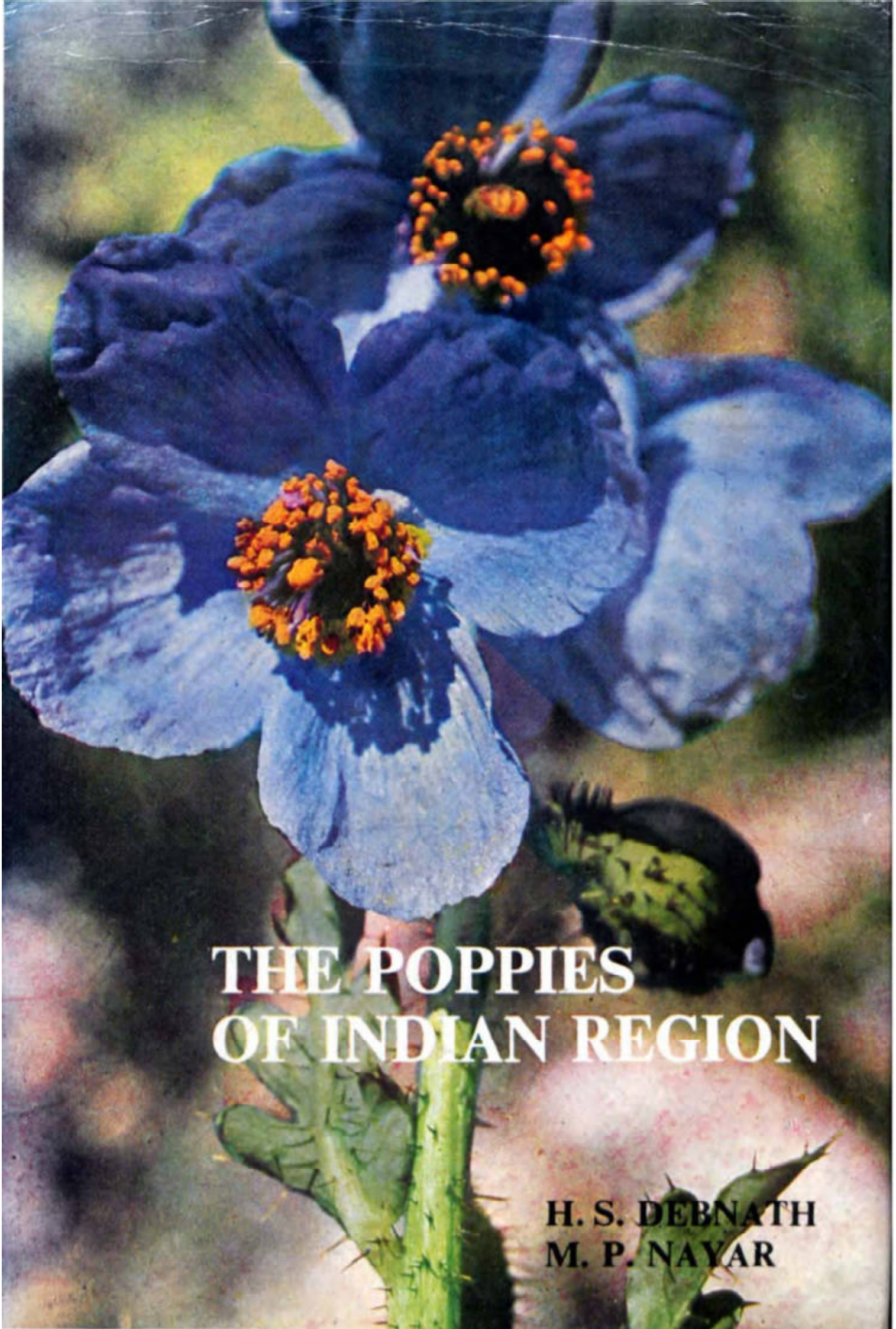

THE POPPIES OF INDIAN REGION

H. S. DEBNATH
M. P. NAYAR

The Poppies of Indian Region by H. S. Debnath, M.Sc., Ph.D. and M. P. Nayar, M.Sc., Ph.D. (London), F.L.S. is a monograph on taxonomical studies of the family Papaveraceae of Indian region. In this book the family Papaveraceae is circumscribed as per the modern concept and the genera included in the sub-families Fumarioideae and Hypecoideae are considered as separate families. The genus *Hypecoum* is treated under a separate family Hypecoaceae on the basis of study of palynology and seed morphology. A detailed taxonomic account of this genus is also given. In order to understand the taxonomy of the family Papaveraceae of Indian region, detailed work on distribution, phenology and ecology of some of the species in its natural habitat have been studied. These studies include pollen and seed morphological study with scanning electron microscope.

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THE POPPIES OF INDIAN REGION

(PAPAVERACEAE)

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FOREWORD

The family Papaveraceae, commonly known as Poppy family, based on the genus *Papaver* is one of the colourful families not only in their colourful flowers which are of ornamental value, but also from time immemorial, some of the species of *Papaver* are used in medicine and narcotic. The latex of *Papaver somniferum* contains some dangerous alkaloids. While other species of the family are mainly cultivated for ornamental value.

As a result of this work, it is established that the subfamily Hypecoideae deserves family rank as suggested by Takhtajan. The Fumitory family (Fumariaceae) previously treated as a subfamily Fumarioideae of the family Papaveraceae is now generally accepted as a separate family.

Meconopsis is the largest genus having twenty two species in the Indian region and they are growing mainly in the temperate Himalayan ranges. Some of the species of *Meconopsis* are introduced in European gardens. Sir George Taylor monographed the genus *Meconopsis* during 1934. The present study of the family encompasses the taxonomy of the family, the morphology of seeds and palynology. This work was done by Himadri Sekhar Debnath, Research Scholar working under my guidance for his Ph.D. The authors have undertaken high altitude collection tours in Sikkim and several endemic species were collected.

Botanical Survey of India is bringing out monographs on several families with illustrations for Flora of India work.

M. P. NAYAR
Director
Botanical Survey of India

Calcutta
20th August, 1986.

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We would like to express our sincere thanks and gratitude to Governor of Sikkim for allowing us to survey Poppies in the protected area of Northern and Eastern Sikkim.

In the preparation of a book of this magnitude, the help of various individuals and institutions were needed and we offer our sincere thanks to all of them: to scientists like Dr. J. Cullen, Prof. Gilbert Bocquet, Director, Conservatoire et Jardin botaniques, Dr. William C. Burger, Chairman, Department of Botany, Field Museum of Natural History for some scientific information which was gathered through correspondence.

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Thanks are due to the Directors of British Museum, London; Royal Botanic Garden, Kew, London; Botanical Survey and Herbarium, Kathmundu, Nepal; Forest Research Institute, Dehra Dun, India and Officer-in-Charge of the various regional herbaria of Botanical Survey of India for providing valuable information and help during the period of our research work.

We are thankful to the Officer-in-Charge of Regional Sophisticated Instrumentation Centre, Bose Institute, Calcutta for taking scanning electron microscopic photographs of pollen and seed.

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CONTENTS

GENERAL INTRODUCTION

The species of the family Papaveraceae, the name derived from the genus *Papaver*, commonly known as Poppies have become a part of human civilisation from time immemorial through their beautiful ornamental flowers, their utility in medicine, and their drug value as narcotic and hallucinogenic agents.

The family Papaveraceae comprises about 26 genera and 200 species and they occur in temperate and subtropical regions of the Old and New World. They are mainly herbs excepting the genus *Bocconia* (a small tree). The members of this family grow from sea level to 5800 m altitude and the species include pantropical weed like *Argemone mexicana* and endemic species of *Meconopsis* of restricted distribution.

The family Papaveraceae because of the above mentioned qualities has received a fair share of attention from the herb gatherers, narcotic dealers and quack medicine practitioners. But its taxonomy, cytology, biochemistry and palynology which throw light on the speciation patterns did not receive appropriate attention until recently.

The family Papaveraceae first received taxonomical attention by Jussieu (1791) who included the following genera: *Argemone, Bocconia, Chelidonium, Fumaria, Glaucium, Hypecoum, Papaver, Sanguinaria*. Linnaeus (1753) in his Species Plantarum included six genera.

In general the family Papaveraceae has been treated as a primitive family, though taxonomists placed the family in different orders. Bentham & Hooker f. (1862) placed it under the order Parietales. Later Engler & Prantl (1936) placed it under a separate order Papaverales which is also supported by Takhtajan (1966) and Cronquist (1968). Hutchinson (1959) classified this family under the order Rhoeadales, while Thorne (1968) placed it under the order Berberidales.

The revision of the family Papaveraceae for the Indian region was done by Hooker & Thomson (1872) in Flora of British India, and they considered 5 genera and 16 species for an area comprising India, Tibet, Pakistan and Afghanistan. Recent monographic studies on the genera *Argemone* by Ownbey (1958) and *Meconopsis* by Taylor (1934) have helped the better understanding of the family Papaveraceae of Indian region. Since then more specimens and data have become available due to fresh collections. Recent studies on cytology by Hrishi (1960), Grover (1970), Malik (1974), Malik et Grover (1973), Malik et Mary (1973, 1975), Malik *et al.* (1979), Mary et Malik (1973), Mary *et al.* (1974) have helped the understanding of the speciation patterns of some of the genera.

In this study the family Papaveraceae is circumscribed as per the modern concept and the genera included in the sub-families Fumarioideae and Hypecoideae are considered as separate families and hence not included. The family Papaveraceae now under consideration includes following genera: *Argemone, Dicranostigma, Eschscholtzia, Glaucium, Meconopsis, Papaver* and *Roemeria.* In this study the genus *Hypecoum* is treated under a separate family Hypecoaceae on the basis of study of palynology and seed morphology. A detailed taxonomic account of the genus *Hypecoum* is also given.

In order to understand the taxonomy of the family Papaveraceae of Indian region, detailed study on distribution, phenology and study of some of the species in its natural habitat have been undertaken. These studies include pollen and seed morphological study with scanning electron microscope.

Taxonomic revision of the family Papaveraceae of Indian region is presented in three Chapters: 1. Taxonomy. 2. Pollen morphology. 3. Seed morphology.

Following are the main objectives of this study :

1) To study and understand the taxonomy of the family Papaveraceae of the Indian region with its nomenclatural status and their distribution.

2) To classify the family Papaveraceae of the Indian region after study of the taxonomy aided by pollen and seed morphology.

CHAPTER 1: TAXONOMY

1.1. INTRODUCTION

Since the work of Hooker et Thomson (1872) on the Papaveraceae of India there is no other comprehensive account of the Indian Papaveraceae at present. In this taxonomic study it is proposed to reassess the family Papaveraceae with reference to taxonomic status and patterns of distribution, alliances, nomenclature and synonymy.

1.1.1. General Survey of Principal literature of the family Papaveraceae

It was Jussieu in 1791, who first proposed the family Papaveraceae and divided the family into two groups: (1) Indefinite stamens—On which genera *Argemone, Bocconia, Chelidonium, Glaucium, Papaver, Sanguinaria* are included (2) Definite stamens—the genera are *Hypecoum* and *Fumaria*.

Linnaeus (1753) included the family in his Polyandria Monogynia and he recognised the following two genera *Papaver* and *Argemone*, occurring in India.

A. P. De Candolle's description of Papaveraceae in Prodromus systematis naturalis Regni Vegetabilis 1: (1824) was the first major account of this family on a World basis and he recognised the following three genera *Argemone, Meconopsis* and *Papaver* occurring in India.

The first revision of the family Papaveraceae for the Indian region was done by Hooker & Thomson (1872) in the Flora of British India and they considered 5 genera and 16 species.

The most recent monograph of the family Papaveraceae for the World is that of Friedrich Fedde in "Das Pflanzenreich" published in 1909. He divided the family into two subfamilies Hypecoideae and Papaveroideae and recognised 28 genera.

Popov in Flora USSR 7: (1937) divided the family Papaveraceae into three subfamilies Hypecoideae, Papaveroideae, Fumarioideae.

Jafri et Qaiser (1974) in Flora West Pakistan considered 7 genera and 21 species. He also included the genus *Hypecoum* in the family Papaveraceae.

Debnath et Nayar (1984) in the Flora of India considered 5 genera and 26 species and treated the genus *Hypecoum* under a separate family Hypecoaceae.

1.1.2. Historical Review of the Taxonomic literature of the genera

ARGEMONE Linn.

It was Tournefort in 1694, who first established the generic name *Argemone*, based on one species *Argemone mexicana*. This taxon was first described by Casper Bauhin (1596) under the name *Papaver spinosum*. A year later Bauhin's description was followed by Gerard (1597) who described the same species under the name *Carduus chrysanthemus peruanus*. Tournefort (1694) referred Bauhin's *Papaver spinosum* and coined the name *Argemone mexicana*.

In 1753 Linnaeus in his Species Plantarum listed three species *Argemone armeniaca*, *A. mexicana* and *A. pyrenaica* and he included the genus *Argemone* in his Polyandria Monogynia. According to all subsequent authorities *Argemone armeniaca* and *A. pyrenaica* belong to the genus *Papaver*.

Prain's paper (1895) embodied the first detailed study of the genus *Argemone*. He revised the genus and recognised six species and five varieties.

In 1903 Rose published a brief account of the Mexican species of *Argemone*. In that account he recognised eleven species.

In 1909 Friedrich Fedde published a revision of *Argemone* for the World in Das Pflanzenreich. He recognised nine species and twelve varieties.

The most recent comprehensive monographic treatment of the genus *Argemone* for North America and the West Indies is "Monograph of the genus *Argemone* for North America and the West Indies" by Gerald B. Ownbey (1958). Ownbey reviewed Fedde's treatment of the genus *Argemone* and he added modifications of the existing treatment. He recognised twenty three species and ten additional subspecies.

Ownbey (1961) in his latest revision, on the genus *Argemone* of South America and Hawaii, recognised six species.

DICRANOSTIGMA Hook. f. & Thoms.

The first species of the genus *Dicranostigma* was described by Hooker and Thomson in 1855 from Himalaya, under the name *Dicranostigma lactucoides*. Due to the identical fruit character Bentham and Hooker (1862)

referred this genus to *Stylophorum* which was supported by Baillon (1871) and adopted by Hooker and Thomson (1872).

Prain's paper "Revision of the genus Chelidonium" (1895) embodied detailed study of the genus *Dicranostigma*. He then considered the genus *Dicranostigma* as a section under the genus *Chelidonium*.

Fedde 1909, referred *Dicranostigma* as a distinct genus and considered three species.

ESCHSCHOLTZIA Cham.

In 1820 Chamisso first established the genus *Eschscholtzia*, in honour of Johann Friedrich Eschscholz, 1793—1831, physician and naturalist, with the type species *Eschscholtzia californica*.

In 1909 Friedrich Fedde published a revision of the genus *Eschscholtzia* for the World in "Das Pflanzenreich". He recognised one hundred and twenty three species.

GLAUCIUM Miller

The genus *Glaucium* was well known to the pre-Linnean botanists as horned poppy. The name *Glaucium* was first coined by Tournefort in 1719.

The nomenclatural history of this plant begins with Linnaeus (1753) who gave it the name of *Chelidonium glaucium*.

In 1789 Jussieu gave a clear definition of the genus *Glaucium* which helped in distinguishing the genus *Glaucium* from *Chelidonium sensu stricto*.

Crantz in 1763 defined *Chelidonium* and *Glaucium* as separate genera, admonishing Linnaeus for errors in both generic and specific descriptions.

In 1909 Friedrich Fedde in his account of the genus *Glaucium* in Das Pflanzenreich described twenty one species for the World.

MECONOPSIS Vig.

The first species of *Meconopsis* known to science was *Meconopsis cambrica* which was proposed by Viguier in 1814. It was based on the single species *Papaver cambricum* which was previously described by Linnaeus in 1753. On the basis of differentiated characters from typical *Papaver* i.e. presence of distinct style and the complete absence of a sessile, stigmatic disc surmount-

ing the ovary, Viguier proposed his new genus *Meconopsis* and considered it as intermediate between *Papaver* and *Argemone.*

In 1824 De Candolle described *Meconopsis napaulensis,* the first asiatic representative of the genus *Meconopsis.*

In 1852 W. J. Hooker described one species under the name *Meconopsis wallichii* due to apparent difference in flower colour and supposed geographical isolation from *Meconopsis napaulensis.* Taylor (1934) on the basis of Nepal collections, relegated *Meconopsis wallichii* to a synonym of *Meconopsis napaulensis* as they are conspecific.

The next two additions to the genus *Meconopsis* was made by Hooker and Thomson in 1855. Of these two new species, one of which *Meconopsis robusta* and the other one is *Meconopsis horridula* based on the Hooker's specimens.

The first detailed study of the genus *Meconopsis* was done by David Prain in 1896. He considered twelve species for India, of which two species were newly described by him.

In 1825 D. Don described yellow flowered *Papaver paniculatum* on which he also included *Meconopsis napaulensis* as a synonym. But according to Prain the identification of these two new species was quite erroneous. Prain stated that the plant generally known as *Meconopsis napaulensis* was really the original *Papaver paniculatum* which is transferred to the genus *Meconopsis* in 1896.

A more comprehensive review of *Meconopsis* was that prepared by Prain, published in 1906. He recognised a total of twenty seven species. On the basis of trichome characters Prain considered the genus *Meconopsis* to be composed of two sections (i) *Eumeconopsis* of which the species have simple trichomes and (ii) *Polychaetia* of which the species bear the barbellate trichomes. Under these two sections he arranged nine subordinate groups under which he considered twenty seven distinguishable species.

Prain's treatment was supported by Fedde (1909) in his account of the Papaveraceae in Das Pflanzenreich but he treated Prain's sections as subgenera and the subordinate groups as sections.

In 1915 Prain added nine species of *Meconopsis* in his revision of the genus which comprises a total of forty three species for the World.

The most recent revision of *Meconopsis* for the World is "An account

of the genus *Meconopsis* by George Taylor (1934). He recognised forty one species for the World, four of which were newly described and two of which were transferred by him from *Cathcartia* to *Meconopsis*. Taylor added modifications of the existing classification and suggested the establishment of two sub-genera *Eumeconopsis* and *Discogyne* on the basis of stylar disc, under the genus *Meconopsis*. On the basis of habit, flower colour and pubescence, he recognised three sections *Cambricae*, *Eucathcartia* and *Polychaetia*. *Eucathcartia* comprises two series *Chelidonifolae* and *Villosae*. *Polychaetia* divided into two subsections—*Eupolychaetia* which comprises two series and other *Cumminsia* which is composed of six series.

PAPAVER Linn.

The first species of *Papaver* known to science was *Papaver somniferum* which was described by Linnaeus in 1753.

In 1754 Linnaeus described this genus in his Genera Plantarum.

The most comprehensive monographic treatment of the genus *Papaver* for the World is that of Elkan in 1839.

In 1909 Friedrich Fedde published revision of *Papaver* for the World in Das Pflanzenreich. He recognised ninetynine species and many varieties under nine sections.

Popov in 1937 described fifty two species under eight sections for U.S.S.R.

Jafri et Qaiser in 1974 described nine species for West Pakistan.

ROEMERIA Medic.

It was Medicus who first established the genus *Roemeria*.

In 1824 De Candolle in his Prodromous systematis naturalis Regni Vegetabilis described three species *Roemeria hybrida*, *R. refracta* and *R. bivalvis*.

In 1909 Friedrich Fedde in Das Pflanzenreich published a revision of the genus *Roemeria* for the World. He recognised nine species and nine varieties.

1.2. PROCEDURE

For the study of the family Papaveraceae an assessment of the data pertinent to the literature references, study of herbarium specimens and field observation of living specimens have been undertaken.

Literature references which the authors have consulted is given in the bibliography.

Field trips have been undertaken in Sikkim Himalaya, Kumaon and also Nepal Himalaya. Several species of *Meconopsis* and *Papaver* have been observed in their natural habitat.

A key to the genera of the family Papaveraceae of the Indian region and key to the species of the each genus are presented. The keys are intended to indicate, as far as practicable, the natural affinities of the taxa by placing those with the most characters in common, closest together.

The revision gives synonymes, exhaustive literature references, keys, descriptions, habitat of each species, local names wherever known and distributions. Also the types are mentioned. Lectotypes and neotype have been selected for some species where original description gave syntypes and for those species where the holotype has been lost or destroyed. Specific descriptions have been given after study of herbarium specimens and details of field notes have been taken into consideration. For most of the species line drawings have been prepared.

In this chapter 40 species, 1 subspecies and 1 forma have been described under 7 genera of the family occurring in India and adjacent countries : Pakistan, Nepal and Bhutan.

The abbreviations/acronyms of Herbaria are used according to *Index Herbariorum* (ed. 5, 1964).

1.3. GEOGRAPHIC DISTRIBUTION

The Papaveraceae are found mostly in temperate and subtropical regions of northern hemisphere, including western North America and eastern Asia.

The genus *Argemone* is an exclusively American genus with the exception of one species (*Argemone glauca* Linn. ex Pope) which is restricted to the Hawaiin Islands, but some species are naturalized as weeds in most of the warm countries of the World.

The genus *Dicranostigma* is distributed in Himalaya and western China.

The majority of the species of the genus *Eschscholtzia* are extensively distributed in North America.

The genus *Glaucium* is distributed chiefly in the Mediterranean and central Asian regions.

Western Europe is the home of the type species of the genus *Meconopsis*. All other members of the genus *Meconopsis* occur in the Himalayan belt and they are distributed in south-central Asia from the southern boundary, extending from Chitral and Kashmir and intervening ranges to northern Yunnan, southern Tibet and the province of Szechuan to southern Kansu, central Shensi and western Hupeh.

The species of the genus *Papaver* are distributed mostly in temperate Europe and Asia.

The genus *Roemeria* is found in south west Europe, Asia and north Africa.

1.4. GENERAL CHARACTERS OF THE FAMILY PAPAVERACEAE

The family Papaveraceae consisting of about 26 genera and about 200 species form a natural an well defined group exhibiting a number of common features. In habit they are mainly annual, biennial or perennial herbs with milky or coloured latex. Certain genera are shruby *(Dendromecon)* or arborescent *(Bocconia)*.

The leaves are alternate, rarely opposite or whorled, petiolate or sessile, with varied length of the petiole. Stipules are absent. The leaves are entire or pinnately or palmately cleft.

The stems and leaves are usually provided with indumentum of small or barbellate hairs or pubescence or rarely glabrous. Hairs are simple, setose-villous, stellate or barbellate.

Metcalfe and Chalk (1957) studied the anatomy and some of the salient general features are given below "..... The stem of most Papaveraceae exhibits, in transverse sections, a single ring of widely spaced vascular bundles, which are nearly always collateral. The xylem groups frequently tend to be V-shaped. Several rings of bundles sometimes present in *Papaver*. Hairs scanty, uniseriate, biseriate or multiseriate. Shaggy hairs occasional. Glandular hairs absent. Stomata ranunculaceous. Petiole, in transverse sections, commonly exhibiting an arc of vascular bundles not accompanied by sclerenchyma. Variously coloured latex present, sometimes in articulated laticiferous tubes, but elsewhere in cells or sacs, the latter sometimes arranged in longitudinal rows. Crystals of calcium oxalate recorded only in *Bocconia frutescens* Linn., but said to be present in the floral leaves of a few other species. Cluster crystals also noted in *Romneya*. Alkaloids are common in the family. These include such well-known substances as morphine and codeine. Berberin, which is characteristic of Berberidaceae, is known to occur in *Argemone mexicana* Linn."

Inflorescences are cymose, mostly solitary, rarely subumbellate or paniculate.

Flowers are usually showy, large, bisexual, regular, hypogynous. Bracts are present.

Calyx are of 2, rarely 3 sepals. Sepals are free or rarely compactly united, imbricate, caducous at flowering, covering the entire bud.

Corolla are large, showy, imbricate, sometimes crumpled in bud. Petals are of 4-6 (rarely 8-12) in number, arranged in 1-2, rarely 3 whorls, free and the petal colours are mainly yellow, blue, red, purple, and white.

Stamens are numerous, in several whorls and free. Anthers are dithecous, dehiscing lengthwise. Filaments are filiform to winged, often coloured.

Pollens are usually from oblate to perprolate, rarely square shape in polar view *(Papaver decaisnei)*.

The ovary is superior, unilocular, rarely bilocular, 2-many carpels. Ovules are numerous in each locule. The placentation is parietal, rarely solitary and basal, anatropous or campylotropous. Styles are usually one or obsolete. Number of the stigmas are as many as carpels. Stigmas are disc like, capitate, 2-partite or 2-lobuled.

The fruits are capsular, dehiscent or indehiscent, dehiscent by 2-valves, rarely 3-6 valved or of many carpels and also by pores opening below the disc like stigma *(Papaver)*.

Seeds are usually small, smooth or striate, rugose or reticulate, pitted, with or without aril. Embryo is minute. Endosperm is oily and mealy.

1.5. KEY TO THE GENERA

1a. Stigma lobes alternate to placentas. Capsules opening throughout its length:

2a. Leaves ternately dissected into narrow segments. Sepals forming a hood or calyptra like cap. Stigmas 4-6 ... *Eschscholtzia* 3

2b. Leaves pinnatifid-pinnatipartite. Sepals not forming any hood or calyptra like cap. Stigmas bifurcate ... *Dicranostigma* 2

1b. Stigma lobes opposite to placentas. Capsules usually opening by pores or by short valves, rarely throughout its length:

3a. Capsules linear, at least ten times as long as broad:

4a. Stigmas 2, conical. Capsules with 2 horns at the apex, 2-valved ... *Glaucium* 4

4b. Stigmas 3-4, capitate. Capsules without horns, 3-4 valved ... *Roemeria* 7

3b. Capsules oblong or subglobose, less than ten times as long as broad:

5a. Styles absent. Stigmas discoid. Capsules opening by pores just beneath the prsistent stigmas ... *Papaver* 6

5b. Styles present or inconspicuous. Stigmas not discoid. Capsules opening by usually short valves:

6a. Styles distinct, conspicuously broad and large. Stigmas forming a globular mass over the ovary ... *Meconopsis* 5

6b. Styles inconspicuous (rarely very short). Stigmas not forming globular mass over the ovary ... *Argemone* 1

1.6. TAXONOMIC STUDIES

ARGEMONE

[Tournef., Elem., p. 204, t. 121. 1694; Inst. Rei Herb. 1: 239, 2: t. 121. 1700]; Linn., Sp. Pl. 1: 508-509. 1753 (excluding *A. armeniaca* Linn. & *A. pyrenaica* Linn.); Gen. Pl., ed. 5: 225. 1754; Lamarck, Encycl. Meth. 1: 247. 1783; Gaertn., Fruct. et Sem. Pl. 1: 287, t. 60. 1788; Jussieu, Gen. Pl. p. 236. 1789; Lamarck, Planches 2: t. 452. 1797; Tournef., Elem., ed. aug. (Jolyclere) 2: 12, 5: t. 121. 1797; Nutt., Gen. 2: 9. 1818; DC., Reg. Veg. Syst. Nat. 2: 85. 1821; DC., Prodr. 1: 120. 1824; Bernb., in Linnaea 8: 461. 1833; Endl., Gen. Pl., p. 856. 1836-1840; Meisner, Pl. Vasc. Gen., Pars prior, p. 7, pars altera, p. 9. 1836-1843; Gray, Gen. Pl. U.S. 1: 111, t. 47. 1849; Benth. & Hook. f., Gen. Pl. 1: 52. 1862; Baillon, Hist. Pl. 3: 112-113, figs. 125-127. 1871; Prain, in Journ. Bot. 33: 129. 1895; Gray, Syn. Pl. N. Am. 1.1: 87-88. 1895; Rose, in Contrib. U.S. Nat. Herb. 8: 23-27. 1903; Fedde, in Engler, Pflanzenr. 4. 104: 271. 1909; Fedde in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 17b: 105. 1936; Ownbey, Mem. Torrey Bot. Club 21. 1: 1-159. 1958; Ownbey, Brittonia 13: 103. 1961; Cullen, in Rechinger f., Fl. Iran. 34: 23.

1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 20. 1974; Debnath et Nayar, Fasc. Fl. Ind. 17: 2. 1984.

Type: Argemone mexicana Linn., Sp. Pl. 1: 508. 1753.

Erect, prickly, often glabrous, annual herbs with yellow latex. Leaves epetiolate, inciso-pinnatifid, sinuate-lobulate, middle and upper elliptic-oblong, lower obovate or oblanceolate, margin toothed, terminated into prickle, smooth to prickly. Buds subspherical to elliptical, oblong or obovate. Flowers white, yellow or orange, terminal solitary, pedunculate. Stamens numerous; filaments filiform; anthers linear, 2-loculed, basifixed. Ovary ovate-oblong or subfusiformis, unilocular, parietal placentas; ovules numerous; styles very short or obsolete; stigmas radiating, 3-7 lobed, lobes opposite the placental strands. Capsules elliptical to oblong, lanceolate or ovate, prickly (except *A. mexicana* f. *leiocarpa)*, dehiscing by 3-6 short valves. Seeds numerous, subspherical-spherical, pitted.

Generic Synonyms of Argemone

Ectrus Lour., Fl. Cochinch. 1: 344. 1790.

Enomegra Nels., Analyt. Key Fl. Pl. Rocky Mt. Reg., p. 27. 1902; Nels., in Bot. Gaz. 34: 365. 1902.

Generic Relationships

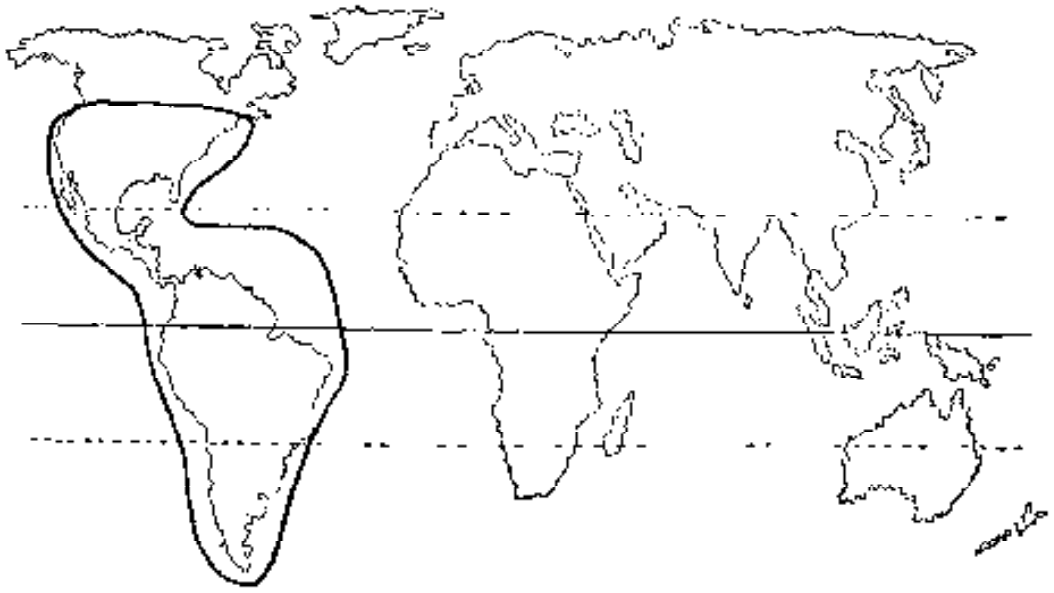
The genus *Argemone* is closely allied to the genera *Papaver* and *Meconopsis*. It is possible to set apart *Argemone* from other genera by using a combination of characters rather than any single character. The presence of sepal horns, basically trimerous arrangement of sepals and petals, united styles and the mode of dehiscence of capsules distinguish the genus *Argemone* from its allied genera *Papaver* and *Meconopsis*.

The genus *Argemone* appears to be most closely related to the genus *Papaver*. For example, trimerous flowers and horned sepals are found in both genera. But the distinguishing character of the stigma (the stigma concrete in *Papaver* whereas the lobes remain discrete in *Argemone)* is noteworthy.

The dehiscence mechanism of capsules and united styles are similar in both the genera *Argemone* and *Meconopsis*. However, in the genus *Meconopsis* the flowers are commonly dimerous, whereas in the genus *Argemone* the flowers are trimerous. In *Meconopsis* the sepals are without any horn-like appendage, while it is present in the species of *Argemone*.

Geographical Range of Argemone

The species of *Argemone* are indigenous to America excepting *Argemone glauca* which is restricted or endemic to the Hawaiin Islands. In North America the species of *Argemone* are found along the coastal areas of south-eastern and southern United States to Texas, westward to the Pacific and northward across the Great Plains to western south Dakota and southern Montana. In central America *Argemone* is present throughout Mexico, throughout the islands of the West Indies and southward along both coasts to the Isthmus of Panama. There are six recognisable species found in Chile, Argentina, Uruguay, Paraguay and Bolivia of South America (Map 1).



Map 1. Geographical distribution of the genus *Argemone*

In Indian region the species of this genus occur as adventive weeds exclusively in low rainfall regions at elevations from sea level to 2500 m.

Argemone mexicana is native to the West Indies and according to Ownbey (1958) it is probably also native in parts of central America and Florida. At present this species has become a pantropical weed throughout tropical and subtropical parts of the World. In the native area *Argemone mexicana* is a common weed in fields and sea port cities. The spread of this weed to the other tropical parts of the World might have taken place through import of agricultural crops.

Probably *Argemone ochroleuca* ssp. *ochroleuca* which is native to Mexico, has come to India due to the activities of man. Ownbey (1958) stated that in America the habitat and distribution of *Argemone ochroleuca* ssp. *ochroleuca*

and *A. mexicana* are different. But in India the above mentioned adventive weeds grow in the same habitat.

Argemone mexicana f. *leiocarpa*, the glabrous form of *Argemone mexicana*, was also introduced into India from its native area southern Florida, Keys and Dry Tortugas.

Argemone subfusiformis ssp. *subfusiformis* was recorded from Udaipur (Malik & Grover, 1969). It is native to South America and described from Argentina.

Ecology

In Indian region the species of this genus occur as weeds in the disturbed and waste places along roadways, fields and inter-mountain plains from sea level to 2500 m.

KEY TO THE TAXA

1a. Flowers bright yellow; stigmatic lobes closely crowded together and appressed to the style at anthesis; styles inconspicuous, 0-1 mm long in fruit:

2a. Plant spinescent ... *A. mexicana* 1

2b. Plant glabrous, devoid of any spines except leaf margin ... *A. mexicana* f. *leiocarpa* 1a

1b. Flowers white (turning pale yellowish with age), very pale yellow; stigmatic lobes are divergent and not appressed to the style; styles conspicuous in fruit, 1-3 mm long:

3a. Capsules lanceolate or ovate-lanceolate. Sepal horns 6-8 mm long. Leaves whitish green, whitish tinge prominent along the midribs and veins ... *A. ochroleuca* subsp. *ochroleuca* 2

3b. Capsules subellipsoid to subfusiformis. Sepal horns 10-14 mm long. Leaves pale green ... *A. subfusiformis* subsp. *subfusiformis* 3

1. **Argemone mexicana** [Tournef. Elemens de Bot., p. 204. t. 121. 1694; Tournef. Inst. Rei Herb., 1: 239, 2: t. 121. 1700]; Linn., Sp. Pl. 1: 508. 1753; Syst. Nat., ed. 10, 2 : 1073, 1759; Miller, Gard. Dict., ed. 7. 1759; Miller, Figures 1: 33, t. 50. 1759; Lamarck, Encycl. Meth. 1: 247. 1783; Gaertn., Fruct. et Sem. Pl. 1: 287, t. 60. 1788; Walter, Fl. Carol, P. 153. 1788; Aiton, Hort. Kew., ed. 1, 2: 225. 1789; Curtis, Bot. Mag. 7. t. 243, 1794; Lamarck, Planches 2: t. 452. 1797; Lestib., Bot. Belg. ed. 2, pt. 3. 2: 131. 1799; Willd., Sp. Pl. 2: 1148. 1799; Pers., Syn. Pl. 2: 62. 1807; Aiton Hort. Kew., ed. 2, 3: 290. 1811; Lunan, Hort. Jamaic. 2: 312. 1814; Hornem., Hort. Hafn., p. 489. 1815; Nutt., Gen. 2: 9. 1818, excluding white-flowered species; DC., Reg. Veg. Syst. Nat. 2: 85. 1821; DC., Prod. 1: 120. 1824; Elliott, Bot. Carol. & Georg. 2: 13. 1824, excluding white-flowered variety; Roxburgh, Fl. Ind. 2: 571. 1832; Hook., in Journ. Bot. 1: 190. 1834, as to Drummond 15; Graham, J., Cat. Pl. Geo. in Bomb. & Vic. 6. 1839; Wight, Ill. Ind. Bot. 1: t. 11. 1840; Walp., Rep. 1: 109. 1842, excluding varieties; Voigt, Hort. Sub. Cal., 6. 1845; Hook. f. & Thoms., Fl. Ind. 1: 251. 1855; Oliv., Fl. Trop. Afr. 1: 54. 1868; Hook. f. & Thoms. in Hook. f., Fl. Brit. Ind. 1: 117. 1872; Cooke, Fl. Pres. Bomb. 1: 27. 1901 (Repr. ed. 1: 29. 1958); Duthie, Fl. Upper Gang. Pl. 1: 36. 1903 (Repr. ed. 1: 37. 1960); Prain, Beng. Pl. 1: 216. 1903 (Repr. ed. 1: 142. 1963); Strachey, Cat. Pl. Kumaon 8. 1906; Fedde, in Engler, Pflanzenr. 4. 104: 273, 274, fig. 36B. 1909; Gamble, Fl. Pres. Madr. 1: 35. 1915 (Repr. ed. 1: 25. 1957) ; Haines, Bot. Bih. & Or. 1: 23. 1921 (Repr. ed. 1: 24. 1961); Kanjilal, Fl. Assam. 1(1): 66. 1934; Fedde in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 17b: 107. 1936; Van Steenis, Fl. Malesiana, 1.5: 114-115. 1955-1958; Ownbey, Mem. Torrey Bot. Club 21.1: 1. 159. 1958. Ownbey, Brittonia 13: 103. 1961; Backer *et al.*, Fl. Java, 1: 177. 1963; Mowat, in Tutin *et al.* in Fl. Europ. 1: 251. 1964; Hara in Hara, Fl. East. Him. 1: 103. 1966; Cullen, in Rechinger f., Fl. Iran. 34: 23. 1966; Jafri, Fl. Karachi, 129. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 21. 1974; Saldanha *et al.*, Fl. Hassan Dist. 71. 1976; Bhandari, Fl. Ind. Desert, 30-31. 1978; Debnath et Nayar, Fasc. Fl. Ind. 17: 3. 1984. *A. mexicana* var. *typica* Prain in Journ. Bot. 33: 308. 1895. *A. mexicana* var. *ochroleuca* Britton, Man., p. 439. 1901 not *A. ochroleuca* Sweet. Fig. 1

Common Names: In Gerard (1597) *Argemone mexicana* is termed "The golden Thistle of Peru". *A. mexicana* was referred to by various authors by various names. It is commonly called as "Mexicana Prickly Poppy" or "Prickly Poppy." In India *Argemone mexicana* is termed as *Baroshial Kanta, Sial-Kanta* (Beng.); *Darudi* (Guj.); *Bharbhand, Piladhutura, Farangi-dhutura, Ujar-kanta, Sial-Kanta* (Hind.); *Brahma-danti* (Mal.); *Kandiari, Bialkanta, Bhatmil Satyanasa, Bherbhand, Katci, Bhat Kateya* (Punj.); *Srigala kanta, Brahmadandi* (Sans.); *Gokhulajanum* (San.); *Birama-dandu, Kurukkum ckedi* (Tam.); *Brahma-dandi-chettu* (Tel.); *Baramdandi* (Urdu); *Kantu-Kusam* (Oriya).

In West Pakistan, according to Jafri et Qaiser (1974) *A. mexicana* is termed as *Pilawala dhatura, Bhat Katia.*

Annual, erect, prickly herbs, latex yellow. Stems 30-125 cm tall, divaricately branched, armed with 0-6 perpendicular or slightly reflexed prickles per square cm of surface or devoid of any spines (in *f. leiocarpa*). Leaves sessile, alternate, semiamplexicaul, elliptic oblong, variegated green and white, the light blue markings over the veins, 3-22×2-8 cm broad, pinnatifid, sinuate-lobulate, ultimate segments, the segments inciso-dentate, margin acute, toothed with spines, lower surfaces of the leaves sparingly prickly on the main veins, about 0-3 prickles per cm of vein, the upper surfaces wholly smooth or very distantly prickly, prickles very sharp, yellow, prickle 2-10 mm long or both upper and lower surfaces of the leaves totally smooth (in *f. leiocarpa*). Buds subspherical, 9-24×6-12 mm, very sparingly prickly or totally smooth (in *f. leiocarpa*). Flowers bright yellow, 4-7 cm diameter, sessile, subtended by 2-3 foliaceous bracts. Sepals 8-12×5-7 mm, each sepal with an acute terete horn, about 6-9 mm long, very sparsely prickly outside, imbricate, caducous. Petals 4-6, usually bright yellow, obovate, imbricate, cuneiform, more or less crumpled in aestivation. Stamens indefinite, 8-10 mm long; filaments pale lemon yellow; anthers 2 mm long, yellow. Ovary ovate, 8-15 mm long (including stigma), 3-6 mm broad covered with long soft spines; stigmas purple, 3-6 lobed, lobes usually broad, closely crowded together and appressed to the style at anthesis. Capsules oblong or elliptic-oblong, 1.0-3.9 cm long (including stigma), 0.5-2.1 cm broad, with rounded ribs, covered with sharp erect 10-21 spreading spines per valve, the largest spines commonly 4-9 mm long or the surface totally smooth (in *f. leiocarpa*). Seeds many, blackish brown to deep brown, more or less rounded, 1.6-2.0 mm long, deeply reticulate-suborbiculate.

Type: Holotype: Mexico, Jamaica, Carribies & S. Europe, Herb. Linn. No. 670/1 (Linn.).

Fls.: February—March. *Frts.:* March—May.

Distrib.: INDIA: Throughout India, between sea level to 2500 m; PAKISTAN; NEPAL; BHUTAN.

Uses: The yellow juice of this plant is used as a medicine for dropsy, jaundice and cutaneous affections. It is also diuretic, relieves blisters, heals and ulcers.

The seed oil is used as a medicine for ulcers and eruptions.

Note: While studying the genus *Argemone* L. Debnath et Nayar (1980) had come across an interesting specimen of *Argemone mexicana* L. with green

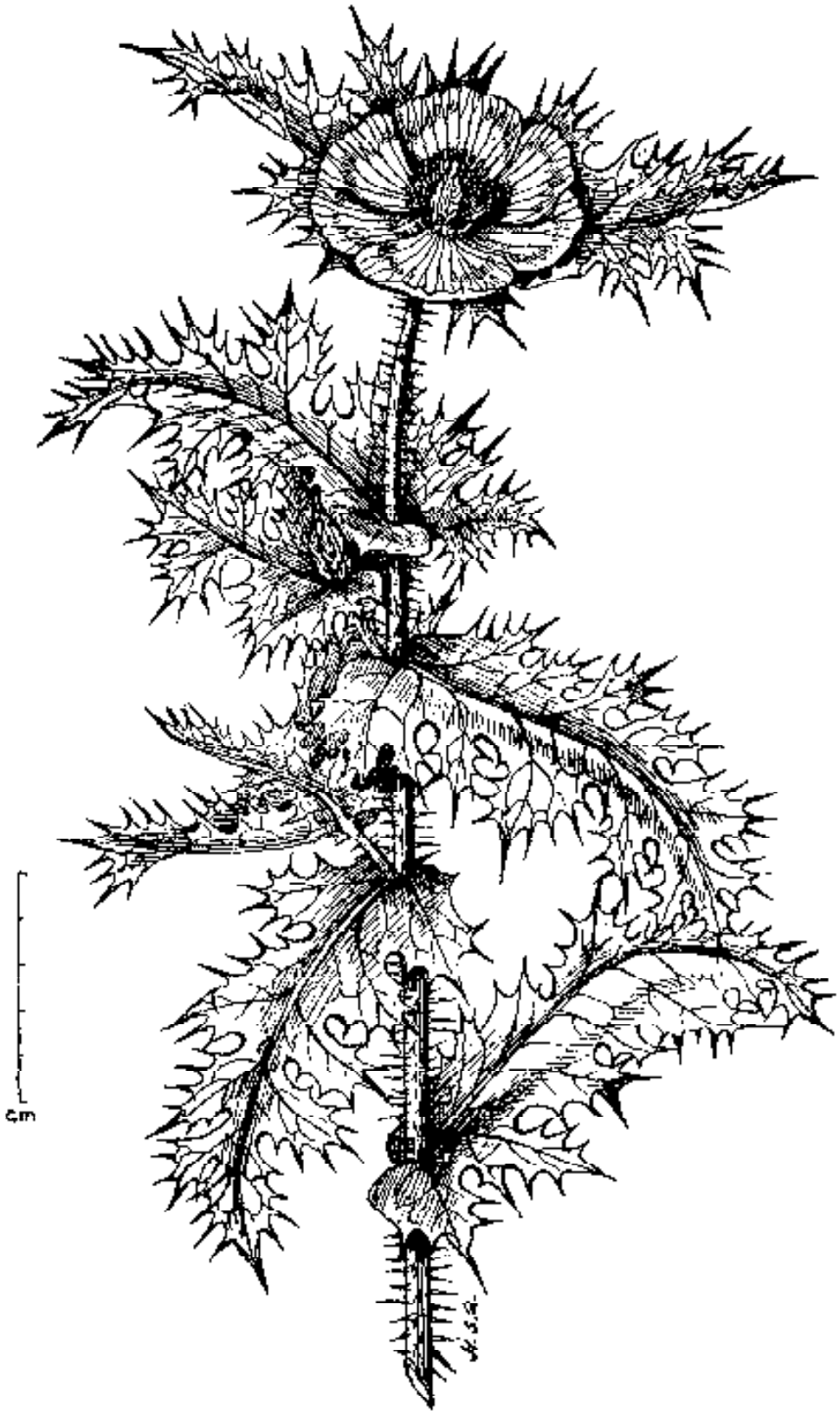


Fig. 1. Habit of *Argemone mexicana* Linn.

coloured flower and gynoecium as long as 5.3-5.6 cm with prominent style and stigma (*A.S. Bell* 178, collected from Banda, U.P.). The gynoecium is prominently placed over the stamens. This appeared to be a teratological variation due to some external stimuli. The specimen is otherwise healthy with normal leaves.

Worsdell (1915) indicated the importance of teratology in the phylogenetic interpretations of plant organs. It is seen that external stimuli results in the development of aberration in plant tissues leading to monstrosities and recapitulation of plant organs which may give clue to their phylogeny. The hereditary alteration of earlier stages in the evolution or padaemorphsis is according to Takhtajan (1954) a major evolutionary process. *Argemone mexicana* L., having such a large ovary with prominent style and stigma could not miss the fertilization and hence it is suggested that the petals turn leafy. Usually teratological forms develop due to external stimuli, due to fungal or insect infestation. When such stimuli trigger off the mechanism of genetic inheritance they are of interest from the phylogenetic angle. Monstrosities occur as "sports" and they may not be hereditarily fixed. The variations of this monostrosity in *Argemone mexicana* are tabulated below.

	Argemone mexicana L.	Teratological variations in *A. mexicana* L.
1. Flowers	Bright yellow in colour.	Green flowered.
2. Bract	Flowers subtended by 2-3 foliaceous bracts.	Flowers subtended by 2 foliaceous bracts.
3. Bracteoles	Absent	Two foliaceous bracteoles present, about 2.8 cm long and 1.5 cm broad, ovate-acuminate.
4. Petals	4-6, bright yellow, obovate, 2.5-3.5 cm long, 1.5 -2.5 cm broad.	4, green, spathulate, 3.1-3.3 cm long, 0.9-1.1 cm broad.
5. Stamens	0.8-1.0 cm long, anthers 0.2 cm long.	2.1 cm long, anthers 0.5 cm long.
6. Ovary	Ovate, 0.8-1.5 cm long, 0.3-0.6 cm broad, stigmas sessile, appressed to the styles, stigmas 3-6 lobed.	Linear-oblong, 5.3-5.6 cm long, 0.7 cm broad, stigmas not sessile, styles distinct about 0.5 cm long, stigmas capitate.

A. mexicana is closely akin to *A. ochroleuca*. The two species are sufficiently close morphologically and present a problem of correct identification if herbarium specimens are examined. Some differences between the two taxa are discussed under *A. ochroleuca*.

1a. **Argemone mexicana** L. f. **leiocarpa** (Greene) Ownbey, Mem. Torrey Bot. Club 21.1: 1-159. 1958; Malik & Grover, Indian Forester 95(2): 123-124. 1969. Debnath et Nayar, Fasc. Fl. Ind. 17:4. 1984. *A. leiocarpa* Greene, in Pittonia 3: 345. 1898; Small, Fl. Southeast, Unit. St. 462. 1903; Fedde, in Engler, Pflanzenr. 4. 104: 278, fig. 36 E. 1909. *A. mexicana* var. *leiocarpa* Prain, in Journ. Bot. 33: 311. 1895, provisional name with no taxonomic standing. *A. alba* var. *leiocarpa* Fedde, in Engl., Pflanzenr. 4. 104: 279. 1909, *nomen nudum* in synonomy; *non A. alba* Lestib.

Erect, glaucous, glabrous (not aculeate), annual herbs. Stems 25 cm to more tall, clusteredly branched, devoid of any spines. Leaves deeply sinuate-dentate or sinuate-pinnatifid, segments repand dentate, both lower and upper surfaces devoid of any spines except all the teeth prolonged into long spines, 3-15 × 1-5 cm. Flower buds totally smooth, 1 × 1 cm, with very glabrous sepals, forming 5-7 mm long narrowed cylindrical horn. Flowers bright yellow, 2-3 cm diameter, arranged in cymose inflorescence, subtended by 2-foliaceous bracts, 1.5-3.0 cm long, narrowed. Petals obovoid, obcuneate, narrowed at the apex, truncate subrotund. Styles somewhat absent or short or distinctly provided, valves coriaceous, very glabrous, reticulate vein; stigmas with sub-drooping lobes. Capsules 3.0-4.0 × 1.25-1.50 cm, 4-6 carpellate, smooth, oblong, scarcely subobovoid, apex subrotund or largely attenuate, 4-5 valved. Seeds dark-brown, globose, regularly, thinly and distinctly reticulate.

Type: Lectotype: Key West, Florida (Plants of Subtropical Florida), March 9, 1899, *Charles L. Pollard, G. N. Collins* and *E. L. Morris* 2 (ND; Isotypes, F, MIN, NY, US). **Fig. 2.**

Fls.: January—March. *Frts.:* February—May.

Distrib.: INDIA: Rajasthan (Udaipur). U.S.A. (southern Florida, Florida Keys); SOUTH AMERICA (Brazil); WEST AFRICA.

Note: *A. mexicana* f. *leiocarpa* differs from *A. mexicana* in having stems, flower buds and capsules devoid of any spines or prickles.

2. **Argemone ochroleuca** Sweet subsp. **ochroleuca** Ownbey, Mem. Torrey Bot. Club 21.1: 40. 1958; Venkatesh, in Current Science, 31(6): 250-251. 1962; Babu, Herbaceous Flora of Dehra Dun, 50. 1977; Debnath et Nayar, Fasc. Fl. Ind. 17: 5. Fig. 1. 1984. *Argemone ochroleuca* Sweet, Brit. Fl.

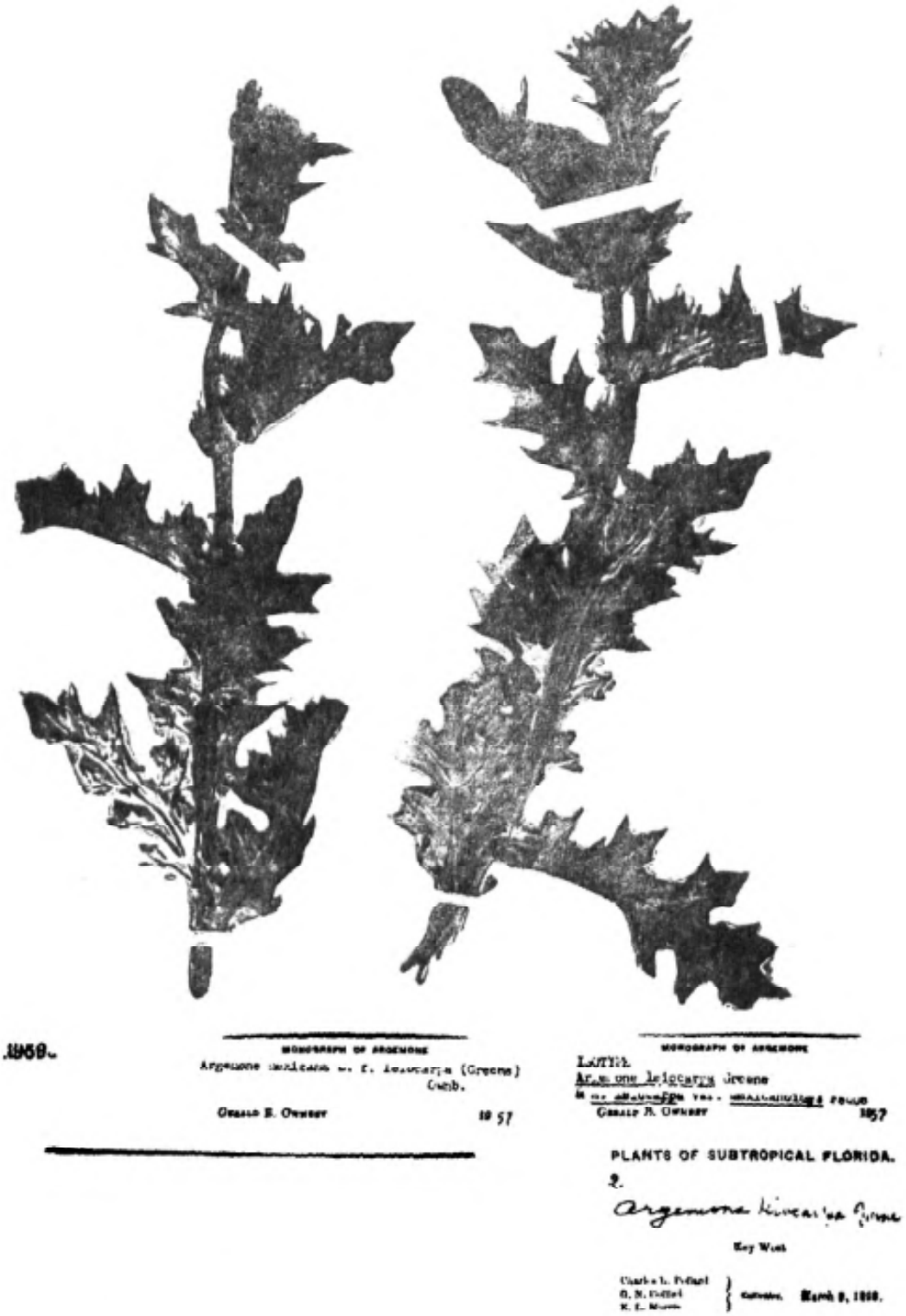


Fig. 2. Type photo of *Argemone mexicana* f. *leiocarpa* (Greene) Ownb.

Gard. 3: t. 242. 1829; Walp. Rep. 1: 110. 1842; Hemsl., Biol. Cent. Am., Bot. 1: 27. 1879; Rose in Countr. U.S. Nat. Herb. 8: 25. 1903; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 22. 1974; Raizada, Supp. Duthie's Fl. Up. Gang. Pl. ed. Siw. & Sub-Himalayan Tracts, 5. 1976. *Argemone mexicana* var. *ochroleuca* Lindl., in Edward's Bot. Reg. 16: t. 1343. 1830; Prain, in Journ. Bot. 33: 310. 1895, as to Mexico distribution; Fedde, in Engler, Pflanzenr. 4. 104: 277, fig. 360. 1909, excluding Yucatan specimens cited, *non A. mexicana* L. **Fig. 3**

Common Names: In Mexico, according to Martinez (1937) the name "Chicalote" is used for *A. ochroleuca*. In India, *A. ochroleuca* is termed as *Bharbhar* (Gorakpuri), *Satyanashi* (Punj.).

Erect, prickly, glaucous, simple or branched annual or perennial herbs. Stems 15-100 cm tall, armed with 0-10 perpendicular or slightly reflexed stoutish prickles per square cm of surface, young stems whitish purple or violaceous. Leaves glaucous, sessile, semi-amplexicaul, oblanceolate, middle and upper leaves elliptic to oblong, lower leaves in a rosette, upper ones sessile, sinuate to pinnatifid, basal leaves deeply lobed to the midrib, lobes oblong, yellowish prickles on the margin and nerves, spinulose-dentate, white variegate-pruinose along and on the nerves, 5-20×3-8 cm. Flower buds oblong, 8-15×4-9 cm, the slender sepal horns 6-8 mm long including the slender terminal spine. Flowers white or creamish white or pale lemon yellow, sessile or on a short pedicel, axillary; 2.5-3.5 cm across, subtended by 2-3 foliaceous bracts, bracts 2-4 cm long, about 5 mm broad. Sepals 3, 8-12×5-7 mm, obovate oblong. Petals 6, white or creamish white or pale lemon yellow, outer ones obcuneate, inner ones obcuneate-obovate, 2.8-3.0 cm long and about 1.8 cm broad. Stamens many, 8-10 mm long; filaments pale yellow; anthers dark-yellow oblong, recurved. Ovary ovate, 8-10×5 mm covered with long sharp erect pointed spreading spines; stigmas dark red, distantly spreading, deeply dissected, 5-lobed, stigmatic lobes divergent and not appressed to the style and the bluish non-receptive areas between them visible; styles 1-3 mm long. Capsules ovate-lanceolate or lanceolate, 1-4 cm long (excluding style length), 4-17 mm broad, covered with 12-26 sharp, erecto-patent spines per valve, the largest spine length 10 mm. Seeds black, ± rounded, 1.5-2.0 mm in diameter.

Type Note: Sweet (1829) mentioned that "the specimens from which our drawing was made, were kindly sent to us by Robert Barclay, Esq. in whose superb collection at Bury-Hill they were raised last spring from seeds received from Mexico ....." Ownbey (1958) stated that "At the Royal Botanic gardens, Kew, there is preserved a specimen of *Argemone ochroleuca* cultivated in Barclay's garden. It probably is not possible at this date to establish that this specimen positively was the material from which the original

description and illustration of the species were drawn. I think, however, that the probability of this being the case is sufficiently great that this specimen may be designated the holotype. The illustration accompanying the original description is of such excellence that the identity of the species is unmistakable".

Type: Holotype: Cultivated in Britain from seeds collected in Mexico.

Fls.: February—April. *Frts.:* April—June.

Distrib.: INDIA: A common weed in fields and embankments: Punjab, Delhi, Uttar Pradesh; PAKISTAN; Native of MEXICO. Ownbey (1958) stated ".....its native areas now indeterminable because of widespread introductions."

Note: Argemone ochroleuca is very closely similar to *A. mexicana* and did present a problem of correct identification if herbarium specimens are examined. The important morphological characters by which *A. ochroleuca* can be distinguished from *A. mexicana* are tabulated in the following table.

	A. ochroleuca	*A. mexicana*
Leaves	Narrower, more deeply divided and sharper pointed leaves than *A. mexicana.*	
Flower buds	Oblong.	Nearly subspherical.
Petals	White or creamish or pale lemon yellow.	Bright yellow.
Stigmas	Distinctly spreading.	Closely crowded together.
Stigma lobes	Stigmatic lobes divergent and not appressed to the style and the bluish non receptacle areas between them visible.	Stigmatic lobes appressed to the style and the non-receptive areas between them completely hidden by the receptive surfaces.
Capsules	Ovate-lanceolate or lanceolate.	Oblong or elliptic oblong.

Cytogenetically *Argemone ochroleuca* differs from *A. mexicana*. *A. ochroleuca* has 2n = 56, whereas *A. mexicana* has 2n = 28. The basic chromosome number of the genus *Argemone* is 7 (Darlington and Wylie, 1955). On the basis of the above reports, it is believed that *A. mexicana* is tetraploid and *A. ohroleuca* is octaploid.

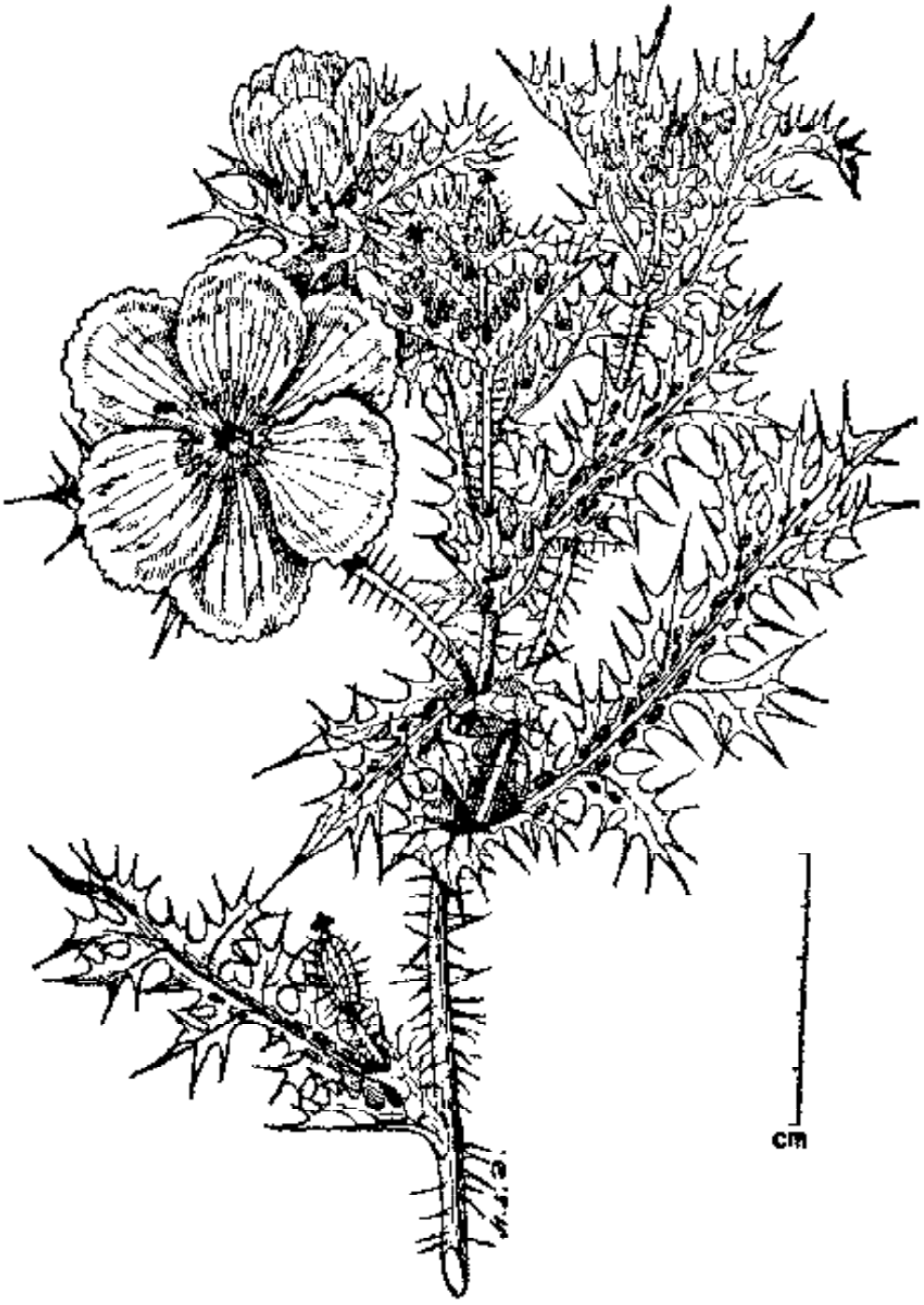


Fig. 3. Habit of *Argemone ochroleuca* Sweet

A. mexicana and *A. ochroleuca* did not have overlapping distribution in South America. But they occur together in the same habitat in India. Hybrids between the two species were also reported by Malik and Grover (1973).

3. **Argemone subfusiformis** Ownbey subsp. **subfusiformis** Ownbey, Brittonia 13: 102, figs. 12-14. 1961; Malik et Grover, Indian Forester, 95(7): 480-481. 1969; Sci. & Culture 41(5): 220-223. 1975; Raizada, Supp. Duthie's Fl. Up. Gang. Pl. ed. Siw. & Sub-Himalayan Tracts, 5. 1976; Debnath et Nayar, Fasc. Fl. Ind. 17: 5. 1984. *A. mexicana* var. *ochroleuca* subvar. *gymnophora* Fedde, in Engler, Pflanzenr. 4. 104: 278, Fig. 36 D, P. 374. 1909.

Annual or subperennial, prickly herbs. Latex yellowish. Stems 40-100 cm tall, branched, armed with 0-5 perpendicular or reflexed prickles per square cm of surface. Leaves glaucous, lobed, sinuses equal, margins dentate, teeth acute, apex spiny, lower surface of the leaves sparingly prickly, about 0-3 prickles per cm of vein, upper surface very smooth. Flower buds oblong, 15-20×8-12 mm, prickly. Flowers 2.8-4.6 cm diameter. Sepal horns terete, 10-14 mm long. Petals lemon yellow, cunneate, suborbicular. Stamens 25-50; filaments yellowish; anthers yellow. Stigmas purple, 2-3 mm broad, 1.5-2.0 mm long at the time of anthesis. Stigma lobes narrow, spreading, not appressed. Capsules subellipsoid to subfusiform, 29-45 mm long (including stigma), 14-15 mm broad, 3-4 (-5) carpellate; styles 0.5-3.0 mm long, surface armed with patent subequal spines. Seeds many, blackish brown, more or less rounded, 1.8-2.5 mm long.

Holotype: ARGENTINA: La Rioja: Dept. Famatine, Famatina, alt. 1620 m., 6 Feb. 1942, *T. Meyer* 4243 (GH). Isotypes (F, ILL., US).

Fls. & Frts.: April—November.

Distrib.: INDIA: Rajasthan (Udaipur): Native of SOUTH AMERICA (Bolivia, Chile, Peru, Ecuador).

Note: The Indian distribution of this species was reported by Malik & Grover (1969) from Udaipur, Rajasthan. The pressed specimens of *A. subfusiformis*, *A. ochroleuca* and *A. mexicana* resemble closely each other and it is very difficult to distinguish them. *A. subfusiformis* is distinguishable from *A. ochroleuca* by having larger flowers and subellipsoid-subfusiform capsules and from *A. mexicana* by oblong buds with larger sepal horns, larger flowers with pale-yellow petals and more spindle-shaped capsules.

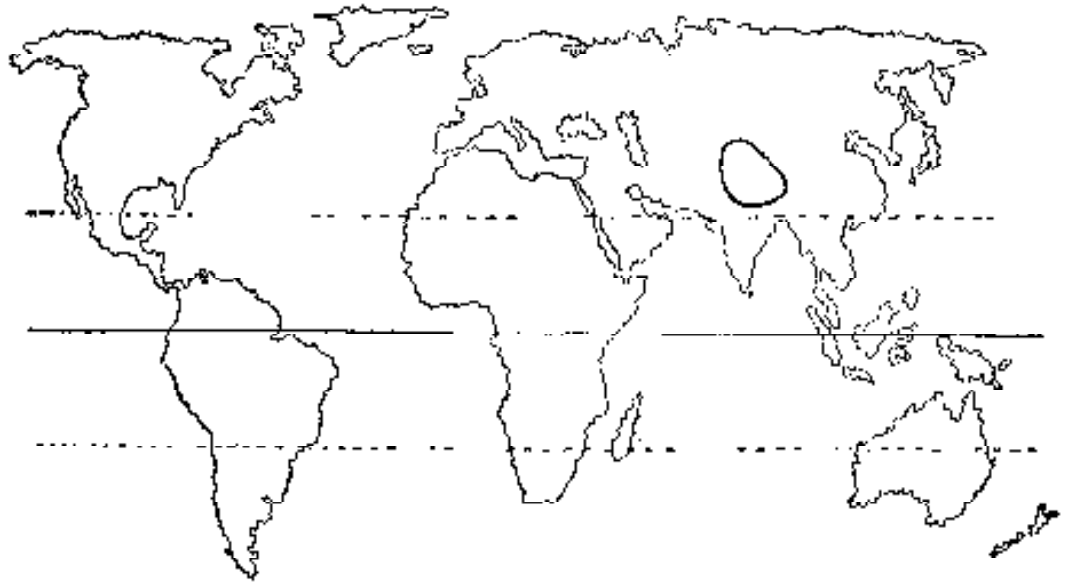
DICRANOSTIGMA

Hook. f. & Thoms., Fl. Ind. 1: 255. 1855; Fedde, in Engler, Pflanzenr. 4. 104: 210. 1909; Debnath et Nayar, Fasc. Fl. Ind. 17:7. 1984. *Chelidonium* subg. IV *Dicranostigma* Prain in Bull. Herb. Boiss. 3: 576. 1895.

Type: Dicranostigma lactucoides Hook. f. & Thoms., Fl. Ind. 255. 1855.

Annual or perennial, glaucous, puberulous herbs with woody root. Stems many, lower part without leaf, branched, alternate leafy bracts above. Leaves mainly radical, petioled, pinnatifid-pinnatipartite, segments distant, rhomboid, acute, sharply cut, terminal trifid. Pedicels ebracteate. Sepals 2, ovate. Petals 4, orange or yellow. Stamens many. Stigmas bifurcate. Capsules narrowly cylindrical or linear, softly hairy or glabrous. Seeds not cristate.

Distrib.: *ca.* 3 species in HIMALAYA and W. CHINA (Map 2). In India the genus is represented by 1 species.



Map 2. Geographical distribution of the genus *Dicranostigma*

Dicranostigma lactucoides Hook. f. & Thoms., Fl. Ind. 1: 255. 1855. Debnath et Nayar, Fasc. Fl. Ind. 17: 7. 1984. *Stylophorum lactucoides* (Hook. f. & Thoms.) Benth. & Hook. f., Gen. Pl. 1: 53. 1862; Hook. f. & Thoms. in Hook. f., Fl. Brit. Ind. 1: 119. 1872; Rau & Rao, Bull. Bot. Surv. Ind. 3: 29, t. 1. 1961; Whitmore in Hara & Williams, En. Fl. Pl. Nepal 2: 35. 1979.

Plant 20-60 cm long, puberulous. Stems 3 or 4, slender, erectly branched above, ending with terminal flower. Leaves pinnatifid-pinnatipartite, segments 4-6 paired, radical leaves 12-25 × 3-5 cm, cauline 2.5 cm long, petiole 3.5-5.0 cm long, winged. Pedicels 5.0-7.5 cm long, slender. Sepals 1.5-2.0 cm long, acute, puberulous, horned at apex. Petals 2.5 cm long, orange. Stamens many; anthers linear oblong. Ovary narrowly ovate, puberulous; styles distinct, 5 mm long; stigma mitriform, crowned. Capsules 5.0-6.0 × 0.5 cm, cylindrical, acute, softly hairy. Seeds numerous, small, 0.8-1.0 mm in diameter, subreniform.

Type: Himalaya: Garhwal, Rogila, 3333 m, *Strachey & Winterbottom* 3 (K).

Fls.: June—August. *Frts.:* September—October.

Distrib.: INDIA: Himalaya, recorded between 2700-4000 m, Uttar Pradesh; NEPAL (Map 3).

Map 3. Geographical distribution of *Dicranostigma lactucoides* in Indian region

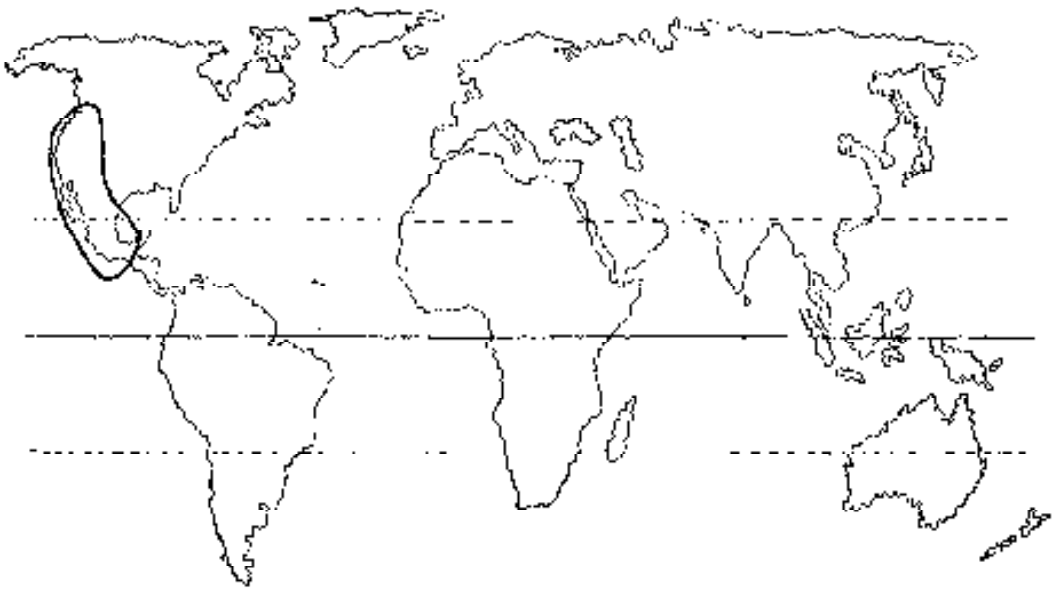
ESCHSCHOLTZIA

Chamisso in Nees, Horae Phys. Berol. 74, t. 15. 1820; Linnaea 1: 554. 1826; Endl. & Fenzl., Gen. Pl. 2: 857. 1837; Endl. Gen. n. 4827. 1839; Benth. & Hook. f., Gen. Pl. 1: 54. 1862; Gray in Proc. Amer. Acad. 22. 2: 271-273. 1887; Fedde, in Engler, Pflanzenr. 4. 104: 144. 1909; Fedde in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 17b: 81. 1936; Jepson, Man. Fl. Pl. California 402. 1951; Mowat, in Tutin *et al.*, Fl. Europ. 1: 251. 1964; Bailey, Cyclop. Hort. 1: 1145. 1967; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 25. 1974; Debnath et Nayar, Fasc. Fl. Ind. 17: 8. 1984.

