, even the inflorescence and the leaf nerves beneath. Pedicels are remarkably long in proportion to the flowers.

Distribution : India. Kerala, Tamil Nadu.

Ecology : Grows on damp shady places at 1025-1350m above m.s.l.

Specimens examined : TAMIL NADU : Coimbatore dist, Sholaiyar submergible area, *K. M. Sebastine* 17265 (MH); Madurai dist. Periyakulam, *E. Barnes* 1565 (K). KERALA: Kottayam dist. Peermade, *R. H. Beddome* 3639 (BM); Munnar ghat., *E. Barnes* 304 (K); Pamba, *D. B. Deb* 30449 (MH).

2. *O. barnesii* Fischer in Kew Bull. 1939:248. 1939 (*Type* : Travancore High Range, Kalaar valley, September 1937, *Barnes* 1754 holo. K!, *Barnes* 1753 para. L!); K.N. Sebastine in Bull. Bot. Surv. India 4: 223. 1962., Deb & Mondal in Nayar & Sastry, Red Data Book Ind. Pl. 1:331. fig.1.1987. (Fig.11)

Herbs perennial; stems erect, somewhat woody at base, terete and glabrous below, puberulous above, fistular, purplish-brown. Leaves 5-13 \times 1.4-4 cm, ovate-lanceolate to lanceolate, caudate acuminate at apex, tapering into petiole at base, slightly asymmetric, glabrous, dark green above, pale below, lateral nerves 6-9 on either side;

petioles 1-3 cm long, glabrous; stipules 1.5-2.5 mm long, subulate, entire, glabrous. Inflorescence, axillary, trichotomous corymbose cymes, 1-1.75 cm across, branches short, glabrous; peduncles 2.5-3 cm long, elongating up to 6 cm when in fruit, slender, glabrous. Flowers 9-11 mm long; pedicels 1-1.25 mm long, glabrous; bracts and bracteoles, similar, persistent, 2-6.5 mm long, linear, 1-nerved, acuminate, glabrous; pedicels 1-1.25 mm long, glabrous. Hypanthium 0.75-1 \times 0.5-0.75 mm, obovoid, glabrous. Calyx lobes 0.75-1 \times 0.4-0.6 mm, ovate-lanceolate, acute, glabrous. Corolla 8.25-10 mm long, infundibuliform, glabrous outside and inside except for a villous ring slightly below the middle of corolla tube, just above the insertion of filaments; lobes 2.75-3.25 \times 1.5-1.8 mm, ovate, acute, glabrous. Stamens adnate to the middle of corolla tube or slightly below, inserted; filaments 2.5-2.75 mm long, glabrous; anthers 1.25-1.5 mm long, oblong-linear. Ovary 0.6-0.8 \times 0.4-0.7 mm, obovoid; disc 0.5-0.6 mm high; style 1.5-2.5 mm long, lobes glabrous; stigma 2-lobed, 1.25-1.6 mm long, lobes narrowly ovate, acute, entire, warty. Capsules 1.5-3 \times 4.5-8 mm, glabrous, locules ovate-oblong with straight tip. Seeds 0.4-0.5 \times 0.4 mm, 5-8 angular, glabrous, brown; wall of the areole thick with a number of tubercles on it.

Fl. & Fr. : September.

Pollen : Suboblate to oblate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = 35-(37)-38 \times 42-(44)-45 μ m, 3-colporate; colpi 15-17 \times 3-3.5 μ m,

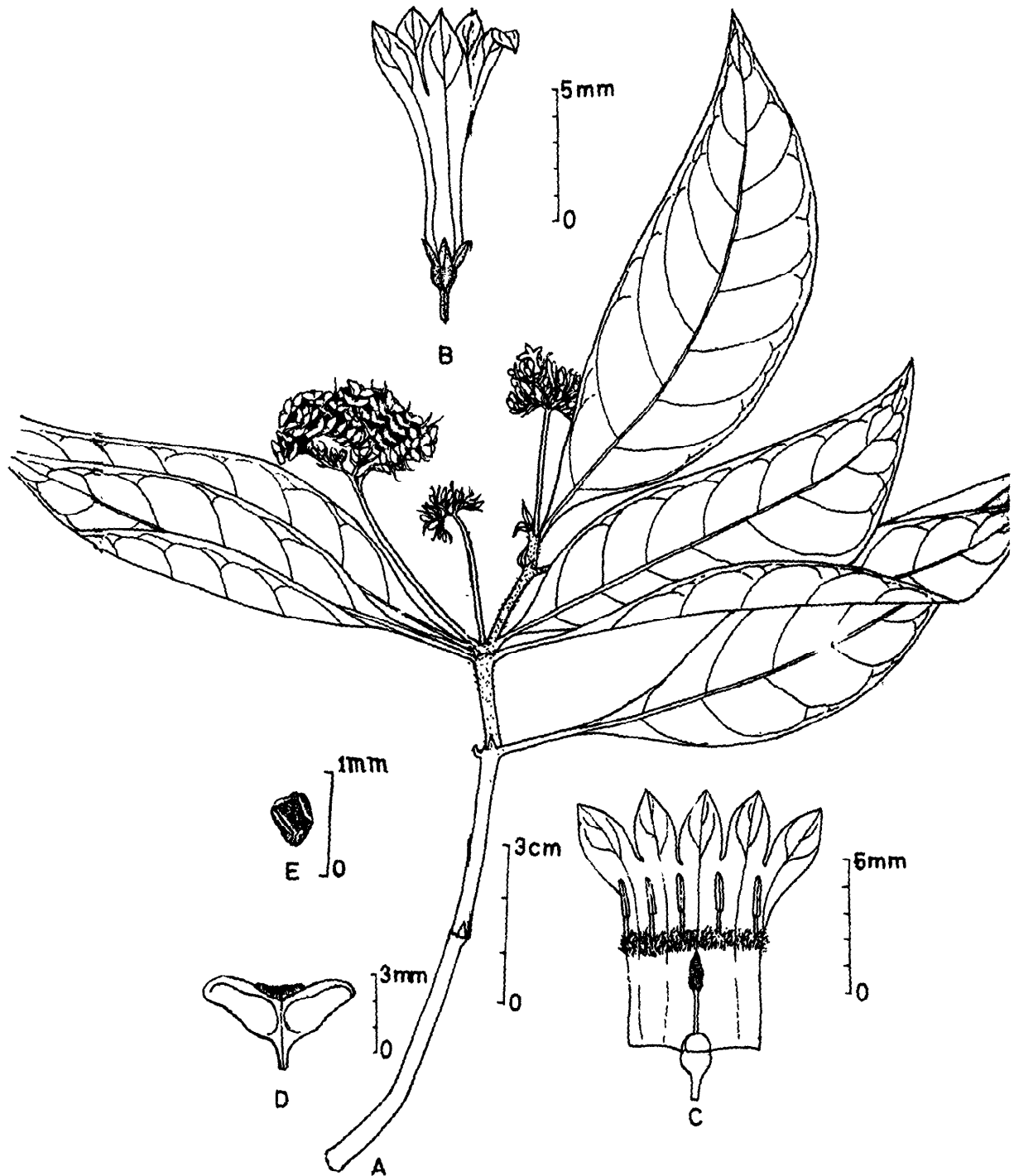


Fig.11. *O. barnesii* Fischer
A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

tapering to obtuse ends; ora circular, 5 μ m in diameter, sexine 1.75 μ m, nexine 0.25 μ m, ruguloreticulate; lumina 0.75-1 μ m, muri 0.5-0.75 μ m.

Occurrence : Kerala, in high mountains on forest floor in Travancore. Endemic. Possibly extinct. It has not been seen in the natural habitat, after the original discovery in 1937, although the region has been well-explored during the past forty years. Its habitat might have undergone changes due to developmental activities.

3. **O. borii** Deb et Mondal in Journ. Bomb. Nat. Hist. Soc. 79(2): 379, 1982 (*Type* : Nagaland, Naga Hills, Zulhami, about 1800 m, 24th June 1935, *N.L. Bor* 4471 holo. DD; iso. K; Naga Hill, Thekubama, about 1800 m, 19th June 1935; *N. L. Bor* 4465 Para.-DD, K).

(Fig. 12)

Herbs, small; stem-erect, unbranched, ridged, puberulous; internodes 1-3.5 cm long. Leaves 3-8 \times 2-4 cm, ovate, acute, subacuminate or obtuse at apex, acute or attenuate at base, puberulous above and on the nerves beneath; lateral nerves 8-10 on either side; petioles 0.5-1 cm long, puberulous; stipules persistent, 3-8 mm long, subulate with broad base, entire, sometimes bifid dividing almost to the base, puberulous. Inflorescence terminal panicle of helicoid cymes, 2-3.5 cm across, puberulous; peduncles 1-2.2 cm long, puberulous. Flowers 6-8 mm long, pink or white, tinged with pink, bracts deciduous, 1.5-5.5 mm long, linear, acute, puberulous;

bracteoles deciduous, 1-1.5 mm long, linear, acute, puberulous; pedicels 0.5-1.25 mm long, puberulous. Hypanthium 1-1.25 \times 1.2-1.5 mm, obovoid, puberulous. Calyx lobes 0.5-0.8 \times 0.25-0.5 mm, ovate-lanceolate, obtuse, puberulous. Corolla 5-6.75 mm long, somewhat campanulate, tube 3.75-5.5 mm long, slightly swollen at base, pubescent outside, villous below the throat within; lobes 1-1.5 \times 0.6-0.75 mm, lanceolate, inwardly curved and acute at apex, strongly keeled at back. Stamens adnate slightly below the middle of corolla tube, inserted; filaments 0.3-0.5 mm long; anthers 1.2-1.5 mm long, narrowly oblong. Ovary 0.8-1.2 \times 1-1.4 mm, obovoid; disc 0.5-0.7 mm high, 0.6-1 mm wide; style as long as corolla, pubescent; stigma bifid, 0.3-0.4 \times 0.2-0.3 mm, lobes broadly ovate, warty, exserted. Capsules (immatured) 1-1.25 \times 2-2.25 mm, pubescent.

Fl. & Fr. : June.

Pollen : Oblate-spheroidal, semicircular in polar outline, polar axis (P) \times equatorial axis (E) = 30-(31)-33 \times 32-(34)-37 μ m, 3-colporate; colpi 29-32 \times 6-6.5 μ m, tapering to obtuse ends; ora circular, 6-7 μ m in diameter, sexine 1.5 μ m, nexine 0.25 μ m, rugulo-reticulate; lumina 0.75-1 μ m, muri 0.5-0.75 μ m.

Occurrence : Nagaland, Naga Hills, Zulhami and Thekubama at about 1800 m, above m.s.l.

4. **O. brunonis** Wight & Arn. Prodr. 405. 1834 (*Type* : *Wight Cat.* 1288 K-W Photo! , E!); Walp. Rep. Bot. Syst. 2 :

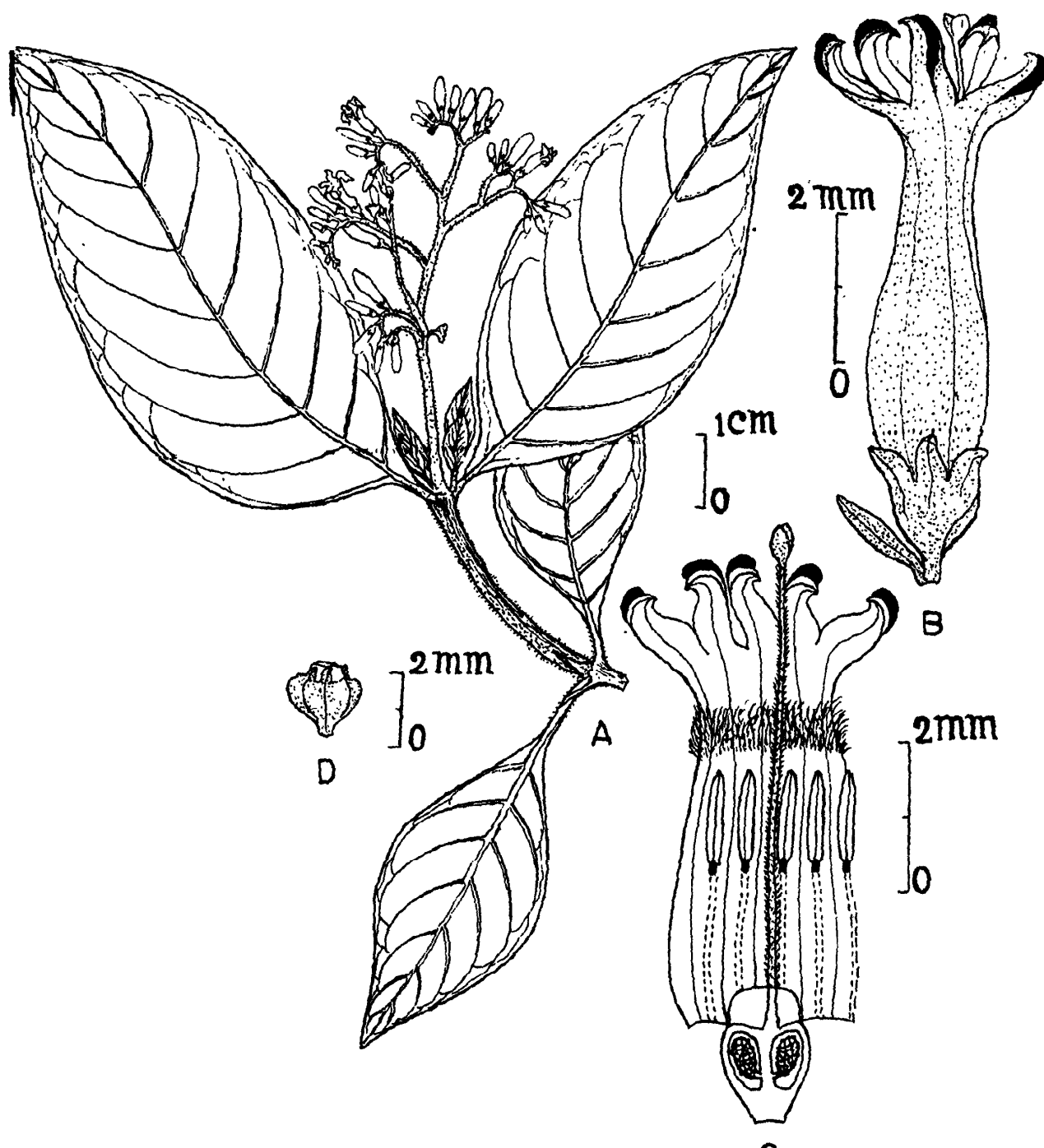


Fig. 12. *O. borii* Deb & Mondal
 A. habit; B. flower; C. flower split open; D. fruiting (immature)

503. 1843; Hook. f. Fl. Brit. India 3 : 80. 1880; Rao, Flower, Pl. Travanc. 206. 1914; Fyson, Fl. Nilgiri Pulney Hill Tops 1: 191. 1915; Gamble, Fl. Pres. Madras 608. 1921. Deb & Mondal in Nayar & Sastry, Red Data Book Ind. Pl. 1: 333 fig.1.1987. (Fig.13)

Herbs, 10-50 cm tall, sometimes undershrubs; stems erect, branched, glabrous or puberulous. Leaves 3-15 × 1.5-6.5 cm, ovate to ovate-lanceolate, acuminate at apex, acute or attenuate at base, glabrous or scabrous above, glabrous or puberulous on the nerves beneath; lateral nerves 6-14 on either side; petioles 0.8-3.5 cm long, glabrous or puberulous; stipules 4-12 mm long, narrowly subulate, bifid or entire, glabrous or puberulous. Inflorescence terminal or axillary, subcorymbose cymes, 1-4 cm across, puberulous; peduncles 0.5-2.3 cm long, puberulous. Flowers 6.5-15.25 mm long, white or lilac; bracts persistent, 9-15 mm long, linear, puberulous; bracteoles persistent, 5-12 mm long, linear or filiform, puberulous; pedicels 0.5-1.25 mm long, puberulous. Hypanthium 1-1.5 × 0.75-1.5 mm, obovoid, puberulous. Calyx lobes 0.75-1.25 × 0.25-0.5 mm, subulate, acute, puberulous. Corolla 5.5-14 mm long, infundibuliform, glabrous or puberulous outside, villous at the throat or middle within; lobes 1.5-4.5 × 0.75-1.5 mm, ovate or lanceolate, acute. Stamens adnate to the base of corolla or slightly above, inserted or slightly exserted; filaments 0.5-2 mm

long, glabrous; anthers 2-3.25 mm long, oblong-linear. Ovary 0.75-1.25 × 0.6-1.25 mm, obovoid; disc 0.5-0.75 mm high; styles $\frac{1}{3}$ rd or as long as corolla tube, glabrous; stigma 2-lobed, 0.75-2.25 mm long, lobes ovate-lanceolate, acute, glabrous. Capsules 2-3 × 4-7 mm, crowded, glabrous, locules ovate-oblong, tip slightly inclined outwards. Seeds 0.4-0.5 × 0.35-0.4 mm, irregularly angular, glabrous, brown; wall of the areole thin with a number of tubercles on it and hooded over the areolar space.

Fl. : February to July. *Fr.* : March to August.

Pollen : Prolate-spheroidal, angular in polar outline, polar axis (P) × equatorial axis (E) = 35-(39)-45 × 32-(36)-40 μ m, 3-colporate; colpi 27-40 × 5-8 μ m, tapering to acute ends; ora circular, 5.5-9 μ m in diameter; sexine 2.25 μ m, nexine 0.25 μ m, rugulo-reticulate; lumina 1.25 μ m, muri 0.5-1 μ m.

Distribution : Tamil Nadu, Kerala and Karnataka; on damp, shady spots in rocky slopes at 930-2150m above m.s.l.

Note : This species has not been collected after 1952, though the region has been well explored. It appears to be extinct.

Key to the varieties

- 1a. Stem glabrous; corolla tube short, glabrous outside, villous at the throat within; styles $\frac{1}{3}$ rd as long as corolla tube
...*O. brunonis* var. *brunonis*
- 1b. Stem puberulous; corolla tube long, narrow, puberulous outside, villous at

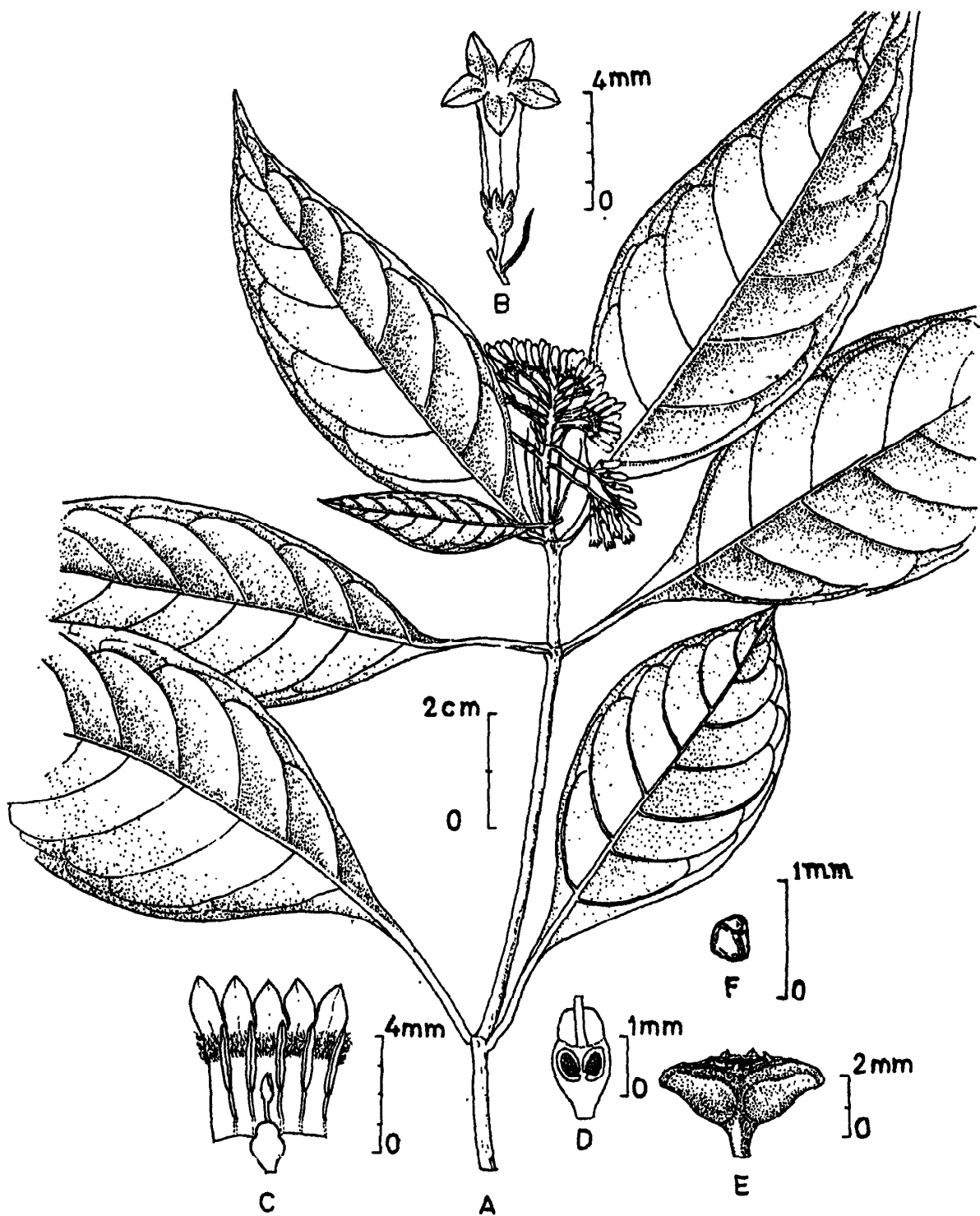


Fig. 13. *O. brunonis* W. & A. var. *brunonis*
 A. habit; B. flower; C. flower split open; D. l.s. of ovary; E. fruiting; F. seed.

the middle within; style as long as corolla tube. ...*O. brunonis* var. *johnsonii*

O. brunonis* Wight & Arn. var. *brunonis

Herbs, 16-50 cm tall, sometimes undershrubs, branched, glabrous. Leaves 3-15 × 1.5-6.5 cm, ovate or elliptic-ovate, acuminate at apex, attenuate at base, glabrous; lateral nerves 6-10 on either side; petioles 0.8-3.5 cm long, glabrous; stipules 4-12 mm long, narrowly subulate, bifid or entire. Inflorescence 1-4 cm across; peduncles 0.5-1.8 cm long. Flowers 6.5-12 mm long; bracts and bracteoles 5-15 mm long, linear or filiform; pedicels 0.75-1.25 mm long. Hypanthium 1-1.5 × 0.75-1.25 mm. Calyx lobes 0.75-1 × 0.25-0.5 mm, subulate. Corolla 5.5-10.5 mm long, glabrous outside, villous at the throat within; lobes 1.5-2 × 1-1.5 mm, ovate, acute. Filaments 1.75-2 mm long; anthers 2.5-3.25 mm long. Ovary 0.75-1.25 × 0.6-1 mm; disc 0.5-0.75 mm high; styles $\frac{1}{3}$ rd as long as corolla tube; stigma 2-lobed, 0.75-1 mm long. Capsules 2-3 × 4-7 mm. Seeds 0.4-0.5 × 0.35-0.4 mm.

Fl. & Fr. : February - August.

Distribution : Tamil Nadu, Kerala and Karnataka.

Specimens examined : TAMIL NADU : Coimbatore dist. sholer, *C.E.C. Fischer s.n.* (CAL); Nilgiri dist. Coonoor, *C. B. Clarke* 11001 (BM); Ootacamund, *J. S. Gamble* 17473 (BM). KERALA: South Malabar district, Sallimalai, Attafadi Hills, *C. E. C. Fischer* 2785 (CAL). KARNATAKA: Raichur

dist. Gangamoola, *K. S. Srinivasan s.n.* (BSIS).

O. brunonis* Wight & Arn. var. *johnsonii

Hook. f. *Fl. Brit. Ind.* 3: 80. 1880 (*Type*: Cochin, *Johnson K!*). (Fig. 14)

Herbs, 10-25 cm tall; stems erect, puberulous. Leaves 8-14 × 3.5-5.5 cm, lanceolate, acuminate at apex, acute at base, scabrous above, puberulous on the nerves beneath; lateral nerves 9-14 on either side; petioles 1.5-2.8 cm long, puberulous; stipules 5-10 mm long, subulate, entire, puberulous. Inflorescence 2.5-3 cm across; peduncles 2-2.3 cm long, puberulous. Flowers 12-17.25 mm long; bracts and bracteoles 9-15 mm long, linear or filiform, puberulous; pedicels 0.5-0.7 mm long, puberulous. Hypanthium 1-1.25 × 1.25-1.5 mm. Calyx lobes 1-1.25 × 0.8 mm, subulate. Corolla 11-16 mm long, tube long, narrow, puberulous outside, villous at the middle within; lobes 2-2.25 × 0.75-1 mm, lanceolate, acute. Filaments 0.5 mm long; anthers 2-2.25 mm long. Ovary 0.75-1 × 1-1.25 mm; disc 0.6 mm high; style as long as corolla tube, glabrous; stigma 2-lobed, 2-2.25 mm long.

Occurrence : Cochin (Kerala).

Specimens examined : KERALA Cochin, *Johnson s.n.* (K).

5. ***O. caudata*** Fischer in *Kew Bull.* 1938(3): 125. 1938 (*Type* : Travancore High Range, Kalaar, *E. Barnes* 1560 holo K!); Sebastine in *Bull. Bot. Surv. India* 4: 223. 1962; Deb & Mondal in

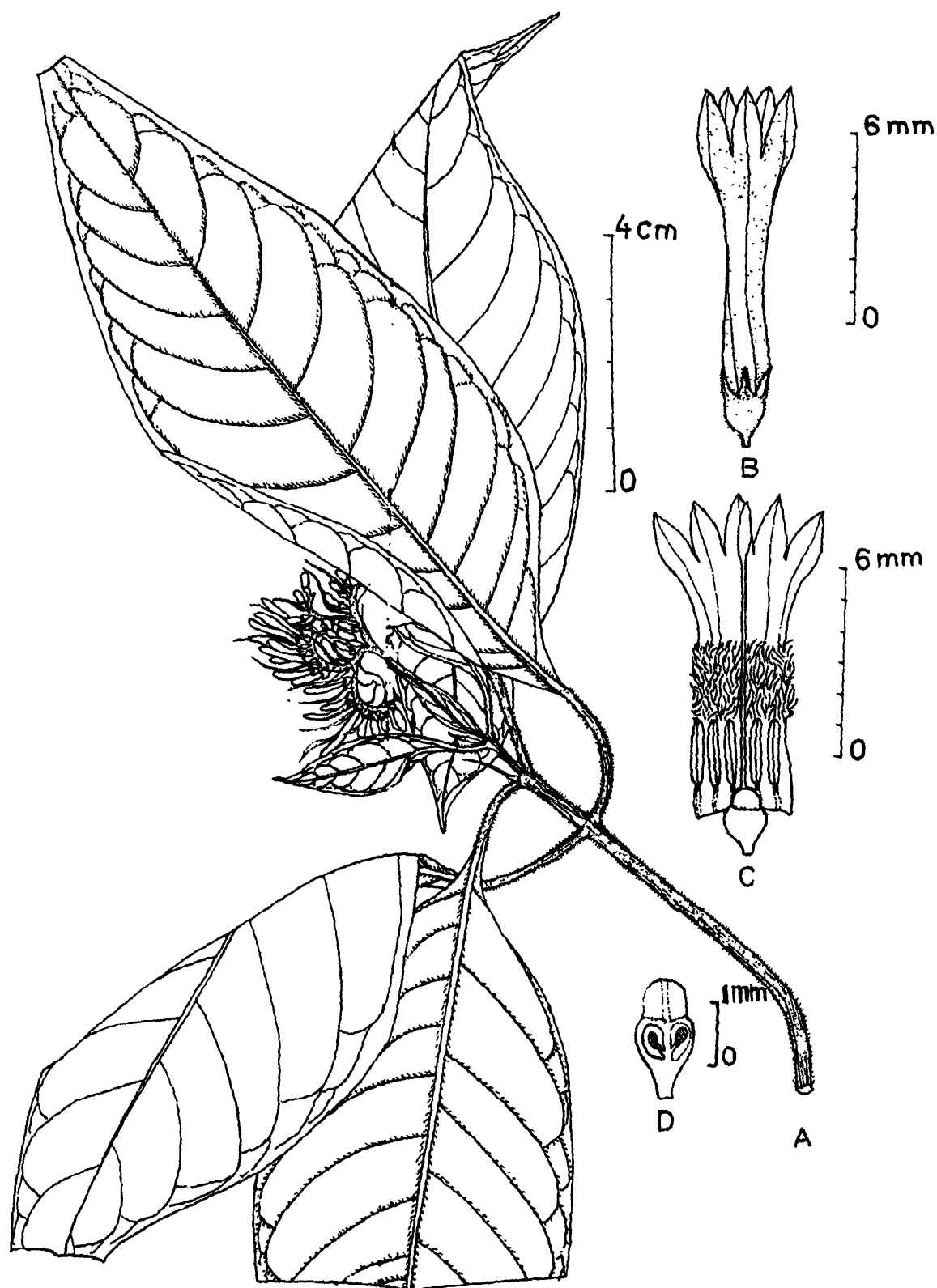


Fig. 14. *O. brunonis* W. & A. var. *johnsonii* Hook. f.
A. habit; B. flower; C. flower split open; D. l.s. of ovary.

Nayar & Sastry, Red Data Book Ind. Pl. 1: 355. fig. 1. 1987. (Fig.15)

Herbs, 38-78 cm tall; stems erect, suffruticose, terete below, internodes 3-11 cm long, glabrous. Leaves 5-12 × 1.5-3.5 cm, elliptic-lanceolate, caudate-acuminate at apex, acuminate at base, glabrous, sometimes minutely scaberulous along the margin above, dark olivaceous green above, pale brownish green below; lateral nerves 7-9 on either side; petioles 0.5-1.5 cm long, glabrous; stipules 3-6 mm long, ovate-lanceolate, caudate acuminate, entire, glabrous with prominent midrib. Inflorescence terminal capitate cymes, 1-2 cm across, contracted, glabrous; peduncles 3-4.5 cm long, glabrous. Flowers 9-13.3 mm long, white; bracts and bracteoles similar, persistent, 5.5-9.5 × 2-5 mm, lanceolate to ovate-lanceolate with distinct midrib, somewhat oblique, acute, glabrous; pedicels 1-1.5 mm long, glabrous. Hypanthium 1-1.3 × 0.5-0.75 mm, cup-shaped, glabrous. Calyx lobes 1-1.6 × 0.4-0.5 mm, ovate-lanceolate, acute, slightly keeled at back, glabrous. Corolla 8-12 mm long, infundibuliform, glabrous outside with a villous ring of hairs (\pm 2 mm long) at the middle of corolla tube within just above the insertion of filaments; lobes 1.5-2.5 × 0.8-1.5 mm, ovate, subacute to acute, glabrous outside, minutely papillose within. Stamens adnate slightly below the middle of corolla tube, inserted; filaments 3.5-4 mm long, slender; anthers 1.5-1.8 mm long, oblong-linear. Ovary 0.75-1 × 0.4-0.6 mm,

obovoid; disc 0.4-0.5 mm high style 2.5-3.25 mm long, slender, glabrous; stigma 2-lobed, 0.75-1.25 mm long, lobes linear, glabrous. Capsules (immature) 1.5-2.5 mm, glabrous.

Fl. : May.

Pollen : Suboblate, angular in polar outline, polar axis (P) × equatorial axis (E) = 34-(37)-40 × 37-(43)-46 μ m, 3-colporate; colpi 32-36 × 4-6 μ m, tapering to obtuse ends; ora lalongate, 7.5-10 × 6-7 μ m; sexine 1.75 μ m, nexine 0.25 μ m, rugulo-reticulate; lumina 0.75-1 μ m, muri 0.5-0.75 μ m.

Occurrence : Kerala, in high mountains.

Note : This species is known only from the type collected in 1937, but has not been collected since then, though the region has been botanically explored during the last forty years. It is apparently extinct.

6. **O. caudipetala** Deb et Mondal in Kew Bull. 37(3): 483. 1982 (*Type*: Meghalaya, Khasi Hills, \pm 1830 m, 4th June 1886, C.B. Clarke 44072 C holo. CAL, 44072 A iso. K & 44072 E iso. BM). (Fig.16)

Herbs, 15-75 cm long, straggling, branching usually from the base, sometimes above; stems erect, slender, quadrangular or ridged, pubescent. Leaves 2.5-10 × 1.5-3 cm, ovate-lanceolate, acute or acuminate at apex, attenuate at base, scabrous above, pubescent on the nerves beneath; lateral nerves 6-9 on either side; petioles 0.5-2 cm long, pubescent; stipules 2-6 mm long, linear, broader at base, entire, pubescent.

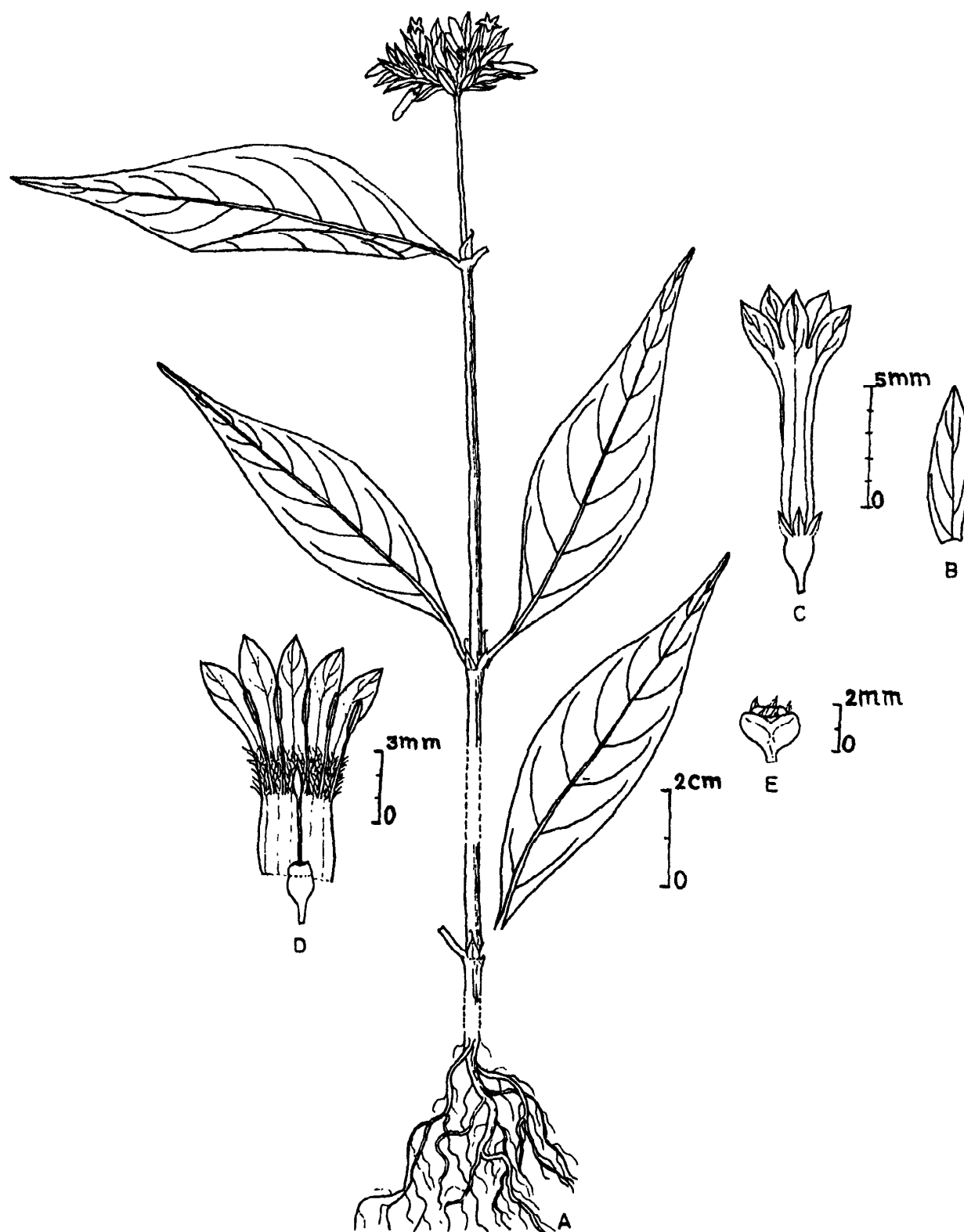


Fig.15. *O. caudata* Fischer
A. habit; B. bract; C. flower; D. flower split open; E. fruiting.

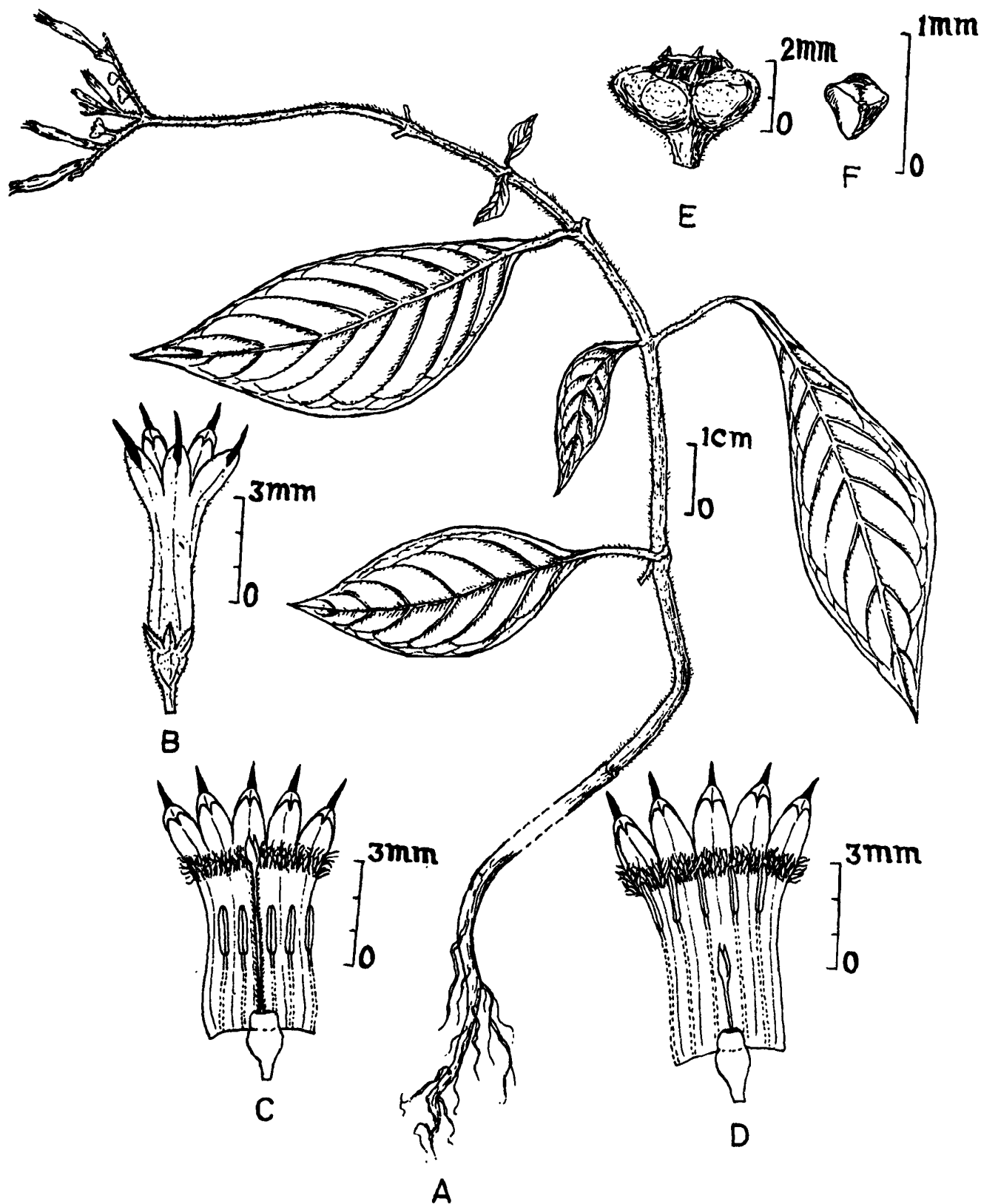


Fig. 16. *O. caudipetala* Deb et Mondal
 A. habit; B. flower; C. & D. flower split open; E. fruiting; F. seed.

Inflorescence terminal, corymbose cymes, 1-2.5 cm across, branches subopposite, pubescent; peduncles 1-2.5 cm long, elongating up to 4 cm when bearing fruits, pubescent. Flowers heterostylous, 6-8.5 mm long, white, pink or yellow; bracts and bracteoles similar, persistent, 3-7 mm long, linear, pubescent; pedicels 1-1.5 mm long, pubescent. Hypanthium $0.75-1.5 \times 0.75-1.25$ mm, obovoid, pubescent. Calyx lobes deciduous, $0.75-1.5 \times 0.25-0.5$ mm, ovate-lanceolate, acute, pubescent. Corolla 5.25-7.25 mm long, narrowly infundibuliform; tube 4-6.25 mm long, broader at base, pubescent outside, with a villous ring at the throat or below inside; lobes $1-2 \times 0.75-1.5$ mm, ovate or ovate-lanceolate, acute, inwardly curved, with 0.5-1.5 mm long, glandular horn at back. Stamens adnate slightly below the middle of corolla tube in long-styled flowers or above the middle of corolla tube in short-styled flowers raising the anthers to the throat of corolla; filaments 0.5-1.5 mm long; anthers 1-1.75 mm long, oblong-linear. Ovary $0.5-1.25 \times 0.5-1$ mm, obovoid, disc 0.4-0.5 mm high; style either as long as corolla tube and pubescent or 1/3 rd of corolla tube and glabrous; stigma 0.75-1.5 mm long, 2-lobed, lobes slightly unequal, ovate-lanceolate, acute or obtuse, warty. Capsule $1.5-2.5 \times 3-5.5$ mm, pubescent, locules ovate-oblong with straight tip. Seeds $0.3-0.6 \times 0.3-0.4$ mm, 5-7-angular, glabrous, brown; areoles with thin wall and a number of tubercles on it.

Fl.: April-June.

Fr.: June-August.

Pollen: Suboblate to prolate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = $29-(30) \times 31-(37)-39$ μ m, tricolporate; colpi $23-24 \times 6-7$ μ m, tapering to acute ends; ora lolongate, $9-10 \times 7-8$ μ m; sexine 1.75 μ m, nexine 0.25 μ m, ruguloreticulate; lumina 0.75-1 μ m, muri 0.6-0.7 μ m.

Occurrence: Meghalaya (Khasi hills).

Ecology: Grows in damp soil among boulders in forest, sometimes in gorges at 1500-2000 m above m.s.l.

Specimens examined: MEGHALAYA: Khasi hills, East gorge below Dumpah, *Burkill & Banerjee* 35181 (CAL); Shillong, *C.B. Clarke* 38634 A (K); Shillong, *N.L. Bor* 177 (DD); Mawphlong, *Thakur Rupchand* 7604 (L); Pynursla, *Nayar et al.* 50012 (LWG); Shillong peak, *Nayar et al.* 50509 (LWG).

7. *O. chandrasekharanii* Subba Rao and Kumari in Journ. Bomb. Nat. Hist. Soc. 81(1):156.1984 (*Type*: Vankachinta, Visakhapatnam Dist. Andhra Pradesh: 1st June 1968, *Subba Rao* 30049 holo.-CAL, iso-MH).

Herbs, up to 32 cm tall; stems branching, pubescent. Leaves up to 11.2×4.6 cm, oblong, oblong-lanceolate or ovate, shortly acuminate at apex, narrowed at base, membranous, scabrous above, glaucous with pubescent nerves beneath; lateral nerves 7-9 on either side; petioles up to 1.5 cm long, tomentose; stipules up to 11×3

mm, subulate, acuminate, pubescent. Inflorescence axillary and terminal corymbose or subcorymbose cyme, up to 5 cm across; peduncles up to 4.5 cm long, fulvous tomentose. Flowers 12.5 mm long, white, yellow on drying; bracts persistent, up to 4 mm long, narrow, linear, acute, pubescent, ciliate; pedicels minute. Hypanthium up to 2 mm long, fulvous tomentose. Calyx lobes up to 1.5 mm long, ovate, narrow, acute, pubescent. Corolla up to 11 mm long, narrowly infundibuliform, tube 9 mm long, ribbed, pubescent outside, crisped pubescent within except the base, with a long hairy ring 1 mm above the base; lobes up to 2 mm long acute. Stamens adnate slightly above the base of corolla, inserted; filaments 1.5 mm long; anthers up to 2 mm long. Ovary 1.75 mm long; disc 2-lobed, minutely glandular; style 2 mm long; stigma 2-lobed, 1.5 mm long, narrowly lanceolate, acute. Capsules up to 8×3 mm, pubescent. Seeds many, minute, angled.

Fl. & Fr. : May-June.

Distribution : Andhra Pradesh.

Note : No specimen could be examined. Holotype not yet sent to CAL.

8. **O. codyensis** Gamble in Kew Bull. 1919: 406. 1919 (*Type*: Coorg, Sampaji Ghat, October 1913, *Bourne* 6197 K! a-selected as Lecto, b-iso); Gamble, Fl. Pres. Madras 608. 1921; Fyson in Journ. Ind. Bot. 2: 210. 1921. (Fig. 17)

Herbs, 15-40 cm tall; stems erect, suffruticose, branched, terete and glabrous

below, quadrangular and puberulous above. Leaves $6-16 \times 2-4$ cm, ovate-lanceolate, caudate acuminate at apex, alternate at base, membranous, glabrous above, puberulous on the nerves beneath; lateral nerves 7-12 on either side; petioles 1-4 cm long, slender puberulous; stipules $4-10 \times 3-7$ mm, broadly ovate with a number of strong nerves arising from the base and converging to the apex, entire or bifid, acute, glabrous. Inflorescence axillary corymbose cyme; branches spreading, 1-2 cm across, glabrous or minutely puberulous; peduncles 2-5 cm long, slender, glabrous or minutely puberulous. Flowers 7-9 mm long; bracts and bracteoles similar, persistent, 4-7.5 mm long, lanceolate to linear-lanceolate, acuminate, glabrous with prominent midrib; pedicels 0.75-1 mm long, glabrous. Hypanthium $0.75-1 \times 0.6-0.75$ mm, obovoid, glabrous. Calyx lobes $0.6-0.75 \times 0.4-0.5$ mm, subulate, acute, glabrous. Corolla 6.25-8 mm long, infundibuliform, glabrous outside, with a villous ring at the middle of corolla tube within; lobes $1.5-1.75 \times 0.75-1$ mm, ovate, acute, glabrous. Stamens adnate slightly above the base of corolla, inserted; filaments 0.3-0.5 mm long, glabrous; anthers 1.25-1.4 mm long, oblong-linear. Ovary $0.6-0.8 \times 0.5-0.7$ mm, obovoid; disc 0.4-0.5 mm high; styles 5.5-6 mm long, glabrous; stigma capitate, $0.4-0.5 \times 0.5$ mm, warty. Capsule $1-2 \times 4-6$ mm, glabrous, locules ovate-oblong with slightly inclined tip. Seeds $0.4-0.5 \times 0.25-0.4$ mm,



Fig. 17. *O. codyensis* Gamble
A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

angular, glabrous, brown; wall of the areole thin with a number of tubercles on it.

Fl. & Fr. : Sept.-Oct.

Pollen : Oblate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = 27-(30)-31 \times 29-(32)-34 μ m, 3-colporate; colpi 25-28 \times 4-5 μ m, tapering to obtuse ends; ora circular, 4.5-5.5 μ m in diameter, sexine 1.75 μ m, nexine 0.25 μ m, rugulo-reticulate; lumina 0.75-1 μ m, muri 0.5-0.75 μ m.

Note. : Known only from the type gathering. Stipules broadly ovate, largest among the Indian species, entire or 2-fid, acute, glabrous with 4-7 strong nerves converging to apex. Raphides present on the ovary wall, capsule and stem.

Occurrence : Karnataka. Coorg dist. Sampaji Ghat.

9. **O. eriantha** Wight, Icon. 3: 4. t. 1067. 1848 (*Type* : Courtallum, August 1835, *Wight* s.n. Holo !K) ; Hook. f. Fl. Brit. India 3: 81. 1880; Rao, Flower. Pl. Travanc. 207. 1914; Gamble Fl. Pres. Madras 608. 1921. (Fig.18)

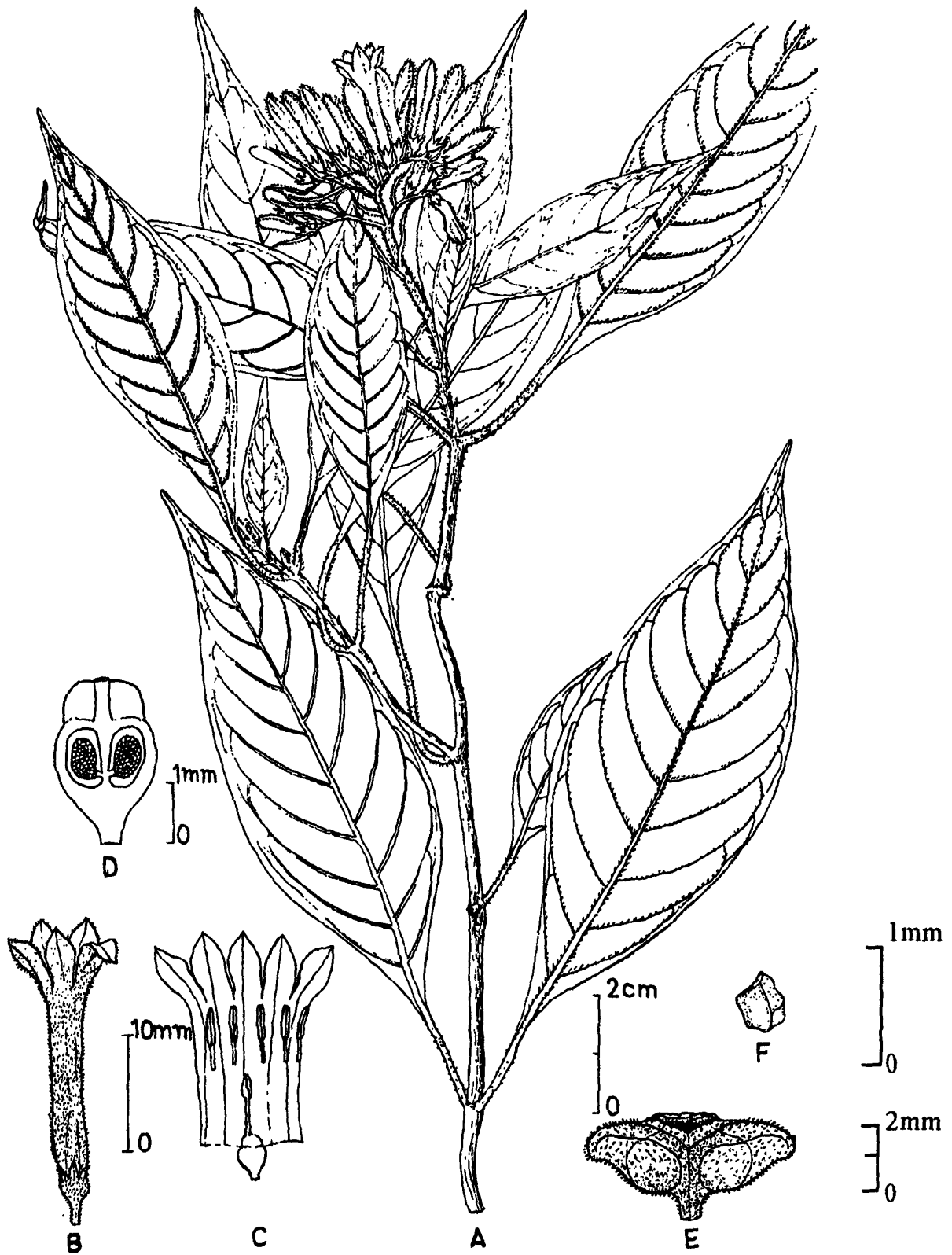
Herbs, 30-100 cm tall, sometimes undershrubs; stems erect, suffruticose, branched, pubescent when tender, gradually glabrous with age. Leaves 4-19 \times 2-7.5 cm, elliptic-lanceolate, acuminate at apex, tapering at base, thin, membranous, glabrous above, puberulous on the nerves beneath; lateral nerves 6-16 on either side, close; petioles 0.5-3 cm long, glabrous or puberulous; stipules 0.5-1.5 cm long,

lanceolate, often bifid, glabrous, sometimes puberulous. Inflorescence terminal corymbose cymes, 1-5 cm across, contracted, branches erect, villous; peduncles 1.7-5.5 cm long, villous. Flowers 19-27 mm long, white or pinkish-white, sometimes greenish-white, fragrant; bracts persistent, 10-17 mm long, narrowly linear, pubescent; bracteoles persistent, 6-10 mm long, narrowly linear, pubescent; pedicels 1-2 mm long, pubescent. Hypanthium 2-2.25 \times 1.75-2 mm, obovoid, pubescent. Calyx lobes 1.5-2 \times 0.75-1 mm, subulate, acute, pubescent. Corolla 17-24.75 mm long, infundibuliform, villous outside, glabrous within; lobes 5-7 \times 2-3.5 mm, broadly ovate, acute. Stamens adnate to the middle of corolla tube, inserted; filaments 2-2.75 mm long; anthers 3-3.25 mm long, oblong-linear. Ovary 1.75-2 \times 1.6-1.8 mm, obovoid; disc 0.75-1 mm high; style $\frac{1}{4}$ th as long as corolla, glabrous; stigma 2-lobed, 2.5-3.25 mm long, lobes lanceolate, acute, glabrous. Capsule 2.5-3.25 \times 7-8.5 mm, pubescent, locules ovate-oblong, tip slightly inclined outwards. Seeds 0.5-0.6 \times 0.4-0.5 mm, 4-6 angular, glabrous, deep brown, wall of the areole thick with a number of branched projections.

Fl. : February-September.

Fr. : April-October.

Pollen : Suboblate, angular in polar outline, polar axis (P) \times equatorial axis (E) = 22-(30)-38 \times 24-(35)-43 μ m, 3-colporate; colpi 20-36 \times 3.5-6.5 μ m, tapering to obtuse ends; ora lolongate, 4-7 \times 3-5 μ m; sexine

Fig.18. *O. eriantha* Wt.

A. habit; B. flower; C. flower split open; D. l.s. of ovary; E. fruiting; F. seed.

1.25 μ m, nexine 0.25 μ m, ruguloreticulate, lumina 0.5-1 μ m, muri 0.5 μ m.

Note : Wight (1848) stated in his *Icone* that it is of western slopes of the Shevagherry Mountains but his specimen (K) is labelled to have been collected from Courtallum, August 1835.

Distribution : Tamil Nadu, Kerala.

Ecology : Grows on laterite and loamy soil in crevices of rocks in shady moist places at 750-1500m. above m.s.l.

Specimens examined : TAMIL NADU : Coimbatore dist., Anamalai Hills, *Wight* 366 (E); Anamalai Hills, *R. H. Beddome* s.n. (CAL); Anamalai Hills, *R. H. Beddome* 3616 (BM); Kanniyakumari dist.: Balamar estate, *R. S. Rao* 61395 (BSI); Mahendragiri *B. V. Shetty* 28039 (CAL, MH); Panagudi, *B. D. Sharma* 40024 (MH); Muthukuzhivayal, *A. N. Henry* 47582 (MH); Nilgiri dist, Mulaikadu, Oucherlong valley, *J.L. Ellis* 43215 (MH); Tirunelveli Hills, *R. H. Beddome* 3621 (BM); Agastyamalai, *A. N. Henry* 16305 (CAL, MH); Sengalteri, *E. Vajravelu* 29216 (CAL, MH). KERALA: Kottayam dist. *D. John* 186 (BSIS); Pirmade, *R. H. Beddome* 3622 (BM); Pachemalai, *R. H. Beddome* 3623 (BM); Pallivasal, *E. Barnes* 1595 (K); Pamba, *D. B. Deb* 30313 (MH); Cardamom Hills, Mankulam below Munnar, *C.E. Ridsdale* 218 (K).

10. *O. fasciculata* D. Don, Prodr. 136. 1825 (*Type* : Nepal, Suembu, 22.6.1802, *Buchanon* s.n. BM. CAL!). DC. Prodr.

4:416.1830; G. Don, Gen. Syst. Gard. Bot. 3:521.1834; Hook. f. Fl. Brit. India. 3: 83.1880; C.B. Clarke in Journ.Linn. Soc. Bot. 25:31.1889; Duthie, Fl. Upper Gang. Pl. 1:384. 1903; Burkill in Rec. Bot. Surv. Ind. 4:112. 1910; Lacaita in Journ. Linn. Soc. Bot. 43:470.1916; Haines, Bot. Bih. Orissa 443. 1922; Kanjilal et. al. Fl. Assam 3:42.1939; Kitam. in Fauna Fl. Nep. Himal. 231. 1955; Deb in Bull. Bot. Surv. India. 3:312. 1961; H. Hara. Fl. E. Himal. 313. 1966; Babu, Herb. Fl. Dehra Dun 228. 1977; Hara in Hara & Williams, Enum. Nepal 2:206. 1979; Balakr. Fl. Jowai 1: 249. 1981. *O. mungos* auct. non L., Roxb. Fl. Ind. 2:544. 1824. *O. bracteolata* R. Br. (in Wall. Cat. 6228A. 1832, nom nud.) ex G. Don, Gen Syst. Gard. Bot. 3: 521. 1834 (*Type* : Nepal, 1821, *Wallich* 6228 CAL, K); Walp. Rep. 2: 503. 1843.

(Fig.19)

Herbs perennial, 8-50 cm tall, sometimes small shrubs, up to 2 m tall; stems erect, somewhat woody at base, branched, pubescent. Leaves 3-16 \times 1-6.5 cm, elliptic-lanceolate to ovate-lanceolate, acute to acuminate at apex, tapering at base, glabrous or scattered short hairy above, pubescent on the nerves beneath, membranous; lateral nerves 6-16 on either side; petioles 1-5 cm long, slender, pubescent; stipules 3-15 mm long, lanceolate with broad base, acute, often entire, sometimes bifid, glabrous or pubescent. Inflorescence terminal and

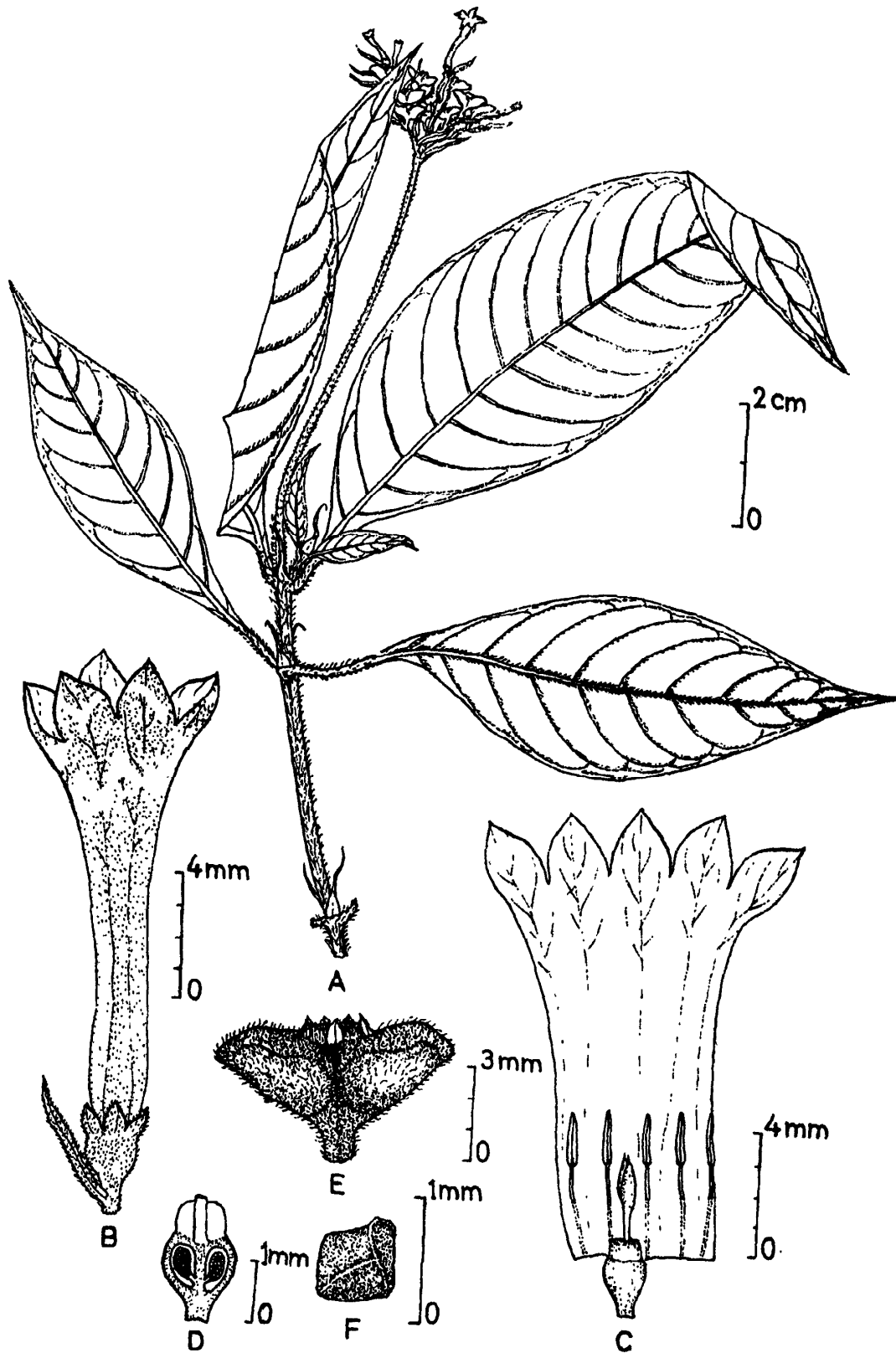


Fig. 19. *O. fasciculata* D. Don
 A. habit; B. flower; C. flower split open; D. l.s. of ovary; E. fruiting; F. seed.

axillary cymes, fascicled, 1-5 cm across, 3-5 branched, pubescent; peduncles 1-8 cm long, elongating in fruit, slender, pubescent. Flowers 16-19 mm long, white, purple-rose or pink; bracts persistent, 6-12 mm long, lanceolate, pubescent, pinkish-red; bracteoles persistent, 4-7 mm long, narrowly lanceolate, pubescent, pinkish-red; pedicels 1-2 mm long, pubescent. Hypanthium 1-1.75 × 1.25-1.5 mm, obovoid, pubescent. Calyx-lobes 1-1.25 × 1 mm, ovate, acute, pubescent. Corolla 15-17.25 mm long, infundibuliform; tube slender, puberulous outside, glabrous within; lobes 1.5-2.25 × 1.25-1.75 mm, broadly ovate-oblong, acute. Stamens adnate to the base of corolla or slightly above, inserted; filaments 1.5-1.75 mm long; anthers 1.5-1.75 mm long, linear-oblong. Ovary 1-1.5 × 1-1.25 mm, obovoid; disc 0.5 mm high; style 1.25-1.5 mm long, glabrous; stigma 2-lobed, 2-2.5 mm long, lobes lanceolate; glabrous. Capsule 1.5-4.5 × 4-10.5 mm, pubescent, locules ovate-oblong, with straight tip. Seeds 0.5 × 0.3-0.4 mm, 5-6-angular, glabrous, brown; wall of the areole thick with a number of tubercles on it and hooded over the areolar space.

Fl. : March-September.

Fr. : June-October.

Pollen : Prolate-spheroidal, semicircular in polar outline, polar axis (P) × equatorial axis (E) = 26-(29)-32 × 25-(30)-33 µm. 3-colporate; colpi 25-30 × 3.5-4.5 µm, tapering to acute ends; ora circular, 4-6 µm

in diameter; sexine 1.5 µm, nexine 0.25 µm, ruguloreticulate; lumina 0.5-1 µm, 0.5-0.75 µm.

Note : Raphides present in the stem, calyx lobes, ovary wall and the disc.

Distribution : Western Himalaya (Kumaon), Nepal, Bhutan, Sikkim, West Bengal (Darjeeling dist.) and Orissa to Myanmar and Malay.

Ecology : Grows on moist soil in rocky slopes along ravines at 150-2400 m, above m.s.l.

Local name and uses : It is known as "Akha-p-Abor" and its fruit is edible among the people of Koppu to Geling, Siang dist., Arunachal Pradesh.

Specimens examined : INDIA: Uttar Pradesh. Almora dist. Kumaon-Sarju valley, *J.F. Duthie* 2989 (BM); Kopkote, *J.F. Duthie* s.n. (K); Boramgaon. Gori valley, *Inayat* 24494 (CAL); Jeolikote, *N. Gill* 73 (CAL, LWG); Dogaun, *N. Gill* 648 (CAL, LWG) & *Bis Ram* 2291 (DD, E); Thanakpur, *T.A. Rao* 11539 (BSD); Barun Maiti, *C.M. Arora* 45527 (BSD); Daffo Dhuru, *C.M. Arora* 49516 (CAL); Mussoorie, *J. F. Duthie* 566 (CAL); *C.R. Babu* 33381 (CAL, BSD); Garhwal dist. Bhainkil kota range, *Inayat* 25908 (DD, K); Batwatebari, *M.A. Rau* 6377 (BSD); Naraikoti, *M.A. Rau* 6477 (BSD); Ukhimath, *M.A. Rau* 38770 (CAL, BSO, L). SIKKIM : Cheerrakhud, *C.B. Clarke* 42815 (CAL); Raiotdong, *C.B. Clarke* 42815 (CAL); *F.E. Younghusband* s.n.

(CAL); Sangachelling, *I. H. Burkill* 32120 (BSIS); Temi, *W.W. Smith* 2922 (CAL). West Bengal. Darjeeling dist. Pankabari, *S. Kurz* s.n. (CAL); Rungbee, *C.B. Clarke* 8566 (CAL, BM); Rishap, *C.B. Clarke* 8704 (CAL); Tista, *C.B. Clarke* 11815 (CAL) & 11836 (BM); Rungbee, *C.B. Clarke* 12355 (BM); Ryang, *C.B. Clarke* 13765 (BM); Choonbuttee, *C.B. Clarke* 26568 (BM); Terai, *C.B. Clarke* 26724 A (CAL); Darjeeling, *C.B. Clarke* 26936 C (K); Budum Jhom, *C.B. Clarke* 27064 (CAL); Runjeet, *C.B. Clarke* 27143 B (CAL); Terai, *J.S. Gamble* 866 B (K); Kurseong, *C.B. Clarke* 36535 (BM); Lubdah, *Prain's Collector* s.n. (CAL); Tista valley, Ribu 829 (CAL); Rungio, *W.W. Smith* 290 (CAL); Mungpoo, Kari 1627 (CAL); Rungpo, *I. H. Burkill* 34069 (BSIS); Mirik, *G.H. Cave* s.n. (E); Rungpo, *G.H. Cave* s.n. (E); Kalimpong, *H.J.C. Kinghorn* 7 (CAL); Mungpoo, *G.H. Cave* s.n. (CAL, E); Tista, *G.H. Cave* s.n. (E); Kalighora, *G.H. Cave* s.n. (E); Rongseong, *G.H. Cave* s.n. (E); Sonada, *G.H. Cave* s.n. (E); Ryong, *G.H. Cave* s.n. (E); Sevoke, *G.H. Cave* s.n. (E); Mungpoo, *G.H. Cave* s.n. (E); Ghoom hills, *M.B. Raijada* 19019 (DD); Dikchu, *K. Biswas* 6746 (CAL); Ghungthung, *K. Biswas* 6969 (CAL); Darjeeling *G.A. Gammie* s.n. (D); Birch hill, *H. Hara & M. Togashi* 1267 (K). Meghalaya. Naklow, *J.D. Hooker & T. Thomson* s.n. (CAL, K); Umwai, *C.B. Clarke* 5293 (CAL); *C.B. Clarke* 16571 A (BM) & 16583 (CAL); Cherra, *G. Gallatly*

189 (CAL); Kullong, *C.B. Clarke* 40007 A (CAL); Mawphlong, *C.B. Clarke* 45076 C (CAL); Khasi hills, *G. Mann* s.n. (CAL); Tura Top, *G. Panigrahi* 22409 (CAL). Arunachal Pradesh. Siang dist., Koppu to Geling, *G.K. Murthy* 13082 (CAL); Manipur. Konglatonghi, *A.A. Bullock* 571 (K). Mizoram. Mizo hills, *R. M. Datta* 33540 (CAL). Orissa. Kalahandi dist., Goyal-Khojghati, *H.F. Mooney* 3501 (K, L); Koraput dist., Joypore Estate, Bhalupodar Valley, *H.F. Mooney* 3886 (DD), NEPAL: *Hamilton* s.n. (CAL); Kathmandu, *Kalka Prashad* s.n. (CAL).

11. ***O. glechomaefolia*** Thw. Enum. 140. 1864 (Type : Sri Lanka, Ambaramowa dist., in the forests, *Thwaites C.P.* 1708! iso. CAL, BM); Hook. f. Fl. Brit. India 3:84. 1880; Trimen, Fl. Ceylon 2:323. 1895. (Fig. 20)

Herbs, 10-50 cm long; stems creeping, branched, hispid. Leaves 0.6-1.8 × 0.5-1.4 cm, ovate or ovate-orbicular, apiculate at apex, rounded or cordate at base, hispid; lateral nerves 4-7 on either side; petioles 0.3-0.8 cm long, hispid; stipules 0.5-1 cm long, linear, entire, glabrous. Inflorescence terminal panicle of cymes, 0.6-1.3 cm across, contracted, branches short, suberect, hispid; peduncles 1-2 cm long, slender, hispid. Flowers 5-8 mm long, white; bracts persistent, 2-4 mm long, linear with prominent midrib, acute, hispid; pedicels 0.3-0.7 mm long, hispid. Hypanthium 0.5-1 × 0.4-0.8 mm, obovoid, hispid. Calyx lobes 1.5-3 × 0.3-0.7 mm, linear-lanceolate,

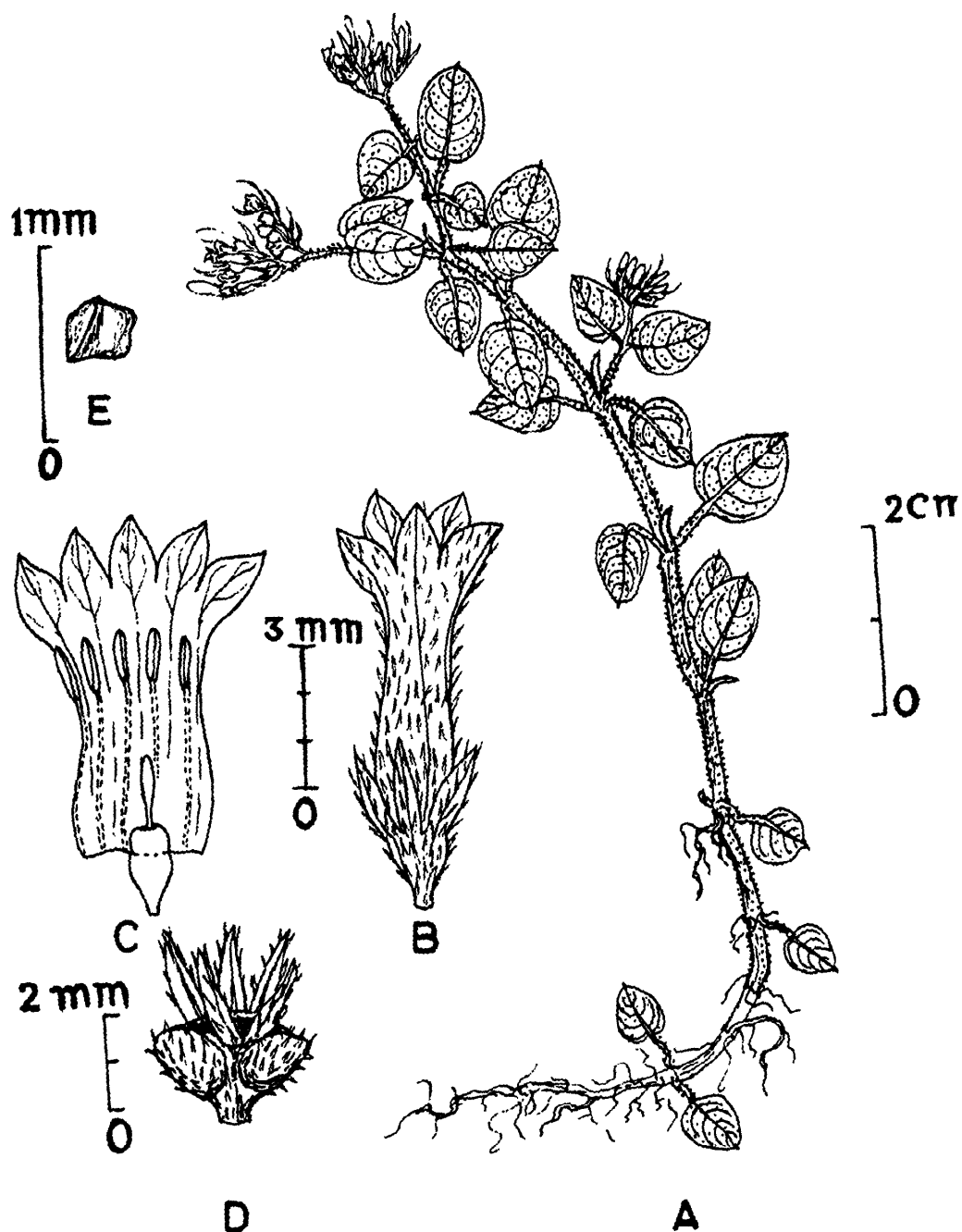


Fig. 20. *O. glechomaefolia* Thw.
A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

acute, hispid. Corolla 4.5-7 mm long, infundibuliform; tube 3.75-5.5 mm long, base slightly broader, hispid outside, glabrous within; lobes $0.75-1.5 \times 0.5-1$ mm, ovate, acute, hispid. Stamens adnate to the middle of corolla, inserted; filaments 0.25-0.3 mm long; anthers 1 mm long, oblong. Ovary $0.4-0.8 \times 0.3-0.75$ mm, obovoid; disc 0.5 mm high; style 1-1.25 mm long, glabrous; stigma club-shaped, 1 mm long, glabrous. Capsule $1.5-1.75 \times 2.5-3.5$ mm, hispid, locules ovate-oblong with straight tip. Seeds $0.3-0.4 \times 0.3-0.4$ mm, 6-8-angular, glabrous, brown; wall of the areole thick with a number of tubercles on it and hooded over the areolar space.

Pollen : Oblate spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = $24 - (27)-30 \times 25-(28)-33 \mu\text{m}$, 3-colporate; colpi $21-26 \times 3-4 \mu\text{m}$, tapering to acute ends; ora circular, $4-5 \mu\text{m}$ in diameter; sexine $1.5 \mu\text{m}$, nexine $0.25 \mu\text{m}$ ruguloreticulate; lumina $0.5-0.75 \mu\text{m}$, muri $0.5 \mu\text{m}$.

Distribution : Sri Lanka.

Ecology : Grows on rocky soil as forest undergrowth.

12. *O. gracilis* Kurz in Journ. Asiat. Soc. Beng. 41(4) : 311. 1872 (*Type* : Tenasserim, Attaran, *Brandis* s.n. !K); Hook. f. Fl. Brit. India 3: 80. 1880; C. B. Clarke in Journ. Linn. Soc. Bot. 25: 31. 1887. Deb & Mondal in Nayar & Sastry, Red Data Book Ind. Pl. 2: 219. fig.1.1988). (Fig.21)

Herbs annual, 15-30 cm tall; stems erect, simple, glabrous. Leaves $6.5-22.5 \times 2-4$ cm, lanceolate or elliptic-lanceolate, caudate-acuminate at apex, tapering at base, membranous, glabrous, pale beneath; lateral nerves 6-10 on either side; petioles 1-2.5 cm long, slender, glabrous; stipules caducous, 3-12 mm long, subulate, bifid, filiform above, glabrous. Inflorescence terminal cyme, 1-1.5 cm across, glabrous; peduncles 2.75-3.2 cm long, glabrous. Flowers subsessile, 7-8 mm long, white or purplish; bracts caducous, 1.5-2 mm long, linear, glabrous. Hypanthium $1-1.2 \times 0.75-1$ mm, obovoid, glabrous. Calyx lobes $0.5-0.7 \times 0.5-0.6$ mm, triangular, acute, glabrous. Corolla 6-6.8 mm long, infundibuliform, glabrous both outside and inside; lobes $1-1.25 \times 0.75-1$ mm, ovate, obtuse, glabrous. Stamens adnate to the base of corolla or slightly above, inserted; filaments 2-2.2 mm long; anthers 2 mm long, narrowly oblong. Ovary $0.8-1 \times 0.6-0.8$ mm, obovoid; disc 0.4-0.5 mm high; style 2-2.25 mm long, glabrous; stigma bilobed, 1-1.2 mm long, lobes ovate-lanceolate, acute, glabrous. Capsule not seen.

Pollen : Oblate-spheroidal, usually semicircular sometimes angular in polar outline, polar axis (P) \times equatorial axis (E) = $32 - (34) - 36 \times 34-(37)-42 \mu\text{m}$, 3-colporate; colpi $30-32 \times 5-7 \mu\text{m}$, tapering to acute ends; ora circular, $6-8 \mu\text{m}$ in diameter; sexine $1.75 \mu\text{m}$, nexine $0.25 \mu\text{m}$,

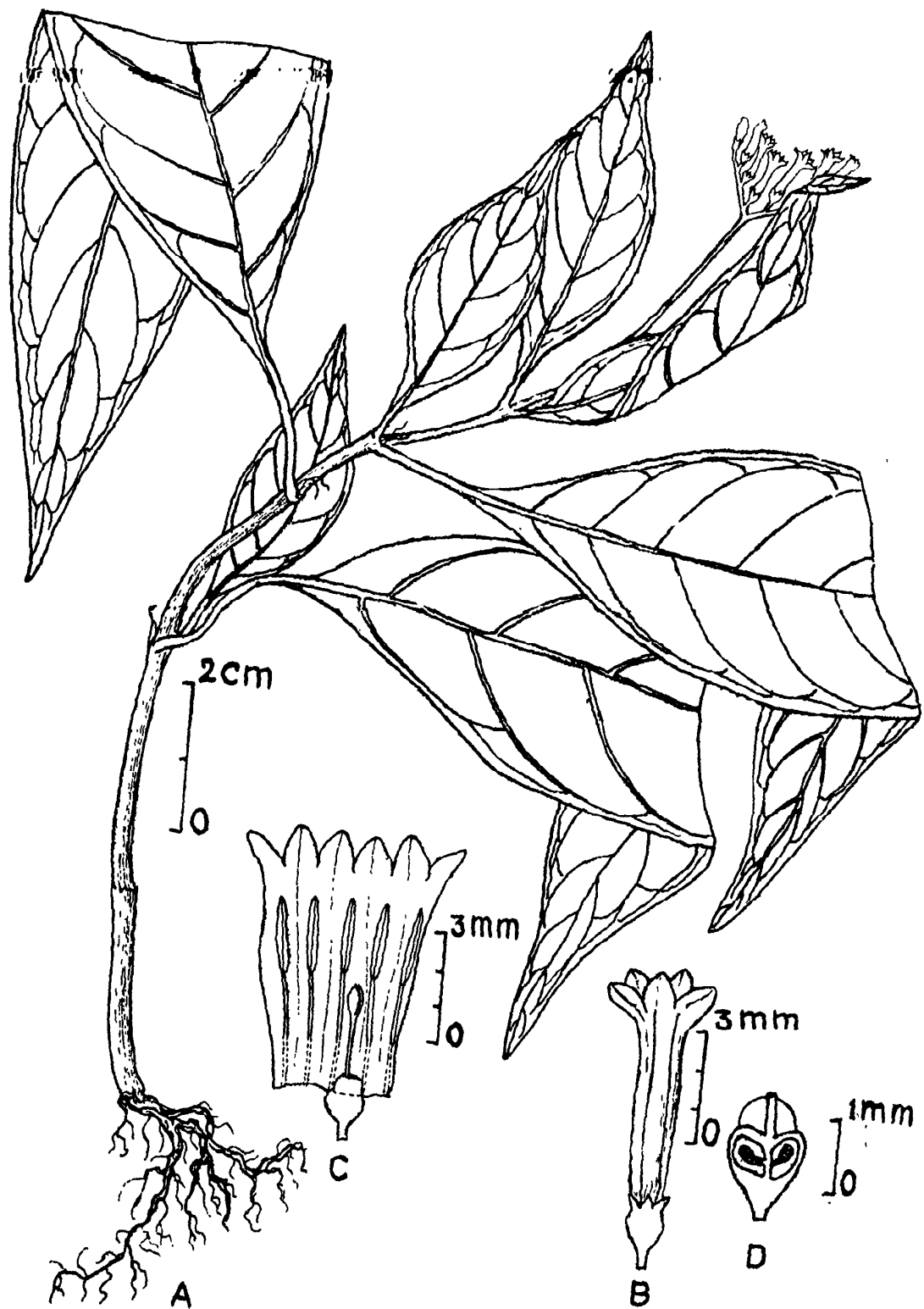


Fig.21. *O. gracilis* Kurz
A. habit; B. flower; C. flower split open; D. l.s. of ovary.

rugulo-reticulate; lumina $0.75-1\ \mu\text{m}$, muri $0.75\ \mu\text{m}$.

Distribution : India, Nagaland (Kohima); Myanmar.

Specimens examined : MYANMAR : *Brandis* s.n. (CAL).

Note : This species has not been collected within the last one century. The localities from which this plant was collected have been scarcely surveyed in any organised way. Hence the status of its existence cannot be stated with certainty.

13. *O. grandiflora* Wight, Icon. 3: 4. t. 1069. 1848. (*Type*: Shevagherry Hills, August 1836, *R. Wight* s.n. lecto K! Iso -CAL!); Hook. f. Fl. Brit. Ind. 3: 80. 1880; Rao, Flower. Pl. Travanc. 207. 1914; Gamble, Fl. Pres. Madras 608. 1921. (Fig. 22)

Herbs, 10-40 cm tall; stem erect, somewhat suffrutescent, branching, glabrous. Leaves $6-17.5 \times 2-6\ \text{cm}$, elliptic-lanceolate, acuminate at apex, acute at base, glabrous; lateral nerves 6-10 on either side, glabrous beneath; petioles 1-4 cm long, glabrous; stipules caducous, 4-8 mm long, linear-lanceolate, glabrous. Inflorescence terminal corymbose cymes, 1.5-7 cm across, contracted, branches suberect, glabrous; peduncles 1-4.5 cm long, glabrous. Flowers 20-40 mm long, white; bracts persistent, 12-25 mm long, linear, glabrous, sometimes pubescent at margin; bracteoles persistent, 8-20 mm long, linear, usually glabrous, sometimes pubescent at

margin; pedicels 1.5-3 mm long, glabrous. Hypanthium $1.5-2.25 \times 1.25-2\ \text{mm}$, obovoid, glabrous. Calyx lobes $2-2.5 \times 1-1.5\ \text{mm}$, lanceolate, acute, glabrous. Corolla 18-38 mm long, 15-20 mm across, infundibuliform; tube slender, pubescent outside usually at base along the veins, glabrous within; lobes $4-6 \times 3.5-4.5\ \text{mm}$, broadly ovate, acute. Stamens adnate to the middle of corolla tube, inserted; filaments 3-3.5 mm long, glabrous; anthers 2.5-3.5 mm long, linear-oblong. Ovary $1.3-2 \times 1-1.8\ \text{mm}$, obovoid; disc 1-1.25 mm high; styles 3-4.5 mm long, glabrous; stigma 2-lobed, 3-3.5 mm long, lobes linear to lanceolate, acute, glabrous. Capsule $2.5-3.5 \times 6-8\ \text{mm}$, glabrous, locules ovate-oblong, tip slightly inclined outwards. Seeds $0.6-1 \times 0.5-0.75\ \text{mm}$, irregularly angular, glabrous, brown; wall of the areole moderately thick with a few tubercles hooded over the areolar space.

Fl. : May-November.

Fr. : June-December.

Pollen : Suboblate to oblate-spheroidal, semicircular in polar outline, polar axis (P) \times equatorial axis (E) = $26-(29)-36 \times 29-(33)-38\ \mu\text{m}$, 3-colporate; colpi $24-32 \times 3-5\ \mu\text{m}$, tapering to obtuse ends; ora lolate, $4-6.5 \times 3.5\ \mu\text{m}$; sexine $1.25\ \mu\text{m}$, nexine $0.25\ \mu\text{m}$, ruguloreticulate; lumina $0.5-1\ \mu\text{m}$, muri less than $0.5\ \mu\text{m}$.

Distribution : India. Tamil Nadu, Kerala.

Ecology : Grows on moist soil in rocky

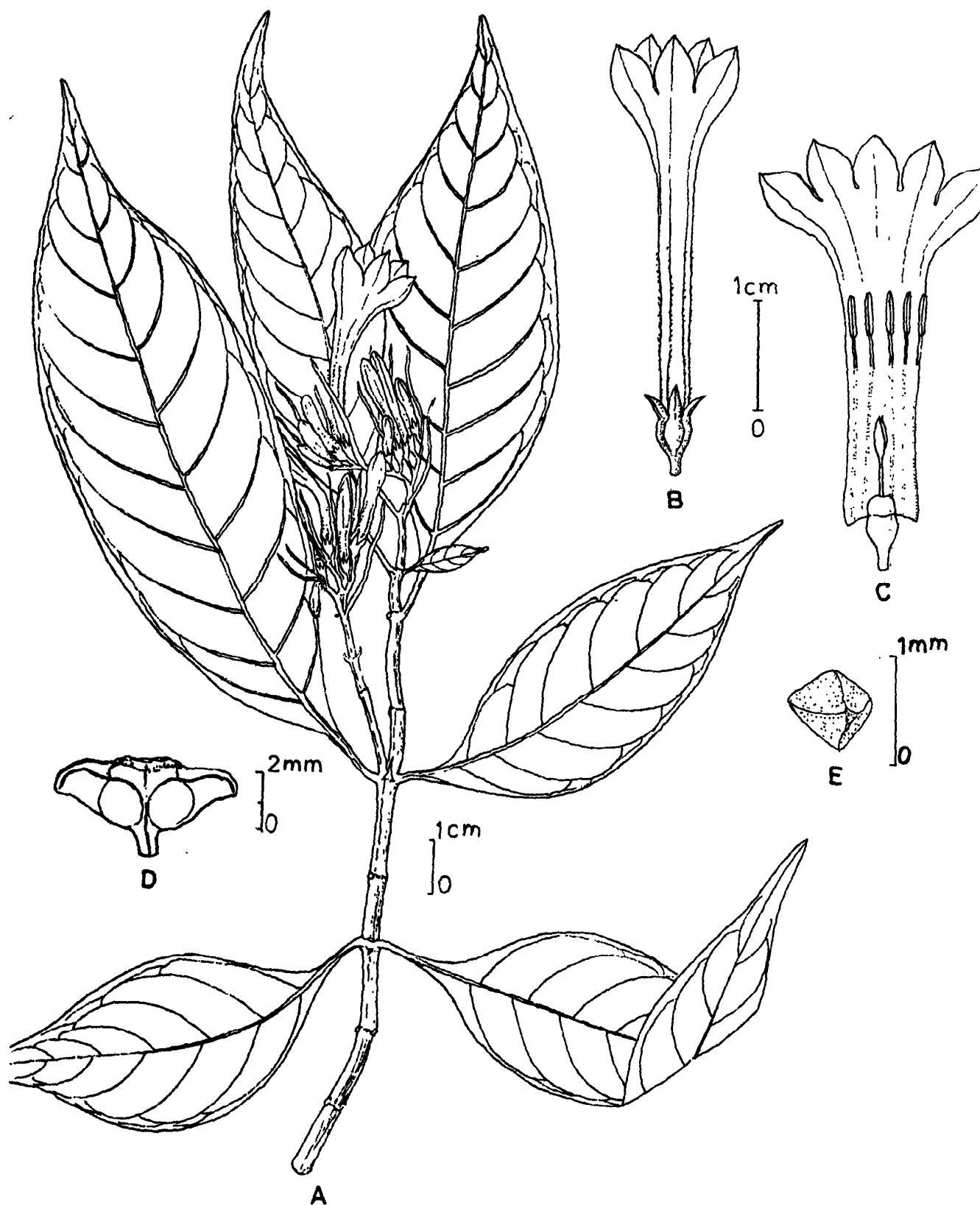


Fig.22. *O. grandiflora* Wt.
A. habit; B. flower; C. flower split open, D. fruiting; E. seed

slopes at 1000-1733 m above m. s. l.

Specimens examined : TAMIL NADU : Coimbatore dist.: Anaimalai Hills, *R. H. Beddome* 3614, 3615, 3616 (BM); Kanniyakumari dist.: Upper Kodayar, *A. N. Henry* 49634 (MH); Madurai dist.: Aruna Estate, *K. Subramanyam* 9506 (MH); Tirunelveli Hills, *R. H. Beddome* 3611 (BM); Kodanadi, *E. Barnes* 781 (K); Netterikal, *E. Barnes* 2001 (K); Kakachi, *K. M. Sebastine* 4495 (MH); Arankathumalai, Kakachi, *K. M. Sebastine* 5824 (CAL, MH); Upper Godaiyar, *A. N. Henry* 17418 (CAL, MH); Naterikal, *E. Vajravelu* 29185 (CAL); Ashamdu Hills, Kabkkadu R. F., *J. F. Oates* 62 (K). KERALA: Kottayam dist., Peermade, *A. Meebold* s.n. (CAL).

14. ***O. griffithii*** Hook.f. Fl. Brit. India 3: 82.1880 [*Type* : Naga Hills, Kuttack Boom, March 16th 1837, *Griffith* s.n. (holo.! K)]; Kanjilal *et al.* Fl. Assam 3: 42. 1939; Deb & Mondal in Nayar & Sastry, Red Data Book Ind. Pl. 2: 221 fig. 1. 1988. *OPHIORRHIZA* Sp. Griff. Icon. Pl. Asiat. 1 : 264. t.475. 1854. (Fig.23)

Herbs about 20 cm tall; stems erect, glabrous or puberulous when young. Leaves 7.5-15 × 6-7 cm, broadly elliptic, acute at apex and base, glabrous, pale greenish on drying; lateral nerves 12-15 on either side; petioles 1.5-5 cm long, glabrous or slightly puberulous; stipules 7-15 mm long, upper oblong, lower broadly lanceolate, entire, acute, glabrous. Inflorescence terminal corymbose cyme, 2-3.5 cm across, puberulous; peduncles 1-2

cm long, erect, glabrous or slightly puberulous. Flowers crowded, 19-22 mm long, purple; bracts persistent, 9-11 mm long, linear-lanceolate, acute, glabrous except midvein; bracteoles persistent, 7-10 mm long, linear-lanceolate, acute, pubescent on the midvein; pedicels 1.5-2.25 mm long, puberulous. Hypanthium 2-2.5 × 2.3-2.5 mm, broadly obovoid, pubescent. Calyx lobes 1-1.25 × 1 mm, triangular, acute, glabrous. Corolla 17-20 mm long, infundibuliform, glabrous outside, villous at the middle of corolla within; lobes 2-2.25 × 2.75-3 mm, broadly ovate, acute, winged at the back. Stamens adnate to the middle of corolla tube, inserted; filaments 1.25-1.5 mm long; anthers 3.25-3.5 mm long, oblong-linear. Ovary 1.75-2 × 2-2.25 mm, obovoid, disc 1.25-1.5 mm high; styles ± 4 mm long, pubescent; stigma 2-lobed, 5-5.5 mm long, lobes linear-lanceolate, pubescent. Capsule (immatured) 2.5-3.25 × 2.5-2.75 mm, pubescent.

Fl. : March.

Fr. : April-May.

Pollen : Oblate spheroidal, angular in polar outline, polar axis (P) × equatorial axis (E) = 27-(30)-35 × 30-(34)-38 µm, 3-colporate; colpi 25-30 × 3-4.5 µm, tapering to obtuse ends; ora lolongate, 4-6 × 3-4.5 µm; sexine 1.25 µm, nexine 0.25 µm, ruguloreticulate; lumina 0.5-1 µm, muri 0.5 µm.

Distribution : India, Nagaland, Myanmar.

Specimens examined INDIA: Nagaland, Naga Hills, Kuttack Boom, *Griffith* s.n.

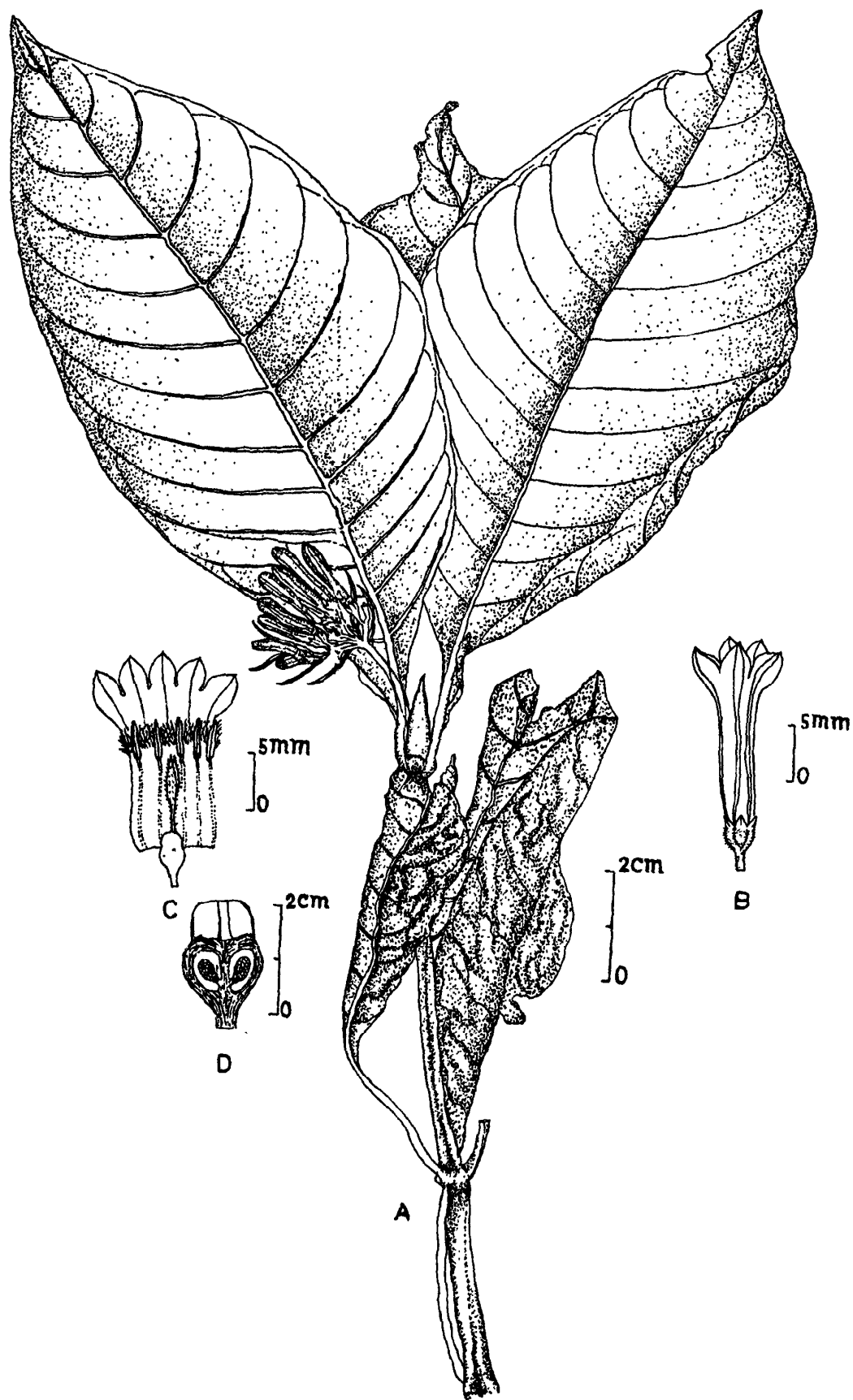


Fig. 23. *O. griffithii* Hook. f.
A. habit; B. flower; C. flower split open; D. l.s. of ovary.

(K); MYANMAR. *Griffith* s.n. (CAL).

Note : This species is based on two gatherings made in 1837. Since then the localities where it was found have not been botanically explored properly. Hence efforts should be made for collecting the plant from Nagaland and nearby localities, and if available to grow in the garden.

15. *O. heterostyla* Dunn in Kew Bull. 1920(4) : 133. 1920 (*Type* : Arunachal, Kameng District, (Abor Hills), *Burkill* 36116 CAL! 37334 CAL!, 38158 CAL! K! (Syntype) ; *Burkill* in Rec. Bot. Surv. Ind. 10 (1) : 50. 1924; *Deb et Mondal* in Journ. Bomb. Nat. Hist. Soc. 82 (2) : 696. 1984. *O. seshagiriana* Sikdar et Maiti in Journ. Bomb. Nat. Hist. Soc. 78(1) : 142. 1981. (Fig. 24)

Herbs perennial, 30-40 cm tall, stems branching, glabrous. Leaves 5-16 × 1.5-4 cm, narrowly lanceolate, caudate-acuminate at apex, acute at base, glabrous; lateral nerves 5-9 on either side; petioles 3-9 mm long, glabrous; stipules 2.5-6 mm long, ovate to ovate-lanceolate with acute apex, entire, glabrous or puberulous. Inflorescence terminal dichotomously or trichotomously branched corymbose cymes, 2.5-4 cm across, puberulous; peduncles 0.5-1 cm long, puberulous. Flowers 9-14 mm long, white, reddish tinged at the apex; bracts and bracteoles deciduous, minute, linear, puberulous; pedicels either 1.25-1.5 mm (in short-styled flowers) or 2.5-3.5 mm long (in long-

styled flowers) puberulous. Hypanthium 1.5-1.75 × 1.5-2 mm, obovoid, puberulous. Calyx lobes 0.75-1 × 0.5-0.75 mm, triangular to subulate, acute; glabrous or puberulous. Corolla 7.5-12.25 mm, long, tubular; tube 5.5-7.5 mm long, bulbous at the base glabrous outside, villous ring at the throat within in long-styled one, and extending up to the middle of corolla tube in short-styled one; lobes 3-5 × 0.75-1.25 mm linear-oblong, reflexed, inwardly curved and acute at apex, keeled, sparsely hairy within. Stamens adnate either slightly above the base (in long-styled one) and inserted or at the middle of corolla and exserted (in short styled one); filaments either 0.75-2 mm (in long styled one) or 4-5 mm long (in short-styled one); anthers 1.5-2.5 mm long. Ovary 1.25-1.5 × 1.25-1.75 mm, obovoid; disc 0.75-1 mm high, 1.5-1.75 mm wide; style as long as corolla, pubescent towards base with exserted stigma or $\frac{1}{3}$ rd as long as corolla, inserted and glabrous; stigma 1-1.6 × 0.5-0.75 mm, 2-lobed, lobes ovate to ovate-lanceolate, obtuse, glabrous or puberulous. Capsules (immatured) 1.8-2 × 2-2.8 mm.

Fl. : February-March.

Pollen : Prolate-spheroidal, angular in polar outline, polar axis (P) × equatorial axis (E) = 25-(29)-34 × 22-(26)-31 μ m, 3 colporate; colpi 23-32 × 3.5 μ m, tapering to obtuse ends; ora circular, 4-6 μ m in diameter; sexine 1.75 μ m, nexine 0.25 μ m, rugulo-reticulate; lumina 0.75-1 μ m, muri 0.5-0.75 μ m.

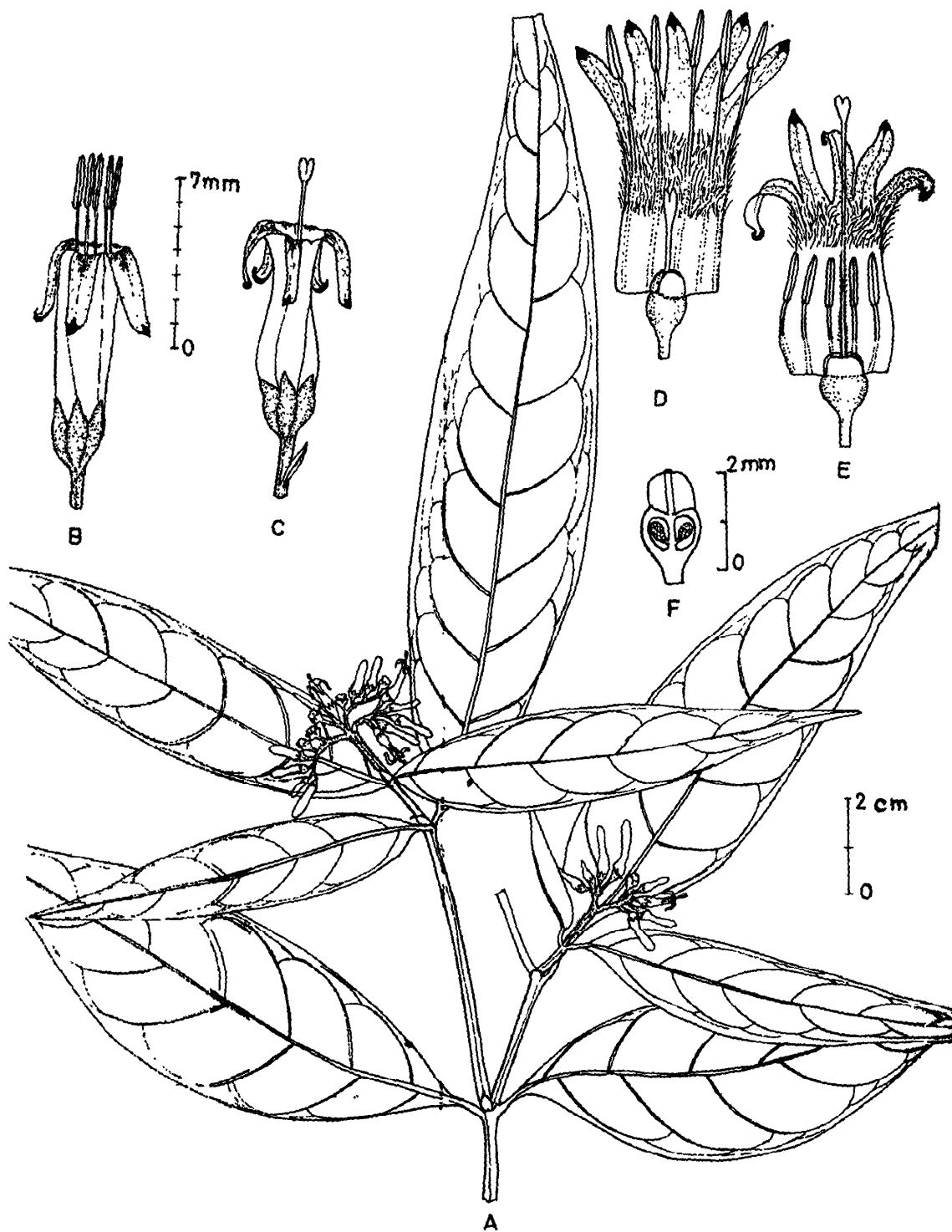


Fig. 24. *O. heterostyla* Dunn
A. habit; B. & C. flower; D. & E. flower split open; F. l.s. of ovary.

Distribution : India. West Bengal (Jalpaiguri dist.), Arunachal Pradesh; Myanmar.

Ecology : Grows on moist soil in deep shade at 540–2250m.

Specimens examined : INDIA : Arunachal Pradesh. Siang dist. Abor Hills, *I. H. Burkill* 38158 (CAL, K) ; Above Igar Stream, *I. H. Burkill* 36116 (CAL). MYANMAR : Kachin State, Sumprabum subdivision, Janrawang Bum, *J. Keenan, U Tun Aung & U. Tha Hla* 3206 (E).

16. *O. hirsutula* Wight ex Hook. f. Fl. Brit. Ind. 3: 81. 1880 (*Type*: Nilgiri Mts., Sisparah, *Wight s.n.* holo - K!); Gamble, Fl. Pres. Madras 608. 1921; Barnes in Journ. Bomb. Nat. Hist. Soc. 44(3) : 443. 1944; Ramamoorthy in Saldanha & Nicolson, Fl. Hassan dist. 587. 1976. *O. brunonis* Wight & Arn. var. *hirsutior* Hook. f. Fl. Brit. Ind. 3: 80. 1880 (*Type* : Nilgiri, *Gardner s. n.* holo K!). (Fig. 25)

Herbs, 15-45 cm tall; stem prostrate, rooting at the lower nodes, then becoming erect, branched or unbranched, rusty pubescent. Leaves 3-17.5 × 2-6 cm, ovate to ovate-lanceolate, acute or acuminate at apex, obtuse at base, scabrid above furfuraceous and pale beneath; lateral nerves 8-12 on either side; petioles 1-3.75 cm long, rusty pubescent; stipules 5-12 mm long, subulate, entire, pubescent. Inflorescence axillary or terminal subcorymbose cyme, 1-2.5 cm across, rusty pubescent; peduncles 1-5 cm long,

elongating up to 5.5 cm in fruiting, pubescent. Flowers 14-16 mm long, white or pinkish-white, fragrant; bracts persistent, 4.5-6.5 mm long, linear, pubescent; bracteoles persistent 4-5 mm long, linear, pubescent; pedicels 0.5-2 mm long, pubescent. Hypanthium 1.25-2 × 1.25-1.75 mm, obovoid, hispid. Calyx-lobes 1.25-1.6 × 0.75-1 mm, lanceolate, obtuse, hispid. Corolla 13-14 mm long, infundibuliform, hirsute outside, glabrous within; lobes 1.5-2.5 × 0.5-1.75 mm, lanceolate, erect, acute. Stamens adnate to the base of corolla, inserted; filaments 0.5-1.5 mm long, glabrous; anthers 1-1.75 mm long, oblong-linear. Ovary 1-1.75 × 1-1.5 mm, obovoid; disc 0.4-0.6 mm high; style 1.25-4 mm long, glabrous; Capsules 2-2.5 × 5-8 mm, pubescent, locules ovate-oblong, tip slightly inclined outwards. Seeds 0.4-0.5 × 0.3-0.4 mm, irregularly angular, glabrous, brown; wall of the areole moderately thin with a number of tubercles on it.

Fl. April-November.