Type: *Eschscholtzia californica* Chamisso in Nees, Horae Phys. Berol. 74, t. 15. 1820.

Annual or perennial glaucous herbs. Sap watery. Leaves ternately dissected into narrow segments, alternate, petioled. Flowers solitary, terminal or axillary, long pedicelled, large, showy. Torus turbinate with a broad, flat or recurved border surrounding the base of pistil, inner edge of which calyx, corolla, stamens inserted showing perigynous appearance. Sepals 2, oblong, deciduous, connate, forming a hood or calyptra like cap which is pushed off by the expanding petals. Petals 4, free, whitish or yellow. Stamens many, inserted at the base of petals; anthers long; filaments shorter than anthers, dilated base. Ovary linear, ribbed; styles very short; stigmas 4-6, filiform, unequal. Capsules linear, with a narrowed base, dehiscing by 2 valves from base to apex, ribbed. Seeds numerous, globose, reticulate.

Distrib.: The genus *Eschscholtzia* consisting of about 10 species, distributed mostly in NORTH AMERICA (Map 4), is represented by only one species in the Indian region.



Map 4. Geographical distribution of the genus *Eschscholtzia*

Eschscholtzia californica Chamisso in Nees, Horae Phys. Berol. 74, t. 15. 1820; Sweet, Brit. Fl. Gard. 3. t. 265. 1827-1829; DC., Prodr. 3: 344. 1828; Spach, Hist. veg. 7: 48. t. 140. 1839; Hook. et Arn. in Bot. Beech. voy. 134. 1841; Benth. Pl. Hartw. 296. 1848; Brewar et Wats. Bot. Calif. 1: 22. 1880; Bot. Reg. 14: t. 1168. 1882; Gray in Proc. Amer. Acad. 22. 2:271. 1887; Curren in Proc. Calif. Acad. Sci. 1: 245. 1889; Greene, Fl. Francisc. 284. 1892; Man. bot. S. Francisc. 11. 1894; Gray, Synopt. Fl. North Amer. 1. 1: 90. 1895; Fedde, in Engler, Pflanzenr. 4. 104: 154. 1909; Fedde in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 17b: 81. 1936; Jepson, Man. Fl. Pl. California 402. 1951; Mowat in Tutin *et al.* Fl. Europ. 1: 251. 1964; Bailey Cyclop. Hort. 1: 1145. 1967; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 26. 1974; Debnath et Nayar, Fasc. Fl. Ind. 17: 8. 1984. **Fig. 4**

Perennial, erect to diffuse herbs. Stems 30-50 cm tall, quadrangular, scapose or leafy, dichotomously branched, glabrous or nearly so. Leaves 10-30 cm long, alternate, radical or cauline, ternately dissected into very narrow, linear segments, segments *ca.* 1 mm broad, acute or subobtuse. Petioles 5-20 cm long, becoming shorter in the upper leaves. Flower buds ovate, 2.0-2.5×1.0-1.5 cm. Pedicels 6-20 cm long. Flowers solitary, axillary or terminal, 4-8 cm in diameter, showy. Sepals 2, united into a calyptra, deciduous, leaving 2 rims at the base of the ovary, conical, *ca.* 2 cm long-outer spreading rim of the receptacle, 3-4 mm broad with parallel striations, inner rim erect, short. Petals 4, 1.5-6.0×1.0-4.0 cm, yellow, broadly obovate, shortly clawed. Stemens many; anthers 4-6 mm long, linear-lanceolate, basifixed, ditheceous; filaments short, 3-5 mm long. Ovary *ca.* 8-10 mm long; styles short; stigmas 4, filiform, uncqual, 3-4 mm long. Capsules 7-10 cm long & 3-4 mm broad, longitudinally prominently ribbed, glabrous, dehiscing by 2 valves, straight. Seeds 2 mm in diameter, black, globose, reticulate.

Type: USA, 1820, *Chamisso* (B,P,W); USA, *Douglas* (K)

Fls.: February—June. *Frts.:* May—August.

Distrib.: A native of North America (California, Oregon). Cultivated widely Europe, Asia as an ornamental plant. In India cultivated in gardens as an ornamental plant, often runs wild.

GLAUCIUM

[Tourn. Inst. 254, t. 130. 1700] Miller, Gard. Dict. abr. ed. 4. 1754; Adans. Fam. d. plant. 2: 432. 1763; Juss. Gen. 236. 1789; DC., Prodr. 1: 122. 1824; Endl. & Fenzl, Gen. Pl. 2: 856. 1837; Benth. & Hook. f., Gen. Pl. 1: 53. 1862; Boiss., Fl. Or. 1: 119. 1867; O. Ktze. in Act. hort. Petrop. 10: 147. 1887;

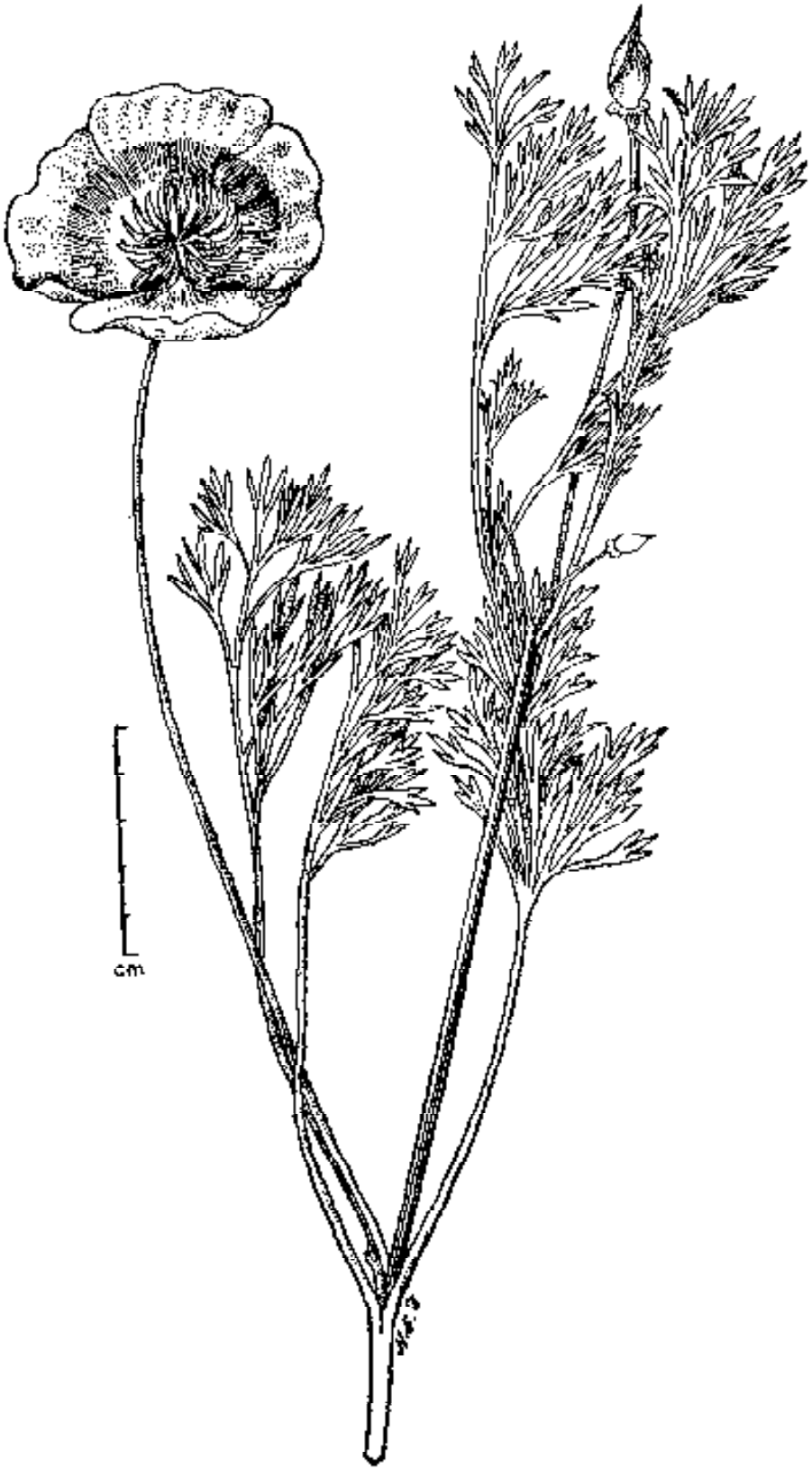
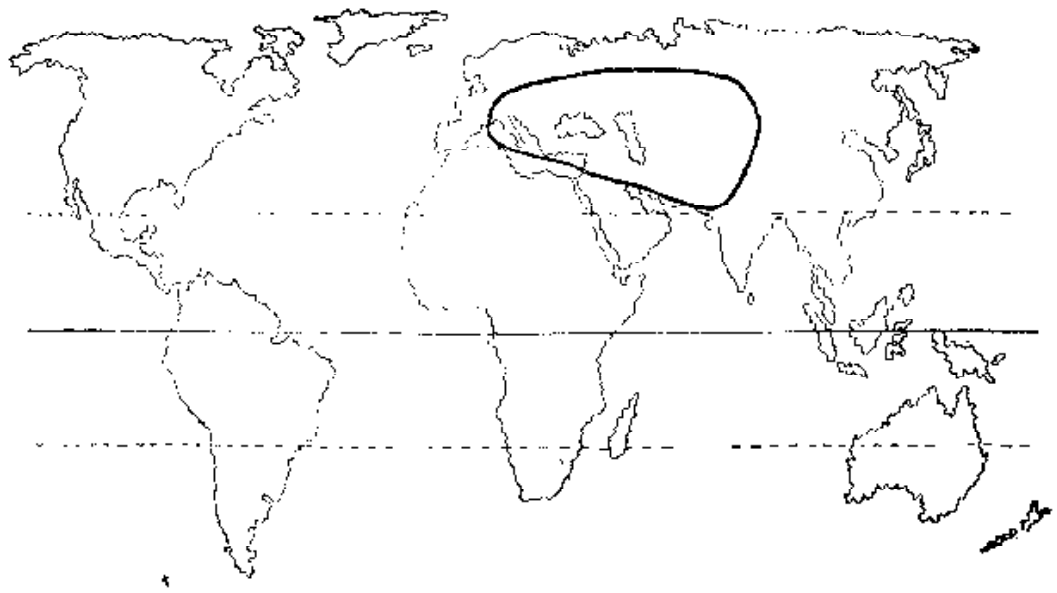


Fig. 4. Habit of *Eschscholtzia californica* Cham.

K. Prantl u. J. Kundig in Engl. U. Prantl, Pflzfam. 3. 2: 141. 1889; Fedde, in Engler, Pflanzenr. 4. 104: 221. 1909; Fedde in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 17b: 92. 1936; Popov in Komarov, Fl. U.S.S.R. 7: 585. 1937; Bailey, St. Cycl. Hort. 2: 1346. 1950; Clapham, Tutin and Warburg, Fl. Brit. Is. ed. 2: 123. 1962; Cullen in Rechinger f., Fl. Iran. 34: 2. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 2. 1974.

Annual, biennial or rarely perennial, sparsely hairy herbs. Latex yellow. Stems branched, large. Leaves alternate, pinnatifid or pinnatisect, glabrous or slightly villous, segments lobed or dentate. Flowers solitary, axillary or terminal, large, showy. Pedicels erect, rarely recurbed in fruits. Sepals 2, caducous. Petals 4, yellow, orange or red, somtimes with oblong spots at base, orbicular-obovate. Stamens numerous, yellow; filaments filiform; anthers oblong or linear, extrorse. Ovary linear-oblong, bi-loculed, glabrous or covered with appressed spine-like setae; styles incospicuous; stigmas large, conical, broader than high, with two laterally divergent horizontal or recurved horns. Fruits *siliqua*-like capsules, up to 25 cm long, usually cylindrical-linear, 2-loculed, dehiscing by 2-valves. Seeds numerous, large, reticulate-pitted, slightly curved, ovate-reniform, without aril, embeded in spongy septum, produced from the fusion of two opposite placentas.

Distrib.: *ca.* 25 species distributed in Mediterranean and central Asian regions (Map 5), is represented by 2 species in Indian region: PAKISTAN.



Map 5. Geographical distribution of the genus *Glaucium*

Ecol.: The genus occurs in the stony woodless, gypsiferous clayey and slopy slopes, loose or clayey bluffs, pebbly riverbeds, fields, stony localities, in the lower and middle mountain belt and in the semidesert zone.

KEY TO THE SPECIES

1a. Siliques very torulose, dehiscing from base to apex. Seeds oblong cylindrical ... *G. elegans* 1

1b. Siliques slightly torulose, dehiscing from apex to base. Seeds reniform ... *G. fimbrilligerum* 2

1. **Glaucium elegans** Fisch. et Mey. in Ind. Sem. Hort. Petrop. 1: 29. 1835; Boiss., Fl. Or. 1: 120. 1867; Trantv. in Act. hort. Petrop. 10. 1: 98. 1887; Fedde, in Engler, Pflanzenr. 4. 104: 230. 1909; Fedde in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 17b: 96. 1936; Popov in Komarov, Fl. U.S.S.R. 7: 594. 1937; Kitamura, Fl. Afghan. 135. 1960; Cullen in Rechinger f., Fl. Iran. 34: 4. Fig. 1, B-D. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 2. 1974. *G. pumilum* Boiss., Ann. Sc. Nat. Ser. 2, 16: 374. 1841. *G. squamigerum* Bunge in Lehm., Mem. Sav. Etrang Acad. Petersb. 7: 192. 1847 *non* Kar. & Kir. in Bull. Soc. Nat. Mosc. 15: 141. 1842. *G. tenue* Regel et Schmalh. in Regel, Descr. Pl. Nov. Fedtschenk. 2. 1882.

Fig. 5

Annual, glaucous herbs. Stems slender, dichotomously branched, glabrous to sparsely pilose, basal part covered with persistent leaf sheaths, 5-30 cm tall. Radical leaves in small rosette, 3-12×1-3 cm, lyrately pinnatilobate or pinnatisect, segments oblong or irregularly ovate-triangular, apex acute or slightly acuminate, margin angular crenate or incised, petioled; upper leaves 1.2-4.0×1.0-3.5 cm, with amplexicaul base, cordate-rounded, sinuate-dentate, with teeth terminated into a short awns, sessile. Petioles 1-6 cm long, glabrous-slightly pilose. Bracts foliaceous, 4-10×3-9 mm. Flower buds 7-20×2-6 mm narrowly oblong to oblong, acute, glabrous or with short aculeate papillae. Pedicels short, *ca.* 2 cm long, increasing up to 6 cm in fruiting condition. Sepals 6-18 mm long, obtrulate-oblong, glabrous or sparsely pilose outside. Petals 12-15×12-14 mm, orange, with brownish black spots at base, suborbicular-obovate, margin wavy. Stamens multiseriate, 10-12 mm long; filaments obscurely winged or dilated throughout its length; anthers 1.5-2.0 mm long, oblong. Ovary linear-oblong, 10-12 mm long; styles inconspicuous; stigmas dome shaped with horizontal horns. Siliques up to 13 cm long, *ca.* 2 mm broad, erect, thin, often arcuate or irregularly contorted, torulose, dehiscing from base to apex, covered with smooth conical spine-like papillae. Seeds oblong cylindrical, 10-12 mm diameter.

Fig. 5. Habit of *Glaucium elegans* Fisch. et Mey.

Type: North Iran (LE)

Fls.: April—May. *Frts.:* May—July.

Distrib.: PAKISTAN; AFGHANISTAN; IRAN; USSR.

2. **Glaucium fimbrilligerum** (Trautv.) Boiss., Fl. Or. 1: 120. 1867; Fedde, in Engler, Pflanzenr. 4.104: 228. 1909; Fedde in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 17b: 96. 1936; Popov in Komarov, Fl. U.S.S.R. 7: 593. 1937; Kitamura, Fl. Afghan. 135. 1960; Cullen in Rechinger f., Fl. Iran. 34: 5. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 3. 1974. *G. luteum* var. *fimbrilligera* Trautv. in Bull. Soc. Nat. Mosc. 33, 2: 92. 1860. *G. persicum* Bunge in Lehm., Mem. Sav. Etrang Acad. Petersb. 7: 192. 1847 *non* DC. Syst. Nat. 97. 1821. **Fig. 6**

Annual, biennial or perennial herbs. Stems robust, branched, slightly pilose, basal part covered with persistent leaf sheaths. 30-60 cm tall. Leaves glabrous or slightly villous; radical leaves in rosette, 3-10 × 1-3 cm, lyrately pinnatisect, segments triangular to ovate, irregularly broad-angular, acute or slightly acuminate, petioled; upper leaves 1.5-5.0 × 1.0-4.5 cm, with amplexicaul base, subcordate-cordate, lobed, lobes acute-acuminate, with teeth terminated into a long bristles, sessile. Petioles 1.5-5.0 cm long, slightly pilose. Bracts foliaceous, 3-8 × 2-6 mm. Flower buds 15-20 × 4-5 mm, oblong or ovate-oblong, acute, glabrous or sparsely pilose. Pedicels 2-10 cm long, increasing up to 20 cm in fruiting condition. Sepals 15-20 × 4-5 mm, oblong, acute, glabrous or sparsely pilose outside. Petals *ca.* 2 cm long, 1.5-2.0 cm broad, yellow, obovate, margin wavy. Stamens multiseriate; filaments 4-8 mm long, narrow ends, middle dilated; anthers 0.5-1.0 mm long, oblong, basifixed. Ovary linear, 1.5-2.0 cm long, covered with appressed spine-like setae; styles inconspicuous; stigmas dome-shaped with horizontal horns. Siliques up to 18 cm long, 1.0-2.5 mm broad, erect, often slightly arcuate, rarely slightly torulose, dehiscing from apex to base, covered with sparsely appressed spine-like setae. Seeds reniform.

Type: USSR, 1842, *Lehmann* 52 (P); Afghanistan, *Griffith* 142 (GOET); *Griffith* 988 (G-BOIS); USSR, *Selman* s.n. (G-BOIS).

Fls.: April—July. *Frts.:* May—September.

Distrib.: PAKISTAN; AFGHANISTAN; TURKISTAN; IRAN; USSR.

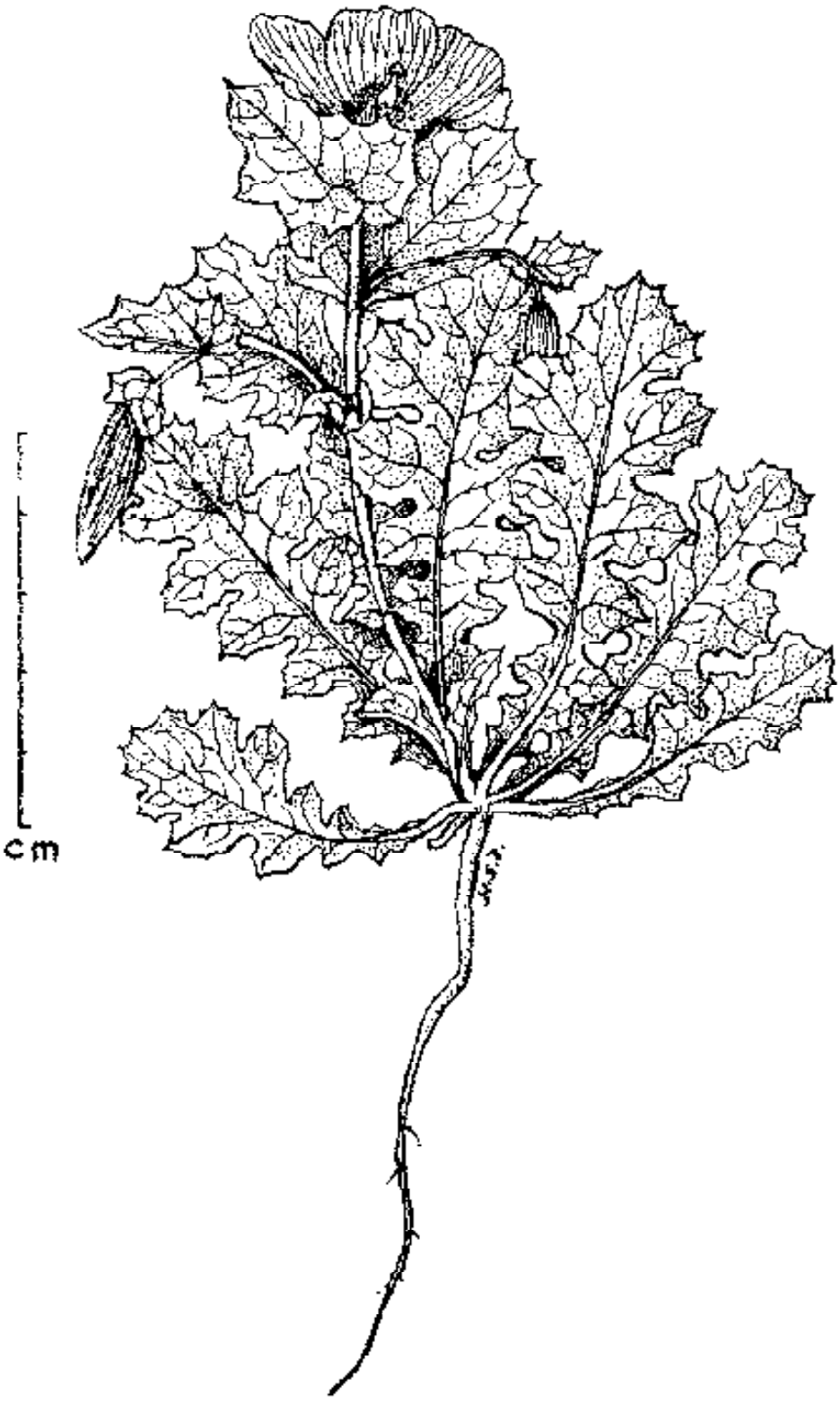


Fig. 6. Habit of *Glaucium fimbrilligerum* (Trautv.) Boiss.

Note: Two varieties *G. fimbrilligerum* var. *typicum* and *G. fimbrilligerum* var. *leiocarpum* have been recognised by Popov (1937) on the basis of the presence or absence of bristles on siliques. The variety *leiocarpum* differs from var. *typicum* by glabrous siliques.

MECONOPSIS

Vig., Hist. Pavot. et Argemone. 48. 1814; Hook. f. & Thoms. in Hook. f., Fl. Brit. Ind. 1: 118. 1872; Prain in Journ. Asiat. Soc. Beng. 63, 2: 81. 1894; ibid. 64. 2: 309. 1895; in Roy. Bot. Gard. Calcutta, 9. 1: 2. 1901; Ann. Bot. 20: 323. 1906 et in Kew Bull. 1915: 129. 1915; Fedde, in Engler, Pflanzenr. 4. 104: 247. 1909 et in Engler & Prantl, Nat. Pflanzenfam., ed. 2. 17b: 98. 1936; G. Tayl., Acc. genus Meconopsis 1-130. 1934; Debnath et Nayar, Fasc. Fl. Ind. 17: 9. 1984.

Type: Meconopsis cambrica (Linn.) Vig., Hist. Pavot. et Argemone, 48, fig. 3. 1814.

Erect, perennial, monocarpic or polycarpic herbs, stout often woody base. Stems scapose or leafy, usually simple, often branched. Leaves radical or cauline, entire to 2-pinnatifid-pinnatipartite, rarely palmatifid. Flowers solitary, terminal on scapose stems or on pedicels arising all along the central flowering axis, forming leafy racemes or in axillary cymules forming a leafy panicled inflorescence. Sepals 2, caducous. Petals 4, more often 5-9 (-10), variously coloured, showy. Stamens many; filaments filiform, linear, mostly coloured like petals. Ovary sessile, ellipsoid-oblong or ovoid or obovoid or subglobose, usually with a distinct style, stigmas of 2-12, free or confluent, more or less decurrent lobes, forming clavate or subglobose or capitate structure, with the lobes opposite to the placental ridges. Capsules ellipsoid oblong or ovoid-oblong or obovoid. Usually dehiscing by interplacental valves at apex only or rarely to the base. Seeds many, subreniform or ellipsoid-oblong, smooth or rugose, often papillose.

Generic Synonymy of Meconopsis

Cathcartia Hook. f. in Bot. Mag. t. 4596. 1851; Hook. f. & Thoms. in Hook. f., Fl. Brit. Ind. 1: 119. 1872.

Generic Relationships

It is very difficult to set apart *Meconopsis* from other genera of the family Papaveraceae by a single character. Though the combination of characters rather than any single one it is possible to distinguish the genus *Meconopsis*. So the relationships of *Meconopsis* with allied genera are very close.

The genus *Meconopsis* appears to be most closely related to *Papaver*, *Argemone* and *Stylomecon*.

Certain species of *Meconopsis* and species of *Argemone* show close affinity. For example, there is similarity in the mode of dehiscence of the capsules and the presence of united styles.

Though the genus *Argemone* is closely related to *Meconopsis*, but there are some characteristic differences. In *Argemone* the sepals are surmounted by a horn-like appendage, while the sepals of *Meconopsis* do not have the horn-like appendage. Besides, the flowers of *Argemone* are generally trimerous whereas those of *Meconopsis* are commonly dimerous.

The type species of the genus *Meconopsis* is originally named as *Papaver cambricum*. Until 1814 both the genera were considered congeneric. In 1814 Viguier proposed his new genus *Meconopsis* which was differentiated by him from typical *Papaver* by the presence of a short style and the complete absence of sessile stigmatic disc surmounting the ovary. It is seen that there are some species of *Meconopsis* where the stigma is sessile and the arrangement of the stigmatic rays shows the same condition as that of the section *Milantha* of the genus *Papaver*. Some species of *Meconopsis* show the astylar forms, but in the astylar forms the stigmatic rays have prominently decurrent over fluted stigmatic columns. These types of stigmatic rays are absent in *Papaver*.

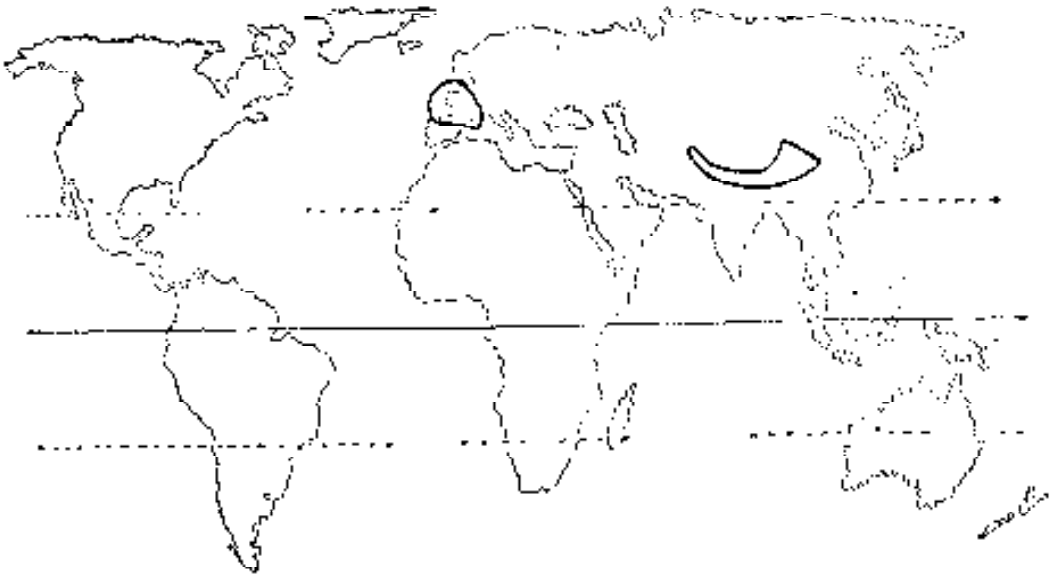
The relationship of *Stylomecon* with *Meconopsis* appears so close that the monotypic genus *Stylomecon* have been referred previously to the series or section *Anomalae* of the genus *Meconopsis* by many authors. The flattening character of the ovary at the apex in the genus *Stylomecon* shows to be very close to the condition of the subgenus *Discogyne* of *Meconopsis*. On the basis of annual habit, bicoloured flowers and general facies, Taylor (1934) separated *Stylomecon* from *Meconopsis* and recognised it as a new genus.

Geographical Range of Meconopsis

The species of *Meconopsis* are distributed in south-central Asia (except *M. cambrica* of western Europe) from the southern boundary, extending from Chitral and Kashmir along the Himalaya and intervening ranges to northern Yunnan, southern Tibet and the province of Szechuan to southern Kansu, central Shensi and western Hupeh (Map 6). Indian species are almost all of them are confined to the Himalaya. Type species of the genus *M. cambrica* which is the extra-Asiatic representative forms a peculiar geographical outlier confined to western Europe, extending from western England, Wales and Ireland to northern Spain.

The genus is restricted to montane habitats mostly between elevations of 2135 to 5795 m (Fig. 7). *M. cambrica* have been collected at lower elevations (below 608 m) and *M. horridula* has been gathered above 5500 m to highest limit of phanerogamic vegetation. The occurrence of this species at an elevation above 5500 m in the Himalaya indicates its wide tolerance of altitude and climatic conditions.

The majority of the Indian region species of *Meconopsis* are localized in geographical distribution. Notable species concentrations of that localized species occur in only three disjunct areas within the range: from central Nepal, south-eastern or south-central Tibet to Bhutan, from south-eastern Tibet, north-eastern Yunnan and northern upper Burma, from north-western Frontier Province to Kumaon (Fig. 8).



Map 6. Geographical distribution of the genus *Meconopsis*

Meconopsis horridula, M. paniculata, M. napaulensis and *M. lyrata* are the only species with comparatively widespread ranges. *M. horridula* the most widely dispersed of all, is found from western Kansu to north-western Yunnan, through upper Burma and along the Himalaya to central Nepal. *M. paniculata* occurs along the Himalaya from eastern Nepal to north-western Assam. *M. napaulensis* is found from central Nepal to western Szechuan and *M. lyrata* from north-western Yunnan to central Nepal.

The two endemic species are *Meconopsis robusta* and *M. latifolia* confined to Kumaon and northern Kashmir respectively. The species *Meconopsis dhwojii, M. graciliper, M. longipetiolata, M. regia* are confined to Nepal. *Meconopsis neglecta* is known only from Chitral State. Poor seed dispersal may be a causative factor in the localized distribution of species.

Although many species are geographical overlapping in various degrees, even in these areas of overlap species may be seen in isolation due to topographic features, altitudinal habitats and other environmental stresses. In central Nepal, south-eastern and south-central Tibet to Bhutan *Meconopsis villosa* extends from 2745-4270 m, *M. simplicifolia* from 3050-5000 m, *M. bella* from 3965-4880 m, *M. discigera* from 3355-4880 m and *M. superba* only from 3965-4270 m.

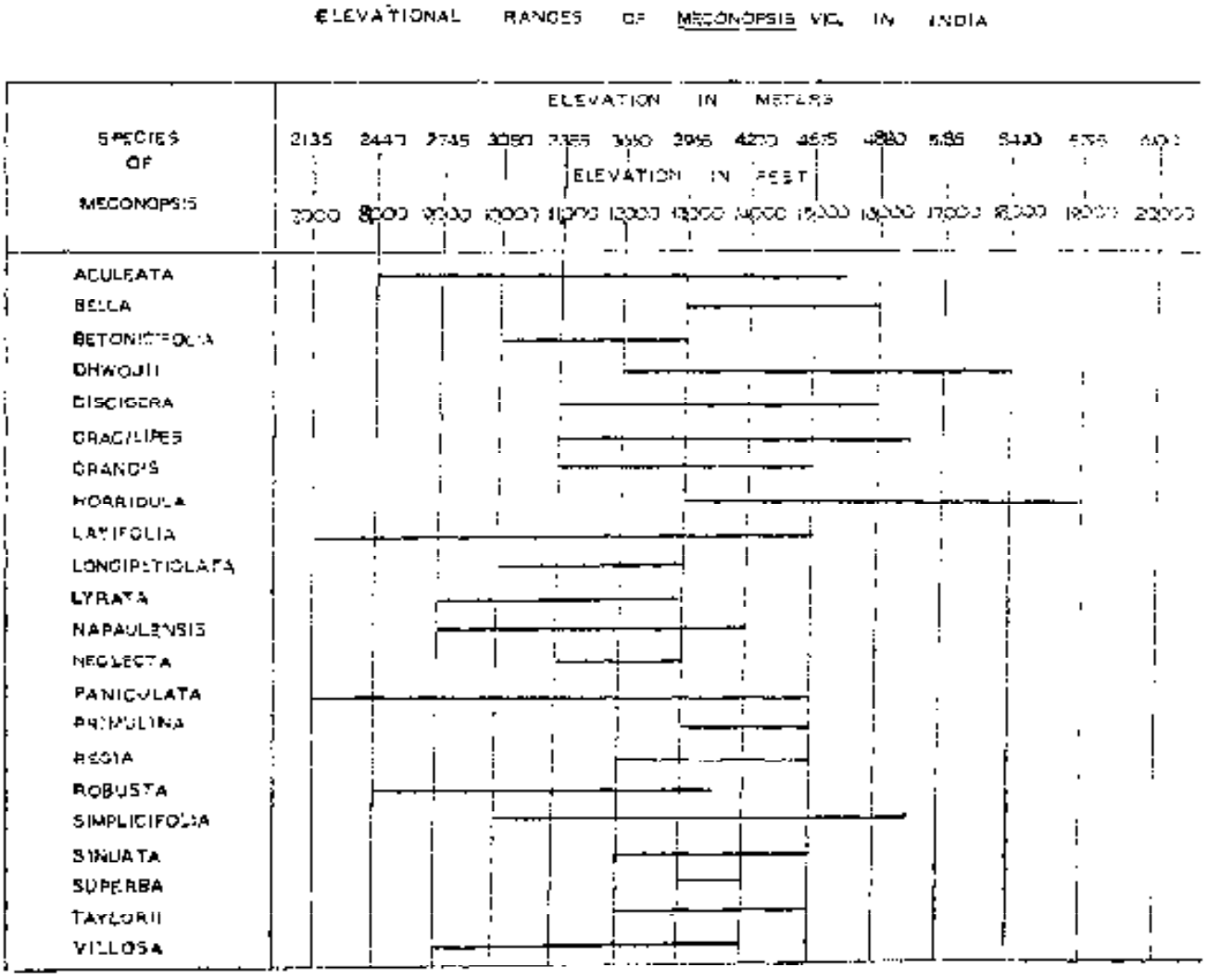


Fig. 7. Elevational ranges of the genus *Meconopsis* Vig. in India

Ecology

In Indian region the genus occurs in the alpine woods and scrub, meadows and scree slopes of the Himalaya from 2135 to 5795 m altitude.

GEOGRAPHICAL DISTRIBUTION OF THE SPECIES OF MECONOPSIS

SPECIES OF MECONOPSIS	PAKISTAN	INDIA								NEPAL	BHUTAN	BURMA	TIBET	CHINA
		KASHMIR	HIMACHAL PRADESH	PUNJAB	UTTAR PRADESH	WEST BENGAL (DARJEELING)	SIKKIM	ARUNACHAL PRADESH	ASSAM					
ACULEATA	+	+	+	+	+									
BELLA							+			+	+			
BETONICIFOLIA								+				+	+	+
DHWOJII										+				
DISCIGERA							+			+	+		+	
GRACILIPES										+				
GRANDIS							+			+	+		+	
HORRIDULA							+			+	+	+	+	+
LATIFOLIA	+	+												
LONGIPETIOLATA										+				
LYRATA						+	+			+	+		+	+
NAPAULENSIS					+	+	+		+	+	+			+
NEGLECTA	+	+												
PANICULATA					+	+	+			+	+		+	
PRIMULINA											+		+	
REGIA										+				
ROBUSTA					+									
SIMPLICIFOLIA							+			+	+		+	
SINUATA							+			+	+			
SUPERBA							+				+		+	
TAYLORII										+				
VILLOSA						+	+			+	+			

Fig. 8. Geographical distribution of the species of the genus *Meconopsis* Vig.

COMPARATIVE MORPHOLOGY

Figs. 9-12

Habit and Branching

Species of *Meconopsis* are monocarpic or polycarpic herbs or both monocarpic and polycarpic nature seen in the same species. As regards habit, the species of *Meconopsis* have slender non-scapose, sparingly branched, leafy stems. Majority of the species of Indian region are monocarpic herbs. Some species *(M. simplicifolia, M. betonicifolia)* are both monocarpic and polycarpic.

The most of the species have stems with more or less dense rufous spreading bristles or soft appressed or villous or setose villous hairs. In *M. horridula*

stem is very short and base of stem is covered with persistent leaf-bases usually interspersed with prickles. The flowering stem is usually accompanied by scapes arising from the axils of the basal leaves. When central flowering stem is absent then flowers are borne on basal scapes only.

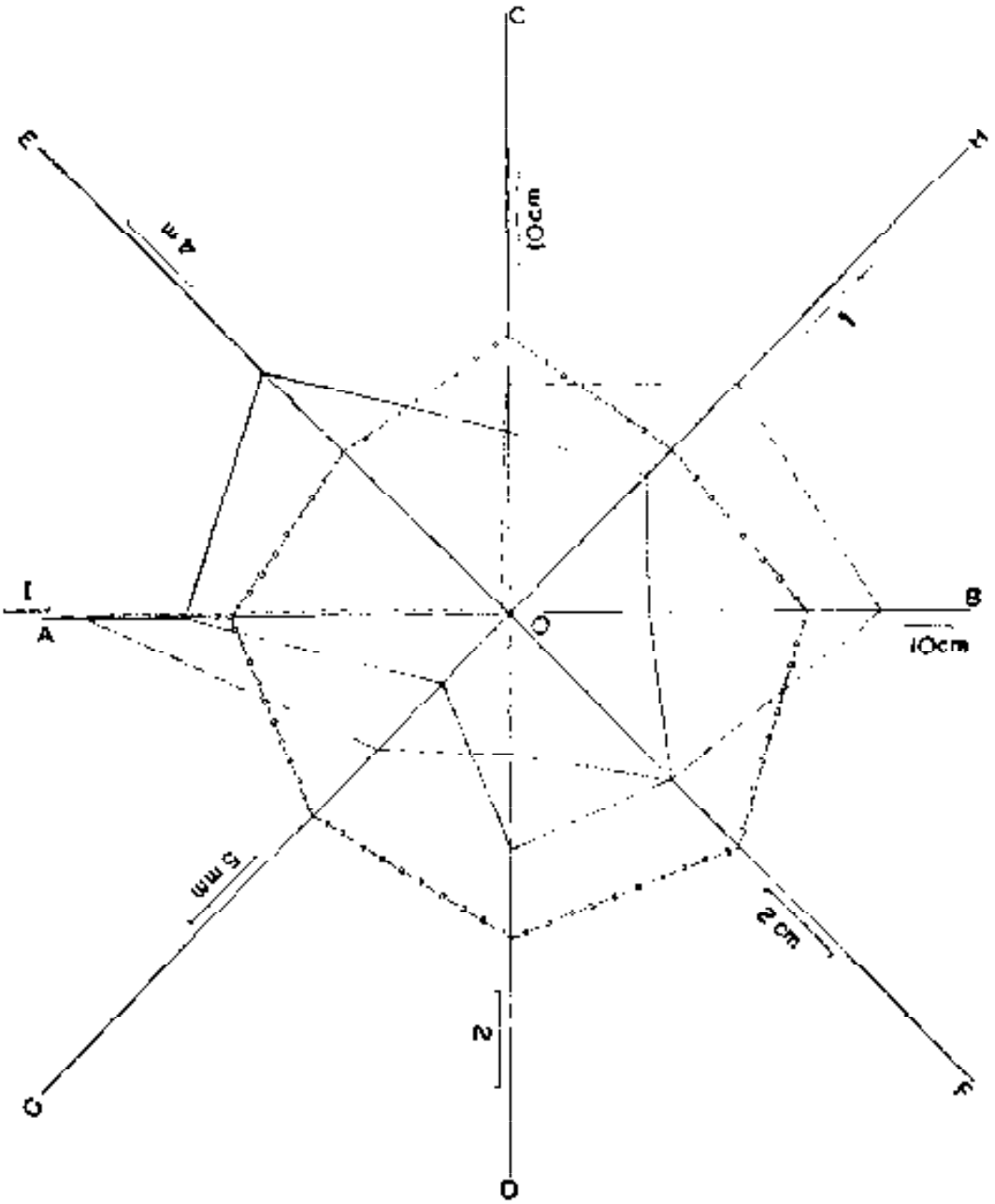


Fig. 9. Diagrammatic representation of the highest dispersion value of different characters of the species *Meconopsis betonicifolia* (———), *M. grandis* (—o—o—o—o—), *M. simplicifolia* (—.—.—.—.—). OA—Stigma lobed, OB—Length of pedicel, OC—Length of petiole, OD—Breadth of petal, OE—Length of stem, OF—Length of petal, OG—Length of style, OH—Length-breadth ratio of lamina

Stems may be rigidly erect or may be short and thick. When the stem is rigidly erect *(M. betonicifolia, M. grandis)* it may be glabrous or covered with scattered spreading rufous hairs or more or less densely bristles. At the base it is densely covered with persistent leaf bases interspersed with rufous barbellate hairs. When the stem is short and thick *(M. simplicifolia)*, it is concealed by the dense rosette of basal leaves and membranous in the lower part, densely covered by rufous bristles. The stem of *M. tyrata* is very weak, glabrous or sparsely hairy. Length of the stems of the species vary from 5 to 20 cm. In *M. napaulensis* the branched flowering stem reaches 20 cm height.

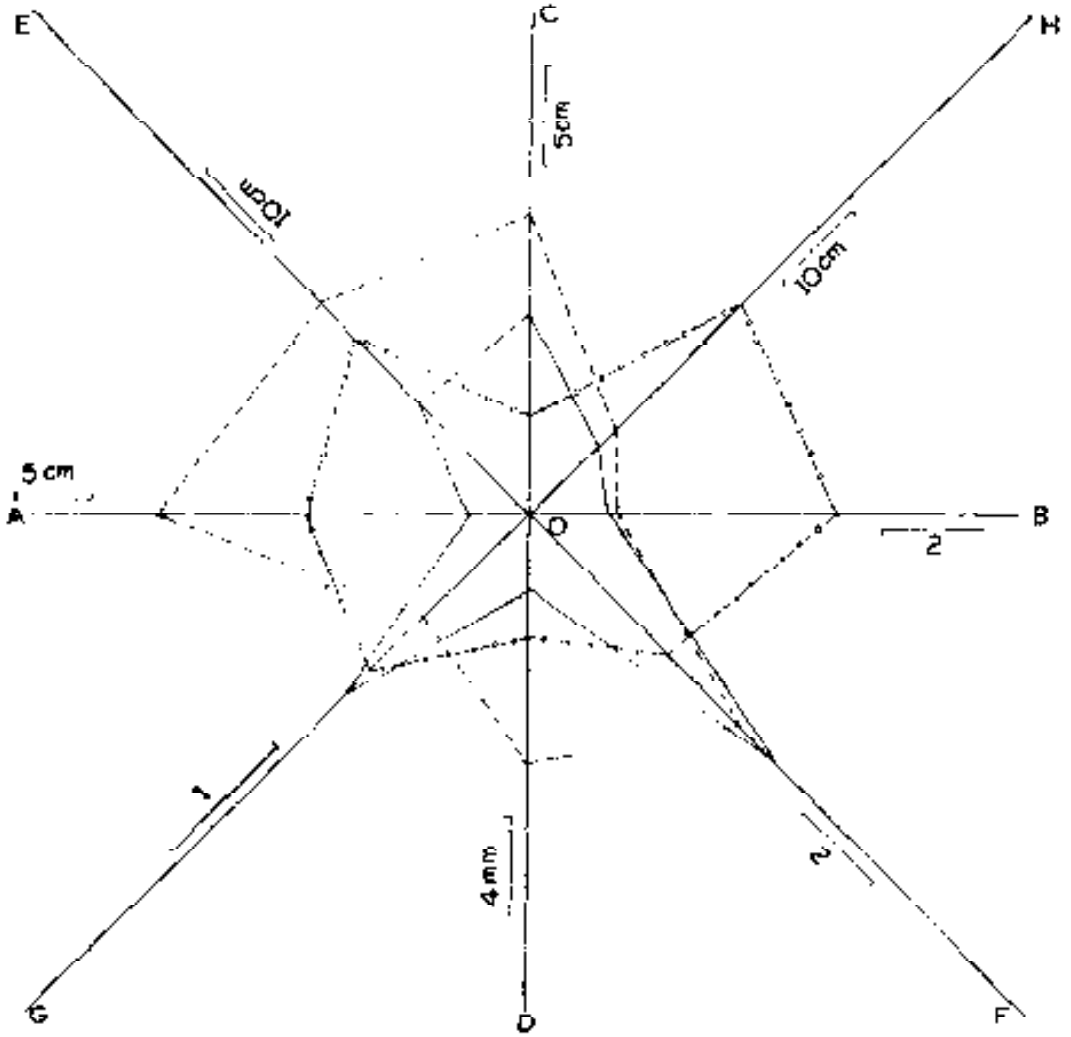


Fig. 10. Diagrammatic representation of the highest dispersion value of different characters of the species *Meconopsis aculeata* (—·—·—·—), *M. latifolia* (—— ——), *M. sinuata* (— o— o—o —). OA—Length of pedicel, OB—Length-breadth ratio of capsule, OC—Length of petiole, OD—Length of style, OE—Length-breadth ratio of lamina, OF—Number of capsule valves, OG—Length-breadth ratio of petiole, OH—Length of root

The species *M. bella* is a distinctive member of the genus with its dwarf-tufted habit. It may be pointed out that the species *M. horridula* growing at lower elevations are usually taller and those that are growing at higher elevations usually tend to become dwarfer, and generally assume caespitose habit. The species *M. grandis* of Nepal does not appear to be so robust as in Sikkim.

The majority of the Indian species are monocarpic, except few are polycarpic. In the members of the monocarpic species the tap root may be narrowly dauciform, stout, elongated or short and napiform, attaining maximum one foot in length. In the polycarpic members the tap root may be short and stout, covered with persistent leaf bases and rufous bristles or narrowly dauciform or sometimes the root system is fibrous.

The production of bulbils in the axils of the stem leaves of the two species *M. lyrata* and *M. chelidonifolia* represent an unique feature which appears to be quite exceptional in the family Papaveraceae and perhaps among Ranales (Taylor, 1934).

Leaves

There is a wealth of striking differential foliage features within the genus *Meconopsis*. Some species have crowns that persist, others have crowns that die down during winter, some are dense rosette, others tufted but apparently soon withering.

Leaves of *Meconopsis* usually are entire or subentire, less often lobed or dissected, glabrous or beset with simple or barbellate hairs or setae or prickles.

The species *M. paniculata, M. robusta, M. napaulensis* are distinct from others by having persistent crowns. The plants have usually branching stems central to a crown leaves which does not die away during the winter. Whereas the species *M. sinuata, M. horridula, M. aculeata* & *M. latifolia* lose their crown during the winter months.

M. paniculata, M. robusta, M. napaulensis have deeply lobed leaves. Leaves are very variable in shape, pinnatisect towards the base and pinnatifid towards the apex and the base of the leaves is cuneate to auriculate.

The pubescence of the leaves is characteristic in the following species. In *M. robusta* the leaves have sparse or dense hairs which ultimately break off, leaving short hispid bases. In *M. paniculata* the leaves have long barbellate and much branched hairs which clothe the surface of the leaves so as to give the appearance of fine substellate down. In *M. napaulensis,* in both the surfaces of the leaves have long weak bristles which are sparsely or densely covered.

The species *M. sinuata, M. aculeata, M. latifolia, M. horridula* lose their crown leaves during the winter months and have obovate-oblanceolate with deeply or irregularly lobes *(M. sinuata)*, oblong to ovate or broadly lanceolate, usually cuneate but occasionally obtuse or rounded at the base with crenations at the margin and coarsely serrate *(M. latifolia)*, irregularly pinnatifid or pinnatisect *(M. aculeata)* leaves.

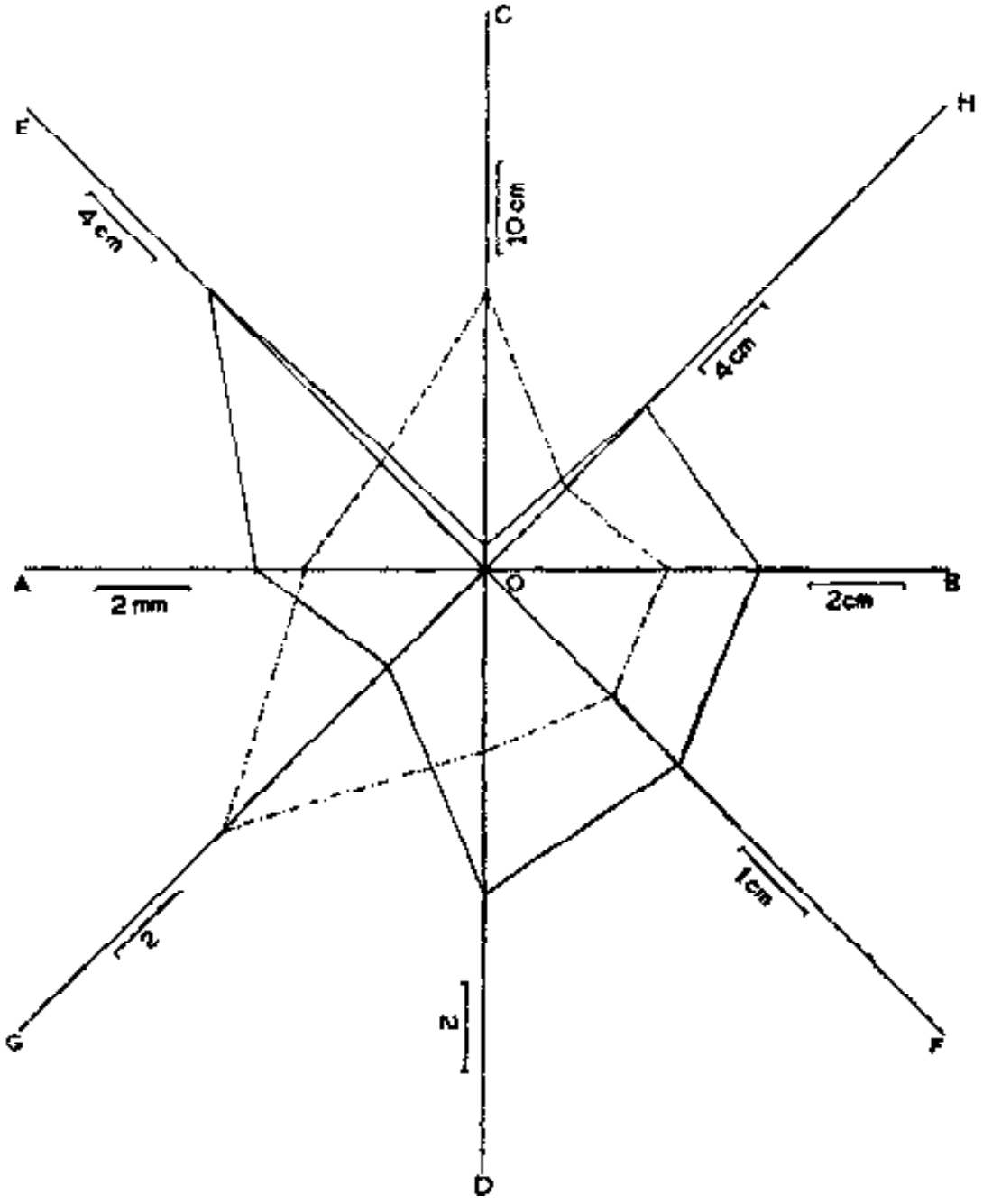


Fig. 11. Diagrammatic representation of the highest dispersion value of different characters of the species *Meconopsis bella* (———). *M. lyrata* (—.—.—). OA—Length of style, OB—Length of lamina, OC—Length of stem, OD—Number of stigma lobes, OE—Length of root, OF—Length of petal, OG—Length-breadth ratio of capsule, OH—Length of petiole

Very dense rosette leaves are present in *M. discigera* and *M. superba*. In *M. superba* leaves are at first densely sericeous and ultimately many of the longer hairs breaking off, leaving barbellate bases.

In *M. lyrata* the leaves get withered and few in number while in *M. villosa* the leaves are tufted.

In *M. lyrata* the leaves are glabrous or sparsely hairy on both surfaces and the shape of the leaves are varied e.g, ovate, oblong-ovate, spathulate or oblanceolate, and the base of the leaves are either cordate or obtuse or rounded. In *M. villosa* the base of the leaves are cordate and length and breadth of the leaves are same.

In *M. bella* the leaves are numerous and crowded or with a few bristles.

Calyx and Corolla

The sepals of *Meconopsis* extending from the torus, are free. Number of sepals are normally 2, occasionally 3 to 4 particularly in terminal flower. Sepal length is measured from the torus upward. Sepals of *Meconopsis* are caducous, ovate-oblong, orbicular, obtuse-rounded at the apex. Sepals of the most of the species are bristly except *M. bella* and *M. lyrata* where occasionally sepals are glabrous. Differences in shape, orientation and length of the sepals may be useful in the delimitation of species or allied groupings.

Petals are most commonly 4 (often varying from 5-10). The free petals are convoluted in bud. Upon expansion, petals are oriented in a horizontal, spreading whorl with concave nature of the inner side of the petal surfaces. Except for colouration, petal characters are of minimal taxonomic value. They are basically glabrous and obovate to suborbicular with apices ranging from obtuse to rounded. In many species the petals are minutely notched or denticulate at the apex. Colouration ranges from white through yellow, pink, purple, blue, pale rose, dark crimson and red.

Colour differences are present in *M. napaulensis, M. simplicifolia, M. betonicifolia, M. lyrata, M. horridula, M. aculeata, M. discigera*. In some species petal colour appears to be constant, but it is rarely preserved in herba-rium specimens.

Androecium

The stamens are numerous. In *M. lyrata* the number of stamens varies from 12-36. Fedde (1909) counted the number of the stamens in *M. betonicifolia* where it is 64 in number. The anthers are smooth, narrowly oblong,

Meconopsis horridula Hook. f. & Thoms.
Locality : Gochung, North Sikkim
Courtesy : M. Sanjappa

Meconopsis aculeata Royle
Locality : Kashmir

Meconopsis simplicifolia (D. Don) Walp.
(Flowers in younger stage)
Locality : Thangu, Sikkim
Courtesy : M. Sanjappa

Meconopsis simplicifolia (D. Don) Walp.
(Flowers in older stage)
Locality : Gochung, North Sikkim
Courtesy : M. Sanjappa

basifixed. The filaments range from narrowly linear to filiform. Length of the filaments varies from 0.5-1.5 cm. The anthers are almost always with yellow colour, but in some species (*M. horridula, M. villosa*) the yellow anthers turn to dark brown to dark black colour according to age.

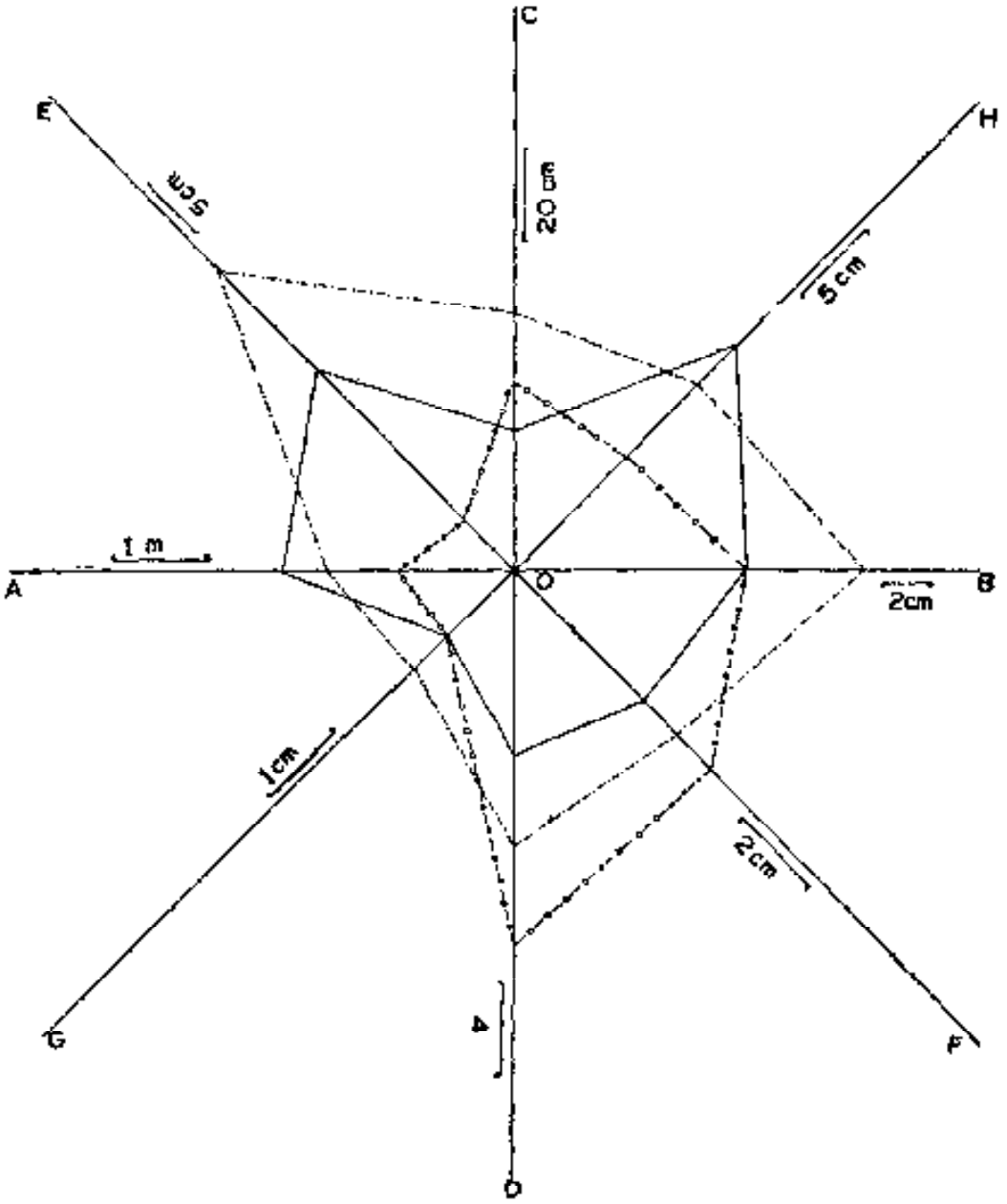


Fig. 12. Diagrammatic representation of highest dispersion value of different characters of the species *Meconopsis napaulensis* (———), *M. paniculata* (—·—·—·—), *M. superba* (—o—o—o—o—). OA—Length of stem, OB—Length of pedicel, OC—Length of lamina, OD—Number of stigma lobes, OE—Length of petiole, OF—Length of petal, OG—Length of style, OH—Breadth of lamina

Gynoecium and Capsule

The superior, subglobose or ovoid or obovoid to narrowly subcylindric ovary is attached to the receptacle. The body is glabrous to tomentose, but in some species (*M. lyrata* and *M. villosa*) the body is always glabrous. It is unilocular with parietal placentation. Many ovules on parietal placentae are projecting to the ovary.

The slender, distinct (often very short), occasionally obsolete, rarely with an expanded base style arises from the summit of the ovary and terminates in a free, capitate or subclavate stigma which is radiating and forming a globular mass over the ovary.

The stigmatic rays in some of the flowers are completely separated as in the case of *M. discigera*. But in most of the species the stigma is capitate or clavate with decurrent subcontiguous rays.

In the species of *Meconopsis* the capsule has no disc and the apex ends in a persistent style, crowned by the clavate or subcapitate slightly lobed stigma. But *M. discigera* is characterised by the presence of a disc surmounting the ovary. Apart from the distinct style and more or less free stigmatic lobes the structure is like the typical condition of *Papaver* where the ovary is always provided with a disc. Capsules of the species of *Meconopsis* dehisce by inter-placental valves usually for a short distance from the apex or rarely almost to the base *(M. villosa)*.

Seeds

Size and shape of the seeds are generally uniform to the genus. The seeds are many, ovoid or more or less reniform or falcate-oblong or ellipsoid-oblong, smooth or obscurely or prominently longitudinal pitted, sometimes densely papillose, 0.8-3.0 mm long.

KEY TO THE SPECIES

1a. Style base expanded into broad glabrous disc surmounting the ovary ... *M. discigera* **5**

1b. Style when present, of uniform thickness throughout or swollen, but never expanded into a disc:

2a. Polycarpic. Petals yellow ... *M. villosa* **22**

2b. Polycarpic (but then petals never yellow) or monocarpic. Petals yellow, blue, purple, red or rarely white:

3a. Indumentum of soft hairs, if present:

4a. Hairs if present non barbellate:

5a. Plants scapose. Leaves 2 pinnatifid-pinnatipartite. Capsules obovoid or pear shaped ... *M. bella* 2

5b. Plants with leafy or subscapose stems. Leaves entire to lyrato-pinnatifid. Capsules oblong or oblong-obovoid:

6a. Leaves oblanceolate to elliptic with a narrow decurrent base. Flowers borne on long, usually almost basal pedicels ... *M. primulina* 15

6b. Leaves ovate, oblong-ovate, spathulate or oblanceolate with a hastate or subcordate rounded base. Flowers borne singly in the axils of the upper cauline leaves, rarely on a basal scapes ... *M. lyrata* 11

4b. Hairs barbellate:

7a. Indumentum of long hairs mixed with short much branched hairs:

8a. Basal leaves deeply lobed:

9a. Plants with setose-villous hairs ... *M. napaulensis* 12

9b. Plants villous with or without densely substellate or stellate hairs:

10a. Length of the petioles one third of the basal leaves; leaves with substellate pubescence ... *M. paniculata* 14

10b. Length of the petioles half of the basal leaves; leaves without substellate pubescence ... *M. longipetiolata* 10

8b. Basal leaves not deeply lobed:

11a. Capsules ellipsoid-oblong:

12a. Flowers borne singly on axillary pedicels. Petals white ... *M. superba* 20

12b. Flowers, except the uppermost ones, borne on several flowered axillary cymules. Petals yellow ... *M. regia* 16

11b. Capsules narrowly clavate ... *M. taylorii* 21

7b. Indumentum of only long hairs:

13a. Leaves imperfectly 1-2 pinnatifid-pinnatipartite:

14a. Flowers borne singly on axillary pedicels ... *M. robusta* 17

14b. Flowers borne on 1-3 flowered cymules:

15a. Plants densely bristly ... *M. diwojil* 4

15b. Plants sparsely bristly and ultimately glabrescent ... *M. gracilipes* 6

13b. Leaves entire to sinuate-dentate:

16a. Flowers on leafless scapes from base ... *M. simplicifolia* 18

16b. Flowers on leafy stems:

17a. Basal leaves truncate or cordate at base ... *M. betonicifolia* 3

17b. Basal leaves wedge-shaped at base ... *M. grandis* 7

3b. Indumentum of prickly bristles:

18a. Stems scapose or leafy only at base:

19a. Leaves deeply pinnatifid ... *M. neglecta* 13

19b. Leaves entire to sinuate-lobed ... *M. horridula* 8

18b. Stems leafy:

20a. Leaves imperfectly 1-2 pinnatipartite ... *M. aculeata* 1

20b. Leaves entire to sinuate-lobed:

21a. Lamina oblong to ovate or broadly lanceolate. Upper flowers ebracteate, many flowered. Capsules 1.0-1.5 cm long (excl. beak) ... *M. latifolia* 9

21b. Lamina narrowly oblanceolate. Upper flowers (like the lower ones) bracteate, 4-8 flowered. Capsules ÷ 4.5 cm long (excl. beak) ... *M. sinuata* 19

1. **Meconopsis aculeata** Royle, Illustr. Bot. Himal. 67, tab. 15. Mar. 1834; Walp., Repert. Bot. Syst. 1: 110. 1842; Hook. f. & Thoms., Fl. Ind. 1: 253. 1855; in Hook. f., Fl. Brit. Ind. 1: 118. 1872; Prain in Journ. Asiat. Soc. Beng. 64, 2: 314. 1896; in Ann. Bot. 20: 347. 1906; Fedde, in Engler, Pflanzenr. 4, 104: 255, fig. 35 N. 1909; G. Tayl., Acc. genus Meconopsis 100. 1934; Chittenden, Dict. Gard. 3: 1270. 1956; Evans, Journ. Roy. Hort. Soc. 84: 505. 1959; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 24. 1974; Debnath et Nayar, Fasc. Fl. Ind. 17: 12, Fig. 2. 1984. *M. aculeata* var. *nana* Prain in Bull. Misc. Inf. Kew 1915: 144. 1915. *M. aculeata* forma *normalis* Prain in Bull. Misc. Inf. Kew 1915: 144. 1915. *M. aculeata* forma *acutiloba* Prain in Bull. Misc. Inf. Kew 1915: 144. 1915; *M. bikramii* Aswal, Ind. Journ. For. 8(1): 84-85. 1985 *syn. nov.* **Fig. 13**

Monocarpic, prickly herbs. Tap roots *ca.* 12 cm long, narrowly elongated or fusiform, rarely divided into rootlets. Stems *ca.* 60 cm long, simple or rarely branched in the lower part, leafy, clothed with bristly persistent leaf-sheaths, covered with patent, yellowish or shiny golden colour, 2-7 mm long bristles. Basal cauline leaves on 2.5-10.0 (-15) cm long petioles, up to 30 cm long (incl. petiole), higher leaves sessile, smaller, all leaves oblong in outline, pinnatipartite, rarely 2-pinnatipartite, segments oblong or obovate or ovate-triangular, obtuse or rounded at apex, a few acute, bristly on both sides of the lamina and in the petioles, a few number of smaller size leaves, attaining up to 2 cm long, present on the base of the pedicels. Petioles expanded at the base. Flowers borne singly on long, slender, spiny axillary and terminal pedicels. Pedicels 1-15 cm long. Sepals 1-2 cm long, broadly oblong-orbicular, bristly. Petals usually 4, rarely 6, blue, purplish blue or red, obovate-suborbicular, entire to denticulate, up to 3.5 cm long and 3.5 cm broad. Stamens numerous; filaments 0.5-1.0 cm long, filiform; anthers golden-

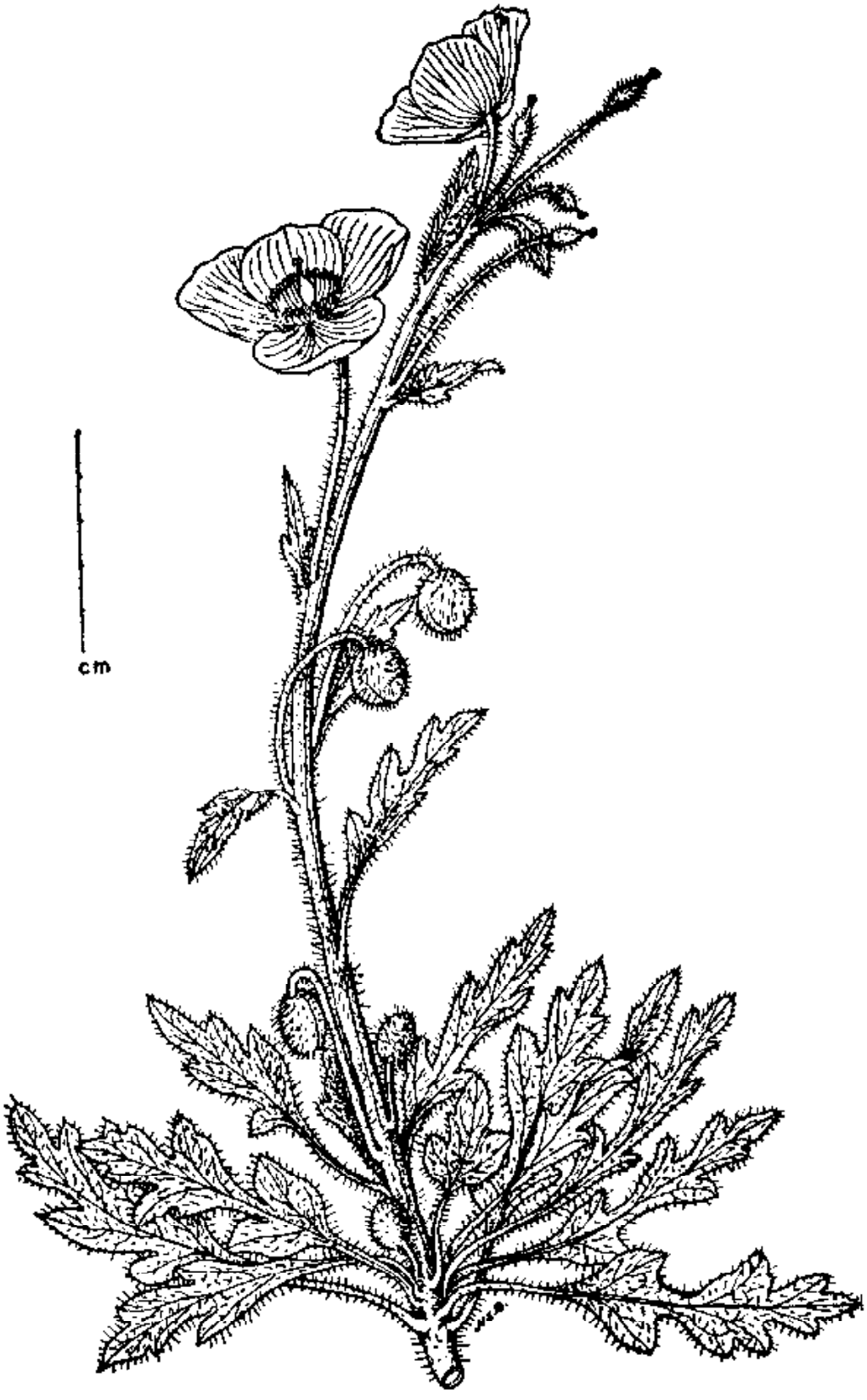


Fig. 13. Habit of *Meconopsis aculeata* Royle

yellow, 1.0-1.5 mm long, basifixed. Ovary subglobose or ellipsoid, densely spiny, spines straw in colour at first appressed but ultimately spreading; styles distinct, 4-10 mm long, swollen at the base; stigmas capitate or sublgobose. Capsules 10-15 mm long, ellipsoid oblong or subglobose, bristly, dehiscing by 4-6 valves, 1.0-1.5 cm long (excl. style). Seeds subreniform, 1 mm long.

Type: Holotype: Peer Punjal 9/8 (LIV).

Type note: Royle stated in his original description about the type material that "The Plant is common on the Choor and Kedarkanta, as well as in Kunawar, and has also been brought me from Peer Punjal".

Fls.: July—August. *Frts.:* August—October.

Distrib.: Recorded between 2440-4700 m altitude, INDIA: Western Himalaya, Kashmir, Himachal Pradesh, Punjab, Uttar Pradesh; PAKISTAN.

Note: The species *Meconopsis aculeata* is very variable in habit, size, dissection of leaf blade (Fig. 14), nature of inflorescence and size and colour of petals.

It is closely related to *Meconopsis horridula* but is easily recognizable by leafy stems, globose flower buds, pinnatifid-pinnatipartite leaves.

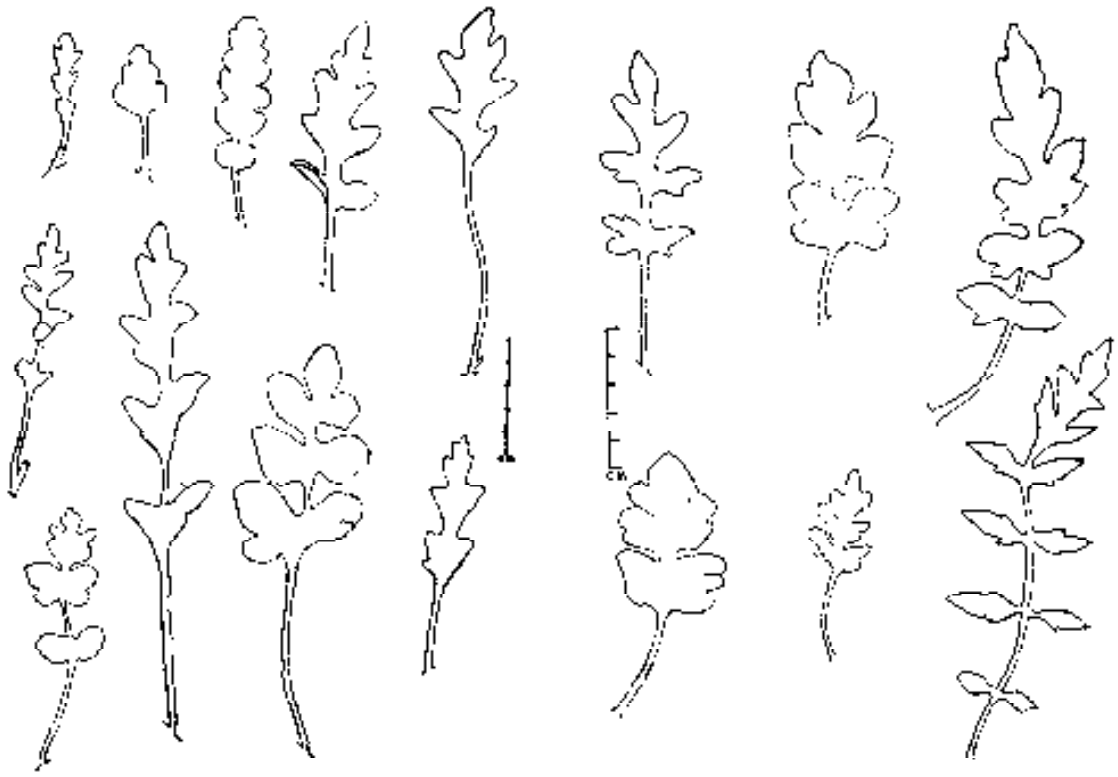


Fig. 14. Leaf variations in *Meconopsis aculeata* Royle

2. **Meconopsis bella** Prain in Journ. Asiat. Soc. Beng. 63, 2: 82. 1894; et 64, 2: 321. 1896; in Ann. Roy. Bot. Gard. Calcutta, 9, 1 : 3, tab. 4. 1901; in Ann. Bot. 20: 351. 1906; in Bull. Misc. Inf. Kew 1915: 163. 1915; Fedde, in Engler, Pflanzenr. 4. 104: 261, fig. 35J. 1909; G. Tayl., Acc. genus Meconopsis 105. 1934; Chittenden, Dict. Gard. 3: 1480. 1956; Evans, Journ. Roy. Hort. Soc. 84: 503. 1959; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 37. 1979; Debnath et Nayar, Fasc. Fl. Ind. 17: 14. 1984. **Fig. 15**

Polycarpic herbs. Tap roots up to 17 cm long, stout, narrow, elongated, produced above into a short caudex *ca.* 2.5 cm long, clothed with persistent, dark-brown, membranous leaf-sheaths. Leaves numerous, 1.5-6.0 cm long, all basal, crowded, lamina irregularly pinnately or bipinnately lobed, ultimately segments usually 3-fid, glabrous or thinly bristly, segments obovate or obovate-oblong, obtuse or rounded at apex. Petioles 2.5-10.0 cm long, slender, glabrous or sparsely bristly, expanded at the base. Flowers solitary on scapose stem, scapes 1-25, glabrous or bristly. Scapes usually bearing at least a few fine long thread like hairs, particularly under the flowers, erect and 2.5-10.0 cm long during anthesis, recurved and up to 20 cm long in fruiting condition. Sepals 2, oblong, obtuse, glabrous or sparsely bristly 7-10 mm long. Petals 4, rarely 5-6, 1.5-3.0×2.5 cm, pale blue or purple, obovate-suborbicular, entire-denticulate. Stamens numerous: filaments filiform, 5-7 mm long, dark-purple; anthers golden-yellow, up to 2 mm long. Ovary ellipsoid or obovoid-subglobose, glabrous or sparsely bristly; styles stout, 2-5 mm long, swollen at the base, becoming much swollen at the base in fruit; stigmas capitate, 4-7 lobed. Capsules 1-2 cm long (incl. beak), obovoid or pear-shaped, rarely obovoid-ellipsoid, glabrous or sparsely bristly, dehiscing by 4-7 valves. Seeds ellipsoid, 1.2-1.4 mm long.

Type: INDIA: Sikkim, Peykeangla, Dzongri, July 1887, *Dr. King* s.n. (Lectotype CAL, K).

Type note: M. bella was first described by Prain in 1894 from specimens obtained by Dr. King from two localities at altitudes of 12,000 and 14,000 feet on the Nepal-Sikkim frontier in 1887. Prain (1894) mentioned about the type material in his protologue *"In Himalaya orientali : Sikkim, in tracta Jongri apud Pe-kiong circa 12,000 p.s.m., et Nyegu and fines Nepaliae orientales, 14,000 p.s.m., kingii mercenari in mense Julio floret."*

While studying the specimens of *M. bella* deposited in Calcutta herbarium authors found three specimens of the Dr. King's collections. One of which was collected from Nyegu Nepal frontier at 14,000 feet altitude on July 1888 and other two specimens from Peykeangla (Dzongri) on Aug. 1887 and July 1887.

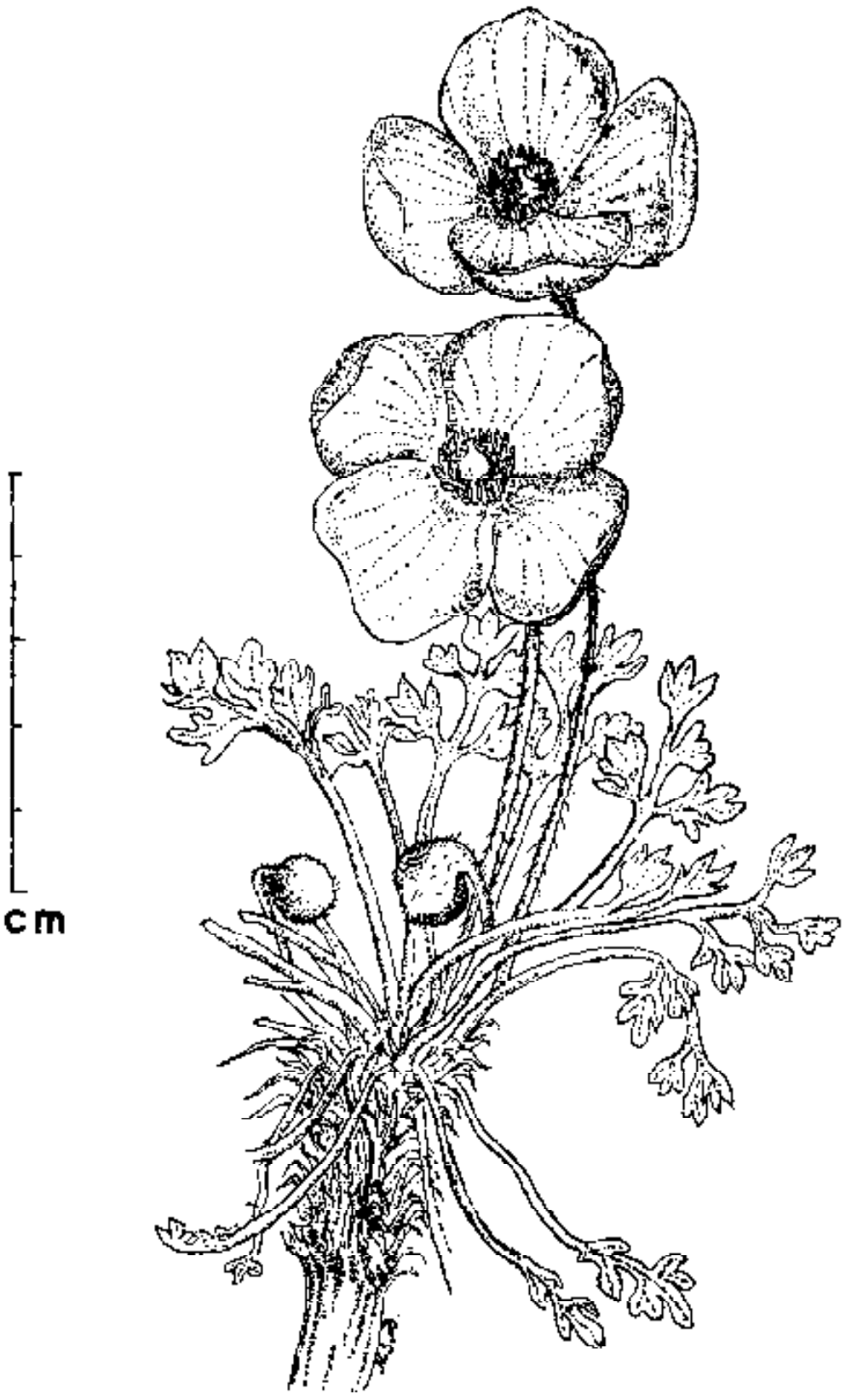


Fig. 15. Habit of *Meconopsis bella* Prain

Of these three specimens July 1887, Peykcangla specimen by Dr. King collector the herbarium sheet bears the line drawing of the floral parts of *M. bella* drawn by Prain. Then illustration also matches with the type description and drawing given by Prain (Ann. Roy. Bot. Gard. Calcutta, 9. 1: 3. table 4, 1901). Hence the specimen of Dr. King s.n. (CAL) is designated as the lectotype for *M. bella*.

Fls.: July—August. *Frts.*: September—October.

Distrib.: Recorded between 3965-4880 m altitude, INDIA: E. Himayala, Sikkim; NEPAL; BHUTAN.

3. **Meconopsis betonicifolia** Franch., Plant. Delav. 1: 42, tab. 12. 1889; Prain in Bull. Misc. Inf. Kew 1915: 143. 1915; G. Tayl., Acc. genus Meconopsis 63: 1934; Chittenden, Dict. Gard. 3: 1270-1271. 1956; Evans, Journ. Roy. Hort. Soc. 84: 501-502. 1959; Debnath et Nayar, Fasc. Fl. Ind. 17: 14, Fig. 3. 1984. *Cathcartia betonicifolia* (Franch.) Prain, in Ann. Bot. 20: 396. 1906. *Meconopsis baileyi* Prain in Bull. Misc. Inf. Kew 1915: 161. 1915. *M. baileyi* var. *pratensis* Kingdon-Ward, in Gard. Chron., Ser. 3, 82: 506. 1927. *M. betonicifolia* var. *baileyi* (Prain) [Edwards in Gard. Chron., Ser. 3, 85: 473. in obs. 1929, *nomen nudum*]; L.H. & E.Z. Bailey, Hortus, 390. 1930. *M. betonicifolia* forma *baileyi* (Prain) Cotton in Gard. Chron., Ser. 3, 85: 143. 1929. *M. betonicifolia* forma *franchetii* Stapf in Curt. Bot. Mag. 153: sub tab. 9185. 1930. **Fig. 16**

Monocarpic or polycarpic herbs. Root stocks short, clothed with dark-brown, bristly membranous persistent leaf sheaths. Stems 100-150 cm long, simple, rigidly erect, glabrous or with scattered rufous hairs. Leaves 10-15 × 5-7 cm, basal leaves petioled, upper one sessile, amplexicaule at the base, oblong to elongate-oblong, truncate or cordate at base, more or less decurrent on the petiole, subacute or obtuse or rounded at the apex, margin broadly ovate, incisio-crenate, sometimes coarsely, irregularly serrate, even lobed, rufous scattered setose along the nerve on both surfaces. Petioles up to 20 cm long. Flowers 6 cm in diameter, long pedicillate, produced from the axils of the uppermost leaves and occasionally from the axils of the lower cauline leaves, semipendulous. Pedicels 25-30 cm long. Petals 4-6, 5 × 5 cm, blue-violet, purple, broadly ovate, slightly sinuate, rounded at the apex, fine veins. Stamens numerous; filaments filiform, white; anthers deep yellow. Ovary ellipsoid oblong, glabrous or covered with rufous bristles; styles green, not exceeding 1 cm long; stigmas green, 4-7 lobed. Capsules oblong to oblong-ellipsoid, splitting by 4-7 valves. Seeds reniform, with longitudinal rows of shallow pits.

Type: CHINA: *Delavay* 2152 (K, P).

Fls. & Frts.: July—September.

Distrib.: Recorded between 3050-3965 m altitude, INDIA: Arunachal Pradesh; BURMA; TIBET; CHINA.

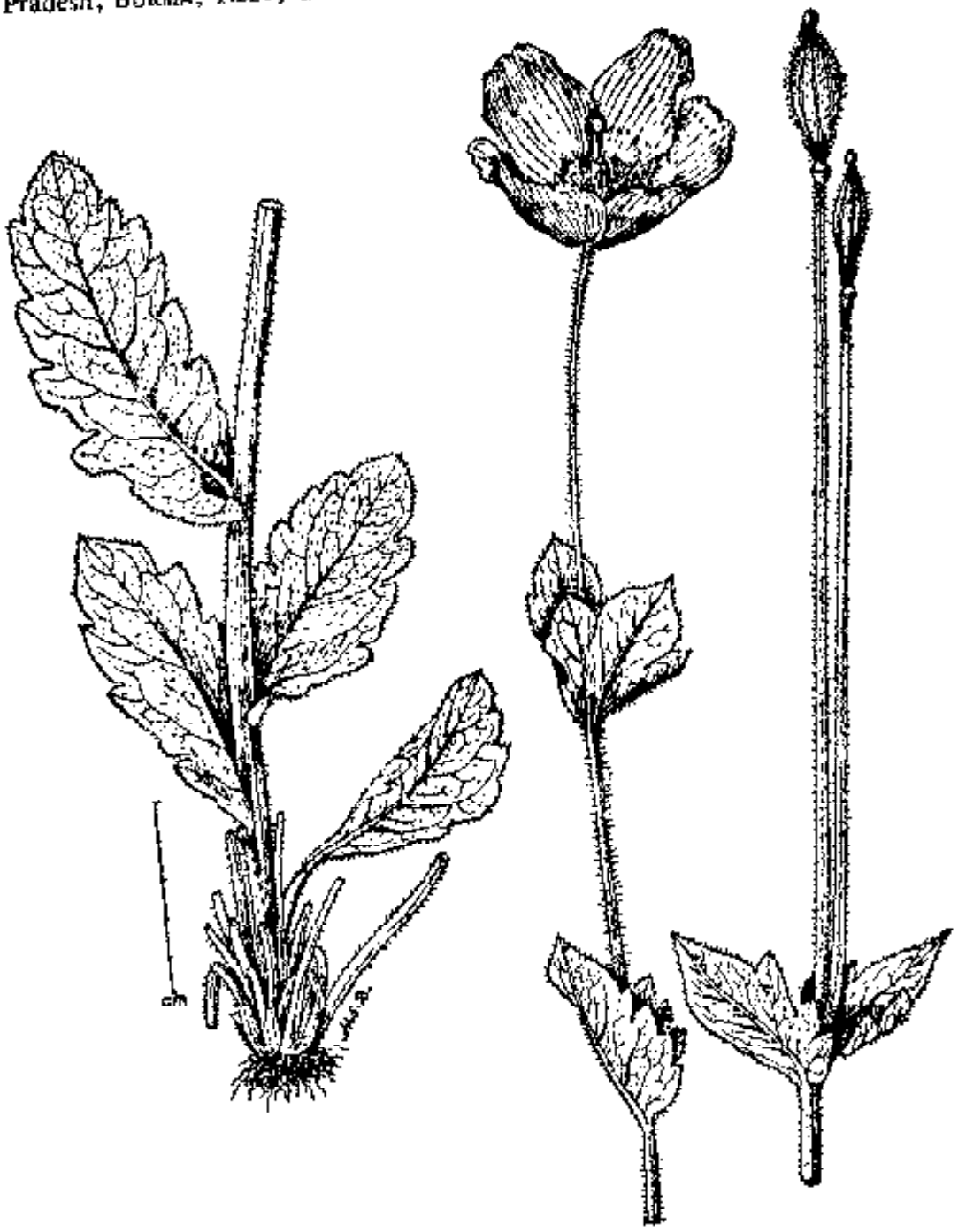


Fig. 16. Habit of *Meconopsis betonicifolia* Franch.

Distribution of this taxon in India is known only from K. C. Sahni's report in 10th General Assembly and 11th Technical meeting of International Union for Conservation of Nature and Natural Resources at N. Delhi, India. on 24th November to 1st December 1969 that Hari Dung, Secretary, Wild Life Preservation Society, Dehra Dun, collected this plant from Kameng, NEFA, Arunachal Pradesh.

Note: The occurrence of this plant in India was first reported by K. C. Sahni in 10th General Assembly and 11th Technical meeting of International Union for Conservation of Nature and Natural Resources at N. Delhi, India, on 24th November to 1st December 1969. In that meeting it was reported by him under the topic "Protection of Rare and Endangered plants in the Indian Flora" that "*Meconopsis betonicifolia*, blue poppy of E. Himalayas, S. E. Tibet, upper Burma and Yunnan, introduced to cultivation in 1924 now widely grown in Europe. It has been collected by Hari-Dung, Secretary, Wild Life Preservation Society, Dehra Dun from Kameng, NEFA in recent years".

It is included in the "Threatened plants of India, a state-of-the Art Report (Jain et Sastry, 1980).

4. **Meconopsis dhwojii** G. Tayl. ex Hay in New Fl. & Silva 4: 225, fig. 82. July 8, 1932; G. Tayl., in Gard. Chron., Ser. 3. 92: 41. July 16, 1932; G. Tayl., Acc. genus Meconopsis 37. Pl. 6. 1934; Chittenden, Dict. Gard. 3: 1271. 1956; Evans, Journ. Roy. Hort. Soc. 84: 507. 1959; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 37. 1979. **Fig. 17**

Monocarpic herbs. Tap roots dauciform. Stems 50-60 cm long, fistular, covered with patent, yellow, 9-10 mm long bristles. Leaves 7-20 ×2-5 cm, pinnatisect towards base and pinnatifid-pinnatipartite towards apex, segments roundly, obtusely or subacutely lobed, sparsely bristly on both surfaces, basal leaves on 4-8 cm long petioles, upper one seesile. Bracts sessile, auriculate, pinnatifidly lobed. Flowers borne on axillary branches, 3-5 flowered, upper branches 1-flowered. Pedicels 3-25 cm long, covered with the same type of bristles as on the stem, bristles tufted immediately below the flowers. Petals 4, yellow, 3-4×3-4 cm, obovate-orbicular. Stamens numerous; filamants 1.0-1.2 cm long, filiform, whitish; anthers 2-3 mm, orange-yellow. Ovary globose or ovoid or ellipsoid, birstly; styles 3-4 mm long, slender, slightly thickened towards the base; stigmas capitate, 5-6 lobed. Capsules 0.8-2.5×0.5-1.0 cm, ellipsoid oblong, dehiscing by 5-6 valves. Seeds ovoid-ellipsoid-oblong.

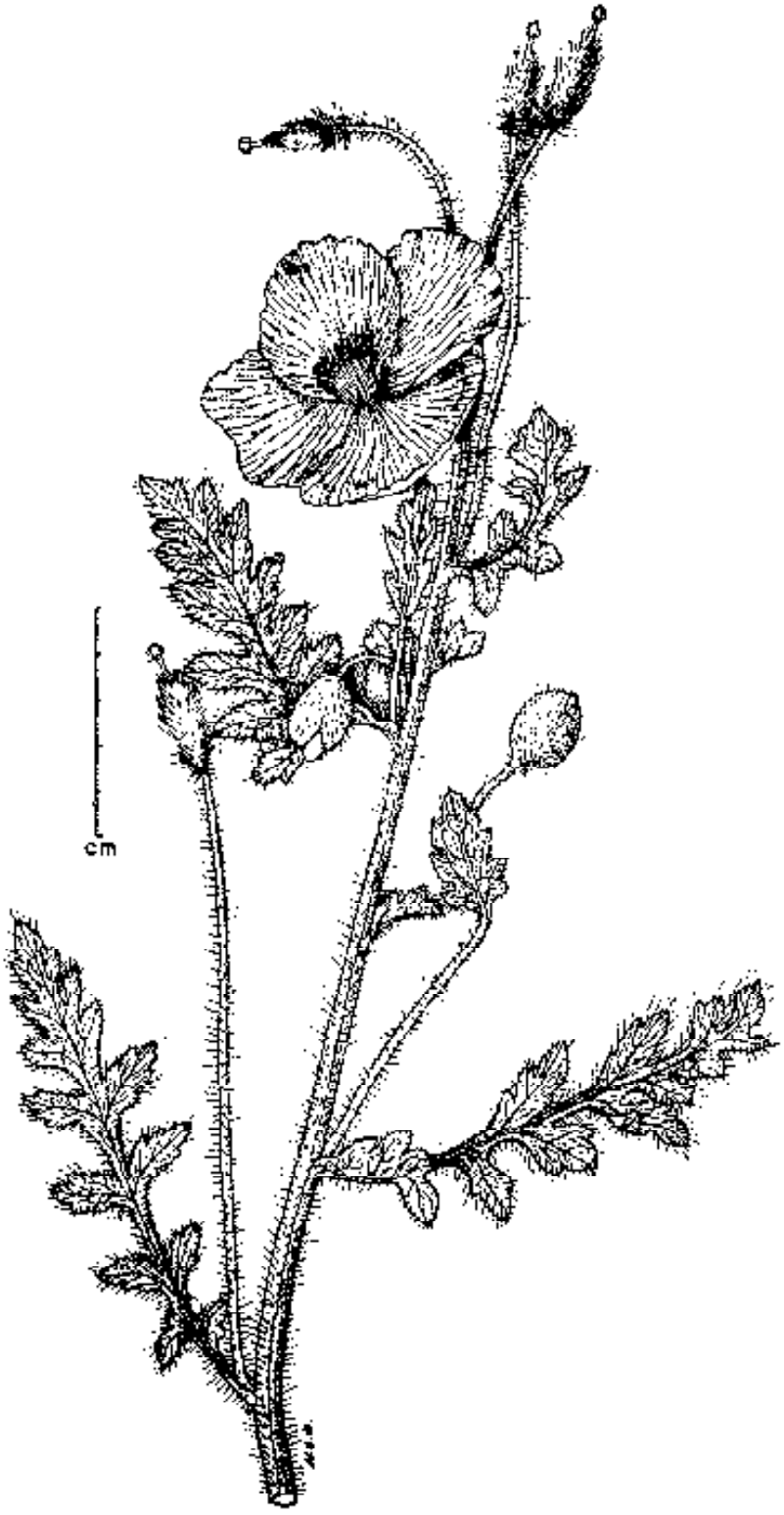


Fig. 17. Habit of *Meconopsis dhwojii* G. Tayl.

Type: NEPAL: Sangmo, 3648-5472 m, 1930, *Capt. Lall Dhwoj* 0297 (Holotype BM).

Fls.: June—August. *Frts.:* August—October.

Distrib.: Recorded between 3660-5490 m, restricted to Eastern NEPAL.

5. **Meconopsis discigera** Prain in Ann. Bot. 20: 356, tab. 24, fig. 12. 1906; in Bull. Misc. Inf. Kew 1915: 170. 1915; Fedde, in Engler, Pflanzenr. 4. 104: 266. 1909; G. Tayl., Acc. genus Meconopsis 108. 1934; Chittenden, Dict. Gard. 3: 1271. 1956; Evans, Journ. Roy. Hort. Soc. 84: 505. 1959; Hara in Ohashi, Fl. E. Him. Bull. 8: Plate 3b. 43. 1975; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 37. 1979; Debnath et Nayar, Fasc. Fl. Ind. 17:16.1984. **Fig. 18**

Polycarpic or apparently monocarpic herbs. Roots dauciform, *ca.* 10 cm long. Stems up to 40 cm long, stout, sulcate due to decurrent pedicels, with persistent bristly membranous leaf sheaths, clothed with golden brown, barbellate patent or deflexed bristles or their persistent bases. Leaves entire or 3-lobed, oblanceolate or elliptic oblanceolate, with a narrow decurrent base, subacute to rounded at apex, appressed-bristly with often purple-based, golden-brown, barbellate bristles, basal leaves petioled, up to 15 cm long (incl. petiole), higher one sessile, smaller. Flowers solitary, axillary or terminal, forming leafy racemes. Pedicels clothed with the same hairs as on the stem, 2-5 cm long, strongly decurrent down the stem and at the apex swollen into a relatively broad torus. Petals 4, 4-5×3-4 cm, obovate, red, purple or pale blue. Stamens numerous; filaments filiform, dark coloured; anthers narrowly oblong. Ovary densely covered with more or less spreading bristles; styles slender, 5-6 mm long. Capsules oblong, 6-ribbed, appressed bristly, crowned with ovate, laciniate, reflexed, 5-7 mm long stylar disc-lobes and persistent 1 cm long styles, dehiscing by 6-10 valves, 1.2-2.0 cm long. Seeds reniform, with longitudinal ribs.

Type: INDIA: Sikkim, Gucha-La, 11-12,000', *Cave* s.n. (K).

Type note: *M. discigera* was first described by Prain in 1906 from fruiting specimens collected by Cave at an altitude between 11,000 and 12,000 ft., on the mountains of Gucha La in western Sikkim in 1905. Prain (1906) mentioned about the type material in his protologue *"Sikkim, Gucha-La, 11-12,000 p.s.m. in mense Septembri fructifera, Cave!"*

Authors could not find any specimens of Cave's collector in Calcutta Herbarium.

Fls.: June—August. *Frts.:* August—September.

Fig. 18. Habit of *Meconopsis discigera* Prain

Distrib.: Recorded between 3355-4880 m altitude, INDIA: E. Himalaya, Sikkim; NEPAL; BHUTAN; TIBET.

Note: Allied to *Meconopsis torquata* Prain, a Tibetan species, but is easily recognizable by 4-lobed, laciniate stylar disc, glabrous petals and distinct style. *M. torquata* is, however, distinguished by its narrower oblanceolate leaves, close aggregation of the flowers, almost sessile stigma, and presence of bristles at the back of the petals. "This latter character is found in no other species of *Meconopsis*"- Taylor, Acc. genus Meconopsis P. 110. 1934.

6. **Meconopsis gracilipes** G. Tayl., Acc. genus Meconopsis 38. 1934; Ray in Journ. Roy. Hort. Soc. 59: 461. 1934; Evans. Journ. Roy. Hort. Soc. 84: 507. 1959; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 37. 1979. **Fig. 19**

Monocarpic herbs. Stems branched, leafy, attaining 90-120 cm tall, covered with pale brown 1-5 mm long hairs, along with their persistent hispid bases. Leaves 3-30×1.5-7.0 cm, basal leaves on 5-10 cm long petioles, upper one sessile, pinnatisect towards base, more or less deeply pinnatilobed towards apex, lamina auriculate at base, all leaves sparsely covered on both surfaces with barbellate hairs, along with their hispid bases. Flowers borne on axilliary branches, branches up to 20 cm long, lower branches 3-5 flowered, upper branches 1-flowered. Pedicels 2-10 cm long, covered with same type of bristles as on the stem, bristles tufted below the flowers. Sepals 8-10 ×7-9 mm, ovate-oblong, bristly. Petals 4, obovate-suborbicular, up to 3.5 cm in length, 2.5 cm in breadth, yellow. Stamens numerous; filaments 5-7 mm long, filiform; anthers 2-3 mm long, orange. Ovary subglobose to ellipsoid, densely covered with appressed or obliquely spreading hairs; styles 3-5 mm long, distinct; stigmas capitate, 4-7 lobed. Capsules 1.0-2.0× 0.5-0.9 cm (excl. beak), ellipsoid to oblong-ellipsoid, dehiscing by 4-7 valves. Seeds reniform.

Type: Central NEPAL, Khorlak, 1928, *Capt. Lall Dhwoj* 17 (BM).

Fls.: June—July. *Frts.:* July—September.

Distrib.: Recorded between 3355-5000 m altitude, restricted to NEPAL.

Note: *Meconopsis gracilipes* is closely allied to *M. robusta*, but it is recognizable from that species by geographical segregation and morphological differences. *M. gracilipes* is distributed in Nepal, whereas *M. robusta* is confined to Kumaon Himayala. Morphologically the species differs from *M. robusta* in having the flowers borne on a branched inflorescence.

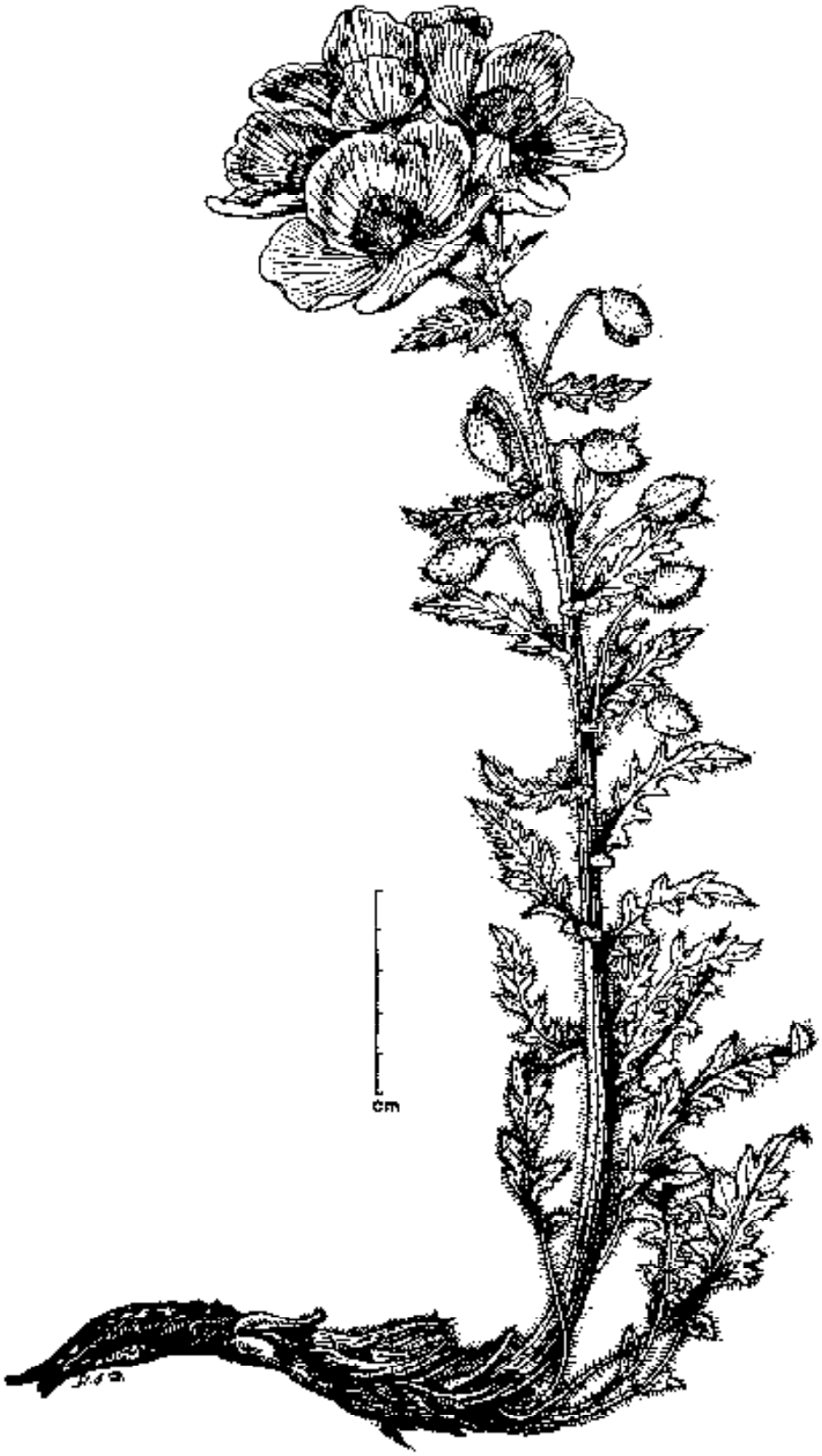


Fig. 19. Habit of *Meconopsis gracilipes* G. Tayl.

7. **Meconopsis grandis** Prain in Journ. Asiat. Soc. Beng. 64, 2: 320. 1895; in Ann. Roy. Bot. Gard. Calcutta, 9. 1: 2, tab. 2. 1901; in Ann. Bot. 20: 352. 1906; in Bull. Misc. Inf. Kew 1915: 167. 1915; Fedde, in Engler, Pflanzenr. 4, 104: 263 fig. 35D. 1909; G. Tayl., Acc. genus Meconopsis 68. 1934; Chittenden, Dict. Gard. 3: 1271. 1956; Evans, Journ. Roy. Hort. Soc. 84: 502. 1959; Hara in Ohashi, Fl. E. Him. Bull. 8: 43. 1975; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 37. 1979; Debnath et Nayar, Fasc. Fl. Ind. 17: 17, Fig. 4. 1984. **Fig. 20**

Polycarpic herbs. Roots short, fibrous. Stems 40-100 cm long, leafy, rarely scapose, basal part covered with appressed bristly, membraneous persistent leaf sheaths, clothed with rufous, deflexed, 5-8 mm long bristles. Leaves 7-20×2-8 cm, elliptic oblong or oblanceolate to lanceolate, wedge-shaped at base, subglobose or acute at apex, distantly and irregularly serrate or with broad crenations at the margin, appressed rufous bristly on both surfaces, basal leaves petioled, upper leaves sessile. Petioles 10-31 cm long, bristly, sheathing at base. Flowers solitary, produced in succession from the axils of the uppermost leaves or occasionally of the lower cauline leaves. Pedicels attaining up to 64 cm long, clothed with the same hairs as on the stem. Sepals 3.0-3.5 cm long, broadly ovate-oblong, obtuse, appressed bristly. Petals (4-) 5 (-9), 4-6×6 cm, purple or blue, obovate-suborbicular, entire. Stamens numerous; filaments filiform, whitish, 1.0-1.5 cm long; anthers yellow, 2 mm long. Ovary oblong or ellipsoid oblong, patent or appressed bristly; styles 0.5-1.5 cm long; stigmas globose, 4-6 lobed, lobes often decurrent on the style. Capsules 3.5-4.5 cm long (excl. style), ellipsoid oblong or oblong, glabrous or patent bristly dehiscing by 4-6 valves. Seeds reniform.

Type: INDIA: Sikkim, Dzongri, 3900 m, 23.6.1892, *Gammie* 199 (Syntype CAL, L).

Type note: It was Prain in 1895, who first described the species *M. grandis*. Prain mentioned in his protologue "Sikkim: Jongri, in western Sikkim, very common at 10-12,000 feet, King's collectors! Watt n. 5435! G. A. Gammie!"

Three specimens of King's collector, collected from Jongri 14,000' & 15,000' altitude, on June 1887 and June 1888, are available at CAL. But they are not type materials.

So another Gammie's collection No. 199, Jongri 13,000', on 23.6.1892 Acc. No. 18800 & 18790 designated here as syntype for *Meconopsis grandis*.

Fls.: June—July. *Frts.:* August—September.

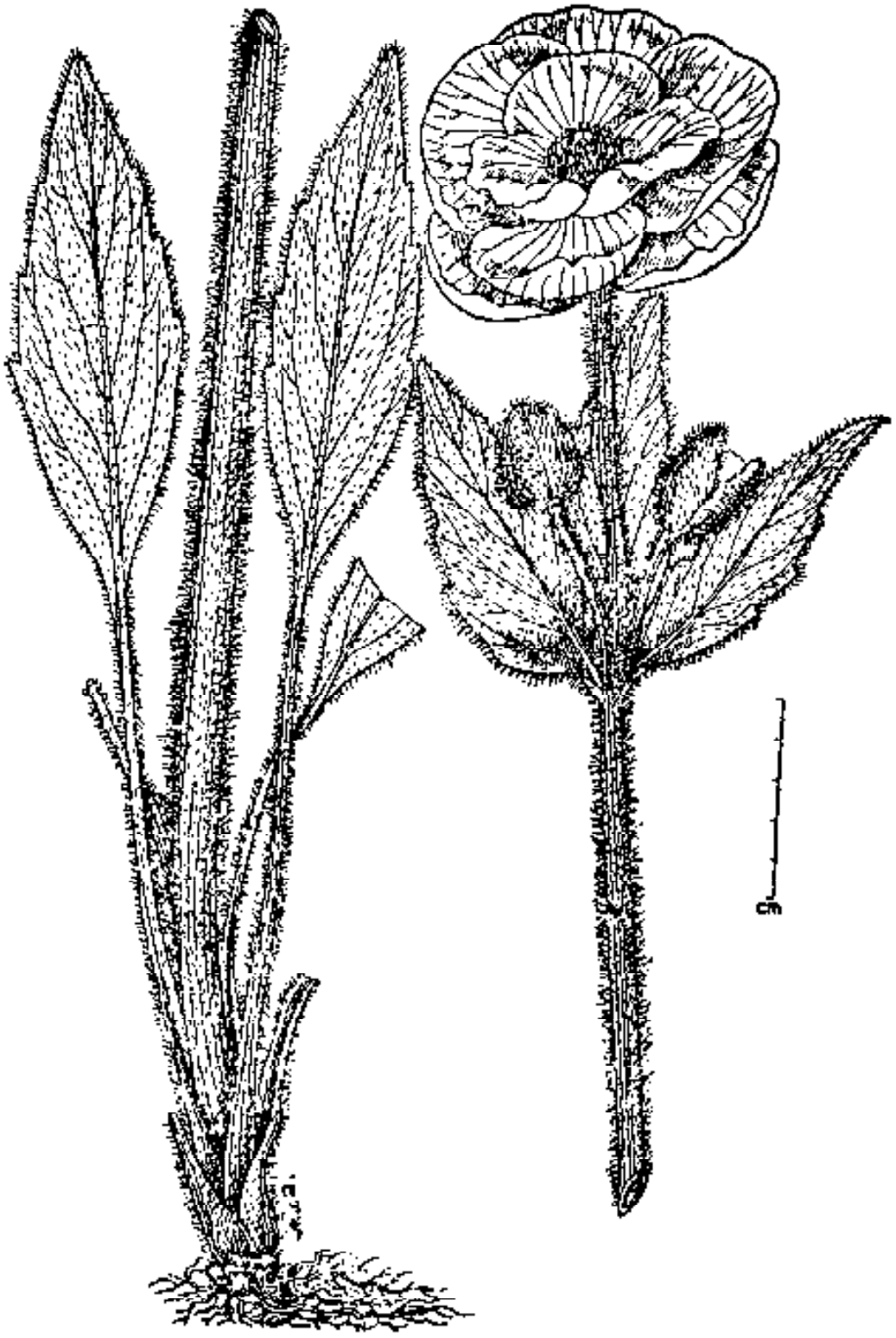


Fig. 20. Habit of *Meconopsis grandis* Prain

Distrib.: Recorded between 3355-4575 m altitude. INDIA: E. Himalaya, Sikkim; NEPAL; BHUTAN; TIBET.

Note: Very similar to *Meconopsis integrifolia* (Maxim.) Franch.—a Sino-Burmese species, but is easily recognizable by blue or purple flowers and sinuate-dentate leaves in contrast to yellow flowers and entire leaves of *M. integrifolia* (Maxim.) Franch.

It is readily distinguished from the rest of the Indian species by having involucral leaves and from *M. simplicifolia* (D. Don) Walp. by whitish staminal filaments apart from having involucral leaves.

8. **Meconopsis horridula** Hook. f. & Thoms., Fl. Ind. 1: 252. 1855; in Hook. f., Fl. Brit. Ind. 1: 118. 1872; Walp., Ann. Bot. Syst. 4: 171. 1857; Prain in Journ. Asiat. Soc. Beng. 64, 2: 313. 1896; in Ann. Bot. 20: 348. 1906; in Bull. Misc. Inf. Kew 1915: 152. 1915; Fedde. in Engler, Pflanzenr. 4, 104: 257, fig. 35 k. 1909; G. Tayl., Acc. genus Meconopsis 91. 1934; Chittenden, Dict. Gard. 3: 1272. 1956; Evans, Journ. Roy. Hort. Soc. 84: 505. 1959; Biswas, Pl. Darjeeling & Sikkim Him. 1: 126. 1966; Hara in Ohashi, Fl. E. Him. Bull. 8 : 43, Plate 3a. 1975; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 37. 1979; Debnath et Nayar, Fasc. Fl. Ind. 17: 19. 1984. *Meconopsis racemosa* Maxim. in Bull. Acad. Imp. Sc. St.-Petersb. 23: 310. 1877; *Meconopsis horridula* var. *typica* Prain in Journ. Asiat. Soc. Beng. 64, 2: 313. 1896. *Meconopsis horridula* var. *racemosa* (Maxim.) Prain in Journ. Asiat. Soc. Beng. 64, 2: 313. 1896. *Meconopsis horridula* var. *rudis* Prain in Journ. Asiat. Soc. Beng. 64, 2: 314. 1896. *Meconopsis sinuata* var. *Pratti* Prain in Journ. Asiat. Soc. Beng. 64, 2: 314. 1896. *Meconopsis rudis* (Prain) Prain in Ann. Bot. 20 : 347. 1906. *Meconopsis horridula* var. *abnormis* Fedde, in Engler, Pflanzenr. 4, 104: 258. 1909. *Meconopsis pratti* (Prain) Prain in Curt. Bot. Mag. 140: subtab. 8568 in obs. 1914. *Meconopsis rudis* var. *intermedia* Prain in Bull. Misc. Inf. Kew 1915: 151. 1915. *Meconopsis racemosa* forma *horridula* Farrer, Engl. Rock-Gard. 1: 480. in obs., tab. 50 sinistr. 1919. *Meconopsis prainiana* Kingdon-Ward in Garden 90: 115, fig. (Feb.) 1926. *Meconopsis caliciphila* Kingdon-Ward in Gard. Chron., Ser. 3, 82: 506. in obs. 1927.

Fig. 21

Monocarpic herbs. Roots narrowly elongated, up to 25 cm long. Stems subscapose, clothed with glabrous persistent leaf-sheaths at base, prickly with patent or deflexed, yellowish 3-7 mm long bristles. Leaves mostly basal or subbasal or rarely few cauline, up to 25 cm in length (including petiole) & 3.5 cm in breadth, basal leaves on 0.5-9.0 cm long bristly petioles, cauline few, sessile, passing into bracts, all leaves oblanceolate, linear-oblong-anceolate or obovate-elliptic, with a narrow decurrent base, acute or rounded

Fig. 21. Habit of *Meconopsis horridula* Hook. f. & Thoms.

at apex, entire to sinuate-lobed, bristly. Flowers solitary, terminal on scapes arising from axils of basal leaves or on 2-15 cm long pedicels arising along the central flowering stem. Sepals 1-2 cm long, oblong, obtuse or rounded, bristly. Petals 4-8, 2-3 cm long, blue or rarely white, obovate, denticulate at the top. Stamens numerous; filaments 8-10 mm long, filiform, dark-blue; anthers darkish. Ovary ellipsoid or ellipsoid-oblong or subglobose, appressed bristly; styles 2-5 mm long; stigmas capitate or clavate. Capsules ellipsoid-oblong, oblong or subglobose, bristly, 1-2 cm long (excl. stylar beak). Seeds subreniform, 8 mm long.

Type: INDIA: Sikkim, alpina, 4270-5185 m, *J.D.H.* s.n. (Isotypes CAL, G, K, L, P).

Type note: This polymorphic taxon, with highly variability in habit, size and shape of leaves, nature of inflorescence, number and colour of petals, shape and length of debiscing sutures of capsules, was described in 1855 by Hooker and Thomson. From their protologue it is seen that the specimen on which the species was based, was collected in *Himalaya orientali alpina*; Sikkim, alt. 14,000-17,000 feet. While studying the specimens of *M. horridula* deposited in Calcutta herbarium (CAL) authors found one specimen collected by J. D. Hooker s.n., from Sikkim, alpine region, 14,000-17,000 feet, Acc. no. 18638 (CAL), which is considered as the isotype of *M. horridula*.

Fls. & Frts.: July—September.

Distrib.: Recorded between 3965-5795 m altitude, INDIA: Sikkim; NEPAL; BHUTAN; BURMA; CHINA; TIBET.

Note: Highly variable in habit, size and shape of leaves, nature of inflorescence (Fig. 22), number and colour of petals, shape and length of dehiscing sutures of capsules. Based on these variable characters, several taxon have been recognized, which are correctly referred here under a single polymorphic taxon, *Meconopsis horridula* Hook. f. & Thoms., following Taylor's (An Acc. genus Meconopsis 91-96: 1934) treatment of this highly variable species.

It may be pointed out that plants growing at lower elevations are usually taller and those that are growing at higher elevations usually tend to become dwarfer and generally assume caespitose habit.

The occurrence of this interesting species at an elevation of 5490 m in Himalaya indicates its wide tolerance of climatic and altitudinal stresses prevailing at that altitude, which is the upper limit for the existence of flowering plants.

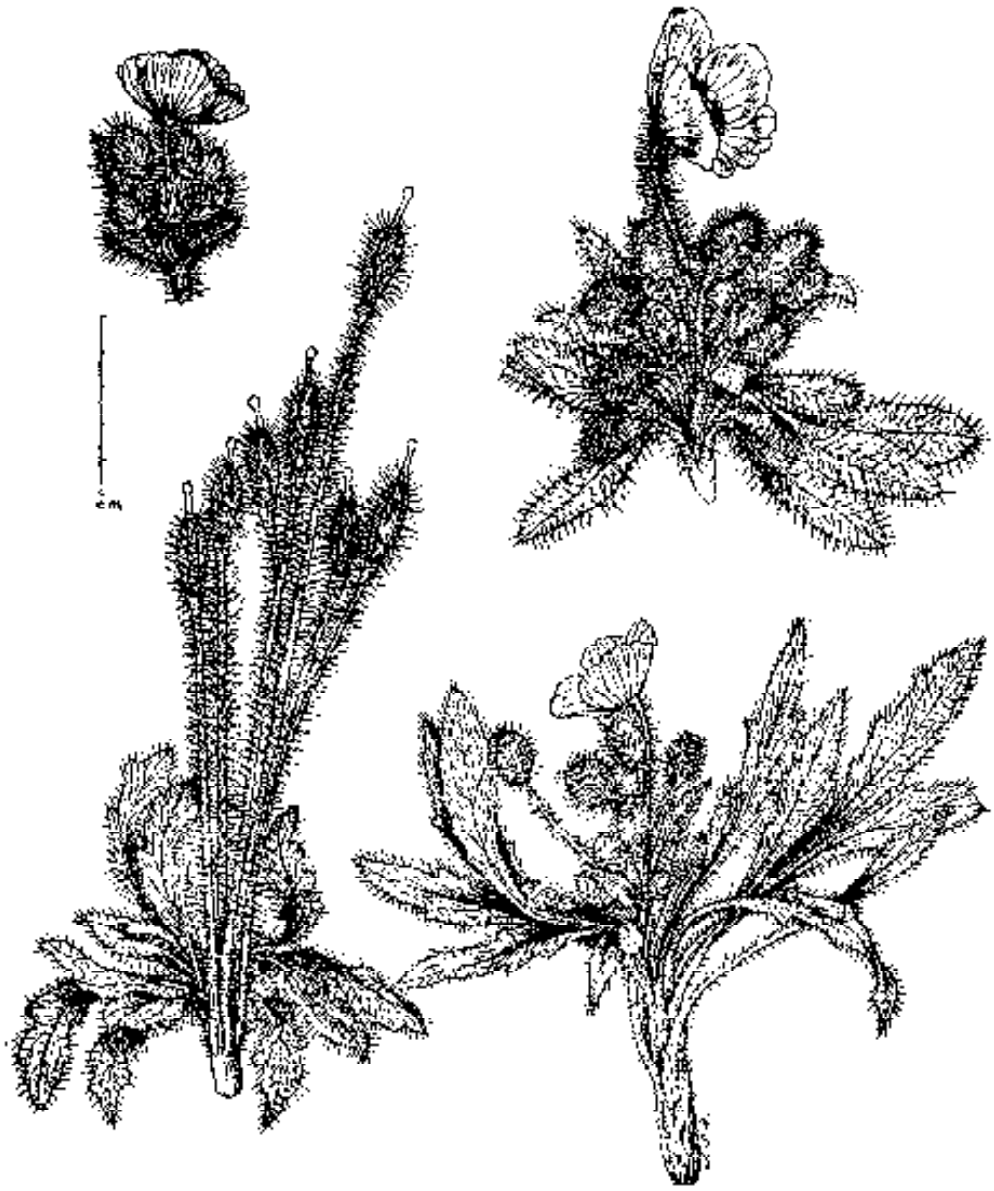


Fig. 22. Variations in *Meconopsis horridula* Hook. f. & Thoms.

9. **Meconopsis latifolia** (Prain) Prain in Bull. Misc. Inf. Kew 1915: 146. 1915; Bull. Misc. Inf. Kew 1916, App., 63. 1916; G. Tayl., Acc. genus Meconopsis 96. 1934; Chittenden, Dict. Gard. 3: 1272. 1956; Evans, Journ. Roy. Hort. Soc. 84: 505. 1959; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 24. 1974; Debnath et Nayar, Fasc. Fl. Ind. 17:20. 1984. *M. sinuata* var. *latifolia* Prain in Curt. Bot. Mag. 134: tab. 8223. 1908. **Fig. 23**

Monocarpic herbs. Tap roots stout, elongated. Stems 30-100 cm long, simple, leafy, clothed with patent, yellowish brown or golden-brown,

2-8 mm long bristles. Leaves 8-30 (incl. petiole) × 2-6 cm, oblong or ovate-lanceolate, with or rounded, decurrent base, acute or obtuse at apex, sinuate-lobed or deeply incised-serrate, rarely pinnatilobed, bristly, basal

Fig. 23. Habit of *Meconopsis latifolia* (Prain) Prain

leaves petioled, upper one sessile, smaller. Petioles 2-8 (-10) cm long. Flowers axillary or terminal, forming leafy racemes, uppermost flowers usually ebracteate. Pedicels 1-4 cm long, clothed with the same hairs as on the stem. Sepals 1.0-1.5 cm long, broadly oblong, sparsely bristly. Petals 4, 2-3 cm long, blue or white, obovate or suborbicular, entire. Stamens numerous; filaments 0.8-1.0 cm long; anthers yellowish. Ovary ovoid, bristly; styles 1.5-3.0 mm long; stigmas oblong. Capsules ellipsoid oblong, bristly, dehiscing by 4-7 valves, 1.0-1.5 cm long (excl. stylar beak). Seeds subreniform-planoconvex.

Type: Based on a plant cultivated at Kew, raised from seeds sent by *Lt. Col. Appleton* in 1906.

Type note: Prain in protologue stated as follows "Northern Kashmir: Curais Pass, 12,000 ft., *Winterbottom* 498; Tragbol, 10,500 ft, *Clarke* 29299; passes north of Kashmir, *Falconer* 3139, 3191/2, *Appleton*." Seeds collected by Lt. Col. Appleton, R.E. in 1906 and cultivated at Kew.

Fls.: July—August. *Frts.:* September—October.

Distrib.: Recorded between 2135-4575 m altitude, restricted to Kashmir Himalaya (Map 7).

Note: The species *M. latifolia* is intermediate between *M. aculeata* Royle and *M. sinuata* Prain and it may probably connect the latter with the former. The following characters—broader leaves, shorter capsules and more flowered inflorescence distinguished *M. latifolia* from *M. sinuata* and shorter pedicels and less dissected leaves distinguished *M. latifolia* from *M. aculeata*.

10. **Meconopsis longipetiolata** G. Tayl. ex Hay in New Fl. and Silva 4: 226, fig. 83. July 8. 1932; in Gard. Chron., Ser. 3. 92: 409, figs. 200-201. 1932; G. Tayl. in Gard. Chron., Ser. 3. 92: 41. July 16. 1932; G. Tayl., Acc. genus Meconopsis 42. 1934; Chittenden, Dict. Gard. 3: 1272. 1959.

Monocarpic herbs. Leaves up to 20 cm long, on long bristly petioles, pinnatisect towards the base, pinnatilobed towards the apex, segments obtusely or subacutely lobed, upper leaves smaller, all leaves densely covered on both the surfaces with long bristles along with minute puberulous hairs. Petioles 8-10 cm long. Flowers borne on axillary branches, branches up to 40 cm long, lower branches 3-flowered, upper branches 1-flowered. Bracts sessile. Petals 4, 3.5×3.5 cm, yellow, obovate-suborbicular. Stamens numerous; filaments filiform; anthers orange yellow. Ovary ovoid, densely covered with appressed bristles; styles up to 5 mm long, slightly curved; stigmas capitate, 5-lobed, green. Seeds ovate-oblong.

Map 7. Geographical distribution of *Meconopsis latifolia*

Type: Neotype: NEPAL, Langtang to Kyangchin, 3261 m, 14.7.1967, *Malla* 9040 (KATH).

Type note: Taylor (P. 42-43, 1934) noted about the type specimens as follows "This particularly graceful member of this genus originated from seed sent from Nepal and the original description was based on a plant which flowered in 1932. At that time the species could not be correlated with any field specimens, but more recent collections from Nepal include *M. longipetiolata.* In the original publication it was stated that the type-specimen was deposited in the British Museum (Natural History), but, by an unfortunate misunderstanding, the living plant on which the description was based was removed and has since been lost."

Since there is no extant plant or specimen from which the type description was made, it is necessary to select a specimen matching with the original plant from the type locality, Nepal. A specimen of Malla 9040 (KATH)

matching with type description of the species collected from Langtang to Kyangchin. Nepal is selected as a neotype.

Fls. & Frts.: June—September.

Distrib.: Recorded between 3050-3965 m altitude, restricted to NEPAL.

11. **Meconopsis lyrata** (Cummins & Prain) Fedde [in Engler, Pflanzenr. 4. 104 : 246. 1909, *nomen synonymum*] ex Prain in Bull. Misc. Inf. Kew 1915: 142. 1915; in Ann. Bot. 40: 539. 1926; G. Tayl., Acc. genus Meconopsis 73. 1934; Fedde in Engler & Prantl, Nat. Pflanzenfam., ed. 2, 17b: 101. 1936; Hara in Ohashi, Fl. E. Him. Bull. 8: 43. 1975; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 37. 1979; Debnath et Nayar, Fasc. Fl. Ind. 17: 21. 1984. *Cathcartia lyrata* Cummins & Prain ex Prain in Journ. Asiat. Soc. Beng. 64, 2: 325. 1896. *Cathcartia polygonoides* Prain in Journ. Asiat. Soc. Beng. 64, 2: 326. 1896. *Meconopsis polygonoides* (Prain) Prain in Bull. Misc. Inf. Kew 1915: 143. 1915. *Meconopsis compta* Prain in Bull. Misc. Inf. Kew 1918: 212. 1918.

Fig. 24

Monocarpic herbs. Tap roots stout, up to 6.5 cm long, napiform, often elongated. Stems 5-30 cm tall, slender, leafy, simple or often branched at base, clothed with prsistent, glabrous, membranous leafy sheaths at base, glabrous or sparsely bristly with golden-brown bristles. Leaves 0.3-4.0× 0.3-2.5 cm, ovate, oblong ovate, spathulate or oblanceolate with a hastate or subcordate-rounded base and decurrent into the petiole, acute to rounded at apex, entire to lyrate-pinnatifid, glabrous or sparingly bristly, glaucous beneath, basal leaves on linear, 0.5-5.0 cm long petioles which expanded into sheathing base, often with bulbils in their axils; upper leaves on the lower part of the stem with long petioles but becoming sessile and more or less stem-clasping on the upper part. Flowers borne singly in the axils of the upper cauline leaves, rarely on a basal scape, solitary, terminal and axillary. Pedicels pendulous, glabrous or sparingly bristly, 2-15 cm long. Sepals 8-10 mm long, obovate-oblong, glabrous or sparingly bristly, 0.8-1.0 cm long. Petals 4 (-5-6), 0.9-1.8×1.0-2.0 cm, obovate-suborbicular, acute to rounded, denticulate-fimbriate, pale pink, blue or white. Stamens 12-36; filaments filiform, 4-5 mm long; anthers 2 mm long, golden-yellow. Ovary narrowly oblong or oblong-ellipsoid, glabrous; styles 2-4 mm long; stigmas subclavate, 2-4 lobed. Capsules narrowly oblong or obovoid, ± 2.5 cm long (incl. beak), glabrous, dehiscing by 3-4 valves. Seeds ellipsoid-oblong.

Type: INDIA: Sikkim, Phullot, 3600 m, Aug. 1887, *Dr. King* s.n. (Lectotype CAL, Isotypes K, DUB); Tankra, 2nd Aug. 1892, *Gammie* 415 (Syntype CAL); Chianie Nepal frontier, 3900 m, Aug. 1888, *Dr. King* s.n. (Syntype CAL)).

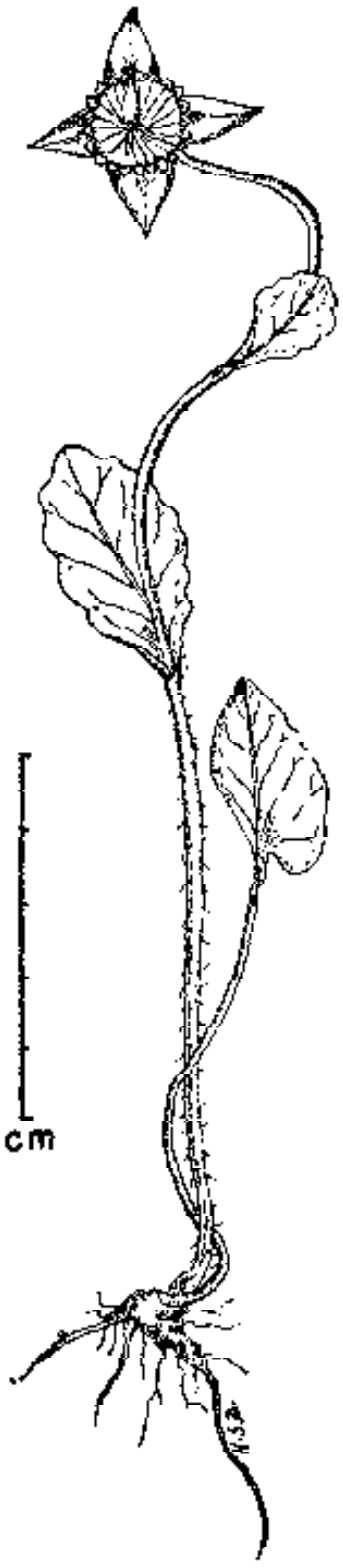


Fig. 24. Habit of *Meconopsis lyrata* (Cummins & Prain) Fedde ex Prain

Type note: *M. lyrata* was originally described under *Cathcartia* and based on several collections from Sikkim. Cummins and Prain (1896) mentioned about the type materials in their protologue "Sikkim Himalaya; 13-14,000 feet, not common; Ta-ne-da, *King*! Chianie, Phallut and Jongri, *King's. Collectors*! Tankra, *G. Gammie*! near Gnatong, *H. A. Cummins*!"

During the study of the specimens of *M. lyrata* deposited in Calcutta herbarium, authors found three specimens, one of them was collected by Gammie from Tankra, bearing collecting no. 415, on 2nd August, 1892 and others two were collected by Dr. King s.n. from Chianie Nepal frontier, 13,000 feet on Aug. 1888 and from Phullot, 12,000 feet on Aug. 1887. Of these three specimens "Aug. 1887-Phullot, 12,000 feet" specimen by Dr. King's Collector the herbarium sheet bears the line drawing of the floral parts of *M. lyrata* drawn by the original author. These illustrations also match with the type description and drawing given by Prain (Ann. Roy. Bot. Gard. Calcutta, 9. 1: 5, tab. 7. 1901). Hence the specimen of Dr. King s.n. Acc. No. 18907 is designated as the lectotype for *M. lyrata*.

Fls.: July—August. *Frts.:* September--October.

Distrib.: Recorded between 2745-3965 m altitude. INDIA: E. Himalaya, West Bengal (Darjeeling), Sikkim; NEPAL; BHUTAN; TIBET; CHINA.

Note: The species *M. lyrata* is very variable in leaf-shape, petal-shape and number of stamens. Based on these variable characters, Prain recognized *M. polygonoides* (in Bull. Misc. Inf. Kew 1915: 143. 1915) and *M. compta* (in Bull. Misc. Inf. Kew 1918: 212. 1918) cannot be maintained as distinct from *M. lyrata* as the specimens of *M. compta* and *M. polygonoides* are variable.

The presence of bulbils in leaf axils is an unique feature of this species in the family Papaveraceae. But Taylor (1934) mentioned that bulbils in leaf axils are also present in *M. chelidonifolia*. It is seen from the species that the vegetative multiplication serves as an additional strategy for survival in case of failure of the germination of seeds in such hostile environment.

12. **Meconopsis napaulensis** DC., Prodr. 1: 121. 1824; Walp., Rep. Bot. Syst. 1: 110. 1842 *pro parte:* Prain in Journ. Asiat. Soc. Beng. 64. 2: 317. 1896; in Ann. Bot. 20: 359. 1906; Fedde, in Engler, Pflanzenr. 4. 104: 269, fig. 35A. 1909; G. Tayl., Acc. genus Meconopsis 44. 1934; Chittenden, Dict. Gard. 3: 1272. 1956; Evans, Journ. Roy. Hort. Soc. 84: 507, 508. 1959; Hara in Hara, Fl. E. Him. 104. 1966; Biswas, Fl. Darjeeling & Sikkim Him. 1: 126. 1966; Hara in Hara, Fl. E. Him. 2nd Report, 40. 1971; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 37. 1979; Debnath et Nayar, Fasc. Fl. Ind. 17: 22. 1984.

Stylophorum nepalense (DC.) Spreng. in L., Syst. Veg., Ed. 16, 4, 2: 203. 1827 *pro parte*. *Meconopsis wallichii* Hook. in Curt. Bot. Mag. 78: tab. 4668. 1852. *Meconopsis wallichii* var. *fusco-purpurea* Hook. f. in Curt. Bot. Mag. 110: tab. 6760. 1884; *Meconopsis wallichii* forma *purpurea* Bulley in Fl. and Sylva 3: 84. 1905. *Meconopsis wallichii* forma *fusco-purpurea* Bulley in Fl. and Sylva 3: 84. 1905. **Fig. 25**

Monocarpic herbs with setose-villous hairs. Stems 0.5-2.0 m long, leafy, branched, clothed with patent ferruginous or golden-brown, 7 mm long bristles mixed with nonsubstellate, short bristles. Leaves up to 45 cm long, elliptic-oblong in outline, imperfectly 1-2 pinnatipartite, uppermost leaves often entire, sparsely to densely clothed with the same type of hairs as on the stem, segments ovate-oblong, sinuate-pinnatilobed, basal leaves on 5-20 cm long petioles, upper one sessile, with semiamplexicaul base, smaller. Flowers axillary, arising in the axils of the leaves, solitary or in cymes. Pedicels clothed with the same hairs as on the stem, 2.5-6.0 (-10) cm long. Sepals 1.5-2.0 cm long, ovate-oblong, obtuse-rounded, clothed with the same hairs as on the stem. Petals 4, 2-4 cm long, red to purple or blue, often white, nerve yellow, obovate-suborbicular, entire to denticulate. Stamens numerous; filaments filiform, 8-10 mm long; anthers 2 mm long. Ovary ellipsoid-oblong or ovoid, clothed with the same hairs as on the stem; styles distinct, 2-10 mm long, often becoming slightly swollen at the base in fruiting specimens, stigmas capitate or subclavate, 5-8 lobed. Capsules 1.0-3.5 cm long, oblong or ellipsoid-oblong, clothed with the same hairs as on the stem, dehiscing by 5-8 valves. Seeds 1.0-1.2 mm long, ovoid-ellipsoid-oblong.

Type: Wallich 8121 (Holotype G-DC, Isotype CAL)

Fls.: July—August. *Frts.:* September—October.

Distrib.: Recorded between 2745-4270 m altitude, INDIA: Uttar Pradesh, West Bengal (Darjeeling), Sikkim, Assam; NEPAL; BHUTAN; CHINA.

Note: The species *M. napaulensis* is very variable in colour of flowers, degree and density of indumentum and size and shape of leaves.

M. wallichii Hook., *M. wallichii* var. *fusco-purpurea* Hook. f. and *M. wallichii* f. *purpurea* Bulley which are based on variable characters are treated under a single polymorphic species *M. napaulensis* DC. The specific epithet is often spelled as 'nepalensis' and 'nipalensis' but the correct spelling is "*napaulensis*" which is original spelling.

Fig. 25. Habit of *Meconopsis napaulensis* DC.

13. **Meconopsis neglecta** G. Tayl., Acc. genus Meconopsis 102. 1934; Cullen, in Rechinger f., Fl. Iran. 34: 23. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 25. 1974; Dhar & Kachroo in Geobios N. Rep. 2: 132. 1983; Debnath et Nayar, Fasc. Fl. Ind. 17: 23. 1984.

Monocarpic, 15-20 cm tall herbs. Tap roots dauciform, up to 14 cm long, 1 cm broad, passing upwards into short stem which covered with persistent leaf bases Leaves radical, 3.5 × 1.0 cm, on 3.0-3.5 cm long petioles, deeply pinnatifid, densely covered on both the surfaces with pungent spines, lobes oblong, round at the apex. Scapes up to 12, up to 15 cm long, sparsely spiny. Petals 4, 1.5-2.0 × 1.5-2.0 cm, broadly obovate or suborbicular. Stamens numerous; filaments filiform: anthers yellow. Ovary ellipsoid, densely covered with pungent spines; styles distinct, about 1 cm long; stigmas capitate.

Type: PAKISTAN, Chitral, Kafristan, *S. M. Toppin* 761 (K).

Distrib.: Recorded between 3355-3965 m altitude, INDIA: Kashmir Himalaya; PAKISTAN: Chitral State (Map 8).

14. **Meconopsis paniculata** (D. Don) Prain in Journ. Asiat. Soc. Beng. 64, 2: 316. 1896; in Ann. Bot. 20: 358. 1906; in Bull. Misc. Inf. Kew 1915: 170. tab. Opp. 170, fig. 1. 1915; Fedde, in Engler, Pflanzenr. 4. 104: 267, fig. 34B. 1909; G. Tayl., Acc. genus Meconopsis 39. 1924; Chittenden, Dict. Gard. 1272. 1956; Evans, Journ. Roy. Hort. Soc. 84: 507. 1959; Hara in Hara, Fl. E. Him. 104. 1966; Hara in Ohashi, Fl. E. Him. Bull. 8: 43. 1975; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 37. 1979; Debnath et Nayar, Fasc. Fl. Ind. 17: 23, Fig. 5.1984. *Papaver paniculatum* D. Don, Prodr. Fl. Nepal. 197. 1825 *nomen illegitimum*. *Stylophorum napaulensis auct. non* DC., 1824; Hook. f. & Thoms., Fl. Ind. 253. 1855 et in Hook. f., Fl. Brit. Ind. 1: 118. 1872 ('Nepalensis'). *Meconopsis paniculata* var. *typica* Prain in Journ. Asiat. Soc. Beng. 64, 2: 316. 1896. *M. paniculata* var. *elata* in Journ. Asiat. Soc. Beng. 64, 2: 316. 1896. **Fig. 26**

Monocarpic herbs. Tap roots stout, elongated, often split into several rootlets. Stems up to 2 m long, leafy, stout, fistular, sparsely or densely clothed with patent or deflexed, golden-brown long bristles mixed with substellate short bristles, rarely glabrescent. Leaves linear-oblong in outline, pinnatilobed-pinnatipartite, often entire in the uppermost part of the stem, densely clothed with the same type of hairs as on the stem, segments ovate-oblong, acute to obtuse at the apex, margin entire or lobed, basal leaves up

Map 8. Geographical distribution of *Meconopsis neglecta*

to 60 cm long and up to 14 cm broad, petiolate, higher ones sessile, with a semi-amplexicaul base, smaller. Petioles up to 20 cm long. Flowers axillary or terminal, solitary or in 2-6 flowered cymes, forming a leafy raceme or panicle. Pedicels 2-15 cm long, pendulous, clothed with the same type of hairs as on stem. Sepals broadly ovate-oblong, obtuse-rounded, clothed with the same type of hairs as on stem. Petals 4(-5), 3-5 cm long, yellow, obovate to suborbicular, margin entire to subentire, rarely denticulate. Stamens numerous; filaments filiform, 0.7-1.5 cm long; anthers 2 mm long. Ovary globose or ovoid-ellipsoid, densely covered with appressed golden-yellow hairs; styles 0.5-1.5 cm long, hairy on the lower part, thickened considerably at the base; stigmas capitate, 6-12 lobed. Capsules oblong or ellipsoid oblong, 1.5-3.5 cm long, clothed with the same type hairs as on the stem, dehiscing by 6-12 valves for a short distance from the apex. Seeds 1.0-1.2 mm long, subreniform.

Type: NEPAL: Gosaingsthan, *Wallich* 8123 E (Syntypes CAL, K).

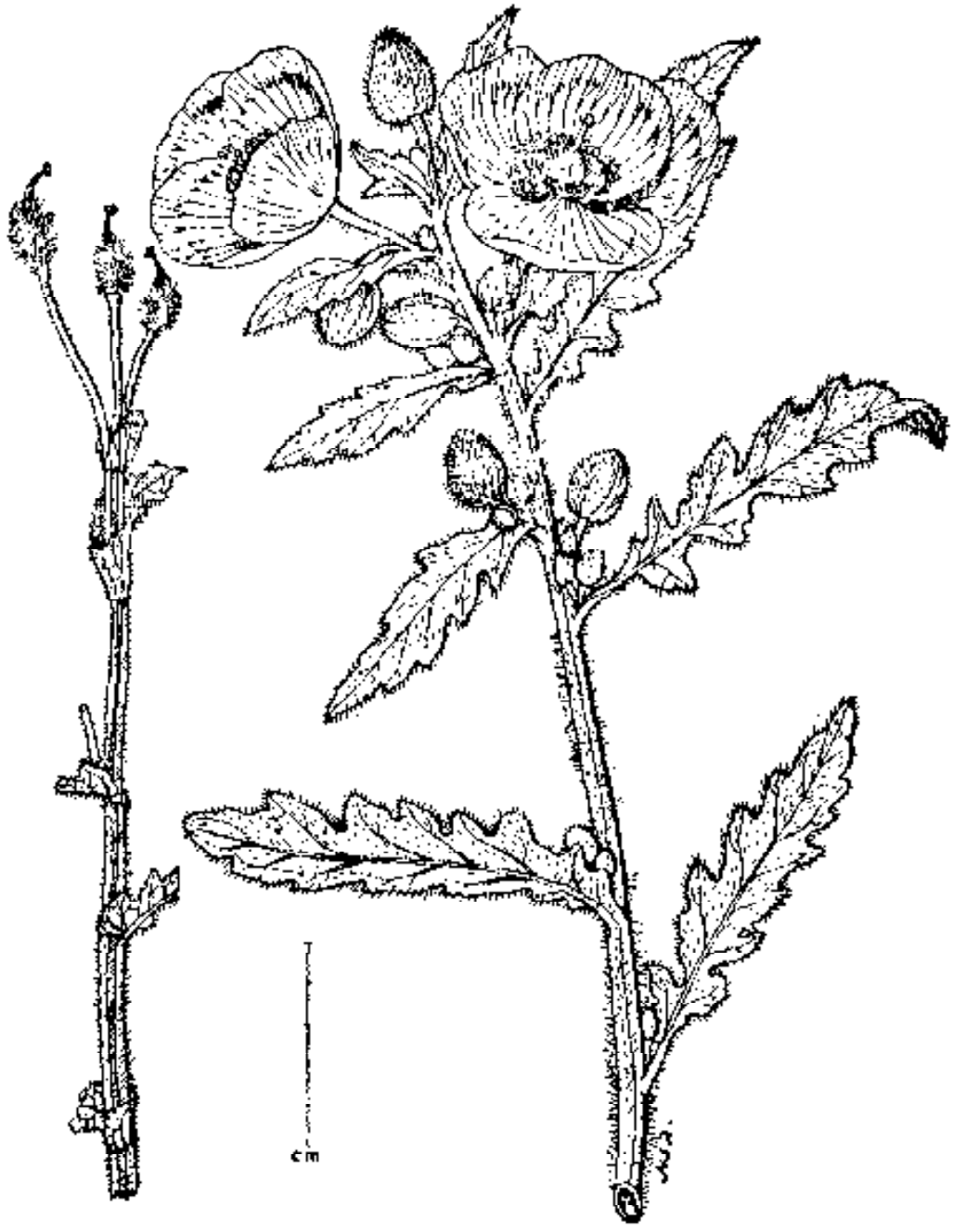


Fig. 26. Habit of *Meconopsis paniculata* (D. Don) Prain

Fls. : June—August. *Frts.* : September—October.

Distrib. : Recorded between 2135-4575 m altitude. INDIA: Uttar Pradesh, West Bengal (Darjeeling), Sikkim; NEPAL; BHUTAN; TIBET.

Note: The species *M. paniculata* is very similar and was previously confused with *M. napaulensis* DC., but is easily recognised by yellow

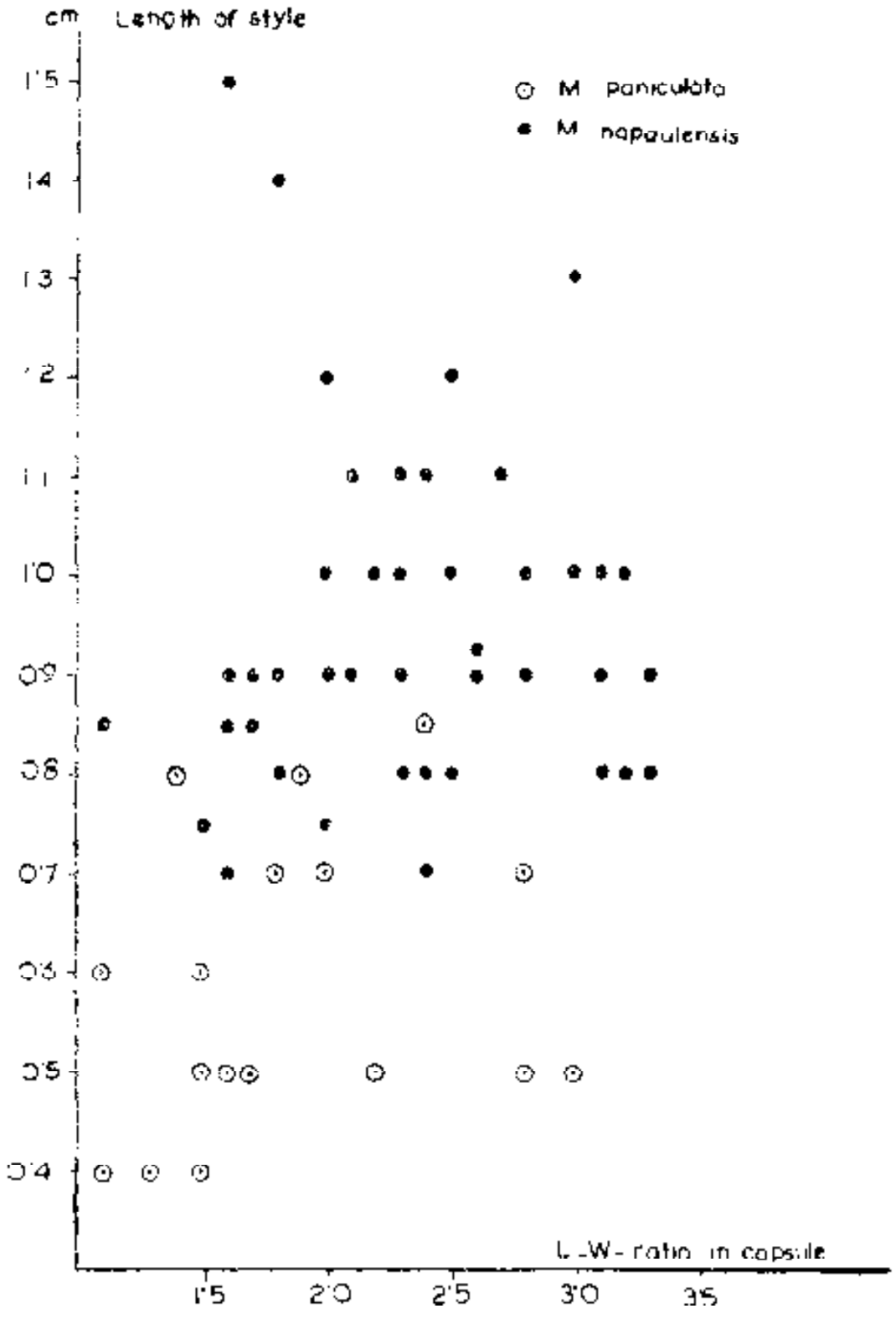


Fig. 27. Graph showing the distinct segregation of *Meconopsis paniculata* (D. Don) Prain and *M. napaulensis* DC.

flowers, pinnatifid-pinnatipartite leaves, length of styles and length-width ratio of capsules (Fig. 27).