Fr. : June-December.

Pollen : Oblate-spheroidal, semicircular in polar outline, polar axis (P) × equatorial axis (E) = 27-(32)-37 × 27-(33)-36 μ m, 3- or 4-colporate; colpi 26-33 × 5-6.5 μ m, tapering to acute ends; ora circular, 5-7 μ m in diameter, sexine 1.75 μ m, nexine 0.25 μ m, ruguloreticulate; lumina 0.75-1 μ m, muri 0.5-0.75 μ m.

Note : Pollen grains dimorphic, either tricolporate (80%) or tetracolporate (20%).

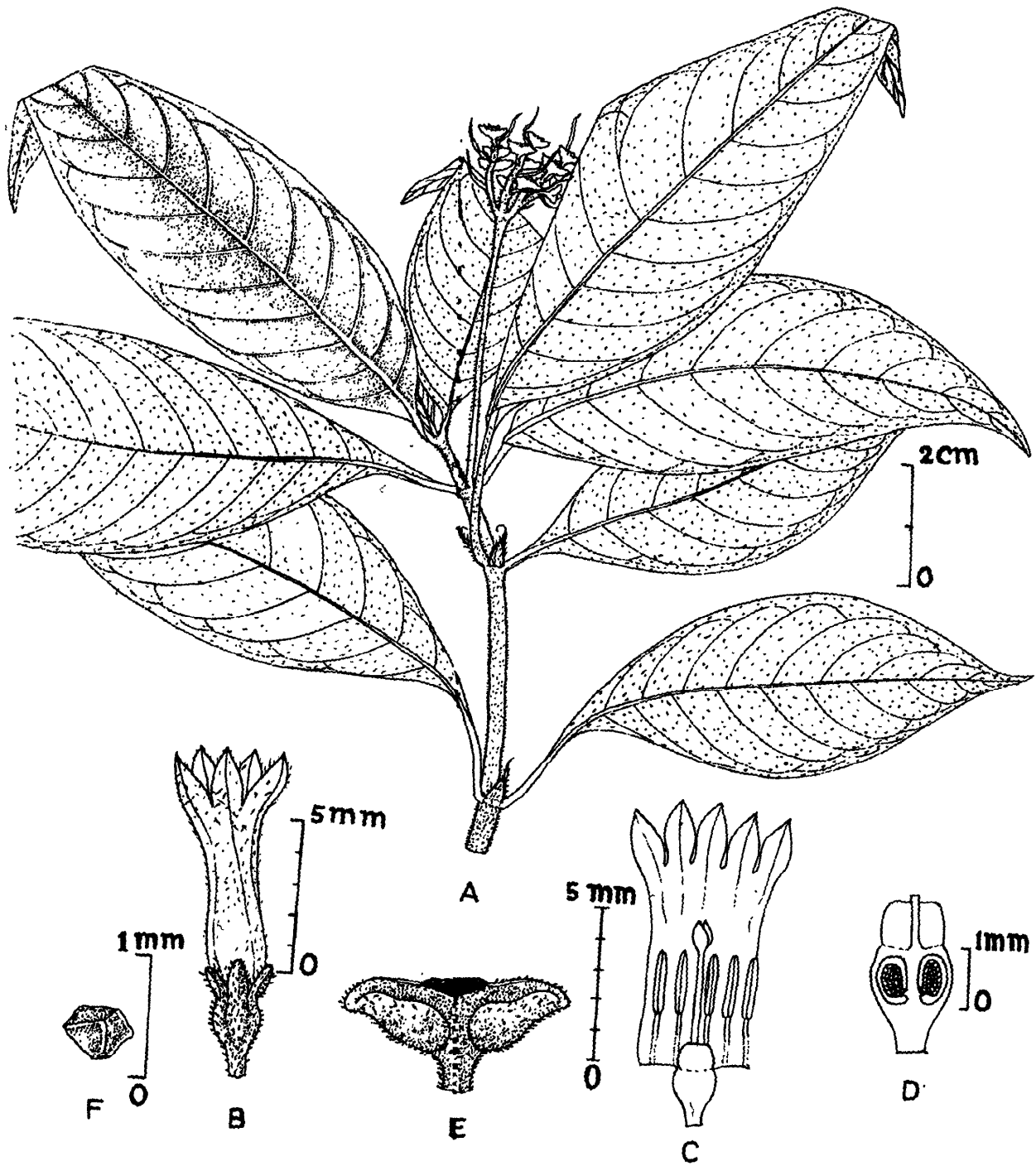


Fig. 25. *O. hirsutula* Wt. ex Hook. f.

A. habit; B. flower; C. flower split open; D. l.s. of ovary; E. fruiting; F. seed.

Distribution : India. Andhra Pradesh, Tamil Nadu, Kerala, Karnataka; Myanmar.

Ecology : Grows on damp soil under shade in evergreen forest at an altitude of 240-2100 m.

Specimens examined : INDIA: Andhra Pradesh. Visakhapatnam dist. Sunkarimetta, *N. P. Balakrishnan* 10930 (CAL, MH) & 754 (CAL); East Godavari Dist. Gannavaram, *G. V. Subba Rao* 24530 (MH). Tamil Nadu. Coimbatore dist. Muttikulam Ghat, *C. E. C. Fischer* 2175 (CAL); Siruvani, Mathukulam, *A. N. Henry* 414 (MH); Anaimalai, *R. H. Beddome* 3634 (BM); Madura, *K. C. Jacob* 17593 (K); Nilgiri dist. Avalanche M. A. *Lawson* 12879 (E); Devala, *J. S. Gamble* 15600 (CAL); Tirunelveli dist. Kuttalam, *Wight* 362 (E). Kerala. Cannanore dist. Mannanthara, *K. N. Subramanian* 77073 (BSI); Manatoddy-Chandanathode, *J. L. Ellis* 25128 (MH); Chandanathode, *J. L. Ellis* 27100 (MH) & 27103 (CAL, MH); Malappuram dist. Moolakadu-onehterlong valley, *J. L. Ellis* 34864 (MH); Palghat dist. Silent valley R.F., *E. Vajravelu* 26052 & 33209 (CAL, MH); Silent valley, *C. E. Ridsdale* 280 (K); Panthanthode, *J. Joseph* 51432 (MH); Palghat Hills, *R. H. Beddome* 3628 & 3633 (BM); Quilon dist. Havelocki bungalow, *C. E. C. Fischer* 2309 (CAL). Karnataka. Hassan dist. Bisleghat, *C. J. Saldanha* 13607 (E); Mysore dist. Sisparaghat, *J. S. Gamble* 13383 (CAL, K); Sisparaghat, *R. H. Beddome* 3632 (BM); North Canara dist. Castle Rock, *A. Meebold* 9930 (CAL).

MYANMAR: Tenasserim division, Paungdow, *J. Keenan, U Tun Aung & R. H. Rule* 541 (E); Paungdow, *J. Keenan, U. Tun Aung & R. H. Rule* 871 (E).

17. *O. hispida* Hook. f. Fl. Brit. India 3: 83. 1880. (Type : Khasia, Cherrapunjee, 1200 m, 13.8.1850, *J. D. Jooker & T. Thomson* *OPHIORRHIZA* 20! (K); Kanjilal *et al.* Fl. Assam 3: 42. 1939; Balakr. Fl. Jowai 1:249. 1981, Deb & Mondal in Nayar & Sastry, Red Data Book Ind. Pl. 2:223. fig. 1. 1988. (Fig. 26)

Herbs, 10-35 cm long; stems procumbent, branched, hispid. Leaves 2-15 × 1-4 cm, ovate-lanceolate, acute or acuminate, sometimes obtuse at apex, obtuse to acute at base, hispid; lateral nerves 6-12 on either side; petioles 0.5-1.8 cm long, hispid; stipules 5-7 mm long, oblong-lanceolate, acuminate, hispid at margin. Inflorescence terminal capitate cymes, 1-2 cm across, subglobose dense-flowered, hispid; peduncles 0.5-1.5 cm long, stout, hispid. Flowers 5-6.5 mm long, greenish-white or reddish; bracts and bracteoles similar, persistent, concealing the flowers, 4-6.5 × 1.5-2 mm, linear-lanceolate, acute at apex, ciliate; pedicels 0.75-1 mm long, hispid. Hypanthium 1-1.25 × 0.75-1 mm obovoid, hispid. Calyx-lobes 0.75-1.25 × 0.5-0.75 mm, ovate-lanceolate, acute, hispid. Corolla 4-5.25 mm long, shortly infundibuliform, broad at base, narrowing upwards, hispid outside, villous at the throat within; lobes 1.25-1.5

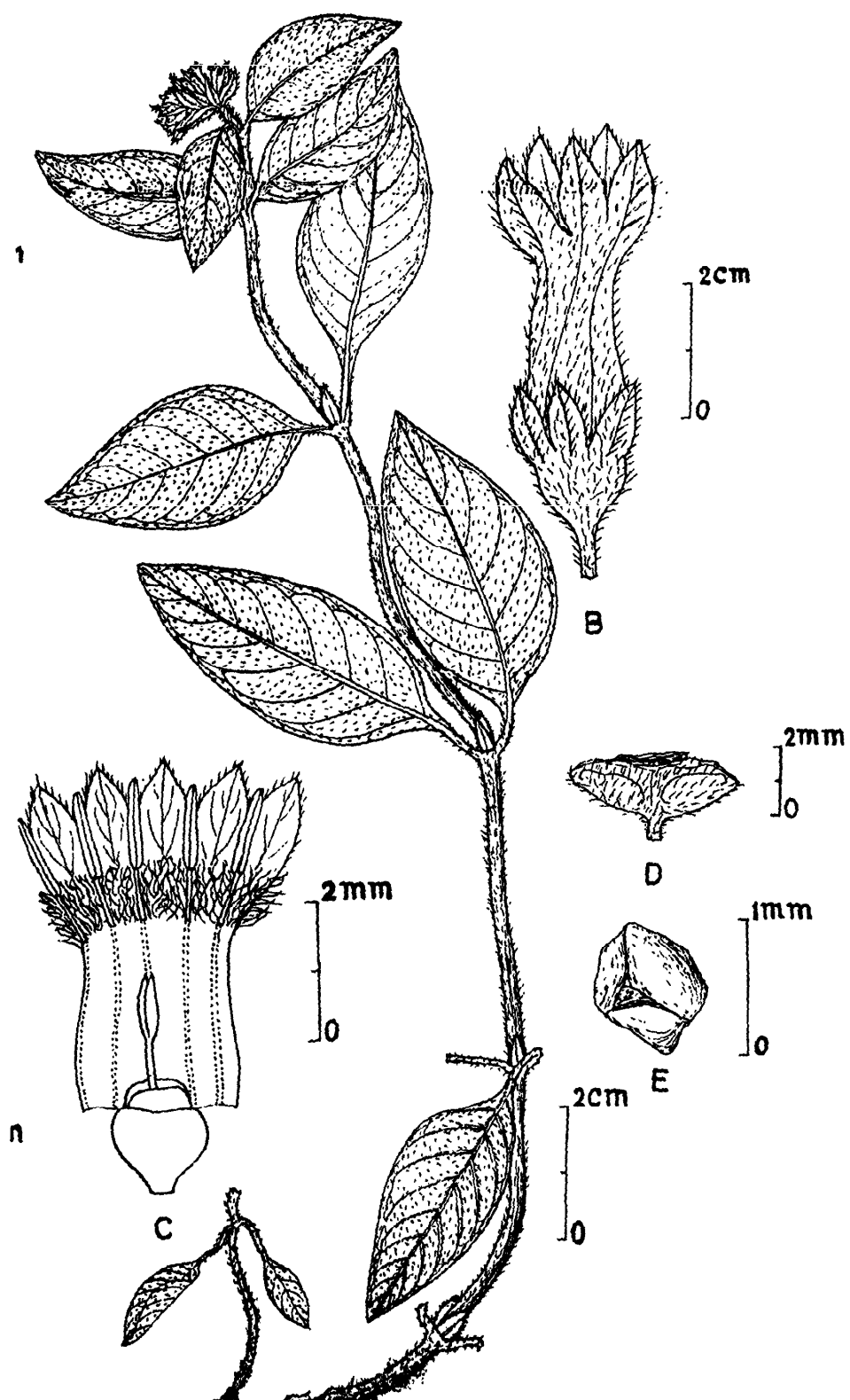


Fig. 26. *O. hispida* Hook.f.
A. habit; B. flower; C. flower split open; D. fruiting; E. seed

× 0.75-1.25 mm, ovate-oblong, spreading, acute, hispid outside. Stamens adnate to the throat of corolla or slightly below, inserted or slightly exserted; filaments 0.8-1 mm long, glabrous; anthers 1-1.25 mm long, oblong-linear. Ovary 0.75-1 × 0.6-0.8 mm, obovoid to subglobose; disc 0.5 mm high; styles 1-1.5 mm long, glabrous; stigma 2-lobed, 1-1.25 mm long, lobes oblong-lanceolate, acute at apex, glabrous. Capsules 1.5-2.5 × 3.5-6 mm, hispid, locules ovate-oblong with straight tip. Seeds 0.3-0.4 × 0.25-0.3 mm, 5-7-angular, glabrous, brown; wall of the areole moderately thin with a number of tubercles on it.

Fl. : April-November.

Fr. : June-December.

Pollen Oblate-spheroidal, angular in polar-outline, polar axis (P) × equatorial axis (E) = 28-(30)-32 × 30-(32)-33 µm, 3-colporate; colpi 26-28 × 4-4.5 µm, tapering to acute ends; ora circular, 5-5.5 µm in diameter; sexine 2 µm, nexine 0.25 µm, rugulo-reticulate; lumina 0.75-1 µm, muri 0.5-0.75 µm.

Distribution : India. Assam, Meghalaya, Myanmar.

Ecology : Grows on damp, shady places near streams at 90-1800 m above m.s.l.

Specimens examined : INDIA: Assam. Lakhimpur dist., Makum, C.B. Clarke 37830 (K, BM, CAL); Namsung, C.B. Clarke 37931 (K, CAL). MYANMAR : Kachin Hills, Kritoo, E. Pottinger 42 (CAL); Chindwin Bhamo,

S. Toppin 3123 & 3125 (CAL); Katha dist., Kadu hills, J.H. Lace 5334 (CAL, E); Bansparae, Shaik Mokim s.n. (CAL).

Note : This species is known from several gatherings, the last one being made in 1911. Since the area is not fully explored, there could be pockets wherein it may be still in existence.

18. *O. incarnata*, Fischer in Kew Bull. 1938(3): 124. 1938 (*Type* : Nilgiri, Wynaad near Nadgani, June 1937, E. Barnes 1559 holo K!); Sebastine in Bull. Bot. Surv. India. 4: 223. 1962; Deb & Mondal in Nayar & Sastry, Red Data Ind. Pl. 1:337. fig. 1. 1987. (Fig.27)

Herbs, 20-30 cm tall; stems erect from horizontal base, rooting below, internodes 2-9 cm long, brown-pubescent. Leaves 5-9 × 1-2.5 cm, narrowly elliptic, acuminate at both ends, slightly inequilateral at base, glabrous and dark green above, pale and scabrid on the nerves beneath; lateral nerves 7-10 on either side, arising at a wide angle from the midrib, arching forwards to unite with a distinct loop well within the margin; petioles 0.5-1.5 cm long, brown-puberulous; stipules deciduous, 0.3-0.8 cm long, subulate, entire, scabrid, sometimes a patch of erect short hairs beneath. Inflorescence terminal capitate cymes, 1.5 cm across, dense-flowered, glabrous; peduncles 2-3 cm long, glabrous. Flowers heterostylous, 8-10 mm long, crimson or pinkish-white; bracts and bracteoles similar, persistent, 5-7 mm long, lanceolate or ovate-lanceolate, glabrous with

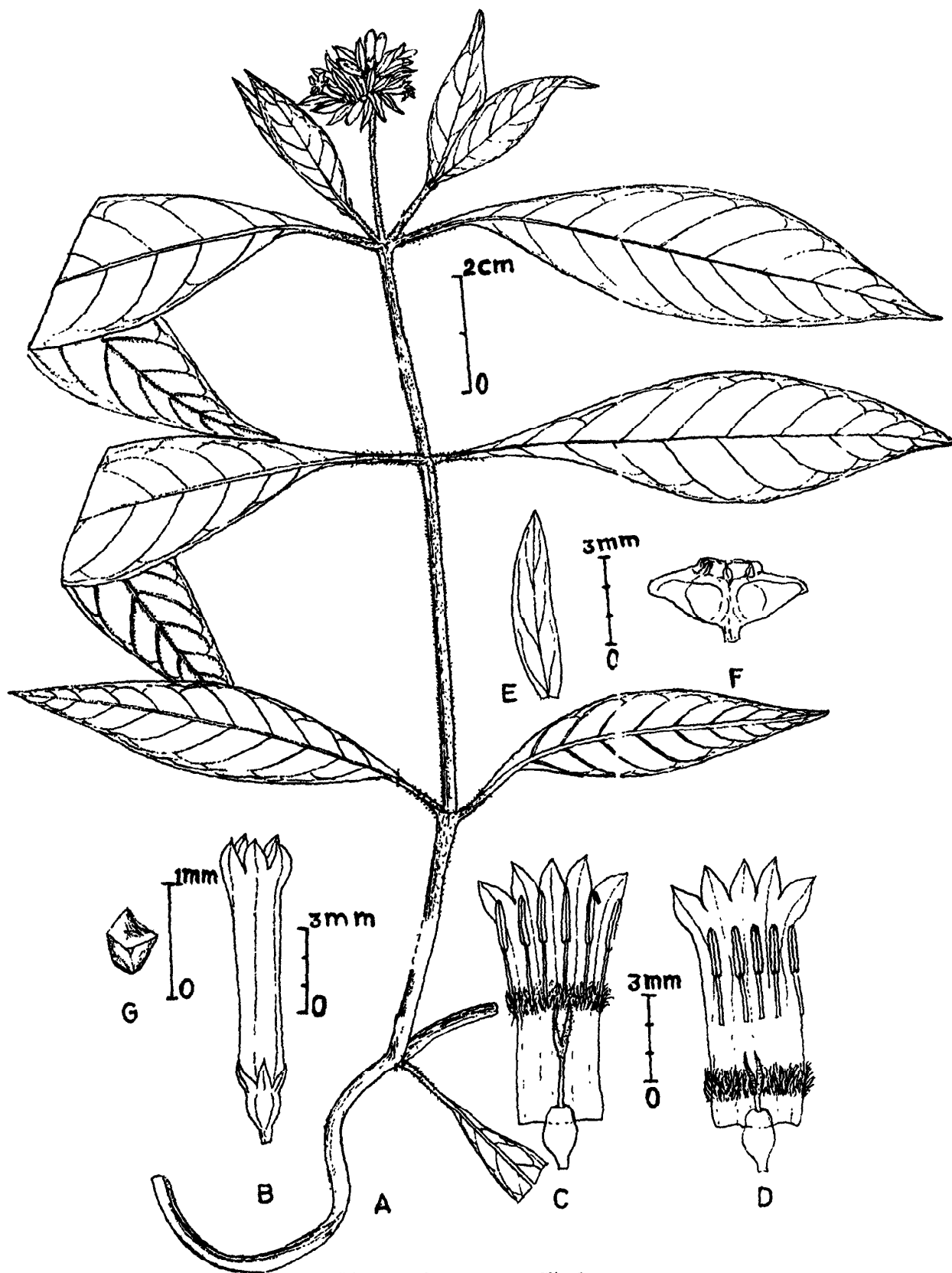


Fig. 27. *O. incarnata* Fischer

A. habit; B. flower; C. & D. flower split open; E. bract; F. fruiting; G. seed.

prominent midrib; pedicels 0.5-1 mm long, glabrous. Hypanthium 1-1.25 × 0.75-1.25 mm, obovoid, glabrous. Calyx lobes 0.8-1 × 0.4-0.5 mm, ovate-lanceolate, acute, glabrous. Corolla 7-8.75 mm long, infundibuliform, wide at the mouth, glabrous outside, with a villous ring at the insertion of filaments within; lobes 1.3-1.5 × 0.75-1.25 mm, broadly ovate, spreading, acute. Stamens adnate either at the middle or above the base of corolla, slightly exserted or inserted; filaments 2.2 - 2.4 mm long; anthers 1.75-2 mm long, oblong-linear. Ovary 0.8-1 × 0.6-1 mm, obovoid; disc 0.5-0.6 mm high; style either 2-2.25 mm or 0.75-1 mm long, glabrous; stigma 2-lobed, 1-2 mm long, lobes linear, caudate acuminate, minutely puberulous. Capsule 2-2.5 × 4.5-6.25 mm, glabrous; locules ovate-oblong with slightly inclined tip. Seeds 0.5-0.6 × 0.5 mm, angular, glabrous, brown; wall of the areole thick with a number of tubercles on it.

Fl. & Fr. : June-July.

Pollen : Oblate-spheroidal, angular in polar outline, polar axis (P) × equatorial axis (E) = 38-(39)-40 × 37-(43)-44 µm, 3-colporate; colpi 34-38 × 6 µm, tapering to obtuse ends; ora circular, 6.5-7.5 µm in diameter; sexine 1.75 µm, nexine 0.25 µm, ruguloreticulate; lumina 0.75-1 µm, muri 0.5-0.75 µm.

Occurrence : Kerala, Kottuyam dist.; on swampy soil at 900 m above m.s.l.

Ecology : Grows in swampy soil at 900 m above m.s.l.

Specimens examined : KERALA: Wynaad near Nadgani, *E. Barnes* 1559 (K) ; Kottuyam dist., Cardamon hills, Mankulum, *C. E. Ridsdale* 231 (K).

Note : This species is closely allied to *O. pectinata* Arn., but differs by the smaller and narrowly elliptic leaves, the lateral nerves arising at a broader angle, arched and anastomosing clearly away from the margin, carmine and glabrous, simple (not keeled) corolla lobes.

It has been collected only once after the original discovery. It is an endangered species, and deserves to be introduced into the garden.

19. *O. lacei* Craib in Kew Bull. 1911: 189. 1911 (*Type* : Burma, N. Shan States, Gokteik Gorge, 450 m, 2nd August 1908, *J. H. Lace* 4151 holo, K! iso CAL!). (Fig.28)

Herbs, 5-27 cm long; stems ascending from rooting horizontal base, puberulous. Leaves 3.5-11 × 1.5-5 cm, elliptic-oblong or ovate-lanceolate, acute, rarely acuminate at apex, attenuate at base, membranous, scattered short hairy above, puberulous on the nerves beneath; lateral nerves 9-15 on either side; petioles 0.5-3.2 cm long, puberulous; stipules deciduous, 3-6.75 mm long, broadly ovate with long tooth, entire, puberulous. Inflorescence terminal helicoid cymes, 1-2 cm across, branches spreading, puberulous; peduncles 1.75-4.5 cm long, puberulous. Flowers 5.5-6.75 mm long, purple; bracts and bracteoles similar,

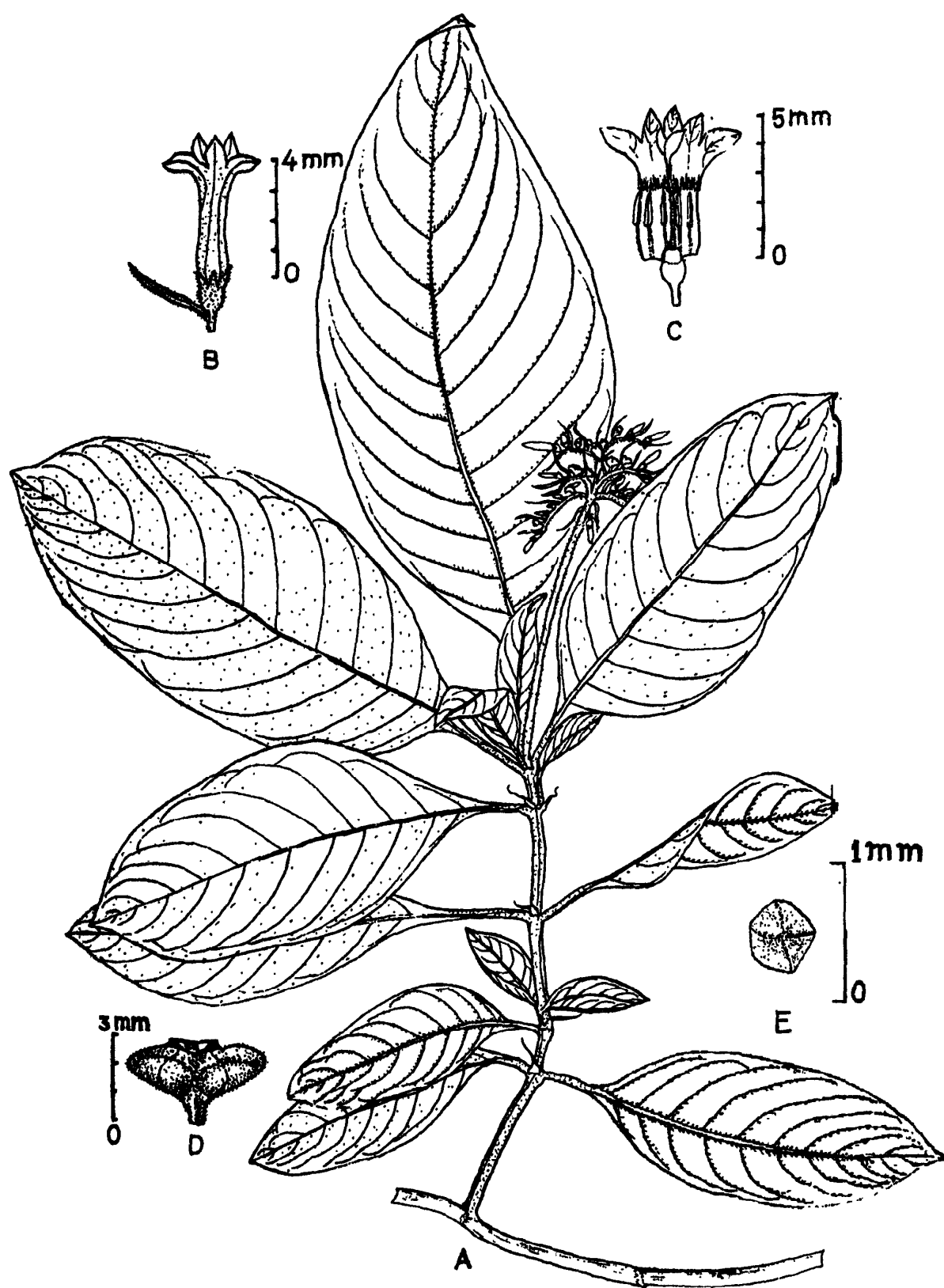


Fig. 28. *O. lacei* Craib
A. habit; B. flower; C. flower split open; D. fruiting; E. seed

persistent, 2-8.25 mm long, linear with prominent midrib, puberulous; pedicels 0.75-1.25 mm long, puberulous. Hypanthium 0.75-1 × 0.6-0.75 mm, obovoid, puberulous. Calyx lobes 0.4-0.5 × 0.3-0.4 mm, triangular-subulate, acute, puberulous. Corolla 4.75-6 mm long, infundibuliform, slightly constricted at middle, puberulous outside, a hairy ring of 0.75-1 mm long erect stiff hairs at the middle of corolla within; lobes 1-1.5 × 0.5-1 mm, ovate-lanceolate, acute, spreading. Stamens adnate to the base of corolla or slightly above, inserted; filaments 0.5-0.8 mm long, glabrous; anthers 1-1.4 mm long, oblong-linear. Ovary 0.6-0.8 × 0.5-0.7 mm, obovoid; disc 0.4-0.5 mm high; style 3.25-3.75 mm long, puberulous; stigma 2-lobed, 1-1.2 mm long, lobes elliptic, acute, glabrous. Capsule 1-2 × 2.5-5.5 mm, puberulous; locules ovate-oblong with straight tip. Seeds 0.4-0.6 × 0.4-0.5 mm, 5-7 angular, glabrous, brown; wall of the areole thin with a number of tubercles on it.

Fl. & Fr. : August-November.

Pollen : Oblate-spheroidal, angular in polar outline, polar axis (P) × equatorial axis (E) = 28-(29)-32 × 26-(28)-30 µm, 3-colporate; colpi 22-28 × 4-5 µm, tapering to acute ends; ora circular, 4-6 µm in diameter; sexine 1.75 µm, nexine 0.25 µm, ruguloreticulate; lumina 0.5-0.75 µm, muri 0.5 µm.

Distribution : Myanmar, Thailand.

Specimens examined : MYANMAR: Sagaing State. Katha dist. Singon, *J. H. Lace* 5213 (E); Chindwin dist., *J. H. Lace* s. n. (E). Shan State, Gokteik Gorge, *J. H. Lace* 4151 (CAL, K) & *J. H. Lace* s. n. (E).

20. *O. lurida* Hook.f. *Fl. Brit. India*. 3: 82. 1880 (*Type* : Sikkim, Pankabari, 600-1200 m April 1850, *J.D. Hooker & T. Thomson* *OPHIORRHIZA* 12 at K designated as lectotype); Deb, *Fl. Tripura State* 2: 76. 1983. Deb & Mondal in Nayar & Sastry, *Red Data Book Ind.* Pl. 2: 225. fig.1. 1988. (Fig.29)

Herbs, 6-25 cm tall; stem very short, ascending with copiously rooting base, sometimes branched, puberulous above. Leaves 1.25-10 × 0.8-4.5 cm, elliptic-oblong, rarely ovate, obtuse or acute, sometimes acuminate at apex, slightly tapering at base, glabrous above, puberulous on the nerves beneath, lateral nerves 6-14 on either side; petioles 0.5-3 cm long, puberulous; stipules 2.5-8 mm long, linear with broad base, entire, glabrous. Inflorescence terminal, corymbose cymes, contracted, 0.5-2.5 cm across, glabrous; peduncles 1.5-7 cm long, slender, glabrous, sometimes puberulous. Flowers 5-10 mm long, white; bracts and bracteoles similar, persistent, 3-8 mm long, lanceolate or linear-lanceolate, acute, glabrous, with prominent midrib; pedicels 1-1.5 mm long, glabrous or puberulous. Hypanthium 0.5-1.25 × 0.4-1 mm, obovoid, pubescent. Calyx lobes 0.4-0.75 × 0.25-0.4 mm, subulate acute,

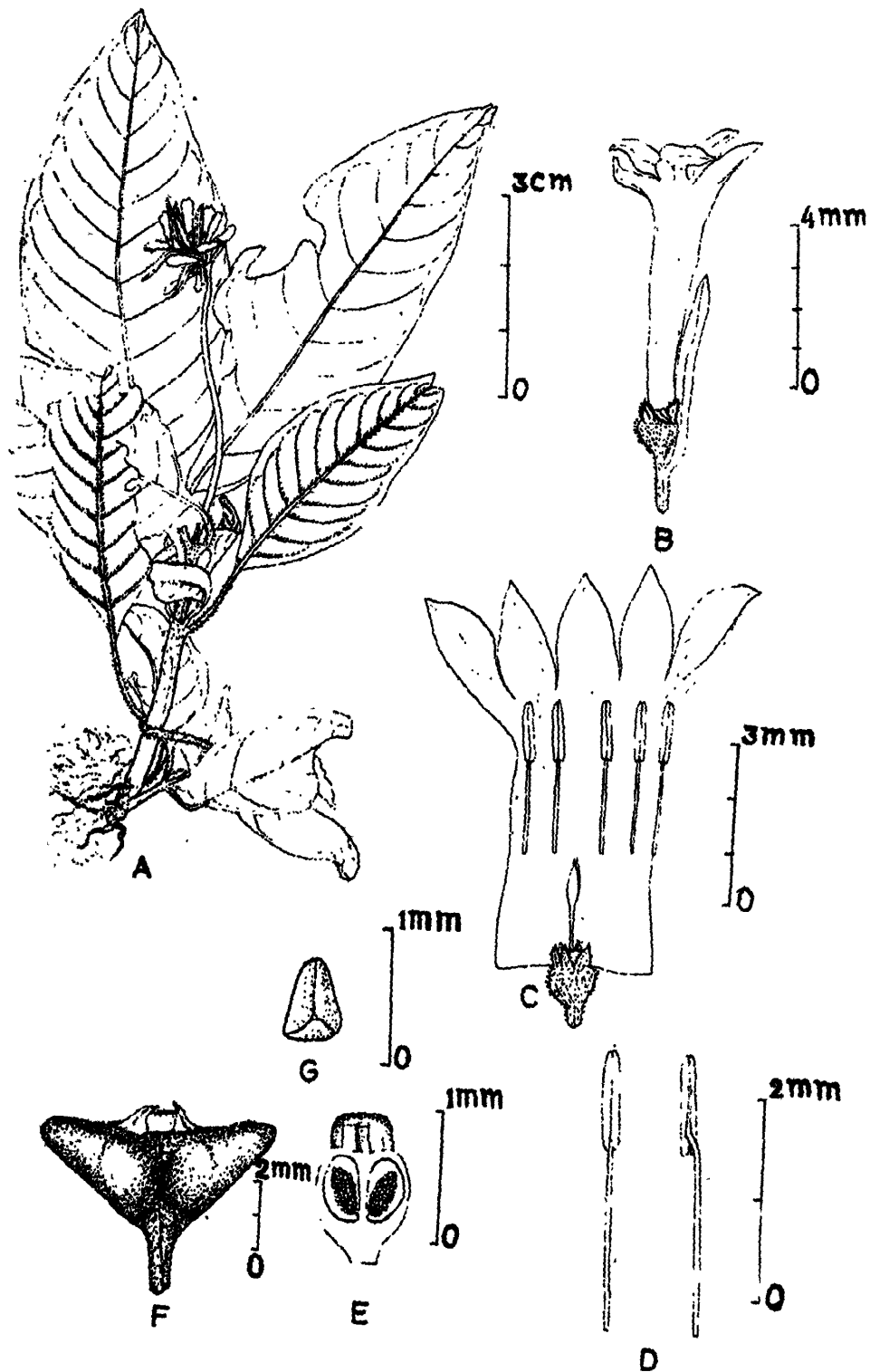


Fig. 29. *O. lurida* Hook. f.
A. habit; B. flower; C. flower split open; D. stamen; E. ovary (l.s.); F. fruiting; G. seed.

pubescent. Corolla 4.5-9.25 mm long, infundibuliform, glabrous; lobes 1.25-1.75 × 0.75-1.25 mm, ovate, acute, glabrous. Stamens adnate to the middle of corolla tube, inserted; filaments 1.25-2 mm long; anthers 1-1.5 mm long, oblong-linear. Ovary 0.4-1 × 0.3-0.8 mm, obovoid; disc 0.25-0.4 mm high; style 1.25-1.5 mm long, glabrous; stigma bilobed, 0.75-1.25 mm long, lobes lanceolate, acute, glabrous. Capsule 1.5-3 × 5-8 mm, glabrous, sometimes puberulous, locules ovate-oblong with straight tip. Seeds 0.4-0.5 × 0.3-0.4 mm, 5-7-angular, glabrous, brown; areoles 4-7 gonol, bounded by thick wall with a number of tubercles on it or hooded over the areolar space, sometimes tubercles on the areole proper.

Fl. : May-September.

Fr. : June-November.

Pollen : Prolate-spheroidal, angular in polar outline, polar axis (P) × equatorial axis (E)=25-(28)-35 × 25-(27)-33 µm, 3-colporate; colpi 24-28 × 3.5-4.5 µm, tapering to obtuse ends; ora circular, 5-6.5 µm in diameter; sexine 1.5 µm, nexine 0.25 µm, ruguloreticulate; lumina 0.75 µm, muri 0.5-0.75 µm.

Distribution : Sikkim to Manipur; Eastern Tibet and Southwest of China.

Ecology : Grows in damp shady places on mountain slopes at 300-1500 m above m.s.l.

Specimens examined : INDIA : Sikkim, *G. King* 860 (CAL); *G. King* s.n. (CAL); *G.*

King 239 (CAL); *G. King* s.n. (CAL); *G. King* 4820 (CAL). West Bengal. Darjeeling dist, Kurseong, Punkabari, *T. Anderson* 162 (CAL); Rishap, *C. B. Clarke* 8705 (K); Rungbee, *C. B. Clarke* 12110 (L); Choonbuttee, *C.B. Clarke* 26577 B (BM); Mongpoo, *C.B. Clarke* 24806 D (BM); Mongpoo, *C.B. Clarke* 24808 (CAL); Kurseong, *G. King* 4853 (CAL); Pankabari, *C.B. Clarke* 35087 (CAL); Kalighora, *G.H. Cave* s.n. (E). Manipur. Kala Naga Hills, *G. Watt* 7286 (K, CAL); Bishenpur, *A. Meebold* 6194 (CAL). Tripura. Kumarghat, *D.B. Deb* 845 (CAL). CHINA North-west Yunnan. *G. Forrest* 21101 (CAL).

Note : Though widely distributed in the past, it has been scarcely collected in recent years. Changes in its original habitats have been a source of threat to the species rendering it very scarce in India.

21. *O. mungos* L. Sp. Pl. 150. 1753 (*Type*: Sri Lanka, *P. Hermann* s. n. BM!); Roxb. Fl. Ind. 2: 544. 1824 & 1: 701. 1832; Bl. Bijdr. 976. 1826; DC. Prodr. 4: 415. 1830; Wight & Arn. Prodr. 404. 1834; G. Don, Gen. Syst. Gard. Bot. 3: 521. 1834; Walp. Rep. 2: 503. 1843; Miq. Fl. Ind. Bat. 2: 216. 1861; Thw. Enum. Pl. Zeyl. 139. 1864; Miq. in Ann. Mus. Bot. 4(2) : 234. 1869; Kurz in Journ. Asiat. Soc. Bengal 46(2) : 130. 1877; Hook. f. Fl. Brit. India 3: 77. 1880; Trimen, Handb. Fl. Ceylon 2: 320. 1895; King in Journ. Asiat. Soc. Bengal 72(4) : 174. 1903 ; Rama Rao, Flower, Pl. Travanc 206. 1914; Gamble, Fl. Pres. Madras

607. 1921; Burkill in Rec. Bot. Surv. India 10(1) : 50. 1924; Kanjilal *et al.* Fl. Assam 3: 42. 1939; Deb in Bull. Bot. Surv. India 3: 312. 1961; Deb, Fl. Tripura State 2:74.1983.

Herbs annual, 8-100 cm tall, sometimes undershrubs; stem sometimes suffrutescent, erect, branching, somewhat fleshy, glabrous or puberulous. Leaves $2.5-22 \times 1-9$ cm, elliptic or elliptic-lanceolate, sometimes oblong-lanceolate, acuminate at apex, narrowed at base, glabrous or sometimes puberulous on the nerves beneath; lateral nerves 7-19 on either side; petioles 0.5-5 cm long, glabrous or puberulous; stipules caducous, 2-8 mm long, triangular or ovate, entire, sometimes bifid, glabrous, or sometimes puberulous on the margin. Inflorescence terminal or axillary, subumbellate or corymbose cymes, 1-7.5 cm across, puberulous; peduncles 0.5-6 cm long, glabrous or tomentose. Flowers 3.5-18 mm long, white, pinkish-white, greenish-yellow or sometimes rosy; pedicels 0.5-1.5 mm long, glabrous or puberulous. Hypanthium $0.5-1.75 \times 0.5-1$ mm, ovoid, puberulous. Calyx lobes $0.4-1 \times 0.3-0.6$ mm, triangular to subulate, acute, puberulous. Corolla 2.75-16.25 mm long, infundibuliform, glabrous outside, villous at the middle within; lobes $0.75-1.5 \times 0.5-1$ mm, ovate, subacute or obtuse, slightly keeled at back. Stamens adnate at the base of corolla or slightly above, inserted; filaments 0.5-2.5 mm long; anthers 0.75-2.75 mm long, oblong-linear.

Ovary $0.4-1.5 \times 0.4-0.75$ mm, obovoid; disc 0.25-0.75 mm high; styles variable, $\frac{1}{4}$ th to $\frac{3}{4}$ th of corolla, glabrous; stigma bilobed, 0.75-1.25 mm long, lobes ovate or linear-lanceolate, obtuse to acuminate, glabrous. Capsules $1.5-3 \times 3-9$ mm, glabrous, rarely puberulous; locules ovate or ovate-oblong, tip slightly inclined outwards. Seeds $0.3-0.4 \times 0.25-0.4$ mm, irregularly angular, glabrous, deep brown; wall of the areole thin, raised with a number of tubercles on it.

Fl. & Fr. Throughout the year.

Pollen : Suboblate to oblate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = $27-(29)-31 \times 33-(35)-38$ μ m, 3-colporate; colpi $36-38 \times 4-5$ μ m, tapering to obtuse ends; ora circular, 5-7 μ m in diameter; sexine 1.5 μ m, nexine 0.25 μ m, ruguloreticulate; lumina 0.75-1 μ m, muri 0.5-0.75 μ m.

Note : This species shows considerable variation in size of leaves, flowers and styles.

Distribution : Nepal and Sikkim in the North Nagaland, Manipur, Mizoram and Myanmar in the East, Malay, Sumatra and Java in the South East and Tamil Nadu, Kerala and Sri Lanka in the South.

Ecology : Grows in cool, shady places on the clayey loam with fairly good amount of moisture. Often common on the ground floor of evergreen forest at the river bank up to 1800 m above m.s.l.

Vernacular names : Beng.-Gandhanakuli; Eng.-Mongoose plant; Guj.-Mungusvel;

Hindi.-Sarahati; Kannari.- Mungisgida, Patalagaruda, Sarpari; Marathi-Mungusavela, Nagvelli; Sans.-Sarpakshi; Singhali.-Dat-Ketiya; Tamil.-Kiripurandan; Telugu.-Chettu.

Key to the varieties

- 1a. Corolla short (2.75-5.5 mm) ; filament longer than anther; stigma lobes linear-lanceolate ...2
- 1b. Corolla long (7.25-16.5 mm); filament half as long as anther; stigma lobes ovate ... *O. mungos* var. *nemorosa*
- 2a. Calyx lobes acute ; style three-fourth as long as corolla *O. mungos* var. *mungos*
- 2b. Calyx lobe obtuse ; style one-fifth as long as corolla... *O. mungos* var. *angustifolia*

***O. mungos* L. var. *angustifolia* (Thw.)**
Hook. f. Fl. Brit. India. 3 : 77. 1880. *O. angustifolia* Thw. Enum. 140. 1864
(Type : Srilanka, Ambagamowa dist. Thwaites C.P. 431 K, CAL!). (Fig.30)

Herbs, 20-35 cm tall, somewhat suffrutescent, branching, puberulous above, glabrous below. Leaves 3-17 × 1-4 cm, elliptic or narrowly lanceolate, acuminate at apex, tapering at base; lateral nerves 7-15 on either side; petioles 0.5-2 cm long; stipules 2-5 mm long, ovate, with long narrow apex. Inflorescence terminal and axillary corymbose cymes, 1-2 cm across; peduncles 1.5-4.5 cm long. Flowers 3.5-6.5 mm long, white; pedicels 0.5-0.75 mm long. Hypanthium 0.5-1 × 0.5-0.75 mm. Calyx lobes 0.5-1 × 0.5-0.6 mm, triangular-subulate. Corolla 2.75-5.5 mm long, infundibuliform; lobes 0.75-1 × 0.5-0.75 mm, ovate. Stamens adnate at the base of

corolla or slightly above; filaments 1-2 mm long; anthers 0.75-1.75 mm long. Ovary 0.4-0.75 × 0.4-0.6 mm; disc 0.25-0.4 mm high; style one-fifth as long as corolla; stigma 0.75-0.9 mm long, lobes linear. Capsules 1.5-2.25 × 5-6 mm, glabrous. Seeds 0.3-0.4 × 0.3 mm.

Fl. & Fr. : January-July.

Distribution : Sri Lanka.

Specimens examined : Sri Lanka: Central Province, Thwaites C. P. 431 (CAL); Kalugammane dist. J. M. Silva 39 & 40 (BM) ; Hakgala, N. D. Simpson 9052 (BM); Ratnapura, Bernnardi 14131 (BM).

***O. mungos* L. Sp. Pl. 150. 1753. var. *mungos*.** (Fig.31)

Herbs, 8-100 cm tall, sometimes suffrutescent, branching, glabrous or puberulous. Leaves 2.5-22 × 1-9 cm, elliptic or elliptic-lanceolate, acuminate at apex, narrowed at base; lateral nerves 10-19 on either side; petioles 1.5-5 cm long; stipules 4-8 mm long, triangular. Inflorescence terminal and axillary, subumbellate or corymbose cymes, 2-7.5 cm across; peduncles 0.5-6 cm long. Flowers 3.5-6 mm long, white, pinkish-white or greenish-yellow; pedicels 0.5-1.5 mm long; Hypanthium 0.5-1 × 0.5-0.75 mm. Calyx lobes 0.5-1 × 0.5-0.6 mm, triangular to subulate. Corolla 3-5 mm long, infundibuliform, slightly constricted at middle; lobes 0.75-1 × 0.5-0.75 mm, ovate. Stamens adnate to base of corolla or slightly above; filaments 2-2.25 mm long; anthers

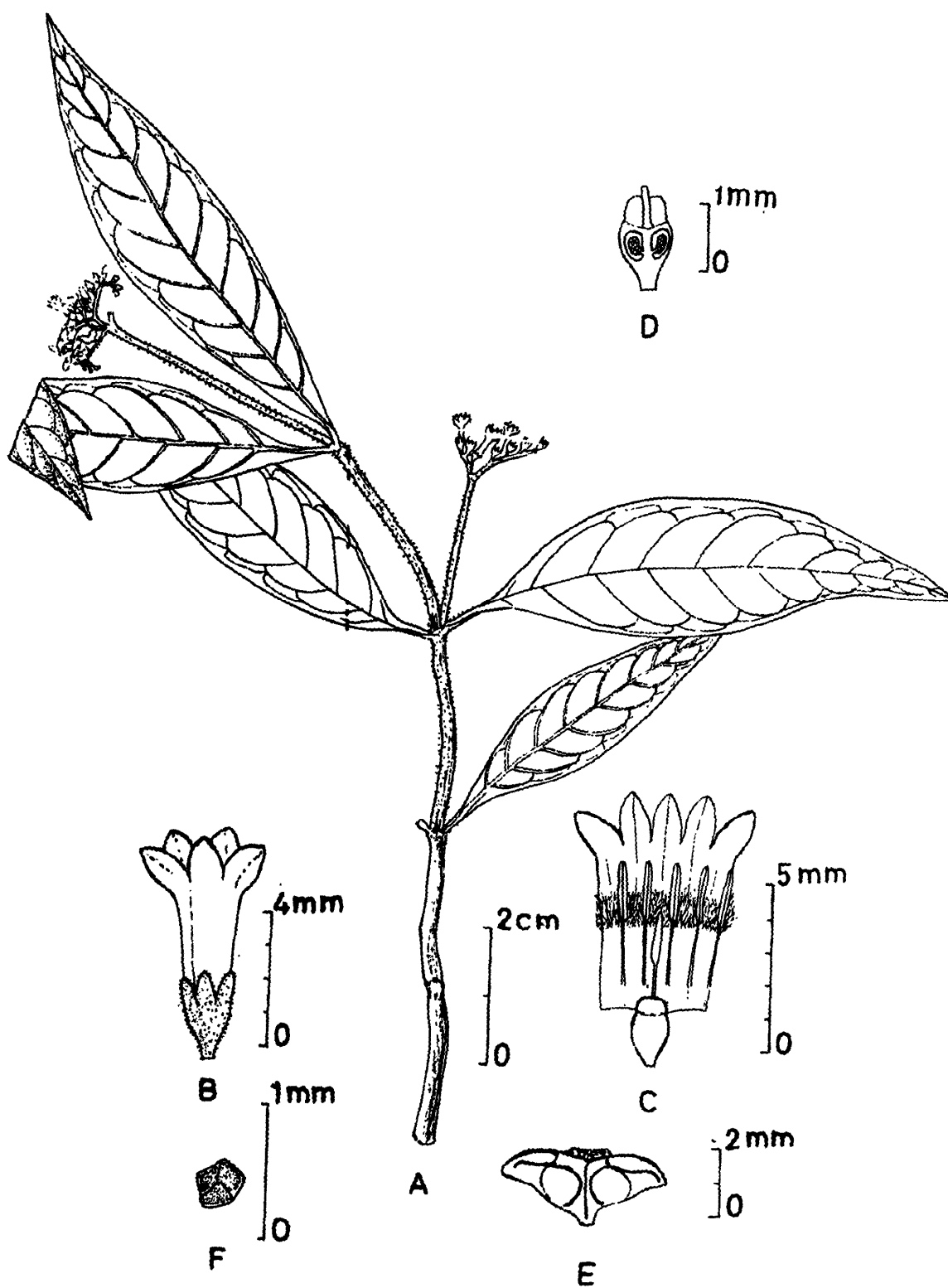


Fig. 30. *O. mungos* var. *angustifolia* (Thw.) Hook. f.
A. habit, B. flower, C. flower split open, D. l.s. ovary, E. fruiting, F. seed.

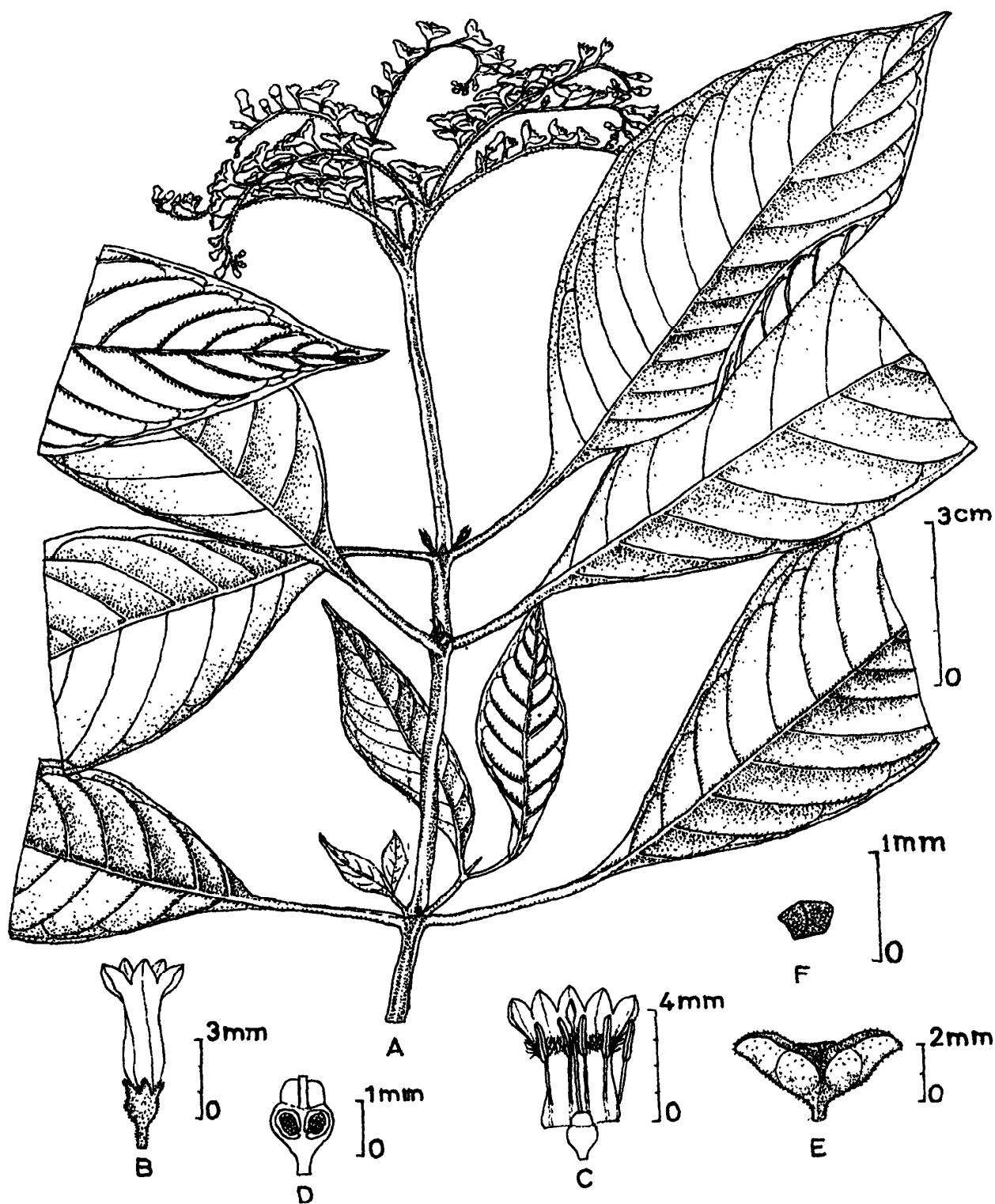


Fig.31. *O. mungos* L. var. *mungos*
 A.habit; B. flower; C. flower split open; D. l.s. of ovary; E. fruiting; F. seed.

0.75-1.5 mm long. Ovary 0.4-0.8 × 0.4-0.6 mm; disc 0.25-0.5 mm high; styles $\frac{3}{4}$ th as long as corolla; stigma 0.5-1.25 mm long; lobes ovate. Capsules 1.5-3 × 3-9 mm, glabrous or puberulous. Seeds 0.3-0.4 × 0.25-0.4 mm.

Fl. & Fr. : Throughout the year.

Distribution : Sikkim and Nepal to Myanmar in the east, Malay, Sumatra and Java in the south-east and Tamil Nadu, Kerala, and Sri Lanka in the south

Specimens examined : INDIA : Sikkim. *G. King* 2017 (CAL). Assam. Nowgong dist, Doboka, *N.P. Balakrishnan* 39517 (CAL); Meghalaya. Khasi & Jaintea Hills, *Jenkins* s.n. (CAL); Nongpoh, *R. S. Rao* 11044 (CAL); Mawsmi cave, *S. L. Kapur* 75835 (LWG). Arunachal Pradesh. Lohit dist., Namgai, *A. S. Rao* 47710 (CAL); Glow village, *J. Joseph* 48536 (CAL); Siang dist., above the Egar stream, *I.H. Burkill* 36113 (CAL); Subansiri dist., Begi to Amjee, *A.R.K. Sastry* 40538 (L). Nagaland. Kohima, *D. Prain* s.n. (CAL). Manipur. Mao, *A. Meebold* s.n. (CAL). Tripura. Jampui Ranges, Sabual, *D. B. Deb* 27228 (ASSAM). Mizoram. Mizo hills, *R. M. Datta* 34006 (CAL). Andaman & Nicobar Islands. S. Andaman. Runguchang hill *Prain's collector* s. n. (CAL); Sawai. *K. Thothathri*. 9329 (CAL); N. Nicobar, Katchal Island, *S. Kurz* s.n. (CAL); Katchal Island - coast forest, *P. Chakraborty* 1119 (CAL, PBL); Jula, *P. Chakraborty* 2147 (CAL, PBL); Passa, *N. G. Nair* 941 (CAL,

PBL); S. Nicobar, *D. Prain* s.n. (CAL); Kopenheat, *N. P. Balakrishnan* 3925 & 3926 (CAL, PBL). Tamil Nadu. Coimbatore dist., Bellaji shola, *Fischer* 344 (CAL); Anamalai hills, *Fischer* s. n. (K); Kariyar shola, *S. R. Raju* 20292 (MH); Top slip, *K. M. Vaid* 23285 (DD); Siruvani, *A. N. Henry* 309 (MH); Kariyar shola, *J. Joseph* 13824 (CAL); Sholaiyar Submergible area, *K.M. Sebastine* 17264 (CAL); Kanniyakumari dist., Balemor, *A. N. Henry* 47502 (MH); Madura dist. Alagar hills, *Fischer* 3182 (CAL); Middle Pulneys, *G. Rodriguez* s. n. (CAL); Kumili, *K. Subramanyam* 8149 (CAL, MH); Pulney hills, *L. Anglade* 1034(K). Nilgiri dist., Benne forest, *K. Subramanyam* 10440 (CAL); Kulivayal, *E. Vajravelu* 41813 (MH); Ramnathapuram dist., Srivilliputtur, *P. S. Jivanna Rao* 15097 (MH); Tirunelveli, *R. H. Beddome* 3627 (BM); Naterikal to Sengalteri, *D. Hooper & M. S. Ramaswami* 38597 (CAL); Thekkumalai, Courtallam, *K. Subramanyam* 2876 (CAL, MH); Kannikatti, *K. M. Sebastine* 9603 (CAL); Agastyarmalai, *A. N. Henry* 16278 (CAL); Aejelandanpillai Estate, *B. V. Shetty* 27966 (CAL). Kerala. Ernakulam, Cochin, *A. Meebold* 12159 (CAL); Idikki dist. Thenkanchi, *B. D. Sharma* 40890 (MH); Thenkady, *B. D. Sharma* 43841 (MH); Moolamatton, Cook, *Rix & Schneller* 12 (K); Thekkadi, *K. Vivekananthan* 45388 (MH); Thekkadi, *K. Vivekananthan* 46688 (CAL, MH). Karnataka. Sampaji, *C. A. Barber* 2375 (CAL, MH). MYANMAR: S. Shan State,

Keng Tung, *R. W. Macgregor* 759 (CAL); Tenasserim, *A. Meebold* 15216 (CAL); Tavoy, *P. T. Russell* 2165 (CAL); Eastern Tenasserim, *A.F.G. Kerr* 21619 (BM).

***O. mungos* L. var. *nemorosa* (Thw.)**
Hook.f. Fl. Brit. Ind. 3: 77. 1880. *O. nemorosa* Thw. Enum. 139. 1864 (Type: Sri Lanka, Central Province, 900-1500 m, *Thwaites C.P.* 205 K, BM!; CAL!).

(Fig.32)

Herbs, 20-50 cm tall, branching, puberulous above, glabrous below. Leaves 3-10.5 × 1-3 cm, elliptic to elliptic-lanceolate, acuminate at apex, attenuate at base; lateral nerves 7-11 on either side; petioles 0.5-2.5 cm long; stipules 2-6 mm long, ovate, with long, narrow apex. Inflorescence terminal corymbose cymes, 1-3 cm across, 2-5 cm when in fruts. Peduncles 1.5-6 cm long. Flowers 6-18 mm long, pinkish-white; pedicels 0.75-1 mm long. Hypanthium 0.75-1.5 × 0.5-1 mm. Calyx lobes 0.4-0.6 × 0.3-0.4 mm, triangular. Corolla 5.25-16.5 mm long, narrowly infundibuliform; lobes 1-1.5 × 0.75-1 mm ovate. Stamens adnate slightly above the base of corolla; filaments 0.5-0.75 mm long; anthers 2-2.75 mm long. Ovary 0.6-1.25 × 0.4-0.75 mm; disc 0.5-0.75 mm high; style three-fourth as long as corolla; stigma 0.75-1.25 mm long; lobes ovate. Capsules 2-2.5 × 4-6 mm, glabrous or puberulous. Seeds 0.3-0.4 × 0.4 mm.

Fl. & Fr : November.

Distribution : Sri Lanka.

Specimens examined : SRI LANKA: Central Province, *Thwaites C.P.* 205 (CAL, BM); Madugoda road, *N. D. Simpson* 8794 (BM).

22. ***O. munnarensis* Fischer** in Kew Bull. 1938(1): 35. 1938 (Type : Travancore, Munnar Ghat Road, 1200-1500 m, September 1935, *E. Barnes* 2005 holo K!); Sebastine in Bull. Bot. Surv. Ind. 4: 223. 1962. (Fig.33)

Herbs, 5-16 cm tall; stems erect or procumbent, rooting below, branched, brown pubescent. Leaves 2.5-6.5 × 1-2.4 cm, elliptic-lanceolate, acute to caudate-acuminate at apex, tapering or sometimes shortly decurrent at base, scabrid; lateral nerves 6-8 on either side, arching, uniting with the above one near the ciliate margin; petioles 0.3-1.4 cm long, slender, puberulous; stipules 2.5-5 mm long, ensiform, caudate-acuminate, entire, pubescent when young, otherwise glabrous. Inflorescence terminal capitate cymes, 1-1.4 cm across, contracted, glabrous. Flowers 8.5-10.5 mm long; peduncles 2.5-3.7 cm long, slender, glabrous; bracts and bracteoles similar, persistent, 5-8 mm long, linear-lanceolate, acute, pale and thinly membranous in flowering, gradually becoming oblong-ovate, acute, brown and stiff in fruiting, glabrous; pedicels 0.75-1 mm long, glabrous. Hypanthium 1-1.25 × 1 mm, obovoid, glabrous; calyx lobes 0.75-1.6 × 0.5-0.75 mm, triangular, acute, glabrous. Corolla 7.5-9.25 mm long, infundibuliform, glabrous outside, with a villous ring at the middle of corolla tube

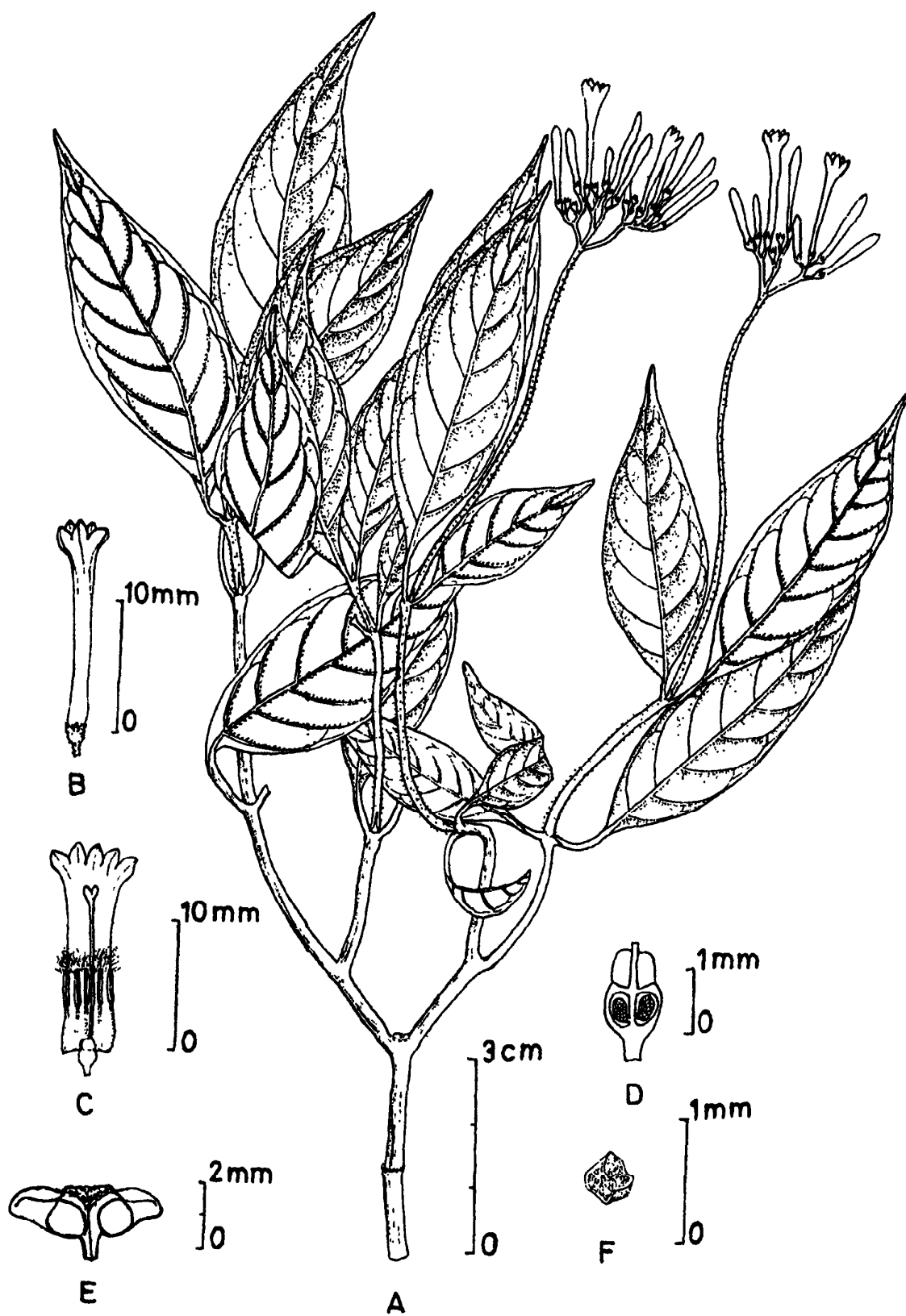


Fig. 32. *O. mungos* L. var. *nemorosa* (Thw.) Hook. f.
 A. habit; B. flower; C. flower split open; D. l.s. of ovary; E. fruiting; F. seed.

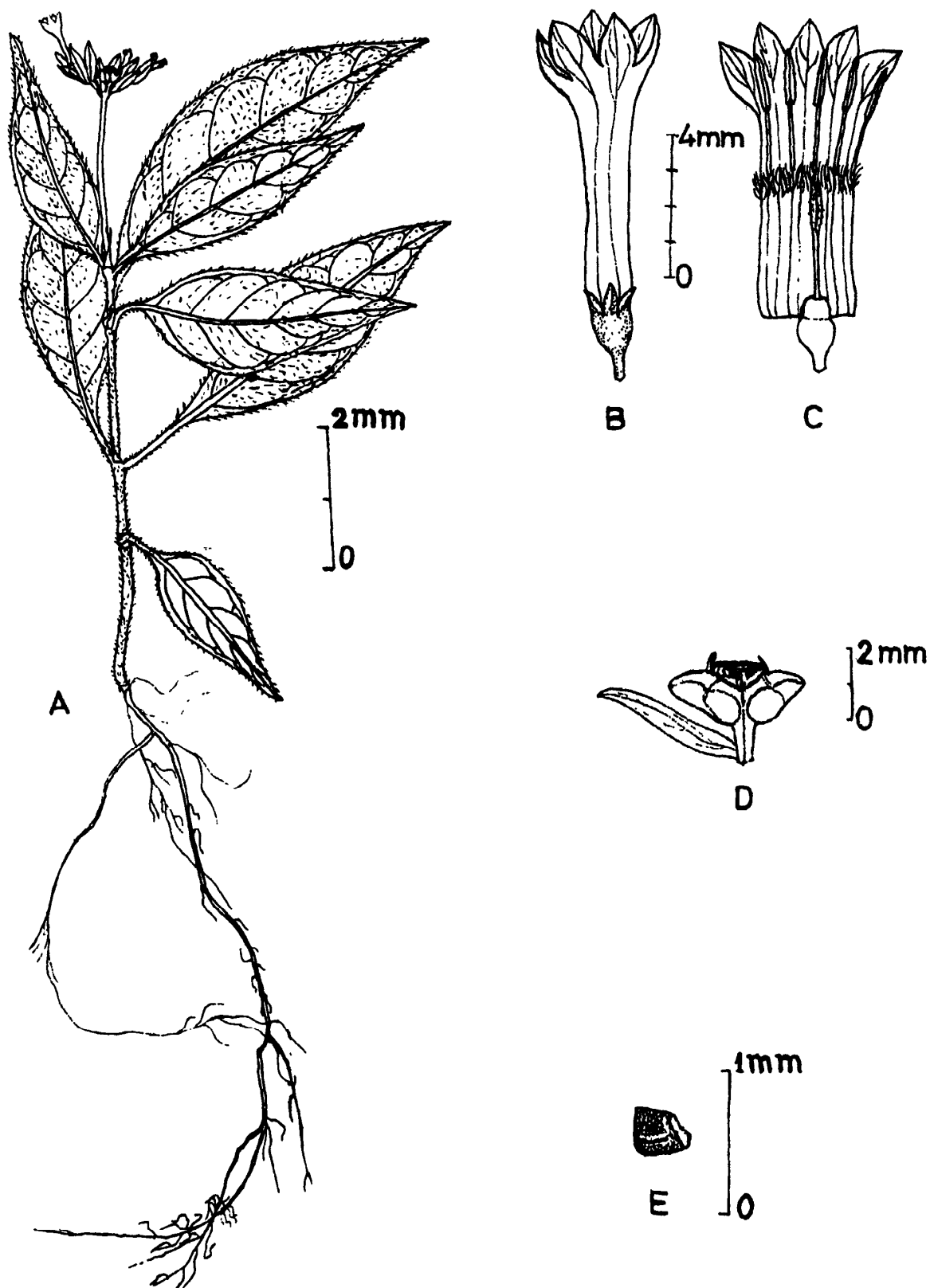


Fig. 33. *O. munnarensis* Fischer
A. habit, B. flower, C. flower split open, D. fruiting, E. seed.

within below the insertion of filaments; lobes $1.25 - 2 \times 0.75-1$ mm, broadly ovate, acute, glabrous. Stamens adnate to the corolla little above the middle; filaments $2-2.25$ mm long; anthers 1.5 mm long, slightly exserted, linear-oblong. Ovary $0.8-1 \times 0.8$ mm, turbinate or obovoid; disc 0.6 mm high; style $2.75-3.25$ mm long, glabrous; stigma 2-lobed, $1.5-1.75$ mm long, lobes linear, warty. Capsule $1.5-1.6 \times 4-4.2$ mm, glabrous, locules broadly ovate-oblong with straight tip. Seeds $0.3-0.4 \times 0.3-0.35$ mm, angular, glabrous, brown; wall of the areole very thin with a number of pits on the areole proper.

Fl. & Fr. : September-December.

Pollen : Prolate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = $41-(46)-47 \times 40-(43)-44 \mu\text{m}$; 3 colporate; colpi $26-29 \times 3.5-4 \mu\text{m}$, tapering to obtuse ends; ora circular, $6-7 \mu\text{m}$ in diameter; sexine $1.75 \mu\text{m}$, nexine $0.25 \mu\text{m}$, ruguloreticulate; lumina $0.75-1 \mu\text{m}$, muri $0.5-0.75 \mu\text{m}$.

Occurrence : Kerala. Munnar Ghat Road and Cochin.

Specimens examined : KERALA: Travancore High Range, Munnar Ghat Road, *E. Barnes* 2005 (K).

23. **O. mussaendiformis** Deb et Mondal in Kew Bull. 37(3): 485. 1982 (*Type*: Meghalaya, Khasi Hills, Mawphlong, 1680m, 14th July 1886, *C.B. Clarke* 44298 holo K). (Fig.34)
Herbs, 12-30 cm tall; stems erect,

villous, sometimes with very short branches, often ribbed. Leaves $3.5-10 \times 1.5-3.5$ cm, ovate-elliptic, larger above, acuminate at apex, attenuate at base, pubescent; lateral nerves 9-12 on either side; petioles $0.5-1.25$ cm long, channelled above, villous; stipules $4-12$ mm long, narrowly-linear, entire or 2-3 -fid, pubescent on the margin. Inflorescence terminal panicle of helicoid cymes, $1.5-3$ cm across; branches spreading, villous; peduncles 1 cm long, villous. Flowers $6.5-8$ mm long; bracts persistent, $5-9$ mm long, linear, pubescent; bracteoles persistent, $3-5$ mm long, linear, pubescent on the margin and midrib; pedicels about 1 mm long, villous. Hypanthium $0.8-1 \times 1-1.4$ mm, broadly ovoid, villous. Calyx lobes $0.75-1 \times 0.3-0.5$ mm, ovate-lanceolate, acute, villous. Corolla $5.5-7$ mm long, narrowly infundibuliform, tube $4.5-5.75$ mm long, slightly swollen at base, villous outside, glabrous within except for a villous ring at the throat; lobes $1-1.25 \times 0.5-0.6$ mm, ovate-lanceolate, acute, inwardly curved, strongly keeled at back, villous. Stamens adnate below the middle of corolla tube, inserted; filaments $0.65-0.75$ mm long, glabrous; anthers $1.3-1.5$ mm long, linear-oblong. Ovary $0.6-0.75 \times 0.8-1$ mm, obovoid; disc $0.5-0.65$ mm high; style $1.9-2.25$ mm long, glabrous; stigma $1.35-1.5$ mm long, clavate, glabrous. Capsule $2-2.75 \times 4-6.5$ mm, densely pubescent, locules ovate-oblong, with straight tip. Seeds $0.4-0.45 \times 0.35-0.4$ mm, irregularly angular,

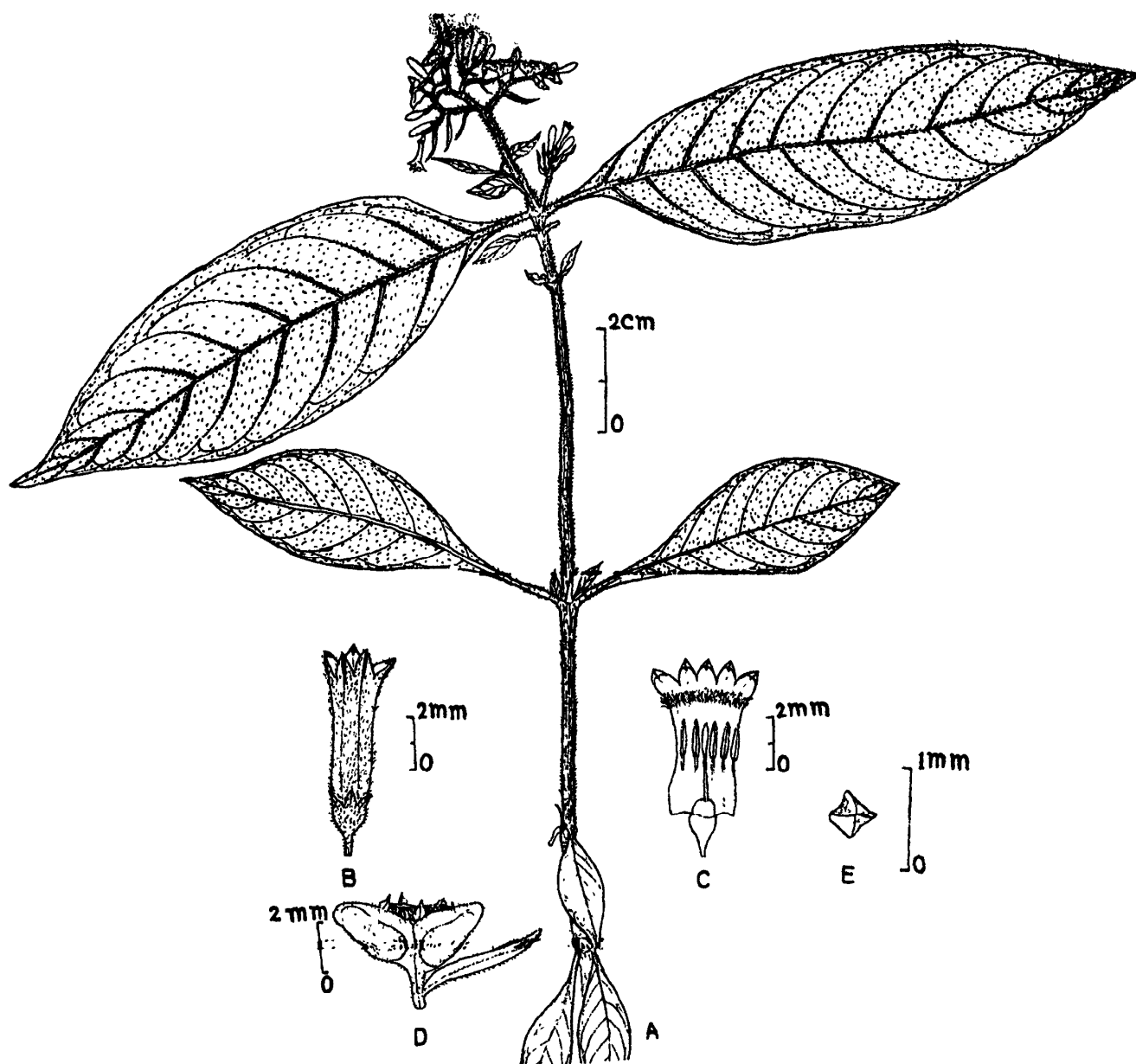


Fig. 34. *O. mussaendiformis* Deb & Mondal
 A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

glabrous, brown; wall of the areole thick with a few highly reflecting tubercles on it.

Fl. & Fr. : July-August.

Pollen : Oblate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = 34-(37)-42 \times 33-(38)-42 μm , 3-colporate; colpi 29-32 \times 6-7.5 μm , tapering to acute ends; ora circular, 6-8 μm in diameter; sexine 1.75 μm , nexine 0.25 μm , ruguloreticulate; lumina 0.75-1 μm , muri 0.5-0.75 μm .

Occurrence : Meghalaya. Khasi Hills, Mawphlong at an altitude of \pm 1680 m.

24. **O. nepalensis** Deb & Mondal in Journ. Bomb. Nat. Hist. Soc. 79(3) : 644. 1982 (*Type* : East Nepal, Saktim Tea Estate, 450 m, 22nd May 1971, J.D.A. Stainton 6881 holotype BM!). (Fig.35)

Herbs, with woody base, about 50 cm tall; stem erect, terete, branching, pubescent when young. Leaves 7-14 \times 2-4.5 cm, broadly lanceolate, shortly acuminate at apex, attenuate at base, glabrous above, pubescent on the nerves beneath; lateral nerves 7-11 on either side; petioles 0.5-1 cm long, pubescent; stipules 4-8 mm long, subulate, entire or bifid above, puberulous. Inflorescence terminal and at the upper axils, dichotomously branched corymbose cymes, sometimes the ultimate branches helicoid; peduncles 1-2 cm long, pilose. Flowers 6-8 mm long, pale green; bracts and bracteoles deciduous, minute; pedicels 0.6 - 0.8 mm long,

puberulous. Hypanthium 0.6 - 0.75 \times 0.8 - 1 mm, obovoid, puberulous. Calyx lobes 0.5 - 0.75 \times 0.4 - 0.6 mm, ovate, acute, puberulous. Corolla 5.25 - 7.25 mm long, cylindric, glabrous outside; lobes as long as tube, linear, inwardly curved and acute at apex, strongly keeled at back, sparsely hairy inside with a villous ring at the throat. Stamens adnate at one-third the height of corolla tube, exserted; filaments 3.5 - 4 mm; anthers 1.25 - 1.5 mm. Ovary 0.5 - 0.6 \times 0.75 - 0.8 mm, obovoid; disc 0.4 - 0.5 mm high; styles 1.5 - 17.5 mm long, glabrous; stigma 2-lobed, 0.75 - 1 mm long, lobes lanceolate, acuminate, puberulous. Capsules 2 - 3 \times 5 - 8 mm, puberulous, locules ovate-oblong, tip slightly curved outwards. Seeds 0.3 - 0.4 \times 0.25 - 0.3 mm, irregularly angular, glabrous, brown; wall of the areole thick with a number of tubercles on it and hooded over the areolar space.

Fl. & Fr. : May-June.

Pollen : Suboblate, angular in polar outline, polar axis (P) \times equatorial axis (E) = 29 - (31) - 32 \times 35 - (36) - 38 μm , tricolporate; colpi 28 - 30 \times 5 - 5.5 μm , tapering to acute ends, ora circular, 5.25 - 6.25 μm in diameter; sexine 1.5 - 1.6 μm , nexine 0.25 μm , ruguloreticulate : lumina 0.6 - 0.8 μm , muri 0.75 μm .

Distribution : Nepal.

Ecology : Grows in shady places at about 450 m above m. s. l.

25. **O. nicobarica** Balakr. in Reinw. 9(4):

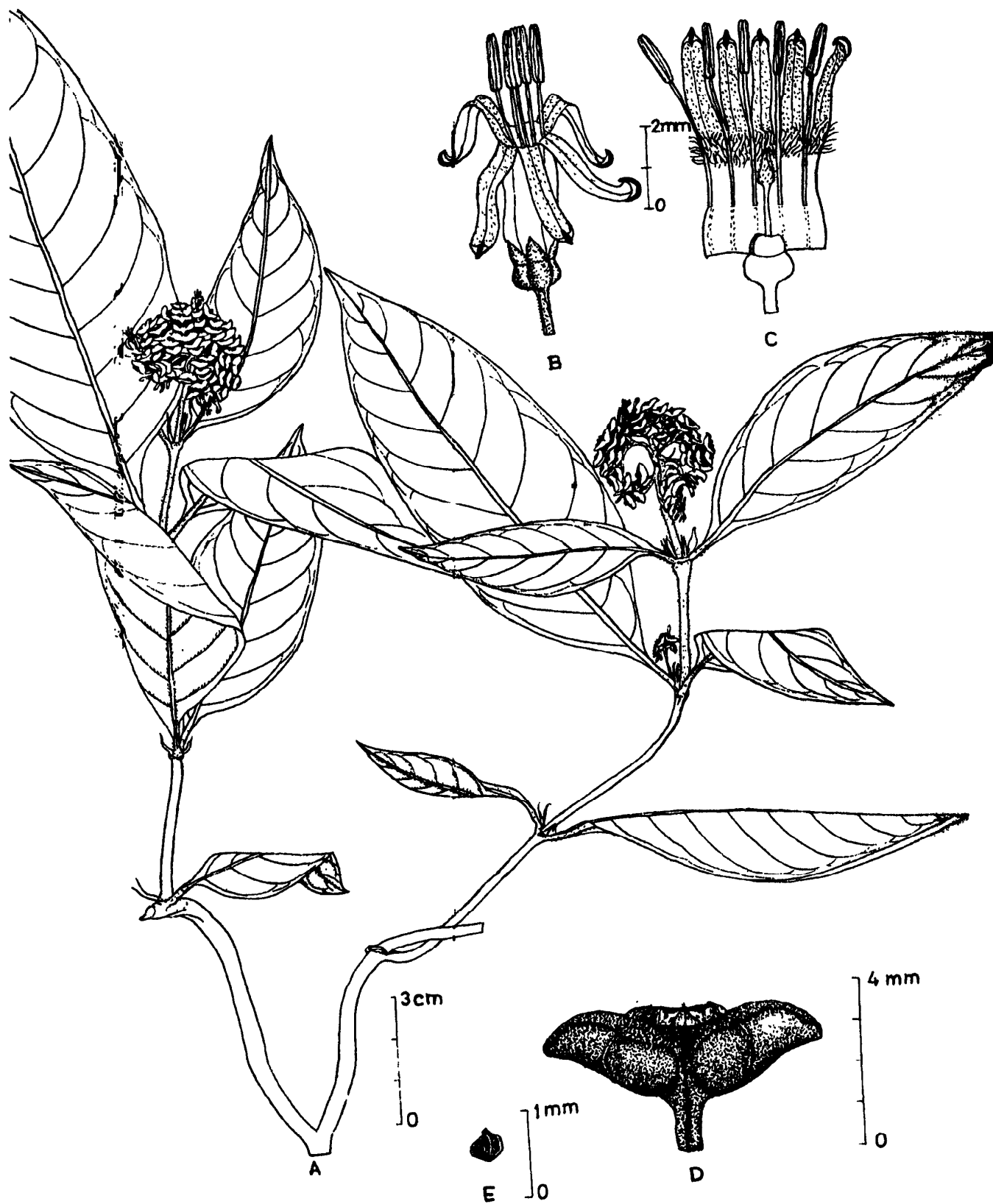


Fig.35. *O. nepalensis* Deb & Mondal
A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

411. 1980 (*Type*: Great Nicobar Island, 17 km from Campbell Bay to Alexandra River, 75 m, 21st August 1975, *Balakrishnan* 3027 A - holo. CAL! B - iso. CAL!). (Fig.36)

Herbs, 20-45 cm long; stems decumbent, rooting at lower nodes, branching, pubescent above, glabrous below. Leaves 2.5-13 × 1.7-6 cm, ovate-lanceolate, subacuminate at apex, obliquely cuneate or acute at base, densely pubescent above, whitish and pubescent beneath; lateral nerves 7-12 on either side; petioles 0.5-5.5 cm long, densely pubescent; stipules 4-5 mm long, linear with broad base, entire, hispid. Inflorescence terminal dichotomous cymes, 1-3 cm across, densely pubescent; peduncles 1.5-3 cm long, densely pubescent. Flowers heterostylous, 12-16 mm long, white; bracts and bracteoles similar, persistent, 3-4 mm long, linear, pubescent on the distinct midrib and margin; pedicels 0.5-2 mm long, pubescent. Hypanthium 1.3-2 × 1.1-2 mm, cup-shaped, densely pubescent. Calyx lobes persistent, 4-5 × 0.75-2 mm, linear, subequal, acute, 1-nerved, sparsely pubescent. Corolla 10.7-14 mm long, narrowly infundibuliform, tube constricted slightly above the base, swollen inflated between base and constriction, pubescent outside with long hairs on the nerves, glabrous inside except for a villous ring at the constriction; lobes 2.5-3 × 1.75-2.25 mm, ovate, acute, reflexed, thickened at margin, keeled at back. Stamens adnate slightly above the base of corolla, inserted; filaments either

1.5-3.5 mm or 5.5-6.5 mm long, slender; anthers 2-3 mm long, oblong-linear. Ovary 1-1.75 × 0.8-1.75 mm, obovoid; disc 0.5-0.75 mm high; styles either half or as long as corolla tube, filiform, glabrous; stigma 2-lobed, either 1 mm or 2.5 mm long, ovate-lanceolate or linear, woolly or glabrous. Capsule 2-5 × 5-10 mm, with persistent calyx lobes, pubescent, locules ovate-oblong with straight tip. Seeds 0.4-0.5 × 0.5 mm, irregularly angular, glabrous, brown, wall of the areole thick with a number of tubercles on it.

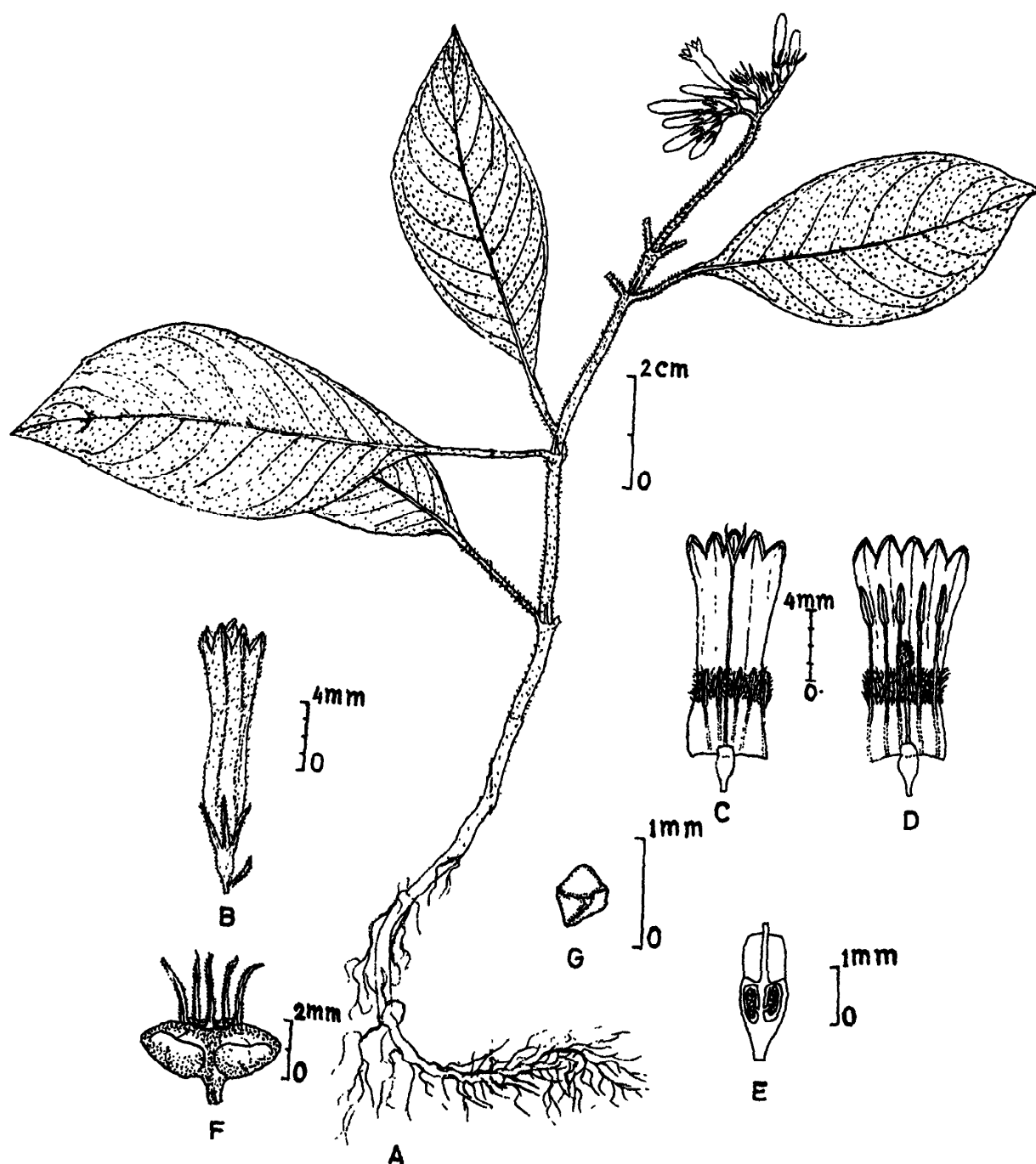
Fl. & Fr. : July-December.

Pollen : Oblate-spheroidal, angular in polar outline, polar axis (P) × equatorial axis (E) = 29-(33)-36 × 30-(34)-38 µm, tricolporate; colpi 26-30 × 4-5 µm, tapering to acute ends; ora circular, 3.5-5 µm in diameter; sexine 1.75 µm, nexine 0.25 µm, rugulo-reticulate; lumina 0.75 µm, muri 0.5-0.75 µm.

Note : Heterostyly occurs in this species. When the style is long (as long as corolla tube), the filaments are short (1.5-3.5 mm) and when the style is short (half as long as corolla tube), the filaments are long (5.5-6.5 mm).

Stem, anthers, filaments, styles, disc and ovary wall possess raphides.

Balakrishnan (1980), stated that the corolla lobes are obtuse at apex. Actually it is acute, keeled on the midrib at the back, margin thickened and together with the apex somewhat inflexed as a result it looks like obtuse.

Fig. 36. *O. nicobarica* Balakr.

A. habit; B. flower; C. & D. flower split open; E. l.s. of ovary; F. fruiting; G. seed.

Distribution : Great Nicobar Island.

Ecology : Grows on loamy soil in shaded streamsides in inland forests at about 75 m above m.s.l.

Specimens examined : South Nicobar, *P. Chakraborty* 3232 (PBL); Great Nicobar, *N. P. Balakrishnan* 4073 (E, CAL).

26. *O. nutans* Clarke ex Hook. f. Fl. Brit. India 3:84.1880 (*Type* : Darjeeling, Rungbee, 1800 m, 28th June 1870, Clarke 12120A-holo. K!, B-iso. BM!, C, D-iso, CAL!); Kanjilal *et. al.* Fl. Assam 3:43. 1939; Balakr. Fl. Jowai 1:249. 1981. (Fig.37)

Herbs, perennial, 10-70 cm tall; stems erect, creeping at base, sometimes branched, pubescent with crisped hairs. Leaves $3-17 \times 2-6.8$ cm, elliptic-lanceolate, sometimes ovate-lanceolate, acuminate at apex, tapering at base, glabrous or sometimes scattered minute hairy above, pubescent on the nerves beneath; lateral nerves 7-15 on either side; petioles 0.5-4 cm long, pubescent; stipules 3-14 mm long, lanceolate with acute apex, entire or 2-fid, ciliate at margin. Inflorescence terminal corymbose cyme, 1-5 cm across, pubescent with crisped hairs; peduncles 1-6 cm long, deflexed, pubescent. Flowers heterostylous, 16-22 mm long, brownish-chocolate, pink or white; bracts and bracteoles similar, persistent, 5-10 mm long, lanceolate or linear-oblong, ciliate at margin; pedicels 1-2 mm long, pubescent. Hypanthium $1.25-1.75 \times 1.25-1.5$ mm, broadly obovoid, hispid. Calyx lobes $1-1.5 \times 0.6-0.8$ mm,

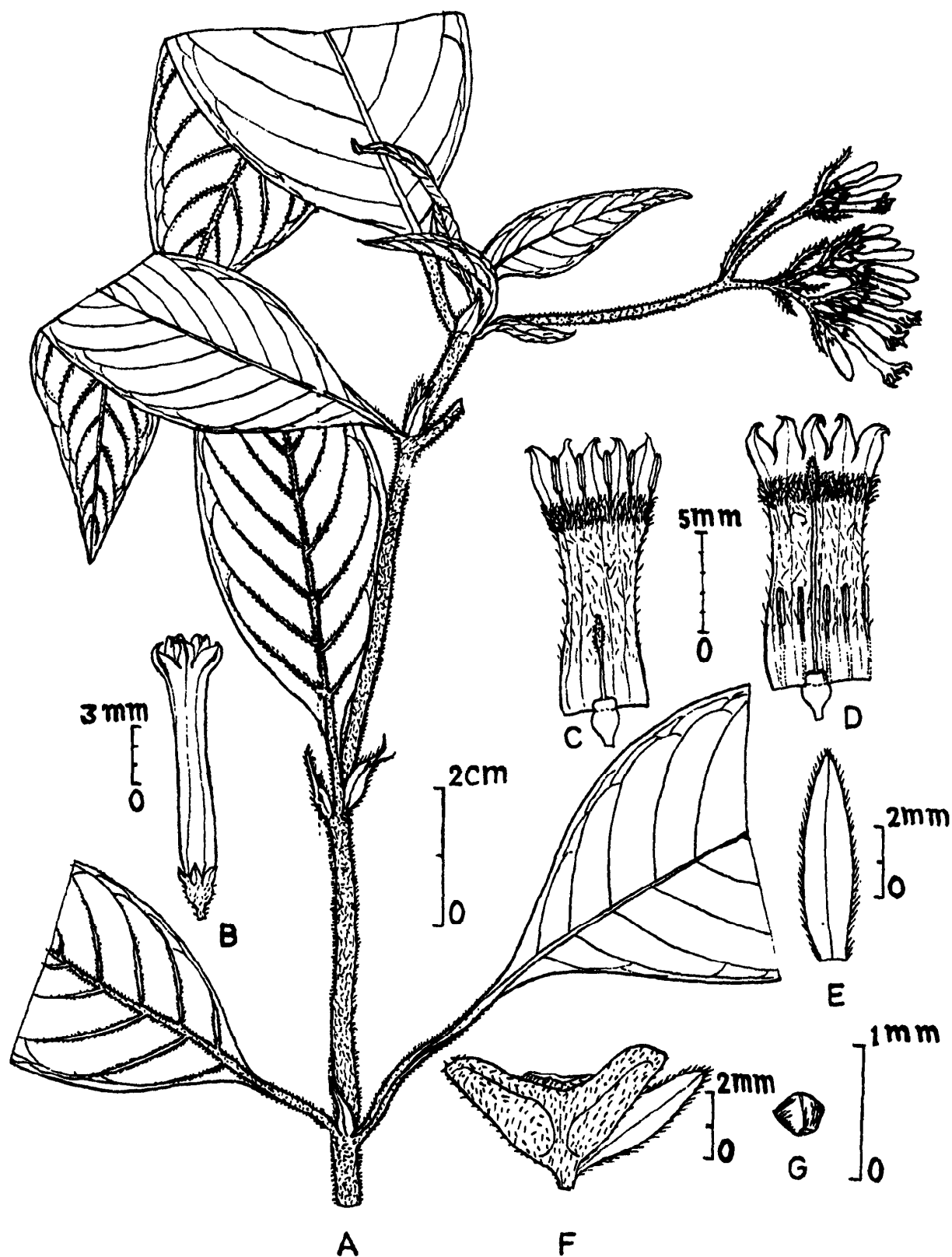
ovate, acute, glabrous. Corolla 14.75-20.25 mm long, infundibuliform, broad at base, narrowing upwards, glabrous outside; villous within; lobes $1.5-2 \times 1-1.5$ mm, ovate-lanceolate, acute, inwardly curved, shortly keeled at back. Stamens adnate either at the base or slightly above the middle of corolla, inserted or slightly exserted; filaments 2.5-2.75 mm long; anthers 2.5-2.75 mm long, linear-oblong. Ovary $1-1.25 \times 1-1.25$ mm, broadly obovoid; disc 0.5-0.75 mm high; styles of two sizes, either three-fourth or one-fourth as long as corolla tube, glabrous or pubescent; stigma 2-lobed, 2.25-2.75 mm long, lobes oblong-lanceolate, pubescent. Capsule $2-3 \times 5-8$ mm, hispid, locules ovate-oblong with straight tip. Seeds $0.3-0.4 \times 0.35-0.4$ mm, 5-7-angular, glabrous, brown; testa 4-7-gonal, or rarely rounded, wall of the areole thick with lateral crenate expansion or sometimes a number of tubercles on the areole proper.

Fl. : May-September.

Fr. : June-November.

Pollen : Oblate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = $24-(29)-33 \times 24-(33)-40$ μ m, 3- or 4 colporate; colpi $23-28 \times 4-4.5$ μ m, tapering to acute ends; ora circular, 4-6.5 μ m in diameter; sexine 1.5 μ m, nexine 0.25 μ m, ruguloreticulate; lumina 0.5-1 μ m, muri 0.5-0.75 μ m.

Distribution : West Bengal (Darjeeling district), Sikkim, Nepal and Bhutan to Myanmar.

Fig. 37. *O. nutans* Clarke ex Hook.f.

A. habit; B. flower; C. & D. flower split open; E. bract; F. fruiting; G. seed.

Ecology : Grows on damp soil in rocks in shady places in the forests near streams at 750-2400 m above m.s.l.

Specimens examined : INDIA: Sikkim. Chigra, *T. Anderson* 295 & 672 (CAL); Sikkim, *S. Kurz* s.n. (CAL); *G. King* s. n. (CAL) & *G. King* s. n. (CAL); *G. King* 2018 (CAL); *G. King* s. n. (CAL); *J. D. Hooker* s.n. (BM). West Bengal. Darjeeling dist., Sinchal, *S. Kurz* s.n. (CAL); Rishap, *C. B. Clarke* 12257 A & B (CAL); Darjeeling, *J. S. Gamble* 3734 A (CAL); Rungbee, *G. King* 592 (CAL) & *J. S. Gamble* 3753 A (K); Rishap, *G. King* 4841 (CAL); Mongpoo, *C. B. Clarke* 36023 D (BM) & *C. B. Clarke* 36482 A & E (K); Sureil, *Ribu* 858 (CAL) & *I. H. Burkill* 32216 (BSIS); Rungbee, *G. H. Cave* s. n. (E); Sonada, *G. H. Cave* s. n. (E); Rungbee, *G. H. Cave* s.n. (E); Darjeeling, *J. M. Cowan* s.n. (E). Assam. Lakhimpur, *G. Panigrahi* 27886 (CAL). Meghalaya. Khasi Hills, *Simson* s.n. (CAL). Arunachal Pradesh. Tirap dist., Bimalpur, *G. Panigrahi* 16963 (CAL, ASSAM). Nagaland. Kohima, *D. Prain* s.n. (CAL). Manipur. Ukhrul, *F. Kingdon-Ward* 18005 (BM). BHUTAN: Duphla, *Borth* s.n. (K). MYANMAR: North triangle, Uring Bum, *F. Kingdon-Ward* 20830 (BM).

27. *O. ochroleuca* Hook. f. Fl. Brit. India. 3: 78. 1880 (Type : Sikkim, 600-1500 m, *J. D. Hooker* OPHIORRHIZA 5 holo K! iso K! CAL!); Burkill in Rec. Bot. Surv. India. 10(1) : 50. 1924; Kanjilal et al. Fl. Assam 3: 42. 1939. (Fig.38)

Herbs annual or perennial, 10-100 cm tall; stem erect, branched, glabrous. Leaves 3.5-22.5 × 1.5-10 cm, elliptic to elliptic-lanceolate, acute to caudate-acuminate at apex, narrowed to the petiole or acute at the base, glabrous; lateral nerves 8-15 on either side; petioles 1.5-4 cm long, glabrous; stipules caducous, 0.4-1.5 cm long, linear-lanceolate, bifid, glabrous. Inflorescence axillary and terminal dichotomous or trichotomous helicoid cymes, branches stout, spreading, 2-10 cm across, pubescent; peduncles 3.5-10 cm long, elongating on fruiting, stout, pubescent. Flowers 6-14 mm long, primrose to yellow-orange or greenish; bracts caducous, minute; pedicels 0.75-1 mm long, puberulous. Hypanthium 1-1.5 × 0.75-1.25 mm, obovoid, puberulous. Calyx lobes 0.8-1.2 × 0.75-1 mm, triangular, acute, puberulous. Corolla 5-12.5 mm long, tubular, fleshy, glabrous outside, villous at the throat within; lobes 1-1.25 × 0.8-1 mm, not spreading, ovate, recurved with a short dorsal spur below the apex. Stamens adnate to the base of corolla or slightly above, inserted; filaments 3-6.5 mm long, glabrous; anthers 2-3.5 mm long, narrowly oblong. Ovary 0.8-1.25 × 0.6-1 mm, obovoid; disc 0.4-0.6 mm high; style three-fourth as long as corolla tube, slender, filiform, glabrous; stigma bilobed, 1.5-2 mm long, lobes linear-lanceolate, pubescent. Capsules 1.5-3 × 4.5-8 mm, glabrous, locules ovate-oblong, tip slightly inclined outwards. Seeds 0.4-0.5 × 0.3-0.5

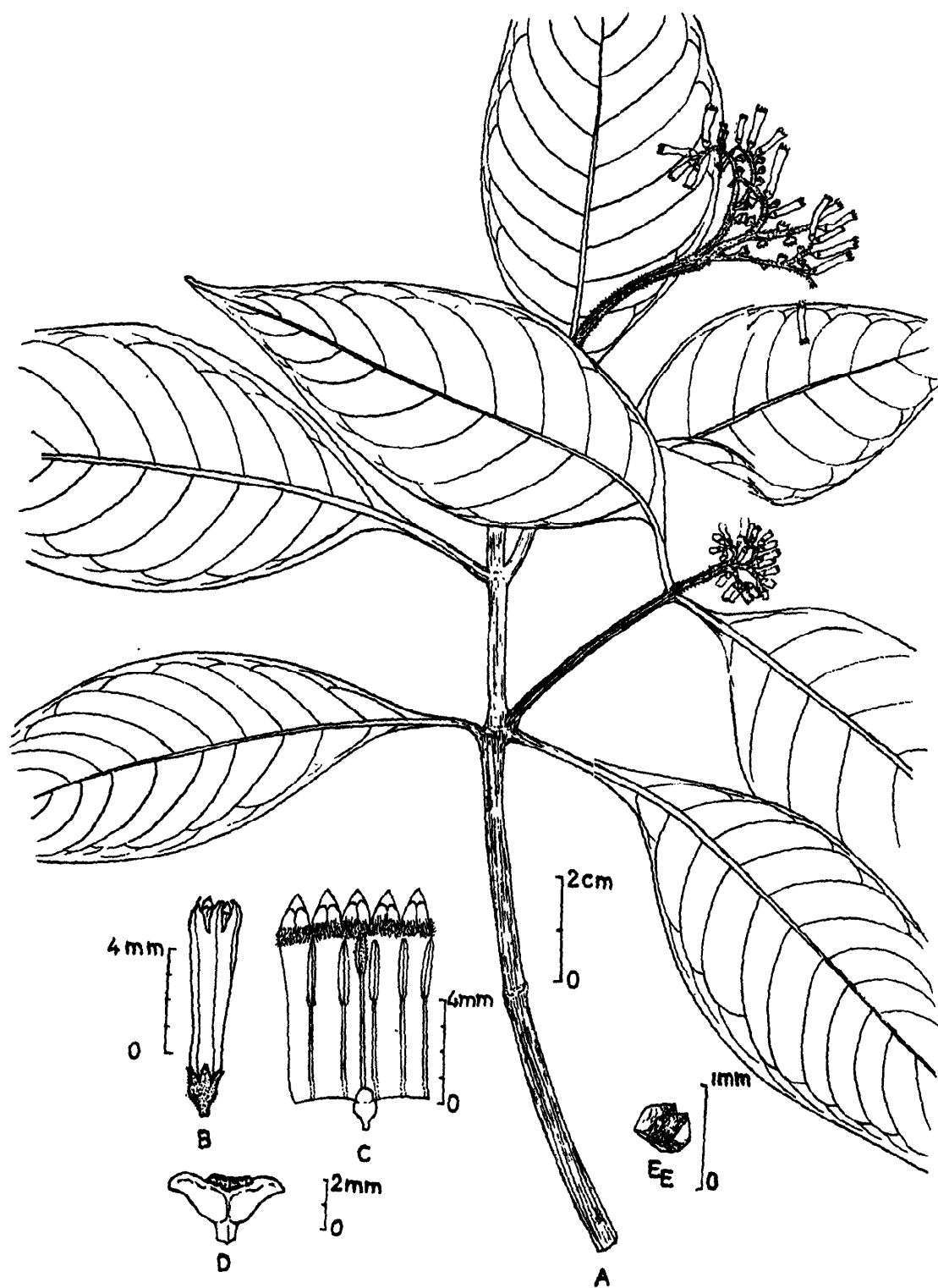


Fig.38. *O. ochroleuca* Hook. f.
A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

mm, 4-7-angular, glabrous, brown; wall of the areole moderately thin and without any ornamentation.

Fl. : March-August.

Fr. : April-November.

Pollen : Oblate-spheroidal to prolate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = 29-(36)-41 \times 33-(36)-41 μ m, 3-colporate; colpi 27-39 \times 4.5-7.5 μ m, tapering to obtuse ends; ora circular, 4.5-7.5 μ m in diameter; sexine 2.25 μ m, nexine 0.25 μ m, rugulo-reticulate; lumina 0.5-1 μ m, muri 0.5 μ m.

Distribution : West Bengal (Darjeeling district) and Sikkim to Myanmar.

Ecology : Grown on damp soil in stone crevices up to 1950 m above m.s.l.