15. **Meconopsis primulina** Prain in Journ. Asiat. Soc. Beng. 64. 2: 319. 1896; in Ann. Roy. Bot. Gard. Calcutta, 9. 1: 3, tab. 3. 1901; in Ann. Bot. 20: 350. 1906; in Bull. Misc. Inf. Kew 1915: 160. 1915; Fedde, in Engler, Pflanzenr. 4. 104: 280, fig. 35C. 1909; G. Tayl., Acc. genus Meconopsis 75. 1934. **Fig. 28**

Monocarpic herbs. Tap roots stout. Stems very short. Leaves 1.5-7.0 (-8.0)×0.2-1.0 cm, oblanceolate to elliptic with a narrow decurrent base, subacute-obtuse, entire to sinuate-dentate, often lyrate at base, glabrous or sparingly bristly, glaucous beneath, basal leaves represented by a dense tuft of persistent membranous leaf bases at time of flowering, cauline leaves all arising from the base of the stem, lower ones petiolate. Petioles up to 2 cm long, glabrous or sparsely bristly. Flowers usually 3, rarely solitary, borne on central subscapose flowering stem or on pedicels arising from axils of basal leaves. Pedicels 6-15 (-20) cm long, glabrous or sparingly bristly with deflexed, golden-brown, 1.5-2.0 mm long, hairy bristles. Sepals 1.0-1.5 cm long, oblong, obtuse, glabrous or sparingly bristly. Petals 4-8, 1.5-2.5 cm long, blue or purple, obovate, suborbicular, denticulate. Stamens numerous; filaments purple, filiform, 7-10 mm long; anthers golden-yellow. Ovary narrowly oblong, glabrous or very sparsely covered with appressed bristles; styles green, 4-5 mm long; stigmas purple, subclavate, 4-lobed, lobes more or less decurrent. Capsules narrowly oblong-ellipsoid or obovoid, dehiscing by 4-valves.

Type: Chumbi, Phari, Sham-Chen, July 1879, *Dungboo* s.n. (Lectotype CAL, Isotype P).

Fls.: June—August. *Frts.:* September—October.

Distrib.: Recorded between 3965-4575 m altitude, BHUTAN; TIBET.

Note: M. primulina is allied to *M. lyrata* but it is easily recognizable from that species in having tuft of persistent membranous leaf bases, oblanceolate to elliptic with a narrow decurrent based leaves (leaves ovate, oblong ovate, spathulate or oblanceolate with a hastate or subcordate-rounded base in *M. lyrata*) and flowers borne on long, usually almost basal pedicels.

16. **Meconopsis regia** G. Tayl. in Journ. Bot. 67: 259. 1929; Acc. genus Meconopsis 33. 1934; Chittenden, Dict. Gard. 3: 1272. 1956; Evans, Journ. Roy. Hort. Soc. 84: 507. 1959; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 37. 1979. **Fig. 29**

Fig. 28. Habit of *Meconopsis primulina* Prain

Monocarpic herbs. Tap roots dauciform. Stems 1.5-2.0 m long, stout leafy, tomentose with appressed, golden, 5-8 mm long, hairy bristles mixed with short much branched hairy bristles. Leaves 10-50×2-20 cm, elliptic-oblong or oblanceolate, tapering towards the base and the apex, acute, acutely serrate at the margin, densely covered on both the surfaces with tomentose bristles mixed with long golden hairs, basal leaves in a dense rosette, decurrent into broad, *ca.* 20 cm long petiole, upper leaves sessile, more densely hairy, stem clasping. Flowers borne on stout densely villous branches, arising from the leaf axils, lower branches up to 4-flowered, upper branches 1-flowered. Pedicels 2-16 mm long, stout, covered with the same type of hairs as on the stem, hairs more dense immediately below the flowers. Petals 4 (6 usually in terminal flower), yellow, rarely red, 6×5 cm, suborbicular. Stamens numerous; filaments 1.2-1.4 cm long, yellow, filiform; anthers up to 3 mm long. Ovary globose or ovoid, tomentose; styles *ca.* 1 cm long, stout, thickened at the base; stigmas with 7-12 distinct lobes, reddish purple. Capsules 1.5-2.0×1.2-1.5 cm, oblong-ellipsoid, tomentose, dehiscing by 7-12 valves. Seeds ± rounded.

Type: Alpine Himalaya: Western NEPAL, Barpak, 3648-4560 m. *Lall Dhwoj* 18 (K); Michet, 4256-4560 m, *Lall Dhwoj* s.n. (E,K).

Fls.: June—August. *Frts.:* August—September.

Distrib.: Recorded between 3660-4575 m altitude, restricted to central NEPAL.

17. **Meconopsis robusta** Hook. f. & Thoms., Fl. Ind. 1: 253. 1855; in Hook. f., Fl. Brit. Ind. 1: 118. 1872 pro parte; Prain in Journ. Asiat. Soc. Beng. 64, 2: 315. 1896 pro parte; in Ann. Bot. 20: 359. 1906 pro parte; Fedde in Engler, Pflanzenr. 4, 104: 268, fig. 34D. 1909 pro parte; G. Tayl., Acc. Genus Meconopsis 35. 1934; Debnath et Nayar, Fasc. Fl. Ind. 17: 25. 1984. **Fig. 30**

Monocarpic herbs. Stems 1-2 m long, leafy, stout, fistular, sparsely clothed with patent ferruginous or yellowish-brown, 5-6 mm long bristles or with their persistent bases. Leaves imperfectly 1-2 pinnatifid to pinnatipartite, often the uppermost entire, sparsely bristly, rarely glabrous, segments ovate or ovate-oblong, acute or obtuse at apex, basal leaves on 10-15 cm long petioles, upper one sessile, with semiamplexicaul base. Flowers borne singly, axillary or terminal, forming leafy racemes. Pedicels clothed with the same type of bristles as on the stem, 5-20 cm long. Sepals 1.5-2.0 cm long, broadly ovate-oblong, bristly. Petals 4, obovate, yellow to sulphur yellow colour. Stamens numerous; filaments 1.0-1.5 cm long, filiform. Ovary ellipsoid or ellipsoid oblong, bristly; styles 0.15-1.0 cm long; stigmas capitate,

Fig. 29. Habit of *Meconopsis regia* G. Tayl.

6-9 lobed. Capsules obovoid-oblong or ellipsoid, 2-3 cm long, dehiscing by 6-9 valves. Seeds subreniform.

Type: In Himalaya temperate: Kumaon, alt. 2400 m, *Wallich* 8124 (Lectotype K, Isolectotypes CAL, E, P).

Fls.: July—August. *Frts.:* September—October.

Distrib.: Recorded between 2440-4100 m, endemic to Kumaon (Uttar Pradesh), INDIA (Map 9).

Note: *M. dhwojii* Taylor ex Hay and *M. gracilipes* Taylor, two central Himalayan (Nepal) species are closely allied to *M. robusta* Hook. f. & Thoms., but can be distinguished by flowers being in 1-3 flowered cymules. From the description of these species, it appears that they may be only forms of *M. robusta* Hook. f. & Thoms. as the inflorescence is quite variable in this species.

Map 9. Geographical distribution of *Meconopsis rabusta*

Fig. 30. Habit of *Meconopsis robusta* Hook. f. & Thoms.

Prain (in Kew Bull. 1915: 171-174. 1915) in his extensive discussion on the typification of *M. paniculata* (D. Don) Prain, *M. napaulensis* DC. and *M. robusta* Hook. f. & Thoms. involving Wallich's specimens 8124, 8123B and 8121 pointed out that all these three Wallichian numbers were distinct and designated 8124 as the lectotype of *M. robusta*, 8123B as the type of *M. paniculata* (D. Don) Prain and 8121 as the type of *M. napaulensis* DC.

18. **Meconopsis simplicifolia** (D. Don) Walp., Repert. Bot. Syst. 1: 110. 1842; Hook. f. & Thoms., Fl. Ind. 1: 252. 1855; in Hook. f., Fl. Brit. Ind. 1: 118. 1872; Prain in Journ. Asiat. Soc. Beng. 64, 2: 321. 1896; in Ann. Bot. 20: 354. 1906; in Bull. Misc. Inf. Kew 1915: 167. 1915; Fedde, in Engler, Pflanzenr. 4. 104: 263, fig. 35F. 1909; G. Tayl., Acc. Genus Meconopsis 50. 1934; Chittenden, Dict. Gard. 3: 1272. 1956; Evans, Journ. Roy. Hort. Soc. 84: 502. 1959; Hara in Hara, Fl. E. Him. 104-105. 1966; Biswas, Pl. Darjeeling & Sikkim Him. 1: 127. 1966; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 37. 1979; Debnath et Nayar, Fasc. Fl. Ind. 17: 26, Fig. 6. 1984. *Papaver simplicifolium* D. Don, Prodr. Fl. Nepal. 197. 1825. *Meconopsis simplicifolia* var. *Baileyi* Kingdon-Ward in Gard. Chron. Ser. 3, 79: 340 in Obs., 459. in obs. 1926. **Fig. 31**

Monocarpic or polycarpic herbs. Tap roots slender, elongated. Stems short, clothed with rufous-bristly persistent leaf sheaths and rosette of leaves. Leaves all basal, 1.5-15.0×1.5-3.0 (-3.5) cm, oblanceolate-spathulate or lanceolate or elliptic-lanceolate to oblong with a narrow decurrent base, subacute to rounded or obtuse at apex, entire to sinuately lobed, densely covered on both surfaces with weak bristles, subsessile or petiolate. Petioles 0.5-25.0 cm long, rufous bristly. Flowers solitary, borne singly on basal pedicels. Pedicels 1-2, produced from each rosette, 5-60 cm long, decurved at the top, densely clothed with rufous patent or deflexed bristles of 2-5 mm long. Sepals 2.0-2.5×1.0-1.2 cm, broadly oblong, obtuse, bristly. Petals 5-9 (-10), 2.5-5.0×1.5-3.0 cm, blue or purple, obovate, crenulate. Stamens numerous; filaments 0.8-2.0 cm long, narrowly linear, bluish; anthers *ca.* 2 mm long. Ovary ellipsoid or ellipsoid oblong, appressed bristly; styles usually distinct, 3-10 mm long, slender to very stout; stigmas clavate or capitate, 2-9 lobed, lobes more or less decurrent. Capsules ellipsoid or ellipsoid-oblong, narrow towards the base, glabrous or bristly, 3-6 cm long (incl. stylar beak). Seeds ovoid-ellipsoid, 3 mm long.

Type: NEPAL: Gosaingsthan, *Wallich* 8125 (Isotype CAL).

Type note: *Meconopsis simplicifolia* was based on the D. Don's species *Papaver simplicifolium*. D. Don cited in his protologue about the type materials, "*in Gosaingsthan regione alpina Himalayae, in Nepalia propria Wallich & ohaee et Themei Sowang Indegenis*".

Fig. 31. Habit of *Meconopsis simplicifolia* (D. Don) Walp.

While studying the specimens of Calcutta herbarium authors found the Wallichian sheet no. 8125 of Gosaingsthan collected on 8th August 1821, Acc. No. 18646 (CAL), which is considered here as the isotype for *M. simplicifolia*.

Fls.: May—July. *Frts.:* September—October.

Distrib.: Recorded between 3050-5000 m altitude. INDIA: Sikkim; NEPAL; BHUTAN; TIBET.

Note: *M. simplicifolia* is very closely allied to *M. grandis*, but is easily recognizable by the following characters. In *M. simplicifolia* there is short stem, usually more densely hairy and the leaves more densely tufted than in *M. grandis*. Flowers are constantly borne on simple basal pedicels and the filaments are always coloured, whereas it is white in *M. grandis*.

The combination has often been attributed to Hooker f. & Thomson (Fl. Ind. 252. 1855), but it was Walpers (1842) who first made the combination.

19. **Meconopsis sinuata** Prain in Journ. Asiat. Soc. Beng. 64. 2: 314. 1896 (excl. var. *Pratii*); in Ann. Roy. Bot. Gard. Calcutta. 9. 1: 5. tab. 6. 1901; in Ann. Bot. 20: 347. 1906; in Bull. Misc. Inf. Kew 1915: 148. 1915; Fedde, in Engler, Pflanzenr. 4. 104: 256, fig. 35 0. 1909; G. Tayl., Acc. genus Meconopsis 102. 1934. Chittenden. Dict. Gard. 1273. 1956; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 38. 1979; Debnath et Nayar, Fasc. Fl. Ind. 17: 28, Fig. 7. 1984. **Fig. 32**

Monocarpic herbs. Tap roots stout, elongated. Stems leafy, 15-45 (-60) cm long, clothed with golden-brown patent or deflexed 2-5 (-7) mm long prickly bristles. Leaves narrowly oblanceolate or oblong, often linear, obtuse at apex, entire-sinuate lobed, glaucous beneath, bristly on both the surfaces. Basal leaves on 2-5 cm long petioles. 10-15 cm long (incl. petiole), higher ones sessile, with a semiamplexicaul base, smaller. Flowers 4-8, axillary or terminal, forming a leafy raceme. Pedicels all bracteate, 2-5 cm long during anthesis, up to 15 cm long in fruiting. Sepals broadly acute-oblong, ± 1.5 cm long, bristly. Petals 4, 2-3 cm long, blue, purple or violet, obovate, subacute to rounded at the apex and slightly irregularly notched. Stamens numerous; filaments filiform, 0.8-1.0 cm long; anthers up to 3.5 mm long, yellowish. Ovary ellipsoid, bristly; styles slender, 1.5-5.0 mm long; stigmas capitate. Capsules ± 4.5 cm long (excl. beak), up to 8 mm broad, narrowly obovoid, bristly, dehiscing by 3-4 valves. Seeds falcate-oblong.

Type: INDIA: Sikkim, Patangla, *Dr. King* 4194 (Lectotype K); Dzongri, Pey-King-la, Aug. 87, *Dr. King* s.n. (Syntype CAL).

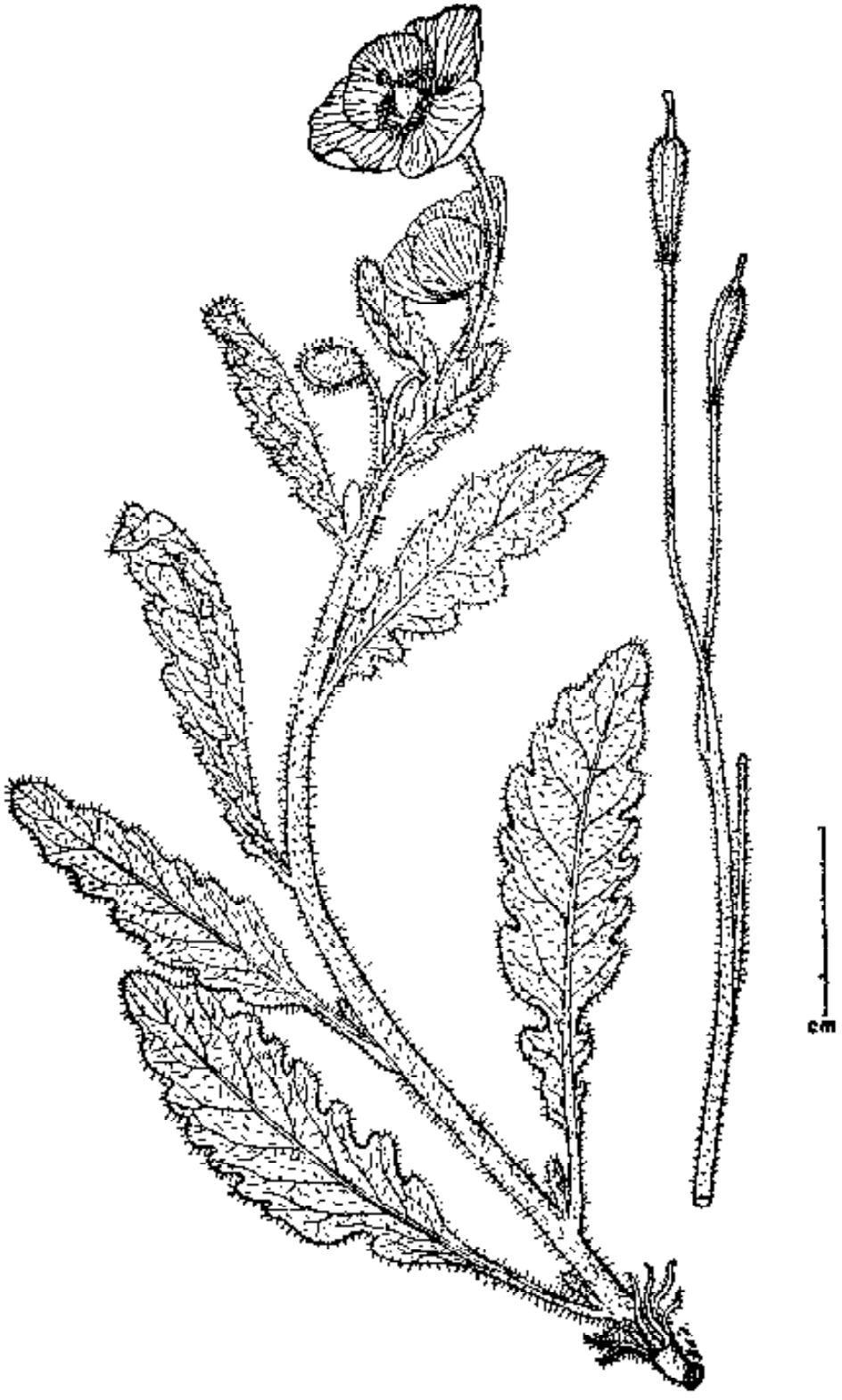


Fig. 32. Habit of *Meconopsis sinuata* Prain

Fls.: July—August. *Frts.:* September—October.

Distrib.: Recorded between 3660-4575 m altitude, INDIA: Eastern Himalaya, Sikkim; NEPAL; BHUTAN.

Note: The species *Meconopsis sinuata* is readily distinguishable from *M. latifolia* (Prain) Prain and *M. aculeata* Royle, to which it is allied by a combination of characters—bracteate, few flowered inflorescence, capitate stigma and long, obovoid capsule.

20. **Meconopsis superba** King ex Prain in Journ. Asiat. Soc. Beng. 64, 2: 317. 1896; Novic. Ind. 119. 1905; King & Prain in Ann. Roy. Bot. Gard. Calcutta, 9. 1: 4, tab. 2. 1901; Prain in Ann. Bot. 20: 357. 1906; in Bull. Misc. Inf. Kew 1915: 170. 1915; Fedde, in Engler, Pflanzenr. 4. 104: 267. 1909; G. Tayl., Acc. genus Meconopsis 32. 1934; Chittenden, Dict. Gard. 1273. 1956; Evans, Journ. Roy. Hort. Soc. 84: 507. 1959; Debnath et Nayar, Fasc. Fl. Ind. 17: 30. 1984. **Fig. 33**

Monocarpic herbs. Tap roots stout, elongated. Stems up to 1.5 m long, stout, leafy, tomentose with appressed golden-brown, 5-8 mm long hairy bristles mixed with short much branched hairy bristles. Leaves elliptic-oblong or oblanceolate-oblong, acute at apex, incised-serrate, densely clothed with short non-substellate tomentose bristles mixed with few long golden-brown hairs, basal leaves on ± 5 cm long petioles, up to 40 cm long and 8.5 cm broad, higher ones sessile with semiamplexicaul base, smaller than the basal. Flowers borne singly on the axils of the uppermost leaves, forming a leafy raceme. Pedicels stout, clothed with the same type of hairs as on the stem, 2-5 cm long. Sepals 2.5-3.0 cm long, broadly ovate-oblong, obtuse, tomentose. Petals 4, white, ovate-suborbicular, 3.5-5.0 cm long and also broad. Stamens numerous; filaments filiform, 1.2-1.5 cm long; anthers up to 0.2 cm long. Ovary globose or ovoid-ellipsoid, tomentose; styles distinct and stout, 3-5 mm long; stigmas capitate with distinct lobes, 12-16 lobed. Capsules ellipsoid oblong, dehiscing by 7-11 valves. Seeds subreniform.

Type: BHUTAN, Ho-Ko-Chu, 16.6.1884, *Dungboo* 280 (Holotype CAL, Isotypes K, P).

Type note: The specimen on which this species was based, was collected by the collectors of the Calcutta Botanic Garden from Ho-Ko-Chu in Chumbi, about 10,000 ft. above sea level (Prain, 1896).

But Prain (1896) failed to give the actual collector's name in his protologue. During the study of the specimens of the *Meconopsis superba*, one

specimen was found by the authors, labelled as collector Dungboo no. 280, collected from Ho-Ko-Chu attached with a habit sketch in a separate sheet and a letter written by R. C. Cooper on Dec. 16th, 1912. From Cooper's letter it was known that *M. superba* was based on the Dungboo's specimen.

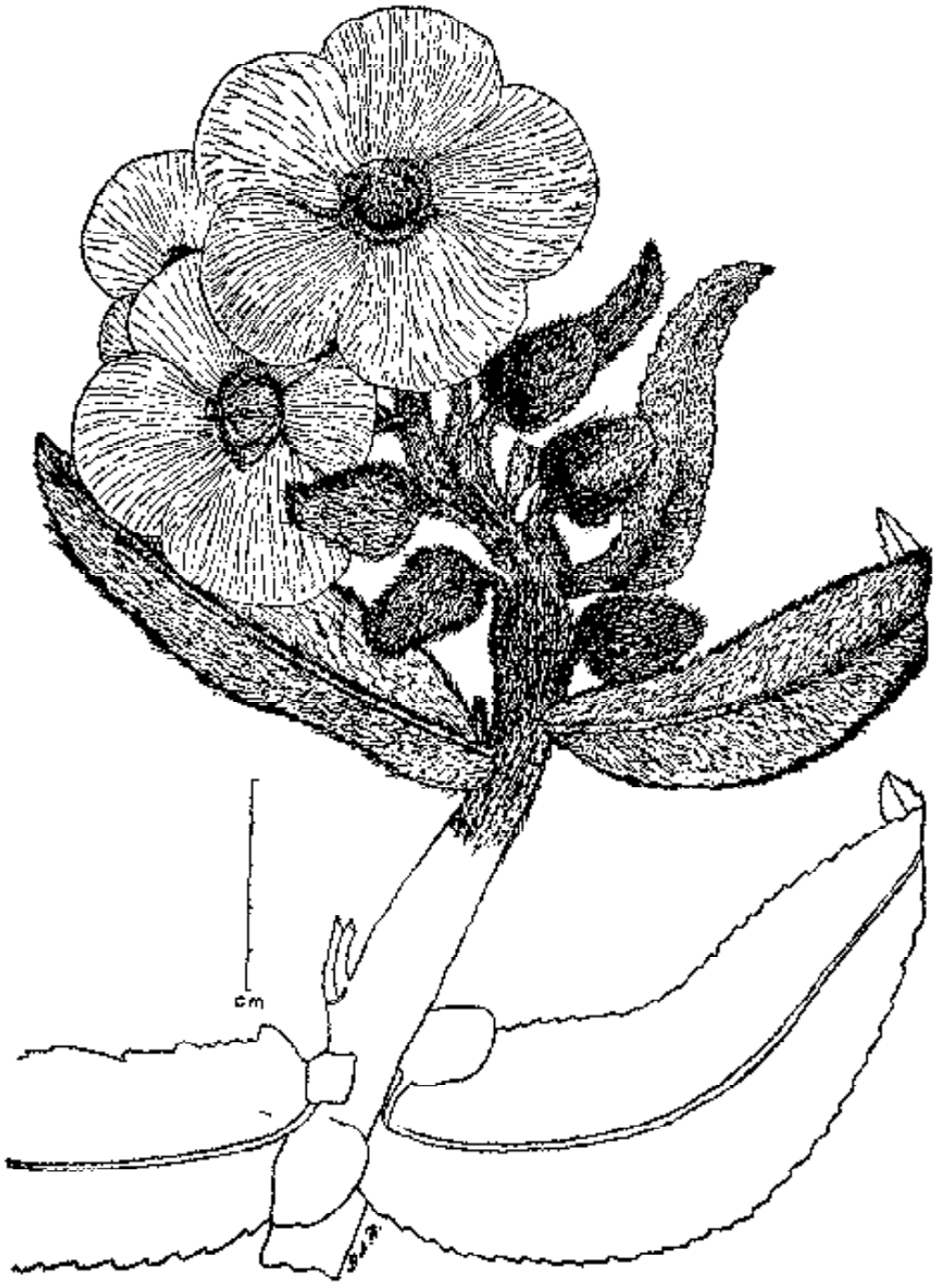


Fig. 33. Habit of *Meconopsis superba* King ex Prain

Fls.: July—August. *Frts.:* September—October.

Distrib.: Recorded between 3965-4270 m altitude, INDIA: Eastern Himalaya, Sikkim; BHUTAN; TIBET.

Note: The species *Meconopsis superba* is allied to *M. paniculata* group, but is easily recognizable by incised-serrate leaves, non-substellate shorter bristles of tomentum, white petals and shorter styles.

21. **Meconopsis taylorii** Williams in Trans. Bot. Soc. Edinb., 41: 347-349. 1972; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 38. 1979.

Monocarpic herbs, 1.5-1.8 cm long, entirely clothed with hairs. Basal leaves 60×16 cm, rosette, narrowly elliptic or oblanceolate, apex acute, margin minutely crenate, densely covered with straw-coloured hairs, hairs denser and darker in colour along the midrib, 0.2-0.5 mm long, mixed with much longer, loosely, appressed, stouter barbellulate, 10-15 mm long hairs, cauline leaves minutely dissected, sessile, base rotund. Flowering stem branched, lower one 5-flowered, upper one 2-flowered. Bracts leaf like, smaller. Pedicels 6-18 cm long, patently hairy, *ca.* 7 mm long. Buds subglobose. Sepals ovate, densely hirsute. Petals 4, 3-4×3-4 cm, pink. Stamens numerous; filaments white; anthers orange. Ovary subglobose, *ca.* 1 cm long, densely hairy; styles 5 mm long during anthesis, attaining *ca.* 1.5 mm long in fruit, minutely pubescent; stigmas capitate, dark brown. Capsules *ca.* 6 cm long, narrowly clavate or ellipsoid, 7-12 valves. Seeds oblong, black, 1.0-1.2 mm long, 0.6-0.7 mm broad.

Type: NEPAL: Annapurna Himal, Seti Khola, 4572 m, 2nd Aug. 1954, *Stainton, Sykes & Williams* 6593 (Holotype BM).

Fls. & Frts.: July-September.

Distrib.: Recorded between 3660—4575 m altitude, NEPAL.

22. **Meconopsis villosa** (Hook. f. ex Hook.) G. Tayl., Acc. Genus Meconopsis 28: 1934; Fedde, in Engler & Prantl, Nat. Pflanzenfam., ed. 2, 17b: 98. 1936; Chittenden, Dict. Gard. 3: 1273. 1956; Evans, Journ. Roy. Hort. Soc. 84: 504. 1959; Hara in Hara, Fl. E. Him. 105. 1966; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 38. 1979; Debnath et Nayar, Fasc. Fl. Ind. 17: 30, Fig. 8. 1984. *Cathcartia villosa* Hook. f. ex Hook. in Curt. Bot. Mag. 77: tab. 4596. 1851; Hook. f. & Thoms., Fl. Ind. 255. 1955; in Hook f., Fl. Brit. Ind. 1: 119. 1872; Fedde, in Engler, Pflanzenr. 4. 104: 205. 1909; Hara in Hara, Fl. E. Him. 2: 40. 1971. **Fig. 34**

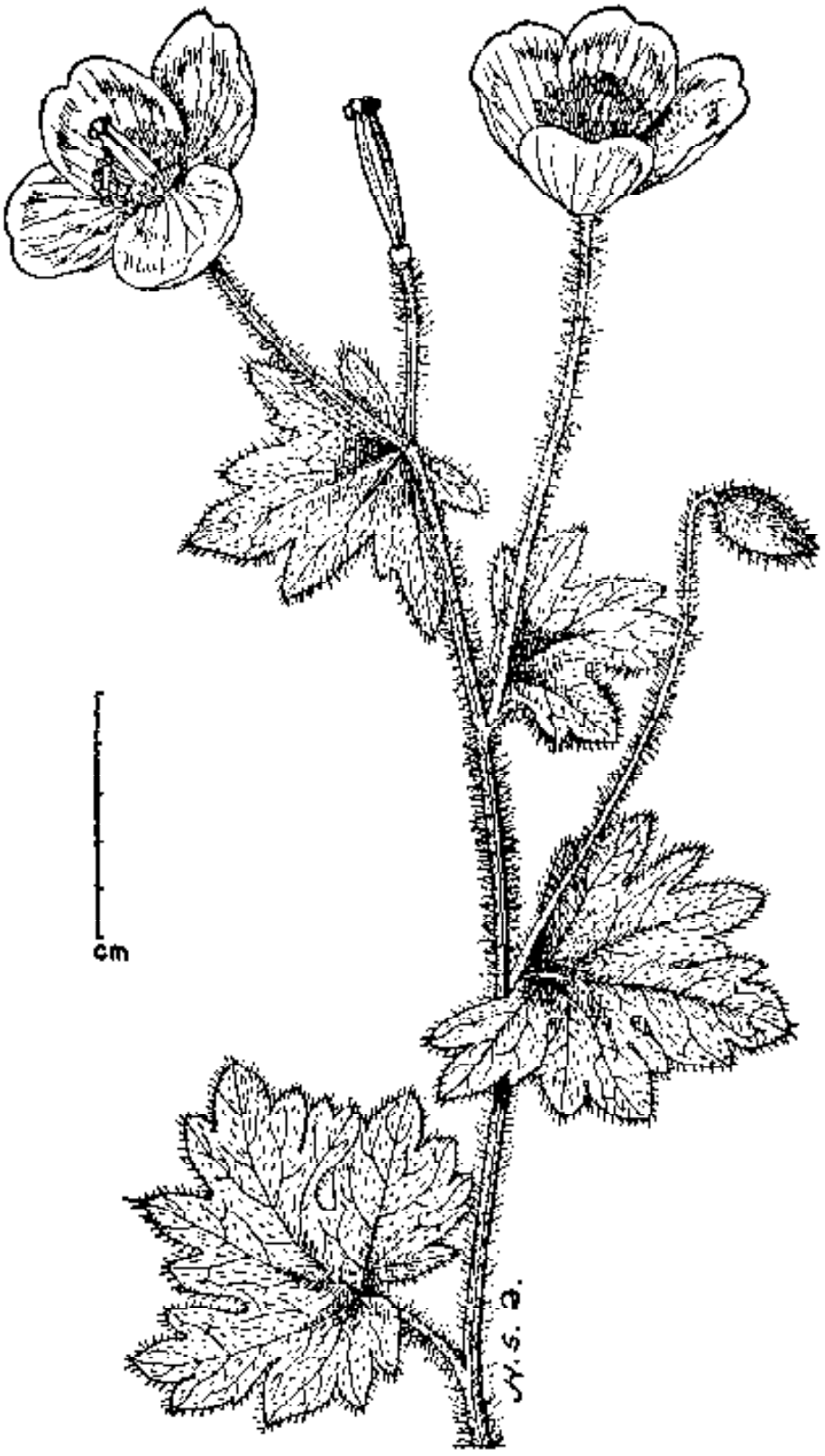


Fig. 34. Habit of *Meconopsis villosa* (Hook. f. ex Hook.) G. Tayl.

Polycarpic herbs. Root stocks stout, short, clothed with rufous bristly membranous persistent leaf sheaths. Stems up to 60 cm long, simple or sparingly branched, patently bristly with rufous, barbellate, 3-5 mm long bristles. Leaves 3-10 × 3-10 cm, broadly ovate-cordate or orbicular, cuneate or cordate at base, 3-palmatifid with palmatilobed segments, appressed bristles on both surfaces, basal leaves petiolate, higher ones sessile, smaller, borne at considerable intervals apart, passing into bracts. Flowers solitary, axillary or terminal, forming 1-7 flowered inflorescence. Pedicels 2.5-12.0 cm long, clothed with the same type of hairs as on the stem. Sepals 1.5-2.0 cm long, ovate-oblong, subacute-obtuse, appressed bristly, 1.5-2.0 cm long. Petals 4, 2.5-3.5 × 3.5-4.0 cm, yellow, obovate-suborbicular, obtuse to rounded at the apex, entire. Stamens many; filaments 0.8-1.0 cm long, filiform, yellow; anthers yellow to dark brown, 2 mm long, basifixed. Ovary narrowly oblong, glabrous, stigma sessile, with 4-7 radiating lobes. Capsules narrowly oblong, with 4-7 prominent ribs alternating with faint ribs, dehiscing by 4-7 valves to more than half way down its length, 0.4 to 9.0 cm long and up to 0.5 cm broad. Seeds subreniform, dark.

Type: INDIA: Sikkim, *J. D. Hooker* s.n. (Holotype K, Isotypes CAL, FI, M).

Fls. & Frts.: July--September.

Distrib. Recorded between 2745-4270 m altitude, INDIA: Eastern Himalaya, West Bengal (Darjeeling), Sikkim; NEPAL; BHUTAN.

Note: *Meconopsis villosa* (Hook. f. ex Hook.) G. Tayl. is based on the species *Cathcartia villosa* Hook. f. ex Hook. Taylor (1934) appropriately considered the genus *Cathcartia* and *Meconopsis* as congeneric.

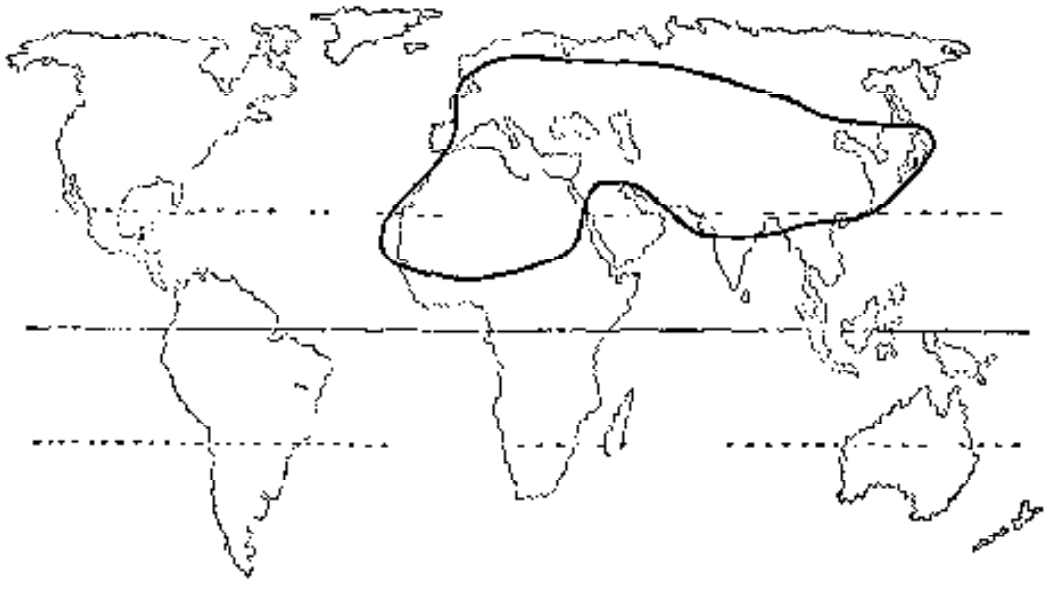
PAPAVER

Linn., Sp. Pl. 1: 506. 1753; Gen. Pl. ed. 5: 224. 1754; DC. Syst. 2: 76. 1821; Prodr. 1: 118. 1824; Elkan, Tent. Mon. Gen. Pap. 1837; Benth. & Hook. f., Gen. Pl. 1: 51. 1862; Hook. f. & Thoms., in Hook. f., Fl. Brit. Ind. 1: 116. 1872; Fedde, in Engler, Pflanzenr. 4. 104: 288. 1909; Fedde in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 17b: 1-45. 1936; Popov in Komarov, Fl. U.S.S.R. 7: 598. 1937; Mowat, in Tutin *et al.* in Fl. Europ. 1: 247. 1964; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 7. 1974; Debnath et Nayar, Fasc. Fl. Ind. 17: 33. 1984.

Type: *Papaver somniferum* Linn., Sp. Pl. 1: 508. 1753.

Annual, biennial or perennial herbs with milky, whitish, yellowish or orange juice. Stems extremely short or long, erect, ascending, mostly patent bristly, rarely glabrous. Leaves mostly pinnatifid or pinnatilobed or pinnatipartite, margin rarely entire, mostly incised, dentate or serrate, segments variously incised, basal leaves petioled, cauline sessile, usually hairy-bristly or glabrous. Flowers singly on long pedicels or on scapes when stem not present, ebracteate, inflorescence often paniculate, mostly patent or adpressed setose. Buds ovate or subglobose. Sepals 2 (3), free, deciduous, ovate-orbicular, minutely setose. Petals 4 (-6), obovate-orbicular with little or no claw, mostly red, yellow, orange, lilac or white. Stemens numerous; filaments filiform or dilated; anthers small, orbicular to linear. Ovary mostly ovoid, rarely cylindrical-oblong, glabrous or setose, superior, ovules numerous on parietal placentas; stigmas sessile, 4-20, borne on a disc margin crenate to deeply dissected, stigma rays opposite placentas, usually united into a continuous disc by a pyramidal convex or flat disc. Capsules narrowly cylindrical, subcylindrical, clavate, oblong or obovate or globular, glabrous or setose or rarely aculeate, dehiscing by pores just beneath the persistent stigmatic disc, 1-loculed, pyramidal convex or flat disc covering the capsule. Seeds very small, kidney shaped, reticulate, brown, black, dark-grey or white, without appendage.

Distrib.: Ca. 50 species, in temperate Europe and Asia of INDIA; NEPAL; PAKISTAN; AFGHANISTAN; IRAN; TURKESTAN; ARMENIA; KURDISTAN; U.S.S.R; JAPAN; CHINA; MONGOLIA; CENTRAL EUROPE; AFRICA (North); SCANDINAVIA; ARCTIC (Map 10). In Indian region the genus is represented by 9 species.



Map 10. Geographical distribution of the genus *Papaver*

Ecol.: The genus occurs in the waste places along road sides, river valleys, sandy meadows, subalpine and alpine zone from sea level to 5000 m.

KEY TO THE SPECIES

1a. Stems very short, scapose with no cauline leaves. Leaves all radical ... *P. nudicaule* 5

1b. Stems long or rarely short, scapose with cauline leaves. Leaves not all radical:

2a. Plants usually densely hispid or stiffy hairy. Cauline leaves not amplexicaul. Many flowered:

3a. Stigmatic segments keeled, marginal lobes deeply dissected ... *P. macrostomum* 4

3b. Stigmatic segments not keeled, marginal lobes shallowly dissected:

4a. Filaments often slightly broad above. Capsules setose:

5a. Stems with rigid spreading bristles. Terminal segments of upper leaves ± elongated. Flower buds with 2 large horns ... *P. pavonium* 6

5b. Stems more minutely hispid. Terminal segments of upper leaves ± as long as the lateral. Flower buds hornless ... *P. hybridum* 3

4b. Filaments filiform, linear. Capsules glabrous:

6a. Terminal segments of leaves much longer than the lateral segments. Capsules campanulate, number of the rays of the stigma disc 9-13 (-15) ... *P. rhoeas* 7

6b. Terminal segments of leaves almost equal to the lateral segments. Capsules oblong-ovate or clavate cylindrical, number of the rays of the stigma disc (5-) 6-8 (-9):

7a. Leaf segments usually 1-2 mm broad. Peduncles short. Capsules 4-5 mm long ... *P. stewartianum* 9

7b. Leaf segments usually 4-10 mm broad. Peduncles long. Capsules 10-20 mm long ... *P. dubium* 2

2b. Plant glabrous or nearly so. Cauline leaves amplexicaul, 1 or few flowered:

8a. Leaves serrate-dentate, rarely pinnatipartite or pinnatifid. Petals 1.5-5.5 cm long, obovate-orbicular. Capsules subglobose or ovoid, base rounded. Stigmatic rays 7-18 in number ... *P. somniferum* 8

8b. Leaves pinnately dissected or laciniate. Petals 1.0-1.5 cm long, broadly obovate-suborbicular. Capsules obconical or clavate (obovate-oblong), base narrow. Stigmatic rays 4-8 in number ... *P. decaisnei* 1

1. **Papaver decaisnei** Hochst. & Steud. ex Boiss. in Ann. Sc. Nat. Ser. 2.16: 372. 1841; Boiss., Fl. Or. 1: 115. 1867; Fedde, in Engler, Pflanzenr. 4. 104: 343. 1909; Kitamura, Fl. Afghanistan, 135. 1960; Cullen in Rechinger f., Fl. Iran. 34: 15. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 17. fig. 4, V-Y. 1974. *P. turbinatum* Fres., Mus. Senckenberg 1: 173. 1833, non DC. 1821. *P. gaubae* Cullen & Rechinger f. in Rechinger f., Fl. Iran. 34: 18. t. 5, fig. 1-2. 1966.

Annual, usually almost glabrous, 5-50 cm tall herb. Stems often branched from below, densely leafy in the lower half, upper half leafless, with long peduncles. Leaves 1.5-1.0 × 1.0-2.5 cm, lamina variable, slightly lobed, pinnatidissect or laciniate, more or less glabrous, apex acute, rarely obtuse, without bristle tipped, base amplexicaul, lobes triangular to oblong, lower lobes narrowed into a short stalk, stalk 5-15 mm long, upper leaves sessile, more conspicuously dissected than the basal leaves. Pedicels (2-) 10-25 cm long, glabrous or very minutely appressedly setose. Flower buds 7-10 × 4-7 mm, ellipsoid, apex acute or minutely acuminate, usually glabrous. Flowers solitary, 2.0-2.5 cm in diameter. Sepals glabrous, 7-10 mm long, *ca.* 5 mm broad. Petals 1.0-1.5 cm long, broadly obovate or suborbicular, caducous, reddish purple-reddish orange. Stamens about as long or slightly longer than the ovary; filaments filiform; anthers *ca.* 1 mm long. Capsules 5-18 × 3-8 mm, obovate-oblong, narrow towards the base, glabrous; stigma rays 4-8, margin of the stigma disc shallowly lobed or wavy. Seeds *ca.* 0.8 mm in diameter, suborbicular, kidney shaped, brownish.

Type: IRAN, *Aucher* 4047 (FI, G, G-BOIS, K, P); EGYPT, 1835, *Schimper* 125 (CAL, DUB, E, FI, K, P, UPS); IRAN, 1842, *Kotschy* 823 (P); IRAN, 1859, *Bunge* s.n. (P); AFGHANISTAN, *Griffith* 138A (P).

Fls.: March—May. *Frts.:* April—June.

Distrib.: PAKISTAN; AFGHANISTAN; IRAN; IRAQ; SINAI; JORDAN.

2. **Papaver dubium** Linn., Sp. Pl. 2: 1196. 1753; DC., Syst. 2: 75. 1821; Prodr. 1: 118. 1824; Elkan, Tent. Mon. Gen. Pap. 25. 1839; Voight, Hort. Sub. Cal. 5. 1845; Hook. f. & Thoms., Fl. Ind. 1: 250. 1855; Boiss., Fl. Or. 1: 115. 1867; Hook. f. & Thoms., in Hook. f., Fl. Brit. Ind. 1: 117. 1872; Strachey, Cat. Pl. Kumaon, 8. 1906; Fedde, in Engler, Pflanzenr. 4. 104: 313. 1909; Bamber, Pl. Punjab, 353. 1916; Blatter et Ethelbert, Beau. Flr. Kashmir, 1: 29. 1927; Popov in Komarov, Fl. U.S.S.R. 7: 639. 1937; Mowat in Tutin *et al.* in Fl. Europ. 1: 248. 1964; Cullen in Davis, Fl. Turkey, 1: 233. 1965; Cullen in Rechinger f., Fl. Iran. 34: 19. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 13, Fig. 4, A-D. 1974; Nair, Fl. Bashahr Him. 22. 1977; Whitmore, in Hara & Williams En. Fl. Pl. Nepal, 2: 38. 1979; Debnath et Nayar, Fasc. Fl. Ind. 17: 34, Fig. 9. 1984. *P. rhoeas* var. *dubium* (Linn.) Schmalh., Fl. 1: 37. 1895. *P. laevigatum* M. Bieb., Fl. Taur.-Cauc. 3: 364. 1808; Boiss., Fl. Or. 1: 114. 1867; Popov in Komarov, Fl. U.S.S.R. 7: 640. 1937. *P. turbinatum* DC., Syst. Nat. 1: 64. 1817. *P. dubium* var. *laevigetum* (M. Bieb.) Elkan, Tent. Mon. Gen. Pap. 25. 1839. *P. dubium* var. *glabrum* Koch, Synops. ed. 1: 30. 1838. *P. litwinowii* Fedde ex Bornm. in Beih A. Bot. Central. b. 19, 2: 202. 1906 (*nom. nud.*) et in Engler, Pflanzenr. 4. 104: 341. 1909 (in adnof.). **Fig. 35**

Annual, caulescent or subscapose, hispid or bristly, rarely near-glabrous, 14-41 cm tall herbs. Stems simple or sparsely branched from below, basi-cauliramous, rather densely and softly villous bristly. Leaves 2-10 ×2-3 cm, basal leaves pinnatisect, sometimes pinnatifid with oblong-ovate, entire, often dentate, obtuse or acute, upper leaves pinnatifid into linear or oblong-linear or lanceolate, entire or dentate, acute segments; segments 4-10 mm broad, apex terminating in a bristle. Peduncles 5-33 cm long, erect, large, with enlarged summit, slightly narrower than the base of the capsule, shorter carpophore, hairs copious and appressed, white. Flower buds 8-16 ×4-8 mm, ovoid, hornless, tapering to a more acute apex, broadest below the middle, roughly tubercular with whiter and more silky hairy. Flowers 3 to 7 cm in diameter, terminal. Sepals 2, ovoid, caducous, glabrous or bristly. Petals 2.4-2.8 ×3.0-3.6 cm, brick red to red in colour, usually ovate, caducous, not overlapping. Stamens few, as long as the ovary; filaments slender, up to 9 mm long; anthers broad elliptic, 1 mm long. Rays of the stigma disc yellow in colour, 6-8 in number. Capsules 10-20×3-9 mm glabrous, sessile, oblong-ovate or clavate cylindrical, tapering from just below the summit, twice as long as broad. Seed purplish black, reniform, 0.6 mm in diameter.

Type: SWITZERLAND & BRITAIN, Herb. Linn. 669/7 (LINN).

Fls.: April—June. *Frts.:* June—August.

Distrib.: INDIA: Recorded between 1000-3000 m, Jammu & Kashmir,

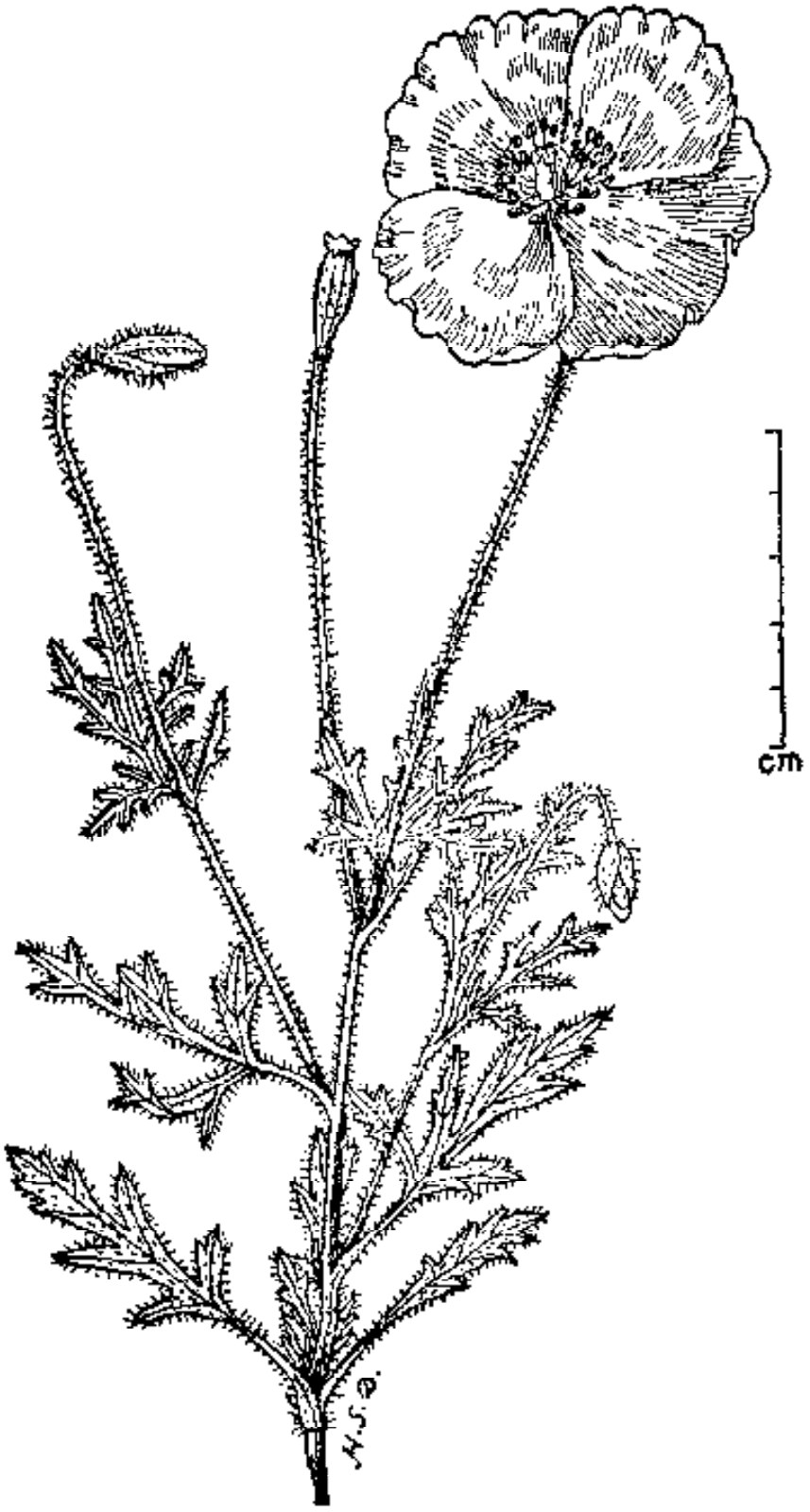


Fig. 35. Habit of *Papaver dubium* Linn.

Himachal Pradesh, Punjab, Uttar Pradesh; PAKISTAN; NEPAL; AFGHANISTAN; IRAN; USSR, Central & Atlantic EUROPE; BALKAN PENINSULA; North AFRICA.

Note: *Papaver dubium* is a variable and complex species. Based on variable characters, several taxa have been recognized, which are collectively referred under a single polymorphic taxon *P. dubium* Linn. which is very closely related to *P. rhoeas*, but is easily recognizable by terminal segments of leaves almost equal to the lateral segments (it is much longer than the lateral segments in *P. dubium*); buds tapering to a more acute apex and are broadest below the middle (buds are blunt at the apex, broadest above the middle in *P. dubium*); capsules twice as long as wide (capsules less than twice as long as wide in *P. dubium*).

3. **P. hybridum** Linn., Sp. Pl. 1: 506. 1753; DC., Syst. 2: 73. 1821; Prodr. 1: 118. 1824; Elkan, Tent. Mon. Gen. Pap. 23. 1839; Voight, Hort. Sub-Cal. 5. 1845; Boiss., Fl. Or. 1: 117. 1867; Hook. f. & Thoms. in Hook. f., Fl. Brit. Ind. 1: 117. 1872; Fedde, in Engler, Pflanzenr. 4. 104: 332. 1909; Bamber, Pl. Punjab, 353. 1916; Popov in Komarov, Fl. U.S.S.R. 7: 629. 1937; Mowat in Tutin *et al.* in Fl. Europ. 1: 249. 1964; Cullen in Davis, Fl. Turkey, 1: 235. 1965; Cullen in Rechinger f., Fl. Iran. 34: 21. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 10. 1974. *P. hispidum* Lam., Fl. Franc., 3: 174. 1778. *P. argemone* Linn. var. *hybridum* (Linn.) Schmalh., Fl. 1: 46. 1895.

Annual, erect, 10-40 (-50) cm tall herb. Latex white. Stems branched, angular, usually covered with appressed or subappressed stify, 1-2 mm long hairs. Leaves 2-3 pinnatisect, profuse, more or less hispid, ultimate lobes linear or oblong, short, margin revolute, apex acute or obtuse, usually tip bristled, basal leaves in a loose rosette, petioled, 6-20 cm long (incl. petiole), 1.5-6.0 cm broad, each leaf with 2-3 pairs of primary lateral segments and one terminal segment, upper cauline leaves 2.0-8.0 × 1.5-3.0 cm, gradually becoming smaller and subsessile upwards. Petioles 3-10 cm long. Peduncles (3-) 5-15 cm long, stout, often flexous, hairy, hairs appressed, ascending, 1.0-2.5 mm long. Flower buds 6-12 × 6-10 mm, broadly ellipsoid, apex entire, horniess, densely subappressed bristly, bristles 1.5-3.0 mm long. Flowers 2-5 cm in diameter, solitary, terminal or axillary. Petals 1-2 cm long, obovate-suborbicular, caducous, pink red to crimson or scarlet with black or violet basal spots. Stamens few, about as long or slightly longer than the ovary; filaments gradually thickening above, tapering below; anthers *ca.* 1 mm long, oval. Capsules 8-15 × 5-10 mm, broadly oval or subglobose, densely covered with yellowish, subspreading, often recurved, ascending, 1.5-3.0 mm long bristles; stigma disc short, convex, much narrower than the width of the capsule, with 4-9 stigma rays. Seeds very small, 0.7 mm in diameter, grey green or black, reniform.

Type: South Europe, Herb. Linn. No. 669/1 (LINN).

Fls.: March—June. *Frts.:* May—September.

Distrib.: Pakistan; Afghanistan; S.W. & C. Asia; North Africa; Europe; introduced elsewhere.

Note: *Papaver hybridum* is closely related to *P. pavonium*, with which it differs by its more minutely hispid stems (stems with rigid spreading bristles in *P. pavonium*); terminal segments of leaves more or less as long as the lateral segments (terminal segments of upper leaves ± elongated in *P. pavonium*); hornless flower buds (buds with two large horns in *P. pavonium*).

4. **Papaver macrostomum** Boiss. et Huet [in Sched. Pl. Huet. 1855, *nomen nudum*] ex Boiss. in Boiss., Fl. Or. 1: 115. 1867; Fedde, in Engler, Pflanzenr. 4. 104: 335. 1909; Popov in Komarov, Fl. U.S.S.R. 7: 634. 1937; Chittenden, Dict. Gard. 3: 1480. 1956; Mowat, in Tutin *et al.* in Fl. Europ. 1: 249. 1964; Cullen in Davis, Fl. Turkey, 1: 231. 1965; Cullen in Rechinger f., Fl. Iran. 34: 16. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 15. 1974; Singh & Kachroo, Forest Flora of Srinagar, 25 & 27. 1976; Debnath et Nayar, Fasc. Fl. Ind. 17: 36, Fig. 10. 1984. *P. tubuliferum* Fedde, in Engler, Pflanzenr. 4. 104: 336. 1909. *P. dalechianum* Fedde l.c. 337. *P. kurdistanicum* Fedde l.c. 337. *P. divergens* Fedde l.c. 337.

Fig. 36

Annual, erect, herbs. Stems cauliramous with soft scattered spreading bristles except peduncle which appressedly hairy, often glabrescent, 20 to 40 cm long. Lower leaves petioled, upper one usually sessile, often subsessile, belonging smaller above. All leaves pinnatisect or deeply incised, with linear-lanceolate or oblong-lanceolate, entire or coarsely or sparsely dentate, acute segments, terminating in a bristle, 1-4 cm long, hairs on both surfaces of the leaf or upper surface glabrous. Peduncles 10-22 cm long, robust, often flexous, appressed bristly. Flower buds 1.0-2.5×0.6-1.1 cm, ovate-oblong, nearly rounded apex, with spreading hairs. Flowers up to 6 cm in diameter. Sepals caducous with spreading hispid hairs. Petals 2-3 cm long, broadly obovate-orbicular, bright red, with or without or basal black blotch. Stamens numerous, *ca*, 1 cm long; filaments almost black, slender; anthers broadly ellipsoid, 1.0 to 1.5 mm long, connective bearing a small, orange, capitate apical appendage. Capsules 9-20×4-10 mm, oblong ellipsoid or somewhat tubulose, broad at the apex and gradually narrowed towards the base, glabrous, glaucous, faintly or not ribbed, usually smooth; stigma rays 5-10, very dissected lobe of the disc, somewhat keeled, disc teeth carinate-ascending, recurved at the edge. Seeds very small, up to 1 mm long, reniform, dark brown, reticulate.

Type: Turkey (Erzurum), Armenia, Circa Tortum ad Vias, 1853, *Huet* (Fl, G, G-BOIS, GOET, K, P); Iran, *Szovits* 235 (G-BOIS, P); Iran, 1858,

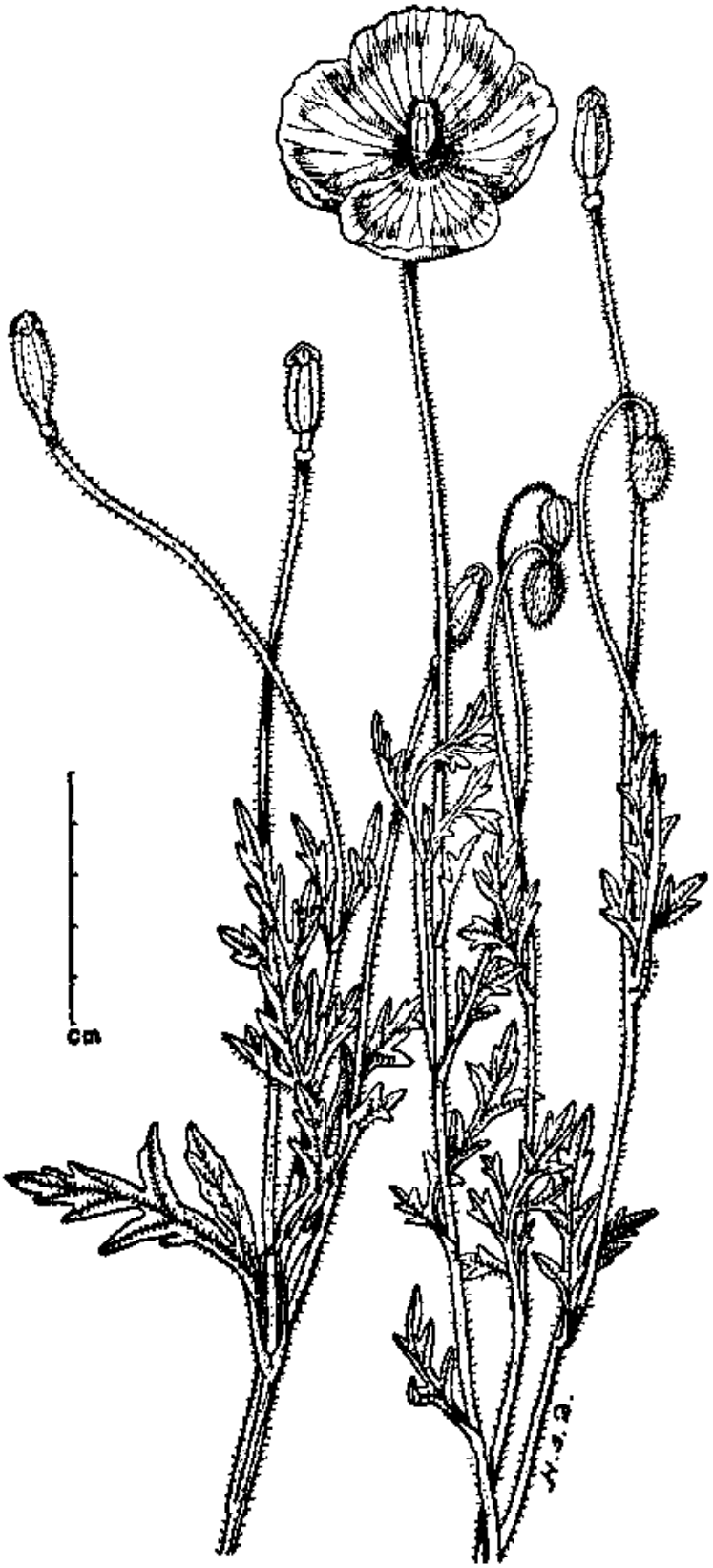


Fig. 36. Habit of *Papaver macrostomum* Boiss. et Huet ex Boiss.

Bunge s.n. (G-BOIS, P); IRAN, 1842, *Kotschy* 151a (BM, G-BOIS).

Fls.: April—July. *Frts.*: July—August.

Distrib.: INDIA: N. W. Himalaya, recorded between 1500-3000 m, Jammu & Kashmir; PAKISTAN; AFGHANISTAN; IRAN; USSR; TURKEY; ARMENIA; KURDISTAN.

5. **Papaver nudicaule** Linn., Sp. Pl. 1: 507. 1753; Willd., Sp. Pl. 2: 1145. 1797; Vig., Hist. Nat. Patrots 43. 1814; DC., Syst. 2: 70. 1821; Prodr. 1: 117. 1824; Hook. f. & Thoms., Fl. Ind. 249. 1855; Hook. f. & Thoms. in Hook. f., Fl. Brit. Ind. 1: 117. 1872; K. Prantl & J. Kündig in Engl. & Prantl, Pflzfam. 3,2: 142. 1889; Fedde, in Engler, Pflanzenr. 4. 104: 376. 1909; Blatter et Ethelbert, Beau. Flr. Kashmir, 1: 28, Pl. 8. 1927; Fedde in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 17b: 119. 1936; Popov in Komarov, Fl. U.S.S.R. 7: 606. 1937. Chittenden, Dict. Gard. 3: 1480. 1951; Van Steenis, Fl. Malesiana 1.5: 116. 1955-58; Backer & Vanden Brink, Fl. Java, 1: 177. 1963; Cullen, in Rechinger f., Fl. Iran. 34: 12. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 9. 1974; Debnath et Nayar, Fasc. Fl. Ind. 17: 38. 1984. *P. croceum* Ledeb., Fl. Alt. 2: 271. 1830; Kitamura, Fl. Afghanistan, 135. 1960. *P. alpinum* var. *croceum* (Ledeb.) Ledeb., Fl. Ross. 1: 87. 1842, partly. *P. nudicaule* ssp. *aurantiacum* (DC.) Fedde, in Engler, Pflanzenr. 4. 104: 390. 1909. *P. nudicaule* ssp. *commune* N. Busch in Fl. Siberia & the Far East. *P. alpinum* L. var. *nudicaule* Fischer et Traetr. in Ind. sem. hort. Petrop. 3: 13. 1836.

Fig. 37

Perennial herbs, hairy with simple somewhat stiff setose hairs. Rootstock scaly, covered with somewhat sheathing persistent leaf bases of the dense rosette basal leaves. Scapes erect, several, 10-58 cm long, 1-flowered, usually bristly or densely hairy; hairs 1.5-3.5 mm long. Leaves all basal, 2-6×1-3 cm, rosulate, petiolate, somewhat glaucous, bristly or ciliate, pinnately 3-lobed, lobes usually pinnatifid; terminal lobe somewhat larger than the lateral ones, often 3-lobulate, secondary lobes upto 11 mm long and 5 mm broad, oblong, acute. Petioles 2.0-8.5 cm long, widened at the base, ending in a leaf sheath. Flower buds ovoid-orbicular or suborbicular, 8-12×5-9 mm, blunt at the apex, densely stiffy and subappressedly hairy with dark brown in colour. Flowers 1.5-5.0 cm in diameter. Sepals concave, caducous, hispid with stiff brown hairs. Petals 4, obovate-suborbicular, yellowish-orange or yellow in colour, 10-18 mm long and usually about as broad. Stamens many, linear; filaments about as long as the ovary; anthers *ca.* 1-2 mm long. Capsules 8-15×5-10 mm, oblong to oblong-globose, usually roughly setose. Stigmatic disc about as broad as capsule, with 7-8 ridges with somewhat channelled, pores 7-8, alternate with ridges. Seeds 0.4 mm in diameter, reniform.

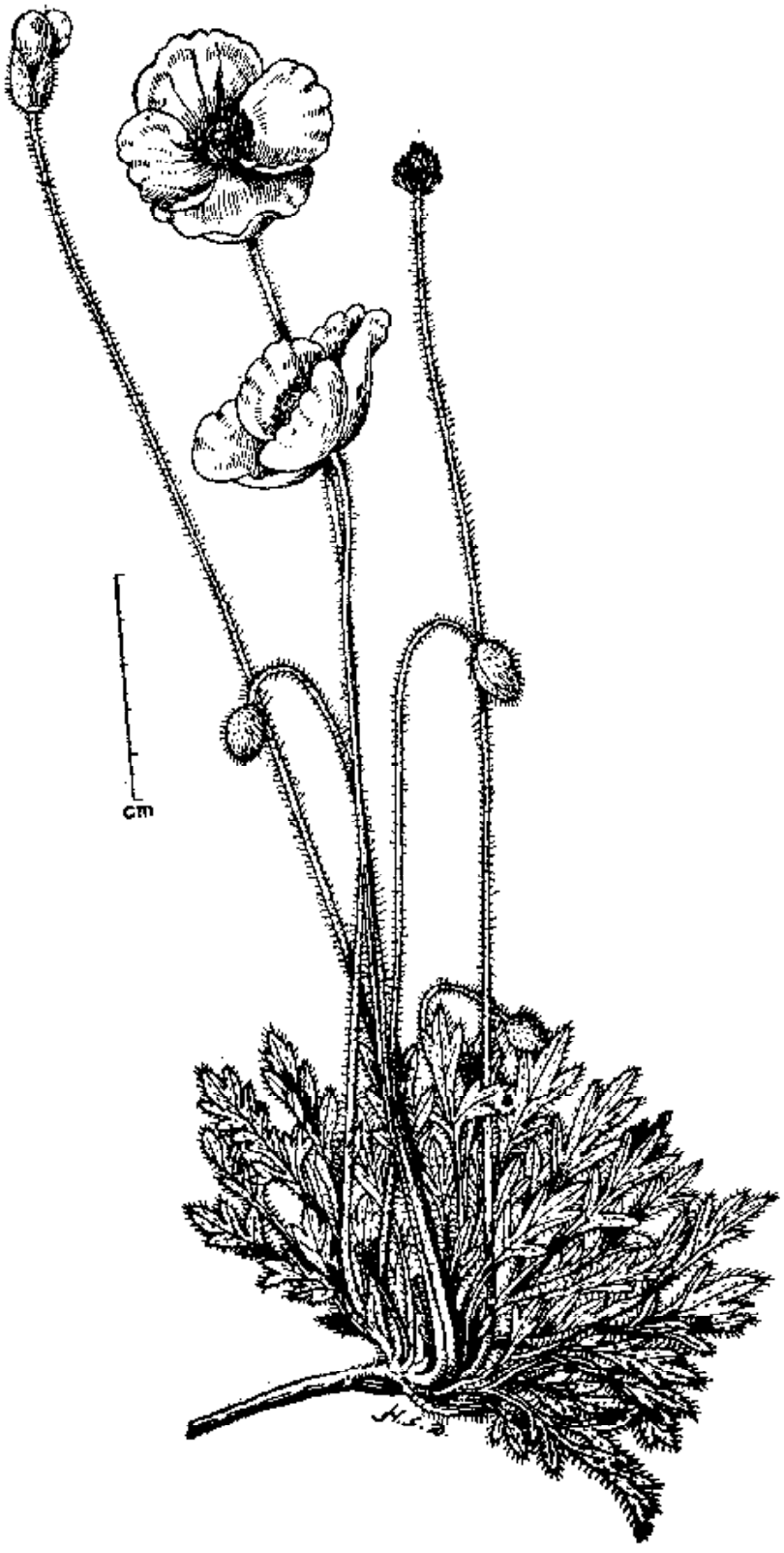


Fig. 37. Habit of *Papaver nudicaule* Linn.

Type: SIBERIA. Herb. Linn. No. 669/5 (LINN).

Fls.: May—July. *Frts.:* July—August.

Distrib.: INDIA: W. Himalaya, recorded between 3000-5000 m, Jammu and Kashmir, Himachal Pradesh; PAKISTAN; AFGHANISTAN; USSR; MONGOLIA.

Note: *Papaver nudicaule* is a very variable species in size and colour of flower. Flower colour varies from pale yellowish to yellow, orange or saffron. Popov (in Komarov, Fl. U.S.S.R. 7 : 607. 1937) mentioned the India-Himalaya distribution of *P. croceum* which he treated as a distinct species. But Jafri et Qaiser (in Nasir et Ali, Fl. W. Pak. 61. : 10. 1974) considered *P. croceum* as a synonym under *P. nudicaule*. The differences between *P. croceum* and *P. nudicaule* are in flower colour (yellow and orange respectively) and in-leaf segmentation (narrow and somewhat broader respectively). On these characters *P. croceum* cannot be maintained as a distinct species from *P. nudicaule*.

6. **P. pavonium** Fisch. et Mey. in Ind. Sem. Hort. Petrop. 9: 82. 1838; Schrenk, Enum. Pl. Nov. 2: 64. 1842; Boiss., Fl. Or. 1: 116. 1867; Fedde, in Engler, Pflanzenr. 4. 104: 333. 1909; Popov in Komarov, Fl. U.S.S.R. 7: 627. 1937; Chittenden, Dict. Gard. 3: 1480. 1956; Kitamura, Fl. Afghanistan, 136. 1960; Cullen, in Rechinger f., Fl. Iran. 34: 22. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 12, Fig. 4. E-I. 1974. *P. conigerum* Stocks in Hook. f., Kew Journ. 4: 142. 1852. *P. hybridum* var. *glabrum* Boiss., Fl. Or. 1: 117. 1867; *P. hybridum* var. *microcarpum* N. Busch, Fl. Cauc. Crit. 3. 4: 35. 1905. *P. pavonium* var. *incornutum* Fedde, in Engler. Pflanzenr. 4. 104: 334. 1909. *P. ocellatum* Woron, Bull. Mus. Caucas. 11: 276-280. 1918; Popov in Komarov, Fl. U.S.S.R. 7: 628. 1937. **Fig. 38**

Annual, erect herbs, 8-35 (-40) cm tall. Stems branched, covered with hispid, often setose below, bristles 1-3 mm long. Leaves 2-3 pinnatisect, hispid, densely hispid under surface, particularly on the mid nerve, ultimate segments oblong or ovate, margin revolute, apex acute or obtuse, tip bristled, basal leaves in a loose rosette, petioled, 5-20 cm long (incl. petiole), 1.5-5.0 cm broad, upper cauline leaves 2-8×1-3 cm, gradually becoming smaller in size and smaller upwards. Petioles 2-10 cm long. Pedicels 1.5-10.0 cm long, bristly, bristles appressed, ascending, 1.5-2.5 mm long. Flower buds 7-15×5-9 mm, oval or ovate, sometimes subglobular, densely spready bristles, with 2, long, hollow apical horns, horns up to 3 mm long, linear-short triangular. Flowers 2-4 cm in diameter, often in groups of 3. Sepals 2 7-15 mm long (incl. apical horns), 6-10 mm broad, obovate-orbicular

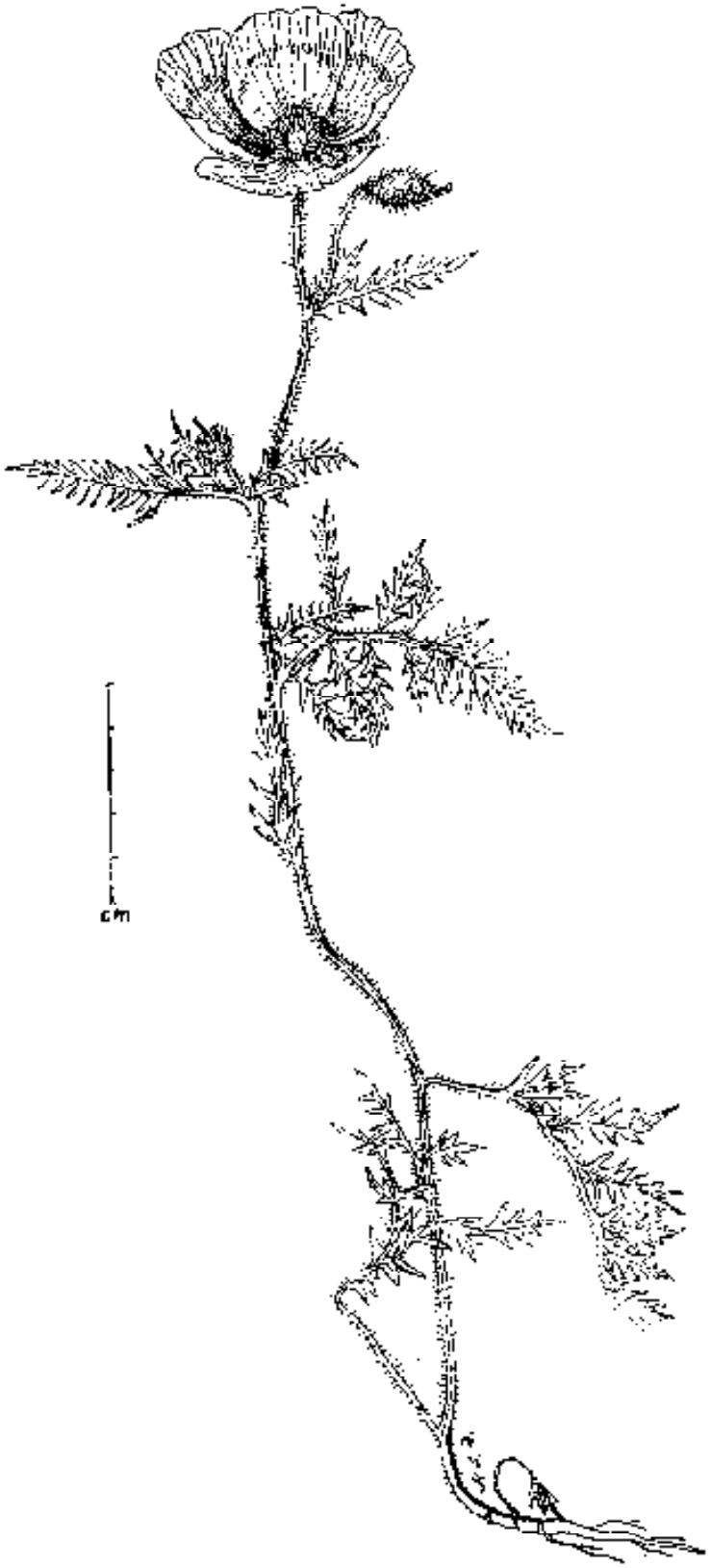


Fig. 38. Habit of *Papaver pavonium* Fisch. et Mey.

or broadly ellipsoid, hispid or bristly, bristles ascending, 1-2 mm long. Petals 1.5-2.5×1.0-2.0 cm, obovate-suborbicular, caducous, bright red with black basal spot. Stamens about as long or slightly longer than the ovary; filaments 4-6 mm long, filiform, often slightly broad above; anthers *ca.* 1 mm long, oblong, with little cordate base. Capsules 5-8×4-6 mm, broadly ovoid to suborbicular, ribbed, densely bristled, bristles 2-3 mm long; stigma disc convex-hemispherical, slightly shorter than the width of the capsule, stigma rays 5-6 (-8) in number. Seeds *ca.* 0.5 mm in diameter, elongated, reniform.