Specimens examined : INDIA : Sikkim. Griffith s.n. (CAL); Tanliaka, T. Anderson 685 (CAL); G. King s.n. (CAL); Lapva, Dongbe, G. King s.n. (CAL); Lopchu, G. King s.n. (CAL). West Bengal : Darjeeling, Rishap, C.B. Clarke 9131 (BM); Rishap, C.B. Clarke 12255 (CAL); Rishap, C. B. Clarke s.n. (CAL); Lebong, J.S. Gamble 3744 A (K); Kalimpong, J.S. Gamble s.n. (CAL); Mongpoo, C. B. Clarke 36182 A (BM); Pashok, W.W. Smith 471 (CAL); Rungbee, W.W. Smith 727 (CAL); Rungbee, W.G. Craib 117 (CAL); Rungbee, G.H. Cave s.n. (E); Rangpoo, K. Biswas 9877 (CAL); Khasia, J.D.H. & T.T. s.n. (K); Khasia, G. King's Collector s.n. (DD); Garo Hills, Tura, C.B. Clarke 43094 B(K); Shillong, C.B. Clarke 44521 (BM, CAL);

Jowai, King's Collector s.n. (BSIS, MH); Garo Hills, Tura, Mrs. N.E. Parry 820 (K); Garo Hills, Tura, Walter N. Koelz 24391 (L); Khasia hills collector of Bot. Garden, Calcutta s.n. (CAL); (E). Assam. Cachar, April 1873, R.L. Keenan s.n. (K); Sibsagar, C. B. Clarke s.n. (CAL); Golaghat King's Collector s.n. (CAL). Arunachal Pradesh. Duffla hills, King's Collector s.n. (CAL); Abor hills, I.H. Burkill 36192 (CAL); Abor hills, Lalik valley I.H. Burkill s.n. (CAL); Abor hills, upper Renging camp, I.H. Burkill s.n. (CAL); Kameng Dist, Kocharigaon to Chardwar, G. Panigrahi 5902 (CAL); Lohit Dist., Dreyi to Badaru, R.S. Rao 10893 (CAL). Nagaland. Dekho valley, R.E.P. 11019 (E, CAL, BSIS); Naga hills, Perenni, N.L. Bor 6453 (K, DD). Manipur. Ainadhar, K.C. Malick 950 (BSIS); Nungba to Oinamlong, K.C. Malick 1257 (BSIS). Mizoram. Kheitem, D.B. Deb 31220 (ASSAM). MYANMAR: Bhamo Division, G.E.S. Cubitt s.n. (CAL); Khempti, Daru Uka, S.M. Toppin s.n. (CAL); Kachin State, Sumprabum sub Division, Hpuginhku J. Keenan, U Tun Aung & Tha Hla 3689 & 3734 (E).

28. *O. oppositiflora* Hook. f. Fl. Brit. Ind. 3 : 80. 1880 (Type : Khasi Hills, October 1873, C.B. Clarke 21878! A-holo. K; B-iso. !K); Kanjilal et al. Fl. Assam 3 : 42. 1939. (Fig.39)

Herbs annual, 15-100 cm tall; stems erect, sometimes procumbent, somewhat woody at base, branched or unbranched, scabrid. Leaves 3-18 \times 1-6.5 cm, ovate-

lanceolate, acute or acuminate at apex, acute at base, greenish and glabrous or sometimes scattered minute hairy above, pubescent on the nerves beneath; lateral nerves 7-12 on either side; petioles 1.5-3 cm long, rusty pubescent; stipules persistent, 2-11 mm long, subulate, entire or bifid, pubescent. Inflorescence terminal and opposite in the leaf axils, corymbose cyme, 1-3.5 cm across, not spreading, rusty pubescent. Flowers 6.5-11 mm long, white, pinkish-white or purple; bracts and bracteoles deciduous, minute; pedicels 0.5-1.5 mm long, pubescent. Hypanthium 0.75-1 × 0.5-0.75 mm, obovoid, pubescent. Calyx lobes 0.5-1 × 0.5 mm, lanceolate or ovate-lanceolate, obtuse at apex, pubescent. Corolla 5.75-10 mm long, infundibuliform; glabrous outside, villous at the middle of the tube within or glabrous; lobes 1.5-2 × 1-1.25 mm, oblong, slightly curved inward, obtuse at apex, keeled at back. Stamens adnate to the base of corolla or slightly above, inserted; filaments 3-3.5 mm long; anthers 1.75-2 mm long, narrowly oblong. Ovary 0.6-0.8 × 0.4-0.6 mm, obovoid; disc 0.5 mm high; style half as long as corolla, glabrous; stigma 2-lobed, 1.5-2 mm long, lobes ovate-lanceolate, glabrous. Capsule 1.5-2 × 3-6 mm, glabrous, locules ovate-oblong, tip slightly inclined outwards. Seeds 0.3-0.5 × 0.4 mm, irregularly angular, glabrous, brown; wall of the areole moderately thick with a number of tubercles on it and hooded over the areolar space.

Fl.: March-October.

Fr.: April-November.

Pollen: Oblate-spheroidal, semicircular in polar outline, polar axis (P) × equatorial axis (E) = 28-(31)-33 × 30-(34)-35 µm, 3-colporate; colpi 25-29 × 4.5-6 µm, tapering to acute ends; ora circular, 4-7 µm in diameter; sexine 1.75 µm, nexine 0.25 µm, rugulo-reticulate; lumina 0.75-1 µm, muri 0.5-0.75 µm.

Distribution: Throughout Eastern India to Myanmar.

Ecology: Grows on damp soil among stones in cool shady areas at 75-1500 m above m.s.l.

Specimens examined: INDIA: Meghalaya. Khasi & Jaintia Hills, *G. Galatly* s.n. (CAL); Mungpo, *G. Galately* s.n. (CAL); Mousto, *C.B. Clarke* s.n. (CAL); Shillong, *King's collector* s.n. (CAL); Nongpoh, *N. Koelz* 22629 (L); Cherrapunji, *N. Koelz* 22629 (L); Cherrapunji, *N. Koelz* 29639 (L) & *N. Koelz* 30370 (L); *Rupchand* 6224 (L); *N. Koelz* 31047 (L); Loobah River bank, *G. K. Deka* 10104 (CAL); Umsing, Noonmati, *J. Joseph* 37564 (ASSAM). Assam. Kamrup dist., Garbhanga forest, *R. S. Rao* 38798 (CAL, L); Mikir Hills, *G. Panigrahi* 9329 (CAL); Deygram, *G. Panigrahi* 9388 (CAL); Dulong Reserve Forest, *G. Panigrahi* 11313 (CAL); Jorhat to Sibsagar, *C.B. Clarke* 38034 (CAL, BM). Arunachal Pradesh. Kameng dist., Chardwar, *G. Panigrahi* 5473 (CAL).

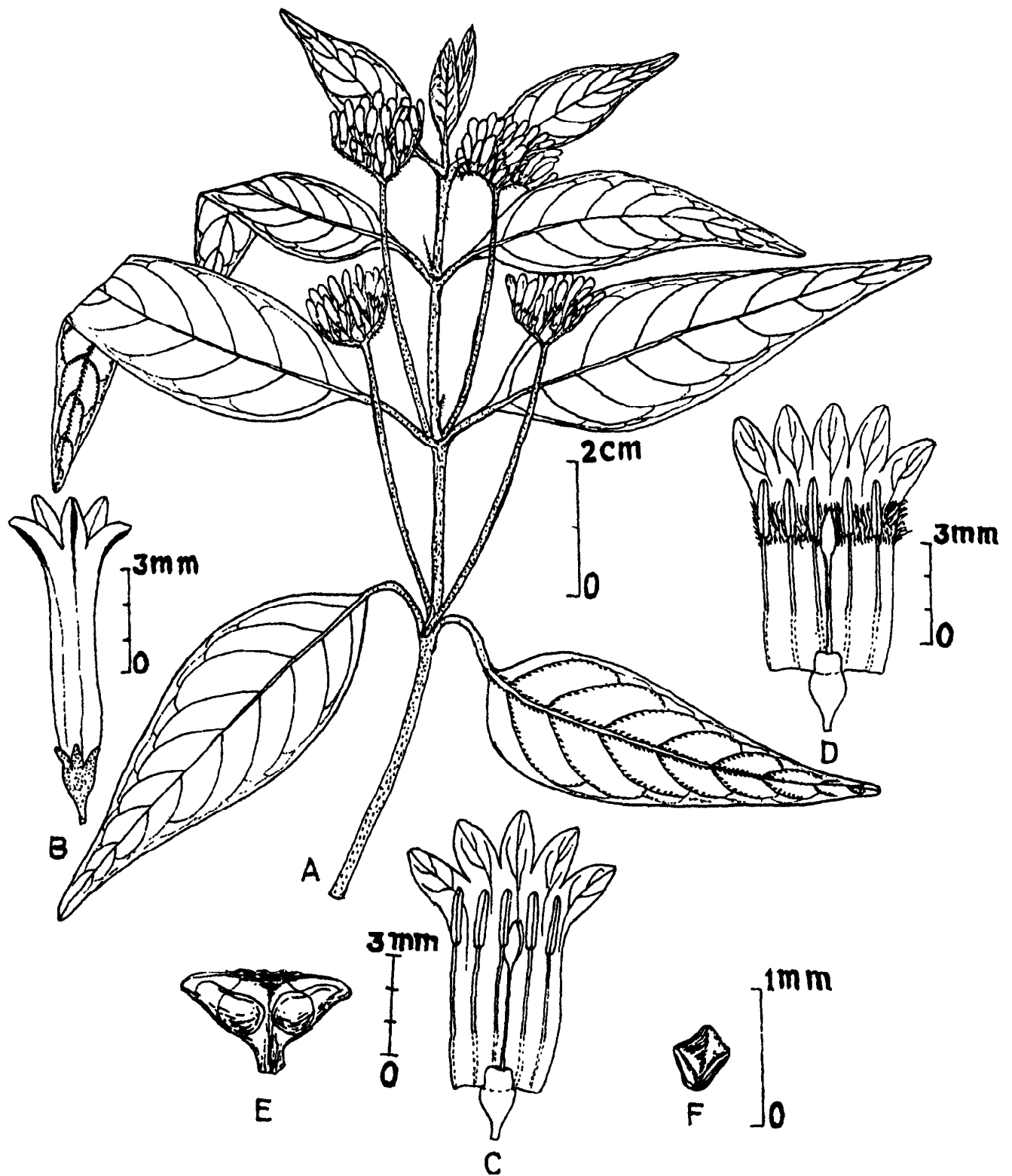


Fig. 39. *O. oppositiflora* Hook. f.
A. habit; B. flower; C. & D. flower split open; E. fruiting; F. seed

Nagaland. Dikho River bank, *G. Watt* 11049 (CAL, BSIS); Themokidima, *G. Watt* 11664 (CAL, BSIS). Tripura. Gorjee Reserve forest, R. S. Rao 8961 (CAL, AS-SAM, L). MYANMAR: Myitkyina dist. Tagwinchaung, *Gokhant* 12415 (DD).

29. ***O. pallida*** Thw. Enum. 140. 1864 (*Type*: Sri Lanka, Ambagamowa dist. in the forest, *Thwaites C.P.* 711 & 3344 CAL! BM!); Hook. f. Fl. Brit. India. 3: 81. 1880; Trimen, Handb. Fl. Ceylon 2: 322. 1895. (Fig-40)

Herbs, 5-40 cm long; stem procumbent, branched or simple, terete, densely pubescent or tomentose. Leaves 1.5-10 × 1-3 cm, ovate or ovate-lanceolate, obtuse, subacute or acuminate at apex, rounded or acute at base, pubescent on both surfaces; lateral nerves 6-11 on either side; petioles 0.7-2.5 cm long, densely pubescent or tomentose; stipules 3-6 mm long, narrowly linear, entire, glabrous. Inflorescence terminal corymbose cymes, contracted, 0.5-1.5 cm across, glabrous; peduncles 2.7-3.2 cm long, glabrous. Flowers 5-6.75 mm long; bracts and bracteoles similar, persistent, 2-7 mm long, linear, glabrous with prominent midrib; pedicels 0.75-1 mm long, glabrous. Hypanthium 0.5-0.75 × 0.6-0.8 mm, obovoid, glabrous. Calyx lobes 1-1.25 × 0.25-0.5 mm, linear, obtuse, glabrous. Corolla 4.5-6.25 mm long, infundibuliform, glabrous outside and inside; lobes 1-1.5 × 0.75-1 mm, broadly ovate, obtuse or rounded at apex, winged at back. Stamens adnate to the middle of corolla tube or slightly below, inserted;

filaments 1.25-1.75 mm long; anthers 1-1.5 mm long, oblong-linear. Ovary 0.4-0.6 × 0.5-0.7 mm, obovoid; disc 0.25-0.4 mm high; style 1.75-2.25 mm long, glabrous; stigma bilobed, 0.75-1.2 mm long, lobes ovate, acute, glabrous. Capsule 1.5-2 × 3.5-6 mm, glabrous, locule's oblong with straight tip. Seeds 0.4-0.5 × 0.3-0.4 mm, 5-7-angular, somewhat flattened, glabrous, brown; testa ruminated.

Pollen : Oblate-spheroidal, angular in polar outline, polar axis (P) × equatorial axis (E) = 23-(25)-28 × 23-(27)-32 µm, 3-colporate; colpi 21-24 × 3-4 µm, tapering to obtuse ends; circular, 3.5-5 µm in diameter; sexine 1.5 µm, nexine 0.25 µm, ruguloreticulate; lumina 0.5-0.75 µm, muri 0.5-0.75 µm.

Distribution : Sri Lanka.

30. ***O. pauciflora*** Hook. f. Fl. Brit. India. 3:84. 1880 (*Type* : Khasia Mts., 1500-2000 m, *J. D. Hooker & T. Thomson* OPHIORRHIZA 18 holo! K, is. CAL! BM! E!); Kanjilal *et al.* Fl. Assam 3:43. 1939; Balakr. Fl. Jowai 1:248. 1981.

Herbs, 8-32 cm long; stems creeping, branching, pubescent. Leaves 0.8-5.5 × 0.5-2.2 cm, ovate, obtuse or subacute at apex, rounded or obtuse at base, glabrous or scattered short hairy above, pubescent on the nerves beneath; lateral nerves 4-8 on either side; petioles 0.3-2 cm long, pubescent; stipules 2-4.5 mm long, linear, entire or sometimes bifid, glabrous. Inflorescence terminal panicle of cymes, 0.5-1.3 cm across, pubescent; peduncles

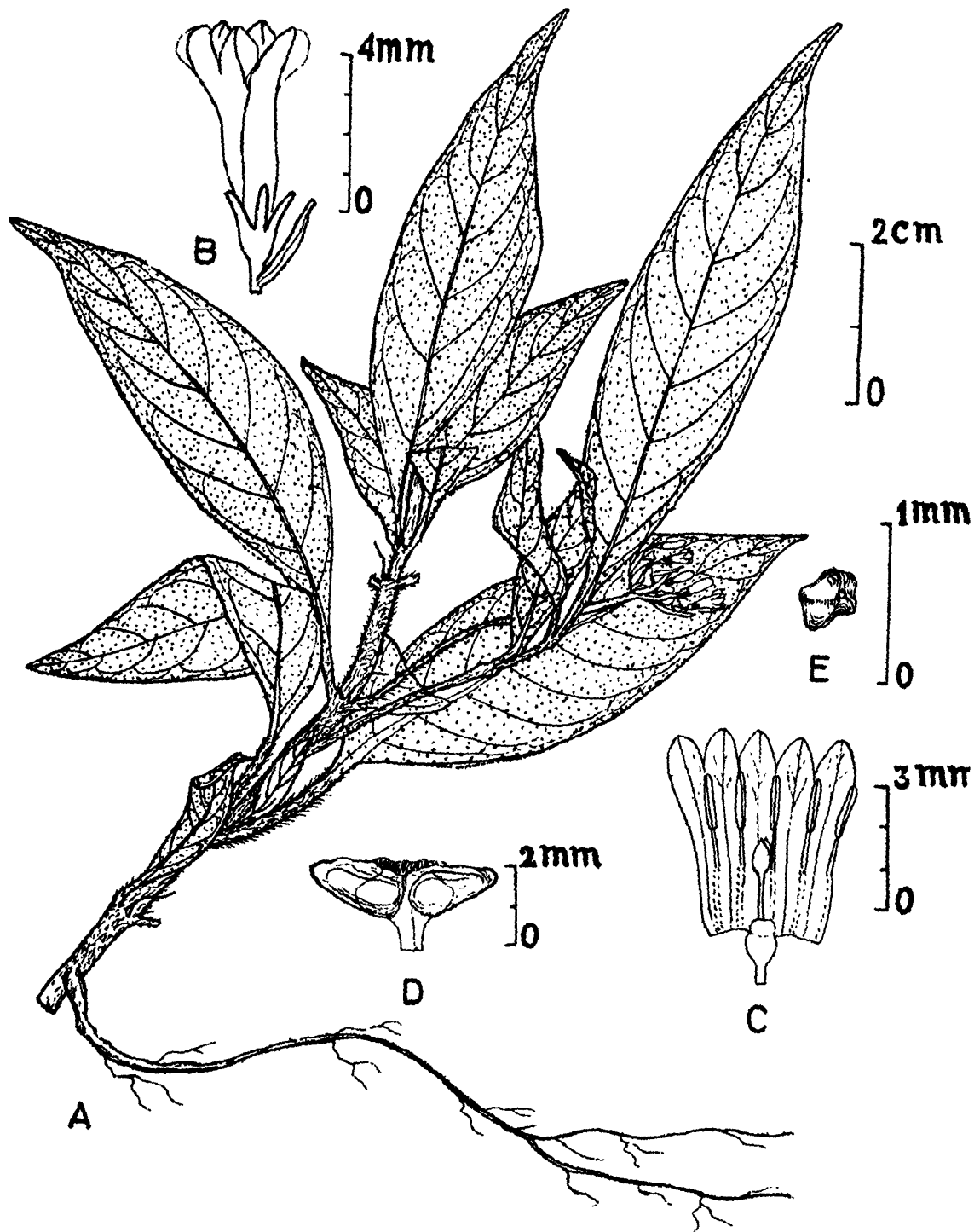


Fig. 40. *O. pallida* Thw.
A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

1.2-3 cm long, slender, pubescent. Flowers heterostylous, 6-12 mm long, white; bracts and bracteoles similar, persistent, 3-6.5 mm long, linear, glabrous or pubescent at the margin and midrib; pedicels 0.5-1 mm long, glabrous or pubescent. Hypanthium 0.5-1.4 × 0.5-1.5 mm, obovoid, glabrous or pubescent. Calyx lobes 0.75-1 × 0.5-0.75 mm, ovate or ovate-lanceolate, obtuse, glabrous or pubescent. Corolla 5.5-11 mm long, infundibuliform, glabrous outside, villous at the middle within or below the throat; lobes 1-3.25 × 0.75-2 mm, ovate, acute, hispid at the back on the midvein or glabrous. Stamens adnate either slightly above the base or at the middle of corolla, inserted; filaments 0.4-0.75 mm, or 1-1.3 mm long; anthers 1-1.3 mm long, oblong-linear. Ovary 0.4-1.2 × 0.4-1.25 mm, obovoid; disc 0.4-0.7 mm high; styles either as long as or 1/3rd of corolla tube, pubescent; stigma 2-lobed, 0.5-1.3 mm long, lobes ovate or ovate-lanceolate, glabrous. Capsule 1.25-2 × 2.75-4 mm, pubescent, locules ovate-oblong, with straight tip. Seeds 0.5-0.6 × 0.3-0.4 mm, 5-6-angular, glabrous, brown; wall of the areole thick without any tubercles.

Fl. & Fr. : May-October.

Pollen : Oblate-spheroidal, angular in polar outline, polar axis (P) × equatorial axis (E) = 31-(33)-36 × 30-(35)-39 µm, 3-colporate; colpi 26-34 × 3-4 µm, tapering to acute ends; ora circular, 4.5-7.5 µm in diameter; sexine 1.5 µm, nexine 0.25 µm ruguloreticulate, lumina 0.75-1 µm, muri

0.5-0.75 µm.

Note : Balakrishnan (1981) stated that it is endemic to Meghalaya but the specimens *D.B. Deb* 26601 & 26612 (ASSAM) collected on 8th July 1961 from Pungchow, Tirap dist, Arunachal Pradesh indicate its distribution in Arunachal Pradesh.

Distribution : Meghalaya to Arunachal Pradesh.

Ecology : Grows on moist shady places in forests and river banks at 600-1600 m above m.s.l.

Key to the varieties

1a. Cyme and floral parts pubescent, floers 6-9 mm long ...*O. pauciflora* var. *pauciflora*

1b. Cyme and floral parts quite glabrous, flowers 10-12 m long ...*O. pauciflora* var. *Glabra*

O. pauciflora Hook. f. var. ***glabra*** Deb et Mondal in Journ. Bomb. Nat. Hist. Soc. 79(3):647. 1982 (*Type* : Arunachal, Lohit dist. Debi valley, 1500-1800 m, 3rd May 1928, *F. Kingdon-Ward* 8148 holo. K!). (Fig.41)

Herbs, 12-25 cm long, creeping at base, branching, pubescent. Leaves 0.8-2.4 × 0.5-1.8 cm, ovate or oblong, lateral nerves 4-6 on either side; petioles 0.3-2 cm long, pubescent; stipules 2-3 mm long, linear, entire, sometimes bifid, glabrous. Inflorescence terminal cyme, 0.5-1 cm across, glabrous. Flowers 10-12 mm long, white; bracts and bracteoles similar, 3-6 mm long, linear, with prominent midrib, glabrous; pedicels 0.5-1 mm long, glabrous. Hypanthium 0.9-1.4 × 1-1.5 mm, glabrous. Calyx lobes 0.8-1 × 0.6-0.75 mm, ovate,

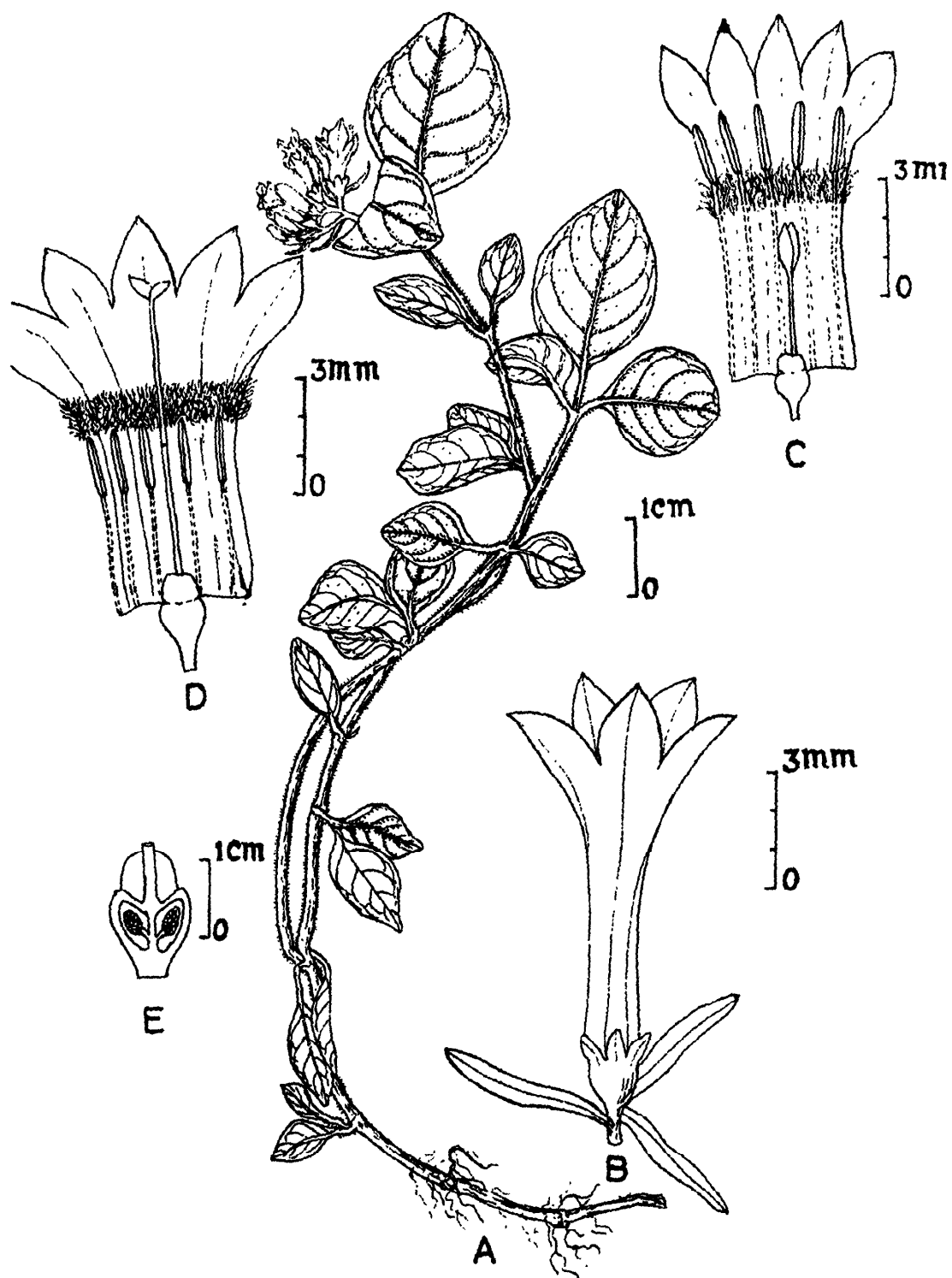


Fig. 41. *O. pauciflora* Hook. f. var. *glabra* Deb & Mondal
A. habit; B. flower; C. & D. flower split open; E. ovary (l.s.)

obtuse, glabrous. Corolla 9-10.6 mm long, infundibuliform, glabrous outside, villous at the middle within or slightly above; lobes $2-3.25 \times 1.25-2$ mm, ovate, glabrous. Stamens adnate either above the base or above the middle of corolla; filaments 0.5-0.75 mm or 1-1.3 mm long; anthers 1.25-1.3 mm long, oblong-linear. Ovary 0.8-1.2 \times 0.75-1.25 mm, disc 0.5-0.7 mm high; style either as long as or 1/3rd of corolla tube, glabrous; stigma either 0.5-0.6 mm long and lobes ovate or 0.8-1.3 mm long and lobes ovate-lanceolate.

Fl. : May-June.

Note : One flower shows 6 stamens and minute style and stigma, style being as long as the height of the disc and stigma 0.5 mm long.

Occurrence : Arunachal Pradesh, Lohit district.

O. pauciflora Hook. f. *Fl. Brit. Ind.* 3:84. 1880 var. **pauciflora**. (Fig.42)

Herbs, 8-32 cm long, pubescent. Leaves 1-5.5 \times 0.6-2.2 cm, ovate; lateral nerves 4-8 on either side; petioles 3-15 mm long, pubescent; stipules 2-4.5 mm long, linear, entire, glabrous. Inflorescence terminal, panicle of cymes, 0.6-1.3 cm across, pubescent. Flowers 6-9 mm long, white; bracts and bracteoles similar, persistent, 3-6.5 mm long, linear, pubescent on the margin and midrib; pedicels 0.5-1 mm long, pubescent. Hypanthium 0.5-0.75 \times 0.25-0.5 mm, pubescent. Calyx lobes 0.75-1 \times 0.25-0.5 mm, ovate-lanceolate, pubescent. Co-

rolla 5.5-8.25 mm long, villous at the middle within, lobes 1-1.25 \times 0.75-1 mm, ovate, hispid at back on the midvein. Stamens adnate either slightly above the base or at the middle of corolla; filaments 0.4-0.6 mm long; anthers 1-1.25 mm long, oblong-linear. Ovary 0.4-0.6 \times 0.3-0.5 mm; disc 0.4-0.5 mm high; styles either as long as or 1/3rd of corolla tube, pubescent; stigma 0.75-1 mm long, lobes ovate-lanceolate, glabrous. Capsule 1.25-2 \times 2.75-4 mm, pubescent. Seeds 0.5-0.6 \times 0.3-0.4 mm, 5-6-angular, glabrous.

Fl. & Fr. : May-October.

Specimens examined : ARUNACHAL PRADESH : Tirap dist. Pungchow, *D.B. Deb* 26601 & 26612 (ASSAM). MEGHALAYA : Khasi hills, *Griffith* s.n. (CAL); *Kurz* s.n. (CAL); *J.D Hooker & T. Thomson* s.n. (E); Mawphlong, *Thakur Rupchand* 7873 (L).

31. **O. pectinata** Arn. *Pugill. Pl. Ind. Or.* 338. 1836 (*Type* : Sri Lanka, *Walker* s.n. ex Herb. Hooker CAL!, K!); *Thw. Enum.* 140. 1864; *Hook. f. Fl. Brit. India* 3: 81. 1880; *Trimen, Fl. Ceylon* 2: 322. 1895; *Rao, Flower, Pl. Travancore* 207. 1914; *Gamble, Fl. Pres. Madras* 608. 1921. (Fig.43)

Herbs, 15-50 cm tall; stems erect, branching, suffruticose, glabrous, internodes 3-8 cm long. Leaves 4-17.5 \times 2-5.5 cm, elliptic-lanceolate, sometimes oblong-lanceolate or ovate-lanceolate, caudate acuminate at apex; tapering at base, glabrous; lateral nerves 6-12 on either side,

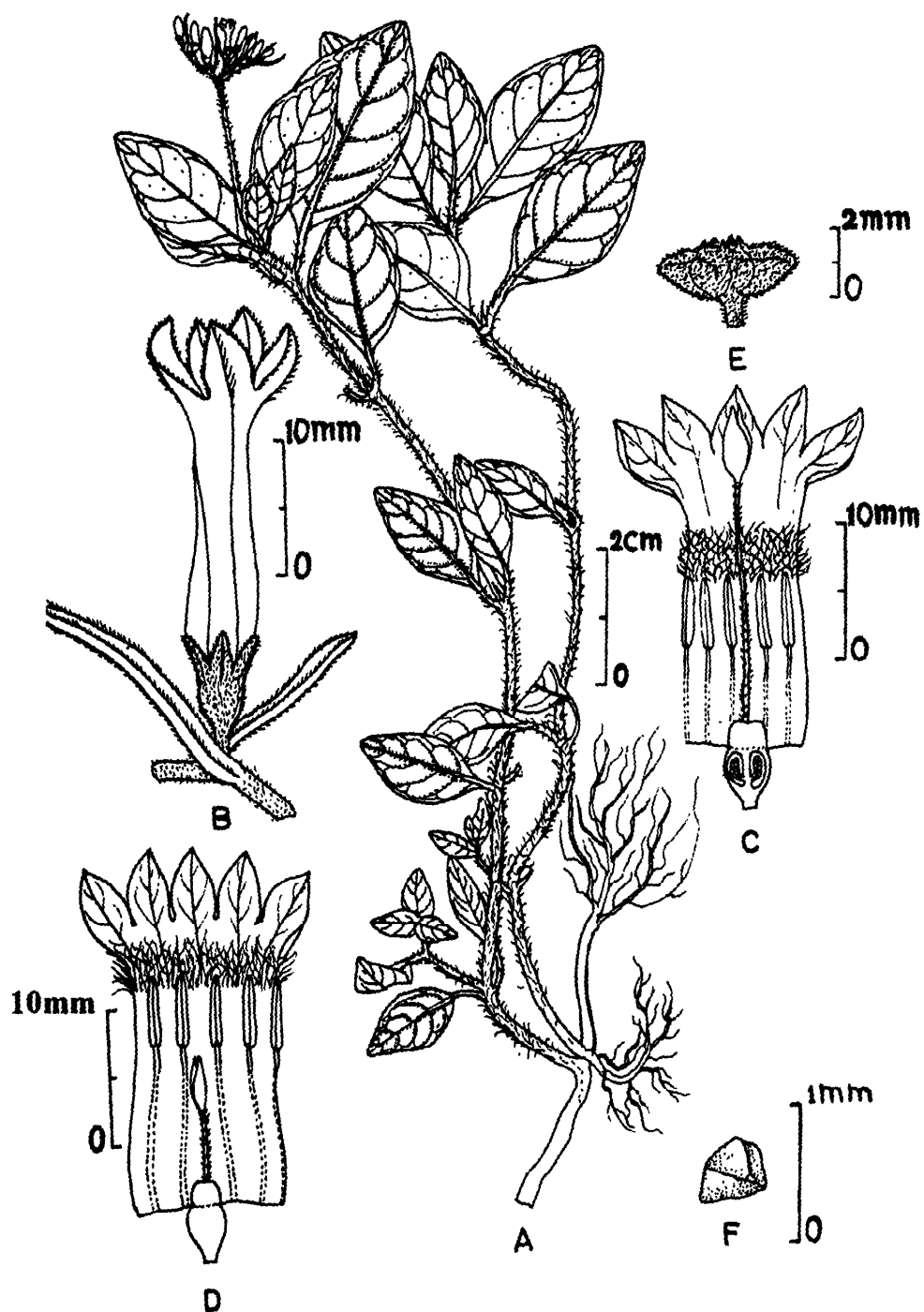


Fig. 42. *O. pauciflora* Hook. f. var. *pauciflora*
 A. habit; B. flower; C. & D. flower split open; E. fruiting; F. seed.

pale beneath ; petioles 1.5-3 cm long, glabrous; stipules 3-13 mm long, subulate with broad base, entire, sometimes bifid, glabrous. Inflorescence axillary and terminal capitate cymes, 0.8-3.75 cm across, contracted, glabrous; peduncles 4-10 cm long, 5-12 cm when bearing fruits, glabrous, sometimes pubescent. Flowers heterostylous, 6-11.5 mm long, white or pink; bracts and bracteoles similar, persistent, imbricate, 5-15 mm long, oblong-lanceolate, sometimes linear-lanceolate or ovate-lanceolate, glabrous with prominent midrib; pedicels 0.5-1.25 mm long, glabrous. Hypanthium 1-1.5 × 0.75-1.25 mm, obovoid, glabrous or sometimes puberulous. Calyx lobes 0.75-1 × 0.5-0.6 mm, subulate, glabrous, sometimes puberulous. Corolla 5-10 mm long, infundibuliform, slightly constricted at base and throat, usually glabrous or sometimes puberulous outside, glabrous or villous at the throat within; lobes 1.75-2.25 mm × 0.75-1.25 mm, lanceolate, acute at apex, keeled at back. Stamens adnate to the middle or base of corolla, inserted or scarcely exserted; filaments 2.5-2.75 mm or 0.5-0.75 mm long; anthers 1.2-1.5 mm long, oblong-linear. Ovary 0.8-1.3 × 0.6-1 mm, obovoid; disc 0.6-0.7 mm high; style as long as corolla tube and pubescent or half of the tube and glabrous; stigma bilobed, lobes either 1.75-2 mm long, linear, warty or 0.5-0.7 mm long, ovate, pubescent. Capsule 1.5-3 × 4-10 mm, glabrous, sometimes puberulous, locules ovate-oblong with straight tip. Seeds 0.4-0.5 ×

0.3-0.4 mm, 5-7 angular, glabrous, brown; testa usually 4-5 gonol, rarely 6-7 gonol, wall of the areole thick with a number of tubercles on it or hooded over the areolar space.

Fl. : May-December.

Fr. : June-January.

Pollen : Oblate-spheroidal semicircular in polar outline, polar axis (P) × equatorial axis (E) = 25-(27)-29 × 27-(31)-33 µm, 3-colporate, colpi 23-27 × 4-4.5 µm, tapering to acute ends; ora circular, 4.5-5.5 µm in diameter; sexine 1.75 µm, nexine 0.25 µm, ruguloreticulate; lumina 0.75 µm, muri 0.5 µm.

Note : Raphides present in stem, calyx lobes, ovary and capsule.

Distribution. India. Tamil Nadu, Kerala; Sri Lanka.

Ecology : Grows on damp shady places near streams at the 910-1500 m above m.s.l.

Specimens examined : INDIA: Tamil Nadu. Coimbatore dist. Anamalai Hills, Iyarpadi, *J. Joseph* 3257 (CAL); Attakatti, *J. Joseph* 12747 (CAL, MH); Attakatti, *J. Joseph* 14159 (CAL, MH); Sholaiyar submersible area, *K. Ramamurty* 18186 (CAL, MH); Madurai dist., Aruna Estate, *K. Subramanyam* 9518 (MH); Ramanathapuram dist., Deoiar Estate, *S. R. Srinivasan* 63536 (MH); Tirunelveli dist., Kuttalam Hills, *R. H. Beddome* s.n. (MH). Kerala: Cannanore dist., *R. H. Beddome* 3640 (BM); Chandanathode, *J. L. Ellis* 25203 (MH); Kottayam dist. Kuttikanam-Peermade, *K. Vivekananthan*

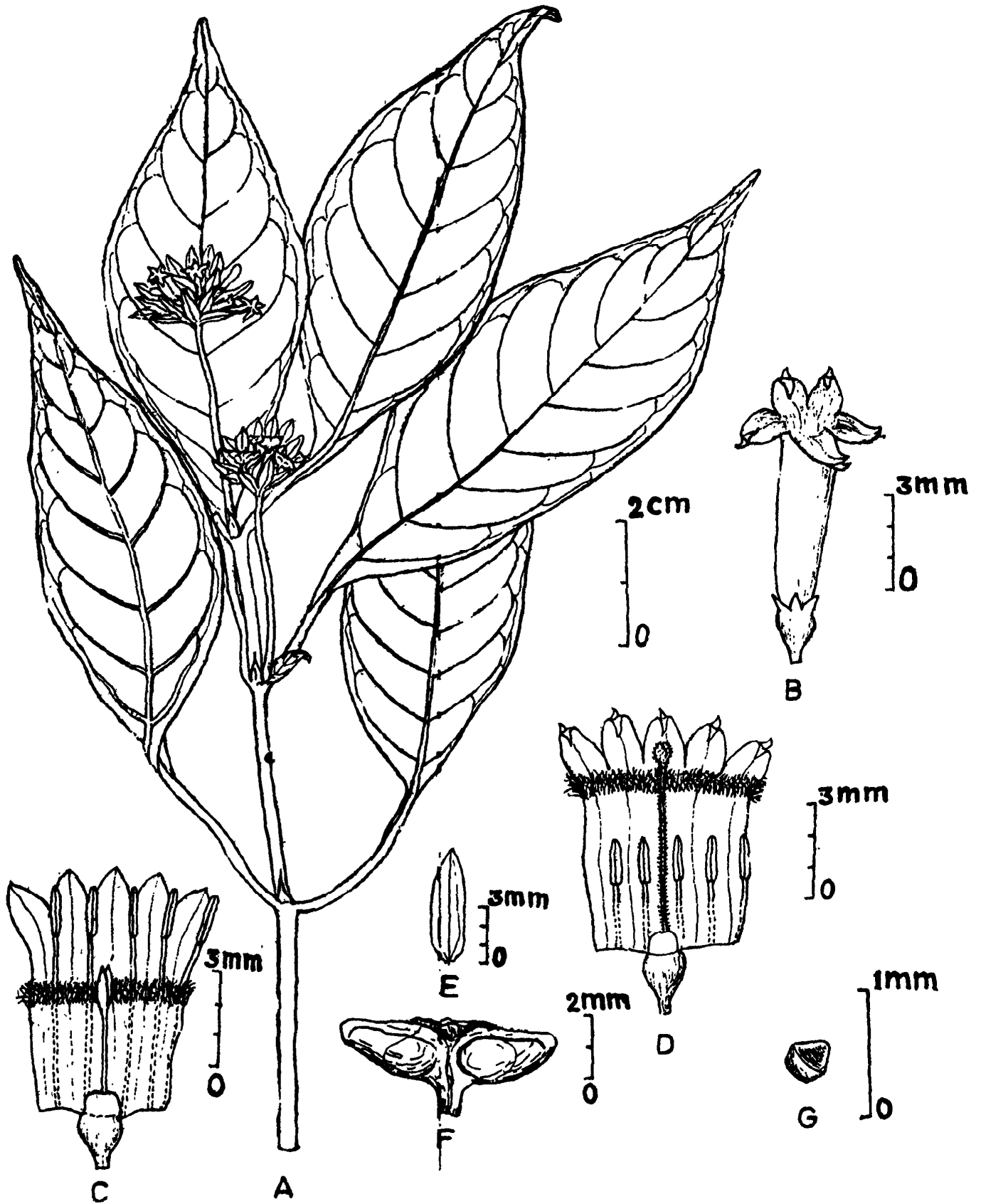


Fig. 43. *O. pectinata* Am.

A. habit; B. flower; C. & D flower split open; E. bract; F. fruiting; G. seed.

21384 (MH); Pamba, *D. B. Deb* 30312 (MH); Quilon dist., Mooghiar, *N. C. Nair* 50850 (MH). SRI LANKA: Central Province, *Thwaites C. P.* 342 (MH); *Thwaites C.P.* 712 (CAL, MH) and *Thwaites C. P.* 750 (MH); *R.H. Beddome* 3642 (BM); Blair Athal, *Alston* 1708 (MH).

32. ***O. pykarensis*** Gamble in Kew Bull. 1919: 407. 1919 (*Type* : Nilgiris, Pykara falls, 1800 m, May 1889, *Gamble* 20506 K, CAL!) & Fl. Pres. Madras 607. 1921; *Fyson* in Journ. Ind. Bot. 2: 210. 1921; *Blasco* in Journ. Bomb. Nat. Hist. Soc. 67(3) : 524. 1970. *Deb & Mondal* in *Nayar & Sastry*; Red Data Book Ind. Pl. 1: 339. Fig. 1. 1987. (Fig. 44)

Herbs, 25-40 cm tall, sometimes undershrubs; stems erect, somewhat woody at base, branching, terete, internodes 0.5-1.5 cm long, pubescent. Leaves 1.5-4.5 × 0.75-1.5 cm, ovate-lanceolate, acute at apex, cuneate, decurrent at base, pale beneath, glabrous above, pubescent on the nerves beneath; lateral nerves 6-10 on either side; petioles 0.5-2 cm long, slender, pubescent; stipules caducous, 1.5-2.5 mm long, triquetrous, acuminate, entire. Inflorescence terminal cyme, small, few flowered, 1-2 cm across, branches very short, puberulous; peduncles 1-1.5 cm long, puberulous. Flowers 10-15 mm long, pale-blue; bracts and bracteoles caducous, minute, puberulous; pedicels 0.5-3.25 mm long, puberulous. Hypanthium 1.5-1.75 × 1-1.25 mm, obovoid, puberulous. Calyx lobes 0.75-1 × 0.75 mm, ovate, acute,

puberulous. Corolla 8.5-13.25 mm long, infundibuliform, tube 6-10.25 mm long, puberulous outside, villous throughout within; lobes 2.5 - 3.25 × 2.25 - 3 mm, ovate, slightly curved inward, acute at apex, strongly keeled at back. Stamens adnate below the middle of corolla, inserted; filaments 0.75 - 1 mm; anthers 2.5 - 2.75 mm. Ovary 1.25 - 1.4 × 0.75 - 1 mm, obovoid; disc 1 mm high; style as long as corolla tube or slightly longer, pubescent; stigma 2-lobed, 0.75 - 1 mm long, lobes ovate, glabrous. Capsule (immatured) 2.5 × 2.5 - 3 mm.

Fl. : May; *Fr.* : June.

Pollen : Oblate-spheroidal, semicircular in polar outline, polar axis (P) × equatorial axis (E) = 26 - (30) - 32 × 29 - (32) - 35 µm, 3-colporate; colpi 20 - 26 × 3 - 3.5 µm, tapering to obtuse ends; ora circular, 4.5 - 6 µm in diameter; sexine 1.5 µm, nexine 0.25 µm, rugulo-reticulate; lumina 0.75 µm, muri 0.5 - 0.75 µm.

Raphides : Raphides are present in the stem, hypanthium, calyx lobes and corolla.

Distribution : Tamil Nadu (Nilgiris). Endemic.

Specimens examined : TAMIL NADU: Nilgiris dist. Pykara falls, *J. S. Gamble* 20506 (CAL); Shola on the saddle of Makurti peak, *E. Barnes* 1172 (K).

Note : After the original discovery it was collected only once in 1935, i.e., about sixty years ago. It could not be traced out. during this period even though the region has been

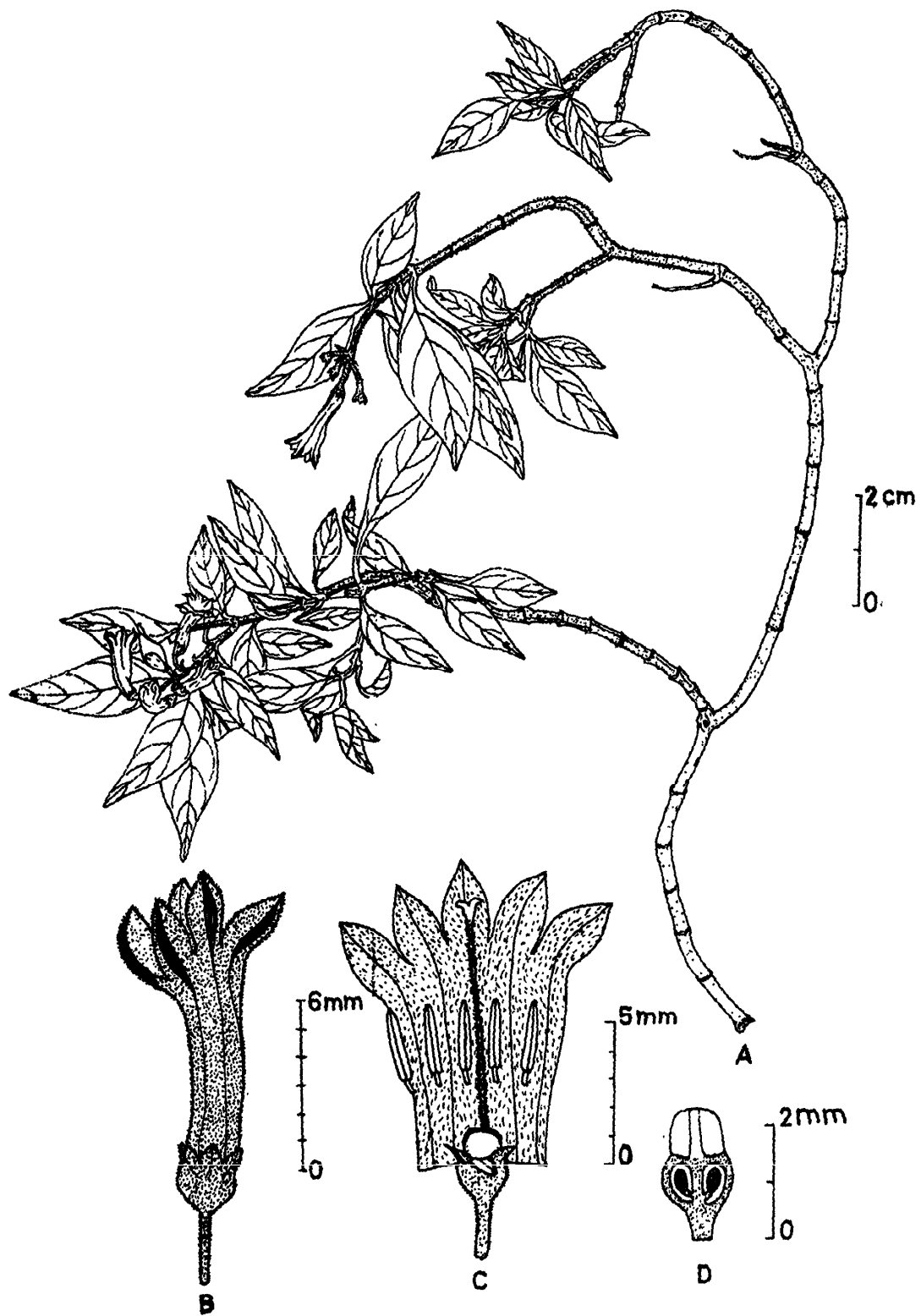


Fig.44. *O. pykarensis* Gamble
A. habit; B. flower; C. flower split open; D. l.s. of ovary.

well explored in recent years. Due to developmental activities the habitat might have undergone changes leading to its extinction.

33. **O. radicans** Gardn. in Thw. Enum, 139. 1864 (*Type* : Sri Lanka, *Thwaites C.P.* 1706 CAL!BM!); Hook. f. Fl. Brit. India 3: 80. 180; Trimen, Handb. Fl. Ceylon 2: 321. 1885. Deb & Mondal in Nayar & Sastry, Red Data Book Ind. Pl. 2: 227. fig. 1. 1988. (Fig. 45)

Herbs, 20-30 cm long; stems creeping, rooting at the nodes, branching, densely pubescent. Leaves 1.3-4 × 1-2.5 cm, ovate, or ovate-orbicular, obtuse to acute at apex, rounded or cordate at base, glabrous above, pubescent on the nerves beneath; lateral nerves 3-5 on either side; petioles 0.5-1.5 cm long, pubescent; stipules persistent, 2-3 mm long, subulate, pubescent. Inflorescence terminal, corymbose cyme, 0.5-1.5 cm across, few flowered, contracted, pubescent; peduncles 2-2.2 cm long, slender, pubescent. Flowers 5-7 mm long, white; bracts and bracteoles similar, caducous, 2-3.25 mm long, linear, puberulous; pedicels 0.5-0.75 mm long, puberulous. Hypanthium 0.75-1 × 0.6-0.75 mm, obovoid, puberulous. Calyx lobes 0.5-0.8 × 0.25-0.5 mm, subulate, acute, puberulous. Corolla 4.25-6 mm long, infundibuliform, glabrous outside, villous at the middle of the tube within; lobes 1.25-1.5 × 1 mm, ovate, slightly curved inward and acute at apex, shortly keeled at back. Stamens adnate to the base of corolla or

slightly above, inserted; filaments 1 mm long; anthers 1 mm long. Ovary 0.6-0.75 × 0.5-0.6 mm, obovoid; disc 0.3 mm high; style 1-1.25 mm long, glabrous; stigma 2-lobed, 0.75-1 mm long, lobes lanceolate, acute, glabrous. Capsules 2 × 3-4 mm, glabrous, locules ovate-oblong with straight tip. Seeds 0.3-0.4 × 0.3-0.4 mm, 5-7-angular, glabrous, brown; wall of the areole thin with a number of tubercles on it.

Fl. & Fr. : November.

Pollen Oblate-spheroidal, angular in polar outline, polar axis (P) × equatorial axis (E) = 24-(28)-32 × 25-(29)-32 µm 3-colporate; colpi 23-30 × 3.5-4.5 µm, tapering to obtuse ends; ora circular, 4.5-6 µm in diameter; sexine 1.75 µm, nexine 0.25 µm, rugulo-reticulate; lumina 0.75-1 µm, muri 0.75 µm.

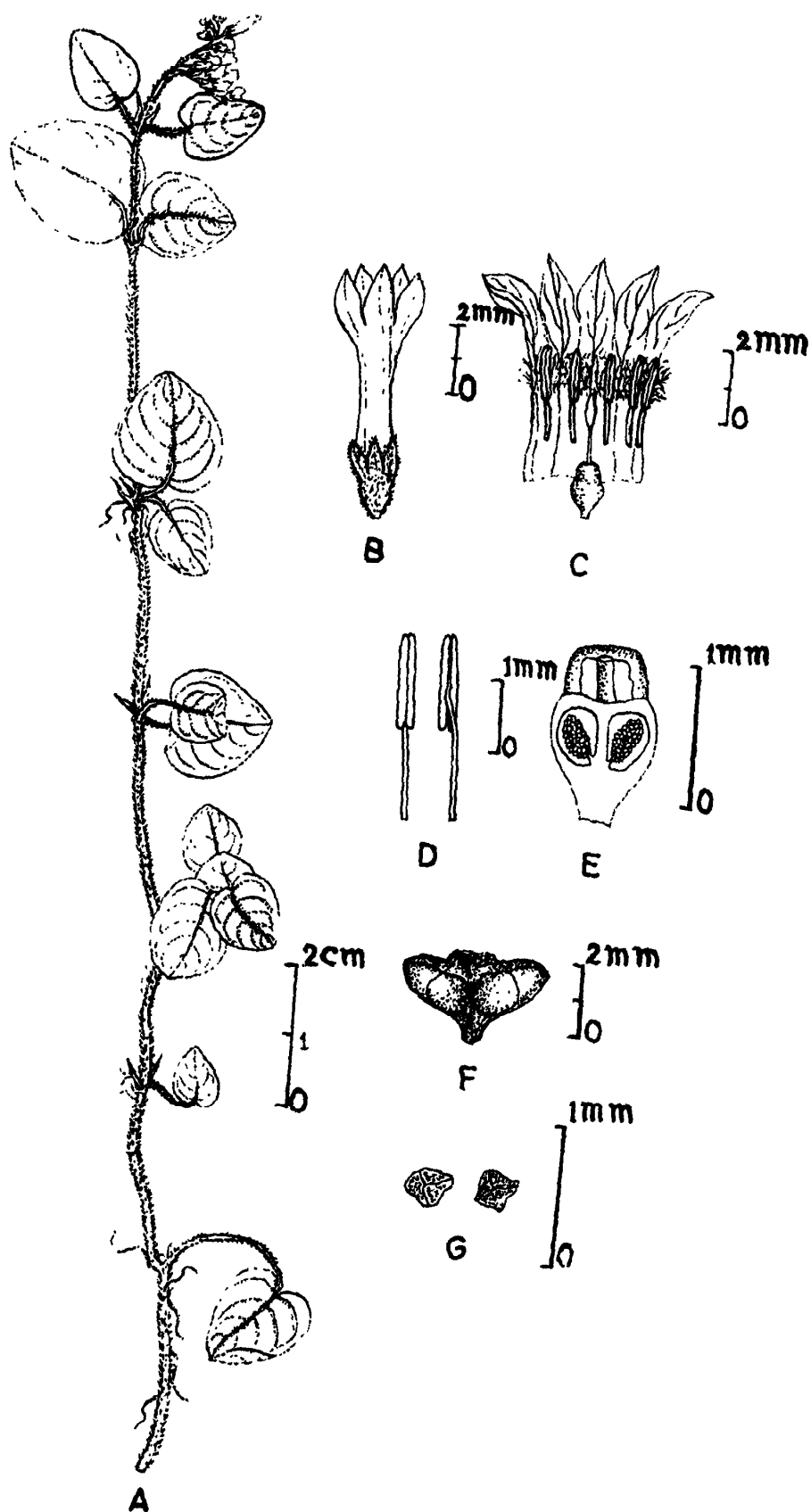
Note : It has not been collected in India after 1893, though Kerala and adjoining areas have been fairly well explored in recent years. Possibly it is extinct.

Distribution : India. Kerala; Sri Lanka.

Ecology : Grows on damp rocky soil in the forest.

Specimens examined : INDIA: Kerala, Colatoorpolay, *M. A. Lawson* 61 (CAL). SRI LANKA : *Thwaites C.P.*

34. **O. repens** (Wall. ex G. Don) Bennet in Ind. Forest. 108(4) : 302. 1982. *Mussaenda repens* Wall. ex G. Don, Gen. Syst. Gard. Bot. 3: 491. 1834. *O. calcarata* Hook. f. Fl. Brit. India 3: 84. 1880 (*Type* : Khasi Hills, 1200-1500 m,

Fig. 45. *O. radicans* Gardn.

A. habit; B. flower; C. flower split open; D. stamen; E. ovary (L.S.), F. fruiting; G. seed.

3rd November 1850, *J. D. Hooker & T. Thomson*, *OPHIORRHIZA* 19-K selected as the lectotype, 3 duplicates in CAL; Khasia, *Griffith* s.n. K, CAL; Mishmi Hills, *Griffith* s.n. K, CAL); *C. B. Clarke* in Journ. Linn. Soc. Bot. 25: 31. 1889; Burkill in Rec. Bot. Surv. India 10(1) : 50. 1924; Kanjilal *et al.*, Fl. Assam 3: 43. 1939; Mukherjee *et al.* in Rec. Bot. Surv. Ind. 20(2) : 119. 1973; Balakr. Fl. Jowai 1: 248. 1981. (Fig.46)

Herbs perennial, 10-100 cm tall, sometimes undershrubs; stems erect, flexuous, creeping below, branched or unbranched, terete, glabrous below, pubescent above. Leaves 2-12 × 1-9 cm, elliptic-lanceolate, acuminate at apex, slightly tapering, often oblique at base, glabrous or hirsute, lurid green above, pubescent, pale beneath; lateral nerves 6-15 on either side; petioles 0.5-2.2 cm long, pubescent; stipules 3-15 mm long, narrowly lanceolate, entire or rarely bifid, pubescent along the margin. Inflorescence terminal corymbose cyme, trichotomously branched, contracted, 1-3 cm across, branches short, ascending, pubescent; peduncles 0.5-3.5 cm long, erect, pubescent. Flowers heterostylous, 18-30 mm long, white, creamy or pink, bracts persistent, shorter than the flowers, 7-12 mm long, linear, pubescent along the margin and midrib; bracteoles persistent, 5-8 mm long, linear, pubescent along the margin and midrib; pedicels 1-2 mm long, pubescent. Hypanthium 1.25-1.75 × 1-1.5 mm,

obovoid, pubescent. Calyx-lobes 1-1.25 × 0.5 mm, ovate-lanceolate, acute, pubescent. Corolla 16.75-28.25 mm long, infundibuliform, puberulous, sometimes tomentose outside, villous at the throat within; lobes 0.75-1 × 0.5 mm, ovate, acute, erect, with 1.5-2 mm long, recurved, pinkish, hispid spur at back. Stamens adnate to the middle of corolla or slightly above, inserted; filaments 0.75-1.25 mm long; anthers 2.5-2.75 mm long, linear-oblong. Ovary 1-1.5 × 0.75-1.25 mm, obovoid; disc 0.75-1 mm high; style 9-22 mm or 1.5-2 mm long, glabrous; stigma 2-lobed, 1.5-1.75 mm long, lobes elliptic-lanceolate, glabrous. Capsule 2-3.5 × 2-8.5 mm, pubescent, locules ovate-oblong with straight tip. Seeds 0.35-0.5 × 0.3-0.5 mm, irregularly angular, glabrous, brown; wall of the areole thick with a number of tubercles on it and also hooded over the areolar space.

Fl. & Fr. : Throughout the year.

Pollen : Oblate-spheroidal, angular in polar outline, polar axis (P) × equatorial axis (E) = 42-(46)-49 × 42-(46)-53 µm, 3-colporate; colpi 32-41 × 5-7 µm, tapering to subacute ends; ora circular, 6.5-9 µm in diameter; sexine 1.75 µm, nexine 0.25 µm, rugulo-reticulate; lumina 0.75-1 µm, muri 0.75-1 µm.

Distribution : Assam, Meghalaya and Arunachal Pradesh to Myanmar.

Ecology : Grows on damp, sandy and alluvial soil on rocks at 420-2250 m above m.s.l.

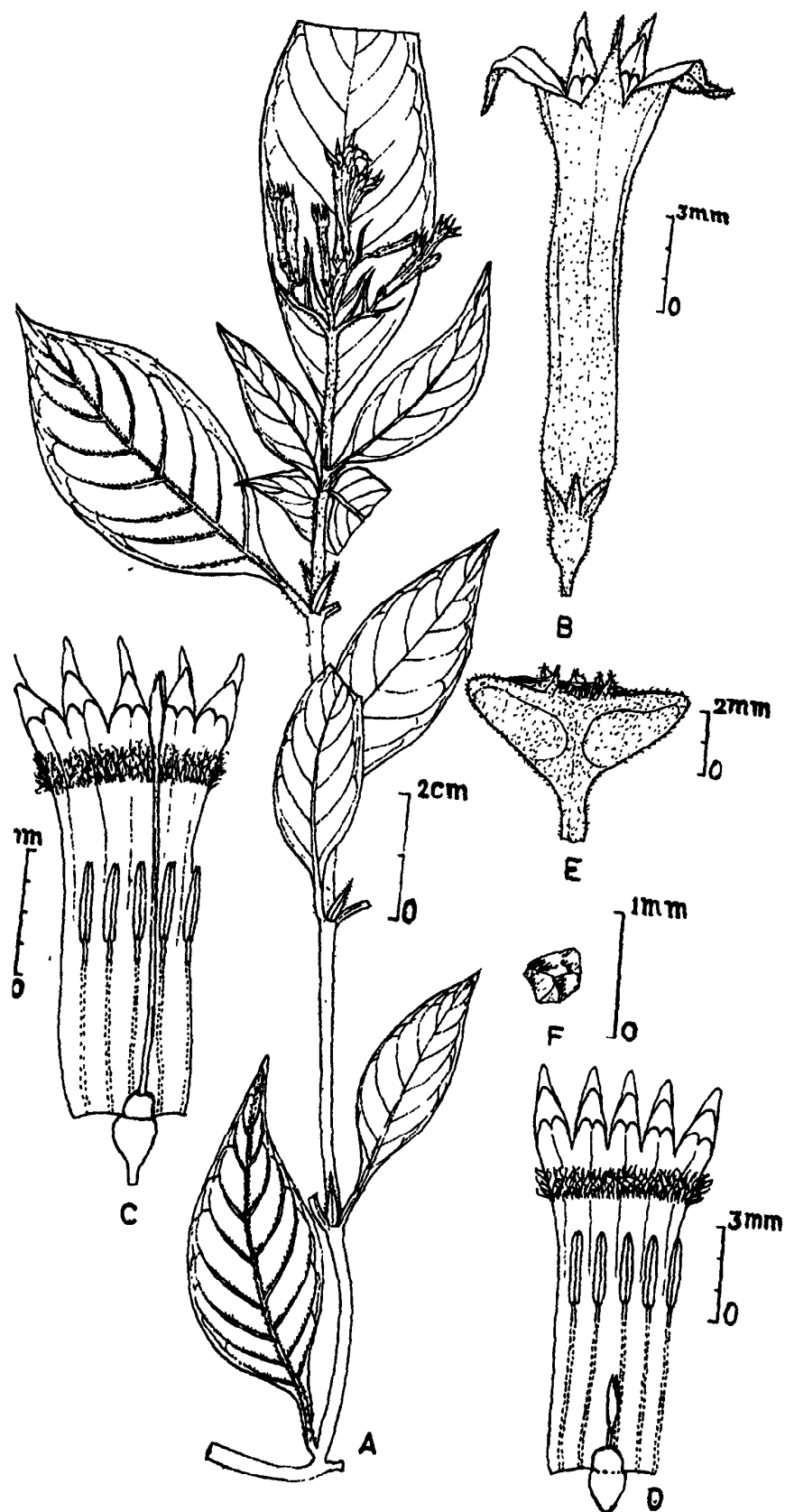


Fig. 46. *O. repens* (Wall. ex G. Don) Bennet
A. habit; B. flower; C. flower split open; D. stamens; E. ovary, F. seed.

Specimens examined : INDIA: Assam. Sibsagar dist., Kaziranga, *R. S. Rao* 9728 (CAL). Meghalaya. Jaintia Hills, Jowai, *King's collector* s.n. (CAL); Jowai, *G. K. Deka* 5065 (CAL); Khasi Hills, *Griffith* s.n. (BM); Cherrapunji, *C. B. Clarke* 5252 (CAL); Sohra, *C. B. Clarke* 15719 (A - BM, D - CAL) & 17803 A (CAL); Melim, *C. B. Clarke* 45924 (A - BM, C CAL); Pynursla, *K. Biswas* 4037 (CAL); Shillong peak, *Thakur Rupchand* 2436 (L); Mawryngkneng, *Thakur Rupchand* 4954 (L); Cherrapunji gate, *G. Panigrahi* 4984 (CAL); Pynursla, *B. K. Nayar* 50017 (LWG); Wahlyer, Shoywang, *G. Panigrahi* 16125 (CAL). Arunachal Pradesh. Siang dist., Renging, *I. H. Burkill* 36674 (CAL); Tuting, *R. S. Rao* 17327 (CAL, ASSAM); Subansiri dist. Apa Tang valley, *Cox & Hutchinson* 458 (K, E). MYANMAR : Kachin Hills, *Shaik Mokim* s.n. (CAL) & *S. M. Toppin* 4357 (CAL); Janrawag Bum, *J. Keenan, U. Tun Aung & U. Tha Hla* 3219 (E); Sumpra Bum Subdivision, *J. Keenan, U. Tun Aung & U. Tha Hla* 3311 (E); Ndum - Zup, *J. Keenan, U. Tun Aung & U. Tha Hla* 3087 (E).

35. *O. rosea* Hook. f. Fl. Brit. Ind. 3: 78. 1880. (Type : Khasi hills, 1200-1500 m, *J. D. Hooker & T. Thomson* *OPHIORRHIZA* 6 holo; K!); Kanjilal *et al.* Fl. Assam 3: 42. 1939; Balakr. Fl. Jowai 1: 248. 1981. (Fig. 47)

Herbs annual or perennial, 0.5-1.5 m tall, sometimes undershrubs; stems erect, branched, glabrous except tender shoots. Leaves 6.5-25 × 2-9.5 cm, elliptic to elliptic-lanceolate, usually acuminate,

rarely acute at apex, tapering at base, glabrous, sometimes scattered short hairy above, puberulous on the nerves beneath; lateral nerves 8-13 on either side; petioles 2.5-5 cm long, glabrous; stipules caducous, 3-7 mm long, ovate, with long tooth, glabrous. Inflorescence axillary and terminal dichotomously branched helicoid cyme, 1.5-4 cm across, many-flowered, spreading, puberulous; peduncles 2.75-5 cm long, elongating on fruits, puberulous. Flowers 6-14 mm long, pale-pink, red or purple; bracts and bracteoles caducous, minute; pedicels 0.75-1.5 mm long, puberulous. Hypanthium 1-1.75 × 0.6-1.25 mm, obovoid, pubescent. Calyx-lobes 0.75-1 × 0.5-0.6 mm, triangular, acute present. Corolla 5-12.25 mm long, tubular, rounded at the tip in bud, glabrous or puberulous outside, glabrous within; lobes 1.25-1.5 × 0.75-1.25 mm, ovate, acute, recurved. Stamens adnate to the base of corolla or slightly above, inserted; filaments 1-1.5 mm long; anthers 2-2.5 mm long, narrowly oblong. Ovary 0.8-1.5 × 0.5-1 mm, obovoid; disc 0.5 mm high; style 3-9 mm long, glabrous; stigma 2-lobed, 1.5-2 mm long, lobes lanceolate, glabrous. Capsules 2-3 × 5-8 mm, glabrous, locules ovate-oblong with straight tip. Seeds 0.35-0.5 × 0.3-0.5 mm, irregularly angular, glabrous, brown; wall of the areole very thin without any tubercle.

Fl. : June-August.

Fr. : July-September.

Pollen: Oblate-spheroidal, semiangular in polar outline, polar axis (P) × equatorial

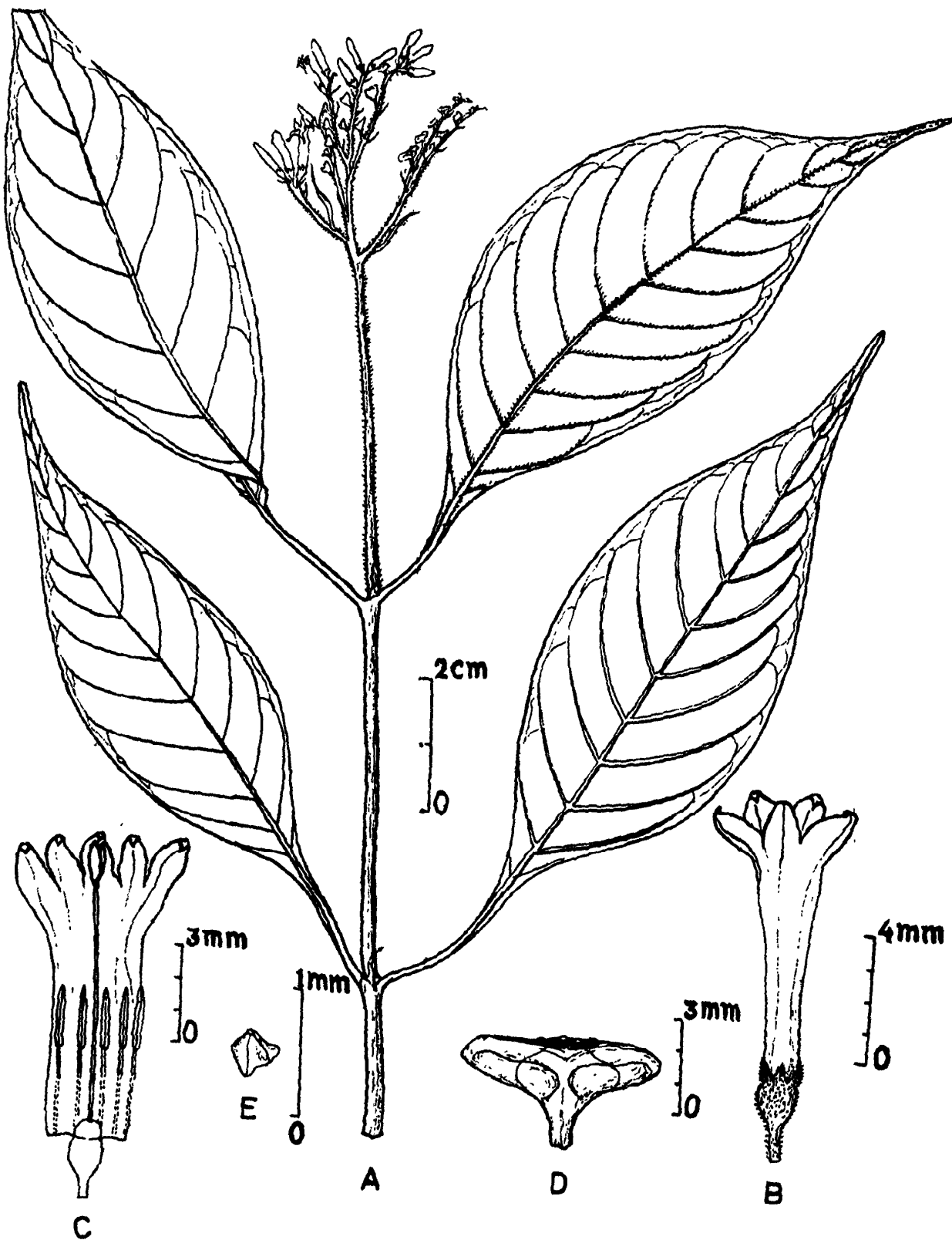


Fig.47. *O. rosea* Hook. f.
A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

axis (E) = 36-(38)-40 × 34-(39)-41 μ m, 3-colporate, colpi 17-22 × 5-7 μ m, tapering with acute ends, ora circular, 5-7 μ m in diameter, sexine 1.75 μ m, nexine 0.25 μ m, ruguloreticulate, lumina 0.75 μ m, muri 0.5 μ m.

Note : Colour of the flowers is always pinkish to purplish except the specimens of Naga hills where it is white outside and pink inside.

Distribution : West Bengal (Darjeeling district) and Sikkim to Myanmar and Thailand in the east, Malay and Sumatra in the south-east.

Ecology : Grows as forest undergrowth on the damp soil in the stone crevices at 1200-3048 m, above m.s.l.

Specimens examined : INDIA: Sikkim. Tonglo, *T. Anderson* 673 (CAL); Sikkim, *G. King* s.n. (CAL) & *G. King* 2017 (CAL); Sikkim, *N.L. Bor's Collector* 918 (DD); Sikkim, *C. B. Clarke* s.n. (CAL); Sikkim, *S. Kurz* s.n. (CAL). West Bengal. Darjeeling, Rungbee, *C.B. Clarke* 8581 (BM); Rungbee, *C.B. Clarke* 9405 (K); Rungbee, *C.B. Clarke* 12115 (CAL); Rungbee, *C. B. Clarke* 12176 (K); Rungbee, *C. B. Clarke* 12334 (B-C; F-CAL); Rishap, *C. B. Clarke* 12398 B (CAL); Darjeeling, *C.B. Clarke* 27007 C (CAL) & 27256 (A-BM, E-CAL); Darjeeling, Rungbee, *G. King* s.n. (CAL); Darjeeling, Lebong, *J.S. Gamble* 7181 (K); Darjeeling, Mongpoo, *C. B. Clarke* 36107 (K). Nagaland. Naga hills, *N. L. Bor* (CAL, ASSAM); Pulebudze, *N. L. Bor* 20770 (CAL, ASSAM); Pulebudze, *N. L. Bor* 6329

(K); Kohima, *Thakur Rupchand* 3245 (L). MYANMAR : Upper Burma, hills around Heawgaw, *George Forrest* s.n. (E); North Burma, North Triangle, *F. Kingdon-ward* 21201 (BM).

36. *O. roxburghiana* Wight, Icon. 3: 4. t. 1068. 1848 (*Type* : Shevagherry Hills, *Wight* s. n. holo K!); Hook. f. Fl. Brit. India 3: 81. 1880; R. Rao, Flower. Pl. Travanc. 207. 1914; Fyson, Fl. Nilgiris and Pulney Hill Tops 3: 63. 1920; Gamble, Fl. Pres. Madras 608. 1921.

(Fig.48)

Herbs, 60-100 cm tall; stems erect, suffrutescent, branched, young shoots densely pubescent. Leaves 4-13 × 1.5-6.4 cm, elliptic-lanceolate, acuminate at apex, acute at base, glabrous above, pubescent on the nerves beneath; lateral nerves 7-10 on either side; petioles 0.5-3.25 cm long, glabrous or puberulous; stipules 0.5-1.2 cm long, ovate-oblong or ovate-lanceolate, with acute apex, entire or bifid, glabrous. Inflorescence terminal corymbose cyme, 2.5-5 cm across, contracted, branches erect, densely pubescent; peduncles 1-5 cm long, elongating in fruits, densely pubescent. Flowers 23-40 mm long, white or pinkish white; bracts persistent, 1-1.3 cm long, linear-lanceolate, glabrous, sometimes pubescent at the margin; bracteoles persistent, 0.5-1 cm long, linear-lanceolate, glabrous or sometimes pubescent at the margin; pedicels 1-3 mm long, pubescent. Hypanthium 1.75-2.25 × 1.75-2 mm, obovoid, pubescent. Calyx lobes 3-3.5

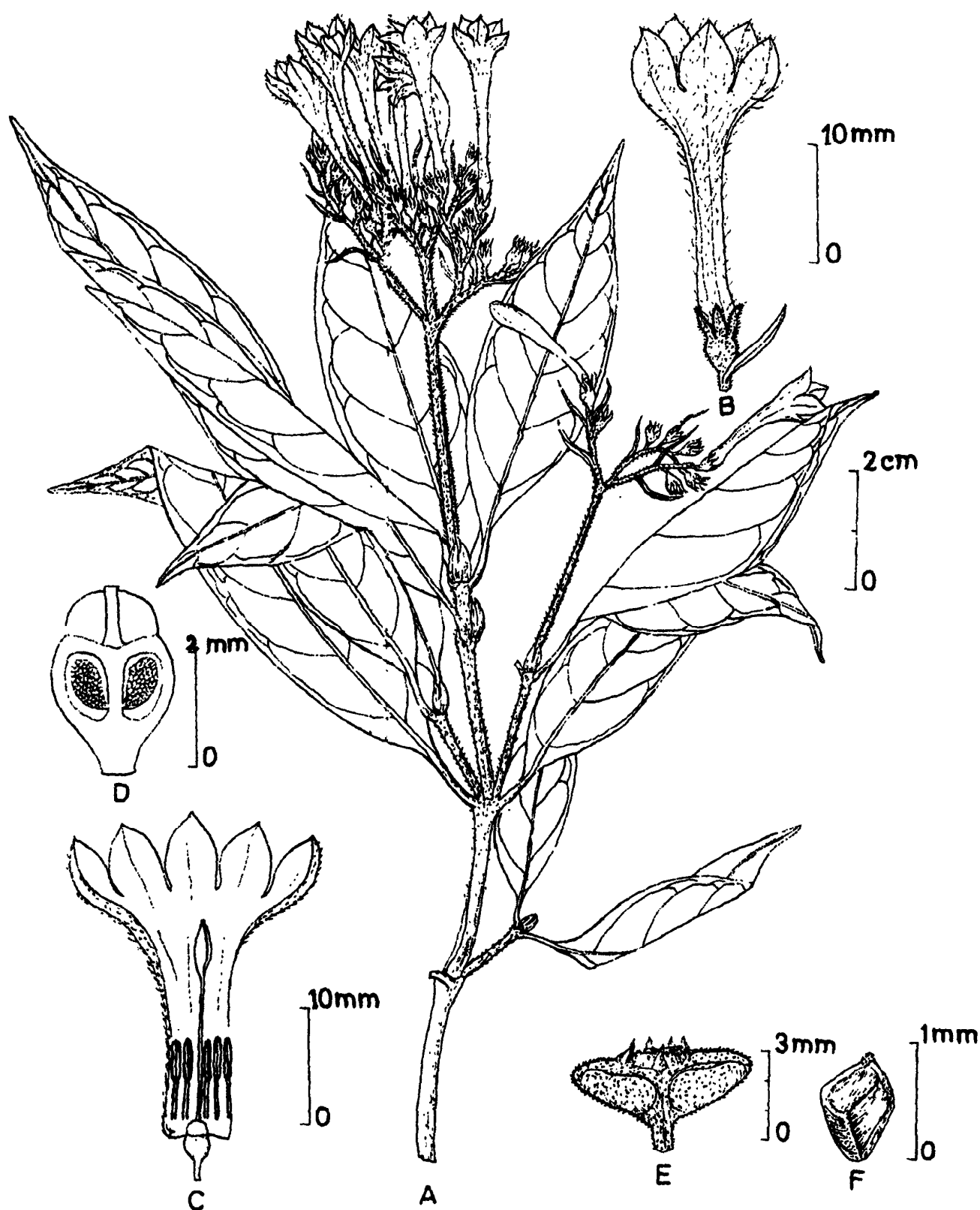


Fig.48. *O. roxburghiana* Wt.
A. habit; B. flower; C. flower split open; D. l.s. of ovary; E. fruiting; F. seed.

$\times 1.75$ -2 mm, lanceolate, acute to acuminate, pubescent. Corolla 21-38 mm long, infundibuliform, pubescent outside, usually glabrous, sometimes villous within; lobes $6-9 \times 4-5$ mm, broadly ovate, acute. Stamens adnate slightly above the base of corolla, inserted; filaments 1.75-2.25 mm long; anthers 3.5-4 mm long, linear-oblong. Ovary $1.6-2 \times 1.6-1.8$ mm, obovoid; disc 1 mm high; style half as long as corolla, slender, glabrous; stigma 2-lobed, 4.5-5.5 mm long, lobes linear-lanceolate, glabrous. Capsule $2-3 \times 5-6$ mm, pubescent, locules ovate-oblong, with straight tip. Seeds $0.6-0.75 \times 0.5-0.6$ mm, irregularly angular, glabrous, brown; wall of the areole thick with a few tubercles either on the wall proper or hooded over the areolar space.

Fl. : May-August.

Fr. : July-December.

Pollen : Suboblate, semicircular in polar outline, polar axis (P) \times equatorial axis (E) = $40-(43)-45 \times 50-(53)-56$ μ m, 3-colporate; colpi $37-40 \times 4$ μ m, tapering to acute ends; ora circular, 5-7.5 μ m in diameter, sexine 1.75 μ m, nexine 0.25 μ m, ruguloreticulate; lumina 0.75-1 μ m, muri 0.75-1 μ m.

Note : Wight (1848) stated that this is a native of the Shevagherry Hills but the label on one of his specimens deposited in MH shows Pulney Mts. September 1836. Hooker also mentioned it in his Flora of British India. But one of his (Wight's) specimens deposited in K indicates that it is of Shevagherry hills, 1835. May be that he collected it from both the places.

Distribution : Tamil Nadu, Kerala.

Ecology : Grows on moist soil in rocky slopes at 1050-1975 m above m.s.l.

Specimens examined : TAMIL NADU: Coimbatore dist. Anamalai hills, R. H. Beddome 66 (CAL) & R. H. Beddome 3617 (BM); Madurai dist.: Palni hills, Periyar shola, Bourne s.n. (CAL); Above Periyakulam, E. Barnes s.n. (K); Kodaicanal, Silver Cascade, D. C. Mondal & M. Ganguly 2437 (CAL); Tirunelveli Hills, R. H. Beddome 3618 (BM); Naterikal to Sengulteri, D. Hooper & M. S. Ramaswami 38619 (CAL). KERALA: Kottayam dist., Kulkundal, A. Meebold 13567 (CAL) & E. Barnes 1597 (K); Umaiya Malai-Devicolam, B. V. Shetty 28342 (CAL).

37. *O. rugosa* Wall. in Roxb. Fl. Ind. 2:547. 1824 (*Type* : Nepal, Shivapoor, 1821, Wall. Cat. 6235 CAL! K-W photo!); Bl. Bijdr. 976. 1826; DC. Prodr. 4: 416. 1830; G. Don, Gen. Syst. Gard. Bot. 3: 522. 1834; King & Gamble in Journ. Asiat. Soc. Beng. 72: 175. 1903; Ridley, Fl. Mal. Penins. 2: 40. 1923; H. Hara, Fl. E. Himal. 314. 1966, in synonym. *O. harrisiana* Heyne in Wt. & Arn. Prodr. 405. 1834; Hook. f. Fl. Brit. India. 3: 78. 1880.

Herbs annual or perennial, 5-60 cm long; stem creeping at the base, branched or unbranched, slender, pubescent. Leaves $1.5-11 \times 1-5$ cm, ovate, ovate-lanceolate or elliptic-lanceolate, obtuse, acute or

acuminate at apex, rounded, acute or tapering at base, glabrous or shining rugose and scabrous above, pubescent on the nerves beneath; lateral nerves 5-12 on either side; petioles 0.5-3 cm long, glabrous or puberulous; stipules persistent, 0.4-1 cm long, subulate or filiform from triangular base, bifid or entire. Inflorescence axillary or terminal corymbose or compound helicoid cyme, 1-3.5 cm across; branches short, suberect, contracted glabrous or pubescent; peduncles 2.5-6 cm long, elongating in fruits, glabrous or pubescent. Flowers 5-12 mm long, pinkish or white; bracts and bracteoles deciduous, 2-3 mm long, linear, glabrous or puberulous. Hypanthium $0.6-1.5 \times 0.5-1.75$ mm, obovoid, glabrous or puberulous. Calyx lobes $0.5-1.25 \times 0.25-1$ mm, triangular to subulate, acute, puberulous. Corolla 4-10.75 mm long, infundibuliform, slightly broader at base, puberulous or glabrous outside, villous at the middle or throat within; lobes $0.75-2.5 \times 0.5-1.75$ mm, ovate-lanceolate, sometimes triangular, spreading, slightly curved inward, acute at apex, slightly keeled at back. Stamens adnate slightly above the base of corolla, inserted; filaments 0.8-2 mm long; anthers 1-2 mm long, narrowly oblong. Ovary $0.5-1.25 \times 0.4-1.5$ mm, obovoid; disc 0.25-0.8 mm high; style as long as corolla tube or slightly shorter, glabrous or pubescent; stigma 2-lobed, 0.3-1.25 mm long, lobes ovate-lanceolate, glabrous. Capsules $1.75-2.5 \times 4-5$ mm, glabrous or puberulous,

locules ovate-oblong, tip straight or slightly inclined outwards. Seeds $0.2-0.4 \times 0.25-0.35$ mm, irregularly angular or sometimes 5-6 angular, glabrous, brown; wall of the areole thin with a number of tubercles on it or hooded over the areolar space.

Fl. : March-November.

Fr. : April-December.

Pollen : Oblate-spheroidal to prolate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = 17-(28) 36×18 -(29)-41 μ m, 3-or 4-colporate; colpi $14-30 \times 3-7 \mu$ m, tapering to acute ends; ora lolongate, $4-9 \times 3-7 \mu$ m or circular with wavy margin, 3-5 μ m in diameter, sexine 1.5-1.75 μ m, nexine 0.25 μ m, rugulo-reticulate; lumina 0.5-1 μ m, muri 0.5 μ m.

Note : Pollen grains vary greatly in size but the shape is more or less constant, oblate-spheroidal to prolate-spheroidal, dimorphic, either tri-or tetra-colporate, ora usually lolongate, a rare occurrence in this genus, sometimes circular with wavy margin.

Distribution : Nepal, Sikkim, West Bengal, Bihar, Orissa and Bangladesh to Myanmar and Thailand in the east, Malaya and Java in the south-east, from Andhra Pradesh to Sri Lanka and Nicobar Islands to the south and Maharashtra and Goa to the west.

Key to the varieties

- | | |
|---------------------------|------|
| 1a. Stem usually simple | ...2 |
| 1b. Stem usually branched | ...3 |

- 2a. Leaves ovate-lanceolate, acute to acuminate at both ends, scattered hairy above : ...*O. rugosa* var. *rugosa*
- 2b. Leaves broadly ovate, obtuse to subacute, rounded or subcordate at base, glabrous above : ...*O. rugosa* var. *prostrata*
- 3a. Leaves ovate or lanceolate, glabrous or short hairy above : ...4
- 3b. Leaves elliptic to narrow elliptic, obtuse or acute at apex, narrowed at base, glabrous above, brownish-green beneath : ...*O. rugosa* var. *decumbens*
- 4a. Leaves narrowly lanceolate, acute or acuminate at apex, acute at base, shining white beneath : ...*O. rugosa* var. *argentea*
- 4b. Leaves ovate to narrowly lanceolate, acute at apex, narrowed at base, greenish beneath : ...*O. rugosa* var. *merguensis*

***O. rugosa* Wall. var. *argentea* (Hook. f.)**
 Deb et Mondal in Bull. Bot. Surv. India. 24: 228. 1982; Deb, Fl. Tripura State 2: 75. 1983. *O. harrisiana* Heyne var. *argentea* Hook. f. Fl. Brit. Ind. 3: 78. 1880 (Type : Sylhet, *W. Gomez* s.n. in *Wall. Cat.* 6229 CAL! K!); *O. argentea* (Hook. f.) Balakr. Fl. Jowai 1: 247. 1981. (Fig.49)

Herbs, 8-50 cm long; stem erect from creeping base, glabrous or puberulous. Leaves 2-10 × 1-4.5 cm, narrowly lanceolate, acute or acuminate at apex, acute at base, shining white beneath, glabrous above; lateral nerves 6-10 on either side; petioles 0.5-2.5 cm long, glabrous or puberulous; stipules 0.4-0.8 cm long, subulate, entire or bifid. Inflorescence 1.5-3 cm across; peduncles 2.5-5 cm long,

glabrous or puberulous; Flowers 6-10 mm long, white with creamy yellow tinge or pinkish-white to rosy red; pedicels 0.5-1 mm long, glabrous or puberulous. Hypanthium 1-1.25 × 0.75-1 mm. Calyx lobes 0.75-1 × 0.4-0.6 mm. Corolla 5-8.25 mm long, infundibuliform, glabrous outside, villous at the middle within; lobes 0.75-1.25 × 0.75-1 mm. Filaments 1-1.5 mm long; anthers 1.25-1.75 mm long. Ovary 0.75-1 × 0.6-0.8 mm; disc 0.35-0.6 mm high; style 3.75-6.25 mm long, pubescent; stigma 0.75-1.25 mm long, lobes ovate to narrowly ovate, glabrous. Capsules 2-2.25 × 4-5 mm, glabrous. Seeds 0.2-0.3 × 0.25-0.3 mm.

Fl. & Fr. : March-December.

Distribution : Nepal and Sikkim, south eastwards to Myanmar. Thailand and Malay through Bangladesh, Meghalaya and all other eastern states of India, Andaman & Nicobar Islands, Karnataka and Sri Lanka to the south.

Specimens examined : INDIA: Meghalaya. Khasi Hills, Cherrapunji, *Schlagiantweit* s.n. (BM); Khasi Hills, *J. D. Hooker & T. Thomson* s.n. (CAL, K, BM); Mausmai, *C.B. Clarke* 43738 A (CAL); Jherria Ghat, *D. Hooper* 34712 (CAL); Pynursla, *A. S. Rao* 47489 (CAL). Assam. Cachar, *J. C. Prugla* 47 (CAL); Lakhimpur, *A. Meebold* 5693 (CAL); Kata Khal R. F., *R. S. Rao* 911 (CAL). Tripura. Sipaijala, *D. B. Deb*. 1772A (CAL). Arunachal Pradesh. *I.H. Burkill* 37380 (CAL); Kameng, Sissini, *G. Panigrahi* 6242

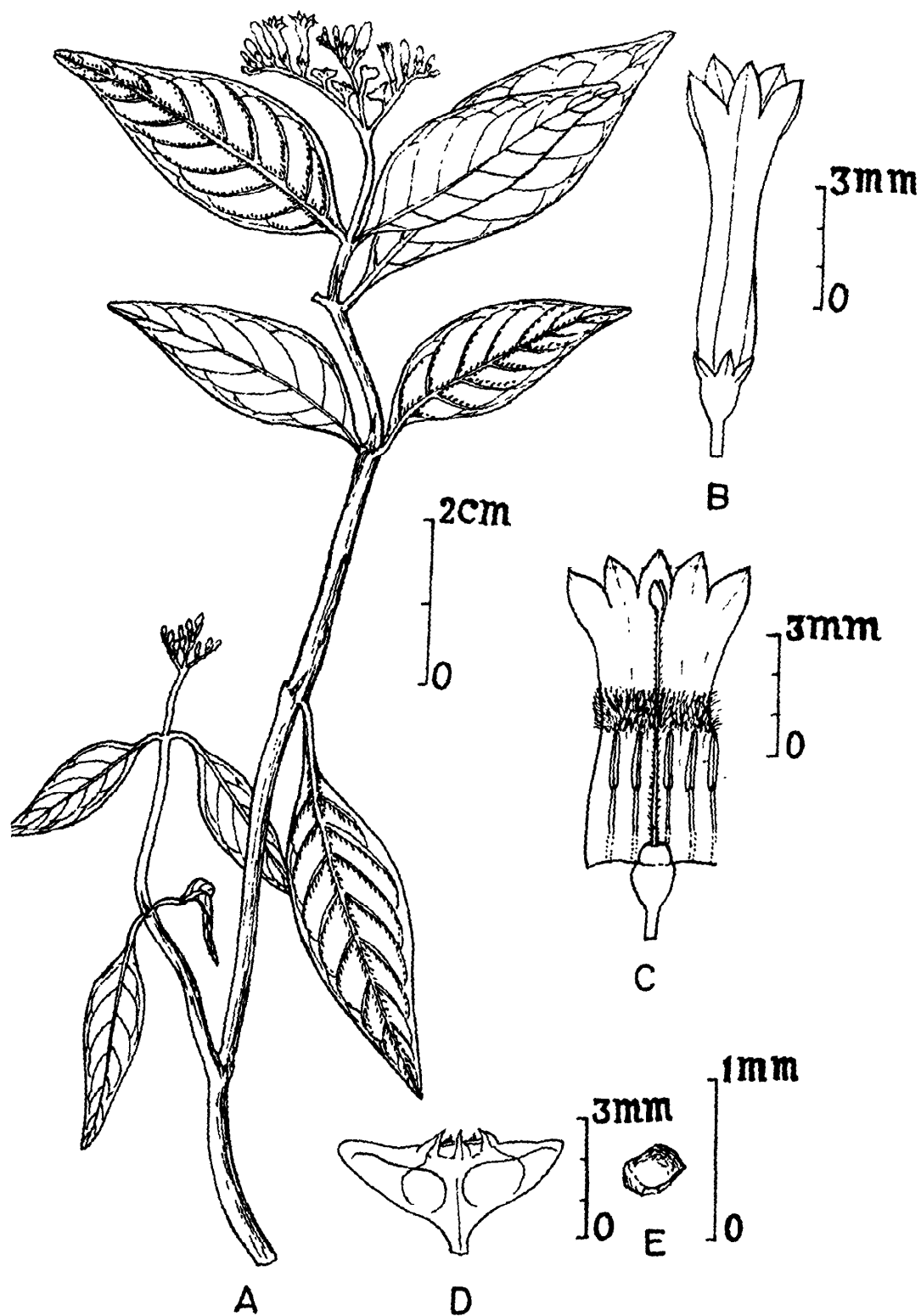


Fig.49. *O. rugosa* Wall. var. *argentea* (Hook.f.) Deb & Mondal
A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

& 6306 (CAL). Nagaland. Ghaspani, *N. L. Bor* 18482 (L). Mizoram Lungleh, *A. T. Gage* 188 (CAL). Lushai Hills, *N. E. Parry* 30 (CAL). Andaman & Nicobar Islands. Great Nicobar hills, *M. A. Ali* 47 (CAL). Karnataka. North Canara, Kutgal, *W. A. Talbot* 628 (CAL); Suddshalli Karwar, *L. J. Sedgwick & T. R. D. Bell* 6628 (CAL, K); North Canara, Sirsi, *L. J. Sedgwick & T. R. D. Bell* 7035 (CAL). BANGLADESH : Sylhet, *W. Gomez* s.n. in *Wall. Cat.* 6229 (CAL, K). MYANMAR: Boronga Island, Arracan, Mingoo hills, *S. Kurz* s.n. (CAL, BM); Kachin hills, *Shaik Mokim* s.n. (CAL). TENASSARIM : Agaye, *A. Meebold* (CAL); Eastern Tenassarim, *A.F.G. Kerr* 21609 (BM).

O. rugosa Wall. var. ***decumbens*** (Gardn. ex Thw.) Deb et Mondal in Bull. Bot. Surv. India. 24: 228. 1982. *O. decumbens* Gardn. ex Thw. Enum. 419. 1864 (Type: Sri Lanka) C. P. 1500 m, *Thwaites* C. P. 3656 A ! in CAL is designated as lectotype). *O. harrisiana* Heyne var. *decumbens* (Gardn. ex Thw.) Hook. f. Fl. Brit. India. 3: 78. 1880.

(Fig. 50)

Herbs, 7-30 cm long; stem decumbent, branching, puberulous. Leaves 2-8 × 1-2 cm, elliptic, or narrow elliptic, obtuse or acute at apex, narrowed at base, glabrous above, brownish green beneath; lateral nerves 6-9 on either side; petioles 0.5-1.5 cm long, puberulous; stipules 0.5-0.7 cm long, triangular, 1-2-toothed. Inflorescence 1-1.5 cm across; peduncles 2.5-4 cm long,

puberulous. Flowers 5-7 mm long; pedicels 0.7 mm long, puberulous. Hypanthium 0.8-1 × 0.6-0.8 mm. Calyx lobes 0.75-1 × 0.4-0.6 mm. Corolla 4.2-6 mm long, infundibuliform, puberulous outside, villous at the middle within; lobes 1.25-1.5 × 0.75-1 mm. Filaments 0.8-1.25 mm long; anthers 1-1.25 mm long. Ovary 0.7-0.9 × 0.5-0.75 mm; disc 0.25-0.5 mm high; style 3-5 mm long, glabrous; stigma 2-lobed, 0.75-1 mm long, lobes lanceolate. Capsule 2-2.5 × 4-4.5 mm, glabrous. Seeds 0.2-0.3 × 0.25 mm, glabrous, brown.

Fl. & Fr. : June-October.

Distribution : India. Kerala, Sri Lanka.

Specimens examined : INDIA: Kerala. Malabar, *Hocks & Law* s.n. (CAL). SRI LANKA: *Thwaites* C.P. 3656 (CAL).

O. rugosa Wall. var. ***merguensis*** (Hook. f.) Deb et Mondal in Bull. Bot. Surv. India. 24: 228. 1982. *O. harrisiana* Heyne var. *merguensis* Hook. f. Fl. Brit. Ind. 3: 78. 1880 (Type : Mergui-K photo!). (Fig. 51)

Herbs 10-25 cm tall; stems erect, rooting below, pubescent. Leaves 2-6 × 1-3 cm, ovate or narrowly lanceolate, acute at apex, narrowed at base, greenish beneath; lateral nerves 6-9 on either side; petioles 0.5-2 cm long, pubescent; stipules 0.4-0.7 cm long, triangular, entire or bifid. Inflorescence 1-3 cm across; peduncle 2.5-3 cm long, tomentose. Flowers 6-9 mm long; pedicels 0.5-0.75 mm long. Hypanthium 1-1.25 × 0.75-1 mm. Calyx lobes 0.5-0.75 × 0.25-

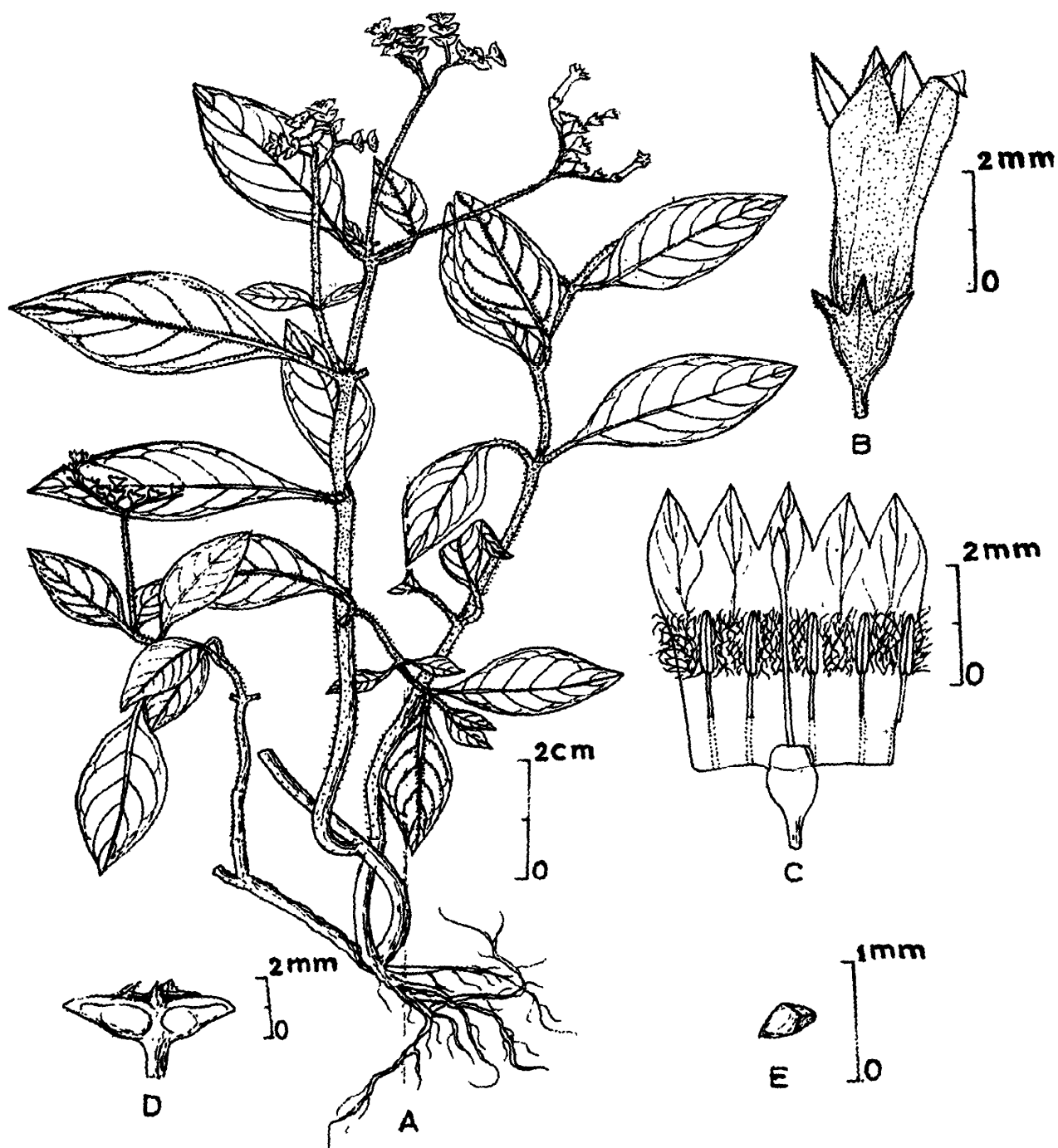


Fig.50. *O. rugosa* Wall. var. *decumbens* (Gardn. ex Thw.) Deb et Mondal
A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

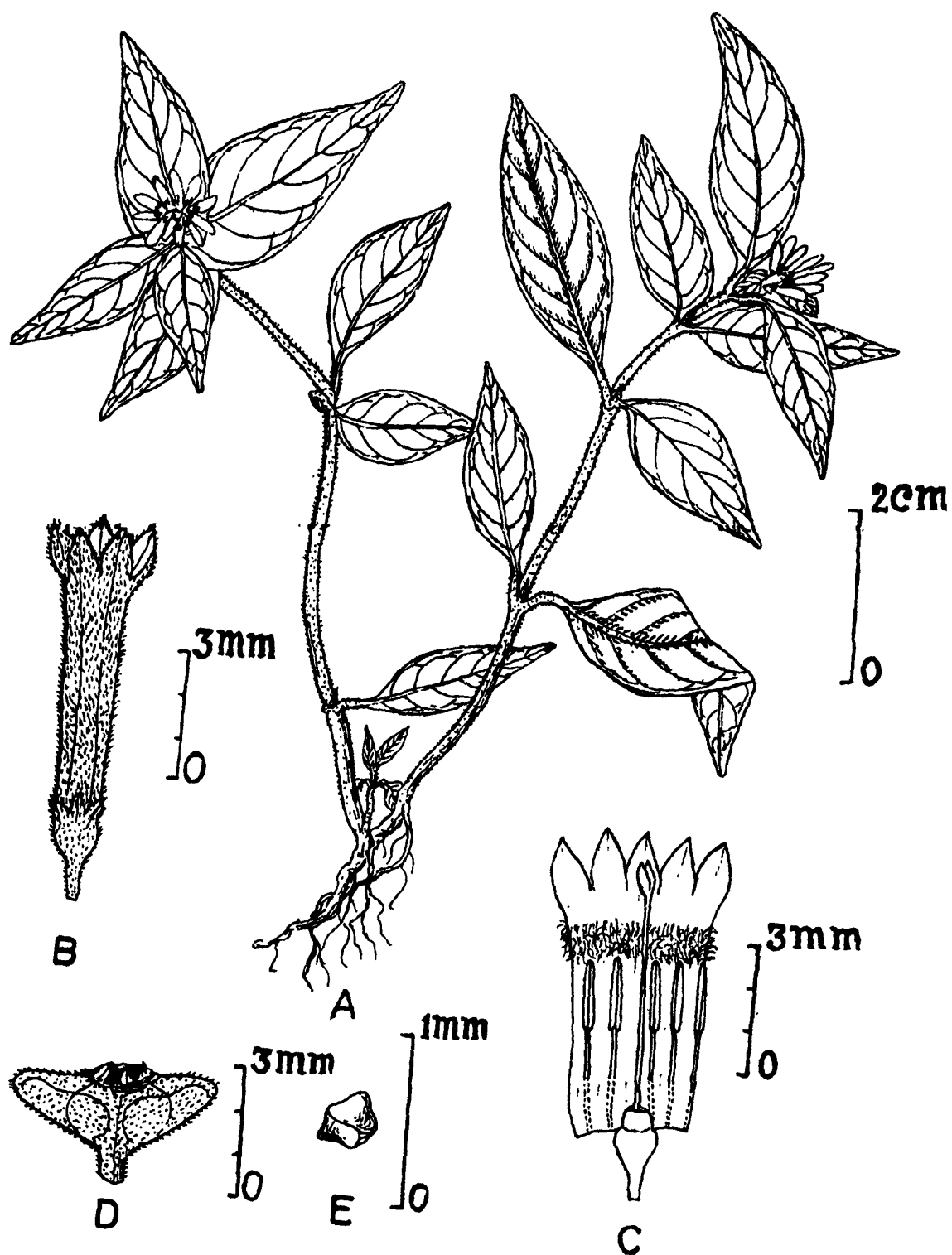


Fig.51. *O. rugosa* Wall. var. *merguensis* (Hook.f.) Deb et Mondal
 A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

0.4 mm. Corolla 5-7.5 mm long, infundibuliform, tomentose outside, villous at the throat within; lobes 1.25-1.5 × 0.5-0.85 mm. Filaments 1.25-1.5 mm long; anthers 1.25-1.6 mm long. Ovary 0.75-1 × 0.6-0.8 mm; disc 0.3-0.5 mm high; style as long as corolla tube; stigma 0.5-0.85 mm long, lobes ovate-lanceolate. Capsule 1.75-2 × 4-4.5 mm, pubescent. Seeds 0.2-0.3 × 0.25-0.3 mm, glabrous, brown.

Fl. & Fr. : March September.

Distribution : Myanmar : Mergui, Rangoon.

Note : Hooker, f. (*l.c.*) cited its occurrence in Nilgherries. Distribution of the variety concerned raises doubt about its occurrence there.

Specimens examined : MYANMAR: Rangoon, C.W. 122 (CAL) ; Mergui, Manglow, A. Meebold 14893 (CAL); Maymyo plateau, A. E. English 45 (E).

O. rugosa Wall. var. **prostrata** (D. Don) Deb et Mondal in Bull. Bot. Surv. India 24: 228. 1982. *O. prostrata* D. Don, Prodr. Fl. Nep. 136. 1825 (*Type* : Nepal, 1813, B. Hamilton s.n. BM, not seen); DC. Prodr. 4: 415. 1830; G. Don, Gen. Syst. Gard. Bot. 3: 522. 1834; Sant. & Marchant in Bull. Bot. Surv. India 3(2) : 109. 1961; H. Hara, Fl. E. Himal. 313. 1966 (*Wall. Cat.* citation erroneous). *O. harrisonii* G. Don, Gen. Syst. Gard. Bot. 3: 523. 1834 (*Type* : Malacca, S. Harris s.n. herb. Heyne s.n. in *Wall. Cat.* 6236 CAL! K!); Trimen, Fl. Ceylon 2: 321.

1895; Cooke, Fl. Pres. Bombay 1: 596. 1903; Gamble, Fl. Pres. Madras 607. 1921; Haines, Bot. Bihar Orissa 443. 1922. (Fig. 52)

Herbs, 7-46 cm long; stem prostrate, rooting at lower nodes, glabrous or rarely puberulous. Leaves 1.5-5 × 1-2 cm, broadly ovate, obtuse to subacute at apex, rounded or subcordate at base, glabrous; lateral nerves 5-7 on either side; petioles 0.5-1 cm long, glabrous or puberulous; stipules 0.3-0.6 cm long, filiform from a triangular base, entire or bifid. Inflorescence 1-2 cm across; peduncle 2.5-3 cm long, glabrous or puberulous. Flowers 8-10 mm long, pale pink; pedicels 0.5-1 mm long. Hypanthium 0.6-1 × 0.5-9 mm. Calyx lobes 0.6-1 × 0.35-0.75 mm. Corolla 7-9 mm long, infundibuliform, glabrous outside, villous at the throat within; lobes 1.25-1.75 × 0.75-1 mm. Filaments 1.75-2 mm long; anthers 1.75-2 mm long. Ovary 0.5-0.8 × 0.4-0.75 mm; disc 0.5-0.75 mm high; style 4.5-7 mm long; stigma 0.3-0.5 mm long, lobes ovate-lanceolate. Capsule 2-2.25 × 4-4.5 mm, glabrous. Seeds 0.2-0.3 × 0.3-0.35 mm, glabrous, brown.

Fl. & Fr. : April-November.

Distribution : Nepal, Bhutan, Bihar and Orissa to Malay through Myanmar and Maharashtra, Goa, Tamil Nadu And Kerala to Sri Lanka.

Specimens examined : INDIA: Bihar, Saranda forest, Srivastava 75210 (LWG). Orissa. Baripada, Meghasni forest, S.L.