Type: USSR, *Lehmann* 50 (GOET, P).

Fls.: April—June. *Frts.:* May—August.

Distrib.: PAKISTAN; AFGHANISTAN; IRAN; ALTAI; USSR.

Note: The species *Papaver pavonium* is very variable in the nature of its leaves and size of the flower buds. It differs from its allied species *P. hybridum* by its 2-horned calyx, usually more densely hispid and shorter pedicels. It is seen rarely that sepal horns become obsolete even on the same plant. *P. ocellatum* Woron is only a variant of *P. pavonium* with obsolete calyx horns, because the characters of the leaves and capsules are exactly like those in *P. pavonium*.

7. **Papaver rhoeas** Linn., Sp. Pl. 1: 507. 1753; DC., Syst. 2: 76. 1821; Prodr. 1: 118. 1824; Elkan, Tent. Mon. Gen. Pap. 27. 1837; Voight, Hort. Sub. Cal. 5. 1845; Boiss., *Fl.* Or. 1: 113. 1867; Hook. f. & Thoms. in Hook. f., Fl. Brit. Ind. 1: 117. 1872; Fedde, in Engler, Pflanzenr. 4. 104: 293. 1909; Bamber, Pl. Punjab, 353. 1916; Blatter et Ethelbert, Beau. Fl. Kashmir, 1: 29. 1927; Chittenden, Dict. Gard. 3: 1480. 1956; Van Steenis, Fl. Malesiana, 1.5: 116. 1955-58; Backer & Van dan Brink, Fl. Java, 1: 177. 1963; Popov in Komarov, Fl. U.S.S.R. 7: 636. 1963; Mowat, in Tutin *et al.* Fl. Europ. 1: 248. 1964; Cullen in Davis, Fl. Turkey, 1: 231. 1965; Cullen in Rechinger f. Fl. Iran, 34: 18. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 16. 1974; Babu, Herbaceous Flora of Dehra Dun, 50. 1977; Debnath et Nayar, Fasc. Fl. Ind. 17: 39. 1984. *P. hookeri* Baker ex Hook. f., in Bot. Mag. t. 6729. 1883; Nair, Rec. Bot. Surv. Ind. 21. 1: 8-9. 1978. *P. rhoeas* var. hookeri (Baker) Fedde, in Engler, Pflanzenr. 4. 104: 308. 1909.

Fig. 39

Common Names: *Lalposht* (Beng.); *Lala, Latkhaskhas* (Guj.); *Lal, Lalpost, Post, Postekebija* (Hind.); *Ghovanna-kashakasha* (Mal.); *Rakta-postavrikshaha* (Sans.); *Siguppapposlaka, Sivappugashagasha* (Tam.); *Erragassa-gassala, Errapostakaya* (Tel.); *Gulelalakebija, Khas khashsiyah* (Urdu).

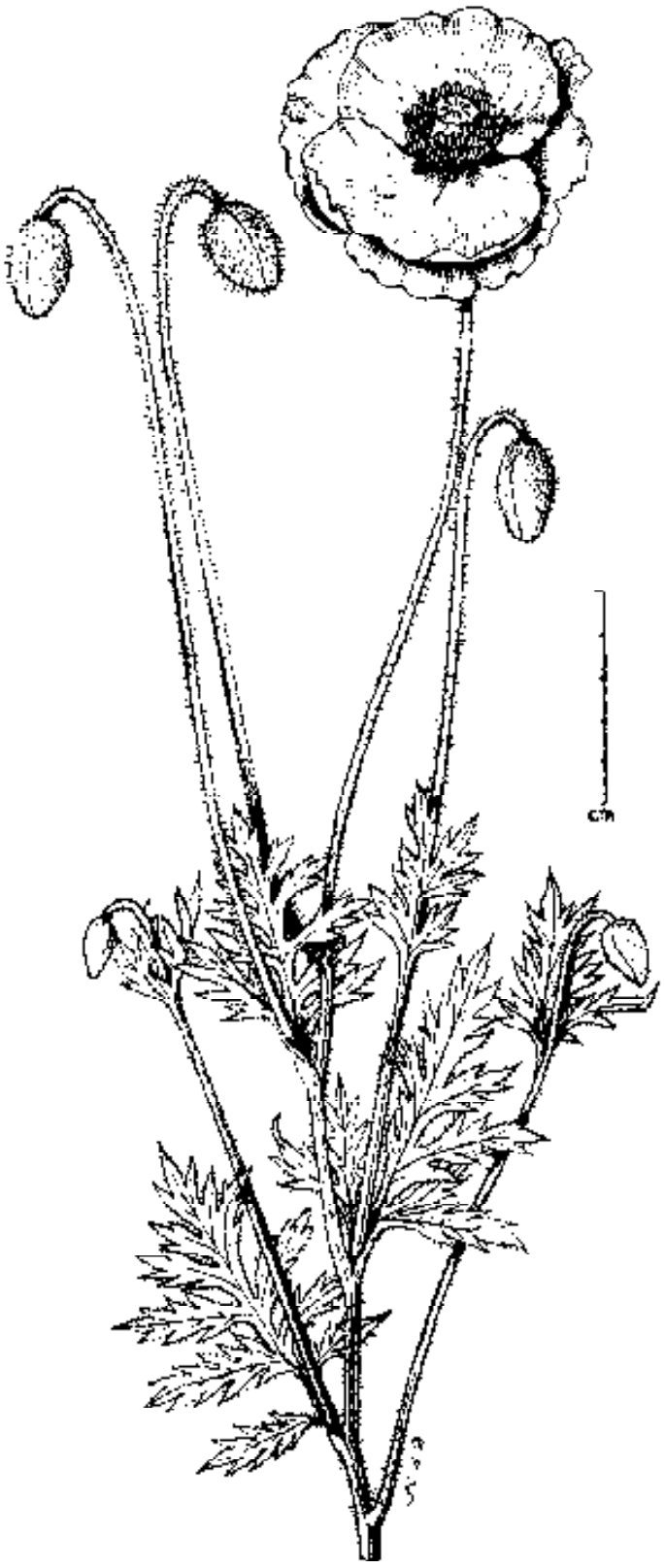


Fig. 39. Habit of *Papaver rhoeas* Linn.

Annual, erect, caulescent, hispid, herbs, 18-50 cm tall. Stems simple or sparsely branched, covered with rigid, horizontally spreading 1-3 mm long bristles. Leaves 5.5-18.5 ×3.0-7.5 cm, sinuate-pinnatifid to pinnatipartite, narrow acute, bristle pointed segments, hispid, variable in size, terminal segments of leaves much larger than the lateral segments, basal or lower leaves petioled and less dissected, upper leaves larger, sessile, more dissected, with an amplexicaul base. Peduncles erect, 10-25 cm long, with dilated summit, broader than the base of the capsules, hairy, hairs irregularly horizontally patent, yellow in colour. Flower buds 1.5-3.0 ×1.0-2.0 cm, obovoid, horntless, blunt at the apex, broadest above the middle or rarely at the middle, coarsely and roughly tuberculately hairy, irregular in shape. Flowers solitary, terminal, *ca.* 7.5 cm in diameter. Sepals 2. Petals 3.7 ×3.3-6.5 cm, obovate-suborbicular. Stamens numerous; filaments linear, filiform; anthers 1 mm long, oblong. Capsules 12.0 ×7.5 mm, campanulate, glabrous; rays of the stigma disc dark in colour, 9-13 (-15) in number. Seeds dark brown.

Type: EUROPE, Herb. Linn. No. 669/6 (LINN).

Fls.: April—July. *Frts.:* July—September.

Distrib.: INDIA: Himachal Pradesh, Punjab, Uttar Pradesh, West Bengal; NEPAL; EUROPE; AFRICA (North).

Uses: The latex from the capsules is narcotic and has slightly sedative properties.

Note: The species *Papaver rhoeas* is a very variable species in size, shape and hairiness of leaves, colour of filaments, black blotch on petals, and shape of capsules.

P. hookeri is often regarded as separate species but it is only a robust and taller form of *P. rhoeas*.

The many forms of *P. rhoeas* are regarded by horticulturists as one of the beautiful species in cultivation. In India such plants are *P. rhoeas* var. *latifolia* Prain and *P. rhoeas* var. *umbrosum* Mott.

8. **Papaver somniferum** Linn., Sp. Pl. 1: 508. 1753; DC., Syst. 2: 81, 1821; Prodr. 1: 118. 1824; Roxburgh, Fl. Ind. 2: 571. 1832; Wight et Arn. Prodr. Fl. Ind. 17. 1834; Elkan, Tent. Mon. Gen. Pap. 30. 1837; Voigt, Hort. Sub. Cal. 5. 1845; Hook. f. & Thoms., Fl. Ind. 1: 256. 1855; Boiss., Fl. Or. 1: 116. 1867; Aitchison, Cat. Pl. Punjab & Sindh, 4. 1869; Hook. f. & Thoms. in Hook. f., Fl. Brit. Ind. 1: 117. 1872; K. Prantl & J. Kündig in Engl. & Prantl, Pflanzfam. 3. 2: 142. 1889; Duthie, Pl. Upper Gang. Pl. 1: 36. 1903 (Repr. ed. 1: 36. 1960); Fedde, in Engler, Pflanzenr. 4. 104: 338. 1909; Gamble, Fl. Pres. Madr. 1: 35. 1915 (Repr. ed. 1: 25. 1957);

Haines, Bot. Bih. & Or. 1: 23. 1921 (Repr. ed. 1: 23. 1961), Popov in Komarov, Fl. U.S.S.R. 7: 644. 1937; Chittenden, Dict. Gard. 3: 1480. 1951. Van Steenis, Fl. Malesiana, I. 5: 116. 1955-58; Mowat, in Tutin *et al.* Fl. Europ. 1: 247. 1964; Cullen in Davis, Fl. Turkey 1: 230. 1965; Cullen in Rechinger f., Fl. Iran. 34: 15. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 19. 1974; Whitmore in Hara & Williams, En. Fl. Pl. Nepal, 2: 38. 1979; Debnath et Nayar, Fasc. Fl. Ind. 17: 40. 1984.

Fig. 40

Common Names : *Posto, Post* (Beng.); *Aphina, Khuskhus, Posta* (Guj.); *Afim, Afyum, Khas kash, Post, Postekebij* (Hind.); *Afium, Keshakasha* (Mal.); *Afim, Doda, Khaskhas, Khishkhash, Post* (Pun.); *Ahifen, Chosa, Khasa, Khakasa, Ullasata* (Sans.); *Abini, Gashagasha, Kasakasa, Postaka* (Tam.); *Abhini, Gasagasala, Gasalu, Kasakasa* (Tel.); *Khashkhashsufaid* (Urdu).

Annual, robust, glabrous or nearly so, herbs, 10-100 cm tall. Stems distally cauliramous, often branched, few hairy. Leaves 3-15 × 1-8 cm, usually simple, repand, serrate-dentate, often with larger teeth alternating with smaller ones, rarely pinnatipartite or pinnatifid, basal leaves with a short stalked, stalks up to 2 cm long, gradually broadening into base, upper leaves sessile, cordate-amplexicaul. Pedicels 3-20 cm long, glabrous or with spreading bristles. Flower buds 1.5-3.0 × 1.0-2.0 cm, ovoid-oblong, obtuse, coriaceous. Flowers 2-10 cm in diameter. Sepals glabrous, evanescent, as large as the bud. Petals 1.5-5.5 × 1.5-6.5 cm, obovate-orbicular, margin wavy. Stamens as long as ovary; filaments yellowish, 5-10 mm long; anthers 1.0-1.5 mm long, oblong-linear. Capsules 7.0 × 5.0-6.0 cm, glabrous, subglobose or ovoid, base rounded abruptly tapering; stigmatic disc scarious, usually 7-18 stigma rays. Seeds *ca.* 0.3 cm in diameter, orbicular, white or grey-black.

Type: South EUROPE, Herb. Linn. No. 669/8 (LINN).

Fls.: April—June. *Frts.:* July—August.

Distrib.: INDIA: recorded up to 3000 m, Haryana, Delhi, Uttar Pradesh, Bihar, Sikkim, Assam, Manipur, Maharashtra, Karnataka, Tamil Nadu, Kerala; PAKISTAN; NEPAL; EUROPE.

Uses: *Papaver somniferum* (opium poppy) is widely cultivated for its latex, which contains alkloids (mainly *Morphine, Narcotine, Papaverine, Codeine, Thebaine*). Latex is obtained by scratching, notching on young capsules by a single pointed needle. Opium, in its primary effects medicinally is stimulant, and its secondary action narcotic, anodyne and antispasmodic. Opium is used in diarrhoea, diabetes and rheumatism and also as a antidoet to snake poison and scorpion sting. The seed itself is used in cooking and making sweets. Seed oil is suitable for making candles, soap, medicine and food.

Fig. 40. Habit of *Papaver somniferum* Linn.

9. **P. stewartianum** Jafri & Qaiser, in Nasir et Ali, Fl. W. Pak. 61: 13. 1974.

Annual, erect, branched herbs, *ca.* 25 cm tall, glabrous except upper portion of the peduncle. Leaves 3.0-7.0 × 1.0-1.5 cm, 2-pinnstisect; lobes 3.0-(10.0-12.0) × 1.0-1.2 mm, thin, oblong or linear, lobulate or entire, basal leaves subrosette, petioled, upper leaves subsessile or sessile. Peduncles 1-4 cm long, very frequently sparsely papillose. Flower buds 5-7 mm in diameter, suborbicular, glabrous, apex rotund. Flowers 2.0-2.5 cm in diameter. Petals 1.5 cm long, obovate-orbicular, dark red or scarlet. Stamens more longer than ovary, 5-6 mm long; anthers 1 mm long, oblong. Capsules 4-5 × 3 mm, oblong, base rotund, glabrous or nearly so; stigma 5-6 lobed, flat.

Type: PAKISTAN, Campbellpore, in grain fields, 2.4.1949, *Stewart* s.n. (RAW).

Fls.: April.

Distrib.: PAKISTAN.

ROEMERIA

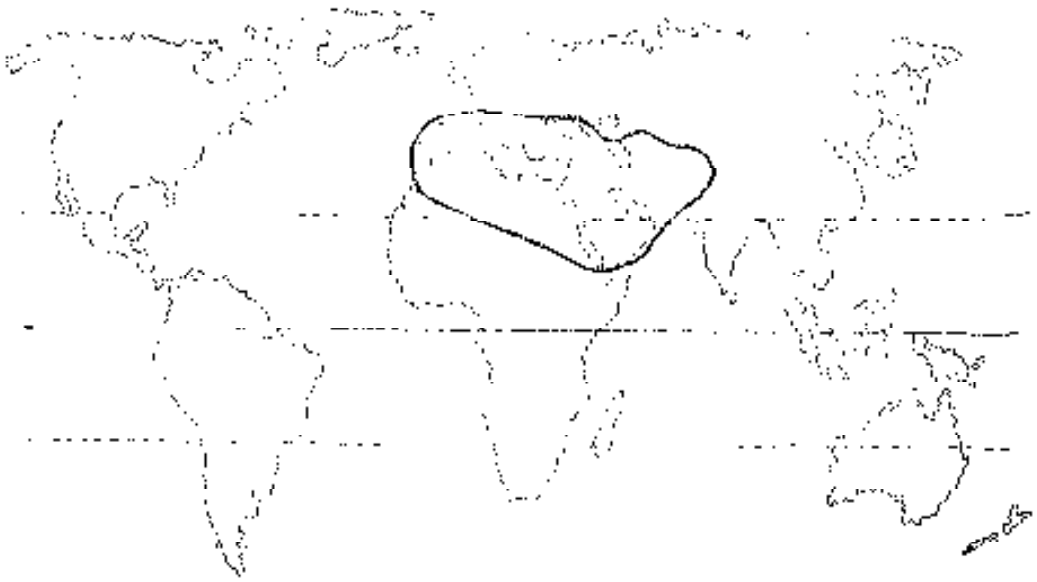
Medicus in Usteri, Ann. Bot. 3: 15. 1792; DC., Syst. Nat. 2: 92. 1821; Prodr. 1: 122. 1824; Endl. & Fanzl. Gen. Pl. 2: 856. 1837; Benth. & Hook. f., Gen. Pl. 1: 53. 1862; Boiss., Fl. Or. 1: 118. 1867; Regel in Act. hort. Petrop. 5. 1: 228. 1877; O. Ktze. in Act. hort. Petrop. 10. 1: 162. 1887; K. Prantl & J. Kündig in Engl. & Prantl, Pflzfam. 3. 2: 141. 1889; Fedde, in Engler, Pflanzenr. 4. 104: 238. 1909; Popov in Komarov, Fl. U.S.S.R. 7: 596. 1937; Mowat, in Tutin *et al.* in Fl. Europ. 1: 251. 1964; Cullen in Davis, Fl. Turkey, 1: 218. 1965; Cullen in Rechinger f., Fl. Iran. 34: 6. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 4. 1974.

Type: *Roemeria violacea* Medicus in Usteri, Ann. Bot. 3: 15. 1792 = **R. hybrida** (Linn.) DC., Syst. Nat. 2: 92. 1821.

Annual, bristly pubescent, foetid herbs. Latex yellow. Leaves bi or tripinnate with narrow much cut lobes, often ending in an acute mucro, lower basal leaves petiolate, upper sessile. Flowers solitary, axillary and terminal. Sepals 2, free, imbricate, caducous. Petals 4, red or violet, broadly obovate, deciduous, crumpled in bud. Stamens numerous; filaments filiform, subulate or dilated; anthers oblong. Ovary 2-6 merous, linear cylindrical, unilocular; styles very short; stigmas 3-4, capitate. Capsules silique like, linear-cylindrical, thin, glabrous to setose, many seeded, dehiscing from apex to base by 3-4 valves. Seeds many, small, grey or black, reniform.

Distrib.: *ca.* 7 species only of S.W. EUROPE, ASIA and N. AFRICA (Map 11). 2 species in Indian region: Pakistan.

Ecol.: Stony and sandy deserts, fields, gardens, clayey slopes of foothills.



Map 11. Geographical distribution of the genus *Roemeria*

KEY TO THE SPECIES

1a. Petals violet. Filaments subulate. Siliques sparsely or densely setose at apex or along entire length ... *R. hybrida* 1

1b. Petals bright red. Filaments slightly dilated. Siliques glabrous except 4 setae projecting beyond the stigma ... *R. refracta* 2

1. **Roemeria hybrida** (Linn.) DC., Syst. Nat. 2: 92. 1921; Prodr. 1: 122. 1824; Gren. et Godr. Fl. France 1: 60. 1848; Boiss., Fl. Or. 1: 118. 1867; Willk. et Lange, Prodr. Fl. hisp. 1: 874. 1880; Batt. et Trab. Fl. alg. 21. 1888; K. Prantl & J. Kündig in Engl. & Prantl, Pflzfam. 3. 2: 141. 1889; Halacsy, Consp. Fl. graec. 1: 40. 1901; Fedde, in Engler, Pflanzenr. 4. 104: 239. 1909; Popov in Komarov, Fl. U.S.S.R. 7: 596. 1937; Kitamura, Fl. Afghanistan, 136. 1960; Mowat, in Tutin *et al.* Fl. Europ. 1: 251. 1964; Cullen in Davis, Fl. Turkey, 1: 218. 1965; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 6. 1974. *Chelidonium hybridum* Linn., Sp. Pl. 1: 506. 1753. **Fig. 41**

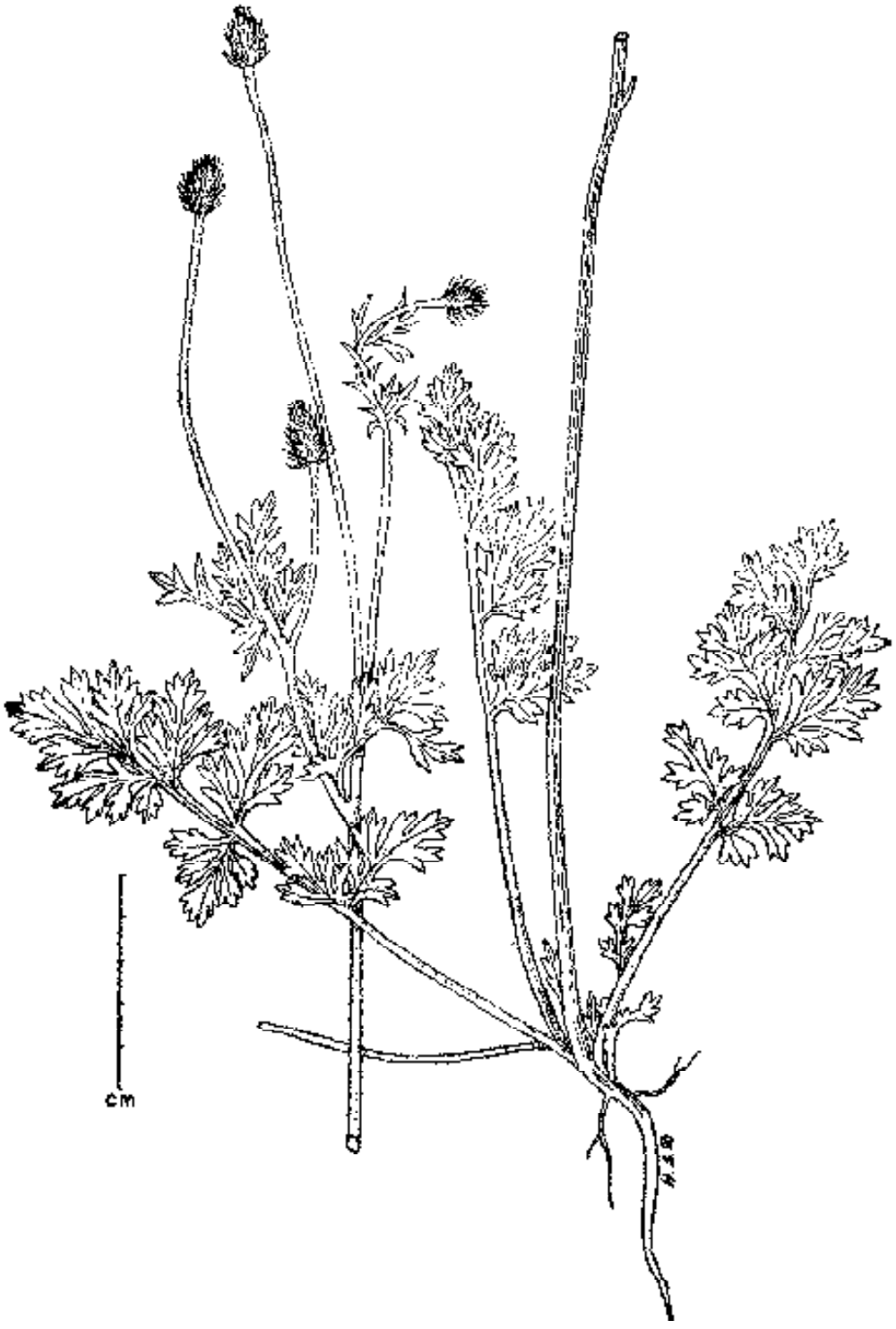


Fig. 41. Habit of *Roemeria hybrida* (Linn.) DC.

Annual, more or less hispid herbs. Stems usually upright, divaricately branched, rarely simple, covered with soft, white, spreading hispid hairs, rarely glabrescent, 5-40 cm tall. Leaves 1.5-6.0 cm long, sparingly hispid, 2-3 pinnatisect, ultimate segments linear or ovate-oblong, 3-20 × 1-3 mm, with or without pointed bristles at the apex, lower and basal leaves petioled, uppermost leaves sessile. Petioles 1-5 cm long, gradually becoming shorter in the upper leaves, somewhat broad and sheathing at base. Flower buds 8-13 × 3-8 mm, oval-oblong, apex obtuse, sparsely covered with bristly hairs. Pedicels 0.5-5.0 cm long, increasing up to 9 cm in fruiting condition, upright or recurved, glabrous to sparsely pubescent. Sepals 8-13 mm long, *ca.* 5 mm broad, oblong, apex hooded, outside pilose. Petals 2.0-2.5 × 1.5-2.0 cm, obovate-subrounded, violet, black blotch at the base. Stamens multiseriate; anthers *ca.* 1.5 mm long, oblong; filaments 7-8 mm long, subulate. Ovary 8-10 mm long, *ca.* 1.5 mm broad, linear oblong; styles very short; stigmas 4, capitate, puberulous. Siliques 1-7 × 1-2 cm, as thick as or little thicker than fruit stalks, linear, dehiscing by 3-4 valves from base to apex, tapering slightly towards apex, sparsely or densely setose at apex or along entire length. Seeds numerous, *ca.* 1 mm diameter, reniform.

Distrib.: S. W. EUROPE; S. W. ASIA; N. AFRICA.

KEY TO THE SUBSPECIES

1a. Ultimate segments of the leaves ovate-oblong, with pointed bristles at the apex. Pedicels erect. Siliques densely setose ... ssp. *dodecandra*

1b. Ultimate segments of the leaves linear, without pointed bristles at the apex. Pedicels recurved. Siliques sparsely setose ... ssp. *hybrida*

subsp. **hybrida**

Annual, more or less hispid herbs. Stems 20-30 cm tall. Leaves 2-3 pinnatisect, ultimate segments of the leaves linear, 10-20 × 1-3 mm. Siliques sparsely setose, at least at the apex or along entire length, with a recurved pedicel.

Type: South EUROPE, Herb. Linn. no. 688/6 (LINN).

Fls.: April—May. *Frts.:* May—June.

Distrib.: PAKISTAN; USSR.; BULGARIA; FRANCE; GREECE; SPAIN; JUGOSLAVIA; PORTUGAL; TURKEY; BRITAIN; NETHERLANDS; North AFRICA.

Note: The occurrence of this plant in Pakistan was first reported by Jafri et Qaiser (1974) as an introduced plant.

subsp. **dodecandra** (Forssk.) Naire in Jahandiez et Maire, Cat. Pl. Maroc. 2: 257. 1932; Cullen in Rechinger f., Fl. Iran. 34: 6. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 6. 1974. *Chelidonium dodecandra* Forssk. Fl. Aegypt.-Arab. 109. 1775. *Roemeria dodecandra* (Forssk.) Stapf. in Denkschr. Akad. Wiss. Wien Math.-Nat. Kl. 51: 295. 1886; Fedde, in Engler, Pflanzenr. 4. 104: 242. 1909. *R. orientalis* Boiss., Ann. Sc. Nat. Ser. 2, 16: 374. 1841; Boiss., Fl. Or. 1: 118. 1867; Cullen in Rechinger f., Fl. Iran. 34: 6. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 6. 1974.

Annual, densely hispid herbs. Stems 5-30 cm tall. Leaves 2-3 pinnatisect, ultimate segments of the leaves ovate to oblong, 3.0-12.0×1.0-2.5 cm, with a pointed bristle at the tip. Siliques densely setose, with an erect pedicel.

Type: EGYPT, in desertis Kahirinis, *Forsskhal* (BM, C, M)

Fls.: April—May. *Frts.:* May—June.

Distrib.: PAKISTAN; AFGHANISTAN; USSR; IRAN; JORDON; EGYPT.

2. **Roemeria refracta** DC., Syst. Nat. 2: 93. 1821; Prodr. 1: 122. 1824; Boiss,, Fl. Or. 1: 118. 1867; Fedde, in Engler, Pflanzenr. 4. 104: 243. 1909; Popov in Komarov, Fl. U.S.S.R. 7: 597. 1937; Kitamura, Fl. Afghanistan. 136. 1960; Cullen in Davis, Fl. Turkey, 1: 218. 1965; Cullen in Rechinger f., Fl. Iran. 34: 7, Fig. 1, A. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 4. 1974. *Glaucium refractum* Stev. in DC., Syst. Nat. 2: 93. 1821 in obs. *nom. nud. Roemeria rhoeadiflora* Boiss., Diagn., Ser. 1. 6: 7. 1855; Boiss., Fl. Or. 1: 119. 1867. *R. bicolor* Regel in Bull. Soc. Nat. Mosc. 43. 1: 249. 1870.

Annual, hispid herbs. Stems upright, with loosely spreading branches, rarely simple, covered with soft or bristly white hairs, rarely glabrescent, basal part covered with persistent leaf sheaths, 9-40 cm tall. Leaves 2-6 cm long, sparingly hairy or glabrous, 2-3 pinnatisect, ultimate segments linear-oblong, apex obtuse, 3.0-15.0×1.0-3.5 mm with or without small seta at the tip, lower and basal leaves petioled, upper leaves sessile. Petioles 2.0-5.5 cm long, gradually becoming shorter in the upper leaves, broad and sheathing at base. Flower buds 7-18×4-9 mm, globose to oblong-pyriform, glabrous or hispid. Pedicels 1-4 cm long, increasing up to 15 cm in fruiting condition, glabrous to densely pubescent. Sepals 7-18×4-9 mm, oblong, apex hooded, outside pilose. Petals 2.0-3.0×1.5-2.5 cm,

obovate-subrounded, bright red, black spot at the base. Stamens numerous, multiseriate; anthers 1.0-1.5 mm long, oblong; filaments 4-8 mm long, slender, slightly dilated. Ovary 8-10 mm long, *ca.* 1.5 mm broad, linear oblong; styles very short; stigmas 4, capitate with ciliate lobes. Siliques 1.5-4.0 cm long, 1-2 mm broad, erect, attenuate, dehiscing by 3-4 mucronate valves, glabrous except 4 setae projecting beyond the persistent stigma; setae *ca.* 1 mm long, alternating with stigma lobes. Seeds numerous, *ca.* 1 mm diameter, reniform.

Type: USSR., Dagestan (Derbent), 1810, *Steven* s.n. (G-DC, H—holo).

Fls.: April—June. *Frts.:* June—July.

Distrib.: PAKISTAN; AFGHANISTAN; IRAN; TURKEY; USSR.

CHAPTER 2: POLLEN MORPHOLOGY

2.1. INTRODUCTION

The study of palynology plays an important role in understanding the systematic position and interpreting taxa of doubtful alliances.

By this time a large number of palynotaxonomical works on different families have been reported. Almost in every case it was observed that pollen morphological data played significant role in evaluating the phylogeneric relationships among different taxa. Also, there are evidences where some taxa of controversial affinities were properly arranged on the basis of pollen morphological characters.

As was stated before the basic objective of the present investigation was to solve the existing controversies of the status of some taxa and their phylogeny. The present investigation on the pollen morphology of Papaveraceae distributed in the Indian region thus, was devoted mainly for the evaluation and reinterpretation of the results of the morphological studies discussed in the chapter 1; and so an attempt has been made to work out a phylogenetic tree purely on pollen morphological characters of the taxa investigated.

There are controversies regarding the systematic position of the genus *Hypecoum* in the family Papaveraceae. Hutchinson (1921) treated *Hypecoum* as a subfamily of Fumariaceae. Fedde (1936) and Engler & Diels (1936) placed it in the family Papaveraceae, along with Papaveroideae and Fumarioideae; but Gleason (1952) and Melchoir (1964) placed it under Papaveracaeae as a subfamily.

Cronquist (1968) suggested that both *Hypecoum* and *Pteridophyllum* were the connecting link between the two families Papaveraceae and Fumariaceae. Thus, the study of pollen morphology of the genus *Hypecoum* was undertaken in order to asses its systematic position in relation to Papaveraceae and Fumariaceae. A conventional pollen key has been incorporated using mainly the light microscopic characters. This key may be useful in future for identification of living and fossil pollen grains.

Reports on pollen morphological studies of the family Papaveraceae were done by Caturan (1951), Madalski (1955), Sagdullaeva (1959), Tarnavschi & Mitrouin (1960), Layka (1976) and Katis (1979). Erdtman (1952) studied the pollen grains of this family and indicated that the family is eurypalynous. Later, Linda D. Rachele (1974) studied the pollen of eleven genera of this family and formed a similar opinion. Work of Henderson (1965) on *Meconopsis* and that of Layka (1975) on *Argemone* are also referrable.

2.2. MATERIALS AND METHODS

Dry polleniferous material was obtained from different herbaria including British Museum, London (BM); Central National Herbarium, Calcutta, India (CAL); Forest Research Institute, Dehra Dun, India (DD); Botanical Survey and Herbarium, Nepal (KATH). Vaucher data and herbarium sheet, accession numbers are listed in table 1.

Preparation of material

In most of the cases the anthers sometimes the flowers or the small buds were acetolyzed according to the method described by Erdtman (1952) and are as follows.

The materials were crushed on a finely meshed (60-100 mm) screen spread out on a funnel kept in a centrifuge tube. The funnel was then washed with acetolysis mixture [acetic anhydride and concentrated sulphuric acid (9:1)]. Acetolysis of the materials was performed in a water bath at 80-100°C till the colour of the solution turned brown (medium-dark depending on the nature of the material). The tubes were then centrifuged at 2000 rpm and the supernatant was decanted. Subsequently, the sediment containing the pollen was washed atleast thrice in distilled water by centrifugation. Then the material was treated in glycerol (50%) and subsequently centrifuged and decanted; the tubes were kept upside down on a filter paper to decant the drops of the fluid and then incubated at 40°C till the material become dry.

However, those material used in SEM study were not treated in glycerol.

Preparation of permanent slide

To prepare the permanent slides minute cubes of glycerine Jelly was taken on a platinum needle. Jelly cube was touched on the surface of the pollen bearing sediment in the centrifuge tube and transferred to a clean slide. Then it was covered with coverslip, Jelly was melted over the flame and was spread. Ultimately coverslip was sealed off with paraffin.

For the detailed study of the surface ornamentations of pollen grains an oil immersion objective 100 × and eyepiece 10 X were used. The photomicrographs were taken with a Zeiss Wetzlar microscope (100 X N.A. 1.30). Magnifications of the photomicrographs demonstrated in the plates have been stated in the legend part of each plate. For Scanning Electron Microscopic (SEM) study acetolyzed pollen grains, after they were properly dried, were mounted directly on the stubs with adhesive tape. Subsequently gold coatings were made to make the material for SEM study. Observation was made with a PSEM 500, Phillips, scanning electron microscope.

TABLE 1: Voucher data for specimens of the family Papaveraceae examined for Pollen morphology

Taxon	Origin and Collector	Number and Herbarium
Argemone ochroleuca ssp. *ochroleuca*	India, Dehra Dun, Ballupur, 450 m, *Ramdayal*	21757 DD
Dicranostigma lactucoides	India, Kumaon, Kalivalley, near Chalele, 3000-3500 m, *Duthie*	532 CAL
Eomecon chionantha	India, Cultivated in Botanical Garden, Calcutta, *Anonymous*	s.n. CAL
Eschscholtzia californica	India, Cultivated in Forest Research Institute, Dehra Dun, *Naithani*	s.n. DD
Glaucium elegans	Pakistan, Beluchistan, Sri Kachh, *Harsukh*	20453 CAL
Glaucium fimbrilligerum	Afghanistan, Harirud Valley, *Aitchison*	272 CAL
Hypecoum leptocarpum	India, West Bengal, Phallut, 3600 m, *King's collector*	s.n. CAL
Hypecoum pendulum var. *parviflorum*	Pakistan, Chitral Dist., *Hamilton*	s.n. CAL
Hypecoum pendulum var. *pendulum*	Pakistan, Asurum, Kaliwali, 600 m, *Kabir*	14794 CAL
Meconopsis aculeata	India, Bashahr, Baspa valley, *Lace*	405 CAL
Meconopsis bella	India, Sikkim, Dzongri, *Prain's collector*	s.n. CAL

Taxon	Origin and Collector	Number and Herbarium
Meconopsis heteroclfolia	Burma-Tibet. Valley of Sienghku. 3500 m. *Kingdon-Ward*	7208 BM
Meconopsis dhwojii	Nepal. Fokte-Mandanda, 3500 m. *Pradhan, Saiju & Shrestha*	2874 KATH
Meconopsis discigera	Nepal, Tamur valley, Mewakhola. Topkigola. 4000 m. *Stainton*	921 BM
Meconopsis gracilipes	Nepal. Langung Himal, 3000 m. *Stainton. Sykes & Williams*	6417 BM
Meconopsis grandis	Bhutan. Chola (S. Side), *Ludlow, Sherriff & Hicks*	20803 BM
Meconopsis horridula	India. Sikkim, *Dungboo*	18667 CAL
Meconopsis integrifolia	Tibet, Sangla, 4500 m. *Ludlow, Sherif & Taylor*	5043 CAL
Meconopsis latifolia	India. Kashmir. Butin Pantsal, 3500 m, *Pinfold*	266 BM
Meconopsis longipetiolata	Nepal, Langtong to Kyangchin, 3261 m. *Malla*	9040 KATH
Meconopsis napaulensis	Nepal. Ganesh Himal, Ankhu khola, 4500 m. *Stainton*	3990 BM
Meconopsis paniculata	Nepal. Topkigola. 3500 m, *Beer*	8244 BM
Meconopsis primulina	Bhutan. Kangla. Karehula. 4500 m. *Ludlow, Sherriff & Hicks*	16569 BM
Meconopsis robusta	Pakistan, Kumaon. Pindi. *Collette*	11 CAL

Taxon	Origin and Collector	Number and Herbarium
Meconopsis simplicifolia	Nepal, Kangrangla, 4000 m, *Williams*	703 BM
Meconopsis sinuata	Nepal, Ratopokhari to Topkegola, 4000 m, *Shrestha & Joshi*	359 KATH
Meconopsis villosa	India, Sikkim, Karponang, 3500 m, *General Secretary of Sikkim Estate*	s.n. CAL
Papaver decaisnei	North west India, Fl. Pentopotamica, 2500 m, *Kubir*	14816 CAL
Papaver dubium	India, N. W. Himalaya, 1500 m. *Thomson*	51 CAL
Papaver hybridum	N. W. India, Hazara, *Inayat*	21122 CAL
Papaver macrostomum	India, Kashmir, Srinagar, 1600 m, *Gammie*	s.n. CAL
Papaver pavonium	Pakistan, Hazara, *Das*	6295 CAL
Papaver rhoeas	Japan, Tokyo, *Makino*	63805 CAL
Papaver somniferum	India, Tamil Nadu, *Narayanaswami*	1888 CAL
Roemeria refracta	India, Kalloka road, N. W. Frontier, *Griffith*	421 CAL

2.3. TERMINOLOGY

Annulus: A pore is frequently surrounded by an annular area (annulus), the exine of which is characterised by differences in the outer layer, the endexine sometimes being thicker, sometimes thinner (Faegri & Iversen, 1950).

Aperture: Any weak, performed part of the general surface of a spore which may be engaged in forming an opening in connection with the normal exit of intraexinous substance (Erdtman, 1952).

Apocolpium: Area at a pole, delimited towards the equator by the polar limits of the mesocolpia (Erdtman, 1952).

B: Breadth: Area of the grains perpendicular to the polar axis.

Bacula (sing. Baculum): Endosexinous rods supporting any ectosexinous elements. Also isolated sexinous rods (diameter ± the same at top and base) (Erdtman, 1952).

Baculate: With bacula.

Colpate: With one or more colpi.

Colpi (sing. Colpus): Equatorial, usually longitudinal apertures (length: breadth ≥ 2; in transcolpate grains, very rarely met with, the length-breadth ratio is ≤ 0.5) (Erdtman, 1952).

Colpus membrane: Membraneous structure without an exenious pattern and the colpus slit.

Ellipsoid: Oblong with rounded base.

Exine: The main, outer, usually resistant layer of a sporoderm (Erdtman, 1952).

Hetero-brochate: Lumina of unequal size and shape.

Infratectal: Infratectal details or patterns are confined to the space between the nexine and the overlying tectum (Erdtman, 1952).

Intectate: Grain devoid of tectum.

Intercolpial distance: Distance between two colpi in equatorial view.

L: Length: Distance between the proximal pole and the distal pole.

LO-pattern: Any pattern which at high adjustment of the microscope appears as "bright islands" (=*L*; from *L. lux*, light) separated by "dark channels" and on lower adjustment presents the reserves picture, *viz*. "dark islands" (=*O*; from *O. obscuritas*, darkness) separated by "bright channels" (Erdtman, 1952).

Lumina (sing. Lumen): The spaces between the muri of a reticulum (Erdtman, 1952).

Muri (sing. Murus): Ridges separating the lumina of an ordinary reticulum (Erdtman, 1952).

Negatively reticulate: Base of projected bodies when look like a reticulate structure in a lower focus in LO-analysis.

Nexine: The inner, non-sculptured part of the exine (Erdtman, 1952).

Oblate: Distinctly flattened. This term is used exclusively in descriptions of radiosymmetric, isopolar spores where the ratio between polar axis and equatorial diameter is 0.75-0.50 (6:8-4:8) (Erdtman, 1952).

Oblate spheroidal: This term is used exclusively in descriptions of radiosymmetric, isopolar spores where the ratio between polar axis and equatorial diameter is 1.00-0.88 (8:8-7:8) (Erdtman, 1952).

Optical section: View where focal plane is half-way through grain, where the grain wall becomes so visible that it seems to have been sectioned.

Pantoporate: The pores are scattered all over the surface of the grain.

Parasyncolpate: Colpate pollen grains are parasyncolpate if the colpi (or their extensions) are bifurcate and the branches meet $\pm$ close to the poles, leaving intact apocolpia of regular shape (Erdtman, 1952).

Perforate: With tectum provided with holes (diameter less than 1 μm.)

Perprolate: This term denotes exclusively the shape of radiosymmetric, isopolar spores where the ratio between polar axis and equatorial diameter is >2 ($>8:4$) (Erdtman, 1952).

Porate: With one or more pore.

Pori (sing. Porus): Equatorial, ± isodiametric apertures. The limit between porus and colpus is defined by the length-breadth ratio of 2:1 (Erdtman, 1952).

Prolate: This term denotes exclusively the shape of radiosymmetric, isopolar spores where the ratio between polar axis and equatorial diameter is 2.0-1.33 (8:6-8:7) (Erdtman, 1952).

Prolate spheroidal: This term denotes exclusively the shape of radiosymmetric, isopolar spores where the ratio between polar axis and equatorial diameter is 1.14-1.00 (8:7-8:8) (Erdtman, 1952).

Puncta: Perforations (smaller than scrobiculae) on the tectum of the pollen grains (Erdtman, 1952).

Puncti-tegillate: With a tegillum with minute perforations (puncta) (Erdtman, 1952).

Reticulate: With a reticulum.

Reticulum: Sculptural pattern consisting of brochi (*i.e.* of muri separated by lumina) (Erdtman, 1952).

Scabrae: Radial projection of sculpturing elements, ·: isodiametric, area: $\leqslant 1.0\ \mu$.

Scabrate: With scabrae.

Sexine: The outer, sculptured part of the exine (Erdtman, 1952).

Spheroidal: Spherical figure, a little depressed at each end.

Spines: Long, conspicuous, and generally sharp, pointed excrescences, length exceeding $3\ \mu$ (Erdtman, 1952).

Spinose: Surface bearing spines.

Spinules: Small spines, not exceeding about $3\ \mu$ in length (Erdtman, 1952).

Striate: Minute processes/wholes arranged in parallel rows.

Striato-reticulate: A sculptural pattern ± intermediate between striate and reticulate (Erdtman, 1952).

Supratectal: Occurring over the tectum.

Syncolpate: With colpi anastomosing at the poles (Faegri and Iversen, 1950; Erdtman, 1952).

Tectate: Grains with tegillum.

Tectum: It is like a roof formed by the outer layer of the exine by the union of the heads of the columellae/baculae etc.

Tegillum: An ectosexinous, ± homogenous layer usually distinctly separated from the nexine by a baculate zone (endosexine) (Erdtman, 1952).

Tenuimar-ginate: With thin margins (Erdtman, 1952).

Tetrads: Spores united in fours (Erdtman, 1952).

Verrucae: Wartlike sculptinous projections (basal diameter as a rule longer than any other tangential diameter) (Erdtman, 1952).

Verrucate: Exine of the grains possessing verrucae.

Wart: Blister like processes with dimensions.

Zonocolpate: Colpi arranged in a zone.

2.4. RESULTS

Pollen description

Argemone ochroleuca Sweet subsp. *ochroleuca* (Plates 1-3, 93 & 94)

Pollen grains 3 or 4-zonocolpate, spheroidal, L × B — ± 33.0 × 30.0 μ, syncolpate. Colpi L × B — ± 15.0 × 6.0 μ, colpi appear to be in ridges and protrude beyond the margin of the polar diameter.

Exine ± 1.5 μ thick, sexine ± 1.0 μ thick, intectate to semitectate, surface pattern striato-reticulate, nexine ± 0.5 μ thick.

Dicranostigma lactucoides Hook. f. & Thoms. (Plates 4, 5, 95 & 96)

Pollen grains 3-zonocolpate, prolate-spheroidal, L × B = 30.0-40.0 × 30.0-36.0 μ, colpi 20.0-30.0 μ long, ± 3.0 μ broad, intercolpial distance ± 17.0 μ.

Exine ± 2.0 μ thick, sexine 1.0 μ thick, surface reticulate to reticuloid in LM, in SEM perforated surface was observed with wart like processes on the tectum, nexine ± 1.0 μ thick.

Eomecon chionantha Hance (Plates 6, 7)

Pollen grains 8-10 pantoporate, spheroidal, L × B = 35.0-48.0 × 33.0-45.0 μ. Pore circular, 6.0-8.0 μ in diameter, surrounded by thin annulus, covered by thin membrane.

Exine 2.0-2.5 μ thick, sexine ± 1.5 μ thick, infectate, surface pattern striato-reticulate, nexine 0.75 μ thick.

Eschscholtzia californica Cham. (Plates 8-10, 101 & 102)

Pollen grains 3 & 4-zonocolpate, prolate, L × B = 28.0-33.0 × 21.0-26.0 μ. Colpi 21.0-25.0 μ long, ± 2.0 μ broad, intercolpial distance in tricolpate grains ± 5.0 μ, in tetracolpate grains ± 3.0 μ.

Exine ± 1.5 μ thick, sexine ± 1.0 μ thick, intectate, surface pattern reticulate, heterobrochate, nexine ± 0.5 μ thick.

Glaucium elegans Fisch. et Mey (Plates 11, 12, 97 & 98)

Pollen grains 3-zonocolpate, ± spheroidal, L × B = 26.0 × 24.0 μ. Colpi ± 19.0 μ long ± 7.0 μ broad, intercolpial distance ± 5.0 μ.

Exine ± 1.0 μ thick, tenuimarginate, not entire in outline, sexine ± 0.8 μ thick, supratectal processess spinulose, appear reticulate in LO-analysis and in SEM, colpi covered by thin membrane ornamentation, coarser near aperture, nexine ± 0.2 μ thick.

G. fimbrilligerum (Trautv.) Boiss. (Plates 13-15)

Pollen grains similar to *G. elegans* but, oblate, L × B = 24.0-36.0 × 27.0-30.0 μ. Colpi ± 22.0 μ long, ± 7.5 μ broad, intercolpial distance ± 5.0 μ.

Exine ± 1.5 μ thick, sexine ± 1.2 μ thick, nexine ± 0.3 μ thick.

Hypecoum leptocarpum Hook. f. & Thoms. (Plates 16-18 & 99)

Pollen grains 2 & 3-zonocolpate, ± spheroidal, L × B = 26.5-32.0 × 25.0-30.0 μ, in tricolpate grains one colpi indistinct, appear to be parasyncolpate. Colpi ± 23.0 μ long, ± 3.0 μ broad.

Exine ± 1.5 μ thick, sexine ± 1.0 μ thick, tectate with supratectal spinules, surface pattern striato-reticulate, nexine ± 0.5 μ thick.

H. pendulum Linn. var. *parviflorum* (Kar. et Kir.) Cullen (Plates 19-21, 100)

Pollen grains similar to *H. leptocarpum* but, L×B = 24.0-32.0×24.0-26.0 μ, 28.0-33.0 μ in polar diameter. Colpi 22.0-27.0 μ long, 2.5 μ broad, tricolpate grains showing syncolpate condition.

Exine ± 2.0 μ thick, sexine ± 1.5 μ thick, tectate, nexine ± 0.5 μ thick.

H. pendulum Linn. var. *pendulum* (plates 22-25)

Pollen grains similar to *H. leptocarpum*.

Exine ± 1.5 μ thick, sexine ± 1.0 μ thick, intectate, nexine ± 0.5 μ thick.

Meconopsis aculeata Royle (Plates 26-28)

Pollen grains 3-zonocolpate, prolate, rarely spheroidal, L×B = 33.0-45.0×24.0-35.0 μ. Colpi 26.0-32.0 μ long, ± 3.0 μ broad, intercolpial distance 4.5-9.0 μ showing tendency to unite in pole.

Exine ± 1.5 μ thick, sexine ± 1.0 μ thick, tectate, supractectal processes spinulose, appear negatively reticulate in LO-analysis, nexine ± 0.5 μ thick.

M. bella Prain (Plates 29-31)

Pollen grains similar to *M. aculeata*, but L×B = 25.0 - 36.0×21.0-29.0 μ. Colpi 18.0-31.0 μ long, 1.0-2.0 μ broad, intercolpial distance 5.0-7.0 μ.

Exine ± 2.0 μ thick, sexine ± 1.5 μ thick, supratectal processes wart-like, surface pattern ± striate, nexine ± 0.5 μ thick.

M. betonicifolia Franch. (Plates 32-34)

Pollen grains inaperturate, spheroidal, L×B = 45.0×43.5 μ.

Exine ± 2.0 μ thick, sexine ± 1.5 μ thick, tectate, both spinose and spinulose, spinules in the lower focus appear in more than one semi-circular rows (simply striate) around a spine, spines 3.0-4.0 μ long, apex acute, base 0.5-1.5 μ broad, nexine ± 0.5 μ thick.

M. dhwojii G. Tayl. ex Hay (Plates 35-37)

Pollen grains 4 & 5-zonocolpate, spheroidal, L×B = 24.0-36.0×23.0-34.0 μ. Colpi 14.0-23.0 μ long, 1.0-1.5 μ broad.

Exine ± 1.5 μ thick, sexine 1.0 μ thick, tectate, supratectal processes form negatively reticulate pattern, nexine ± 0.5 μ thick.

M. discigera Prain (Plates 41, 42)

Pollen grains 5 & 6-zonoporate, prolate, L×B = 35.0-60.0×35.0-46.0 μ, pore ± ellipsoid, 9.5-12.0 μ long, 6.0-7.0 μ broad, annulus present, 1.0-1.5 μ thick.

Exine 1.0-1.8 μ thick, sexine 0.6-1.0 μ thick, tectate, supratectal processes spinulose, surface pattern finely reticulate, nexine 0.5-0.8 μ thick.

M. gracilipes G. Tayl. (Plates 38-40)

Pollen grains 3 & 4-zonocolpate, spheroidal. L×B = 20.0-27.0×18.0-26.0 μ, tricolpate grains parasyncolpate.

Exine 1.5-2.0 μ thick, tectate, supratectal processes spinulose, nexine ± 0.75 μ thick.

M. grandis Prain (Plates 103 & 104)

Pollen grains tetrad, inaperturate, subspheroidal-spheroidal, L × B = 40.0-50.0×45.0-51.0 μ.

Exine 2.0-2.5 μ thick, spinose, spines 2.5-4.5 μ long, with ± acute apex, 2.0-2.5 μ broad at the base, surface perforated, perforations inconspicuous in LM.

M. horridula Hook. f. & Thoms. (Plates 43-45 & 107)

Pollen grains 3-zonocolpate, prolate-spheroidal to spheroidal, L×B = 30.0-35.0 × 25.0-29.0 μ. Colpi 19.0-27.0 μ long, ± 1.5 μ broad, some grains appear to be syncolpate in polar view, intercolpial distance ± 6.0 μ.

Exine 1.5-2.0 μ thick, sexine 1.2-1.5 μ thick, with supratectal processes, appear finely striate in LM, nexine ± 0.5 μ thick.

M. integrifolia (Maxim.) Franch. (Plates 49, 50, 105 & 106)

Pollen grains inaperturate, circular in polar view, L × B = 43.0-61.0 × 43.5-62.0 μ.

Exine 1.5-2.0 μ thick, sexine 1.0-1.5 μ thick, tectate, spinose, spines two types, larger ± 4.5 μ long with acute apex, 2.5-4.0 μ broad at base and smaller ± 3.5 μ long, ± 2.0 μ broad at base, surface perforated, perforations observed only in SEM, nexine ± 0.5 μ thick.

M. latifolia (Prain) Prain (Plates 46-48, 108 & 109)

Pollen grains 3 & 4-zonocolpate, prolate to prolate-spheroidal, L × B = 30.0-37.0 × 25.0-29.0 μ. Colpi 24.0-29.0 μ long, 1.9-2.5 μ broad, intercolpial distance 9.0-10.5 μ.

Exine 1.5-2.0 μ thick, sexine 1.0-1.5 μ thick, tectate, surface striato-reticulate in LM, tectal perforations observed only in SEM, nexine $\pm$ 0.5 μ thick.

M. longipetiolata G. Tayl. ex Hay (Plates 55-57, 110 & 111)

Pollen grains 3-zonocolpate, spheroidal, L$\times$B = $\pm$ 39.0$\times$38.0 μ.

Exine $\pm$ 2.5 μ thick, sexine $\pm$ 2.0 μ thick, supratectal processes spinulose, surface in LO analysis finely reticulate to reticuloid, apparently luminar structure distinct in SEM, nexine $\pm$ 0.2 μ thick.

M. napaulensis DC. (Plates 58-60, 112 & 113)

Pollen grains without aperture, spheroidal, L$\times$B = 39.0-45.0$\times$39.0-45.0 μ.

Exine 2.0-2.5 μ thick, sexine $\pm$ 1.0 μ thick, tectum undulating in optical section, supratectal processes range from verrucate-spinulose, spinules with broad base, $\geqslant$ 0.5 μ long, surface pattern reticulate in lower focus, nexine $\pm$ 0.2 μ thick.

M. paniculata (D. Don) Prain (Plates 51-54, 114 & 115)

Pollen grains 4-zonocolpate, $\pm$ spheroidal, L$\times$B = $\pm$ 37.0 $\times$ 38.0 μ. Colpi $\pm$ 25.0 μ long, $\pm$ 2.5 μ broad, intercolpial distance $\pm$ 19.0 μ.

Exine $\pm$ 1.5 μ thick, sexine $\pm$ 1.0 μ thick, tectate, verrucate, verrucae in $\pm$ parallel rows in the top focus, smaller processes wart like, surface pattern striato-reticulate in LM, irregular perforations observed only in SEM, nexine $\pm$ 0.2 μ thick.

M. primulina Prain (Plates 61-63, 116 & 117)

Pollen grains 3-zonocolpate, spheroidal, L$\times$B = 32.0$\times$31.0 μ.

Exine, $\pm$ 1.5 μ thick, sexine $\pm$ 1.2 μ thick, tectate, supratectal processes spinulose, surface pattern striato-reticulate in top focus, nexine $\pm$ 0.5 μ thick.

M. robusta Hook. f. & Thoms. (Plates 64 & 65)

Pollen grains inaperturate, spheroidal, L$\times$B = 40.0-50.0 $\times$40.0-48.0 μ.

Exine $\pm$ 1.7 μ thick, tectate, spinose, wavy in outline, supratectal processes form finely reticuloid pattern, nexine 0.6 μ thick.

M. simplicifolia (D. Don) Walp. (Plates 66, 67)

Pollen grains similar to *M. robusta*.

Exine $\pm$ 1.5 μ thick, sexine $\pm$ 1.0 μ thick, spines $\pm$ 3.5 μ long, 1.0-1.5 μ broad at base, spinules in lower focus (LM) striato-reticulate, nexine $\pm$ 0.5 μ thick.

M. sinuata Prain (Plates 68-70, 118 & 119)

Pollen grains 3 & 4-zonocolpate, spheroidal, L×B = 33.6-42.0 × 32.0-40.0 μ, syncolpate, intercolpial distance in tetracolpate grains ± 22.9 μ, in tricolpate grains ± 24.0 μ.

Exine ± 2.0 μ thick, sexine ± 1.5 μ thick, with supratectal processes, infrequent perforations observed on the processes (only in SEM), surface pattern reticulate in LO analysis (LM), nexine ± 0.5 μ thick.

M. villosa (Hook. f.) G. Tayl. (Plates 71-73)

Pollen grains 3-zonocolpate, spheroidal, L×B = 27.0-35.0×25.0-34.0 μ.

Exine ± 2.0 μ thick, sexine ± 1.5 μ thick, spinose, base of the spines encircled by an elevated ring, formed by minute supratectal projections, nexine ± 0.5 μ thick.

Papaver decaisnei Hochst. & Steud. ex Boiss. (Plates 74, 75, 120 & 121)

Pollen grains 4-zonocolpate, rectangular in polar view, diagonal distance ± 31.5 μ. Colpi L×B = ± 21.0×3.0 μ.

Exine ± 1.5 μ thick, sexine ± 1.0 μ thick, surface pattern striato-reticulate in LM, SEM study confirm the presence of supratectal processes, nexine ± 0.5 μ thick.

P. dubium Linn. (Plates 76, 77, 122 & 123)

Pollen grains 3-zonocolpate, perprolate, L×B = 27.0-32.0×15.0-18.0 μ. Colpi ± 22.5 μ long, 1.5-2.0 μ broad, intercolpial distance 3.0-4.5 μ.

Exine ± 1.5 μ thick, sexine ± 1.0 μ thick, tectum in optical section serrate due to the presence of supratectal processes, striate, with scrabate muri. nexine ± 0.3 μ thick.

P. hybridum Linn. (Plates 78-80 & 124)

Pollen grains similar to *P. dubium*, but L×B = 21.0-30.0×15.0-19.5 μ. Colpi 21.0-22.0 μ long, ± 1.5 μ broad, intercolpial distance ± 4.5 μ.

Exine ± 1.5 μ thick, sexine ± 1.0 μ thick, surface striato-reticulate, nexine ± 0.5 μ thick.

P. macrostomum Boiss. et Huet ex Boiss. (Plates 81-83, 125 & 126)

Pollen grains similar to *P. dubium*, but L×B = 19.0-29.0×13.0-20.0 μ. Colpi 18.0-21.0 μ long, 1.0-1.5 μ broad, intercolpial distance 2.0-3.0 μ.

Exine ± 1.5 μ thick, sexine ± 1.0 μ thick, scabrate, ± striate in the first focus, negatively reticulate in lower focus, nexine ± 0.5 μ thick.

P. pavonium Fisch. et Mey. (Plates 84, 85, 129 & 130)

Pollen grains similar to *P. dubium*, but L×B = 24.0-32.0×15.0-20.0 μ. Colpi 19.0-26.0 μ long, ± 10.0 μ broad, intercolpial distance ± 3.0 μ.

Exine ± 1.5 μ thick, sexine 1.0 μt hick, appear finely striate reticulate in light microscopic study, spinules on the muri of reticulum, nexine ± 0.5 μ thick.

P. rhoeas Linn. (Plates 86 & 131)

Pollen grains similar to *P. dubium*, but L×B = 21.0-30.0×12.0-19.0 μ. Colpi 15.0-24.0 μ long, 1.0-1.5 μ broad, intercolpial distance ± 3.0 μ.

Exine ± 1.5 μ thick, sexine ± 1.0 μ thick, supratectal processes (spines) free at top but unite towards base giving a reticulate pattern in light microscopic study, nexine ± 0.5 μ thick.

P. somniferum Linn. (Plates 87-89, 127 & 128)

Pollen grains similar to *P. dubium*, but L×B = 24.0-27.0×18.0-21.0 μ. Colpi 20.0-22.0 μ long, ± 3.0 μ broad.

Exine ± 1.5 μ thick, sexine ± 1.0 μ thick, intectate, two sets of bacula with two sizes, bacula at top form striate in top focus (LM), bacula at lower level form reticulations, lumina of different diameters, nexine ± 0.5 μ thick.

Roemeria refracta DC. (Plates 90-92)

Pollen grains 3 & 4-zonocolpate, prolate spheroidal, L×B = ± 24.0× 18.0-20.0 μ. Colpi 16.0-18.0 μ long, ± 2.0 μ broad, intercolpial distance ± 3.0 μ.

Exine ± 2.0 μ thick, sexine ± 1.0 μ thick, intectate, bacula free at top forming ± striate pattern, but unite towards base forming a reticulate pattern, nexine ± 0.5 μ thick.

2.5. KEY TO THE TAXA

This key has been formed entirely on the basis of light microscope study.

1a.	Tetrad ...	*Meconopsis grandis*
1b.	Monad:	
2a.	Inaperturate:	
3a.	Only spinose:	
4a.	Two types of spines-one small and the other large ...	*M. integrifolia*
4b.	One type of spines ...	*M. robusta*
3b.	Both spinose and spinulose:	
5a.	Simply striate in lower focus ...	*M. betonicifolia*
5b.	Striato-reticulate in lower focus ...	*M. simplicifolia*
3c.	Both verrucate-spinulose ...	*M. napaulensis*

2b.	Aperturate:		
6a.	Porate:		
7a.	Zonoporate	...	*M. discigera*
7b.	Pantoporate	...	*Eomecon chionantha*
6b.	Colpate:		
8a.	Bicolpate:		
9a.	Intectate	...	*Hypecoum pendulum*
9b.	Tectate	...	*H. leptocarpum*, *H.pendulum* var. *parviflorum*
8b.	Tricolpate:		
10a.	Tectate:		
11a.	Supratectal processes scabrate	...	*Papaver macrostomum*
11b.	Supratectal processes wart like	...	*Meconopsis bella*
11c.	Supratectal processes verrucate	...	*M. longipetiolata*
11d.	Supratectal processes spinulose:		
12a.	Spheroidal:		
13a.	Both spinose and spinulose	...	*M. villosa*
13b.	Only spinulose:		
14a.	Parasyncolpate:		
15a.	Surface pattern striato-reticulate	...	*Hypecoum leptocarpum*
15b.	Not so	...	*Meconopsis gracilipes*
14b.	Not so:		
16a.	Surface pattern simply striate	...	*M. horridula*
16b.	Surface pattern striato-reticulate	...	*Hypecoum pendulum var. parviflorum*
16c.	Surface pattern negatively reticulate	...	*Meconopsis aculeata*
16d.	Surface pattern reticulate:		
17a.	Surface pattern coarser in the apertural region than the rest of the grain surface	...	*Glaucium elegans*
17b.	Not so	...	*Meconopsis sinuata*
16e.	Surface pattern striato-reticulate in 1st focus, negatively reticulate in lower focus	...	*M. primulina*
12b.	Prolate-spheroidal:		
18a.	Surface pattern simply striate	...	*M. horridula*
18b.	Surface pattern striato-reticulate	...	*M. latifolia*

12c.	Prolate:		
19a.	Surface pattern negatively reticulate	...	*M. aculeata*
19b.	Surface pattern striato-reticulate:		
20a.	Syncolpate	...	*Hypecoum pendulum* var. *parviflorum*
20b.	Not so	...	*Meconopsis latifolia*
12d.	Perprolate:		
21a.	Surface pattern striate	...	*Papaver dubium*
21b.	Surface pattern striato-reticulate	...	*P. hybridum*
21c.	Surface pattern reticulate	...	*P. rhoeas*
12e.	Oblate	...	*Glaucium fimbrilligerum*
10b.	Intecate:		
22a.	Spheroidal:		
23a.	Colpi appear to be in ridges and protrude beyond the grain margin	...	*Argemone ochroleuca*
23b.	Not so:		
24a.	Surface pattern reticulate to reticuloid	...	*Dicranostigma lactucoides*
24b.	Surface pattern striato-reticulate	...	*Hypecoum pendulum*
22b.	Prolate-spheroidal	...	*Roemeria refracta*
22c.	Prolate:		
25a.	Two sets of baculae; taller baculae forming striation and smaller baculae forming reticulation	...	*Papaver somniferum*
25b.	One set of baculae	...	*Eschscholtzia californica*
22d.	Perprolate	...	*Papaver pavonium*
8c.	Tetracolpate:		
26a.	Tectate:		
27a.	Spheroidal:		
28a.	Verrucate	...	*Meconopsis paniculata*
28b.	Spinulose:		
29a.	Surface pattern reticulate	...	*M. sinuata*
29b.	Surface pattern negatively reticulate	...	*M. dhwojii*
29c.	Surface pattern not defined	...	*M. gracilipes*
27b.	Prolate	...	*M. latifolia*
26b.	Intectate:		
30a.	Grain rectangular in polar view	...	*Papaver decaisnei*

30b.	Not so:		
31a.	Colpi appear to be in ridges and protrude beyond the grain margin	...	*Argemone ochroleuca*
31b.	Not so:		
32a.	Baculae free at top, unite at base	...	*Roemeria refracta*
32b.	Not so	...	*Eschscholtzia californica*
8d.	Pentacolpate	...	*Meconopsis dhwojii*

2.6. DISCUSSION

An array of differences were observed in shape, size, apertural types, and surface ornamentations of pollen grains of different taxa studied. Pollen grains of different taxa of the family papaveraceae are morphologically heterogeneous. Grains are oblate *(Dicranostigma lactucoides)* to perprolate (in the species of *Papaver*). Even pollen grains having a rectangular shape in polar view were observed in *Papaver decaisnei*. Apertural types are also different. They are usually colpate or rarely porate *(Meconopsis discigera* and *Eomecon chionantha)*. They may be in zone or may be distributed over the surface. Number of apertures usually range from 2 to 10. Sometimes the pollen grains of the same species contained different number of apertures. *Hypecoum* pollen grains are 2-3 zonocolpate. Similarly 3-4 zonocolpate grains are found in *Argemone, Eschscholtzia, Meconopsis, Roemeria;* while the presence of 4-5 zonocolpate grains is the characteristic feature of *Meconopsis dhwojii*. However, majority of the taxa are 3-zonocolpate. 4-zonocolpate grains are also found in *Meconopsis paniculata* and *Papaver decaisnei*. Pollen grains are porate in *Meconopsis discigera* and *Eomecon chionantha;* grains are 5-6 zonoporate in former, but are pantoporate in the later with 8-10 pores.

Sporoderm stratifications in pollen grains of this family are also diverse. Both tectate and intectate grains are present, though majority of the pollen types are tectate grains (*eg.* all species of *Meconopsis*, some species of *Papaver* and *Glaucium* sp. etc.). Pollen grains are intectate in *Argemone ochroleuca, Dicranostigma lactucoides, Eomecon chionantha, Eschscholtzia californica, Hypecoum pendulum, Papaver decaisnei, P. somniferum, Roemeria refracta*. Surface ornamentation pattern shows variability. Surface may have spinules simply dispersed on the tectum (supratectal processes) without forming any definite pattern. Similar pattern is found in *Meconopsis gracilipes, M. grandis, M. integrifolia, M. villosa*. In some other cases supratectal spinules form reticulate pattern (in *Meconopsis discigera, M. longipetiolata, M. sinuata* and

all species of *Papaver* except *P. dubium*). In others they may be striate (in *Hypecoum* sp., *Meconopsis latifolia, Papaver hybridum)* or striato-reticulate (in *Meconopsis betonicifolia, M. horridula* and *Papaver dubium*). Also the surface pattern may be negatively reticulate (in *Meconopsis aculeata, M. dhwojii, M. napaulensis*). In *Meconopsis paniculata* the supratectal processes are of two types,—verrucate and spinulose. Verrucae in the top focus unite in parallel rows; while the spinules in a lower focus form striato-reticulate pattern. Complicated surface patterns are also observed in *Papaver macrostomum* where supratectal processes are scabrate and form striate in the first focus and the same becoming negatively reticulate in the lower focus. In intectate grains sporoderm may be simply reticulate (in *Dicranostigma, Eomecon, Eschscholtzia, Papaver pavonium, Roemeria* etc.) or striato-reticulate (in *Argemone ochroleuca)*. In *Papaver somniferum* two sets of baculae with two different sizes were observed. Tall baculae formed striations in top focus, while the smaller baculae formed reticulation in the lower focus. In *Roemeria refracta* free baculae form striations at top focus, but unite towards the base forming a reticulate pattern.

Pollen morphology in phylogeny

These differences in pollen structure and as well advanced and primitive characters (after Erdtman, 1963) of the pollen helped us to proposed a phylogenetic tree (Plate 132).

The Plate 132 is self explanatory and indicates that during evolution two fundamentally different lines were segregated from the very beginning. One of them constituted the *Papaver* group while the other *Meconopsis* group. The grains of the *Meconopsis* group are characterized by the presence of mainly tectate grains with spheroidal to prolate shape. *Papaver* group on the contrary is characterized by the presence of intectate grains with perprolate shape. The other important group represented by inaperturate grains and remaining at the base seems to be the progenitor of the advanced groups. This inaperturate group may have given rise to *Hypecoum* group with 2-3 zonocolpate pollen grains. Ultimately, *Meconopsis* and *Papaver* lines may have evolved from *Hypecoum*. Special mention can be made about the genus *Meconopsis*. This genus seems to be heterogenous because different members of this genus contained pollen types representing different status in the evolutionary scale. Perhaps some other genera like *Dicranostigma, Roemeria, Argemone* etc. fundamentally evolved from different taxa of the genus *Meconopsis*. Patterns of sporoderm stratification in *Meconopsis*, however, are much diffused and so they could hardly be used as significant criteria for consideration in the interpretation of evolutionary status of different taxa in Papaveraceae.

TABLE 2: Species of Papaveraceae arranged according to Pollen morphological affinity

Species	NPC*	Tectate	Intectate
Meconopsis betonicifolia	000		
M. grandis	000		
M. integrifolia	000		
M. napaulensis	000		
M. simplicifolia	000		
M. robusta	000		
Hypecoum leptocarpum	243,343	+	
H. pendulum var. *pendulum*	243,343	+	
H. pendulum var. *parviflorum*	243,343		+
Meconopsis aculeata	343	+	
M. bella	343	+	
M. horridula	343	+	
M. longipetiolata	343	+	
M. primulina	343	+	
M. villosa	343	+	
Dicranostigma lactucoides	343		+
Glaucium elegans	343	+	
G. fimbrilligerum	343	+	
Papaver dubium	343	+	
P. hybridum	343	+	
P. macrostomum	343	+	
P. pavonium	343		+
P. rhoeas	343	+	
P. somniferum	343		+
Argemone ochroleuca	343,443		+
Eschscholtzia californica	343,443		+
Meconopsis gracilipes	343,443	+	
M. latifolia	343,443	+	
M. sinuata	343,443	+	
Roemeria refracta	343,443		+
Meconopsis paniculata	443	+	
Papaver decaisnei	443		+
Meconopsis dhwojii	443,543	+	

Species	NPC*	Tectate	Intectate
Meconopsis discigera	544,644	+	
Eomecon chionantha	864,964,1064		+

*NPC:—Number, position and character classification grains according to apertures (Erdtman, 1963). The following P and C classes occur in the family Papaveraceae: P 4=zonally arranged, P 6=panto-position; C 3 = colpate, C 4 = porate.

CHAPTER 3. SEED MORPHOLOGY

3.1. INTRODUCTION

The differences in characters of spermoderm (testa) of seeds are known to have relationships with the specific variability of certain taxa and hence they are of taxonomic value.

In recent years considerable information have been obtained about the ultrastructure of spermoderms (testa) through the use of scanning electron microscope (SEM). A recent review on spermoderm patterns by Brisson & Peterson (1976) amply justifies that investigations using SEM may be useful in the understanding of systematics, ecology, genetics and evolution of plants.

In order to help the taxonomic disposition of different taxa, SEM studies of spermoderm of the seeds of the species of Papaveraceae as listed have been undertaken. Corner (1976) studied the morphological and anatomical aspects of some of the seeds of Papaveraceae. Gunn & Seldin (1976), Clark & Jernstedt (1978), Gunn (1980), and Berthlott (1981) after study of the microsculpturing of seed coats of the various taxa of Papaveraceae indicated that the reticulate super cellular pattern of Papaveraceae is very characteristic and may be considered as a family character. In order to examine the characters of spermoderm the taxa of Papaveraceae of the Indian region is undertaken.

Terminology used in this studies for describing the various morphological aspects of the spermoderm are given below.