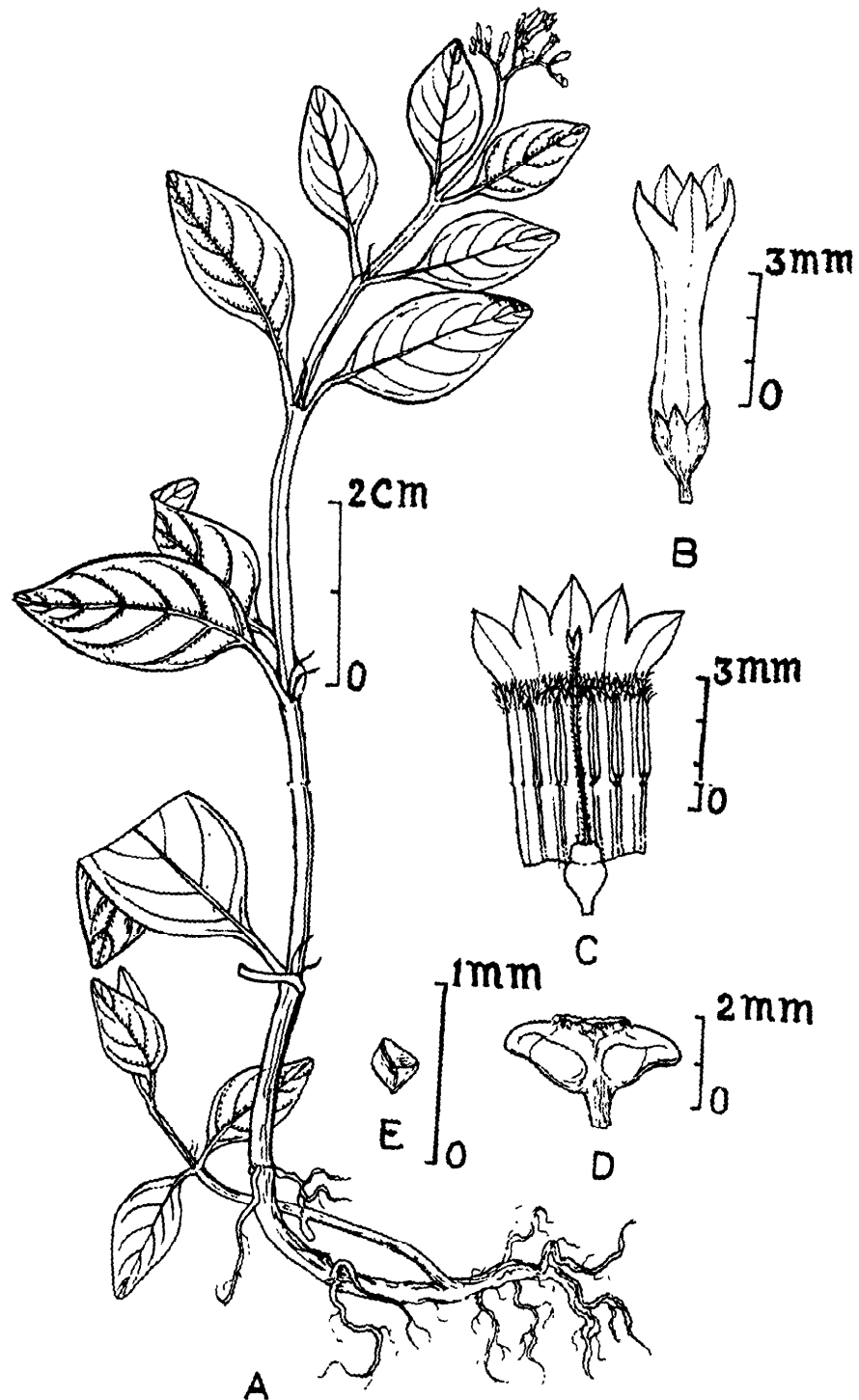


Fig.52. *O. rugosa* Wall. var. *prostrata* (D. Don) Deb & Mondal

A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

Kapoor 73359 (E. LWG). Andhra Pradesh. Godavary Jungles, *R. W. Indu* s.n. (CAL). Tamil Nadu : Kanyakumari, Kilavirumalai, *A.N. Henry* 48134 (CAL, MH). Madras. *Blatter & Hallberg* 203 (CAL); Madura, *K.C. Jacob* 17640 (CAL, MH); Nilgiri, *Thomson* s.n. (CAL); Tirunelveli, Courtallum, *Wight* s.n. (Kew Distrib. No. 365) (E); Siruvani, *A. N. Henry* 511 (CAL, MH). Kerala. Palghat, Silent Valley R.F., *E. Vajravelu* 26058 (CAL, MH); *R. Ansari* 51489 (CAL, MH); Trivandrum, Bonaccord Estate, *J. Joseph* 44492 (CAL, MH); South Malabar, Dhoni, *C. E. C. Fischer* 1996 (CAL); Donmudi Hills, *E. Barnes* 1190 (K). Karnataka. Garsappa falls, *A. Meebold* 9931 (CAL); Castle Rock, *L. S. Sedgwick* 2736 (CAL); North Canara, Yellapur, *R. W. Indu* s.n. (K); South Canara, Sullia, *C. A. Barber* 2130 (CAL, MH); Gundier, *A. Meebold* 9932 (CAL); Balchalley State forest, Augumbe, *K. S. Srinivasan* s.n. (BSIS). Maharashtra. Katlekan evergreen forest, *J. Fernandes* 1940 (CAL); Poona, Kalapani forest, *B. Venkata Reddi* 96020 (BSI). Goa. *N. P. Singh* 124588 (BSI); Usgao, *R. S. Raghavan* 103424 A (BSI). NEPAL : Gokarna, *P. Pradhan & R. Thapa* 4530 (CAL). BHUTAN : Trashmangstchu : *F. Ludlow, G. Sherriff & J. H. Hicks* 20482 (BM). MYANMAR : Kachin Hills, Kingting, *Shaik Mokim* s.n. (CAL); Juonugoo, *A. Reeuger* s.n. (CAL). MALAYA : Malacca, *S. Haris* s.n. ex Wall. Cat. 6236 (CAL, K).

O. rugosa Wall. var. **rugosa**. Hook. f. Fl. Brit. India 3: 78. 1880. (Fig. 53)

Herbs, 5-60 cm long; stem ascending from creeping base, pubescent. Leaves 2-8 × 1-5 cm, ovate to ovate-lanceolate, acuminate at base and apex, scattered, hairy above; lateral nerves 6-10 on either side; petioles 0.5-3 cm long, pubescent; stipules 0.7-1 cm long, filiform from a triangular base, entire or 2-fid. Inflorescence 1-2 cm across; peduncles 3-6 cm long, pubescent. Flowers 7.25-11.25 mm long, white or pinkish-white; pedicels 0.5-1 mm long. Hypanthium 1-1.5 × 1.25-1.75 mm. Calyx lobes 1-1.25 × 0.75-1 mm. Corolla 6.25-10 mm long, infundibuliform, puberulous outside, villous at the throat within; lobes 1.75-2.5 × 1.25-1.75 mm. Filaments 1-1.5 mm long; anthers 1-1.75 mm long. Ovary 0.8-1.25 × 1-1.5 mm; disc 0.5-0.8 mm high; style 5-6 mm long; stigma 0.5-0.8 mm long, lobes lanceolate. Capsules 2-2.5 × 4-5 mm, glabrous. Seeds 0.2-0.4 × 0.25-0.35 mm.

Fl. : May-August.

Fr. : June-October.

Distribution : Nepal, Sikkim, West Bengal (Darjeeling district) to Meghalaya, Nagaland and Myanmar in the east and Malay and Java in the south-east.

Specimens examined : INDIA: Sikkim. Nagree, *T. Anderson* 526 (CAL); Sinchung, *T. Anderson* 671 (CAL); Tumblong, *G. A. Gammie* 240 (CAL); Slik, *Ribu* 888 (CAL); Karponang, *W. W. Smith* 3040 (CAL); Changu, *W. W. Smith* 3248 (CAL); Karponang, *Bor & Kirat Ram* 20743 (DD). West Bengal. Darjeeling dist., Rungbee, *C. B. Clarke* 12211 B (CAL); Suriel, *K. Biswas*

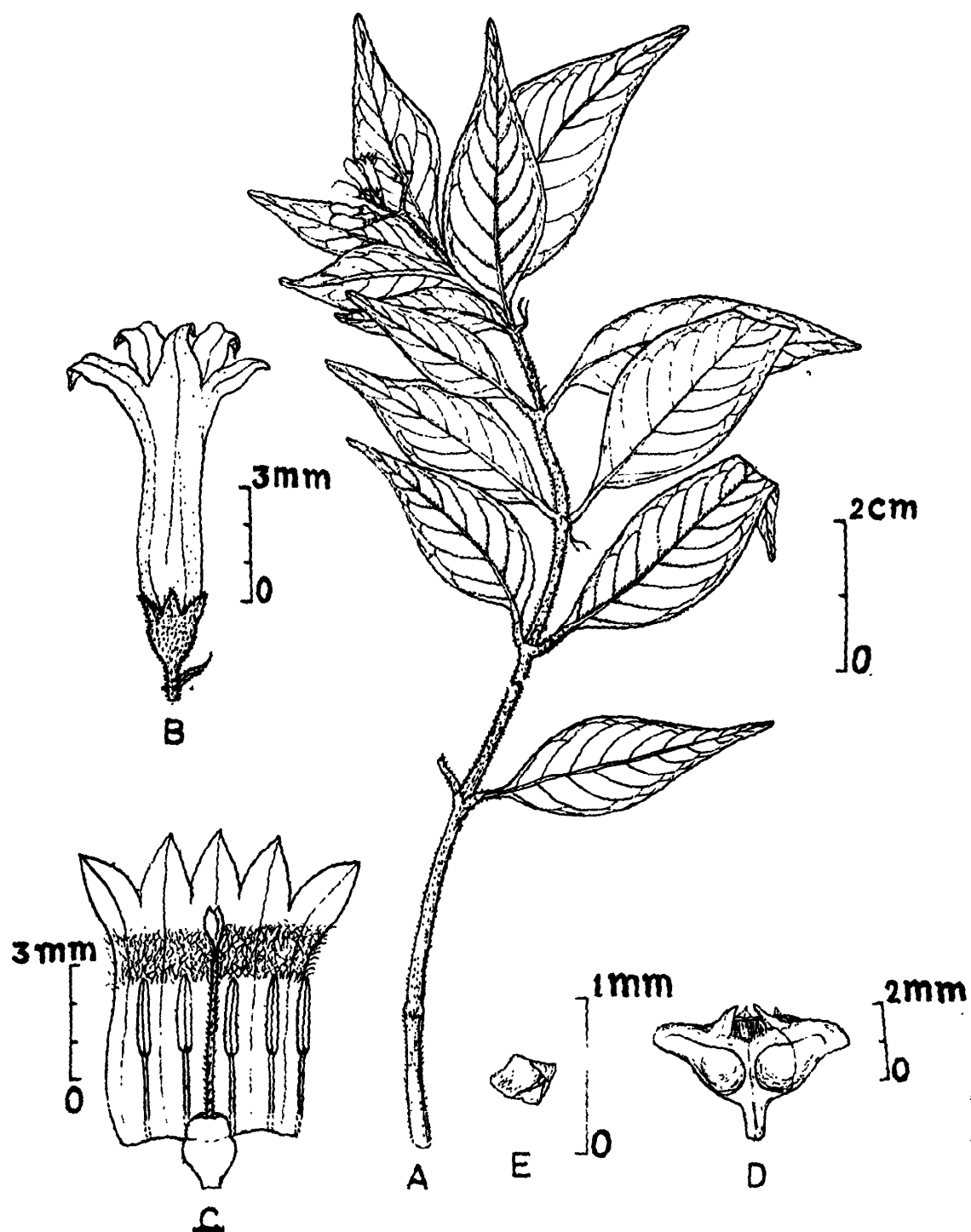


Fig.53. *O. rugosa* Wall. var. *rugosa*
 A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

7450 (CAL); Senchal lake, *D. Das* 143 (CAL). Meghalaya. Khasi & Jaintia Hills, Surarim, *I. H. Burkill & S. C. Banerjee* 142 (CAL); Maslamang, *I. H. Burkill & S. C. Banerjee* 292 (CAL); Jherria ghat, *D. Hooper* 34712 (BSIS); Pynursla, *A.S. Rao* 47489 (CAL). Nagaland. Chudama, *D. Prain* s.n. (CAL, BSIS); Konoma, *G. Watt* 11701 (BSIS). NEPAL : *Wall. Cat.* 6235 (K, CAL); Pahung to Topkegola, *S.C. Banerjee* 778 (CAL). MYANMAR : Htawgaw Bum, *G. Forrest* s.n. (E).

38. ***O. subcapitata*** Wall. ex Hook. f. *Fl. Brit. India.* 3:83. 1880 (*Type* : Sylhet, *W. Gomez* s.n. in *Wall. Cat.* 6238! iso. CAL, BM. *Type locality* Sylhet appears to be erroneous. Probably the type was collected from Khasi or Jaintia [Jowai] Hills by *W. Gomez* who resided at Sylhet wherefrom it was sent to Wallich); *Kanjilal et al.*, *Fl. Assam* 3:42. 1939; *Balakar. Fl. Jowai* 1:248. 1981; *Deb & Mondal in Nayar & Sastry, Red Data Book Ind. Pl.* 2:229. fig.1. 1988.

(Fig.54)

Herbs, 15-30 cm long; stems ascending from creeping base, slender, branching, hirsute. Leaves $3.5-15 \times 1.5-5$ cm, elliptic to elliptic-lanceolate, acuminate at apex, slightly tapering at base, hirsute; lateral nerves 5-14 on either side; petioles 1-2.5 cm long, hirsute; stipules 5-7 mm long, ovate, acuminate, entire, hirsute at margin and midrib. Inflorescence terminal sub-capitate cymes, 0.8-1.8 cm across, contracted, hirsute;

peduncles 2-5.5 cm long, slender, hirsute. Flowers 5-7 mm long, white or pale green; bracts and bracteoles similar, persistent, concealing the flowers, $5.5-9 \times 2-3.5$ mm, lanceolate, obtuse, pinkish when dry, ciliate; pedicels 1-1.75 mm long, hirsute. Hypanthium $1-1.25 \times 0.75-1$ mm, obovoid, hirsute. Calyx lobes $0.8-1.2 \times 0.5-0.6$ mm, ovate-lanceolate, acute, ciliate. Corolla 4-5.75 mm long, broad at base, narrowing upwards, glabrous outside, villous at the throat within; lobes $1-1.3 \times 0.7-0.9$ mm, ovate-lanceolate, spreading, acute, hirsute at back. Stamens adnate to the throat of corolla or slightly below, scarcely exerted, filaments 1-1.3 mm long; anthers 0.9-1.2 mm long, linear-oblong. Ovary $0.8-1 \times 0.6-0.8$ mm, obovoid; disc 0.5 mm high; style 1.8-2.2 mm long, glabrous; stigma capitate, $0.6-0.7 \times 0.4-0.5$ mm, hirsute. Capsules $1.5-1.75 \times 4-4.75$ mm, glabrous, locules ovate-oblong with straight tip. Seeds $0.35-0.5 \times 0.3-0.5$ mm, 5-6-angular, glabrous, brown; areoles 4-6-gonal, wall of the areole moderately thick with a number of tubercles.

Fl. & Fr. : May-October.

Pollen Oblate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = $26-(28)-30 \times 29-(30)-32 \mu\text{m}$, 3-colporate, colpi $24-26 \times 3.5-4 \mu\text{m}$, tapering to acute ends; ora circular, 5 μm in diameter; sexine 2 μm , nexine 0.25 μm , ruguloreticulate; lumina 0.75-1 μm , muri 0.5-0.75 μm .

Distribution : Meghalaya.

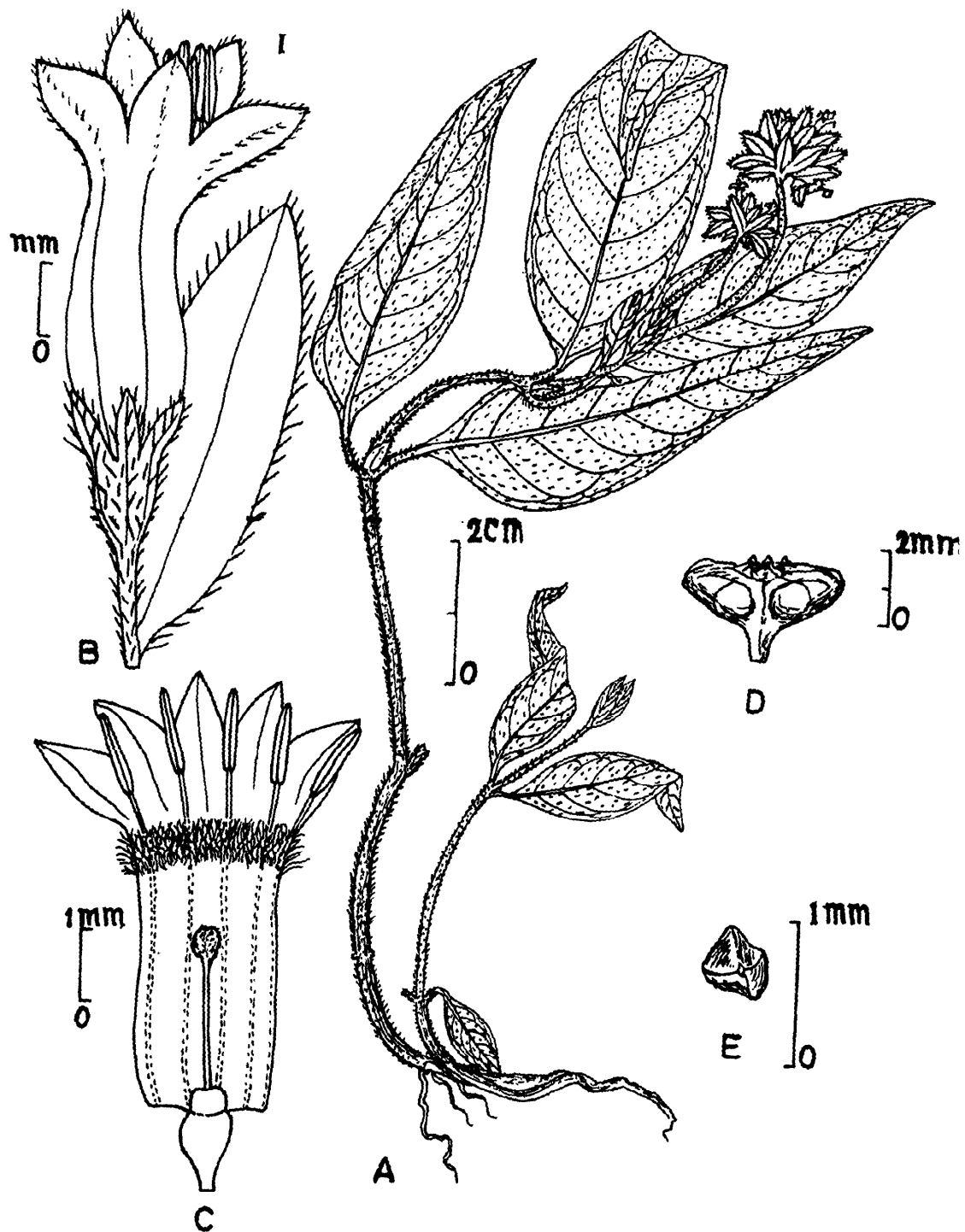


Fig. 54. *O. subcapitata* Wall. ex Hook.f.
A. habit; B. flower; C. flower split open; E. & D. fruiting; E. seed.

Ecology : Grows on moist shaded places in the forest near streams at 900-1600m, above m.s.l.

Specimens examined : MEGHALAYA: Khasi hills, *J.D. Hooker & T. Thomson* s.n. (K, BM, CAL, MH); Mausermai, *R. K. Das* 34956 (CAL); Pynursla, *W. W. Koelz* 23421 (L); Jaintia hills, *N.P. Balakrishnan* 42550 (CAL).

Note : Probably all the collections were made from Jaintia Hills where the natural habitats are being destructed for development activities. Efforts should be made to collect the plant and grow it in Botanic gardens.

39. **O. succirubra** King ex Hook. f. *Fl. Brit. India* 3: 82. 1880 (*Type* : Mungpoo, 1500-1800 m, *J. D. Hooker* OPHIORRHIZA 17! Syntype K, CAL); C.B. Clarke in *Journ. Linn. Soc. Bot.* 25 : 31. 1887; H. Hara, *Fl. E. Himalaya* 314. 1966; Mukerjee *et al.* in *Rec. Bot. Surv. India* 20(2): 120. 1973; Balakr. *Fl. Jowai* 1: 248. 1981; Deb. *Fl. Tripura State* 2: 75. 1983. (Fig.55)

Herbs, 50-75 cm tall; stems erect, somewhat woody at base, branched, glabrous. Leaves 4-20 × 2-8 cm, elliptic to elliptic-lanceolate, sometimes elliptic-oblong, acuminate at apex, acute at base, glabrous, purple beneath on drying; lateral nerves 8-13 on either side; petioles 1-3 cm long, glabrous; stipules 5-7 mm long, broadly lanceolate, entire or bifid, glabrous. Inflorescence terminal corymbose cymes, 2.5-3 cm across, contracted, at first drooping then erect,

glabrous, sometimes puberulous; peduncles 1-3 cm long, glabrous or puberulous. Flowers, 10-15 mm long, pink or white; bracts persistent, 0.7-1 cm long, lanceolate, acute, glabrous with prominent midrib; bracteoles persistent, 0.6-0.8 cm long, linear-lanceolate, acute, glabrous; pedicels 1.5 mm long, glabrous or puberulous. Hypanthium 1-1.75 × 1.5-2 mm, broadly trapezoid, glabrous or puberulous. Calyx lobes 1-1.25 × 0.75-1 mm, triangular, obtuse, glabrous or puberulous. Corolla 9-13 mm long, infundibuliform, glabrous; lobes 2-2.75 × 1.5-2 mm, ovate, acute, shortly keeled at back. Stamens adnate at the middle of corolla-tube or slightly below, inserted; filaments 1-1.5 mm long; anthers 2-4 mm long, oblong-linear. Ovary 0.75-1.25 × 1.5-1.8 mm, broadly obovoid; disc 0.75-1 mm high; style 4-6 mm long, glabrous; stigma deeply 2-lobed, 1.5-2.5 mm long, lobes lanceolate to linear-lanceolate, pubescent. Capsule 2.25-3.5 mm × 6-9 mm, glabrous or puberulous, locules ovate-oblong, tip slightly inclined outwards. Seeds 0.5-0.75 × 0.4-0.5 mm, 5-6-angular, glabrous, brown, wall of the areole thick with a number of tubercles on it and in the areolar space.

Fl. & Fr. : Throughout the year.

Pollen : Oblate spheroidal, angular in polar outline, polar axis (P) × equatorial axis (E) = 30-(33)-42 × 30-(37)-57 μm, 3-colporate; colpi 28-40 × 5-8 μm, tapering to acute ends; ora circular, 4-5.5 μm in diameter; sexine 1.75 μm, nexine 0.25 μm, ruguloreticulate; lumina 0.5-1 μm, muri 0.5 μm.

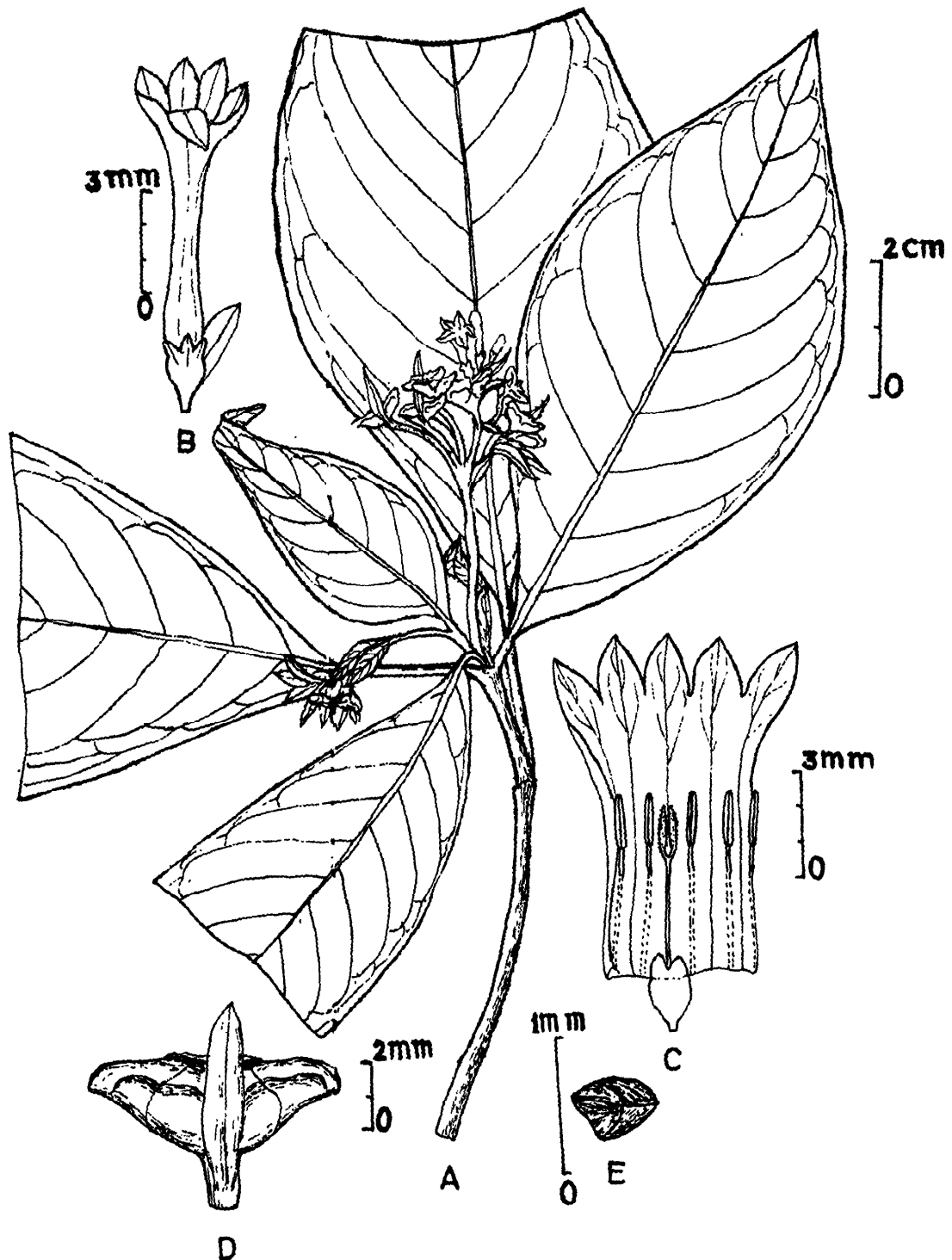


Fig. 55. *O. succirubra* King ex Hook. f.
A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

Note : The colour of leaves particularly the lower surface becomes deep purple on drying. Pollen grains vary greatly in size but the shape is constant.

Distribution Sikkim and West Bengal to Myanmar through Meghalaya, Assam and all other states of eastern India.

Ecology : Grows on clayey soil up to 2400 m in altitude.

Specimens examined : INDIA. Sikkim, *G. King* s.n. (CAL). West Bengal. Darjeeling dist, Rungbee, *C.B. Clarke* 12160 (B, C, D, E-CAL, F-BM); Sormpahar, *C. B. Clarke* 27563 A (CAL); Mungpoo, *C. B. Clarke* 36462 (BM); Rumbhijhora, *W. W. Smith* 351 (CAL); Sonada, *G. H. Cave* s.n. (E); Darjeeling, *S.K. Mukherjee* 873 (CAL). Meghalaya. Garo hills, Phulbari, *W.N. Koelz* 25112 (L), Assam. Nowgong dist, Doboka Reserve forest, *N.P. Balakrishnan* 39479 (CAL). Arunachal Pradesh. Lohit dist, Mawaito Nathai, *J. Joseph* 48831 (CAL); Tirap dist, Lansang forest (Kothong), *D. B. Deb* 21622 (CAL, ASSAM). Nagaland. Kohima, *C. B. Clarke* 41050 (CAL); Kohima, *C. B. Clarke* 41062A (K); Kohima, *D. Prain* s.n. (CAL). Mizoram. Mizo Hills, *R.M. Datta* 33809 (CAL). Tripura. Chandrapur reserve, *D.B. Deb* (CAL); MYANMAR: Tenasserim division, Moolyet, *G. Gallatly* 184 (CAL).

40. *O. thomsonii* Hook. f. Fl. Brit. Ind. 3: 82. 1880 (*Type* : Darjeeling, Griffith s. n. ! K, CAL; Sikkim, 1200-1800 m, *J. D. Hooker* s. n. ! K, CAL; Sikkim,

21.7.1857; *T. Thomson* s.n. K); Hara, Fl. E. Himal. 314. 1966. (Fig. 56)

Herbs perennial, 15-60 cm tall; stem erect, with creeping base, slender, glabrous. Leaves 2-12.5 × 1-4 cm, ovate, ovate-elliptic or sometimes ovate-lanceolate, subacute to acute at apex, obtuse to acute at base, glabrous above, puberulous on the nerves beneath; lateral nerves 5-10 on either side; petioles 0.5-1.8 cm long, slender, puberulous; stipules 3-8 mm long, narrowly linear with broad base, entire, glabrous or puberulous. Inflorescence terminal and axillary corymbose cymes, 1.2-2 cm across, branches spreading, suberect, glabrous; peduncles 1-6 cm long; slender, glabrous. Flowers 5-12 mm long, white or pale pink; bracts and bracteoles similar, persistent, 3-7 mm long, linear, acute, glabrous; pedicels 1-1.5 mm long, glabrous. Hypanthium 0.75-1.25 × 0.6-0.8 mm, obovoid, puberulous. Calyx lobes 0.4-0.6 × 0.3-0.4 mm, subulate, acute, puberulous. Corolla 4.25-10.75 mm long, infundibuliform, tube short, glabrous outside, glabrous or sometimes a villous ring at the middle within; lobes 1.5-1.8 × 0.75-1.25 mm, broadly ovate, acute, shortly keeled at back, glabrous. Stamens adnate to base of corolla or slightly above, inserted; filaments 1.5-2 mm long, glabrous; anthers 1.25-1.5 mm long; oblong-linear. Ovary 0.6-1 × 0.5-0.75 mm, obovoid to subglobose; disc 0.3-0.75 mm high; style as long as corolla tube, slender, glabrous, stigma bilobed, 0.75-1 mm long,

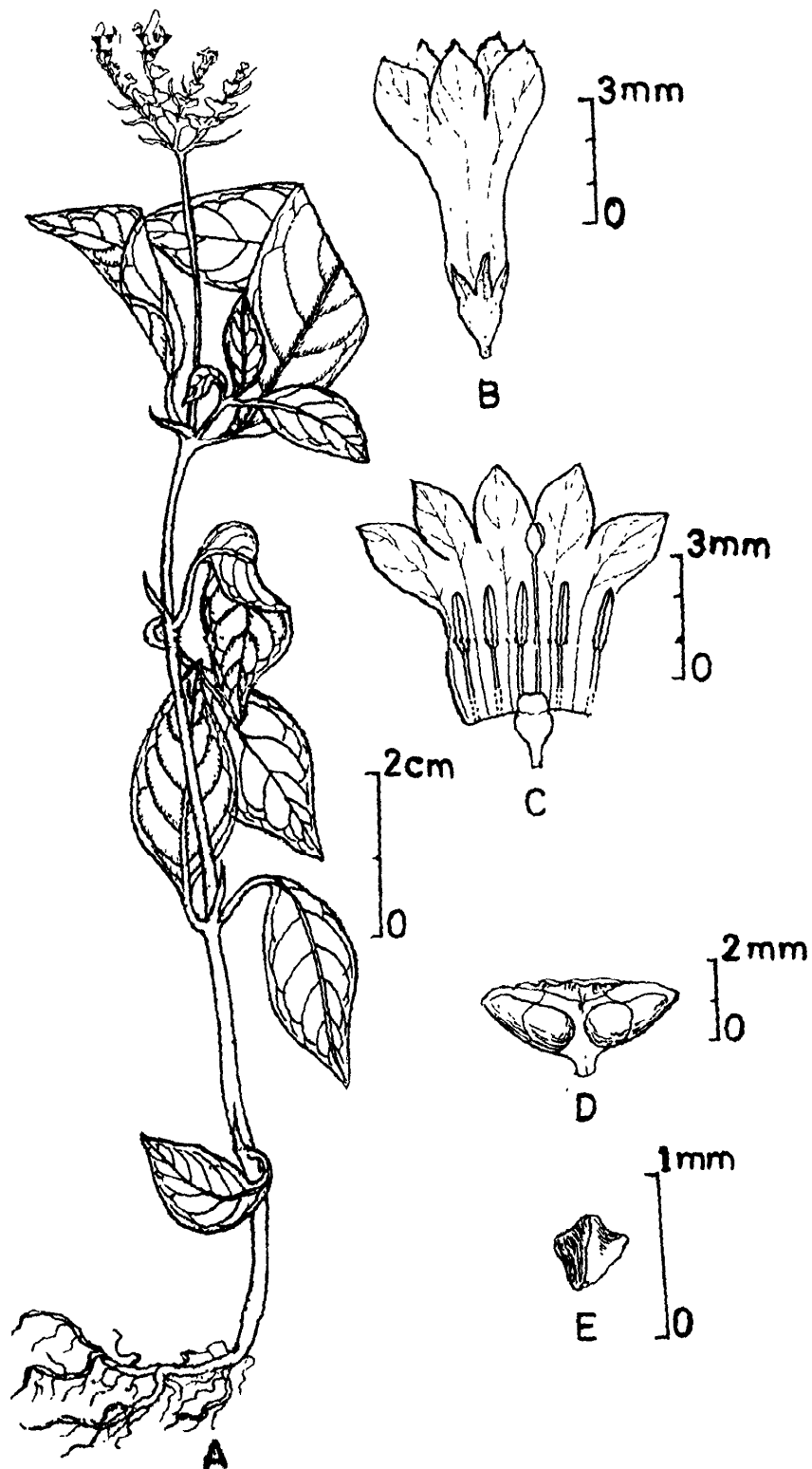


Fig.56. *O. thomsonii* Hook. f.
A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

lobes lanceolate, acute, glabrous. Capsule $1.5-2 \times 3-6$ mm, glabrous, locules ovate-oblong with straight tip. Seeds $0.3-0.5 \times 0.4-0.5$ mm, irregularly angular, glabrous, brown wall of the areole moderately thin with a number of tubercles on it and hooded over the areolar space.

Fl.: January-September.

Fr.: July-November.

Pollen : Oblate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = $30-(31)-32 \times 32-(34)-35$ μ m, 3-colporate; colpi $28-30 \times 4-6$ μ m, tapering to acute ends; ora circular, $5-7$ μ m in diameter; sexine 1.75 μ m, nexine 0.25 μ m, ruguloreticulate; lumina $0.5-0.75$ μ m, muri 0.5 μ m.

Distribution : India, West Bengal, Manipur; Nepal, Bhutan, Myanmar.

Ecology : Grown on moist soil in stone crevices under shade at 1200-2100 m above m.s.l.

Specimens examined INDIA : Manipur. Ukhrul, *F. Kingdon-Ward* 17539 (BM). Sikkim. *G. King* 925 (CAL) & 4722 (CAL); Gangtok, *Bor & Kiratram* 20613 (DD); Gangtok, *H. Hara et al.* 1274 (BM); Gangtok, *N.C. Majumdar & R.N. Banerjee* 316 (CAL). West Bengal. Darjeeling, Kurseong, *J.S. Gamble* 3748 A (K) & *C.B. Clarke* 35589 A & B (CAL); Darjeeling, Laketoni *J.M. Cowan* s.n. (E); Kalimpong, Dobpehan reserve forest, *K.P. Srivastava & A. Singh* 62720 (LWG). BHUTAN : Dumsong, *C.B. Clarke* 26407 A (BM).

MYANMAR: Mt. Victoria, *R.E. Cooper* 5963 A (E); NEPAL: Bongakhani, *Stainton, Sykes & Williams* 3956 (E, CAL); Godavari, Kathmandu valley, *A.D. Schilling* 572 (K).

41. *O. tingens* C.B. Clarke ex C.E.C. Fischer in Kew Bull. 1940: 33. 1940 (*Type* : Naga Hills, Kohima, 1740 m 24th October 1885, *C.B. Clarke* 41121 A! holo -K. iso. CAL); Deb, Fl. Tripura State 2:76:1983. Deb & Mondal in Nayar & Sastry, Red Data Book Ind. Pl. 2 : 231. fig.1. 1988. (Fig.57)

Herbs, 30-150 cm tall, sometimes undershrubs; stems erect, sometimes trailing, simple or branched, terete, somewhat woody glabrous below, puberulous above. Leaves $2.5-17 \times 1-6$ cm. lanceolate or broadly ovate-lanceolate, acute to caudate acuminate at apex, tapering, more or less decurrent at base, dark brown, glabrous or scattered short hairy above, pale or reddish, puberulous on the nerves beneath; lateral nerves 7-14 on either side; petioles 1.5-4 cm long, pubescent; stipules persistent, 2.5-10 mm long, linear-lanceolate, entire or deeply 2-fid, puberulous. Inflorescence terminal corymbose cyme, 1-4.5 cm across, spreading, puberulous; peduncles usually 1-3 cm long, elongating up to 8.5 cm on fruiting, stout, pubescent. Flowers heterostylous, 6-10 mm long, purple or white; bracts deciduous, 5-8 mm long, linear, glabrous or puberulous; bracteoles deciduous, 3-5 mm long, linear, glabrous or puberulous; pedicels 0.75-1 mm long, puberulous. Hypanthium $1-1.25 \times 0.25-1$

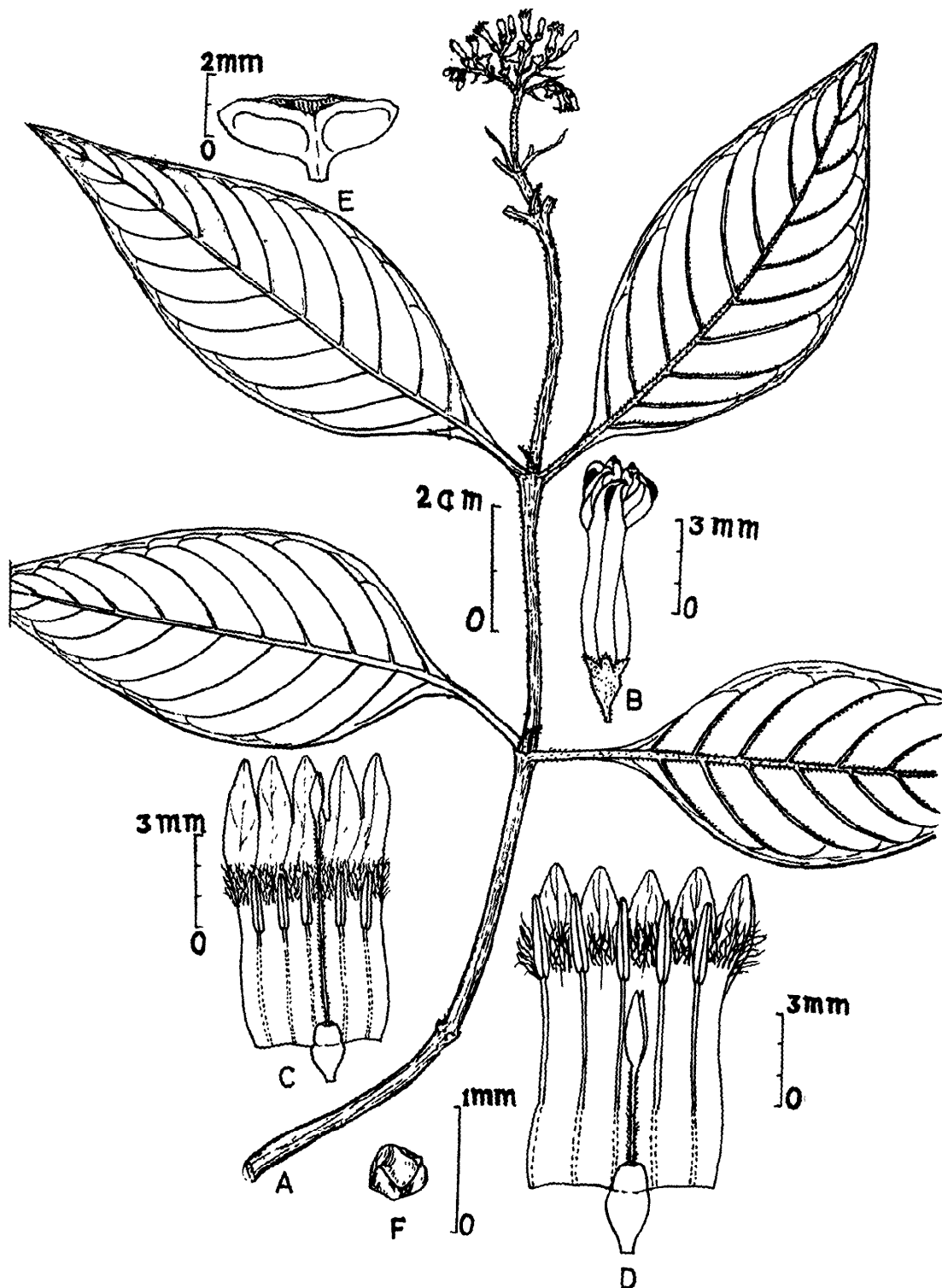


Fig. 57. *O. tingens* Clarke ex Fischer
 A. habit; B. flower; C & D. flower split open; E. fruiting; F. seed.

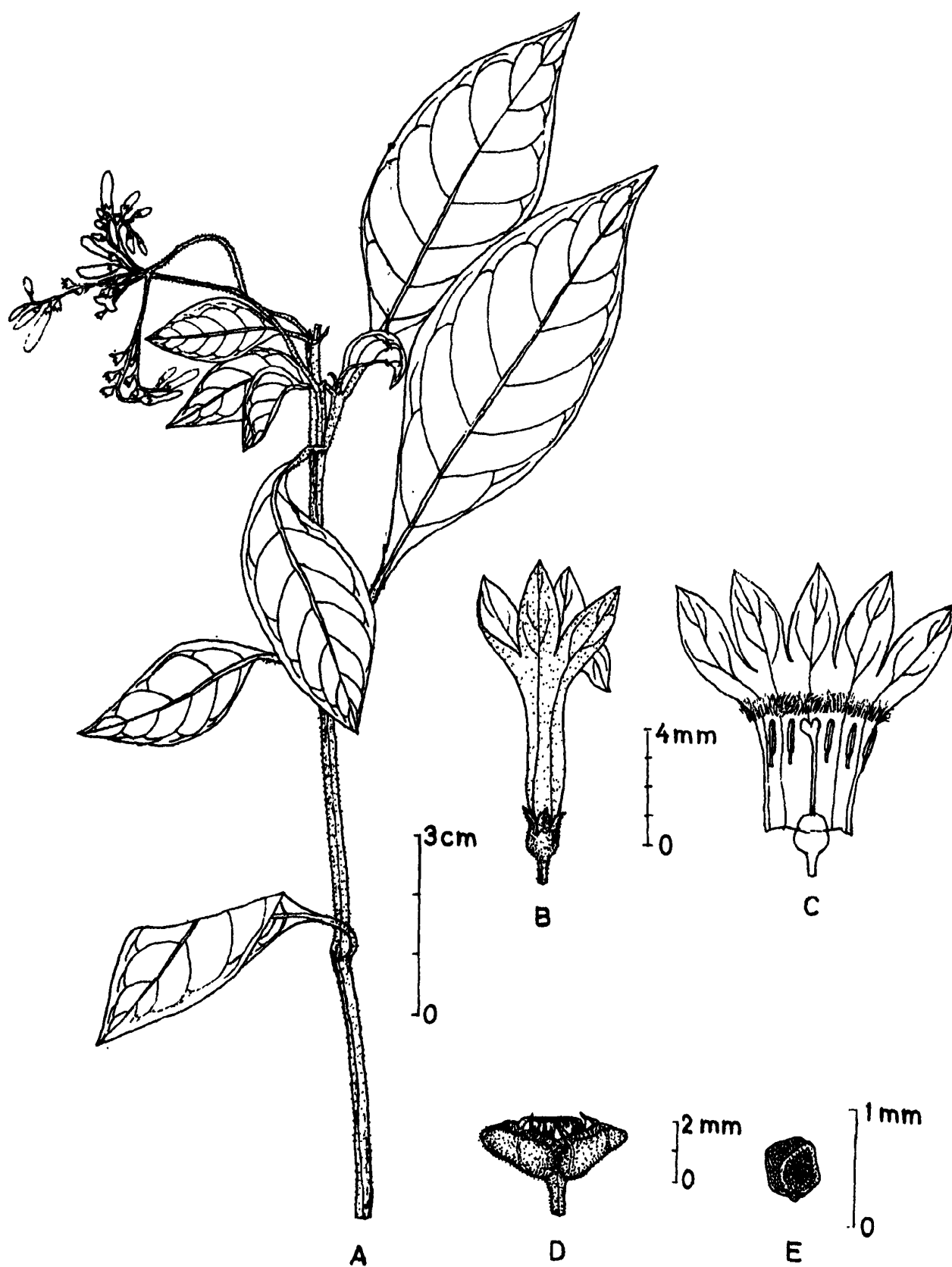


Fig. 58. *O. tirunelvelica* Henry & Subra.
A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

at base, pubescent. Leaves $3-15 \times 1-6$ cm, ovate-lanceolate, subcaudate acuminate at apex, slightly tapering at base, glabrous or scattered short hairy above, pubescent on the nerves beneath; lateral nerves 6-14 on either side; petioles 0.5-3 cm long, pubescent; stipules 2-11 mm long, lanceolate, single-nerved, entire or bifid, pubescent. Inflorescence terminal corymbose cymes, 1.5-4 cm across, branches somewhat stout, ascending, hirsute; peduncles 1-5.5 cm long, elongating in fruit, hirsute. Flowers heterostylous, 8-13 mm long, pink or white; bracts persistent, 6-15 mm long, linear, slender, hispid; bracteoles persistent, 4-8 mm long, linear, slender, hispid; pedicels 1-1.5 mm long, pubescent. Hypanthium $1-1.25 \times 0.75-1$ mm, obovoid, pubescent. Calyx lobes $0.75-1.25 \times 0.5-0.75$ mm, subulate, acute, pubescent. Corolla 7-11.5 mm long, infundibuliform, hirsute outside, glabrous or villous at the middle of corolla within; lobes $1.25-1.75 \times 1-1.5$ mm, ovate, acute. Stamens adnate to the middle of corolla or slightly below, inserted; filaments 0.75-1.5 mm long; anthers 1.25-1.75 mm long, linear-oblong. Ovary $0.8-1 \times 0.6-0.8$ mm, globose; disc 0.5-0.7 mm high; style either 5-8 mm long, slender, pubescent or 1-2 mm long, glabrous; stigma 2-lobed, 0.8-1.25 mm long, lobes ovate, often unequal, glabrous. Capsule $2-3.5 \times 5-8$ mm, pubescent, locules ovate-oblong, tip slightly inclined outwards. Seeds $0.3-0.5 \times 0.3-0.5$ mm, 4-6 angular, glabrous,

brown; testa cells 4-6 gonol, bounded by thick, smooth wall.

Fl. : April-September.

Fr. June-October.

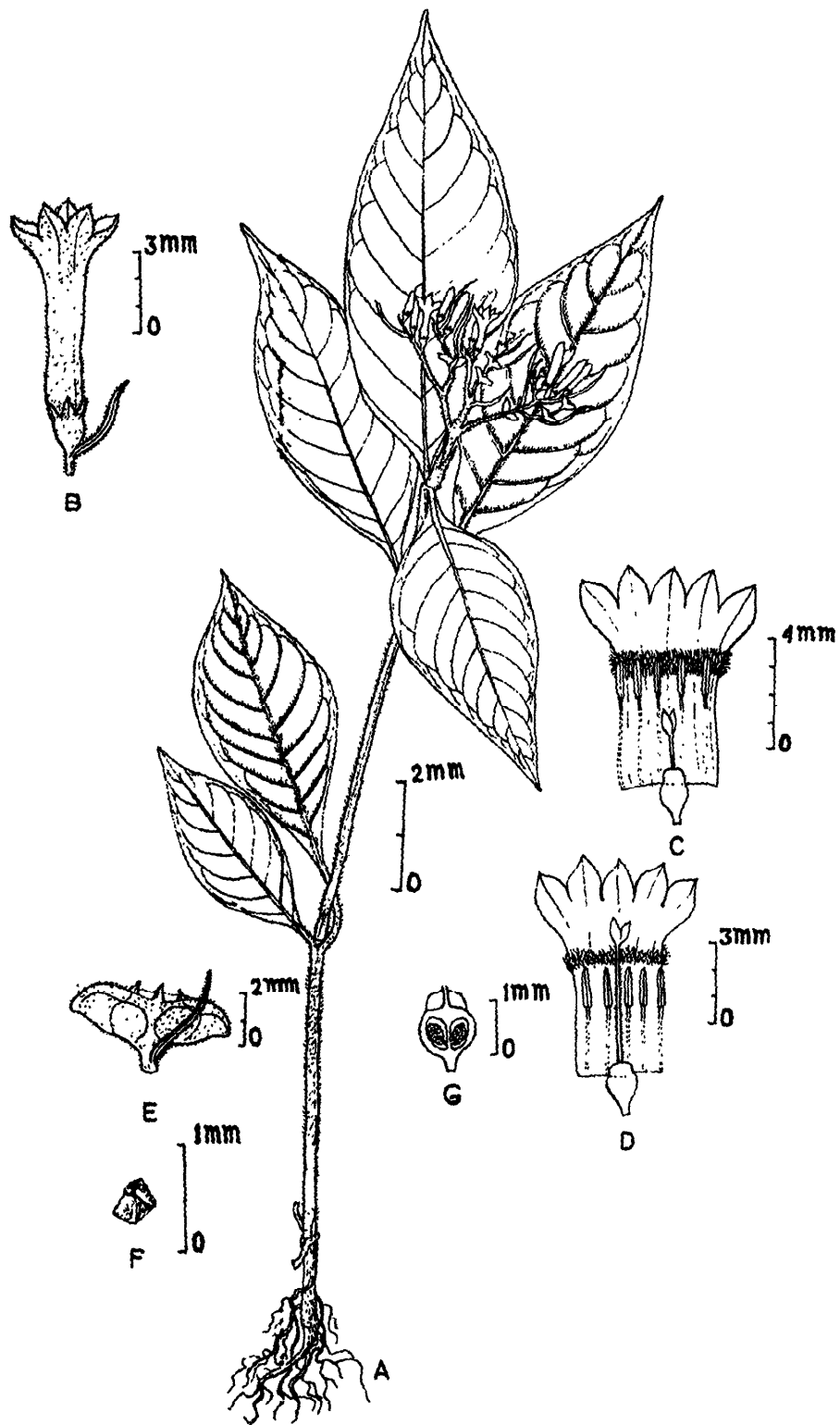
Pollen : Prolate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = $41-(45)-50 \times 37-(44)-51 \mu\text{m}$, 3- or 4-colporate; colpi $29-38 \times 5.5-7 \mu\text{m}$, tapering to obtuse ends; ora circular, $5.5-8.5 \mu\text{m}$ in diameter; sexine $1.75 \mu\text{m}$, nexine $0.25 \mu\text{m}$, rugulo-reticulate; lumina $0.75-1 \mu\text{m}$, muri $0.5-0.75 \mu\text{m}$.

Note. : Raphides present in stems, leaves and petioles.

Distribution : West Bengal (Darjeeling dist.), Sikkim & Nepal to Myanmar.

Ecology : Grows on moist, cool shady places in crevices of rocks at 300-2400 m.

Specimens examined : INDIA: Sikkim. Rungpo, *Kari* 1470 (CAL); Namchi, *Smith & Cave* 843 (CAL); Gangtok, *W. W. Smith* 2922 (CAL); Karponang, *G. H. Cave* s.n. (E); Gangtok, *N. L. Bor* 405 (DD) & *K. Biswas* 7085 (CAL); Yuksum, Dubdi forest, *S. N. Mitra* 9512 (CAL); Dikchu, *S. K. Mukherjee* 4945 (CAL). West Bengal. Darjeeling dist., *C. B. Clarke* 26624 B (BM); *C. B. Clarke* 26711 C (K); *C. B. Clarke* 35207A (CAL); *C. B. Clarke* 35393 E (CAL); Mungpoo, *Rhomoo* 316 (CAL); Mungpoo, *Kari* 1287 (CAL); Munsong, *Kari* 1526 (CAL); Rongoo, *K. Biswas* 9856 (CAL); Kurseong, Dow Hills, *D. Das* 160 (CAL). Meghalaya. Shillong peak, *R. S. Rao* 2747 (CAL) & *R. S. Rao* 14055 (CAL);

Fig. 59. *O. treutleri* Hook. f.

A. habit; B. flower; C. & D. flower split open; E. fruiting; F. seed; G. l.s. of ovary.

Mawphlong, *S. L. Kapoor* 69567 (LWG). Arunachal Pradesh. Lohit dist., Hayuliang, *A. S. Rao* 48046 (CAL); Subansiri dist., Khuni Pahad to Petepool, *G. Panigrahi* 19619 (CAL); Tirap dist., Kothong, *D. B. Deb* 26065 (ASSAM).

44. *O. trichocarpa* Bl. Bijdr. 977. 1826 (Sphalm. trichocarpon) (*Type* : Java, Linga Jattie and Kambanga Island in shady places, 1823, *Blume* s.n. L, not seen); DC. Prodr. 4: 416. 1830; G. Don, Gen. Syst. Gard. Bot. 3: 522. 1834; Hook. f. Fl. Brit. India. 3: 78. 1880; Prain, Beng. Pl. 1: 561. 1903; Bakh f. in Backer & Bakh f. Fl. Java 2: 291. 1965. *O. hispidula* Wall. ex G. Don, Gen. Syst. Gard. Bot. 3: 523. 1834 (*Type* : Tavoy, *Wall. Cat.* 6234); Walp. Rep. Bot. Syst. : 2: 503. 1843; Ridely, Fl. Malay Penin. 2: 40. 1923; Craib, Enum. Fl. Siam 2(1) : 64. 1932. *O. villosa* Kurz in Journ. Asiat. Soc. Beng. 46(2) : 130. 1877 excl. syn. non Roxb. (Fig. 60)

Herbs perennial, 10-15 cm tall; stem erect, branching, densely pubescent. Leaves 1.5-14 × 1-4.5 cm, narrowly ovate, acute or acuminate at apex, acute at base, glabrous or scattered short hairy above, pubescent on the nerves beneath, pale green on drying; lateral nerves 7-12 on either side; petioles 0.5-3 cm long, pubescent; stipules 3-18 mm long, ovate with long narrow apex, pubescent. Inflorescence terminal and axillary dichotomously branched cymes, 1-2.8 cm across, dense-flowered, densely pubescent; peduncles 1-3.5 cm long,

elongating up to 5.5 cm in fruiting, densely pubescent. Flowers 6-10 mm long, pink or white; pedicels 0.75-1 mm long, pubescent. Hypanthium 0.75-1 × 0.6-0.8 mm, obovoid, pubescent. Calyx lobes 0.75-1 × 0.5-0.7 mm, ovate, acute, pubescent. Corolla 5.25-9 mm long, tubular, puberulous outside, villous at the throat within; lobes 1.5-1.75 × 1-1.25 mm, ovate, acute. Stamens adnate to the base of corolla or slightly above, inserted; filaments 0.8-1.2 mm long; anthers 1.3-1.5 mm long, oblong-linear. Ovary 0.6-0.8 × 0.5-0.7 mm, obovoid; disc 0.4-0.5 mm high; style 4.25-5.25 mm long, glabrous; stigma 2-lobed, 1-1.5 mm long, lobes lanceolate, acute, glabrous. Capsules 1.5-2.5 × 3.5-6 mm, pubescent, locules ovate-oblong with straight or slightly inclined tip. Seeds 0.3-0.4 × 0.25-0.4 mm, irregularly angular, glabrous, brown; wall of the areole moderately thin without any tubercles or ornamentation.

Fl. : May-September.

Fr. : July-October.

Pollen : Prolate-spheroidal, angular in polar outline, polar axis (P) × equatorial axis (E) = 28-(32)-37 × 26-(30)-34 μm, 3-colporate; colpi 22-34 × 4-6 μm, tapering to acute ends; ora circular, 3.5-6 μm in diameter; sexine 1.75 μm, nexine 0.25 μm, rugulo-reticulate; lumina 0.5-0.75 μm, muri 0.5 μm.

Distribution : India. West Bengal, Orissa and Andaman Islands; Bangladesh, Myanmar, Thailand, Malay, Java.

Ecology : Grows on moist shady sandy

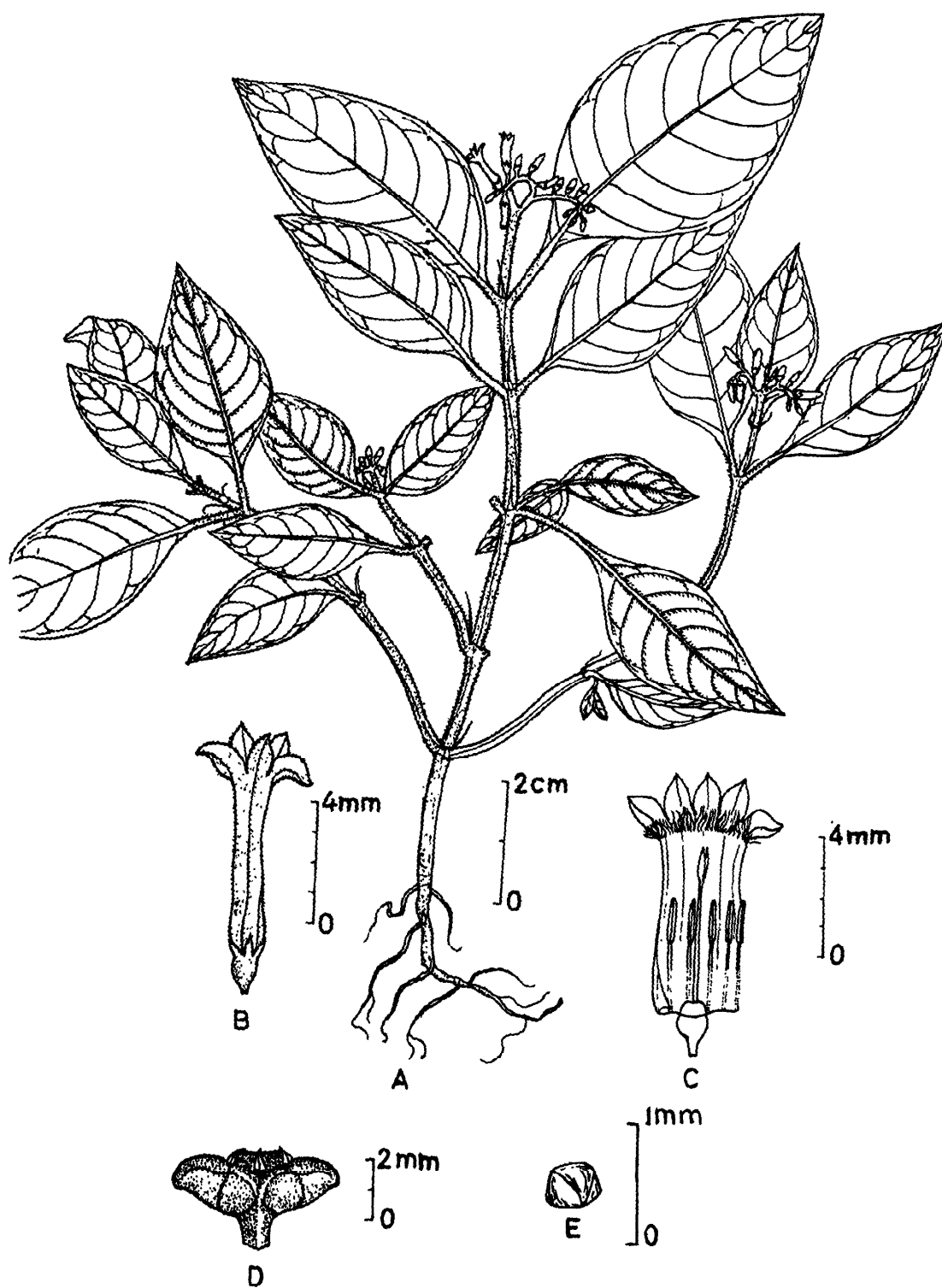


Fig. 60. *O. trichocarpa* Bl.
A. habit; B. flower; C. flower, split open; D. fruiting; E. seed.

soil in stone cravices near streams up to 540 m.

Specimens examined : INDIA: Orissa. Dhenkanal dist. Kapilas Hill, *H.F. Mooney* 2727 (K). Kalahandi dist. Nwangiri, *S. K. Mukerjee* 4184 (CAL); Keonjhar dist., Rebna Reserve forest, Phuljhar Valley, *H.F. Mooney* 1165 (K). Andaman Islands. Pal Muri, *King* s. n. (CAL); Tuggapur, *J. L. Ellis & K. Ramamurty* 18935 (MH); Runguchang, *N. P. Balakrishnan* 277 (CAL, PBL); Nayshahar Island Forest, *N. P. Balakrishnan* 344 (PBL); Betapur, *N. Bhargava* 1851/1 (CAL, PBL); Billyground *N. Bhargava* 1909 (CAL, PBL, E); Nilambur, *N. Bhargava* 2479 (CAL, PBL). Hut Bay, *N. Bhargava* 3276 (CAL, PBL). BANGLADESH : Chittagong, *J. L. Lister* s.n. (CAL); Bariadhala, *D. Hooper* 25915 (BSIS); Hazarikhal, *D. Hooper* 25992 (BSIS). MYANMAR : Pegu, Paungde, *J. Keenan, U. Tun Aung & R. H. Rule* 1013 (E); Sagaing, Katha, Myadaung, *K. Biswas* 538 (CAL). Tenasserim, Thaton, *A. Meebold* s.n. (CAL); Myiffa, *A. Meebold* s.n. (CAL); Wagon, *A. Meebold* s.n. (CAL); Tavoy, *J. Keenan, U. Tun Aung & R. H. Rule* 1291 (E).

45. *O. villosa* Roxb. (Hort. Beng. 85. 1814, nom, nud &) Fl. Ind. 2: 546. 1824 & 1: 702. 1832; (Type: Chittagong, cultivated in Hort. Bot. Calc., *Roxburgh* s.n. in *Wall. Cat.*: 6230 CAL !); DC. Prodr. 4: 415. 1830; G. Don, Gen. Syst. Gard. Bot. 3: 522. 1834; Hook. f. Fl. Brit. India 3: 79. 1880; Prain, Beng. Pl. 1: 561. 1903; Deb, Fl. Tripura State 2: 76. 1983.

(Fig.61)

Herbs perennial, 10-50 cm tall, suffruticose, branched, villous. Leaves 3 $10 \times 1.5 - 5$ cm, narrowly ovate, subacute to acuminate at apex, acute at base, glabrous or pubescent above, villous and pale beneath; lateral nerves 5-11 on either side; petioles 0.5-2 cm long, villous; stipules 6-9 mm long, ovate, fimbriate with two narrow apices, villous. Inflorescence terminal subcapitate cyme, 1-2.25 cm across, dense-flowered, ferruginous pubescent; peduncles 1-6 cm long, villous. Flowers subsessile, 6-8.5 mm long, white or reddish. Hypanthium $0.75-1 \times 0.6 - 0.75$ mm, obovoid, pubescent. Calyx lobes $0.6-0.8 \times 0.5 - 0.6$ mm, ovate, acute, pubescent. Corolla 5.25- 7.5 mm long, tube 5-angular, ferruginous pubescent outside, villous at the throat within; lobes $1.25 - 2 \times 0.8-1.25$ mm, ovate, acute, shortly keeled at back. Stamens adnate to base of corolla or slightly above, inserted; filaments 3-3.5 mm long; anthers 1.5-1.75 mm long. Ovary $0.6 - 0.8 \times 0.5 - 0.7$ mm, obovoid; disc $0.3 - 0.5$ mm high; style 3 - 4 mm long, glabrous; stigma 2-lobed, 0.75 -1 mm long, lobes ovate-lanceolate, obtuse, villous. Capsules $1.5 - 2 \times 3 - 5.5$ mm, hispid; locules ovate-oblong with straight tip. Seeds $0.3 - 0.4 \times 0.35 - 0.4$ mm, 5 - 7-angular, glabrous, brown; wall of the areole moderately thin with a number of tubercles on it.

Fl. & Fr. : April-September.

Pollen : Prolate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = 27 (29) $32 \times 25 - (27) - 31$ μ m, 3-colporate; colpi $18 - 24 \times 3 - 7$ μ m,

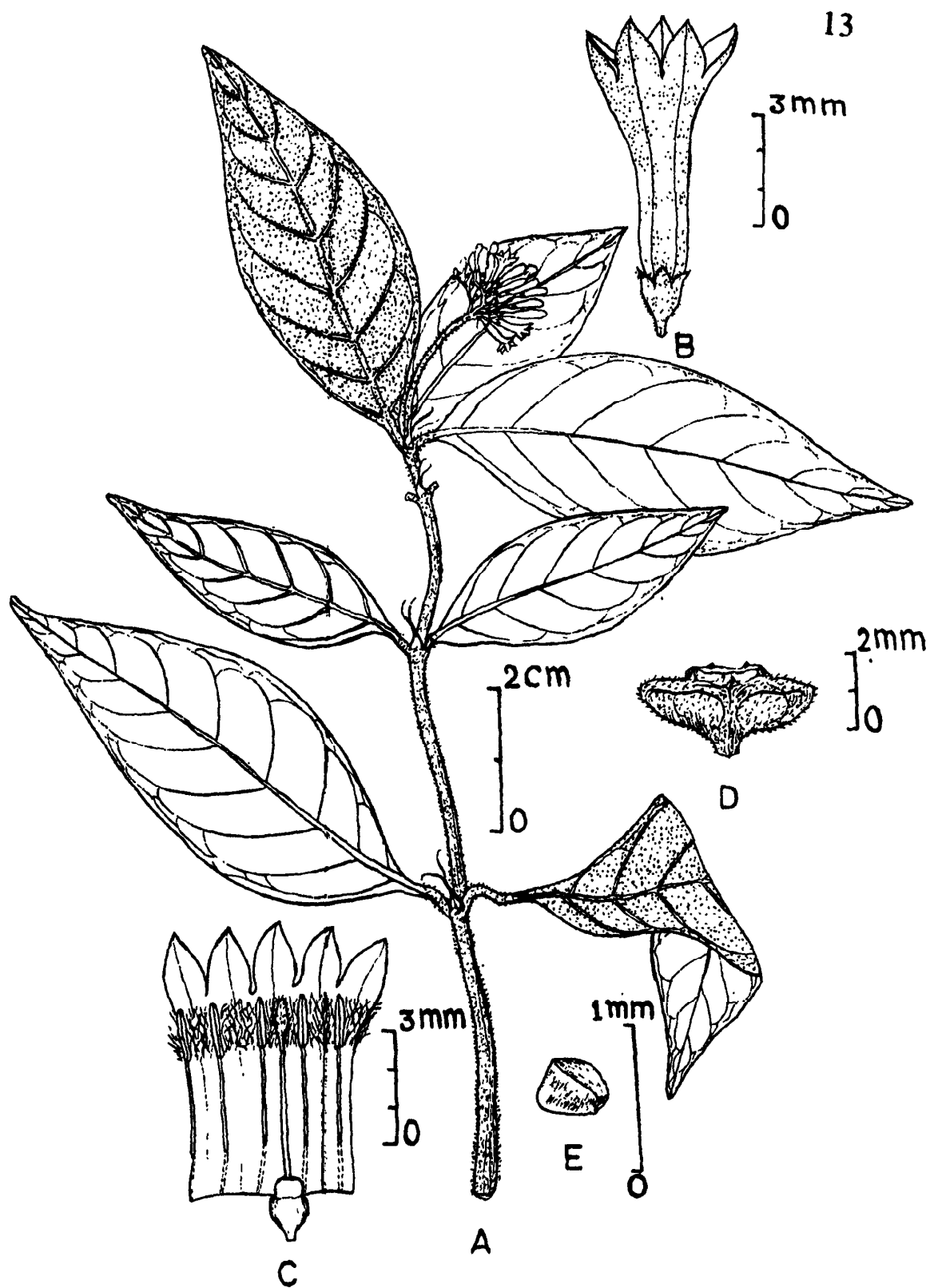


Fig. 61. *O. villosa* Roxb.
A. habit; B. flower; C. flower split open; D. fruiting; E. seed.

tapering to acute ends, ora circular, 3.5 - 7 μm in diameter; sexine 1.75 μm , nexine 0.25 μm , rugulo-reticulate; lumina 0.5 - 0.75 μm , muri 0.5 μm .

Distribution : India. Tripura, Andaman & Nicobar Islands, Bangladesh, Myanmar, Malay.

Ecology : Grows on moist shady places.

Specimens examined : INDIA: South Andaman, North of Margine Bay, *S. Kurz* s.n. (CAL); North of watering cave, *S. Kurz* s.n. Tripura. Kumarghat, *D. B. Deb* 876 (CAL); Sipaijala, *D. B. Deb* 1772 (CAL). BANGLADESH: Chittagong, Demagir; *J.L. Lister* 269 (CAL); Barkul, *J. L. Lister* s.n. (CAL); Chittagong, *King's Collector* s.n. (CAL); Chittagong, *J. Wood* s.n. (CAL); Kodala hill, *King's collector* s.n. (CAL); Barkul, *King's Collector* 520 (CAL); Garjania, *J.M. Cowan* 426 (E); Razu Range, Chainda, *Abdus Salam* 57 (E). MYANMAR: Bhamo Division, *Anderson* s.n. (CAL); Pegu Yomah, *S. Kurz* 3085 (CAL); S. Shan State, Keng Tung, *Mac Grigor* s. n. (CAL).

46. *O. wallichii* Hook. f. Fl. Brit. Ind. 3: 79. 1880 (Type: Khasia Hills, *De Silva* s.n. in Wall. Cat. 8358 K! CAL! BM); Kanjilal *et al.* Fl. Assam 3: 42. 1939.

(Fig.62)

Herbs 30-60 cm tall; stems procumbent, branched, swollen at the nodes, internodes 1.75-2.5 cm long, glabrous. Leaves 6-15 \times 2-6 cm, elliptic-lanceolate, caudate-acuminate at apex, acute, obtuse or sometimes rounded at base, glabrous, coriaceous, pale reddish

beneath on drying; lateral nerves 6-11 on either side; petioles 0.5-2 cm long, slender, glabrous; stipules deciduous, minute, subulate. Inflorescence terminal, corymbose cymes, 1.5-4.5 cm across, puberulous. Flowers heterostylous, 2.5-3 cm long, white, pinkish-white or purple, sweetly fragrant; bracts and bracteoles deciduous, 2.5-3 mm long, linear, puberulous; pedicels 1-2 mm long, glabrous or puberulous. Hypanthium 1.75-2.25 \times 2.25-2.5 mm, broadly obovoid, puberulous. Calyx lobes 1.25 - 1.5 \times 0.8 - 1 mm, subulate, acute, puberulous. Corolla 23.25-27.75 mm long, slender, infundibuliform, glabrous outside, villous either at the throat or at the middle of corolla within; lobes 2-3 \times 1.5-2.5 mm, broadly ovate, slightly curved inward and acute at apex, slightly keeled at back. Stamens adnate either at the throat or below the middle of corolla, inserted; filaments 0.5 mm long; anthers 2-2.5 mm long. Ovary 1.6 - 2 \times 2-2.25 mm, obovoid; disc 0.75 - 1 mm high; styles either $\frac{1}{3}$ rd or $\frac{2}{3}$ rd of corolla, glabrous; stigma 2-lobed, 2.25-2.6 mm long, lobes lanceolate, acute, glabrous. Capsules (immatured) 2-2.5 \times 2.5-2.75 mm, puberulous.

Fl : February-June.

Fr. : April-July.

Pollen : Prolate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = 36 - (40) - 43 \times 31 - (36) - 38 μm , 3-colporate; colpi 28-32 \times 4 - 5 μm , tapering to acute ends; ora circular, 5-6 μm in diameter; sexine 1.5 μm , nexine 0.25 μm ,

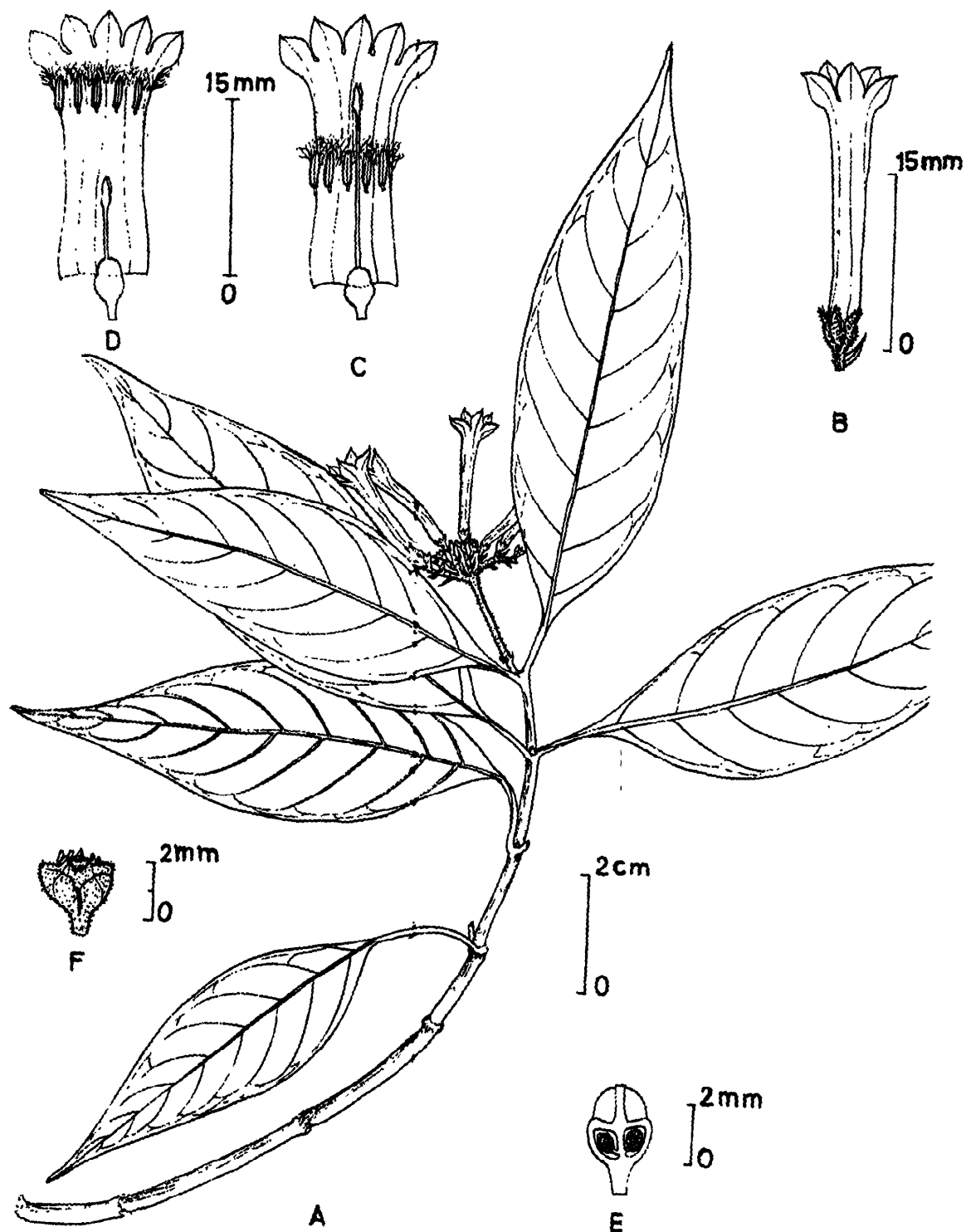


Fig. 62. *O. wallichii* Hook. f.
A. habit; B. flower; C. & D. flower split open; E. l.s. of ovary; F. fruiting (immature).

rugulo-reticulate; lumina $0.75\ \mu\text{m}$, muri $0.5 - 0.75\ \mu\text{m}$.

Note : Styles either $\frac{1}{3}$ rd of corolla when the villous ring is at the mouth or $\frac{2}{3}$ rd of corolla when the villous ring is at the middle of corolla. But this villous ring is always above the anthers.

Distribution : Meghalaya, Nagaland, Arunachal Pradesh to Myanmar.

Specimens examined : INDIA: Meghalaya. Jaintia Hills, Jakorsing Peak, *G. Mann* s.n. (K). Arunachal Pradesh. Lohit District, Theronliang, Tidding valley, *F. Kingdon-Ward* 7927 (K); Mishmi Hills, *F. Kingdon-Ward* 18534 (BM). Nagaland: Naga Hills, Rilima, *N. L. Bor* 2767 (K) & 17822 (ASSAM). MYANMAR: North Kachin state-Suprabum Sub division, Hpuginhku village, *J. Keenan, U. Tun Aung & U. Tha Hla* 3714 (E); Hpuginhku village, *J. Keenan, U. Tun Aung & U. Tha Hla* 3735 (E); Suprabum, *J. Keenan, U. Tun Aung & U. Tha Hla* 3791 (E).

47. *O. wattii* Fischer in Kew Bull. 1940(1): 34. 1940 (*Type*: Manipur, Sirhoifurer, 1500 m, 10th April 1882, *G. Watt* 6350! holo K; iso. CAL, BSIS); Deb & Mondal in Nayar & Sastry, Red Data Book Ind. Pl. 1:341. fig. 1. 1987. (Fig. 63)

Herbs, 10-35 cm tall; stem suffrutescent, erect, rarely decumbent branching or simple, pubescent, rooting at lower nodes. Leaves $6-16.5 \times 2.4-4.5\ \text{cm}$, elliptic or elliptic-lanceolate or ovate, acuminate at apex, tapering to base, dark green above,

pale below when dry, scattered hairy on both surfaces, midrib impressed above, lateral nerves 6-12 on either side, arched, joining above on the margin; petioles 0.5-3.5 cm long, slender; stipules early deciduous, minute, linear, entire or fimbriate. Inflorescence terminal, corymbose cyme, 2-4 cm across, puberulous; peduncles 1.2-6 cm long, elongating in fruits, puberulous. Flowers 13-15 mm long, white; bracts and bracteoles similar, persistent, 4-14 mm long, lanceolate or linear, puberulous, with prominent midrib; pedicels 1-2.5 mm long, puberulous. Hypanthium $1.3-1.6 \times 1.2-1.4\ \text{mm}$, obovoid, puberulous. Calyx lobes $1.25-2 \times 0.2-0.25\ \text{mm}$, ensiform or triangular, acute, puberulous. Corolla 11.7-13.4 mm long, narrowly campanulate, glabrous outside, puberulous within, villous below the middle within; lobes $2-3.75 \times 1.5-2\ \text{mm}$, broadly ovate-oblong, acute, shortly recurved, keeled at back, glabrous. Stamens adnate to the middle of corolla tube, inserted; filaments 3-4 mm long; anthers 2.75-3.5 mm long, oblong-linear, dorsifixed below the middle, hastate at base. Ovary $1.1-1.3 \times 1-1.2\ \text{mm}$, obovoid; disc 1-2 mm high, flattened, style 3-4 mm long, puberulous, stigma bilobed, lobes lanceolate. Capsule $2-2.5 \times 5-7\ \text{mm}$, puberulous, locules ovate-oblong with straight tip. Seeds $0.3-0.5 \times 0.4-0.5\ \text{mm}$, irregularly angular, glabrous, brown; wall of the areole thick with a number of tubercles on it.

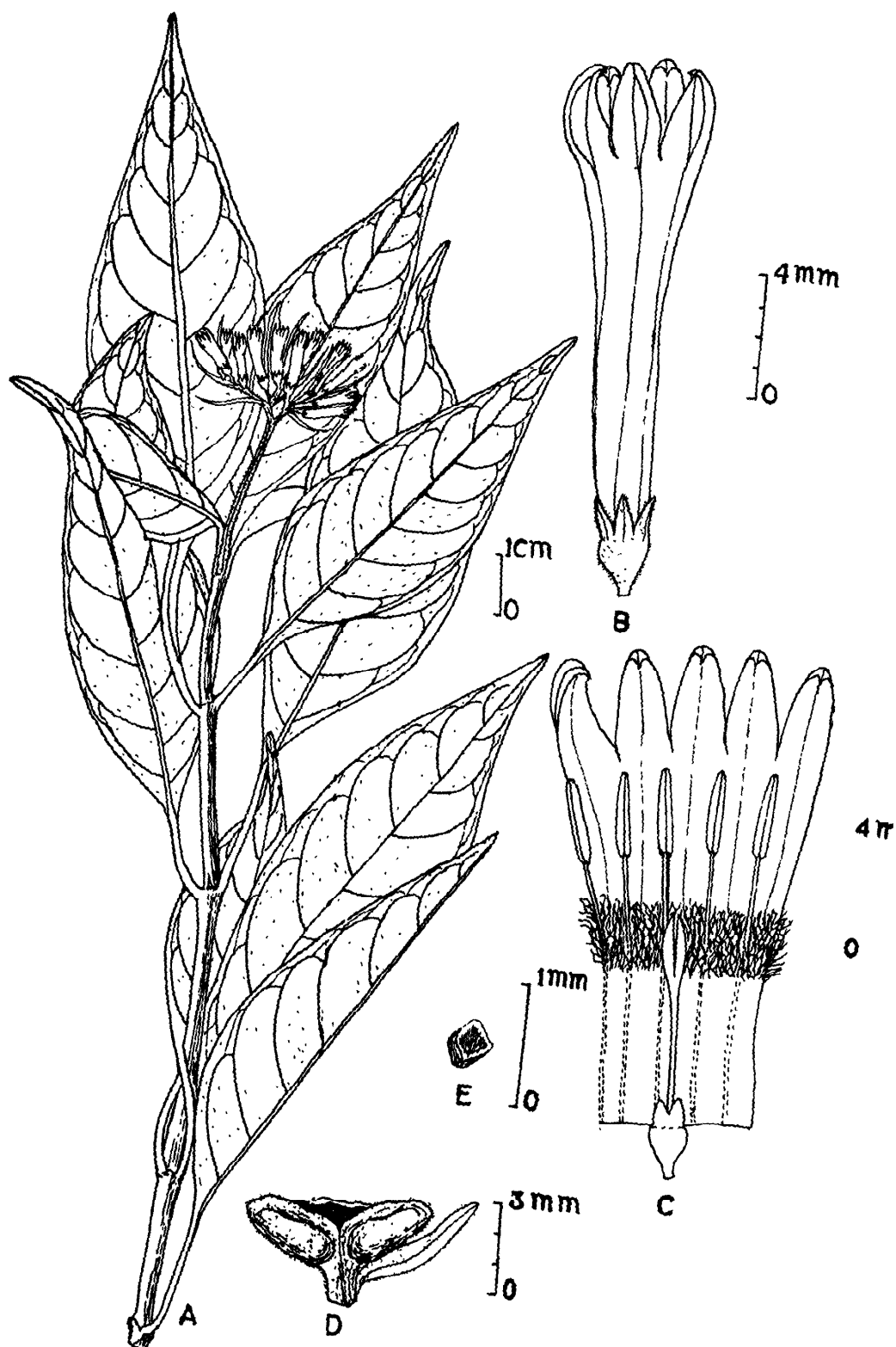


Fig. 63. *O. wattii* Fischer
 A. habit; B. flower; C. & D. flower split open; D. fruiting; E. seed.

Fl. & Fr. : April-December.

Pollen : Oblate-spheroidal, angular in polar outline, polar axis (P) \times equatorial axis (E) = 27-(30)-34 \times 28-(32)-34 μ m, 3-colporate; colpi 24-32 \times 4.5-6 μ m, tapering to obtuse ends; ora circular, 4.5-7 μ m in diameter; sexine 1.75 μ m, nexine 0.25 μ m, rugulo-reticulate; lumina 0.75-1 μ m, muri 0.5-0.75 μ m.

Distribution : Meghalaya, Nagaland, Manipur.

Ecology : Grows on moist shady places at 600-2100 m above m.s.l.

Specimens examined : MEGHALAYA : Khasi hills-Griffith s.n. (CAL); Cherrapunji, G. Gallatly s.n. (CAL). MANIPUR : Sirohifurer, G. Watt 6350 (K, CAL, BSIS); Sungtum, W. N. Koelz 27034 (L).

Key to the variety

Corolla 1.2-1.4 cm long; filaments 3.5-4 mm long : ...*O. wattii* var. *wattii*
Corolla up to 2.5 cm long; filaments 1 mm long : ...*O. wattii* var. *talevalliensis*

***O. wattii* Fischer var. *talevalliensis* (Pal & Giri) Deb & Mondal, Stat. & Comb. nov. Basionym. *O. talevalliensis* Pal & Giri in J. Bomb. Nat. Hist. Soc. 78(2): 433.1991. (Type: Arunachal, Lower Subansiri Dist., Talevalley, Pal 77660 holo. CAL!).**

This differs from the typical var. in larger flowers and shorter filaments. Location of villous hairy ring on the innerside of the corolla tube is of no taxonomic significance in this genus. Both the varieties start flowering

in April in their respective habitats.

Distribution: Arunachal Pradesh, Lower Subansiri Dist.

EVOLUTIONARY TREND IN THE GENUS

According to Corner (1949), Cronquist (1968, 1981), Takhtajan (1969) and others the primitive angiosperm was an evergreen tree in moist tropical forest with alternate, simple, pinnately reticulate veined leaves, stomata without guard cells, solitary flower without nectary, spirally arranged sepals, petals, stamens and carpels and dehiscent fruit. Hutchinson (1959) is of opinion that perennial condition is most primitive from which annual condition developed through biennial. Terrestrial and erect habit is primitive than aquatic and climbing habit Hutchinson (1969). According to Bessey (1915) and Cronquist (*l.c*) simple unbranched stem and evergreen leaves are primitive and branched stem and deciduous leaves are advanced. Cronquist (1981) visualised that the original dicot. plant was a shrub.

Most of the species of *OPHIORRHIZA* are perennials and a few are annuals. Most of the species are erect, suffrutescent, unbranched herbs, some are prostrate and only a few are creeping. According to Hutchinson (*l.c*) broad foliaceous stipule is advanced over simple narrow stipule. Stipules of *OPHIORRHIZA* are usually very narrow, setaceous with comparatively broad membranaceous base. In a few species they are very small, triquetrous or deltoid as found in *O. mungos*, *O. pykarensis*, and *O. wallichii*. In *O. eriantha*, *O. grandiflora*, *O.*

roxburghiana, etc. the stipules are larger and membranaceous. Probably the most advanced stipule is found in *O. codyensis* where it is very large, somewhat foliaceous with many converging nerves.

Parkin (1914) and Takhtajan (*l.c.*) are of opinion that solitary flower terminal on the leafy branches is most primitive from which racemose, umbel, etc. were derived through dichasium. Cronquist (*l.c.*) following Parkin (*l.c.*) and Rickett (1944) explained that termination of apical growth leads to branching just below the terminal flower, forming dichasia or monochasia. Repeated branching of the dichasia leads to compound cyme, then by shifting of growth pattern became panicle and from panicle by suppression of internodes, condensation and modification and by abortion of bracts and bracteoles raceme, spike, helicoid or scorpioid cyme, umbel, etc. develop. According to Rickett (*l.c.*) both racemose and cymose types derived from a panicle by progressive and retrogressive development. In most of the species of OPHIORRHIZA the inflorescence is dichotomous or trichotomous corymbose cyme. In *O. barberi* it is scorpioid cyme with spreading branches. The inflorescence of *O. nepalensis* is intermediate between corymbose and scorpioid cyme where the basic pattern is corymbose sometimes the ultimate branches are helicoid. The most advanced one is found in *O. caudata*, *O. incarnata*, *O. munnarensis*, *O. pectinata*, etc. where it is capitate cyme which probably derived through subcapitate cyme found in *O. subcapitata*. According to Parkin (*l.c.*) well developed bract and

bracteole is advanced over narrow bract and bracteole. The presence or absence of bracts and bracteoles as considered by Schumann (1891) to be of considerable importance in defining species groups within the genus. In a few species bracts and bracteoles are completely lacking. In rest of the species bracts and bracteoles are of three types. The most advanced one is found in *O. caudata*, *O. incarnata*, *O. pectinata*, etc. where it is well developed, lanceolate to oblong-lanceolate, with distinct midrib, and persistent. It derived from minute, subulate, scattered and deciduous bract and bracteole found in *O. ochroleuca*, *O. oppositiflora*, *O. rosea*, *O. rugosa*, etc. through linear, slender and persistent or subpersistent bract and bracteole found in *O. eriantha*, *O. grandiflora*, *O. hirsutula*, *O. roxburghiana* etc.

According to Pennell (1948) and Cronquist (*l.c.*) large, coloured, scented flower with nectary is advanced over small, white flower without scent and nectary. According to Eames (1961), Hutchinson (1969) and Cronquist (*l.c.*) nectary was absent in primitive plants. It developed later on to help insect pollination. Due to wind pollination nectary becomes redundant and was abandoned and disappeared.

The tubular corolla occupies major part of the flower which is white to pinkish-white in more than half of the species being primitive in this respect. In rest of the species the corolla is coloured. In *O. fasciculata*, *O. wallichii* etc. the corolla is both white and purple. In *O. heterostyla* and *O. tingens* they are white and apices of lobes are reddish or pinkish. In *O. mungos*

they are white, pinkish-white, greenish-yellow or rosy i.e., they are being gradually colourful from white. They are quite coloured in *O. ochroleuca* (yellow-orange), *O. pykarensis* (blue), etc. In some species the flower is mildly fragrant which might be due to the secretion from the semicircular glandular disc which encircles the base of style. The corolla lobes of *O. caudipetala* are ovate-lanceolate with acute, inwardly curved apex and a glandular coloured horn at the back. It seems to be a special device for attraction of insects for cross pollination which is an evolved condition in this respect. The corolla lobes of *O. griffithii* and *O. pallida* are winged at the back, it is extended to the base of corolla in *O. griffithii*. This is also a good device to attract insects for cross pollination.

From primitive laminar stamen how a well developed stamen with globose anthers and terete filaments developed has been shown by Takhtajan (*l.c.*) and Cronquist (*l.c.*). According to Eames (*l.c.*) broad, short and winged filament is primitive and terete is advanced over it. According to Takhtajan (*l.c.*) sessile stamen with narrow anther is primitive and stamen with long filament and short, broad anther is advanced. According to Hallier (1901) and Eames (*l.c.*) latrorse dehiscence of anthers is more primitive than extrorse or introrse. Greater length of anther containing much pollen is an anemophilous condition as shown by Eames (*l.c.*). Pennell (*l.c.*) is of opinion that entomophylly is advanced over anemophylly. The length of filament varies greatly in different species.

In *O. caudata*, *O. nepalensis*, *O. ochroleuca*, etc. the length of filament is greater than that of anthers. In this respect they are advanced over a number of species (e.g. *O. gracilis*, *O. grandiflora*, *O. roxburghiana*, etc.) where the length of filament is equal to the length of anther. In most of the species the length of filament is less than that of anther being most primitive. The anthers are linear-oblong or narrowly oblong. In *O. glechomaefolia* it is oblong. The size varies greatly in different species depending upon the size of flowers. Possibly entomophylly takes place in the genus. The pollinating agents are ants or ants like small insects. Their pressed body and white spot at the base of corolla tube inside around the disc in some fragrant flowers evidently indicate that the flowers are insect pollinated and the sweet nectar is produced by the disc. The position of stigma above the anthers and more lower position of nectar facilitates the possibility of insect pollination.

According to Cronquist (*l.c.*) uniaperturate pollen is primitive than multiaperture pollen. According to Walker (1974) the prolate pollen grains are most advanced which is derived through subprolate, prolate-spheroidal and oblate-spheroidal from oblate pollen grains. Pollen with longer colpi and large ora is advanced over pollen with short colpi and small ora. Regarding pollen shape, *O. brunonis*, *O. fasciculata*, *O. heterostyla*, *O. lurida*, *O. munnarensis*, *O. tingens*, *O. treutleri*, *O. trichocara*, *O. villosa* and *O. wallichii* are advanced with prolate-spheroidal grains

occurring in most of the species from suboblate grain occurring in *O. barberi*, *O. caudata*, *O. eriantha*, etc. *O. nutans*, *O. rugosa* and *O. treutleri* possess both tri- and tetra-colporate grains, which is a tendency towards multiaperturate grains an advanced condition. Pollen of *O. caudata*, *O. caudipetala*, *O. eriantha*, *O. grandiflora* and *O. griffithii* with large, lolongate ora is also an advanced condition. Hypothetical primitive carpel is formed by folding of sporophyll. Scattered ovules gradually restricted to marginal position is the first modification as proposed by Bailey and Swamy (1951). Fusion of carpels with marginal ovules produces syncarpous ovary with parietal placentation. Parietal placentation gradually becomes axile. Reduction and abolition of ovules leads to basal placentation. According to Bessey (*l.c.*) Hutchinson (*l.c.*), Eames (*l.c.*), Takhtazan (*l.c.*) and Cronquist (*l.c.*) numerous ovules is a primitive condition and reduction in number is an advanced condition. The placentation is axile and the ovules are numerous in the genus. Eames (*l.c.*) and Cronquist (*l.c.*) are of opinion that differentiation of ovary, style and stigma was gradual evolution, along many lines and at different rates. According to Parkin (1955) and Takhtazan (*l.c.*) well developed, distinguishable style and stigma is advanced over poorly developed and undistinguishable style and stigma. The style is variable in length. On the basis of style length the species may be divided into 4 groups. In *O. codyensis*, *O. lacei*, *O. pykarensis*, and *O. thomsonii* the style is

as long as corolla tube. In those species and in *O. borii*, *O. rosea*, *O. roxburghiana*, *O. rugosa* and *O. trichocarpa* the position of stigma is above the level of anthers and hence cross pollination is obligatory and in this respect they are advanced than those in which the anthers are above the level of stigma. The style is half as long as corolla tube in *O. nepalensis*, *O. subcapitata*, *O. tirunelvelica*. In *O. nepalensis* and *O. subcapitata* the anthers are above the level of stigma and in *O. tirunelvelica* the anthers and the stigma are in same level where the possibility of self pollination is more which is a primitive condition. The style is one-third of corolla tube in *O. barnesii*, *O. caudata*, *O. gracilis*, *O. hispida*, *O. pallida*, *O. radicans*, *O. wattii*, etc. where the stigma is always below the level of anthers. Very short style is found in *O. fasciculata* and *O. grandiflora* where also the stigma is below the level of anthers. Very long style with exserted stigma is found in *O. borii* where cross pollination is obligatory.

The stigma is well developed in the genus and distinguishable from the style and in most of the species it is two-lobed.

According to Cronquist (*l.c.*) dehiscent fruit which releases and disperses seeds is primitive and indehiscent fruit which is dispersed whole with the seeds included is advanced. According to Bessey (*l.c.*), Takhtajan (1948) and Corner (1964) few seeded fruit is advanced over many seeded fruit. In this genus the fruit is two locular, loculicidally dehiscent, many seeded capsule. The number of seeds varies from

45 to 132 in each locule but not always equal in number in two locules.

According to Pritzel (1898), Hallier (1912a), Martin (1946) and Wardlaw (1955) small seed is advanced over large seed. The size of the seed of *OPHIORRHIZA* varies from 0.2 to 1 mm and 0.2 to 0.75 mm.

According to Takhtazan (1948 and 1959) testa with its strongly developed peripheral layer of parenchyma cells is primitive than that without or weakly developed peripheral layer of parenchyma cells. In *OPHIORRHIZA* the testa is areolate, areoles alveolate. The wall of the areole of most of the species is thick but in *O. munnarensis* and *O. pallida* it is very thin. In this respect they are comparatively advanced than other species.

In the present study the primitive and advanced characters have been determined on the basis of Pritzel (1898), Hallier (1901, 1912a), Parkin (1914, 1955), Bassey (1915), Rickett (1944), Martin (1946), Corner (1949, 1964), Pennell (1948), Takhtazan (1948, 1969), Wardlaw (1955), Hutchinson (1959, 1969), Eames (1961) and Cronquist (1968, 1981) and phyletic diagram has been drawn to show probable evolutionary trends in the genus in Fig no. 64. *O. grandiflora* and *O. roxburghiana* with erect, suffruticose habit, flowers in terminal corymbose cyme, white flower, linear bracts, short filament, long anther and suboblate pollen; *O. glechomaefolia* with linear stipulate, small white flower,

linear bracts, very short filament and style and *O. lurida* with flowers in terminal corymbose cyme seems to be most primitive, which possibly are derived from a hypothetical ancestor in which all characters were primitive. *O. barnesii*, *O. eriantha*, *O. griffithii*, *O. lacei*, *O. mussaendiformis*, *O. nepalensis*, *O. pallida*, *O. pauciflora*, *O. pykarensis*, *O. rosea*, *O. succirubra*, *O. thomsonii*, *O. trichocarpa*, *O. villosa* and *O. wattii* are comparatively advanced. *O. barnesii* with subcapitate cyme and suboblate to oblate-spheroidal pollen; *O. lacei* with coloured flower, oblate-spheroidal pollen and longer style; *O. nepalensis* with strongly keeled corolla lobes and slightly longer filament; *O. pykarensis* with longer coloured flower, strongly keeled corolla lobes and longer style; *O. rosea* with slightly longer coloured flower, oblate-spheroidal pollen and longer style; *O. trichocarpa* with shorter anther, prolate-spheroidal pollen and longer style; *O. villosa* with flowers in subcapitate cyme and prolate spheroidal pollen seems to be derived from *O. lurida* with comparatively longer flower in terminal corymbose cyme, longer filament and prolate-spheroidal pollen; *O. pallida* with flowers in terminal corymbose cyme, winged corolla lobes, and longer filament; *O. pauciflora* with longer flower, longer colpi and longer style; *O. thomsonii* with relatively longer flower in terminal and axillary corymbose cyme, longer colpi and longer style possibly derived from *O. glechomaefolia*. *O.*

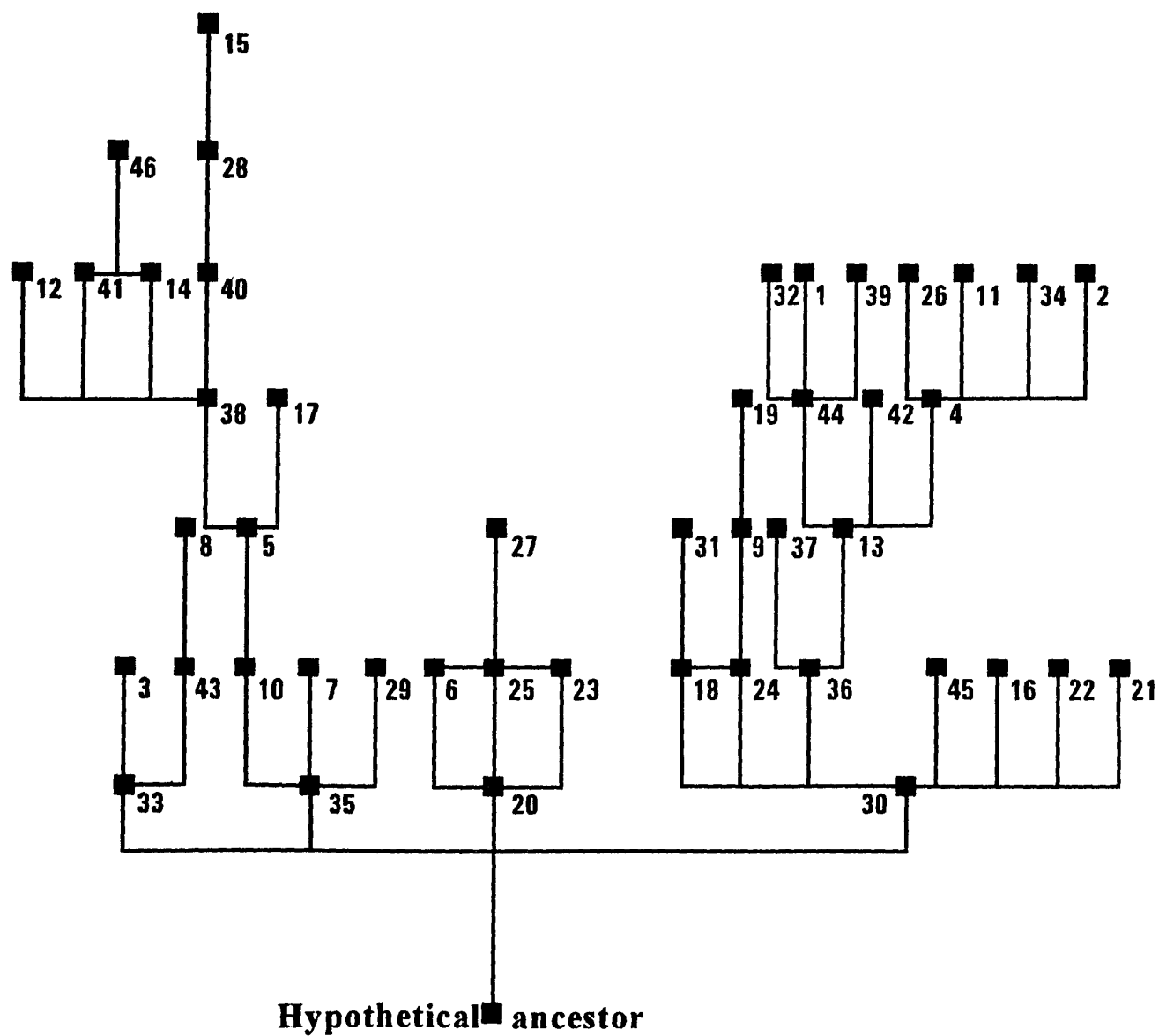


Fig. 64. Digrammatic representation of the evolutionary trend

griffithii with broadly lanceolate to oblong stipules, coloured flower, winged corolla lobes, and oblate-spheroidal pollen; *O. succirubra* with large lanceolate bracts, oblate-spheroidal pollen; and longer style; *O. wattii* with keeled corolla lobes, longer filaments, and smaller seeds seemed to be derived from *O. grandiflora*. *O. eriantha* with relatively longer filament, shorter anthers, lolongate ora and smaller seeds and *O. mussaendiformis* with strongly keeled corolla lobes, shorter anthers, oblate-spheroidal pollen and smaller seeds possibly derived from *O. roxburghiana*. *O. barberi* with slightly shorter anther, longer colpi and *O. tirunelvelica* with slightly shorter anther and oblate-spheroidal pollen are slightly advanced than *O. barnesii* and *O. nepalensis*, *O. borii* with strongly keeled corolla lobes, shorter anther, longer colpi, broader ora and longer style and *O. gracilis* with longer filament, shorter anther, longer colpi and broader ora are slightly advanced over *O. rosea*. *O. brunonis* with shorter anther, prolate-spheroidal pollen, broader ora and longer style is advanced over *O. griffithii*. *O. treutleri* with lanceolate stipule, terminal corymbose cyme, longer flower and prolate-spheroidal pollen is advanced over *O. mussaendiformis*. *O. radicans* is advanced than *O. thomsonii* in creeping habit, shorter anther and smaller seed. It is also advanced than *O. pauciflora* in terminal corymbose cyme, shorter anther, longer colpi and small seed and than *O. pallida* in shorter anther, longer colpi,

broader ora and smaller seeds. *O. codyensis*, *O. incarnata*, *O. mungos*, *O. munnarensis*, *O. oppositiflora* and *O. wallichii* are comparatively advanced than *O. barberi*, *O. borii*, *O. brunonis*, *O. gracilis*, *O. radicans*, *O. tirunelvelica* and *O. treutleri*. *O. incarnata* and *O. munnarensis* with broader bracts, capitate cyme and longer filament and with very thin areolar wall of testa in *O. munnarensis* possibly derived from *O. brunonis* or an ancestor nearer to it. *O. codyensis* with large stipule, axillary corymbose cyme, relatively large, lanceolate bracts and bracteoles and longer colpi is advanced over *O. tirunelvelica*. *O. mungos*, *O. oppositiflora* and *O. wallichii* possibly derived from *O. gracilis*. *O. mungos* with terminal corymbose to subumbellate cyme and longer colpi is advanced over *O. gracilis*. *O. oppositiflora* is advanced over *O. gracilis* in terminal and axillary corymbose cyme, longer flower, filaments and style. *O. wallichii* is advanced over *O. gracilis* in terminal corymbose cyme, white, pinkish-white or purple, fragrant, longer flower and prolate-spheroidal pollen.

O. calcarata, *O. caudipetala*, *O. fasciculata*, *O. hirsutula*, *O. hispida*, *O. nicobarica*, *O. nutans*, *O. ochroleuca*, *O. pectinata*, *O. subcapitata* and *O. tingens* are further one step advanced than *O. codyensis*, *O. incarnata*, *O. mungos*, *O. munnarensis*, *O. oppositiflora* and *O. wallichii*. *O. calcarata*

with narrowly lanceolate stipule, longer, linear bracts and bracteoles, corolla lobes with glandular coloured horn at the back an extra adaptation probably to attract insects for cross pollination, longer filaments and colpi; *O. fasciculata* with broad lanceolate stipule, longer filaments, shorter anthers and longer colpi; and *O. natans* with broad lanceolate stipules, lanceolate to linear-oblong bracts and bracteoles, longer filaments, dimorphic pollen and longer colpi possibly derived from *O. wallichii*. *O. hirsutula* with long subulate stipule, long fragrant flower and long colpi; *O. hispida* with large oblong-lanceolate stipule, coloured flower, longer colpi and relatively small seed; *O. subcapitata* with broad ovate stipule, shorter anthers and longer colpi and *O. pectinata* with long subulate stipule, comparatively long flower, keeled corolla lobes, longer colpi and style seem to be derived from *O. munnarensis*. *O. nicobarica* with relatively long flowers, keeled corolla lobes and oblate-spheroidal pollen; *O. ochroleuca* with lanceolate bifid stipule, bracteate, dark coloured flower, longer filaments and oblate-spheroidal to prolate-spheroidal pollen and *O. tingens* with broad ensiform stipule, bracteate, purple flower, keeled corolla lobes and dimorphic pollen possibly derived from *O. mungos*. One step more advanced condition occurs in *O. caudata* and *O. rugosa*. *O.*

caudata with broad ovate-lanceolate stipule, relatively long flower and filament and large lolongate ora seems to be evolved from *O. pectinata*. *O. rugosa* with dimorphic pollen, lolongate ora, long style and small seed appear to be derived from *O. hispida* and *O. subcapitata*. *O. heterostyla* appears to be most evolved species in the genus with procumbent, branching stem, ovate to ovate-lanceolate stipule, corolla white but tinged with red colour, in reflexed, keeled and inwardly curved apex of corolla lobes.

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