Terminology

Alveoli:	The surface of seed with small cavities or depressions.
Coralloid:	Surface of the spermoderm when looks like that of a Coral.
Lumina:	The spaces surrounded by the muri of a reticulum.
Muri:	Ridges separating the lumina of reticulum.
Pit:	Perforation—a mark with small hollow appearing on the surface.
Reticulum (Pl. Reticula):	An area (lumen) surrounded by a single/multiple strands of fibres (muri).
Rugosus (Rugose):	Spermoderm covered with reticulated bodies, and the enclosed spaces appearing convex.

Striate: Marked with fine lines (ridges) or furrows, ± parallel to each other.

Wrinkle: Elevations when look like irregular.

3.2. MATERIALS AND METHODS

Seeds were taken from the specimens available in British Museum (Natural History) London, England (BM); Central National Herbarium, Indian Botanic Garden, Howrah, India (CAL); Forest Research Institute, Dehra Dun, India (DD) and Botanical Survey and Herbarium, Godawari, Nepal (KATH). Vauhcer data and herbarium sheet, accession numbers are listed in table 3.

Dry mature seeds were directly mounted on the adhesive tapes placed on the stubs and subsequently they were gold coated. Surface pattern of the seeds were studied in different magnifications and for this purpose region of the seeds below the hilum were scanned. Observation was made with a PSEM 500, Phillips, Scanning Electron Microscope.

3.3. DESCRIPTION

Argemone ochroleuca Sweet subsp. *ochroleuca* (Plates 133 & 134)

Seeds 1.5-2.0 mm in diameter, ± rounded, hilum basal, conspicuous.

Spermoderm (testa) in lower magnification rugose (Plate 133), thread like fine structures appear to occupy the lumina; while in higher magnification (Plate 134) finely reticulate, muri single stranded with different shapes and sizes.

Dicranostigma lactucoides Hook. f. & Thoms. (Plates 135 & 136)

Seeds 0.8-1.0 mm, subreniform.

Spermoderm (testa) in lower magnification rugose (Plate 135); in higher magnification (Plate 136) the muri of the reticula formed of compactly set scrobiculae striate in arrangement.

Eschscholtzia californica Cham. (Plates 139 & 140)

Seeds ca. 2 mm in diameter, globose.

Spermoderm (testa) in lower magnification rugose (Plate 139), reticulum like structures arranged in vertical rows in perpendicular to the long axis of the seed; in higher magnification (Plate 140) numerous dispersed pits of different dimensions are observed, each such pit surrounded by amorphous elevated structure, occasionally single stranded fibres traverse those structures.

Glaucium elegans Fisch. et Mey. (Plates 137 & 138)

Seeds 1.0-1.2 mm long, oblong-cylindrical, slightly curved.

Spermoderm (testa) in lower magnification rugose (Plate 137), reticula arranged in parallel rows in longitudinal axis of the seed; in higher magnification (Plate 138) lumina filled with finer and scattered reticulum (secondary reticulations), reticulations when compact form the muri, muri ± lamellate.

Glaucium fimbrilligerum (Trautv.) Boiss. (Plates 141 & 142)

Seeds 1.2-1.5 mm long, reniform.

Spermoderm (testa) in lower magnification rugose (Plate 141), reticula arranged in parallel rows in the longitudinal axis of the seed; in higher magnification (Plate 142) peripheral part of each lumina (of the reticulate bodies) appears as compactly pitted due to intermeshing of strands, ultimately coalesce forming the muri.

Hypecoum pendulum Linn. var. *parviflorum* (Kar. & Kir.) Cullen (Plates 145 & 146)

Seeds *ca.* 2.0 mm long, 1.5 mm broad, planoconvex.

Spermoderm (testa) in lower magnification rugose (Plate 145); in higher magnification (Plate 146) the rugose nature of spermoderm is due to the presence of discrete bodies, square or rectangle in shape, with upper surface ± flat. The space in between the each of such bodies contain fine reticulations (secondary) with muri of single stranded fibre.

Hypecoum pendulum Linn. var. *pendulum* (Plates 143 & 144)

Seeds *ca.* 2 mm long, 1.5 mm broad, planoconvex-reniform.

Spermoderm (testa) in lower magnification rugose (Plate 143); in higher magnification (Plate 144) the rugose nature of spermoderm is due to the presence of discrete bodies, square or rectangle in shape, with upper surface convex, and the space in between each of such bodies contain reticulation of thick strands which project upward in the shape of beads.

Meconopsis aculeata Royle (Plates 147 & 148)

Seeds *ca.* 1 mm long, subreniform.

Spermoderm (testa) in lower magnification rugose, lumina of reticula contain fine structures (Plate 147); which in higher magnification (Plate 148) appear finely reticulate (secondary reticulations), muri unevenly thickened, lumina incorporate interwoven fibres often forming fine reticulation (tertiary).

Meconopsis bella Prain (Plates 149 & 150)

Seeds 1.2-1.4 mm long, ellipsoid.

Stratification of spermoderm (testa) in lower magnification indistinct (Plate 149); same in higher magnification (Plate 150) prominently ribbed, with fine fibrous strands, unevenly thickened and traverse irregularly over the ribs.

Meconopsis betonicifolia Franch. (Plates 151 & 152)

Seeds 0.6-1.0 mm long, reniform, with longitudinal rows of shallow pits.

Spermoderm (testa) in lower magnification indistinctly rugose (Plate 151); in higher magnification (Plate 152) appears to contain parallel ribs formed by compact striato-reticulate structures which intermesh and appearing pitted.

Meconopsis dhwojii G. Tayl. ex Hay (Plates 153 & 154)

Seeds 0.6-0.8 mm long, ovoid-ellipsoid-oblong.

Spermoderm (testa) in lower magnification appear like honeycomb (Plate 153); in higher magnification (Plate 154) the boundary wall (similar to muri) around the cavities (of honeycomb) appear to have been formed by stout thick fibres, coalesced together and the floor of the cavity is scrobiculate (scrobiculae ill defined).

Meconopsis discigera Prain (Plates 155 & 156)

Seeds 0.5-1.0 mm long, reniform, with longitudinal ribbed.

Spermoderm (testa) in lower magnification irregularly rugose (Plate 155); in higher magnification (Plate 156) muri appear to be formed of multistranded fibres—branched and interwoven, lumina sometimes traversed by single stranded fibres.

Meconopsis gracilipes G. Tayl. (Plates 157 & 158)

Seeds 0.5-0.8 mm in diameter, more or less reniform.

Spermoderm (testa) in lower magnification rugose (Plate 157), lumina of the reticula irregular; in higher magnification (Plate 158) it was observed hat the muri are formed of twined fibrous strands (3-4 in number); floor of the lumina undulating.

Meconopsis grandis Prain (Plates 159 & 160)

Seeds 2.0-2.5 mm long, reniform.

Spermoderm (testa) in lower magnification rugose (Plate 159), muri of the reticula arranged regularly in parallel rows to the longitudinal axis of the seed; in higher magnification (Plate 160) muri appear to be formed of longitudinal ribs, ribs branched.

Meconopsis horridula Hook. f. & Thoms. (Plates 161 & 162)

Seeds 0.8 mm long, subreniform.

Spermoderm (testa) in lower magnification rugose (Plate 161), muri of the reticulate bodies arranged irregularly in parallel rows of the longitudinal axis of the seed; in higher magnification (Plate 162) fibres of different dimensions are visible, they are irregularly dispersed; often contain pits of irregular shape; single stranded fibres are also seen which are longitudinally or transversely arranged.

Meconopsis latifolia (Prain) Prain (Plates 163 & 164)

Seeds 1.0-1.5 mm long, subreniform-planoconvex.

Spermoderm (testa) in lower magnification rugose (Plate 163), reticulate bodies arranged in rows; in higher magnification (Plate 164) 1-2 stranded muri encircled the lumina of irregular shape and size.

Meconopsis longipetiolata G. Tayl. ex Hay (Plates 165 & 166)

Seeds 0.8-1.0 mm long, oblong.

Spermoderm (testa) in lower magnification rugose (Plate 165), in higher magnification (Plate 166) numerous, irregular shaped pits of different dimensions are found due to the irregular arrangement of muri; muri again branched and formed secondary reticulations.

Meconopsis lyrata (Cummins & Prain) Fedde ex Prain (Plates 167 & 168)

Seeds 1.5-1.8 mm long, ellipsoid-oblong.

Spermoderm (testa) in lower magnification appear to have parallel ribs in the longitudinal axis of the seed (Plate 167); ribs in higher magnification (Plate 168) are found to be formed of stout rods, beads of wall material dispersed on the lateral side of the ribs; single stranded fine fibres interwoven forming finely reticulate mesh (secondary).

Meconopsis napaulensis DC. (Plates 169 & 170)

Seeds 0.8-1.0 mm long, ovoid-ellipsoid-oblong.

Spermoderm (testa) in lower magnification irregularly rugae (Plate 169), in higher magnification (Plate 170) appear reticulate, muri is formed of stouter fibres; less stout fibres project inside the lumina they often anastomose forming secondary or tertiary reticulations.

Meconopsis paniculata (D. Don) Prain (Plates 171 & 172)

Seeds 1.0-1.2 mm long, subreniform.

Spermoderm (testa) in lower magnification rugose (Plate 171), appearing coralloid; in higher magnification (Plate 172) lumina is ± regular

and the floor of lumina is filled with numerous beads placed on congested and parallely set strands which form muri.

Meconopsis primulina Prain (Plates 173 & 174)

Seeds 1.5-2.0 mm long, subreniform.

Spermoderm (testa) in lower magnification rugose (Plate 173), in higher magnification (Plate 174) reticulate structures prominent, muri formed of one or two stout fibres, floor of lumina contain indistinct scrobiculae.

Meconopsis regia G. Tayl. (Plates 175 & 176)

Seeds 0.8-1.0 mm in diameter, + rounded.

Spermoderm (testa) in lower magnification rugose wrinkled (Plate 175), in higher magnification (Plate 176) irregular muri are visible enclosing irregular shaped lumina with amorphous floor.

Meconopsis robusta Hook. f. & Thoms. (Plates 177 & 178)

Seeds 1.0-1.2 mm in diameter, subreniform.

Spermoderm (testa) in lower magnification rugose (Plate 177), in higher magnification (Plate 178) irregular muri are visible enclosing irregular shaped lumina with amorphous floor.

Meconopsis simplicifolia (D. Don) Walp. (Plates 179 & 180)

Seeds *ca.* 3 mm long, ovoid-ellipsoid.

Spermoderm (testa) in lower magnification rugose (Plate 179) of foliose coralloid appearance; in higher magnification (Plate 180) flatly elevated muri of thinner strands enclosing lumina of irregular shaped.

Meconopsis sinuata Prain (Plates 181 & 182)

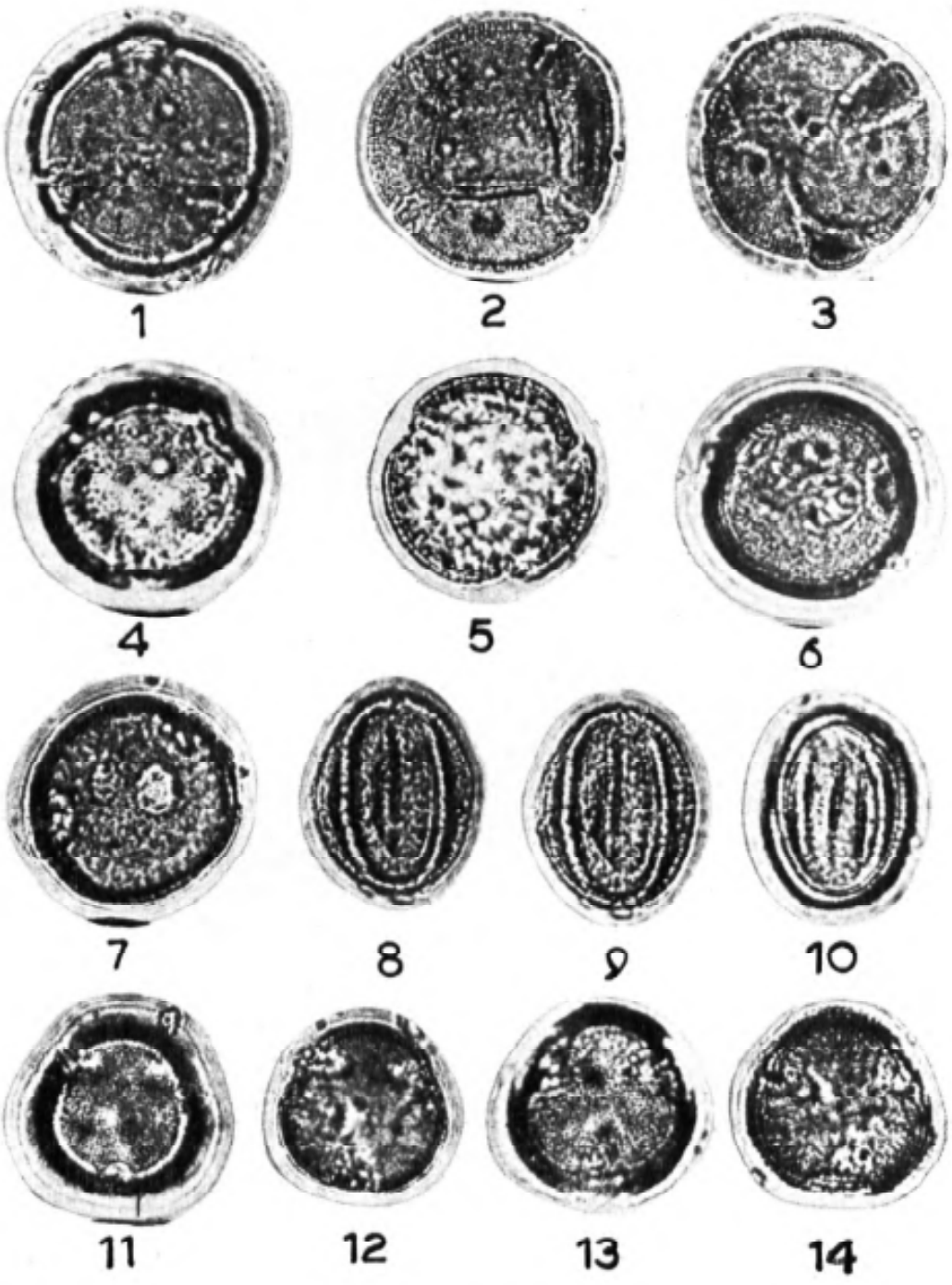
Seeds 1.5-2.0 mm long, falcate-oblong.

Spermodrm (testa) in lower magnification rugose (Plate 181), reticulate bodies ± parallel in long axis of the seed; in higher magnification (Plate 182) lumina are seen to be surrounded by thick fibres, lumina floor contain irregular structure with dispersed beads.

Papaver decaisnei Hochst. & Steud. ex Boiss. (Plates 183 & 184)

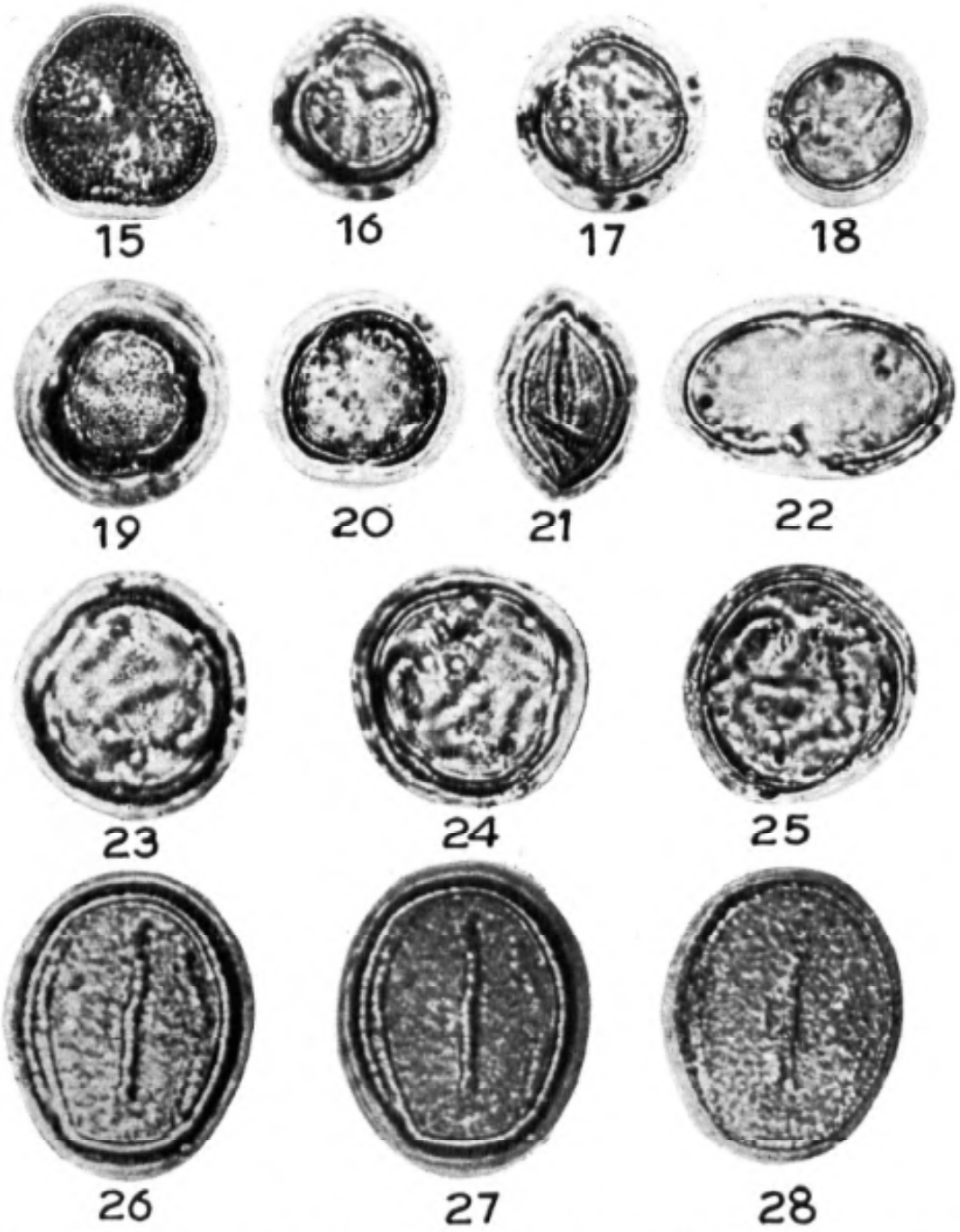
Seeds *ca.* 0.8 mm in diameter, kidney shaped, suborbicular.

Spermoderm (testa) in lower magnification reticulate (Plate 183); in higher magnification (Plate 184) elevated muri with wavy outline are seen to enclose the lumina, each lumina usually incorporate one or two beads.

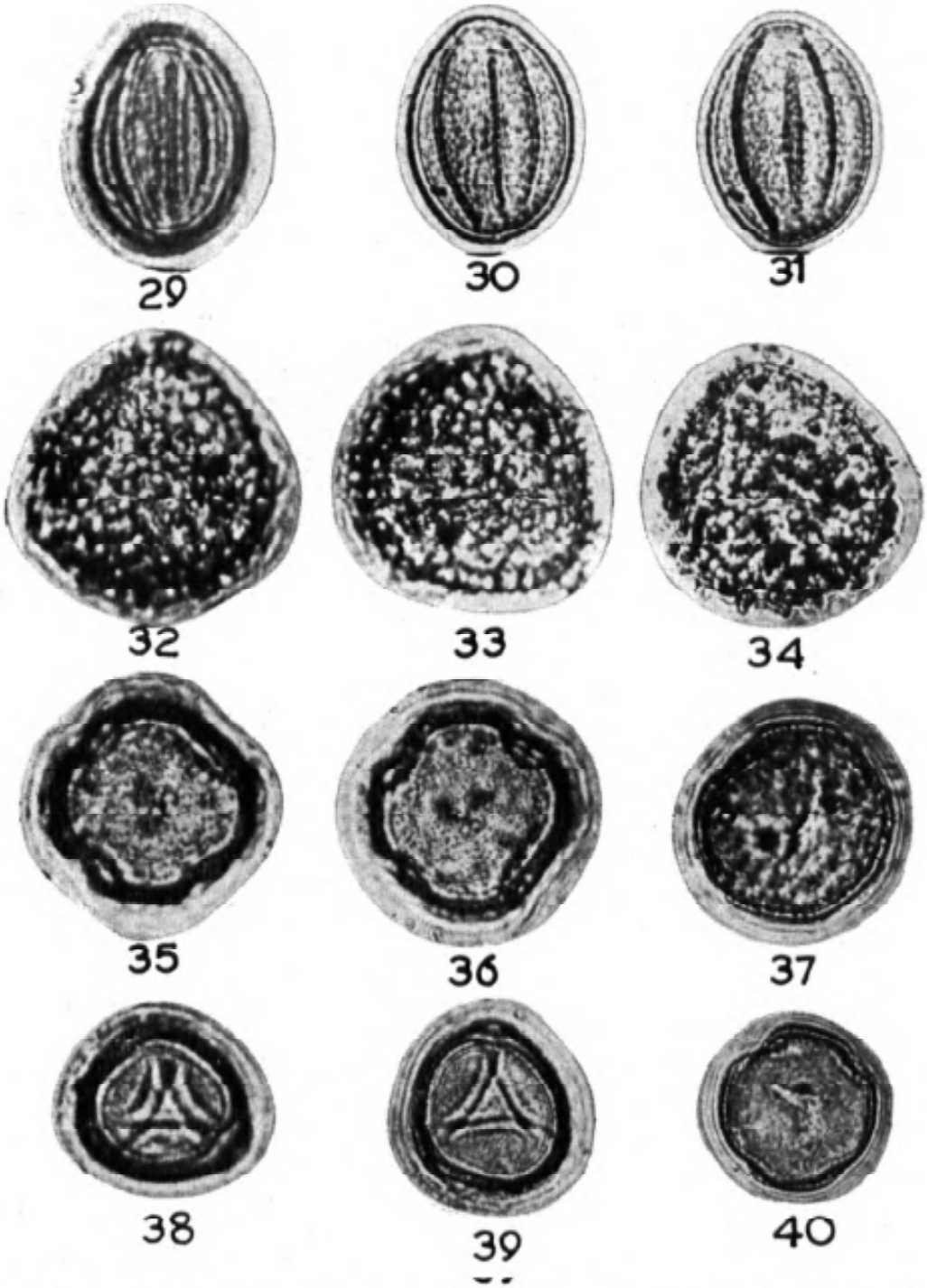


Plates 1-14. Pollen grains (LM) × 1000.—Plates 1-3. *Argemone ochroleuca*.—1: striato-reticulate pattern.—2: optical section of the exine.—3: protruding colpi.—Plates 4 & 5. *Dicranostigma lactucoides*.—4: reticulate-reticuloid surface pattern.—5: optical section of the exine.—Plates 6 & 7. *Eomecon chionantha*.—6: surface pattern in polar view.—7: circular pores.—Plates 8-10. *Eschscholtzia californica*.—8: surface pattern in equatorial view.—9: optical section of the exine.—10: colpi.—Plates 11 & 12. *Glaucium elegans*.—11: reticulate surface pattern.—12: spinules & colpi ornamentation.—Plates 13 & 14. *G. fimbrilligerum*.—13: reticulate surface pattern.—14: colpi ornamentation.

Plates 15-28.

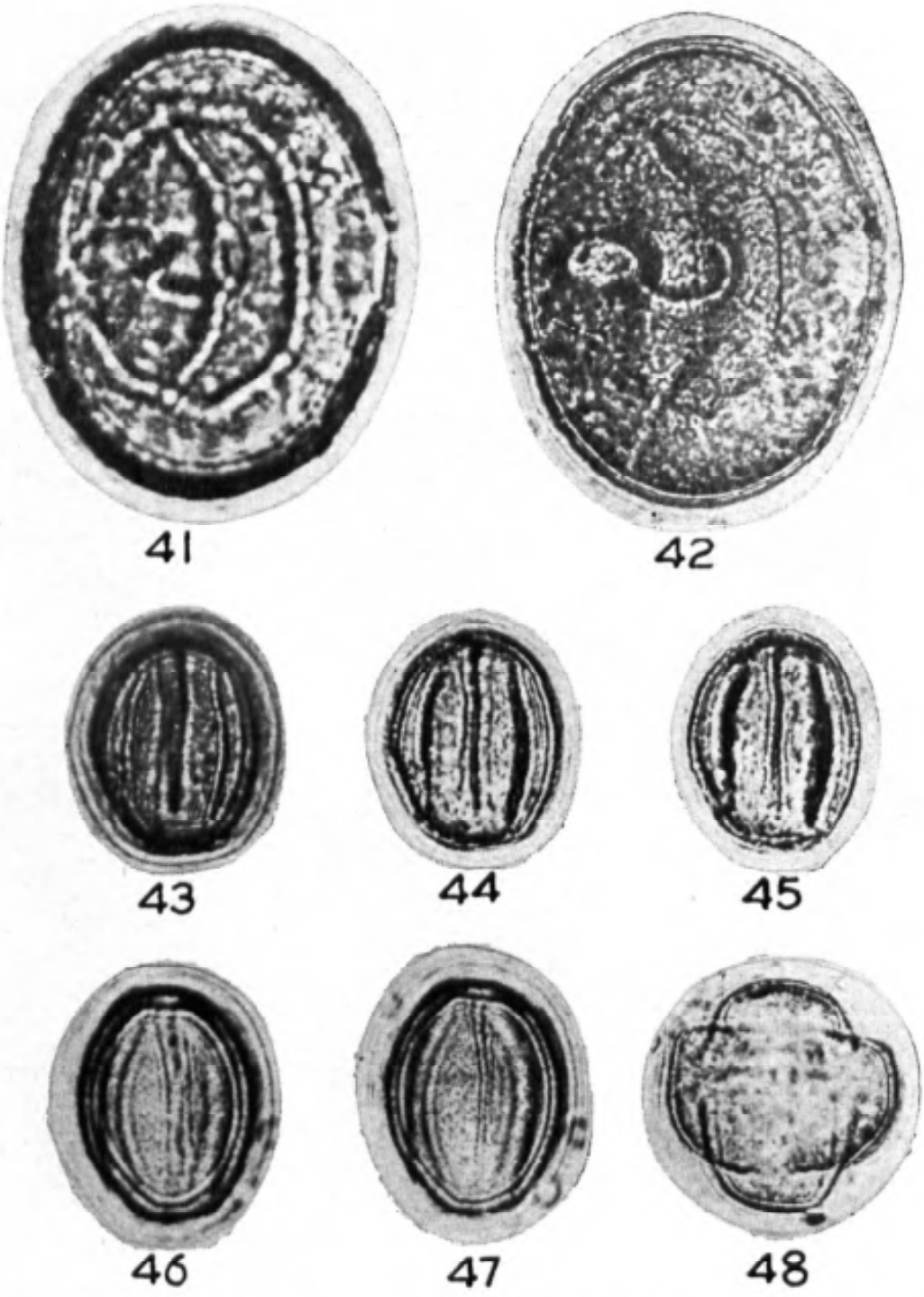


Plates 15-28. Pollen grains (LM) × 1000.—Plate 15. *Glaucium fimbrilligerum*.—spinules.—Plates 16-18. *Hypecoum leptocarpum*.—16: striato-reticulate pattern.—17: surface pattern in second focus.—18: colpi.—Plates 19-21. *H. pendulum* var. *parviflorum*.—19: striato-reticulate pattern.—20: surface pattern in second focus.—21: colpi.—Plates 22-25. *H. pendulum* var. *pendulum*.—22: bicolpate nature.—23: striato-reticulate pattern.—24: surface pattern in second focus.—25: optical section of the exine.—Plates 26-28. *Meconopsis aculeata*.—26: negatively reticulate pattern.—27: surface pattern in second focus.—28: optical section of the exine.

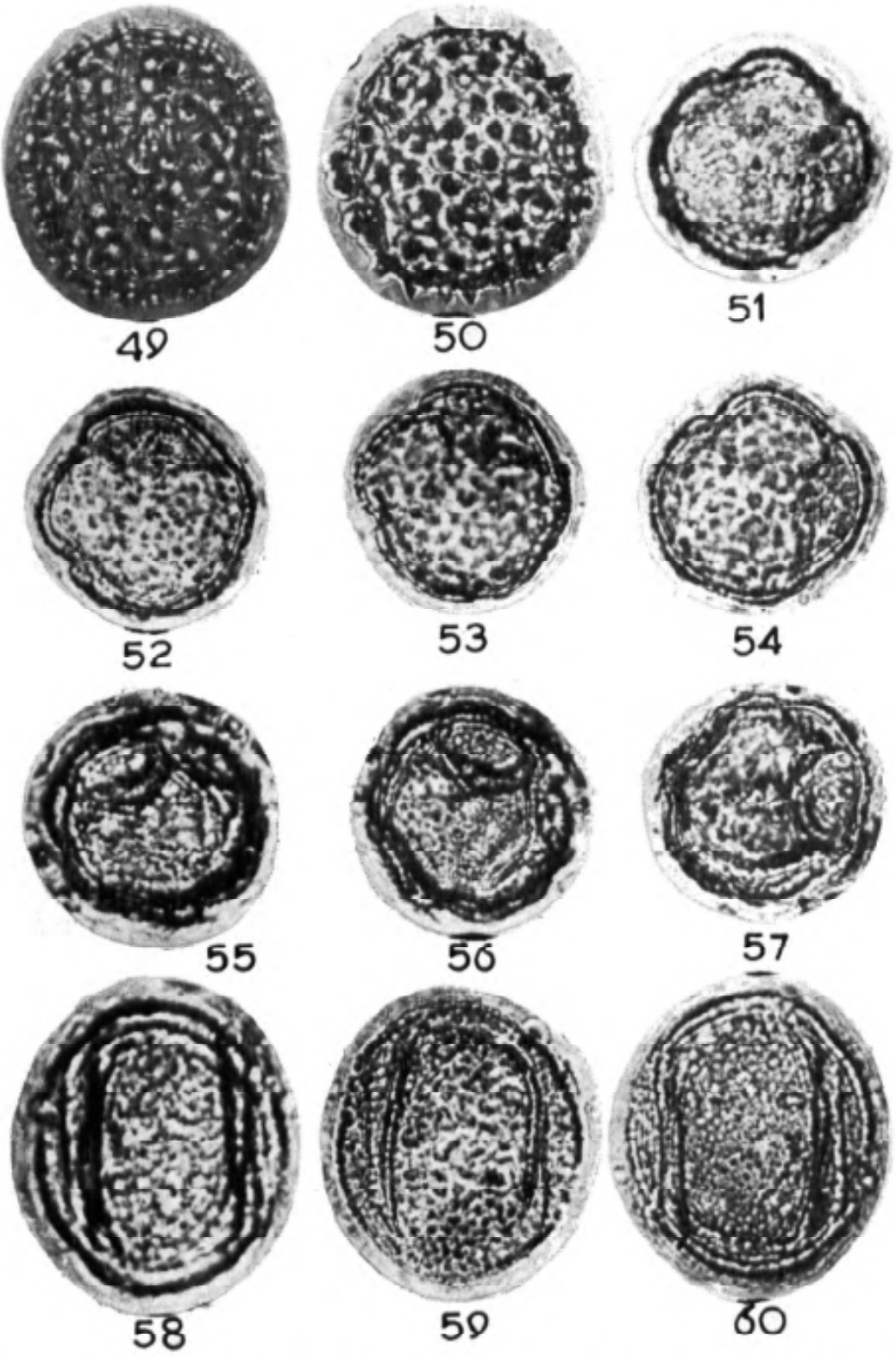


Plates 29-40. Pollen grains (LM) × 1000.—Plates 29-31. *Meconopsis bella*.—29: wart like processes on the surface.—30: ± striate surface pattern.—31: optical section of the exine.—Plates 32-34.—*M. betonicifolia*.—32: spinules in circular rows.—33: striate surface pattern.—34: spines and spinules.—Plates 35-37. *M. dhwojii*.—35: negatively reticulate surface pattern.—36: negatively reticulate surface pattern in lower focus.—37: pentacolpate nature in polar view.—Plates 38-40. *M. gracilipes*.—38: parasyncolpate nature in polar view.—39: surface pattern in second focus.—40: optical section of the exine.

Plates 41-48.

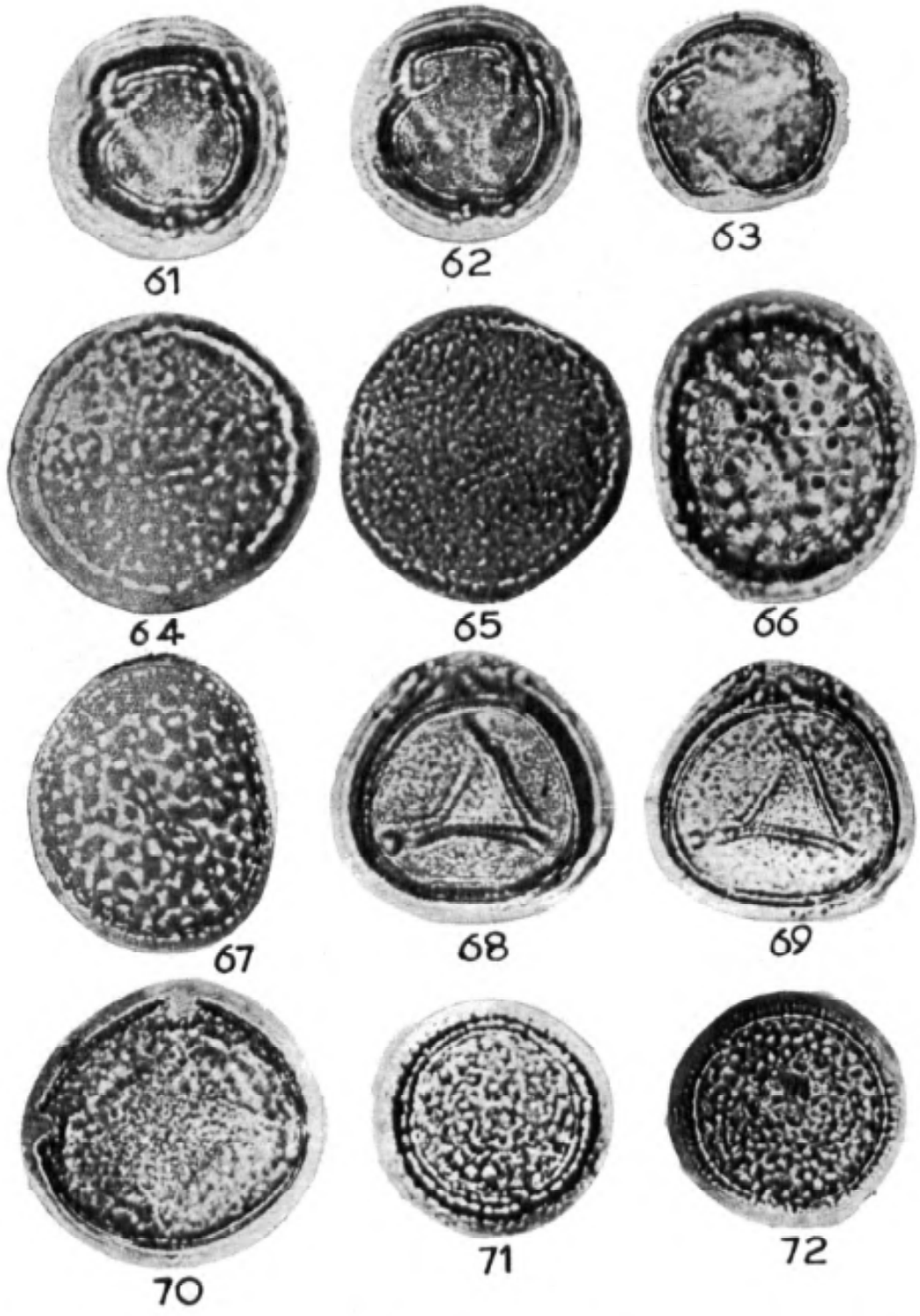


Plates 41-48. Pollen grains (LM) × 1000.—Plates 41 & 42. *Meconopsis discigera*.—41: reticulate surface pattern.—42: spines in optical section.—Plates 43-45. *M. horridula*.—43: striate surface pattern.—44: surface pattern in second focus.—45: optical section of the exine.—Plates 46-48. *M. latifolia*.—46: surface pattern in equatorial view.—47: striato-reticulate surface pattern.—48: optical section.

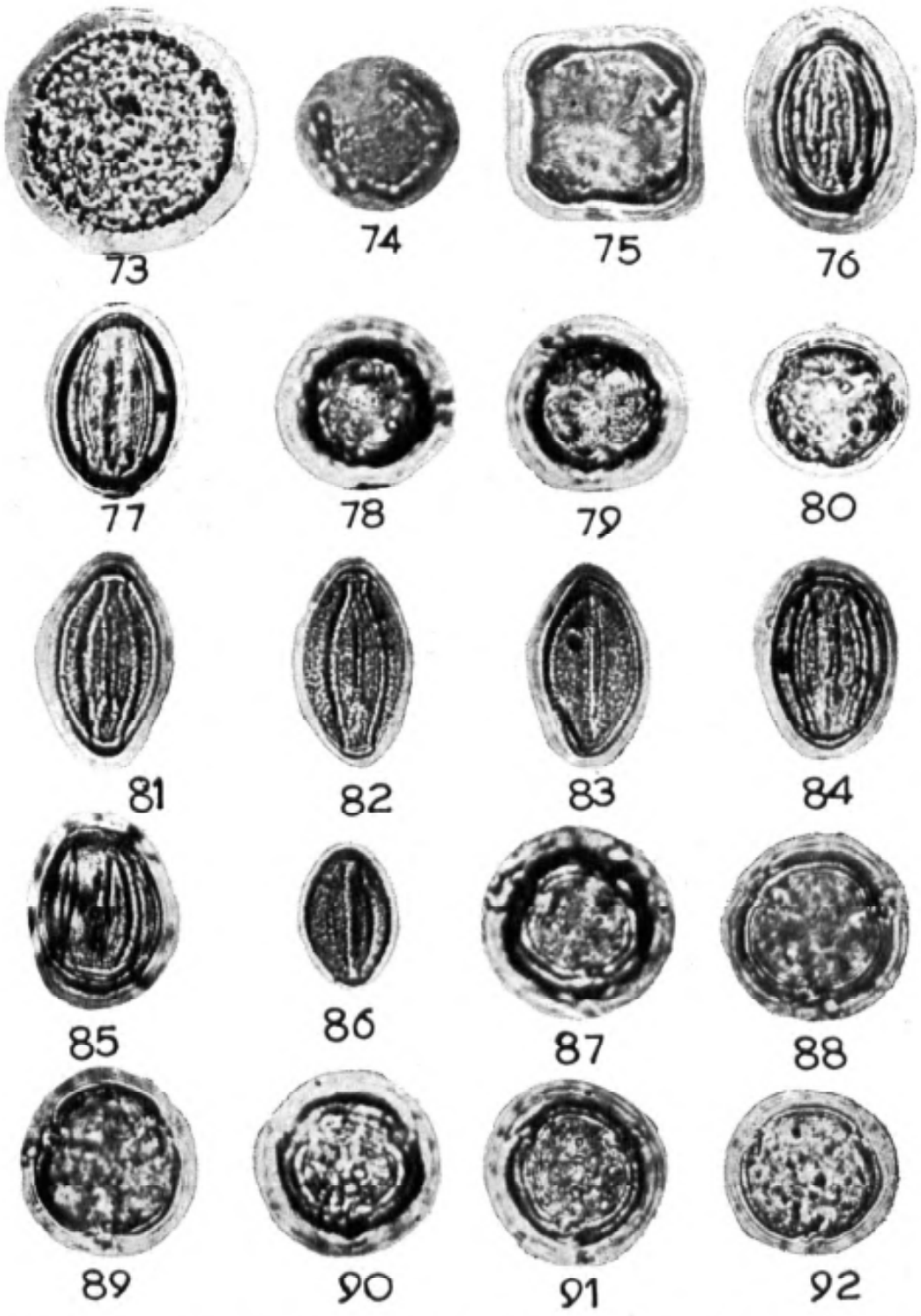


Plates 49-60. Pollen grains (LM) × 1000.—Plates 49 & 50. *Meconopsis integrifolia*.—49: inaperturate.—50: different types of spines.—Plates 51-54. *M. paniculata*.—51: verrucae.—52: verrucae in rows.—53: optical section of the exine.—54: striato-reticulate surface pattern.—Plates 55-57. *M. longipetiolata*.—55: processes on the surface.—56: spinules.—57: optical section.—Plates 58-60: *M. napaulensis*.—58: verrucae-spinules.—59: reticulate surface pattern.—60: optical section.

Plates 61-72.

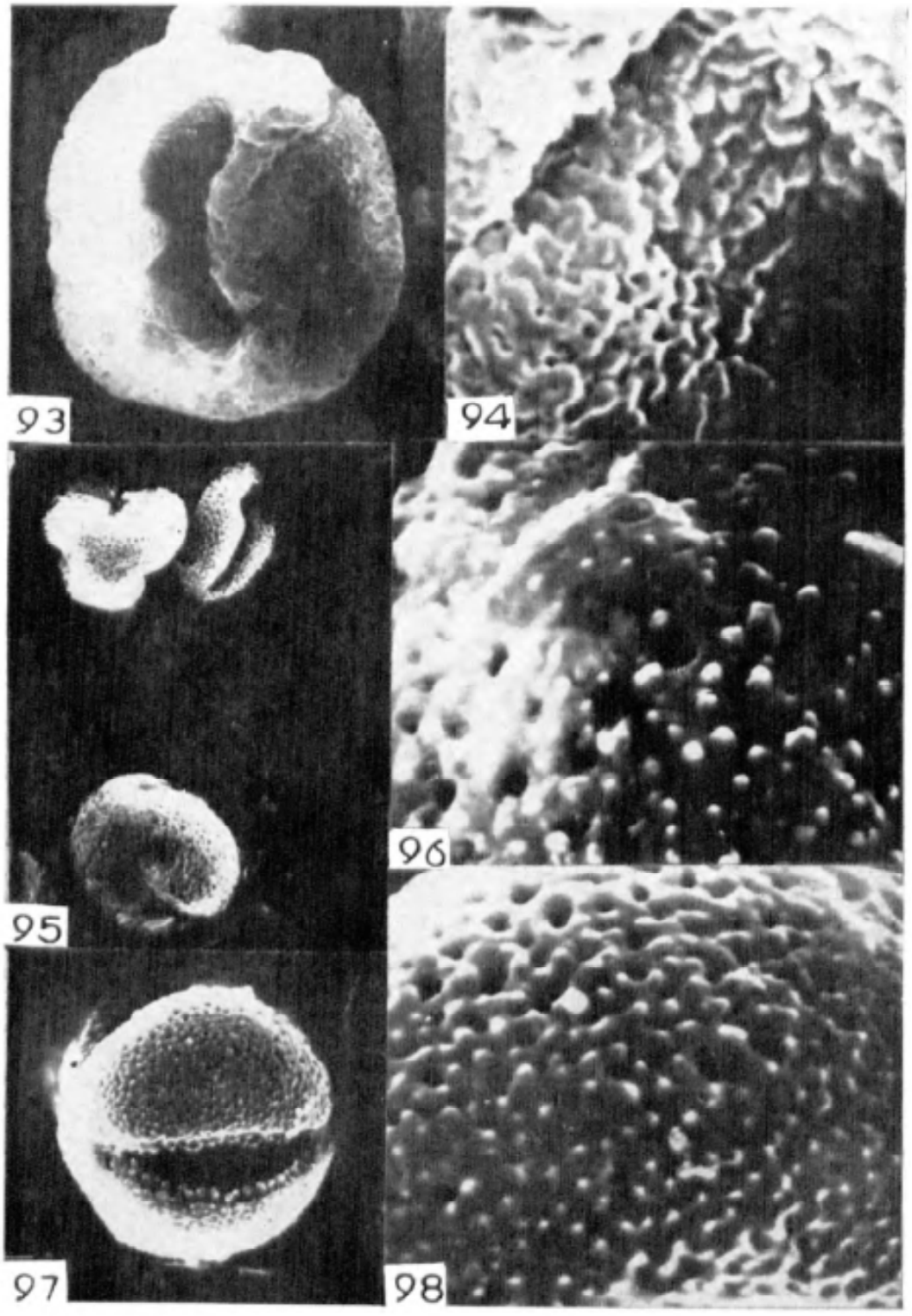


Plates 61-72. Pollen grains (LM) × 1000.—Plates 61-63. *Meconopsis primulina*.—61: striato-reticulate surface pattern.—62: spinules.—63: optical section.—Plates 64 & 65. *M. robusta*.—64: fine reticuloid surface pattern.—65: optical section.—Plates 66 & 67. *M. simplicifolia*.—66: striato-reticulate surface pattern.—67: optical section.—Plates 68-70. *M. sinuata*.—68: reticulate surface pattern.—69: processes.—70: tetracolpate nature.—Plates 71 & 72. *M. villosa*.—71: spines.—72: base of the spines encircled by rings.

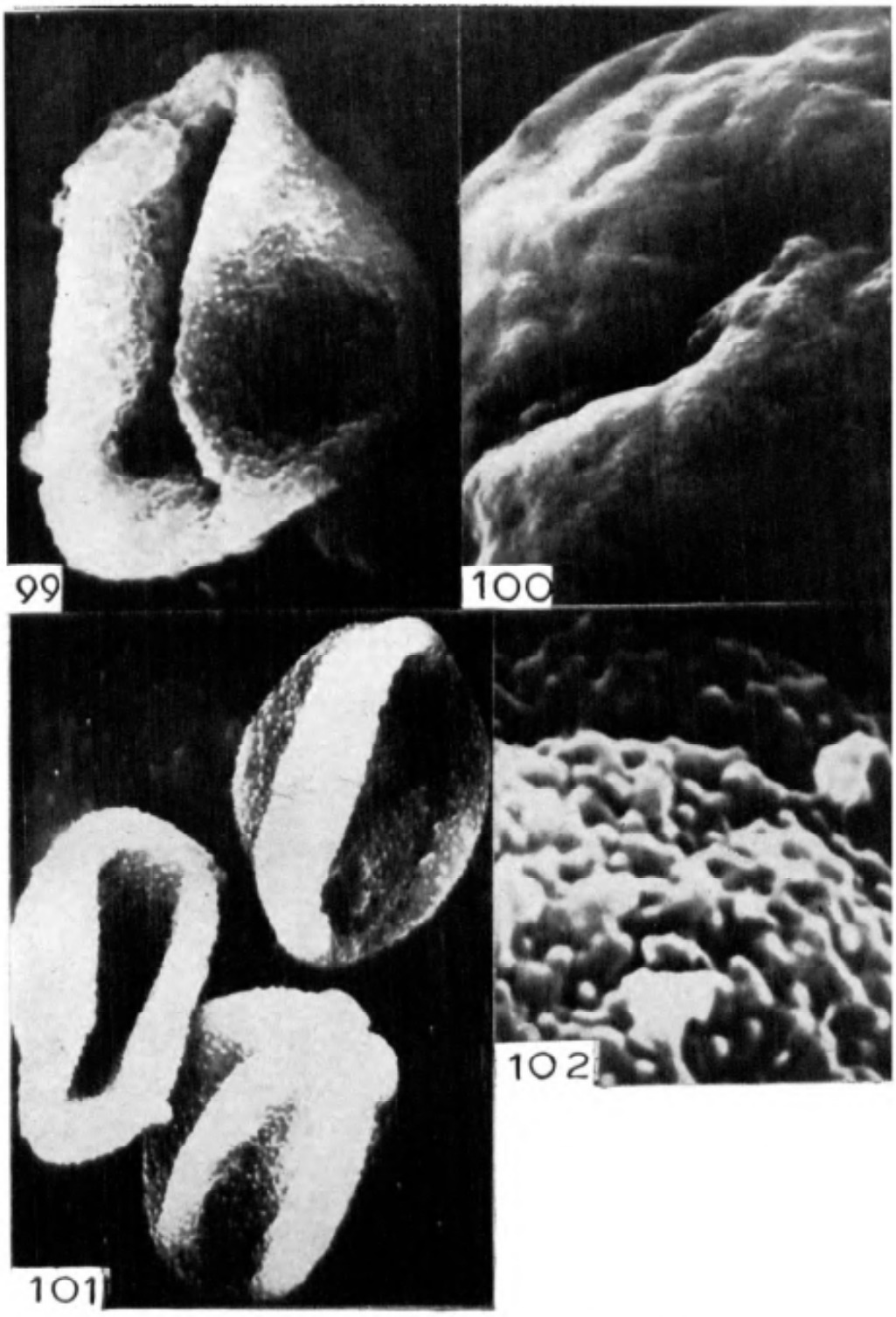


Plates 73-92. Pollen grains (LM) ×1000.—73. *Meconopsis villosa*.—optical section.—74 & 75. *Papaver decaisnei*.—74: reticulation to striato-reticulation—75: A ± square pollen. —76 &77. *P. dubium*.—76: striation.—77: optical section.—78-80. *P. hybridum*.—78: surface in 1st focus.—79: striato-reticulation.—80: optical section.—81-83. *P. macrostomum*.—81: striation.—82: negatively reticulation.—83: optical section.—84 & 85. *P. pavonium*.—84: striations.—85. optical section.—86. *P. rhoeas*.—spines.—87-89. *P. somniferum*.—87: striation.—88: reticulation.—89: optical section.—90-92. *Roemeria refracta*.—90: striation.—91: reticulation.—92: optical section.

Plates 93-98.

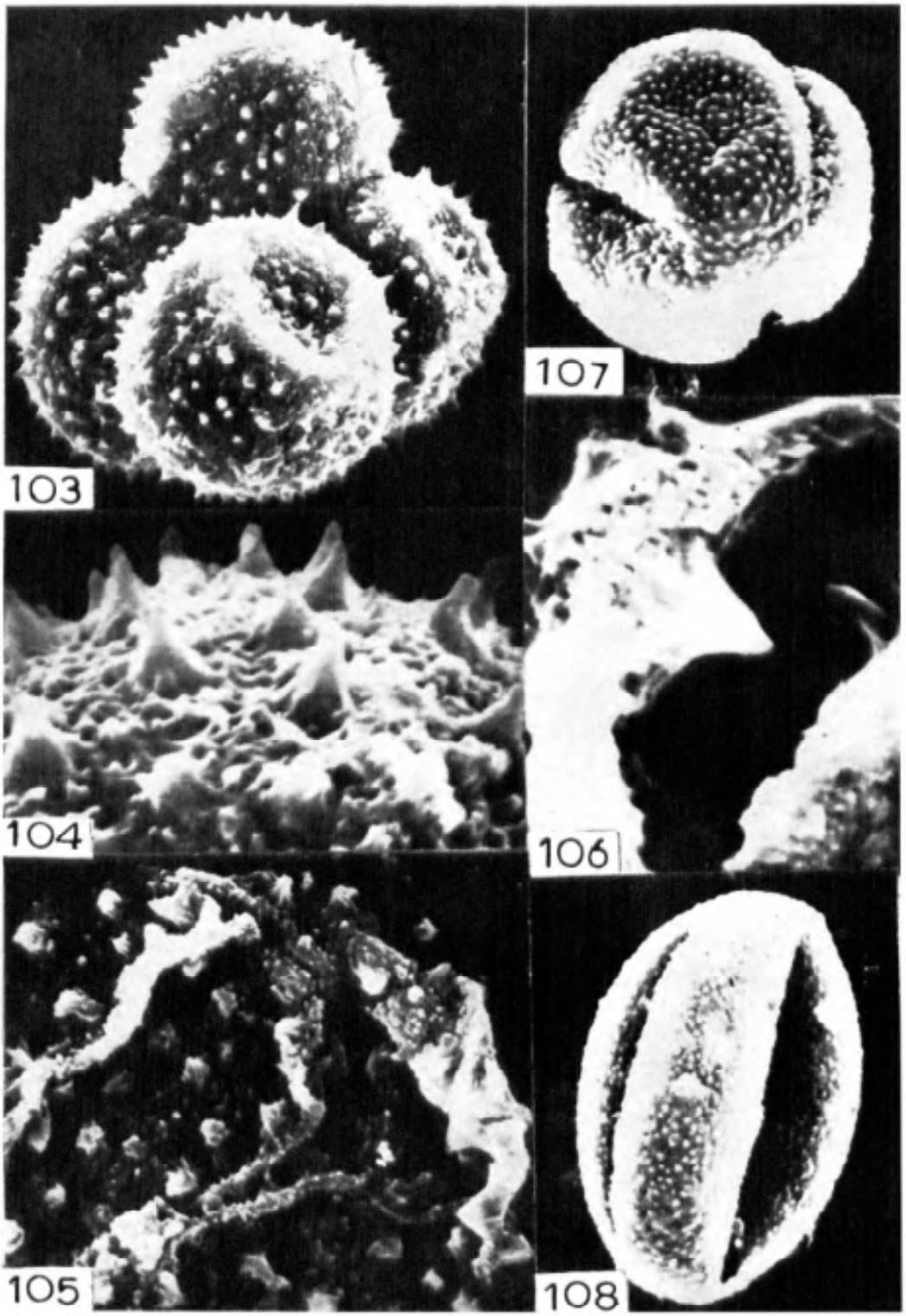


Plates 93-98. Pollen grains (SEM).—Plates 93 & 94. *Argemone ochroleuca*.—93: a pollen showing reticulations. 11,000.—94: part of the surface showing perforations. 45,000.—Plates 95 & 96. *Dicranostigma lactucoides*.—95: a pollen showing perforations. 5500.—96: part of the perforated surface showing wart like processes. - 40,000. - Plates 97 & 98. *Glaucium elegans*.—97: a pollen showing coarser pattern in the aperture. 10,000.—98: part of the perforated surface with spinules. 40,000.

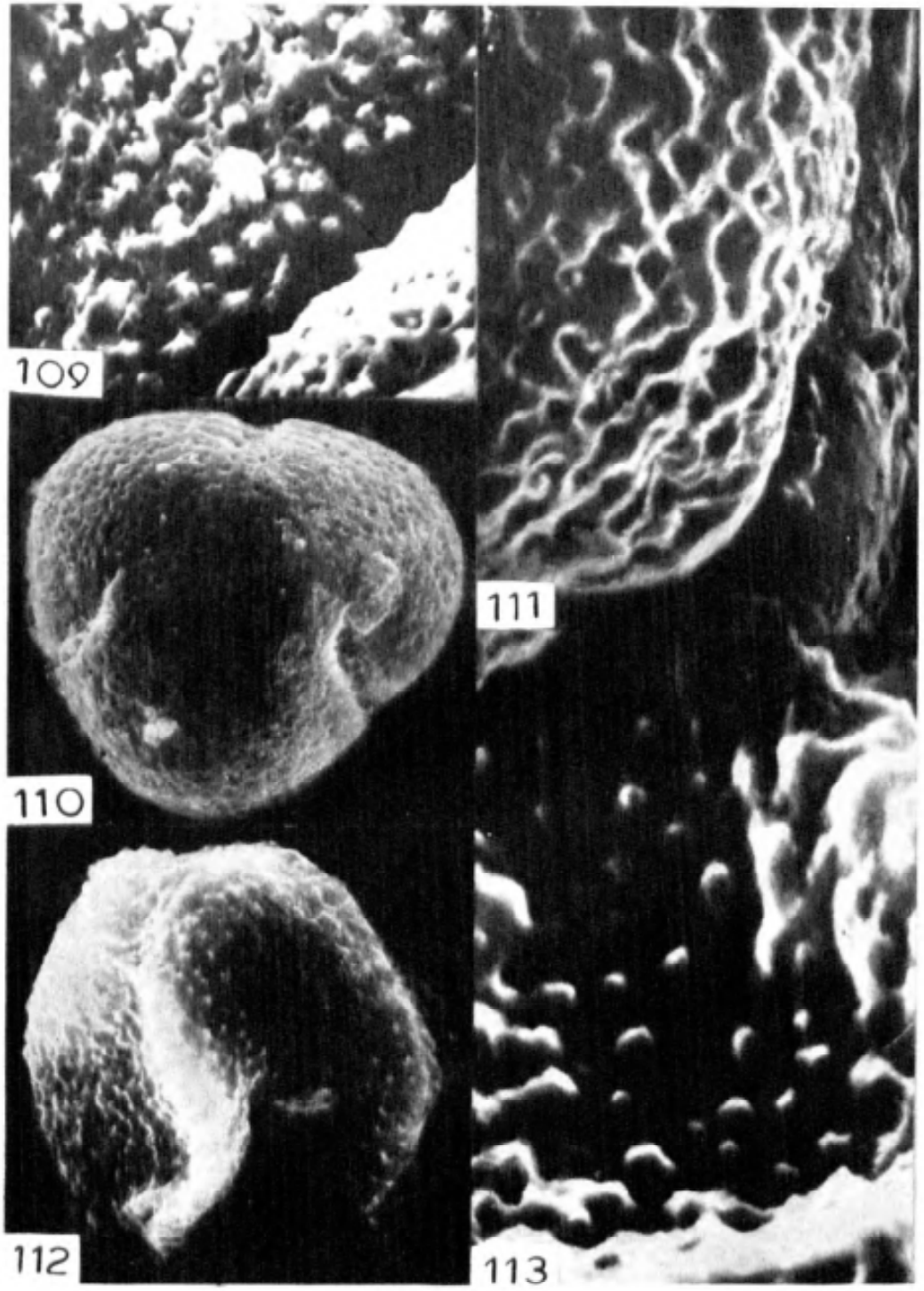


Plates 99-102. Pollen grains (SEM). –Plate 99. *Hypecoum leptocarpum*. a pollen showing processes on the surface. 19,000. Plate 100. *H. pendulum* var. *parviflorum*. surface part showing spinules. 21,500. Plates 101 & 102. *Eschscholtzia californica*. - 101: a pollen showing reticulations. - 10,250.– 102: surface part showing processes. - 54,000.

Plates 103-108.

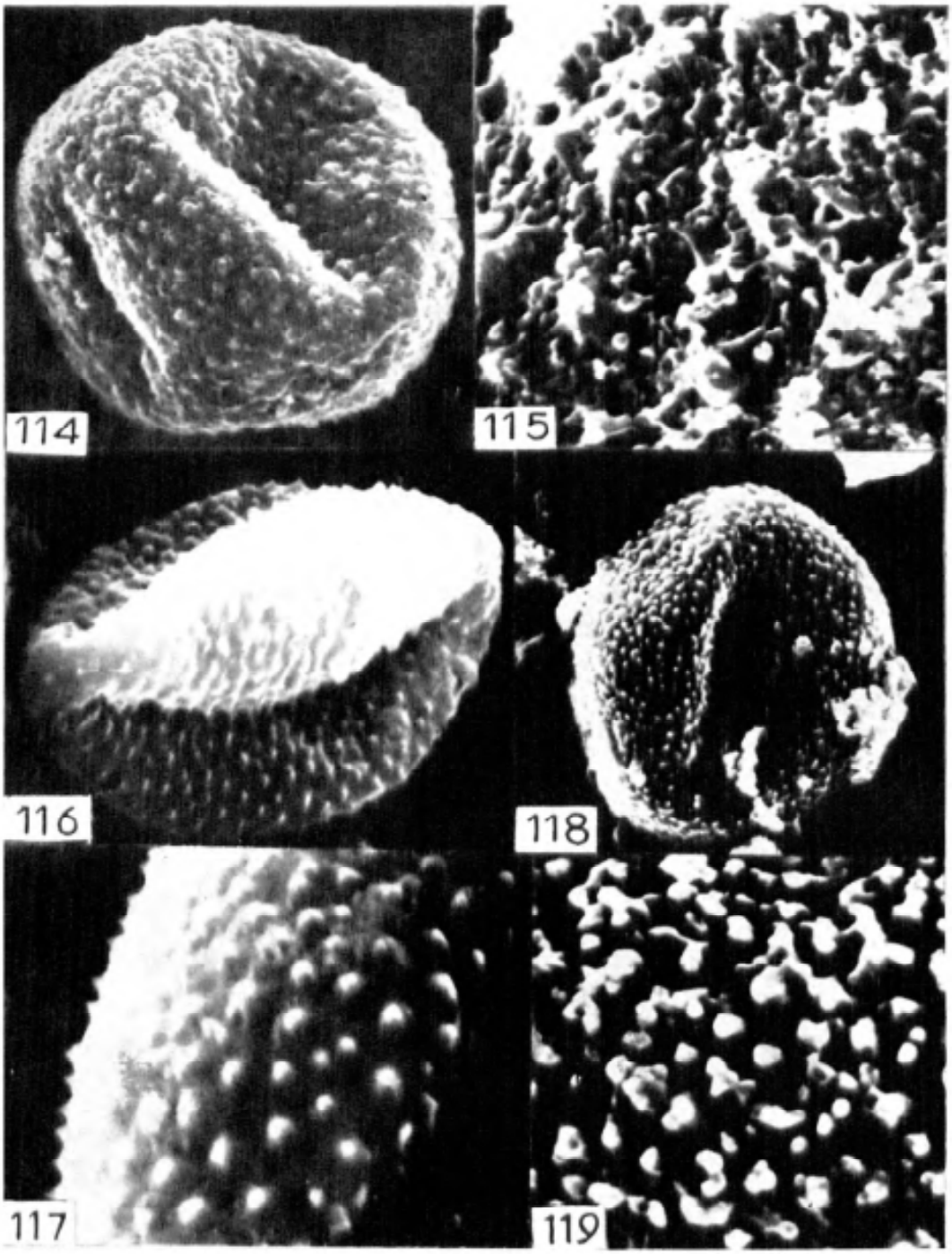


Plates 103-108. Pollen grains (SEM).—Plates 103 & 104. *Meconopsis grandis*.—103: tetrad pollen showing spines. 5,300.—104: surface part showing puncta. 20,000.—Plates 105 & 106. *M. integrifolia*.—105: a pollen showing spines and fine perforations on the surface. 10,750.—106: part of the surface showing spines. 38,000.—Plate 107. *M. horridula*.—tricolpate pollen showing supratectal processes. 10,750.—Plate 108. *M. latifolia*.—pollen showing processes on the surface. 10,750.

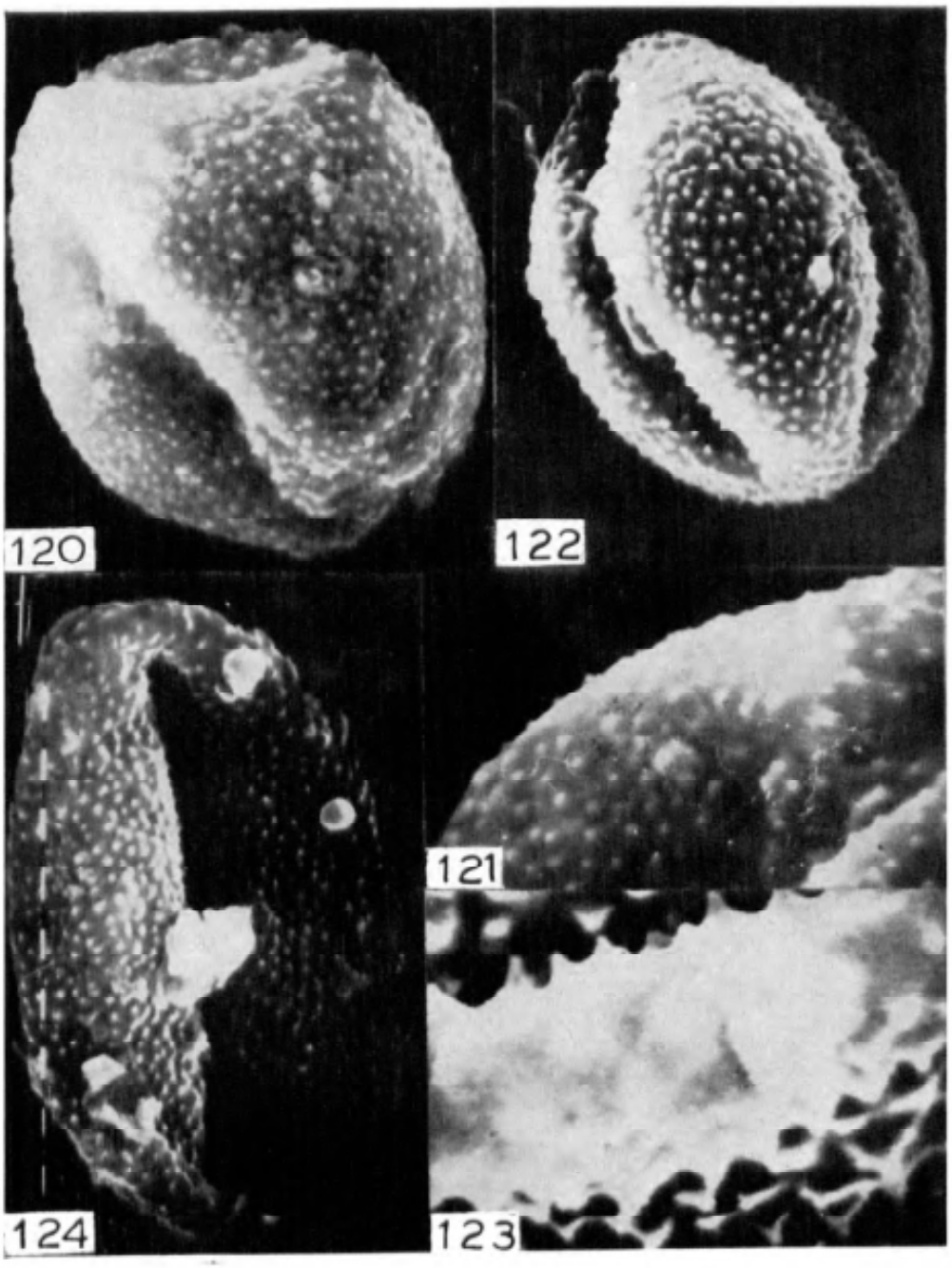


Plates 109-113. Pollen grains (SEM). Plate 109. *Meconopsis latifolia*.– a pollen showing perforations. 39,000.—Plates 110 & 111. *M. longipetiolata*.–110: tricolpate pollen showing spinules on the surface. ×10,750.—111: surface part showing lumina, ×46,000.–Plates 112 & 113. *M. napaulensis*.—112: a pollen showing verrucae. 11,250.—113: surface part showing spines with broad base. 40,000.

Plates 114-119.

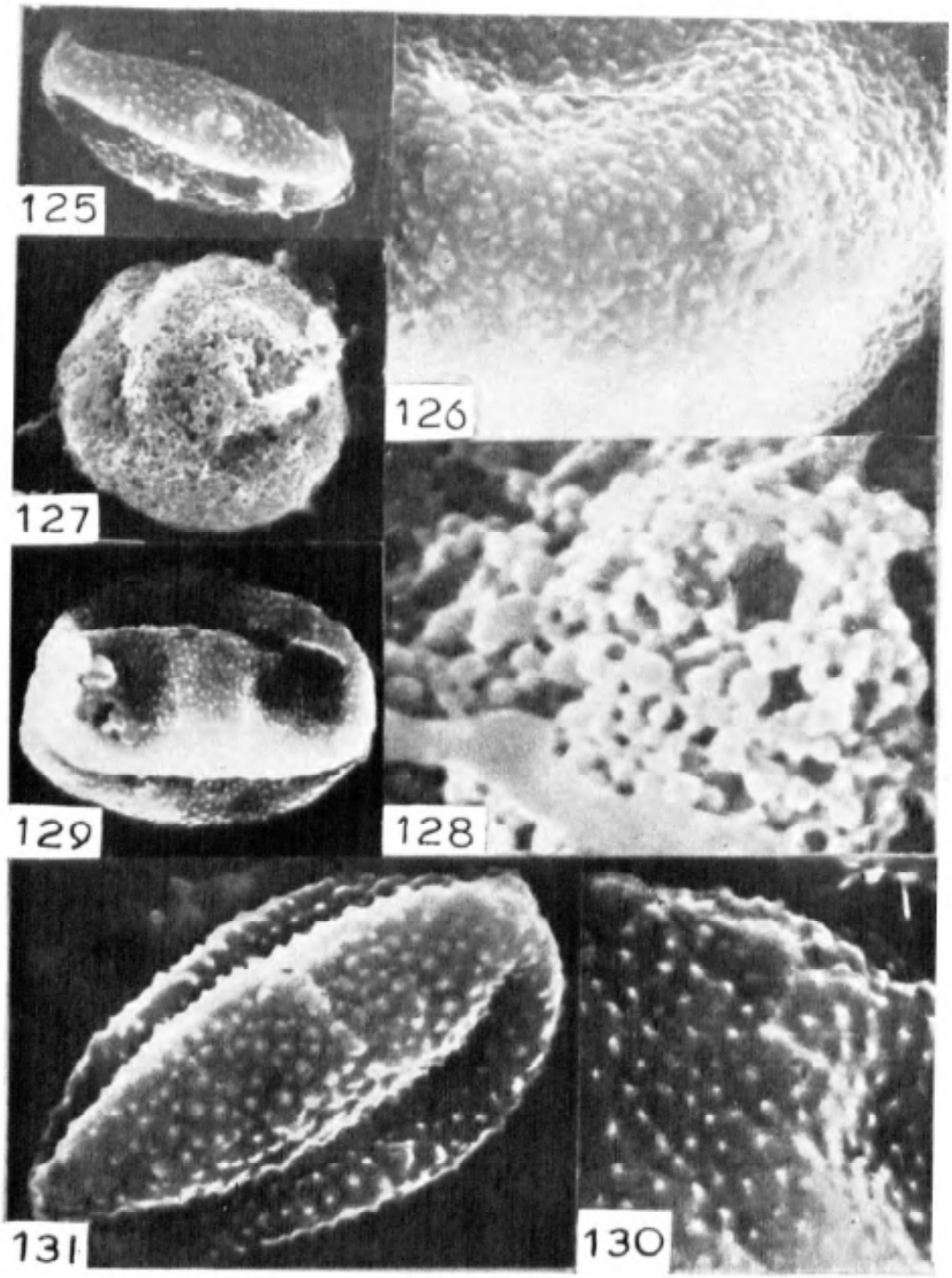


Plates 114-119. Pollen grains (SEM). Plates 114 & 115. *Meconopsis paniculata*. 114: a pollen showing processes on the surface. 10,000.—115: part of the surface showing perforations. 36,000.—Plates 116 & 117. *M. primulina*.—116: pollen showing spinules. 21,500.—117: surface part showing spinules. 35,000.—Plates 118 & 119. *M. sinuata*. 118: pollen showing processes on the surface. 6,000. 119: surface part showing perforations. 37,500.



Plates 120-124. Pollen grains (SEM).—Plates 120 & 121. *Papaver decaisnei*.- 120: pollen showing processes. - 20,000.- 121: part of the surface showing spinules. 38,000.—Plates 122 & 123. *P. dubium*.- 122: a tricolpate grain. 24,500.- 123: surface part showing spines and spinules. 84,000. Plate 124. *P. hybridum*.—a pollen showing supratectal processes. - 22,000.

Plates 125-131.



Plates 125-131. Pollen grains (SEM).—Plates 125 & 126. *Papaver macrostomum*.—125: a pollen showing processes. × 10,500.—126: surface part showing spines and spinules. × 84,000.—Plates 127 & 128. *P. somniferum*.—127: a pollen showing perforations. × 9,000.—128: surface part showing lumina of different dimensions. × 84,000.—Plates 129 & 130. *P. pavonium*.—129: a pollen showing processes. × 13,750.—130: part of the surface showing spinules. × 36,000.—Plate 131. *P. rhoeas*—pollen showing spines. × 25,000.

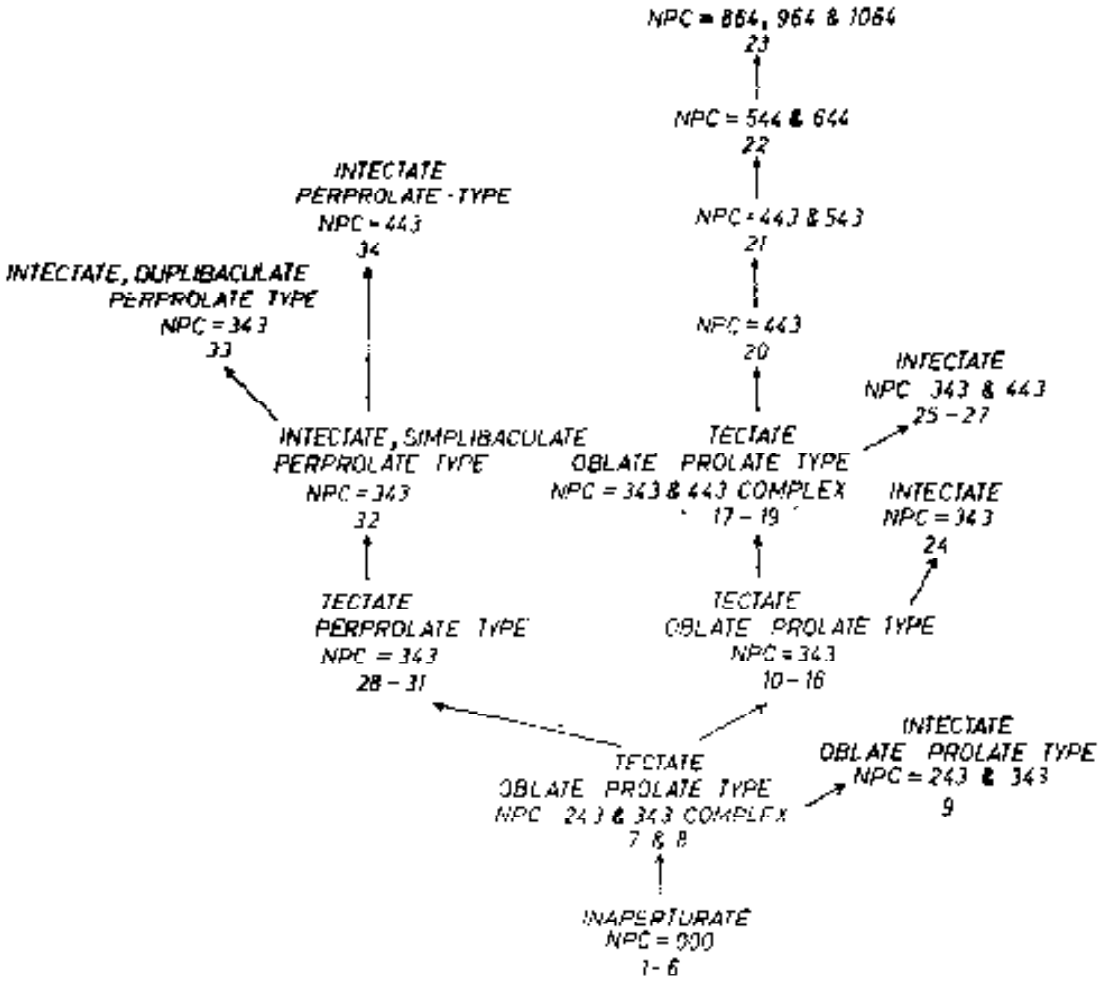
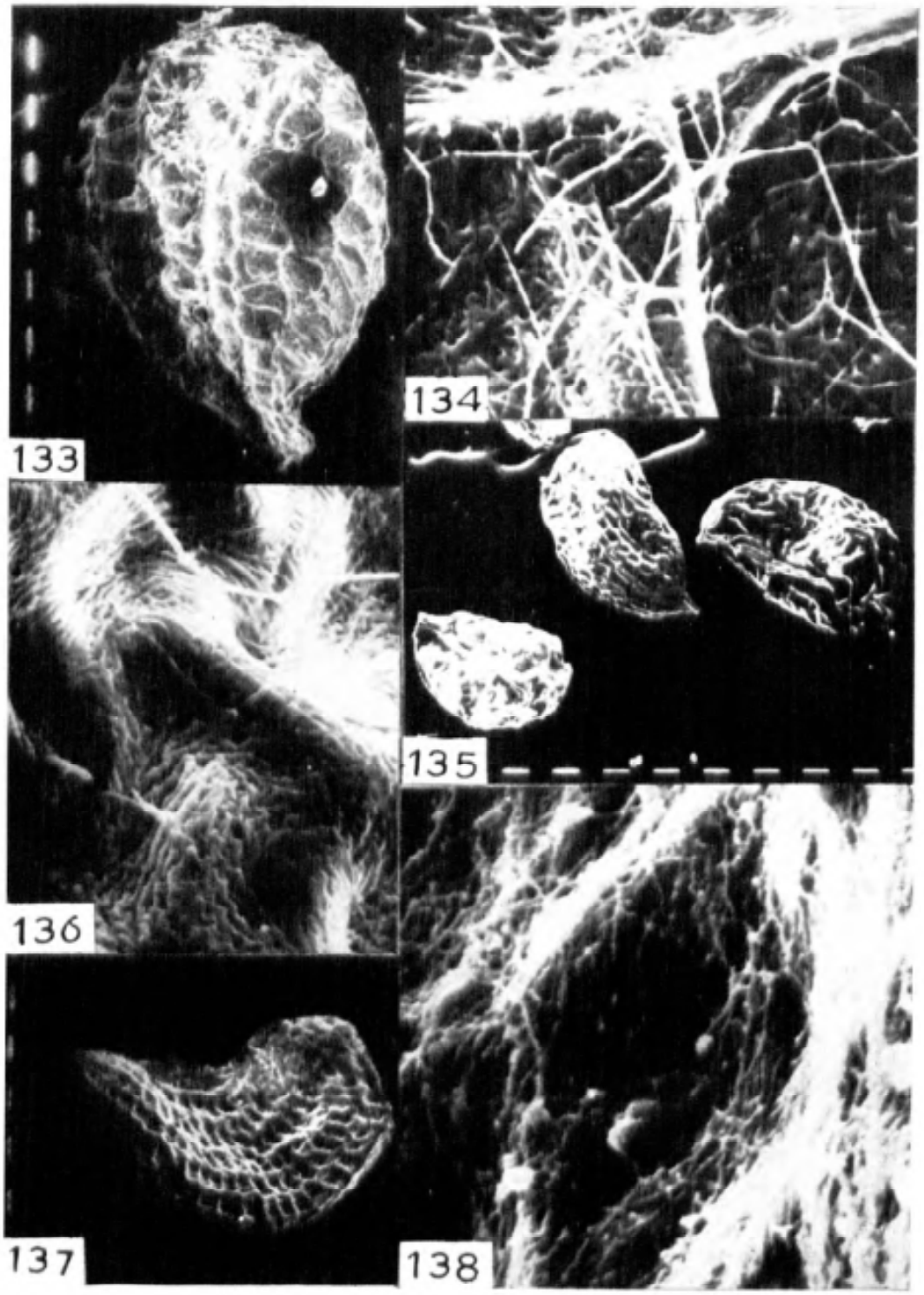
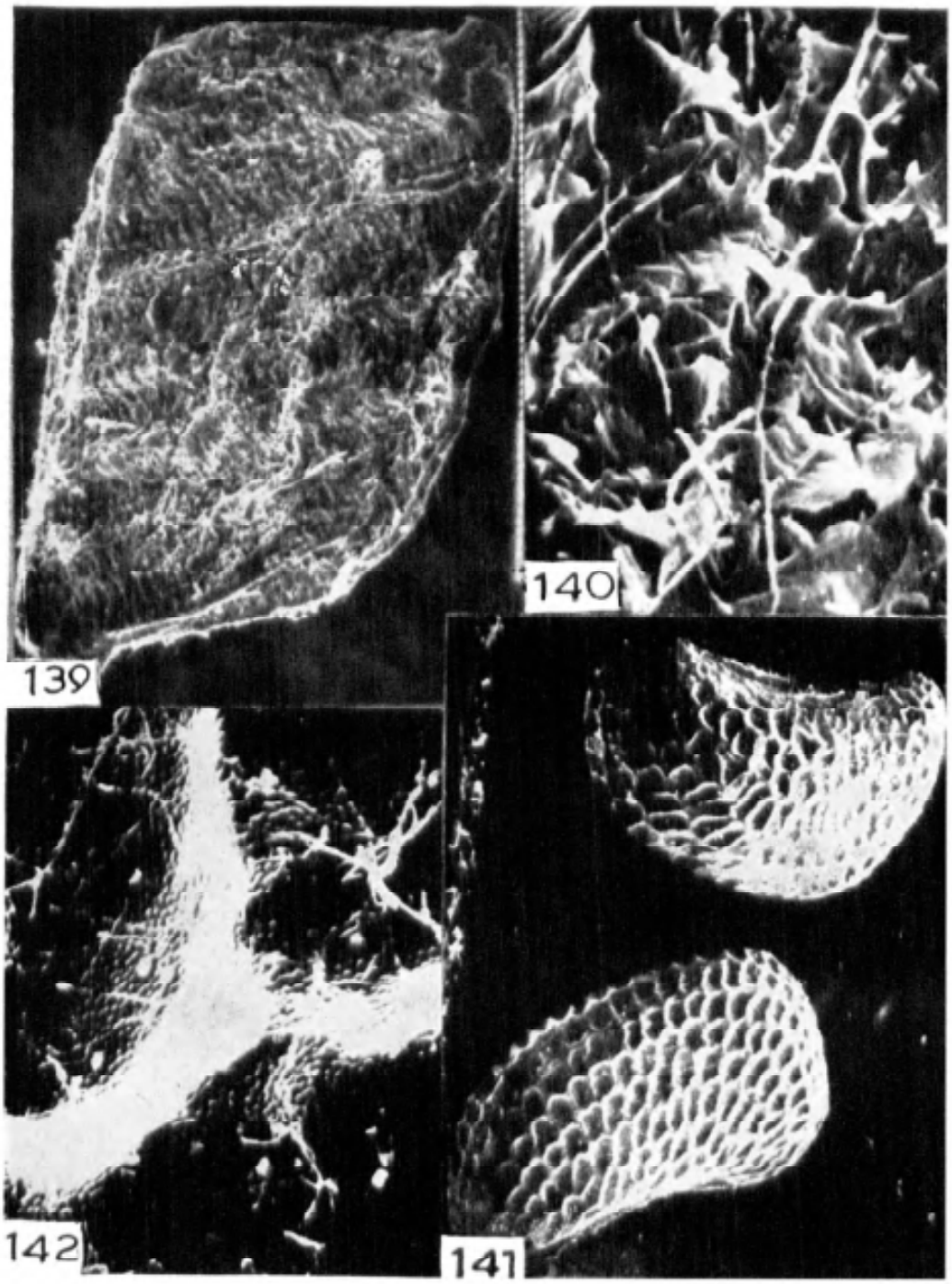


Plate 132. A phylogenetic tree constructed on the basis of pollen morphology. Numbers indicated below each group are the names of different species which are used as examples: 1. *Meconopsis betonicifolia*, 2. *M. grandis*, 3. *M. integrifolia*, 4. *M. napaulensis*, 5. *M. simplicifolia*, 6. *M. robusta*, 7. *Hypecoum leptocarpum*, 8. *H. pendulum*, 9. *H. pendulum* var. *parviflorum*, 10. *Meconopsis aculeata*, 11. *M. bella*, 12. *M. horridula*, 13. *M. longipetiolata*, 14. *M. primulina*, 15. *M. villosa*, 16. *Glaucium elegans*, 17. *Meconopsis gracilipes*, 18. *M. latifolia*, 19. *M. sinuata*, 20. *M. paniculata*, 21. *M. dhwojii*, 22. *M. discigera*, 23. *Eomecon chionantha*, 24. *Dicranostigma lactucoides*, 25. *Argemone ochroleuca*, 26. *Eschscholtzia californica*, 27. *Roemeria refracta*, 28. *Papaver dubium*, 29. *P. hybridum*, 30. *P. macrostomum*, 31. *P. rhoeas*, 32. *P. pavonium*, 33. *P. somniferum*, 34. *P. decaisnei*.

Plates 133-138.

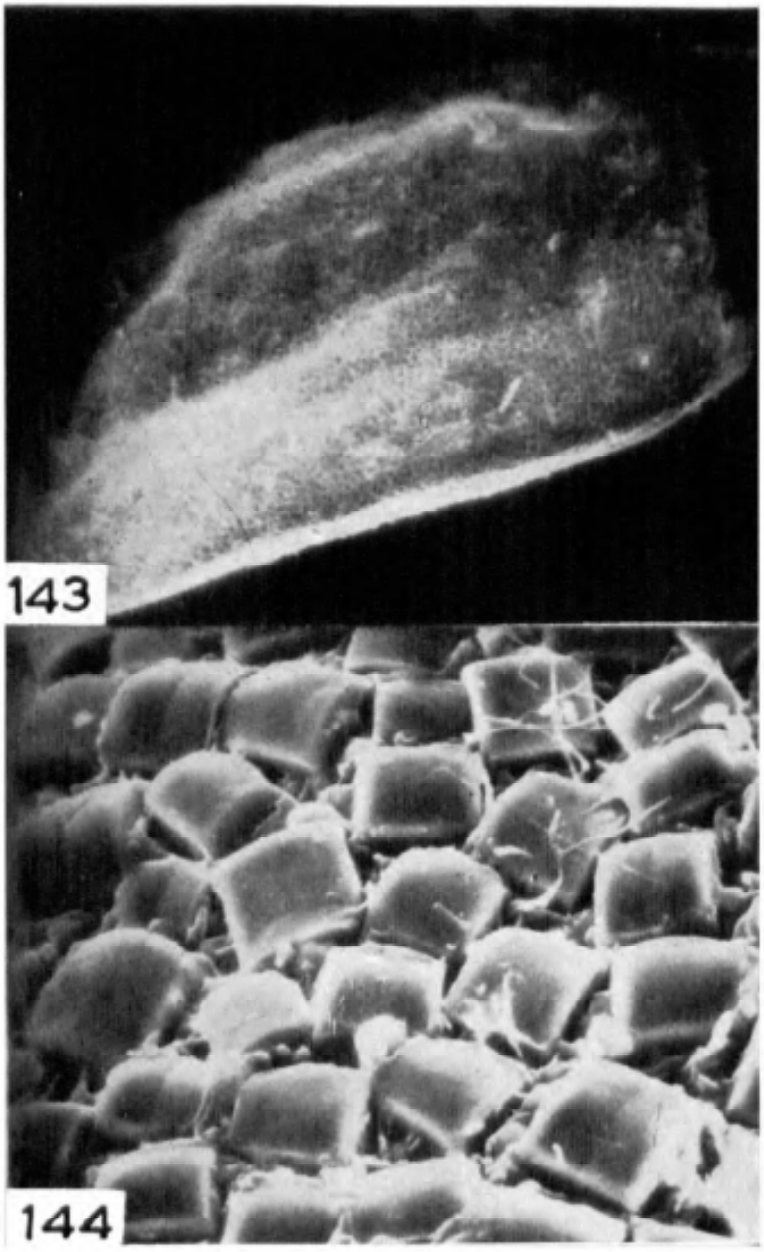


Plates 133-138. Seeds (SEM). – Plates 133 & 134. *Argemone ochroleuca*.—133: seed showing rugose pattern. 225.—134: part of the surface showing single stranded muri of different shapes and sizes. · 3600.—Plates 135 & 136. *Dicranostigma lactucoides*.– 135: seed showing rugose pattern. 200 —136: surface part showing muri of the reticula. · 4000.—Plates 137 & 138. *Glaucium elegans*. - 137: seed showing rugose pattern. · 225.—138: surface part showing secondary reticulations. 8000.

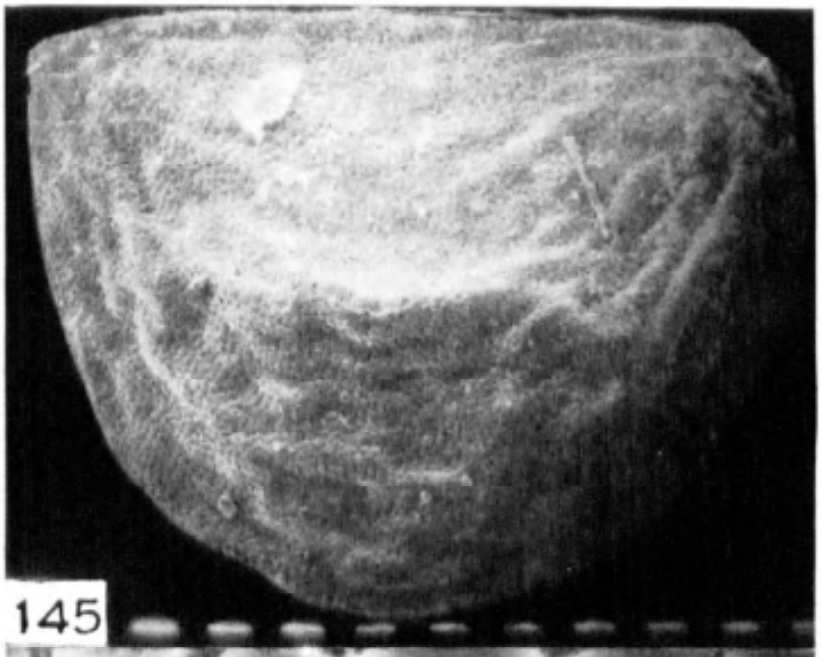


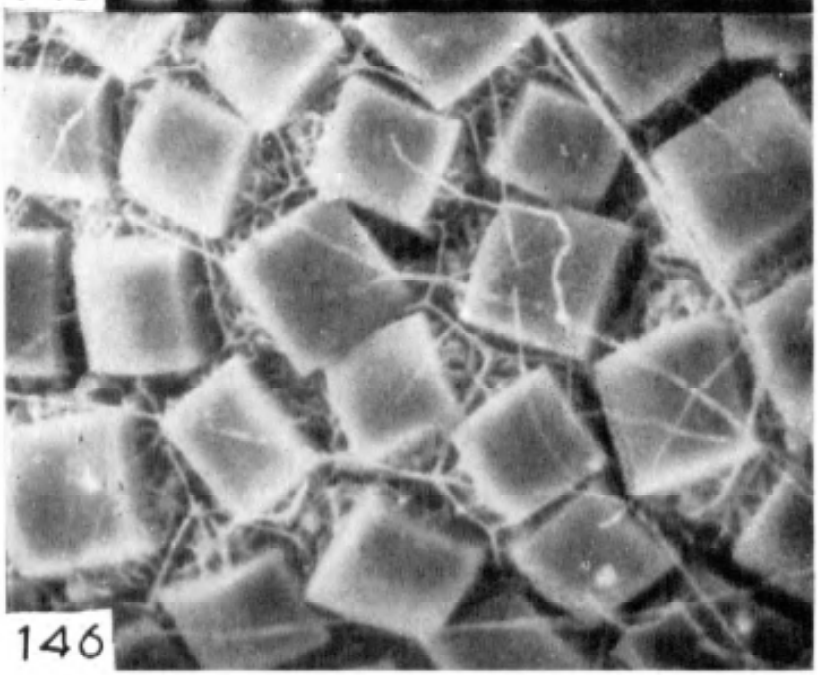
Plates 139-142. Seeds (SEM).—Plates 139 & 140. *Eschscholtzia californica*.—139: seed showing reticulum like structures arranged in vertical rows. 400.—140: surface part showing numerous dispersed pits. 8000.—Plates 141 & 142. *Glaucium fimbrilligerum*.—141: seed showing rugose pattern. 200.—142: surface part showing lumina and muri. 3600.

Plates 143 & 144.



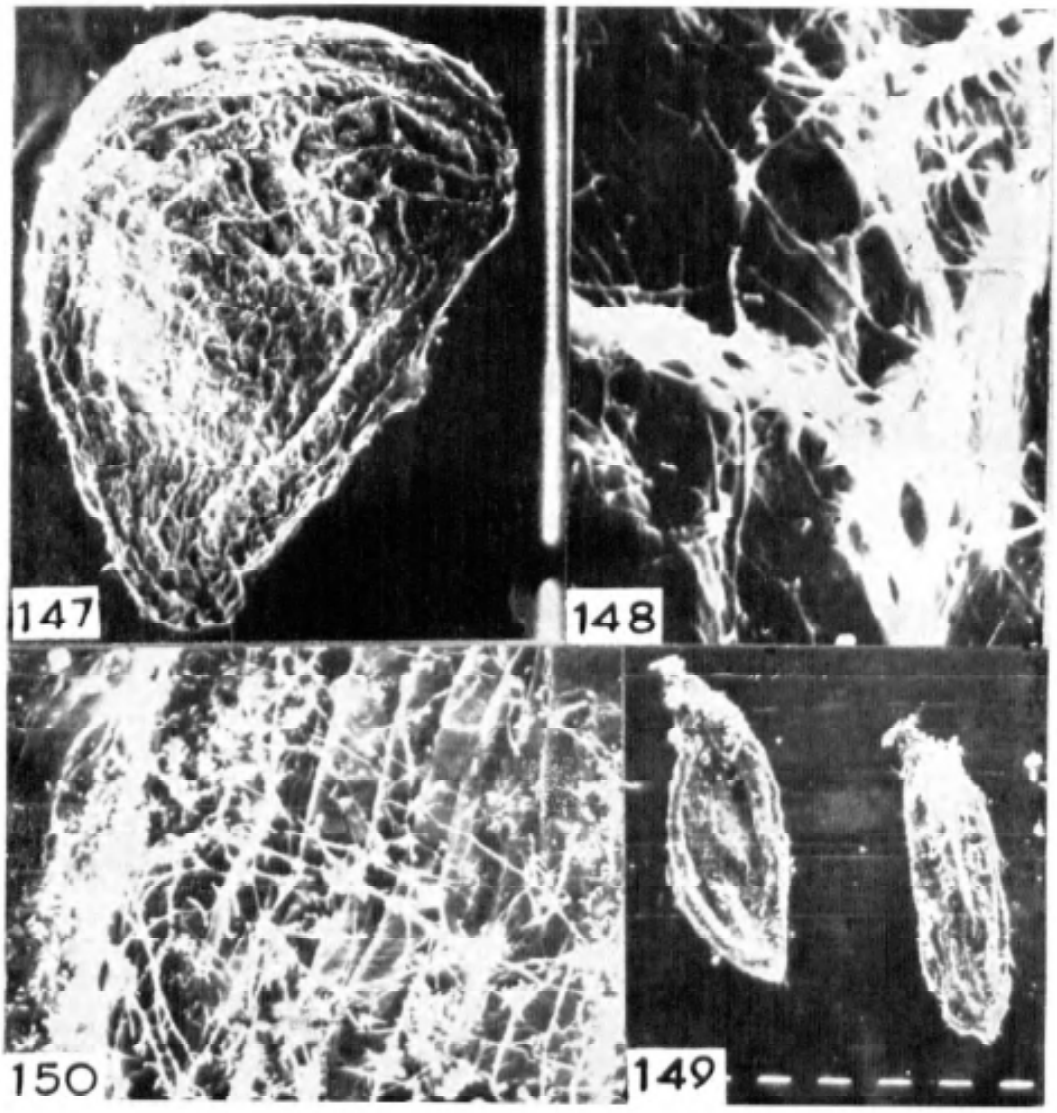
Plates 143 & 144. Seeds (SEM).—*Hypecoum pendulum* var. *pendulum*.—143: seed showing rugose pattern. × 225.—144: surface part showing discrete bodies. 3600.



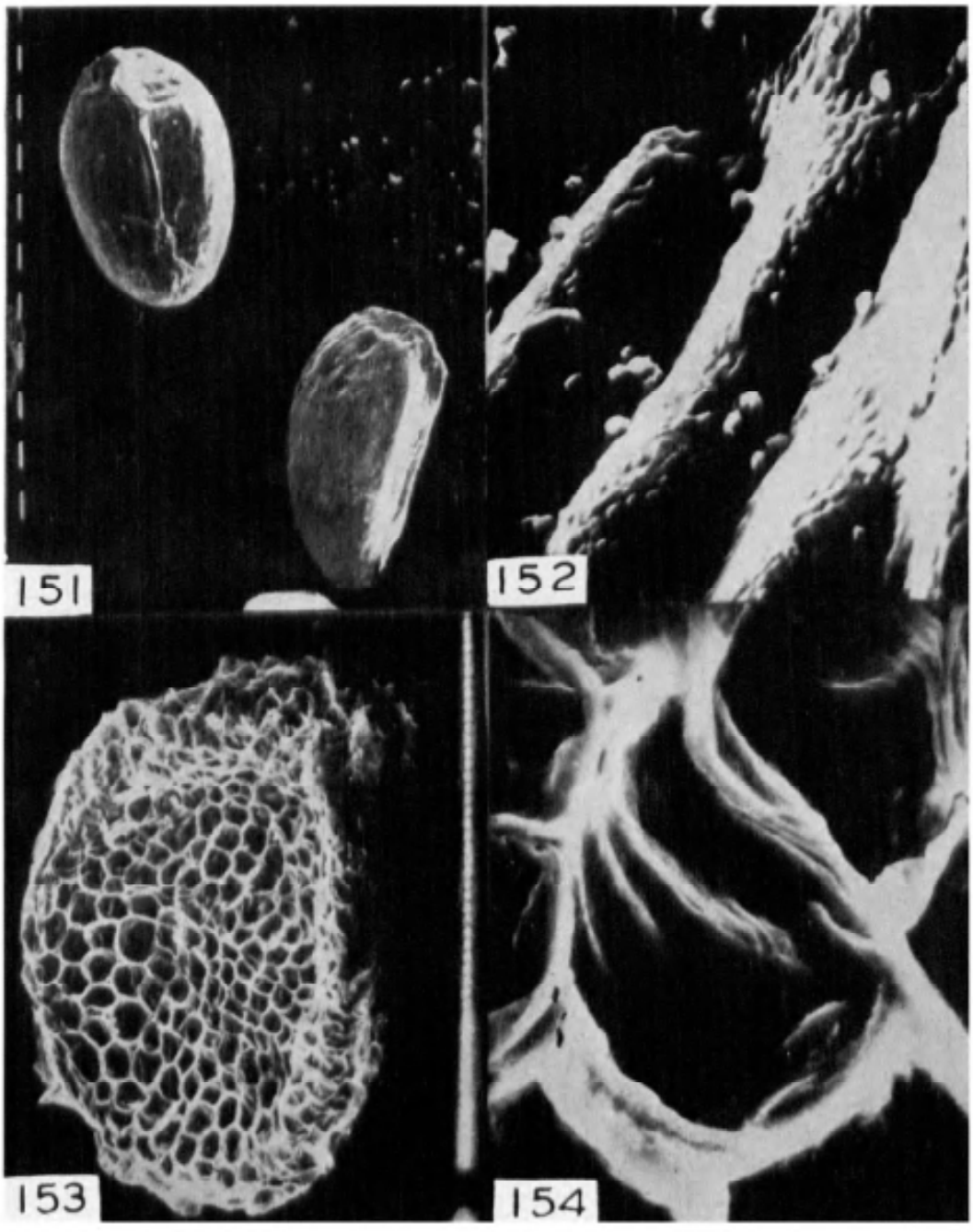


Plates 145 & 146. Seeds (SEM).—*Hypecoum pendulum* var. *parviflorum*.—145: seed showing rugose pattern. 225.—146: surface part showing discrete bodies. · 3600.

Plates 147-150.

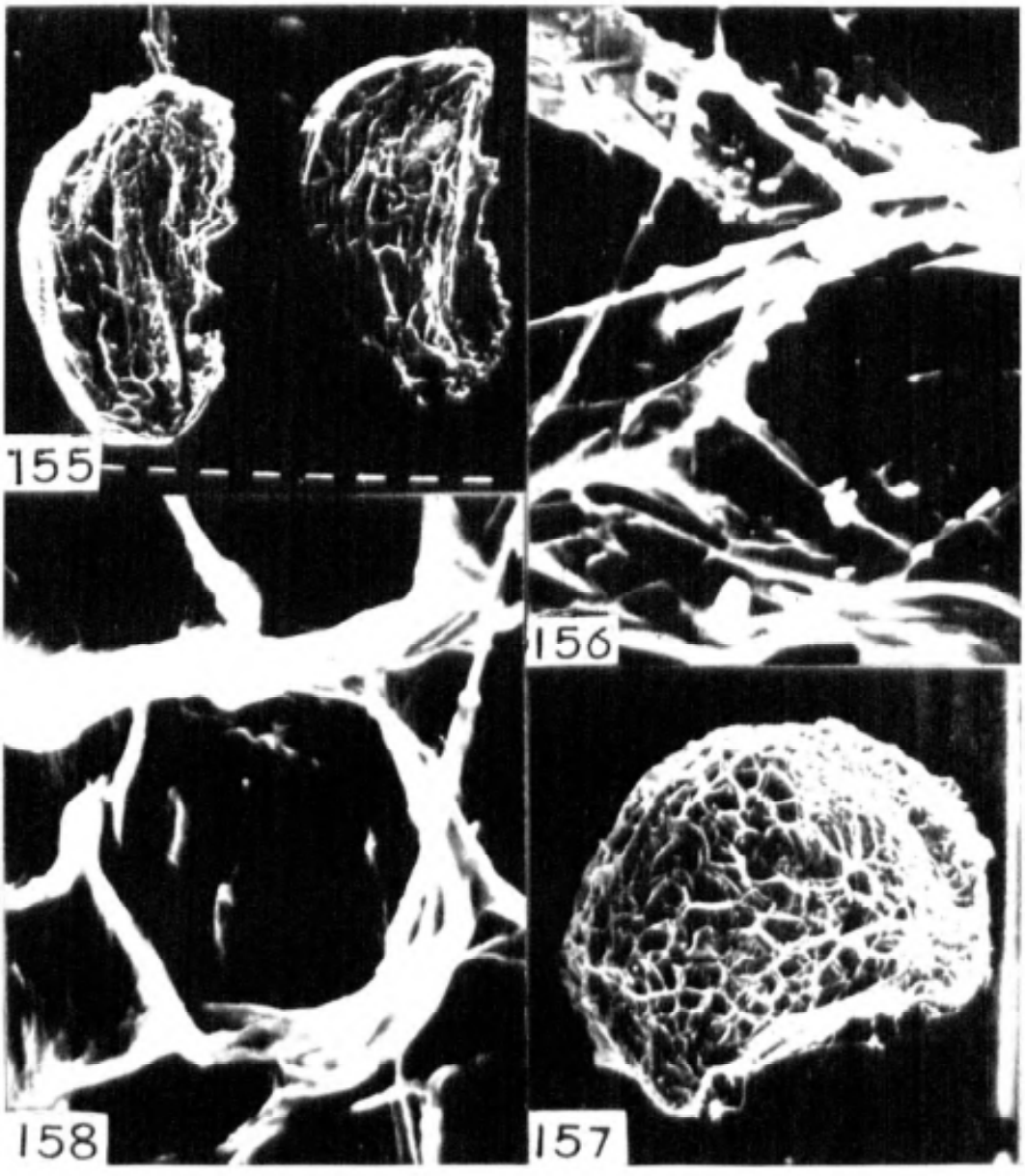


Plates 147-150. Seeds (SEM).—Plates 147 & 148. *Meconopsis aculeata*.—147: seed showing rugose pattern. ×450.—148: surface part showing secondary and tertiary reticulations. 7200.—Plates 149 & 150. *M. bella*.—149: seed showing surface pattern. ×225.—150: surface part showing ribs with fine fibrous strands. ×3600.

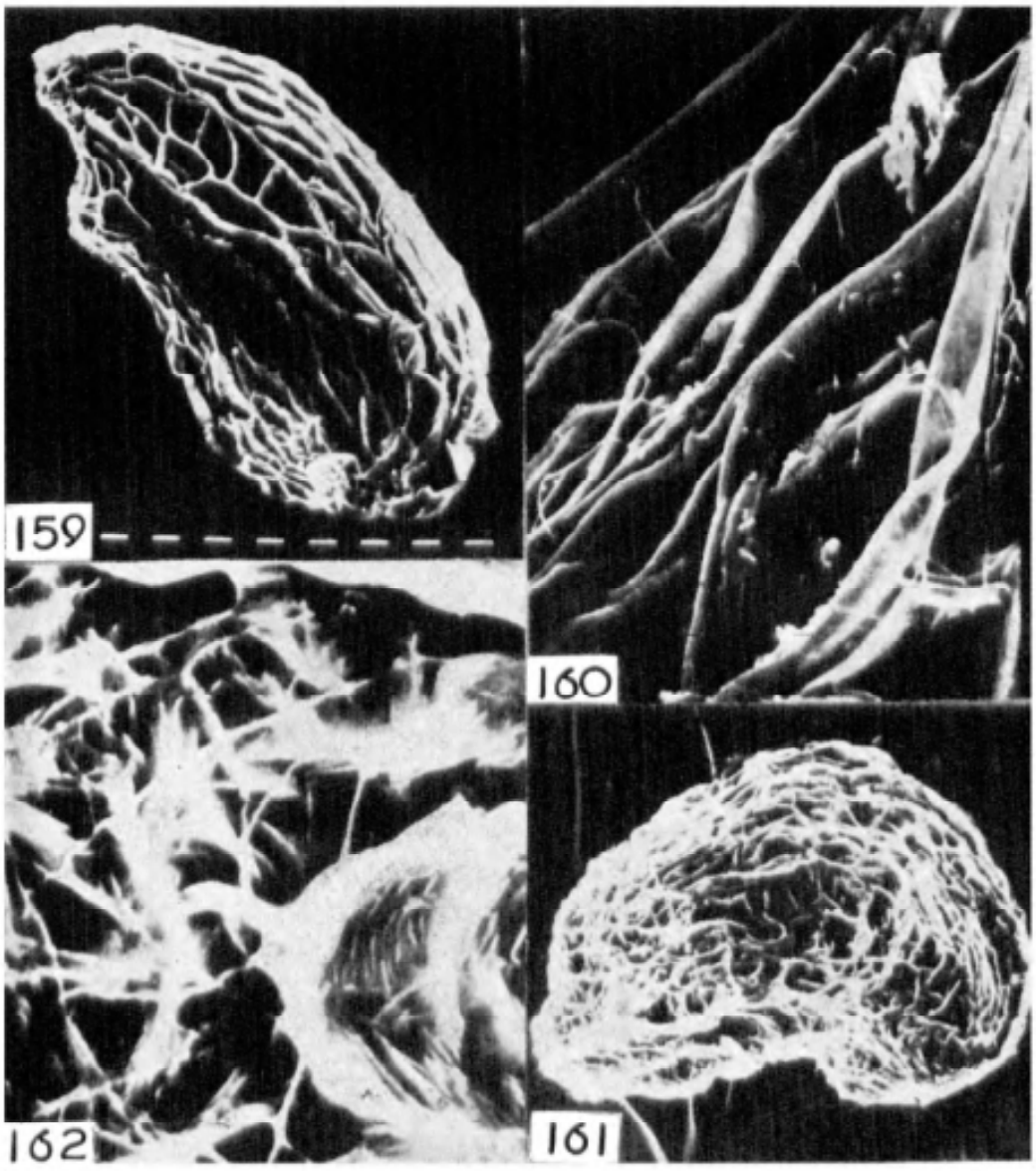


Plates 151-154. Seeds (SEM).—Plates 151 & 152. *Meconopsis betonicifolia*.—151: seed showing indistinct rugose pattern. 180.—152: surface part showing compact striato-reticulate structures. 5625.—Plates 153 & 154. *M. dhwojii*.—153: seed showing honeycomb like structure. 450.—154: surface part showing stout thick fibres. 7200.

Plates 155-158.

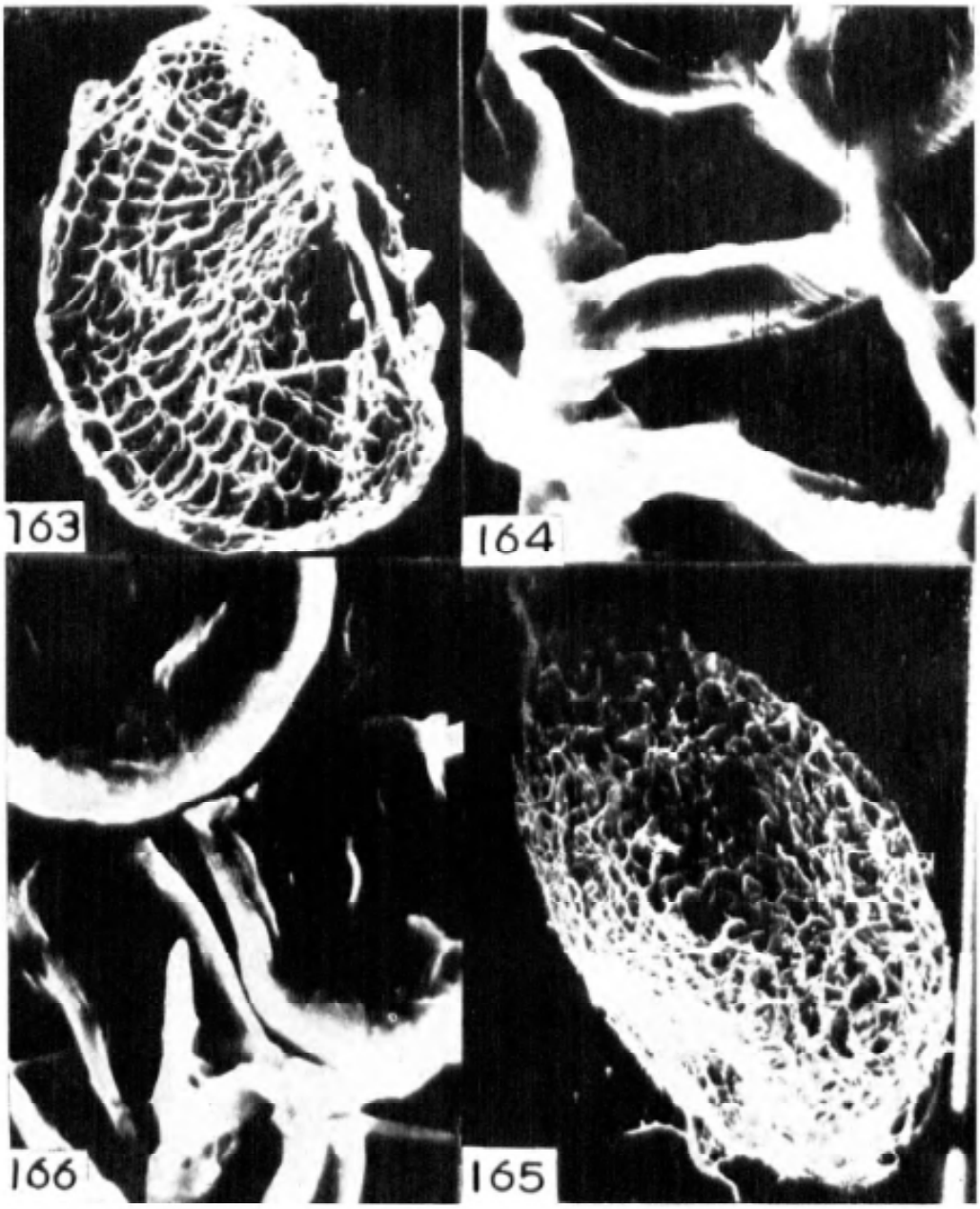


Plates 155-158. Seeds (SEM).—Plates 155 & 156. *Meconopsis discigera*.– 155: seed showing irregular surface pattern. 180.– 156: surface part showing multistranded fibres. 5625.—Plates 157 & 158. *M. gracilipes*.— 157: seed showing rugose pattern. 450.—158: surface part showing twined fibrous strands. 7200.

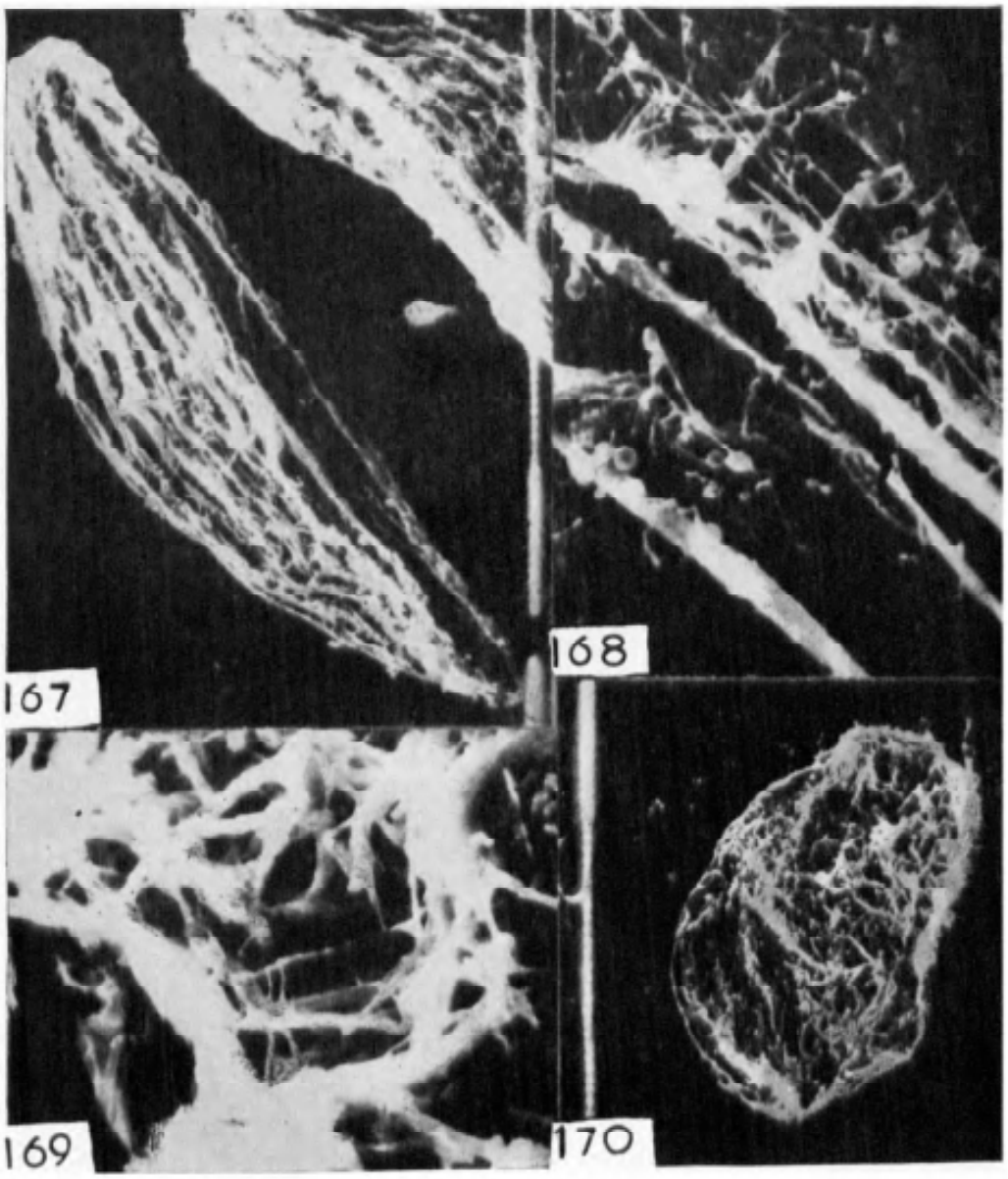


Plates 159-162. Seeds (SEM).—Plates 159 & 160. *Meconopsis grandis*. - 159: seed showing rugose pattern. 180. - 160: surface part showing ribs. 1440.—Plates 161 & 162. *M. horridula*.—161: seed showing rugose pattern. 450.- -162: surface part showing fibres. 7200.

Plates 163-166.

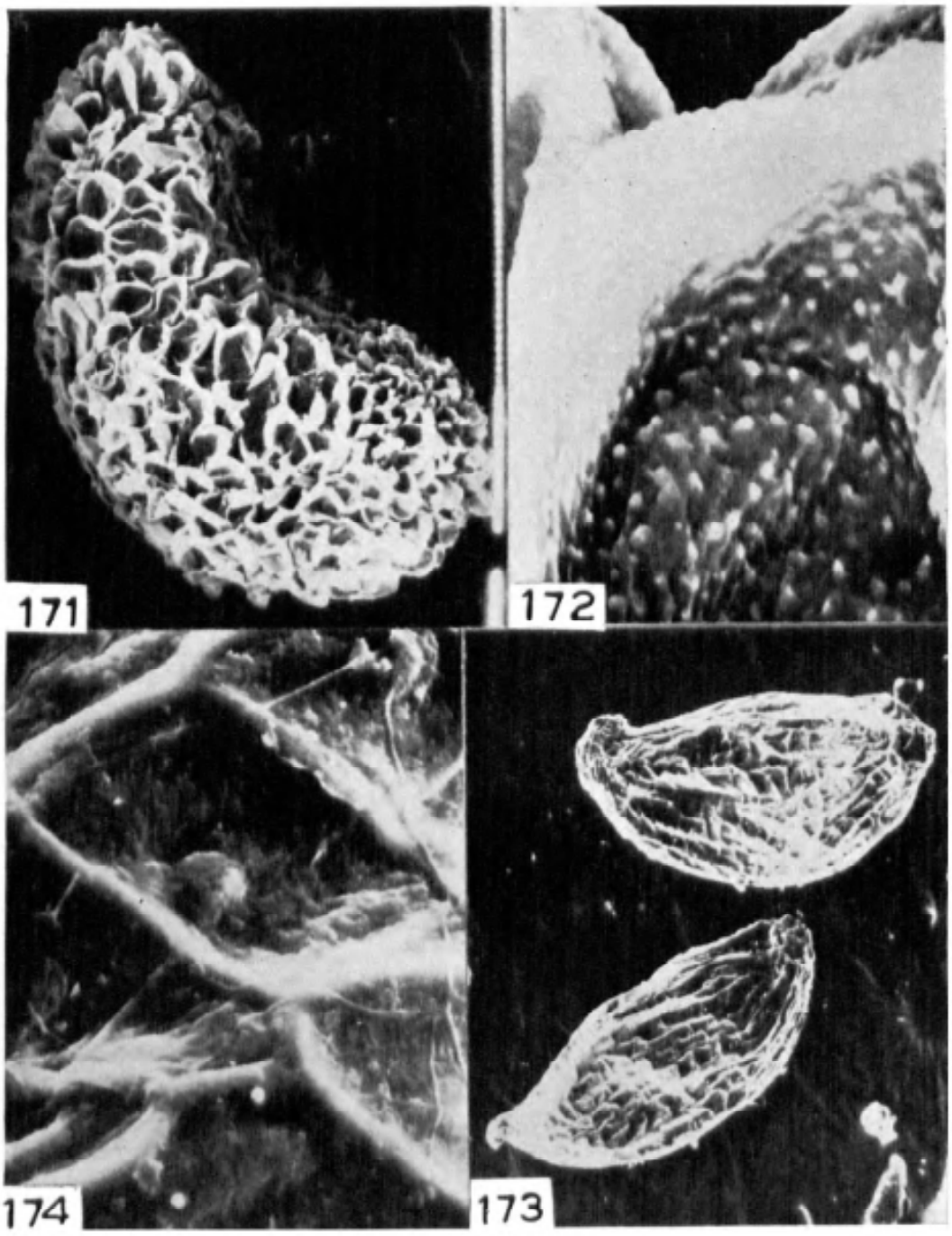


Plates 163-166. Seeds (SEM).—Plates 163 & 164. *Meconopsis latifolia*. –163: seed showing rugose pattern. 450.—164: surface part showing muri and lumina. 7200.—Plates 165 & 166. *M. longipetiolata*.—165: seed showing rugose pattern. 450.—166: surface part showing pits of different dimensions and secondary reticulations. 7200.

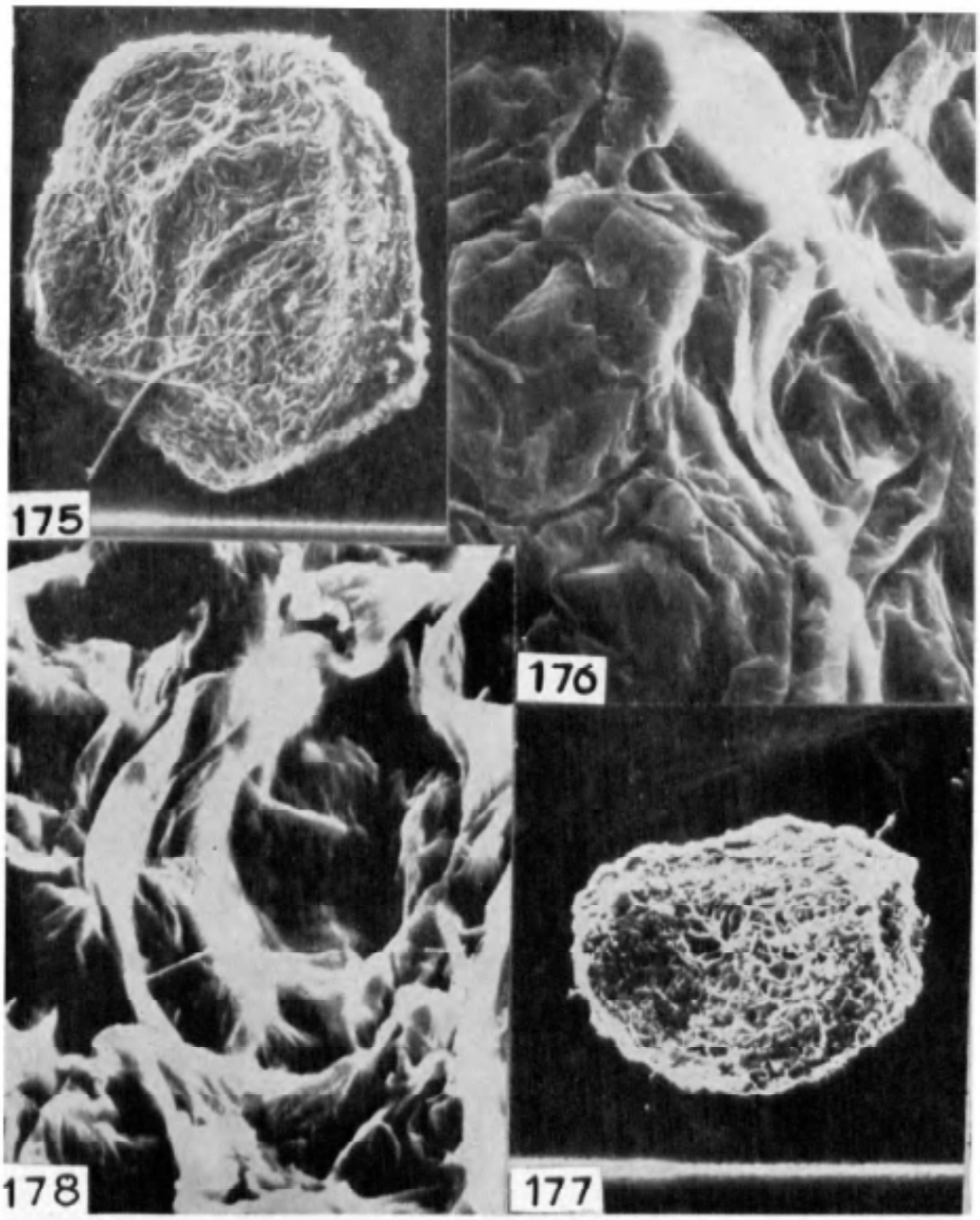


Plates 167-170. Seeds (SEM).—Plates 167 & 168. *Meconopsis lyrata*. - 167: seed showing parallel ribs. 450.—168: surface part showing stout-rods & secondary reticulations. 3600.—Plates 169 & 170. *M. napaulensis*.--169: seed showing irregular rugose. 450.-170: surface part showing lumina and muri. 7200.

Plates 171-174.

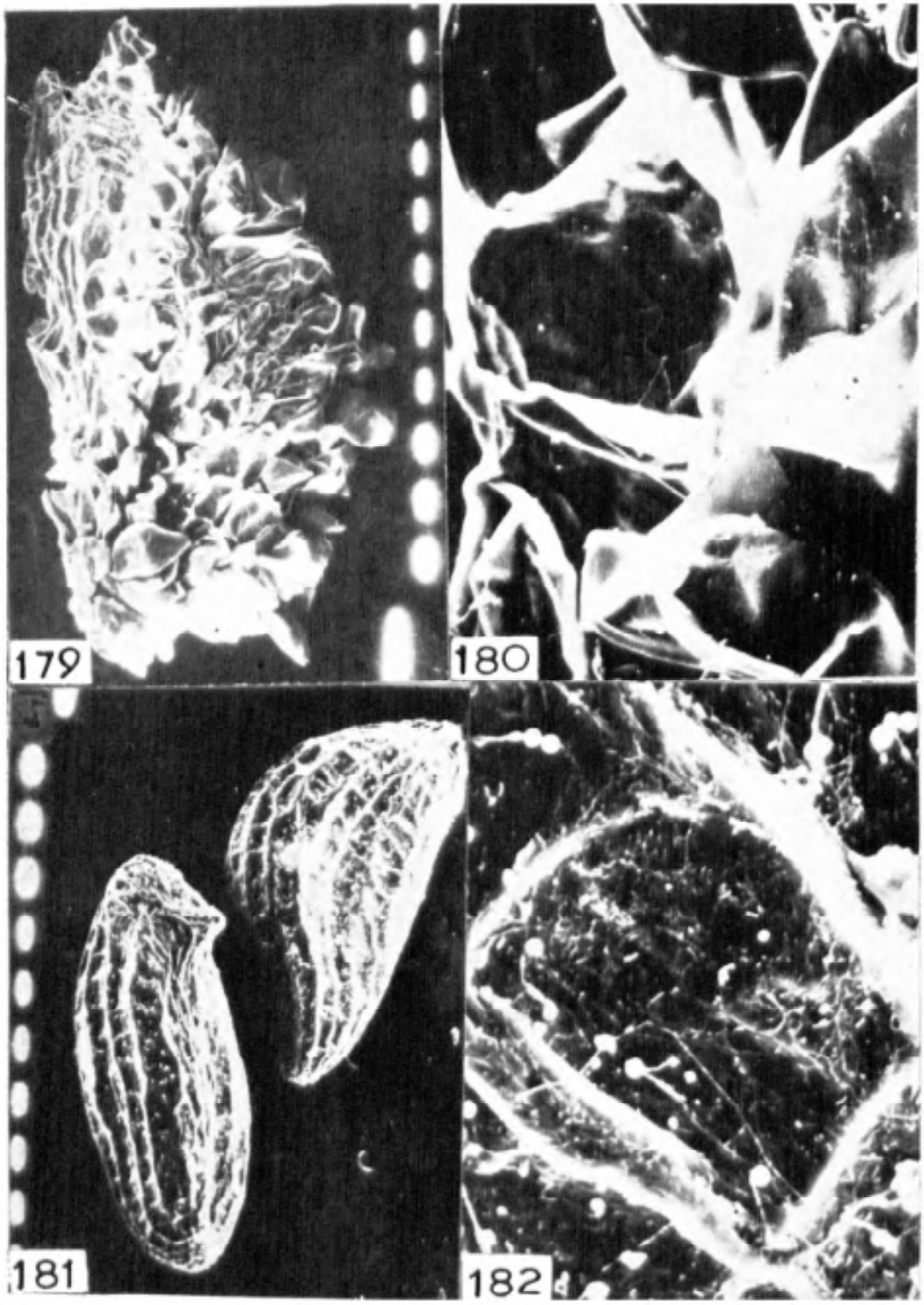


Plates 171-174. Seeds (SEM). Plates 171 & 172. *Meconopsis paniculata*. – 171: seed showing rugose pattern appearing coralloid. 450. 172: surface part showing lumina and muri. 7200. Plates 173 & 174. *M. primulina*. 173: seed showing rugose pattern. 225. – 174: surface part showing stout fibres. 3600.

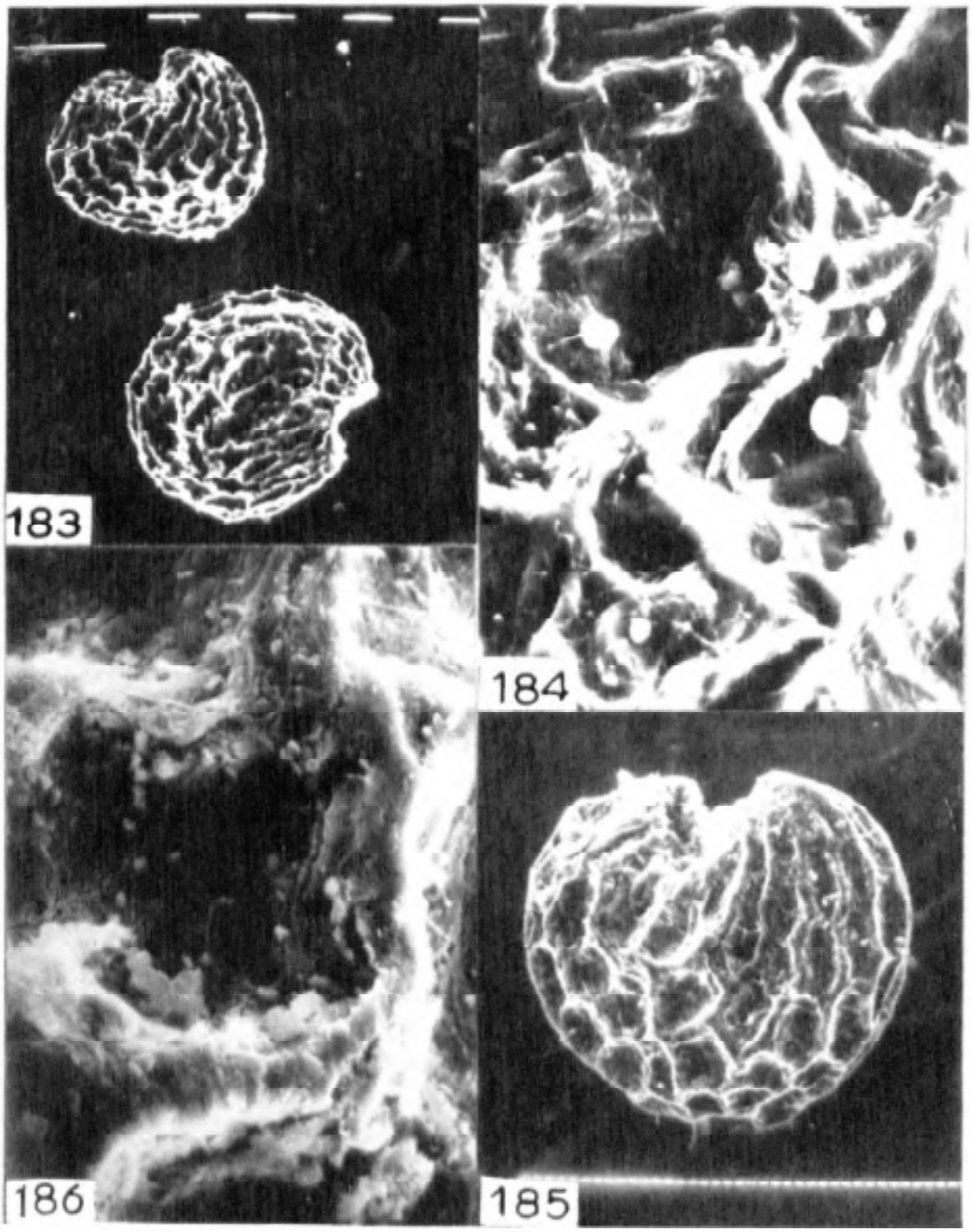


Plates 175-178. Seeds (SEM).—Plates 175 & 176. *Meconopsis regia*.—175: seed showing rugose pattern. 450.—176: surface part showing lumina and muri. 3600.—Plates 177 & 178. *M. robusta*.—177: seed showing rugose pattern. 450.—178: surface part showing lumina and muri. 7200.

Plates 179-182.

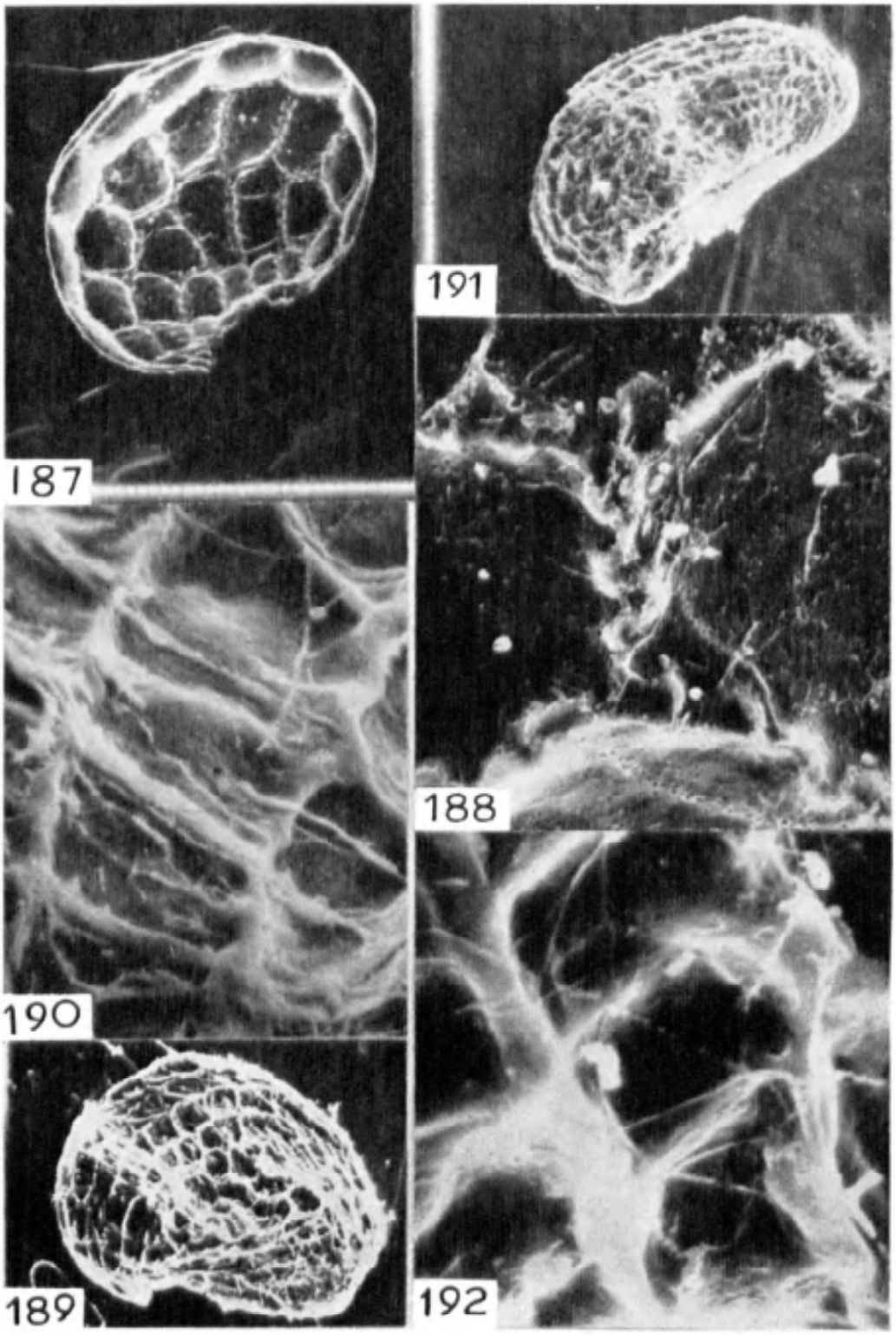


Plates 179-182. Seeds (SEM). Plates 179 & 180. *Meconopsis simplicifolia*.—179: seed showing foliose coralloid structure. 225. 180: surface part showing flat elevated muri. 1800.—Plates 181 & 182. *M. sinuata*.—181: seed showing rugose pattern. 225.—182: surface part showing thick fibres. 3600.



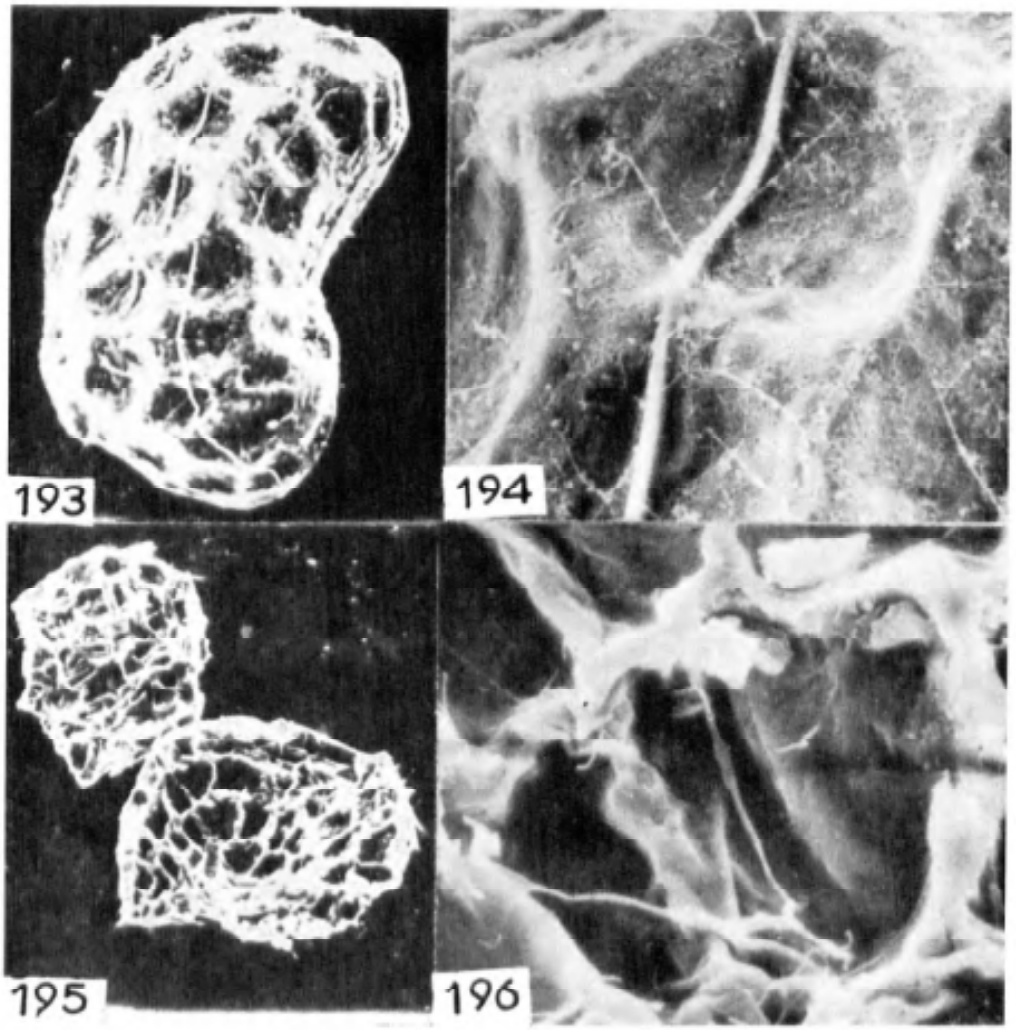
Plates 183-186. Seeds (SEM). – Plates 183 & 184. *Papaver decaisnei*. 183: seed showing reticulations. 225. 184: surface part showing elevated muri with wavy outline. 3600. – Plates 185 & 186. *P. dubium*. 185: seed showing reticulation. 450. 186: surface part showing uneven strands with amorphous depositions. 3600.

Plates 187-192.



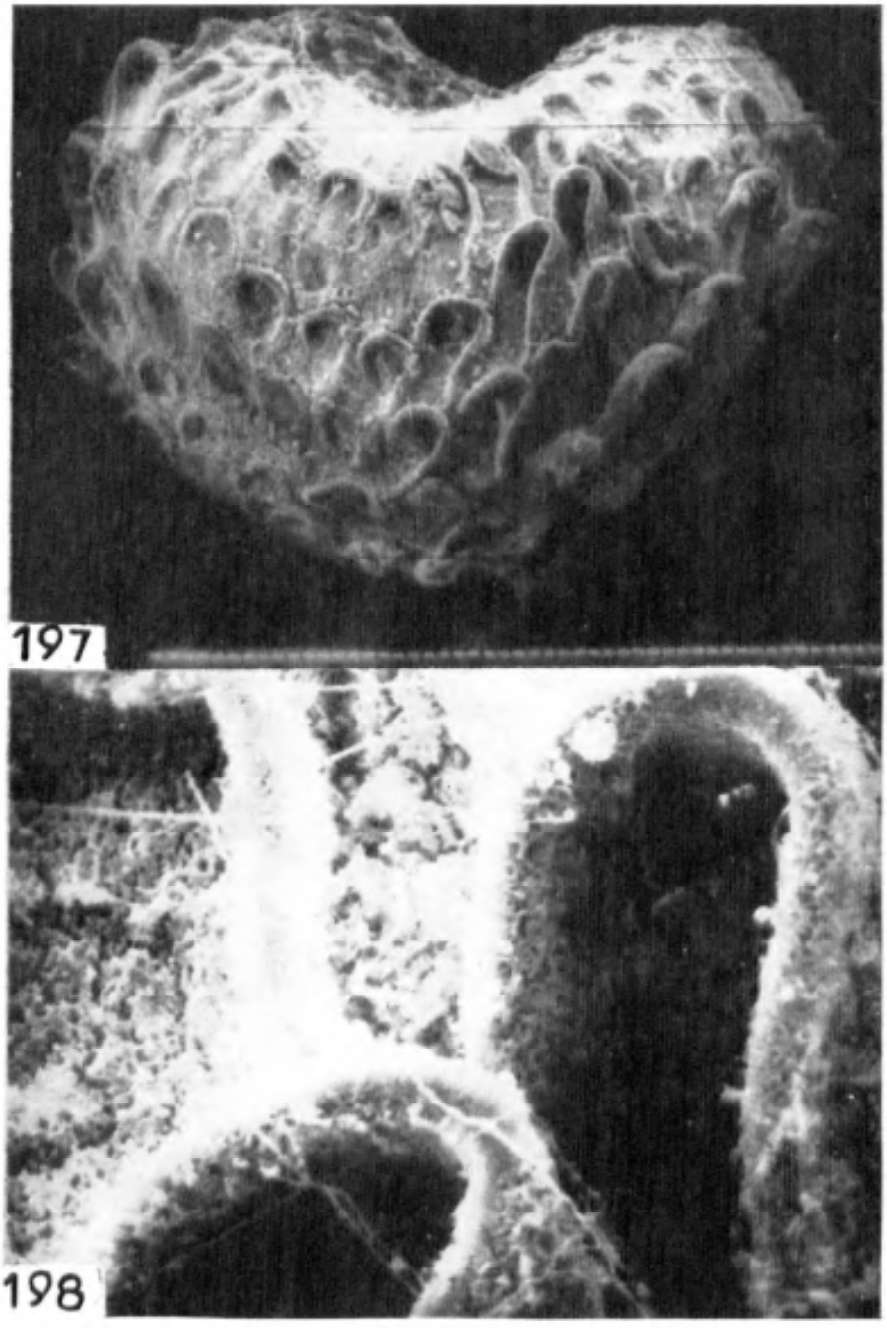
Plates 187-192. Seeds (SEM).—Plates 187 & 188. *Papaver hybridum*.—187: seed showing reticulations. 450.—188: surface part showing undulate muri and muricrons pits. 3600. —Plates 189 & 190. *P. nudicaule*.—189: seed showing reticulations. · 450.—190: surface part showing lumina of different size and dimensions. · 3600.—Plates 191 & 192. *P. pavonium*.—191: seed showing reticulations. 450.—192: surface part showing distinct, stout muri & · rectangular lumina. 7200.

Plates 193-196.



Plates 193-196. Seeds (SEM).—Plates 193 & 194. *Roemeria hybrida* ssp. *dodecandra*.—193: seed showing reticulations. ×450.—194: surface part showing pitted lumina and muri. ×1800.—Plates 195 & 196. *Papaver somniferum*.—195: seed showing reticulations. ×450.—196: surface part showing lumina and muri. ×3600.

Plates 197 & 198.



Plates 197 & 198. Seeds (SEM).—*Roemeria refracta*.—197: seed showing elevated structures. ×450.—198: surface part showing folded & pitted lumina. ×3600.

Papaver dubium Linn. (Plates 185 & 186)

Seeds *ca.* 0.6 mm in diameter, reniform.

Spermoderm (testa) in lower magnification reticulate (Plate 185), in higher magnification (Plate 186) muri irregular due to uneven strands with amorphous depositions, lumina contain dispersed beads of various sizes.

Papaver hybridum Linn. (Plates 187 & 188)

Seeds *ca.* 0.7 mm in diameter, reniform.

Spermoderm (testa) in lower magnification reticulate (Plate 187), lumina ± rectangular; in higher magnification (Plate 188), muri undulating: muri and luminar area pitted.

Papaver nudicaule Linn. (Plates 189 & 190)

Seeds *ca.* 0.4 mm in diameter, reniform.

Spermoderm (testa) in lower magnification reticulate (Plate 189), lumina irregular; in higher magnification (Plate 190) muri are closely ± parallel, lumina ± elongated of different size and dimension, contain fine fibres of irregular disposition.

Papaver pavonium Schrenk (Plates 191 & 192)

Seeds *ca.* 0.5 mm in diameter, elongated reniform.

Spermoderm (testa) in lower magnification reticulate (Plate 191), in higher magnification (Plate 192) distinct and stout muri are visible, lumina ± rectangular, fine fibrous strands of wall materials, few in number, irregularly traverse the lumina.

Papaver somniferum Linn. (Plates 195 & 196)

Seeds *ca.* 0.3 mm in diameter, orbicular shaped.

Spermoderm (testa) in lower magnification reticulate (Plate 195), in higher magnification (Plate 196) stout muri of irregular thickness are seen; lumina ± rectangular, a few strands are made up of fine fibres also irregularly traverse the lumina.

Roemeria hybrida (Linn.) DC. ssp. *dodecandra* (Forssk.) Maire (Plates 193 & 194)

Seeds *ca.* 1 mm in diameter, reniform.

Spermoderm (testa) in lower magnification reticulate (Plate 193), incorporating finer meshes inside the lumina; in higher magnification (Plate 194) each muri is seen to have been formed of unevenly deposited but less compact wall material, lumina ± circular, incorporate fine threadlike strand connects the lumina of reticula longitudinally; lumina and muri pitted.

Roemeria refracta DC. (Plates 197 & 198)

Seeds ca. 1 mm in diameter, reniform.

Spermoderm (testa) in lower magnification rugose (Plate 197), reticulum appears as ± elevated structure is separated from each other; in higher magnification (Plate 198) elevated muri recurved, lumina ± elongated, hollow or folded, the lumina and muri appear as pitted and also beaded throughout due to uneven amorphous surface.

3.4. DISCUSSION

The shape and size of the seeds of different species of the family Papaveraceae are variable. The length ranges from 0.3 mm in *Papaver somniferum* to 3.0 mm in *Meconopsis simplicifolia*. Seeds in most of the species of the genus *Papaver* are orbicular to reniform; those of *Meconopsis* are subreniform to reniform, or ovoid to ellipsoid or oblong. But seeds in *Hypecoum* are planoconvex.

Ultrastructurally, the spermoderms are of various types. It appears from the reports of some earlier investigations with SEM that the terminology for such a study on seeds is yet to be streamlined. In the present investigation however, an attempt has been taken to generalize the terms used for the description of the seeds. Ultrastructures of spermoderm of the seeds in different taxa of the family Papaveraceae are different and they are more or less specific. Surface pattern of the spermoderm (testa) of different species of the genus *Meconopsis* is rugose in general with certain exceptions. In *Meconopsis dhwojii* it is honeycomb like, but it is coralloid in *Meconopsis paniculata* and *M. simplicifolia*. Reticulations of the rugose seeds have muri usually composed of single to multistranded fibres and they again may be of different thickness. Lumina may be of primary type only, or sometimes a larger lumina may incorporate several smaller reticulations termed as secondary reticulations (*Meconopsis aculeata, M. longipetiolata, M. napaulensis*), or similarly secondary reticulations may incorporate tertiary reticulations (*Meconopsis aculeata*) or, the lumina may incorporate interwoven fibres (*Meconopsis aculeata*) or single stranded fibres (*Meconopsis discigera*). Ribbed structures in spermoderm of *Meconopsis betonicifolia* are formed by the condensation of striato-reticulate bodies which intermesh and appearing pitted. In other cases the floor of the lumina may be undulating (*Meconopsis gracilipes*) or scrobiculate (*Meconopsis dhwojii*) or beaded (*Meconopsis paniculata, M. sinuata*). In *Meconopsis regia* and *M. robusta* lumina is irregular due to irregularity in muri and the floor of the lumina is amorphous.

Also, in some species of *Papaver*, the spermoderm is reticulate with muri wavy in outline (*Papaver decaisnei*) or irregular (*Papaver dubium*) or

undulating (*Papaver hybridum*). Sometimes muri appear exceptionally stout (*Papaver pavonium* and *P. somniferum*). Muri are pitted in *Papaver hybridum*.

In *Roemeria hybrida* the lumina itself looks pitted and a similar structure is found in *Papaver hybridum;* in *Glaucium elegans* pits are numerous and conjested. In *Roemeria refracta* the reticulate bodies are elevated and look like discrete structures. But in *Glaucium fimbrilligerum* only the peripheral part of each lumina is pitted.

The spermoderm character of the genus *Hypecoum* is remarkably different from others. In this genus the spermoderm is made up of discrete bodies which are square or rectangular in shape. The structure is different in two varieties of the species *Hypecoum pendulum,* where the upper surface is flat (var. *parviflorum*) or convex (var. *pendulum*). The space in between two such bodies may be finely reticulate (var. *parviflorum*) or may have projected reticulations made up of thick strands (var. *pendulum*).

In the species *Argemone ochroleuca,* lumina is filled with fine thread like structures. The muri of the reticulations in *Dicranostigma lactucoides* is formed of compactly set scrobiculae, striate in arrangement.

In the species *Eschscholtzia californica* spermoderm contains pits of different dimensions remaining surrounded by amorphous elevated structures or rarely they are traversed by single stranded fibres.

Using the spermoderm characters it is seen that the characters of spermoderm is quite unique in the genus *Hypecoum* by the presence of square or rectangular discrete bodies in the spermoderm.

While in the genera *Meconopsis* and *Papaver* the orientation and nature of muri and lumina are characteristic for each species. The nature of the reticulum in the seeds with different orientations and patterns of strands traversing it, is the characteristic of the family Papaveraceae.

TABLE 3 : Voucher data for specimens of the family Papaveraceae examined for Seed morphology

Taxon	Origin and Collector	Number and Herbarium
Argemone ochroleuca ssp. *ochroleuca*	India, Cultivated in Forest Research Institute, Dehra Dun, *Raizada*	58609 DD

Taxon	Origin and Collector	Number and Herbarium
Dicranostigma lactucoides	West Nepal, Karnali zone, Nyorgad to Sipty, Jumla Dist., 2700 m, *Rajbhandari* et *Roy*	3473 KATH
Eschscholtzia californica	U.S.S.R., Botanical Garden, Leningrad, *Anonymous*	s.n. CAL
Glaucium elegans	Beluchistan, Miralikhel, 1060 m, *Harsukh*	18765 CAL
G. fimbrilligerum	Beluchistan, Kachh, 2000 m, *Lace*	3353 CAL
Hypecoum pendulum var. *parviflorum*	Beluchistan, 1700 m, *Lace*	3658 CAL
H. pendulum var. *pendulum*	Pakistan, Asurum, Kaliwali, 600 m, *Kabir*	14794 CAL
Meconopsis aculeata	India, Kashmir, Nilkhantah Pass, 3300 m, *Aitchison*	28 CAL
M. bella	Nepal, Rambrong, Lamjung Himal, 4200 m, *Stainton, Sykes & Williams*	6203 KATH
M. betonicifolia	Burma-Tibet, Valley of the Seinghku, 3300 m, *Kingdon-Ward*	7208 BM
M. dhwojii	Nepal, Sangmo, 3600-5400 m, *Dhwoj*	0297 BM
M. discigera	Nepal, Tamur Valley, Mewakhola, Topkigola, 4200 m, *Stainton*	921 BM
M. gracilipes	Nepal, Langung Himal, 3000 m, *Stainton, Sykes & Williams*	6417 BM

Taxon	Origin and Collector	Number and Herbarium
M. grandis	Nepal, Arunvalley, Barun Khola, N. of Num, 3700 m, *Stainton*	1668 KATH
M. horridula	India, Sikkim, Goaning, 4500 m, *Smith*	3990. CAL
M. latifolia	India, Kashmir, Butin Pantsal, 3300 m, *Pinfold*	266 BM
M. longipetiolata	Nepal, Langtang to Kyangchin, 3261 m, *Malla*	9040 KATH
M. lyrata	India, Sikkim, Bijan, *King's Collector*	s.n. CAL.
M. napaulensis	India, Sikkim, Bijan, *King's Collector*	s.n. CAL
M. paniculata	India, Sikkim, Jemmu Valley, 2800 m, *Smith & Cave*	1050 CAL
M. primulina	Bhutan, Kangla, Karchula, 4500 m, *Ludlow, Sherriff & Hicks*	s.n. BM
M. regia	Nepal, Rambrong, Lamjung Himal, 4200 m, *Stainton, Sykes & Williams*	6139 BM
M. robusta	Pakistan, Kumaon, Pindi, *Collett*	11 CAL
M. simplicifolia	India, Sikkim, Jemmu Valley, 4000 m, *Smith & Cave*	1183 CAL

Taxon	Origin and Collector	Number and Herbarium
M. sinuata	Nepal, Iswakhola, 4500 m, *Beer*	25429 BM
Papaver decaisnei	North West India, Fl. Pentopotamica, 2500 m, *Kabir*	14816 CAL
P. dubium	India, Tihri Garhwal, *Duthie*	19825 CAL
P. hybridum	N. W. India, Hazara, below 600 m, *Stewart*	s.n. CAL
P. nudicaule	Turkestan, Badozan, 2700 m, *Komarov*	s.n. CAL
P. pavonium	Pakistan, Beluchistan, Sheto, *Lace*	3543 CAL
P. somniferum	India, Manipur, 600-1500 m, *Annonymous*	s.n. CAL
Roemeria hybrida ssp. *dodecandra*	P. sintenis, Iterorien talc, *Stapf*	456 CAL
R. refracta	Afghanistan, *Griffith*	s.n. CAL

TAXONOMIC TREATMENT OF THE GENUS HYPECOUM

INTRODUCTION

The genus *Hypecoum* is placed in the family Papaveraceae by Engler and Diels (1936), Fedde (1936), Melchoir (1964), Thorne (1983) as a subfamily Hypecoideae. But Cronquist (1968) resolved the situation by defining the order Papaverales as consisting of two families the Papaveraceae and the Fumariaceae. He was of the opinion that the Asian genera *Hypecoum* and *Pteridophyllum* may form a connecting link between the two families and he placed this subfamily Hypecoideae under the family Fumariaceae. Hutchinson (1959) and Dalhlgren (1975) also placed it under the family Fumariaceae. But Takhtajan (1966) raised this subfamily to the family status Hypecoaceae for the first time.

In Indian region the genus is represented by 2 species. In order to evaluate the systematic position of this genus, the pollen and seed morphological studies were undertaken. The taxonomic description of the genus *Hypecoum* occurring in Indian region is given below.

HYPECOUM

Linn., Sp. Pl. 1: 124. 1753; Gen. Pl. ed. 5: 60. 1754; Hook. f. & Thoms., in Hook. f., Fl. Brit. Ind. 1: 120. 1872 (under Fumariaceae); Fedde, in Engler, Pflanzenr. 4. 104: 85. 1909; Fedde in Engler & Prantl, Nat. Pflanzenfam., ed. 2, 17b: 69. 1936; Popov in Komarov, Fl. U.S.S.R. 7: 576. 1937; Cullen in Rechinger f., Fl. Iran. 34: 23 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak., 61: 26. 1974; Debnath et Nayar, Fasc. Fl. Ind. 17:42. 1984 (under Hypecoaceae).

Annual, erect, ascending or prostrate, glabrous, often glaucous with watery sap herbs. Stems or scapes several, with a dense rosette of radical leaves. Leaves short petiolate, 2-4 pinnatisect, segments subsessile, palmately bipinnatisect into linear to narrowly obovate lobules. Inflorescence dichasial, spreading; floral leaves much reduced and thinly dissected. Sepals 2, free, deciduous, ovate-triangular or oblong, much smaller than petals. Petals white, yellow, slightly pink-violet, 4 in two series, outer two trilobed or entire, obovate, inner two trilobed, lateral lobes linear, median lobe concave, stipitate. Stamens 4, Tree, opposite the petals; filaments winged or dilated, scarious, sometimes with a stipitate gland at the base; anthers linear. Ovary linear, unilocular; styles short; stigmas bipartite, glandular at the tip, often recurved. Capsules linear, many seeded, lomentoid, disarticulating transversely, rarely dehiscent by 2 valves. Seeds small, grey, compressed, without aril, rough or smooth.

Distrib. *ca.* 15 species in PAKISTAN; NEPAL; BHUTAN; EASTERN ASIA; (JAPAN & North CHINA); USSR, North AFRICA; Western ASIA; Central EUROPE. In Indian region the genus is represented by 2 species.

Ecol.: In India the genus occurs in cultivated land, fallow fields, weed infested places, rocky foot hill slopes and intermountain terrains up to 5030 m.

KEY TO THE SPECIES

1a. Flowers white or slightly violet; middle lobe of the inner petals not fringed. Siliques erect, with erect or horizontal pedicels ... *H. leptocarpum* 1

1b. Flowers yellow; middle lobe of the inner petals with fringed margin. Siliques pendulous on recurved pedicels ... *H. pendulum* 2

1. **Hypecoum leptocarpum** Hook. f. & Thoms., Fl. Ind. 1: 276. 1855; Hook. f. & Thoms. in Hook. f., Fl. Brit. Ind. 1: 120. 1872 (Under Fumariaceae); Fedde, in Engler, Pflanzenr. 4. 104: 94. 1909; Fedde in Engler & Prantl, Nat. Pflanzenfam., ed. 2, 17b: 69. 1936; Popov in Komarov, Fl. U.S.S.R. 7: 578. 1937; Cullen in Rechinger f. Fl. Iran. 34: 23. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 27. 1974. **Fig. 42**

Annual, glabrous herbs, with a slender tap root. Stems (scapes) many, 15-35 cm tall, spreading, dichotomously branched, forking at intervals of 5.5 (-10.0) cm, broad in the lower portions but more slender above (almost filamentous when in the flower), leafless except where the stem forks and/or a pedicel arises. Leaves radical, glaucous, rosulate with a sheating leaf base, 2-3 pinnatisect, segments linear, acute, 2-3 mm long, basal leaves 5-11 cm long, petioled, upper leaves up to 3.5 cm long, sessile or subsessile. Inflorescence 2-4 (-5) flowered, dichasial cyme. Pedicels borne singly, each arising from the fork of a stem, very slender and almost filamentous when in flower, lengthening and thickening in fruit, erect or horizontal. Flowers 8-15 mm in diameter, bimerous, symmetrical. Bracts 4-7 mm long, involucre, deeply dissected, lobes linear. Sepals 2, 2.5-3.0×1.5-2.0 mm, free, ovate, glabrous, acute, Petals 4, arranged in two dissimilar, alternative whorls, white or slightly violet; outer petals 2, 9-10×5-6 mm, broadly obovate, obtuse, apex keeled and subcoriaceous; inner petals 2, 5-6×4 mm, lobed up to middle, outer two lobes elliptic oblong, obtuse, middle lobe spathulate, hooded, cuneate at the tip within curved margin. Stamens 4, opposite petals, 6 mm long; filaments 3.5×0.5 mm, membranous, winged, tapered at the apex, broader and sudden swelling at the base; anthers 1.5 mm long,

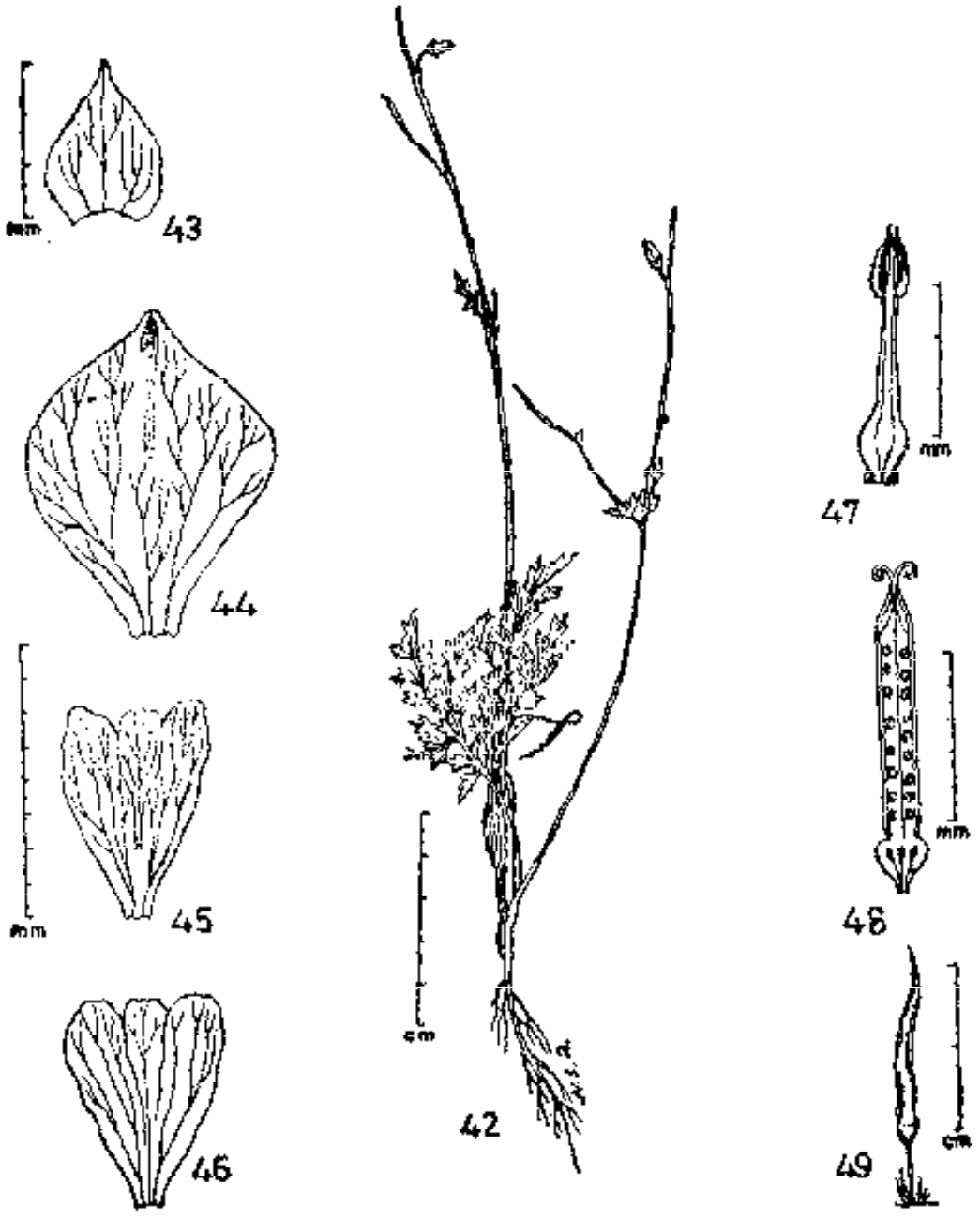


Fig. 42. Habit of *Hypecoum leptocarpum* Hook. f & Thoms.

basifixed, 2-celled, linear-oblong, each anther cell with minute apical projection; two glands present in the base of the filament. Ovary 7-10 mm long, superior, syncarpous, slender; styles slender, bearing two recurved stigmas at the apex, 8.5×0.5 *mm*; stigmas 1.5 mm long, obtuse. Siliques narrowly oblong, 12.0-35.0×1.0-1.75 mm, linear, slender, erect, not pendulous, disarticulating, lomentoid, glabrous. Seeds brown, testa subcoriaceous, arranged in one longitudinal row, *ca.* 7-10 seeds per capsule.

Type: TIBET, Temp. region, 3050-3660 m, *Thomson* s.n. (CAL, K).

Fls. & Frts.: June—September (-October).

Distrib.: Himalaya: INDIA: Kashmir, Sikkim; PAKISTAN; NEPAL; BHUTAN; TURKISTAN; AFGHANISTAN; USSR; TIBET; CHINA; MONGOLIA; JAPAN.

Uses: The latex contains opium alkaloid protopine which has narcotic action (Henry, The plant alkaloids, 299 & 305. 1949; Manske and Holmes, The alkaloids, 4: 158. 1950-54).

Note: Hypecoum leptocarpum varies very much in size and form. It may be noted that plants growing at lower elevations are usually taller than those that are at higher elevations.

The occurrence of this species at an elevation of 5490 m in Himalaya indicates its wide tolerance to severe conditions prevailing at that altitude, which is usually the upper limit for the existence of flowering plants.

2. **H. pendulum** Linn., Sp. Pl. 1: 124. 1753; Cullen in Rechinger f., Fl. Iran. 34: 23. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 27. 1974; Sing in Geobios (Jodhpur), 2 (2-3): 91. 1975; Aston, in Muelleria, 3.3: 177-182. 1976. *H. caucasicum* Koch ex Ledeb, Fl. Ross. 1: 94. 1842; *H. procumbens auct. non* Linn. Hook. f. & Thoms., Fl. Ind. 1: 275. 1855; Hook. f. & Thoms. in Hook. f., Fl. Brit. Ind. 1: 117. 1872; Sharma in J. Bomb. Nat. Hist. Soc. 73: 422-423. 1976.

Annual, glaucous herbs, 5.0-24.5 cm long, with a slender tap root. Stems many, procumbent to ascending, dichotomously forked. Leaves radical, glaucous, forming an erect to spreading rosette, 2-3 pinnatisect, segments linear, 2.0-6.0 × 1.0-1.5 mm, cauline leaves palmatisect, subopposite. Petioles 10-15 cm long. Flowers 8-12 mm in diameter, bimerous. Pedicels borne singly, arising from the fork of a stem or else terminally, very slender, lengthening and thickening in fruit. Sepals 2, 2.0×1.5 mm, ovate, subobtuse-acute, margin entire or shallowly incised. Petals 4, yellow, in two dissimilar, alternative whorls; outer petals 2, rhomboid, entire or obscurely 3-lobed, median

lobe apex keeled, subcoriaceous, 2-lateral lobes each a little broader than the median lobe, projecting laterally in dentate shape, all lobes 7-10 × 4-6 mm, obtuse; inner petals 2, 4-7 mm long, deeply 3-lobed, with a small claw at the base, laterally obtuse-rounded at apex with small scattered purplish spots, middle lobe very shorter or very larger than the lateral lobes, consisting a slender stalk and broad-oblong expansions fringed on the edges, emarginate and recurved, spathulate. Stamens 4, opposite the petals, free 5-6 mm long; filaments 4.5×0.5 mm, flattened, tapered at the apex and broader at the base, with several oblong spots on the edges similar to those on the lateral lobes of the inner petals, glands present at the base, one trace, filaments sudden narrow at the junction of the anthers; anthers linear, 2 mm long, basifixed, 2-celled, linear, each anther cell with minute apical projection. Ovary superior, 5 mm long, cylindrical; styles slender, bearing two divergent stigmas at the apex, 3.5×0.5 mm; stigmas 1.5 mm long, obtuse. Siliques 3.0-7.5×1.5-3.0 mm, pendulous from the apex of the recurved pedicels, indehiscent to pseudo-dehiscent, lomentoid. Seeds grey, compressed, 2.0×1.5 mm, planoconvex-reniform.

1a. Siliques articulating, epidermis not peeling off ... var. *pendulum*

1b. Siliques disarticulating, epidermis peeling off ... var. *parviflorum*

var. **pendulum**

Type: EUROPE: France, Herb. Linn. No. 171/4 (LINN)

Fls. & Frts.: March—July.

Distrib.: INDIA: Himalaya, Kashmir; PAKISTAN; USSR; AFRICA (North); Western ASIA (EGYPT, IRAN, AFGHANISTAN); S.W. & S.E. EUROPE (BULGARIA, FRANCE, GREECE, YUGOSLAVIA, TURKEY).

Note: It differs from *H. procumbens* L. by its terete and cylindrical capsules.

var. **parviflorum** (Kar. & Kir.) Cullen in Rechinger f., Fl. Iran. 34: 25, t. 7, fig. 1, 2. 1966; Jafri et Qaiser in Nasir et Ali, Fl. W. Pak. 61: 30. 1974. *H. parviflorum* Kar. & Kir. in Bull. Soc. Nat. Mosc. 15: 141. 1842; Popov in Komarov, Fl. U.S.S.R. 7: 443. 1937.

Type: "*Hab. in arenosis songoriae* and *fl. Lepsa*".

Fls. & Frts.: March—July.

Distrib.: INDIA: Himalaya; PAKISTAN; AFGHANISTAN; IRAN; TURKEY; USSR.

Note: The Indian-Himalaya distribution of this variety was mentioned only by Popov (1937).

The two varieties *Hypecoum pendulum* var. *pendulum* and *H. pendulum* var. *parviflorum* are closely allied.

Fedde (P. 95. 1909), Cullen (1966), Jafri et Qaiser (1974) stated that outer petals of the var. *pendulum* are rhomboid subtrilobed to trilobed whereas in var. *parviflorum* it is elliptic and entire.

Popov (1937), Mowat (P. 251-252. 1964), Cullen (P. 236-238. 1965), Aston (P. 177-182. 1976) stated that outer petals of the var. *pendulum* are entire without a trace of lobes, where as in var. *parviflorum* it is obovate or oblong, obscurely 3-lobed.

After examination of the specimens it is seen that the character of the outer petals of the two varieties is variable and overlapping.

DISCUSSION

The genus *Hypecoum* is characteristically different from other genera of the family Papaveraceae due to the absence of milky juice, presence of only four stamens instead of numerous stamens and tripartite inner petals. It is also seen that the genus *Hypecoum* is also different from the members of the family Fumariaceae in having regular flowers, tripartite inner petals. Whereas in the Fumariaceae the flowers are zygomorphic and the stamens are arranged in bundles opposite to the inner petals, each bundle has a single filament which divides into 3 parts at the apex and the central part has 2-loculed anther and the lateral part with one loculed anther. While in the genus *Hypecoum* the stamens are 4 in number and the anthers are 2-loculed.

According to Hegnauer (1969) the family Papaveraceae has benzylisoquinoline alkaloids, characteristics of the family Magnoliidae. The family Fumariaceae has spirobenzylisoquinoline alkaloids (Pseisner & Sharmma, 1980) which is different from the family Papaveraceae.

On comparison of morphological data, the genus *Hypecoum* is more related to Fumariaceae than to Papaveraceae. However, the genus *Hypecoum* is characterized in having 2-3 zonocolpate pollen grains. This type of pollen itself is considered as derived from the inaperturate pollen types of the genus *Meconopsis*.

Scanning electron microscope study of spermoderm of the genus *Hypecoum* is quite characteristic as the presence of square and rectangular shaped discrete bodies, which is the diagnostic character of the genus *Hypecoum*.

On the basis of above characters it is appropriate to consider the genus *Hypecoum* to represent the family *Hypecoaceae*.

SUMMARY

In this studies, the family Papaveraceae of Indian region is studied on the basis of taxonomy, pollen morphology and seed morphology. The conclusions are summarised below:

(1) The family Papaveraceae of Indian region consisting of the following genera *Argemone, Dicranostigma, Eschscholtzia, Glaucium, Meconopsis, Papaver, Roemeria* are studied in detail regarding their taxonomy, distribution, ecology and phenology. A key for each genus is presented for identification supported by line drawings. Of the above mentioned genera the genus *Meconopsis* is the largest and consists of 22 species. In the genus *Meconopsis* the following species are endemic to the Indian region. *Meconopsis dhwojii, M. gracilipes, M. longipetiolata, M. regia* and *M. taylorii* are confined to Nepal. *M. latifolia* and *M. neglecta* confined to N. W. Himalaya, and *M. robusta* confined to Kumaon Hill. The second largest genus is *Papaver* which consists of 9 species. Most of them are now cultivated for their horitcultural and drug value. The genus *Argemone* are mainly Mexican and introduced in Indian region for horticultural and medicinal uses.

(2) Pollen morphological studies showed that the pollen grains of different taxa of the family Papaveraceae are morphologically heterogeneous. The pollen grains of the various species of the genus *Meconopsis* are characterized by the presence of mainly spheroidal-prolate grains and the grains are tectate. Species of the genus *Papaver* on the contrary is characterized by the presence of intectate grains with perprolate shape. A phylogenetic tree has been proposed on the basis of the advanced and primitive characters of the pollen grains.

(3) The SEM studies of spermoderms of the seeds in different taxa of the family Papaveraceae are charactristic and they are more or less specific. It is seen that the character of spermoderm is quite unique in the genus *Hypecoum* due to the presence of square or rectangular discrete bodies in the spermoderm. While in the genera *Argemone, Dicranostigma, Eschscholtzia, Glaucium, Meconopsis, Papaver, Roemeria* the orientation and nature of muri and lumina are characteristic for each species.

(4) On the basis of some total evidences *i.e.* morphology, pollen morphology and seed morphology the genus *Hypecoum* may be considered as a separate family *Hypecoaceae.*

EXSICCATA

Argemone mexicana

INDIA: UTTAR PRADESH : Allahabad, Chatham line, 9.7.64, *Prasad* 3284 (CAL); Bareilly, 30.12.1848, *Strachey* and *Winterbottom* s.n. (CAL); Dehra Dun, Sahasradhara, 450-500 m, 15.6.67 *Pradhan* 209 (CAL); Ganja, Jaolikoti, 1220 m, 25.6.1909, *Gill* 1 (CAL); Mirzapur, 29.10.64, *Panigrahi* 2238 (CAL); Rihand dam, 22.7.65, *Misra* 9893 (CAL). BIHAR: Champaran, Bagaha, 20.9.1965, *Banerjee* 701 (CAL): Champaran, Manguahs forest, 4.4.1963, *Thothathri* 10066 (CAL); Chotanagpur, January 1876, *Wood* s.n. (CAL); Hazaribagh Dist., Golah, 28.11.1981, *Prain* s.n. (CAL). WEST BENGAL: Burdwan, Paraj and adjoining areas, 15.9.1962, *Dutta* 185 (CAL); Darjeeling, Karseong, May 1915, *Modder* 24 (CAL); Howrah, Bakultala, 5.4.63, *Bennet* 20 (CAL); Jalpaiguri, Buxa, 24.4.59, *Das* 81 (CAL); Malda, Adina, 24.4.1966, *Dutta* 190 (CAL); Midnapore, Digha, 10.2.66, *Rao* 4401 (CAL); Murshidabad, Berhampore, 13.10.65, *Guha Bakshi* 102 (CAL); Purulia, Kulipal, Kukurdabar, 17.2.70, *Malick* 1001 (CAL). SIKKIM: Samghatta, 29.2.1908, *Ribu* 551 (CAL). ASSAM: Chardwar, 17.2.1957, *Panigrahi* 5794 (CAL); Goalpara, 5.3.1972, *Deka* 51005 (CAL). MIZORAM: Sairang, 12.1.1963, *Deb* 30628 (CAL). MEGHALAYA : Khasia, 1879, *Fisher* s.n. (CAL). TRIPURA : Agartala, 22.3.1920, 6 to 90 m, *Debbarman* 1213 (CAL). ORISSA : Balakhand R.F., 21.4.1965, *Abarham* 144 (CAL): Balimela-Basdamamidi, 180-450 m, 24.5. 1959, *Rao* 18547 (CAL); Gourkella, Kalahandi, 7.5.1956, *Mukherjee* 4295 (CAL); Gurguia, Mayurbhanj, 670 m, 2.5.1941 *Biswas & Kazi* 11 (CAL); Majbisahi, 2.7.1957, *Panigrahi* 8541, (CAL). MADHYA PRADESH : Bheriaghat, 17.1.1961, *Maheswari* 4616 (CAL); Bilashpur, Korba, 16.4.1955, *Panigrahi & Arora* 8621 (CAL); Bilashpur, Lamni, Feb. 72, *Murti* 15391 (CAL); Gualin, Mar. 90, *Marico* 251 (CAL); Kanha National Park, Mandla, 20.2.1964, *Schaller* 169 (CAL); Phalghat, 23.9.1964, *Arora* 5999 (CAL); Saugor town, 600 m, 8.3.1960, *Subramanyam* 10204 (CAL). RAJASTHAN : Barmer Dt., Gandhan, along Sanchor road, 25 m, 28.10.1975, *Shetty* 2347 (CAL); Bikaner Dt., Shiubari tank, 288 m, 11.3.1975, *Roy* 1698 (CAL); Jaipur, Daosa, 15.2.1965, *Wadhwa* 8104 (CAL); Jaismand, 9.4.1963, *Verma* 43 (CAL); Jodhpur Dt., on the left side of Biraidam, 21.12.1972, *Moorthy* 411 (CAL); Pali Dt., Hemawas Dam, 215 m, 6.11.1974, *Shetty* 1361 (CAL); Tonk Dt., Banas river bed near Bentheli village, 300 m, 2.2.1973; *Shetty* 468 (CAL). GUJARAT : Saurashtra, Gopnath, 19.3.1964, *Mukherjee* 2223

(CAL). MAHARASHTRA : Ambivili R.F. Vaitarna Catchment Khardi Range, Thana District, 1.6.1968, *Billore* 116107 (CAL); Katrag Ghats, 18.8.1956, *Jain* 6962 (CAL); Kavarthy Island, 20.2.59, *Wadhwa* 45469 (CAL); Lonawala, 24. 6.1956, *Puri* 2452 (CAL); Lonawala, Kuna hill, 6.5.1956, *Jain* 947 (CAL); Poona, Ambavane, top of the Koraikhilla, 31.1.1964, *Reddi* 95841 (CAL); Poona, Ambavane, Pet village, 23.12.1963, *Reddi* 93345 (CAL); Poona, Parvathi Hill-Lakshmi Park, 5.8.1960, *Subramanium* 64477 (CAL). ANDHRA PRADESH : Godavari agency, opposite Ippur, 11.12.1902, *Barber* 5326 (CAL); Near Narsaper lake, 100 m, 24.4.1959, *Sebastine* 7975 (CAL); Srikakulum, Salur, 150 m, 7.9.1962, *Balakirshnan* 981 (CAL). TAMIL NADU: Chinnathadagan, Thekkumalai, 653 m, 3.7.1956, *Sebastine* 82 (CAL); Peria-ari, Alangayam, 600 m, 14.7.1958, *Subramanyam* 6077 (CAL); Ramapuram, 610 m, 31.7.1905, *Fisher* 101 (CAL); Rameswaram Island, Pamban Shore, 25.5.1962, *Rao* 1568 (CAL); Trichirapally, Near Uppiliya-puram, 233 m, 11.8.1958, *Sebastine* 6271 (CAL); Verapalayam, 666 m, 13.7.1956, *Subramanyam* 260 (CAL). LAKSHADWEEP ISLANDS: Agathi, 22.2. 1959, *Srinivasan* s.n. (CAL); Kavarthi, 20.2.1959, *Srinivasan* s.n. (CAL). ANDAMAN & NICOBAR ISLANDS, Teetop, Car Nicobar, 2.3.1974, *Nair* 951 (CAL).

NEPAL: WESTERN NEPAL : Nepalganj, 181 m, 1.11.1972, *Manandhar* 9212 (KATH); Ridhi, Gulmi Dist., 450 m, 2.3.1976, Manander & *Regmi* 70 (KATH). CENTRAL NEPAL : Khurkot (Sindhuli), 510 m, 2.6.1979, *Manandhar* & *Adhikari* 2033 (KATH); Swyamzhu, 1300 m, 13.4.1970, *Manandhar* 9405 (KATH).

A. ochroleuca ssp. *ochroleuca*

INDIA: Cultivated, Forest Research Institute, Dehra Dun, March 1982, *Raizada* 58609 (DD); Dehra Dun, Ballupur, 6.6.66, *Ramdayal* 21757 (DD).

Dicranostigma lactucoides

INDIA: Kumaon, Kalivalley near Chalele, 3000-3500 m, 25.7.1886, *Duthie* 532 (CAL).

NEPAL: Chote-Kaigaon, 3800 m, 21.6.1966, *Shrestha* 5190 (KATH); Daphe, 3620 m, 24.7.1968, *Malla* 14144 (KATH); Karnali zone, Nyorgad to Sipty, Jumla Dist., 2700 m, *Rajbhandari* & *Roy* 3473 (KATH); Ledar-Thoktung, 4200-5300 m, 18.7.1973, *Joski* & *Amatya* 73/729 (KATH); Marsiandi, 3500-4000 m, 14.6.1950, *Lowndes* L991 (KATH).

TIBET: Drepung, Lhasa, 3600 m, 19.6.1942, *Ludlow & Sherriff* 8727 (KATH).

Eschscholtzia californica

INDIA: MANIPUR: Imphal, 12.3.52, *Deb* 227 (CAL). WEST BENGAL: Cult. Indian Botanic Garden, June 1843, *Annonymous* s.n. (CAL). UTTAR PRADESH: Dehra Dun, Cultivated Forest Research Institute, 2.3.1966, *Naithani* s.n. (DD).

Glaucium elegans

BELUCHISTAN: Mir Ali Khel, 1090 m, 17.5.96, *Harsukh* 18765 (CAL); Sinkachh, 21.5.97, *Harsukh* 20453 (CAL).

AFGHANISTAN: *Griffith* 1406 (CAL).

G. fimbrilligerum

PAKISTAN: Gilgit, 1885, *Giles* s.n. (CAL). BELUCHISTAN: Kach, 1880 m, 13.5.1889, *Lace* 3353 (CAL).

AFGHANISTAN: Badghis, 1.5.1885, *Aitchison* 272 (CAL); Kuram Valley, 1879, *Aitchison* 860 (CAL).

Hypecoum leptocarpum

INDIA: KASHMIR: Ladak, foot of Chang La Pass, 3660 m, *Hruelersare* s.n. (CAL). SIKKIM: Kakuchu, 5030 m, 3.8.1909, *Smith & Cave* 1898 (CAL); Kangralama, 5030 m, 14.8.1909, *Smith & Cave* 2400 (CAL); Llowk, 4420 m, 1.8.1909, *Smith & Cave* 1848 (CAL); Takit, July 1879, *King's native collector* s.n. (CAL); Tonglu, 4570 m, 12.9.1912, *Lepcha* 302 (CAL).

PAKISTAN: Gilgit, Hindukush, 1885, *Giles* s.n. (CAL); Pangi, 3355-5030 m, 1879, *Heyde* s.n. (CAL).

NEPAL: Kali Valley, Cultivated ground, 3050-3355 m, 28.7.1886, *Duthie* 5324 (CAL); Marsiandi, 3500 m, 18.9.1950, *Lowndes* 1514 (KATH); Shyamgonipha-Tarap, 4545 m, 16.7.1966, *Shrestha* 5396 (KATH); Tarap, 4100 m, 17.7.1966, *Shrestha* 5408 (KATH).

BHUTAN: Blume-lei, 15.7.1884, *Dungboo* 229 & 230 (CAL); Byagha, 20.5.1905, *White* 180 (CAL).

TIBET: Bo-Pungkar Chu, 3636 m, 31.7.1947, *Ludlow & Sherriff* 15533 (KATH); Chumbi, 29.6.1878, *Dungboo* s.n. (CAL); Chumbi, 9.7.1913, *Cooper* 186 (KATH); Gantza, Aug. 1912, *Gould* 109 (CAL); Phari, 27.7.1877, *King* 4569 (CAL); Kambajong, 10.7.1903, *Youngshubani* 45 (CAL); Kambajong, Sept. 1903, *Prain* s.n. (CAL); Gyangtse, July-September 1904, *Walton* 45 (CAL); Gyangtse Valley, 18.6.1907, *Stewart* s.n. (CAL); Lhasa, 3636 m, 3.7.1943, *Ludlow & Sherriff* 9737 (KATH); Reting, 60 miles N. of Lhasa, 3939 m, 27.7.1944, *Ludlow & Sherriff* 11075 (KATH); Yusum, Tsangpo Valley, 3030 m, 27.5.1938, *Ludlow, Sherriff & Taylor* 4507 (KATH).

H. pendulum var. *pendulum*

PAKISTAN: BELUCHISTAN, 1877, *Duke* s.n. (CAL).

AFGHANISTAN: Khyber Pass, 34° north latitudes, 9.4.1897, Fallow field, 1000 m, *Johnston* 32 (CAL).

MESOPOTAMIA: Fathah, March 1919, *Calder* 2079 (CAL); Shargat, 5.3.1919, *Calder* 1875 (CAL); Shargat, 7.3.1919, *Calder* 1953 (CAL); 4.4.1888, *Stapf* 278 (CAL).

ARAB: Arabia petraes, Sinai Cultis-mart, 1846, *Boissier* s.n. (CAL).

USSR: Turkomania, Aug. 1896, *Antonow* s.n. (CAL); Serarschanica, Samarkand, Solo Azgylloso, 1000 m, 16.5.1892, *Komarov* s.n. (CAL).

H. pendulum var. *parviflorum*

PAKISTAN: BELUCHISTAN: 1700 m, 27.3.1889, *Lace* 3658 (CAL); 1877, *Duke* s.n. (CAL); Kuettah, *Griffith* 1415 (CAL); Killa aberilla, 12.4.88, *Duthie* 8567 (CAL); Banni Dist., 300-400 m, 20.3.1907, *Marten* 41 (CAL); Chitral Dist. 1896, *Hamilton* s.n. (CAL); Killa aberilla, 12.4.88, *Duthie* 8567 (CAL); Peshwar, *Stewart* 49 (CAL).

Meconopsis aculeata

INDIA: JAMMU & KASHMIR: Apharwat, 4110 m, 11.8.1919, *Rich* 1249 (CAL); Band Kote, *Dr. Falconer's collectors* s.n. (DD); Barmaj Kullah, 3030 m, 7.7.43, *Ludlow & Sherriff* 9139 (BM); Chilas, 3355 m, 24.8.1962, *Wadhwa & Vohra* 611 (CAL); Heddian Valley, Kainmul, on wot rocks, 3050-3355 m, 17.7.93, *Duthie*

13083 (DD); Ladak, Lakong, 4600 m, 22.7.1973, *Bhattacharya* 52123 (BSD); West Lidda, 3636-3939 m, Sept. 1936, *Ward* s.n. (BM); Lidden Valley, 3050-3355 m, 17.7.1893, *Duthie* 13083 (CAL); Nilkhantah Pass, 8 miles from Gulmarg, 3355 m, Aug. 1894, *Aitchison* 28 (CAL); Pir Panjal, 10.8.1901, *Inayat* 25483 (DD); Rozdani, Gurez, 3660 m, 16.8.1927, *Forests* 74 (DD); Sarsangarh, Muzaffarbad, 14.7.79, *Inayat* s.n. (DD); Sind Valley, Gagangir, 3636 m, 12.8.40, *Ludlow & Sherriff* 7981 (BM); Singpur, 2745 m, 15.6.1896, *Clarke* 31333 (CAL); Sonsalwala, 3965-4270 m, 31.7.1893, *Duthie* s.n. (CAL); Suid Valley, near Sonamarg, 2440-2745 m, 26.6.1892, *Duthie* 11490 (CAL). HIMACHAL PRADESH: Badsari, slopes above the village, near the Glacier (Baspa Valley), 10.8.1973, *Janardhanan* 52623 (BSD); Bashahr, Ranikunda, 3600 m, 29.9.1964, *Nair* 34417 (BSD); Bashahr, Baspa Valley, 2900 m, 17.7.1890, *Lace* 405 (CAL); Chenab Valley, Pangi-Chamba State, Aug. 1880, *Clarke* 334, 335, 274 & 352 (DD); Jamsar, Chachpur Peak, 3200 m, June 90, *Gamble* 2300 (DD); Kadasa Kanda, near Rakchamon, left bank of river, 4420 m, 17.7.1974, *Janardhanan* 53582 (BSD); Kangra Valley, Chhota Bangahal, 4110 m, 9.9.1955, *Vaid* 24289 (DD); Kulu Valley, Bhirgu, 4110 m, 15.9.1955, *Vaid* 24656 (DD); Kulu Valley, Chander Khani, 3810 m, 14.9.1955, *Vaid* 24689 (DD); Kulu & Kangra, Sharan, 3840 m, 15.10.1894, *Reporter on Ec. Pr. Govt. India* 13489 (CAL); Lahul, upper Bhaga Valley on metamorphia rocks, 2900-3965 m, June 1865, *Stoliczka* s.n. (CAL); Chhafru, 3350 m, 14.9.1961, *Nair* 16973 (BSD); Jhala, 3965 m, 15.6.1941, *Bor* 9724 (DD); Kenlung, 4600 m, 26.8.1970, *Bhattacharya* 40861 (BSD); Kokrsar, 3500 m, 18.7.1972, *Bhattacharya* 48618 (BSD); Kyelang, 3810 m, 14.7. 1938, *Bor* 8716 (DD); Lingti 29.6.1941, *Bor* 15021 (DD); Mahasu Dist., between Larot and Chanchal Pass, 3500 m, 23.7.1965, *Nair* 36097 (BSD); Parmaur Valley, 3050 m, 4.9.1897, *Lace* 1238 (DD); Rakcham Kanda, Baspa Valley, 4720 m, 13.8.1973, *Janardhanan* 52692 (BSD); Rohtang Pass, 4000 m, 22.7.1974, *Rao* 50347 (BSD); Rohtang, 3660 m, 1.7.1938, *Bor* 12098; Near Rohtang, 3900 m, 1.7.58, *Sethi & Negi* 553 (DD); Rohtang, 11.7.1941, *Bor* 9848 (DD); Rohtang, 3660 m, 1.7.1938, *Bor* 12098 (DD); Rohtang Pass, 3050 m, August 64, *Barudis* 3274 (DD); Lahul, 1856, *Wallich* 8122 (CAL); *Jaeschke* 178 (CAL); Sanch Pass, 3660, *Anonymous* 1713 (CAL); Satrundi, Chamba, 3200 m, 13.7.1964, *Nair* 32406 (BSD); 3500 m, 25.6.1964, *Nair* 32809 (BSD); 3200 m, 13.7.1964, *Nair* 32406 (BSD); Lahul, Sissu-Gondha, 3500 m, 27.6.1958, *Rao* 5913 (BSD); Sissu, 3400 m, 2.7.1958, *Rao* 6069 (BSD); Simla, Regno Iubal, 3355 m, 13.7.1887, *Ram Balesh* 6297 (CAL); Lahul, Tissu, 3140 m,

6.7.1938, *Bor* 12374 (DD); Lahul Zingzingha, 4270 m, 16.7.1938, *Bor* 13989 (DD). PUNJAB: Marhi to Rohtang Pass, 3500m, 30.7.1962, *Singh* 22917 (BSD); Between Machi & Rohtang Pass, 3500 m, *Singh* 22917 (CAL). UTTAR PRADESH : Balati Glacier near ice fall, 3810 m, *Thomas* 20909 (DD); W. Bank Balati Glacier, 3965 m, 30.7.1951, *Thomas* 20955 (DD); Garhwal, Amrit Ganga Valley, 4000 m, 10.10.1970, *Naithani* 42139 (BSD); Bajmora, 3600 m, 17.6.1959, *Rao* 10274 (BSD); Buhna-Bajmora, 3500 m, 17.6.1959, *Rau* 10274 (CAL); Ghangaria, 3200 m, 2.10.1962, *Bhattacharya* 18400 (BSD); Near Hemkund, 4000 m, 22.10.1963, *Rau* 31762 (BSD); Hemkund on way, 3800 m, 19.6.1969, *Bhattacharya* 39066 (BSD); Hemkund, Lokpal, 4270 m, 15.10.1957, *Vaid* s.n. (DD); Kedarnath, 3700 m, 12.10. 1965, *Nair* 35905 (BSD); Valley of Flowers, 4200 m, 13.10.1962' *Bhattacharya* 24455 (BSD); on way to Vabulcital, 3800 m, 12.8.1968, *Rao* 38665 (BSD); Garhwal, 1864, *Falconer* 117 (CAL); Kumaon, Bhatia Lehan, 3800 m, 7.8.1972, *Arora* 49716 (BSD); Bogdwar Bugyas, 3000-5000 m, 21.6.1958, *Rao* 7115 (BSD); Bogdwar, Martoli, 3200-4500 m, 14.5.1958, *Rao* 6779 (BSD); Kumaon, Chipla, 4800 m, 12.8.1972, *Arora* 49876 (BSD); Furkia, Pindari, Horainc, 3500-5000 m, 23-25.9.1957, *Rao* 4497 (BSD); Raliv Valley, 4575 m, August 84, *Duthie* 2698 (DD); Rilkote, Gori Valley, 11.8.1900, *Inayat* 24220 (DD); above Rutam, 3810 m, *Strachey & Winterbottom* 2 (CAL); Simla, Gundee all, 3.5.1843, *Brandis* s.n. (DD); In Monte Bazar Kanda, *Ram* 1235 (DD); Simla Hill, 3660 m, August 1940, *Raizada* 13432 (DD); Simla Hills, 1891, *Annonymous* s.n. (DD), Tehri-garhwal, Gangotri, 4880 m, Sept. 97, *Kerbarimand* 20 (DD); Jaundar Glacier, above Harkidun Tars Forest division, 3660 m, 12.9.1955, *Sahni* 24033 and 21934 (DD); Kidarkanta, 3355-3660 m, May 1879, *Duthie* 1023 (DD); Phulaldaru, 4270-4575 m, 21.6.1883, *Duthie* 1051 (DD); Rhudughera, 3355-3660 m, 19.8.1883, *Duthie* 1051 (DD); Base camp, 4725 m, 29.7.67, *Naithani* 37472 (BSD); July 1883, *Duthie* 1051 (CAL); 3660 m, 29.6.83, *Annonymous* 105 Ta (DD); Brit. Garhwal, near Bhowani, 3355-3660, 15.9.1885, *Duthie* 3818 (DD).

PAKISTAN: Iaka, Dhurmsala, 3333 m, 17th Oct. 1874, *Clarke* 24526 A, and 24548 B (CAL).

M. bella

INDIA: SIKKIM: Bijan, 1888, *King* s.n. (CAL); Chakungchu, Tosar, 4270 m, 26.10.1910, *Ribu & Rhomoo* 4463 (CAL); Dzongri, Pey-Keong-La, Aug. 1887, *King* s.n. (CAL); 3965 m, 1896,

Annonymous s.n. (CAL); Dzongri, 1902, *Prain* s.n. (CAL); Meghu, Oct. 1908, *Ribu* 232 (CAL); Ningbil, 4270-4420 m, 5.8.1910, *Smith* 4084 (CAL); Nyegu Nepal frontr., 4270 m, July 1888, *King* s.n. (CAL); Tosa, 4110 m, 29.7.1910, *Smith* 3926 (CAL); 1887, *King* s.n. (CAL); Sept. 1905, *Prain* s.n. (CAL).

NEPAL: Annapurna Himal, Setikhola, 3787 m, 3.8.1954, *Stainton, Sykes & Williams* 6651 (KATH); Arun Valley, Chhoyang Khola, W. of Num, 3787 m, 23.6.1956, *Stainton* 754 (KATH); East of Chalike Pahar, 4242 m, 23.9.1954, *Stainton, Sykes & Williams* 4559 (KATH); Jargeng Khola, 4545 m. 6.7.1950, *Lowndes* 1138 (KATH); Langtang, 3787-4090 m, 8.6.1949, *Polunin* 184 (KATH); Ledar-Thoktung, 4200-5300 m, 18.7.1973, *Joshi & Amatya* 73/723 (KATH); Lumding Khola-Raule, 27.30' N, 86.30' E, 4242 m, 14.7.1964, *McCosh* 411 (KATH); Lumjung Himal, 4242 m, 13.9.1954, *Stainton,* Sykes & *Williams* 8562 (KATH); Luonding Khola-Raule, 4242 m, 14.7.1964, *McCosh* 411 (KATH); Muktinath, 4545 m, 26.6.1954, *Stainton, Sykes & Williams* 1465 (KATH); Muktinath-Torungse, 3900 m, 4.8.1979, *Shakya, Adhikari, Amatya* 5251 (KATH); Nochet-Thonglu, 3750 m, 26.5.1973, *Shakya & Bhattacharya* 2348 (KATH); Rambrong, Lamjung Himal, 4393 m, 7.7.1954, *Stainton, Sykes & Williams* 6203 (KATH); Ratopokhari to Topkegola, 4242 m, 26.7.1971, *Shrestha & Joshi* 336 (KATH); Above Sauwala Khola, 4242 m, 23.9.1954, *Stainton, Sykes & Williams* 3604 (KATH); Taglung, south of Tukucha, Kaligandaki Valley, 4242 m, 15.7.1954, *Stainton, Sykes & Williams* 1795 (KATH); Thinigaon, Muktinath Himal, 4393 m, 22.6.1954, *Stainton, Sykes & Williams* 1322 (KATH).

M. betonicifolia

BURMA-TIBET: Valley of Seinghku, 3333 m, 29.7.1926, *Kingdon-Ward* 7208 (BM); South East Tibet, Taku-Pu-La, Kongbo, 2878 m, 19.5.1947, *Ludlow, Sherriff & Elliot* 15025 (CAL).

M. dhwojii

NEPAL: Chhulema, Dolakha Dist., 3800 m, 20.7.1977, *Rajbhandari* 1645 (KATH); Ghopte-Gosainkunda, 4000 m, 14.6.1969, *Saman & Bista* 13215 B (KATH); Gosainkunda, 4500 m, 13.6. 1969, *Saman & Bista* 13147 (KATH); Gosainkunda, 4200 m, 27.8.1969, *Malla* 16241 (KATH); Way down from Gosain-

kunda, 3600 m, 28.7.1967, *Malla* 9545 (KATH); Karnali Zone, Marghor lagna, Humla Dist., 3650 m, 29.7.1979, *Rajbhandari & Roy* 4112 (KATH); Lalaurivinayak, 4020 m, 28.7.1967, *Malla* 9526 (KATH); Langtang, 4500-5000 m, 21.6.1949, *Polunin* 485 (KATH); Langtang Valley, Chilime, 3500 m, 13.7.1970, *Kanai & Shakya* 218 (KATH); Rolwaling, 3600 m, 26.6.1974, *Stainton* 4680 (KATH); Terchay, 4393 m, 24.8.1932, *Sharma* E 450 (BM).

M. discigera

INDIA: SIKKIM: Gocheyla, Oct. 1908, *Ribu* 37 (CAL); *Mrs. Townened* 768 (CAL).

NEPAL: Arun-Tamur watershed, Thagla Bhanjyang, N. of Topkegola, 4300 m, 18.9.1956, *Stainton* 1707 (KATH); Chilime Kharka via Nagthali Gyang, 4000-4400 m, July 1949, *Polunin* 1334 (KATH); Marghor Lagna, 3900 m, 16.6.1952, *Polunin, Sykes & Williams* 4317 (KATH); Marghor Lagna, Humla Dist., 3800 m, 29.7.1979, *Rajbhandari & Roy* 4124 (KATH); Marghore Lekh, 3900 m, 13.7.68, *Malla* 14224 (KATH); Phujeug Danda (E. Nepal), 4600 m, 27.6.1972, *Shakya* 1755 (KATH); Tamur Valley, Mewa Khola, Topkegola, 4200 m, 10.7.1956, *Stainton* 921 (BM, KATH); Teengaung, 4848 m, 30.7.31, *Sharma* E 53 (BM); Valley above Kumlik, 3400-3500 m, 8.6.1952, *Polunin, Sykes & Williams* 4289 (KATH).

M. gracilipes

NEPAL: Lamjung Himal, 3040 m, 17.7.1954, *Stainton, Sykes & Williams* 6417 (BM, KATH).

M. grandis

INDIA: SIKKIM: Bijan, 3660 m, August 1888, *King* s.n. (CAL); Dzongri, June 1882, *King* s.n. (CAL); Dzongri, 4270 m, June 1887, *King* s.n. (CAL); Dzongri, Oct. 1902, *Prain* s.n. (CAL); Dzongri, 4575 m, June 1888, *King* s.n. (CAL); Dzongri, 3965 m, 23.6. 1892, *Gammie* 199 (CAL); Dzongri, June 1882, *King* s.n. (DD); Sikkim, Oct. 1908, *Ribu* 74 (CAL).

NEPAL: Arun Valley, Barun Khola, N. of Num, 3300 m, 8.6.1956, *Stainton* 561 (KATH); Bhurchula lekh, near Jumla, 3300-3600 m, 12.7.1952, *Polunin, Sykes & Williams* 4613 (KATH);

Chuchumara danda, Mugu Dist., 3600 m, 19.7.1979, *Rajbhandari & Roy* 3538 (KATH); Near Dojam Khola, Suli Gad, 4393 m, 21.6.1952, *Polunin, Sykes & Williams* 2286 (CAL); Ghurchi Lagna, 3400 m, 22.6.1952, *Polunin, Sykes & Williams* 4371 (KATH); Kaignome-Jumla, 3200 m, 5.6.1966, *Shrestha* 5081 (KATH); Likhu Khola, E. Chaukharma, 27°30'N, 86°15'E, 3200 m, 17.6.1964, *McCosh* 244 (KATH); Maharigaon, 5 miles N.E., 4200 m, 22.7.1952, *Polunin, Sykes & Williams* 270 (KATH); Ratopokhari to Topkegola, 3600 m, 26.7.1971, *Shrestha & Joshi* 348 (KATH); Sialgarchi, near Chaudhabise Khola, 3300 m, 26.5.1952, *Polunin, Sykes & Williams* 2101 (KATH); Simbuakhola, 4000 m, 23.6.1969, *Shrestha* 15841 (KATH); Tamur Valley, Mewa Khola, Topkegola, 3900 m, 20.5.1956, *Stainton* 367 (KATH); Above Topkegola, 4040 m, 16.6.72, *Shakya* 1565 (KATH); Yangle, 3600 m, 7.6.1974, *MCneely* 101 (KATH).

M. horridula

INDIA: Sikkim: Donkia, 4880-5410 m, 16.8.1892, *Gammie* s.n. (CAL); Dzongri to Alokterey, 3965-4575 m, 9.10.1862, *Anderson* 362 (CAL); Gachey-La, Oct. 78, *Ribu* 40 (CAL); Gaoning, 4575 m, 31.7.1910, *Smith* 3990 (CAL); Lachung, 9.7.1878, *Dunghoo* s.n. (CAL); Llanakh, above Thangu, 4270 m, 30.7.1960, *Sahni* 59 (DD); Lingdur, N.E. of Talung, 3660 m, 25.7.1906, *Lace* 219 (CAL); Ningbil, 4270-4575 m, 5.8.1910, *Smith* 4077 (CAL); Rougsa Llousk, 4575 m, 28.7.1909, *Smith & Cave* 2015 (CAL); Tankra La, 4880 m, 1891, *Gammie* 570 (CAL); Tang-Ka-la, north of Belep-la at same elevation, 13.8.1882, *King* s.n. (CAL).

NEPAL: Arun-Tamur watershed, Thagla, Bhanjyang, north of Topkegola, 4400 m, 14.7.1956, *Stainton* 998 (KATH); Balangra Pass, 4500 m, 26.7.1952, *Polunin, Sykes & Williams* 2572 (KATH); Chopuk to Thobu, Dolakha Dist., 4500 m, 27.7.1977, *Rajbhandari & Rou* 1953 (KATH); Dumpush, 3900 m, 16.4.1964, *Shrestha & Bistha* 2368 (KATH); Geldarphui, Helambu, 4200-4500 m, 15.8.1972, *Annonymous* 34 (KATH); Inukhu Khola, Naulekh Mathi, 27.30'N, 86.45' E, 4800 m, 5.7.1964, *McCosh* 374 (KATH); near Jangla-Bhanjyang, 4600 m, 3.7.1952, *Polunin, Sykes & Williams* 2637 (KATH); Khangsar, 4500 m, 25.7.1950, *Lowndes* 1242 (KATH); Lamjung Himal, 4500 m, 13.7.1954, *Stainton, Sykes & Williams* 6334 (KATH); Ledar Thoktung, 4200-5300 m, 18.7.1973, *Joshi & Amatya* 73/724 (KATH); Maharigaon, 4500 m, 16.7.1952, *Polunin, Sykes &*

Williams 198 (KATH); Marghore, 3960 m, 13.7.1968, *Malla* 14255 (KATH); Marghor Lagna, Humla Dist., 3800 m, 29.7. 1979, *Rajbhandari & Roy* 4126 (KATH); Muktinath, 4600 m, 26.6.1954, *Stainton, Sykes & Williams* 1453 (KATH); Muktinath, 4200 m, 1.10.1956, *Stainton, Sykes & Williams* 8061 (KATH); Muktinath-Thorungse, 4400 m, 4.8.1979, *Shakya, Adhikari, Shakya & Amatya* 5260 (KATH); Namdo, north of Mustang, 8.8.1954, 5100 m, *Stainton, Sykes & Williams* 2277 (KATH); Naur Pass, 4500-4900 m, 19.7.1950, *Lowndes* 1309 (KATH); Pauch, Pokhari-Jatapokhari, 4300 m, 28.7.1978, *Pradhan, Shakya, Saiju & Shrestha* 4978 (KATH); Pheriche-Lobuche, 4500-5000 m, 22.4.1958, *Rao* 13785 (KATH); Ringmigaon, 3900 m, 3.8.1973, *Enarsson, Skarby & Wetterhall* 3012 (KATH); above Sauwala Khola, 4500 m, 23.7.1954, *Stainton, Sykes & Williams* 3603 (KATH); Taglung, south of Tukucha, Kali Gandaki Valley, 4300 m, 16.7. 1954, *Stainton, Sykes & Williams* 1842 (KATH); Topkegola to Thudum, 3600 m, 30.7.1971, *Shrestha & Joshi* 370 (KATH); Utai Lagna, below Saipal, 4200 m, 10.7.1953, *Tyson* 94 (KATH).

BHUTAN: 12.7.1906, *White* s.n. (CAL).

TIBET: Ba-ne-gang, between Chola & Chumbi, 18.7.1882, *King* s.n. (CAL); Giagong, 4545 m, 18.7.1903, *Younghusband* s.n. (CAL); Gochung, 4.7.1903, *Younghusband* 8 (CAL); Gyangtse, July to Sept. 1904, *Walton* 9 (CAL); Kambajong, Sept. 1903, *Prain* s.n. (CAL); Kambajong, 20.7.1903, *Younghusband* 116 (CAL); Kaso La Pass, 5000 m, July 1904, *Walton* s.n. (CAL); Hills above Lhasa, Aug. 1904, *Walton* s.n. (CAL); Mee-rik-La, 30.7.1884, *King* 630 (CAL); Mira La, Nyang Chu, 4545-4848 m, 14.8.1938, *Ludlow, Sherriff & Taylor* 6062 (CAL); Sham Chen, July 1879, *Dungboo* s.n. (CAL); above Singma, Kangchung, 3484 m, 21.8.1936, *Chapman* 157 (CAL); near Tachienlu, 2727-4090 m, *Pratt* 525 (CAL); Ta-Chey-Kaug, 21.7.1884, *King* 522 (CAL); Teling, Aug. 1878, *Dungboo* s.n. (CAL).

M. latifolia

INDIA: JAMMU & KASHMIR: Butin Pantsal, 3484 m, 13.8.40, *Pinfold* 266 (BM); Keyan forest, Kaonah vasim, Kishan, Ganga Valley, 2135-2745 m, 12.7.1906, *Keshavanand* 205 (DD); Narda, Kishanagar Valley, 3965-4565 m, 14.10.1906, *Keshavanand* 610 (DD).

M. longipetiolata

NEPAL: Chiline & Langtang Valleys, Mulkharka, 3780 m, 2.7.1970, *Kanai & Shakya* 672212 (KATH); Langtang to Kyangchin, 3261 m, 14.7.1967, *Malla* 9040 (KATH).

M. lyrata

INDIA: WEST BENGAL: Phallot, 3660 m, Aug. 1887, *King's Collector* s.n. (CAL); Phallot, 3660 m, 1887, *Anonymous* s.n. (CAL). SIKKIM: Bijan, 1888, *King's Collector* s.n. (CAL); Chianei Nepal frontr., 3965 m, Aug. 1888, *King's Collector* s.n. (CAL); Dikchu Valley, 3355 m, 23.7.1910, *Smith* 3758 (CAL); Kyanglasha, 2745 m, 22.7.1945, *Bor's Collector* 69 (DD); Sherabthang, 3965 m, 13.8.1910, *Smith* 4308 (CAL); Ta-me-da, 7.8.1877, *King* 4460 (CAL); Yankra, 3965 m, 2.8.1892, *Gammie* 415 (CAL).

NEPAL: Annapurna Himal, Setikhola, 4300 m, 2.8.1954, *Stainton, Sykes & Williams* (KATH); Arun-Tamur watershed, 4200 m, 19.7.1956, *Stainton* 902 (KATH); Lauri Venayak, 3810 m, 26.7.1967, *Malla* 9227 (KATH); Lumding Khola, 3900 m, 13.7.1964, *McCosh* 405 (KATH); Mandana-Fokte, 3600 m, 29.7.1978, *Pradhan, Shakya, Saiju & Shrestha* 4943 (KATH); Rambrong, Lamjung Himal, 4000 m, 10.7.1954, *Stainton, Sykes & Williams* 6254 (KATH).

TIBET: Chumbi, Put-to, 13.7.1884, *King* 523 (CAL); Sham Chen, July 1879, *Dungboo* s.n. (CAL); Lingmoo-tang, 17.7.1884, *King* 331 (CAL); Yunnan, 1917-1919, *Forrest* 15491 (CAL).

M. napaulensis

INDIA: UTTAR PRADESH, Brit. Garhwal, Rocks above Ramri, 3355-3660 m, 18.9.85, *Duthie* 3817 (DD). WEST BENGAL: Darjeeling, Phalloot, 14.10.1868, *Kurz* s.n. (CAL); Phalloot, 3660 m, 28.7.1884, *King* s.n. (CAL); Phullalong, 3050 m, 5.10.1870, *Clarke* 13460C (CAL); Sandakphu, 3355 m, Sept. 1898, *Anonymous* 11839 (CAL); Sandakphu, 3050 m, 12.10.1875, *Gamble* 120 B (CAL); Sandakphu, 3355 m, July 1881, *Gamble* 9481 (CAL); Singalelah, 3050 m, 7.10.1870, *Anonymous* 13518 (CAL); Tongloo, Sept. 1874, *King* 1,2,3 (CAL); Tongloo, Oct. 1908, *Ribu* 386 (CAL); Tongloo, 2440-3050 m, 3.8.1862, *Anderson* 363 (CAL); Tongloo, 2440-3050 m, 3.8.1862, *Anderson* s.n. (DD). ASSAM: Nefa, *Annonymous* 1624 (ASSAM).

SIKKIM: Bijan, 1888, *King* s.n. (CAL); Chakungchu, 3300 m, 18.9.1913, *Cooper* 908 (KATH); Chakungchu, 3660 m, 30.7.1910, *Smith* 3962 (CAL); Cheabhanjan, 3050 m, Sept. 1898, *Annonymous* 11789 (CAL); Dzongri, Aug. 1887, *King* s.n. (CAL); Dzongri, Oct. 1908, *Ribu* 103 (CAL); Dzongri, 27.9.1862, *Annonymous* s.n. (DD); Karponog, 2710 m, 18.7.1956, *Chatterjee* 292 (CAL); Megu, Sept. 1905, *Prain* s.n. (CAL); Pongling, Sept. 1905, *Prain* s.n. (CAL); Samthong, below Dzongri, June 1887, *King* s.n. (CAL); Sandampuk forest, Sept. 1901, *Prain* 229 (CAL); Tanthong, below Dzongri, June 1887, *King* s.n. (CAL); Tamthong, below Dzongri, June 1887, *King* s.n. (DD); Tosar, Chakungchu, 4270 m, 26.10.1910, *Ribu & Rhomoo* 4465 (CAL); 3050 m, *Hooker* 2090 (CAL).

NEPAL: Basantpur-Terhathum, 5000 m, 14.8.1976, *Manandhar* 315 (KATH); above Bhorpatan, 3181 m, 13.7.1954, *Stainton, Sykes & Williams* 3488 (BM); Chakhure lekh (Jumla), 3300 m, 3.8.1981, *Manandhar & Joshi* 6609 (BM); Chankheli, Lagna, 3100 m, 19.6.1952, *Polunin, Sykes & Williams* 4324 (KATH); near Chipli, 2424 m, 18.4.1954, *Puri* 141 (CAL); above Dhorpatan, 3100 m, 13.7.1954, *Stainton, Sykes & Williams* 3488 (KATH); Gurjaghat, 3200 m, 23.6.1979, *Saiju & Tuladhar* 36/79 (KATH); northwest of Gurjakhani, 3600 m, 13.6.1954, *Stainton, Sykes & Williams* 3099 (KATH); Ganesh Himal, Ankhu Khola, 28°12'N (Lat.) 85°5'E (Long.), 4090 m, 11.7.62, *Stainton* 3990 (BM); Iswa Khola, 3300 m, 19.6.1974, *MCneely* 119 (KATH); Kangrang la, 3700 m, 17.6.1969, *Shrestha* 15749 (KATH); Khappre to Chhintapu, Flam Dist., 2800 m, 7.10.1977, *Pradhan, Rajbhandari & Nirola* 328 (KATH); Larjung, south of Tukucha, Kali Gandaki Valley, 2800 m, 27.5.1954, *Stainton, Sykes & Williams* 747 (KATH); Lete, Kali Gandaki Valley, 3600 m, 4.6.1954, *Stainton, Sykes & Williams* 5583 (KATH); Lete, south of Tukucha, Kali Gandaki Valley, 3200 m, 6.6.1954, *Stainton, Sykes & Williams* 970 (KATH); Maharigaon, 4500 m, 20.7.1952, *Polunin, Sykes & Williams* 224 (KATH); Minchin Dhap., 1963, *Hara, Kanai, Kurosawa, Murata, Togashi, Tuyama* 6302885 (KATH); On way to Pinna, 2700 m, 3.7.1968, *Malla* 10709 (KATH); Topkegola-Sewadan, 3300 m, 28.6.1972, *Kanai, Ohashi, Twatsuki, Ohba, Iwatsuki, Shakya* 1793 (KATH); Tukucha, Kali Gandaki Valley, 3100 m, 22.8.1954, *Stainton, Sykes & Williams* 7405 (KATH).

TIBET: 5.11.1903, *Younghusband* 59 (CAL).

M. paniculata

INDIA: Uttar Pradesh: Tihri-Garhwal, Gulmar Pass, 3660-3965 m, 27.8.1883, *Duthie* 1050 (DD). West Bengal: Darjeeling, Phalloot, 3660-3965 m, *Kurz* s.n. (CAL); Sandakphu, 3810 m, 8.10.1941, *Biswas* 5714 (CAL); Sandakphu to Phallut, 3355-3660 m, 19.10.1904, *Burkill* 25228 (CAL); Tongloo to Phallot, 3050-3660 m, *Kurz* s.n. (CAL). Sikkim: Bijan, 1888, *King* s.n. (CAL); Kupup to Nathang, 7.6.1955, *Rao* 933 (ASSAM); Natong, 23.6.1878, *Dungboo* s.n. (CAL); Paiju, 3355 m, 17.7.1906, *Lace* 131 (CAL); Patangla, 2135 m, 16.7.1877, *King* 4158 (CAL); Pongling, Sept. 1905, *Prain* s.n. (CAL); Rasthangoong, Oct. 1908, *Ribu* 120 (CAL); Siamphung, 3660 m, July, 1888, *King* s.n. (CAL); Singalelah Range, 3965 m, 18.6.1892, *Gammie* 150 (CAL); Tankra, 3355 m, 1.8.1892, *Gammie* 471 (CAL); Tanthong to Dzongri, June 1887, *King* s.n. (CAL); Tauthang (Dzongri), June 1887, *King* s.n. (DD); Tha-lam-lee, 3050 m, 22.6.1882, *King* s.n. (CAL); Thopoo, 1901, *Prain* 303 (CAL); Tsomgo, 3900 m, 23.6.1945, *Bor* & *Kirat Ram* 20559 (DD); Yeumtong, Lachung Valley, 3660 m, Aug. 1892, *Gammie* s.n. (CAL); Yeumtong, Lachung, 3660 m, Aug. 1892, *Gammie* s.n. (DD); Yumathong, 3355 m, 6.9.1933; *General secretary to H. H. Maharaja* 1140 (DD); 1882, *King* s.n. (CAL); Zemu Valley, 2900 m, 9.7.1909, *Smith* & *Cave* 1050 (CAL).

NEPAL: Annapurna Himal, Setikhola, 3600 m, 4.8.1954, *Stainton, Sykes* & *Williams* 6658 (KATH); Setikhola, 3500 m, 14.9.1954, *Stainton, Sykes* & *Williams* 8591 (KATH); Arun-Tamur watershed, S. of Topkegola, 3900 m, 9.7.1906, *Stainton* 889 (KATH); Daldong to Demdem, Dolakha Dist., 3750 m, 21.7.1977, *Rajbhandari* & *Roy* 1676 (KATH); Guphapokhari, 3100 m, 20.7.1971, *Shrestha* & *Joshi* 149 (KATH); Jahjale to Balukhop, 4000 m, 23.7.1971, *Shrestha* & *Joshi* 285 (KATH); Langtang Valley, 3000 m, 14.7.1967, *Malla* 9028 (KATH); Niblyu, 3900 m, 19.4.1971, *Shrestha* & *Bistha* s.n. (KATH); Rambrong, Lamjung Himal, 3800 m, 1.7.1954, *Stainton, Sykes* & *Williams* 6068 (KATH); Siringdham, 3000 m, 16.6.1969, *Shrestha* 15654 (KATH); Soorgoorey, 3939 m, 1929, *Dheooj* 235 (BM); Topkegola, 3636 m, 2.7.1971, *Beer* 8244 (BM).

BHUTAN: Tak-Poo, 28.6.1884, *Dungboo* 285 (CAL).

TIBET: Chumbi Valley, Gantnza, 3333-3636 m, Aug. 1912, *Gould* 131 (CAL).

M. primulina

BHUTAN: Kangla Karchu La, 4242 m, 18.6.49, *Ludlow, Sherriff & Hicks* 16569 (BM); Kangla Karchu La, 4242-4545 m, 29.9.49, *Ludlow, Sherriff & Hicks* 17338 (BM).

M. regia

NEPAL: Annapurna Himal, Seti Khola, 4000 m, 30.7.1954, *Stainton, Sykes & Williams* 6554 (KATH), (Red flowers); Chakhure lekh, Jumla Dist., 3700 m, 8.9.1979, *Rajbhandari & Roy* 2901 (KATH); Dori Lekh, Jumla Dist., 3400 m, 17.7.1979, *Rajbhandari & Roy* 3375; Fokte-Mandanda, 3600 m, 26.7.1978, *Pradhan, Shakya, Saiju & Shrestha* 4907 (KATH); Lamjung Himal, 4200 m, 11.7.1954, *Stainton, Sykes & Williams* 6282 (KATH), (Red flowers); Lamjung Himal, 4200 m, 17.9.1954, *Stainton, Sykes & Williams* 8620 (KATH), (Red flowers); Lamjung Himal, 4200 m, 18.9.1954, *Stainton, Sykes & Williams* 8637 (KATH); near Mabu Pass, Dailekh Dist., 3000 m, 6.7.1979, *Rajbhandari & Roy* 2901 (KATH); Mandanda-Jatapokhari, 3800 m, 28.7.1978, *Pradhan, Shakya, Saiju, Shrestha* 4933 (KATH); Morane-Dhorpatan, 3100 m, 24.5.1966, *Shrestha* 5021 (KATH); on way to Pinna, 2700 m, 3.7.1968, *Malla* 10709 (KATH); Rambrong, Lamjung Himal, 4200 m, 5.7.1954, *Stainton, Sykes & Williams* 6139 (KATH).

TIBET: South east Tibet, Sang La, 29°35' (N. Lat.) 94°43' (E. Long.), 4190 m, 29.6.1938, *Ludlow, Sherriff & Taylor* 5043 (CAL); Sobhe La, near Tongyuk Dzong, 3636 m, 21.5.1947, *Ludlow, Sherriff & Elliot* 13748 (CAL); West of Szechuen and Tibetian Frontier, Chiefly near Tachienlu, 2727-4090 m, *Pratt* 756 & 869 (CAL).

M. robusta

INDIA: UTTAR PRADESH: Chamoli, Gandhital (Kedarnath), 4000 m, 17.8.1976, *Madhwal* 53715 (BSD); Garhwal, Rambra-Kedarnath, 3000 m, 11.8.1968, *Rao* 38648 (BSD); Garhwal, 1869, *King* s.n. (CAL); *Kumaon*, 3050 m, 18.6.82, *Collett* 11 (CAL); Kumaon, Almora, Dwati, 33.6.1933, *Bis Ram* s.n. (DD); Kumaon, Pap above Namik, 2440 m, *Strachey & Winterbottom* 1 (CAL & DD); Kumaon, Byans, Palang Geidh, 3355-3660 m, 21.7.1886, *Duthie* 5325 (DD).

M. simplicifolia

INDIA: SIKKIM: Kupup to Nathong, 7.6.1955, *Rao* 955 (ASSAM); Changu, 3750 m, 14.7.1956, *Chatterjee* 243 (CAL); Changu, beyond Natong, 15.10.1884, *King* s.n. (CAL); Dzongri, 4270 m, June 87, *King* s.n. (CAL); Dzongri, 4055 m, 3.6.1954, *Mitra* 9565 (CAL); Dzongri, 3660-4270 m, June 92, *Gammie* s.n. (CAL); above Kupup, 3965 m, 10.10.1928, *Anonymous* 309 (CAL); Kupup, 3950 m, 7th July, *Bor & Kirat Ram* 19812 (DD); Lingdur, N.E. of Talung, 3965 m, *Anonymous* 236 (CAL); Ling-too, 3050 m. June 82, *King* s.n. (CAL); Lachung Valley (Samdong), 4575 m, 15.8.1892, *Gammie* 787 (CAL); Lachung Valley (Samdong), 4575 m, 15.8.1892, *Gammie* s.n. (CAL); Lachung Valley, Aug. 1892, *Gammie* s.n. (DD); Lung thung, 3660 m, June, *Bor & Kirat Ram* 19841 (DD); Na-tong, 20.6.78, *Dungboo* s.n. (CAL); Seamphung near Dzongri, June 87, *King* s.n. (CAL); Sherabthung, 3965 m, 21.9.1926, *Anonymous* 139 (CAL); Thangu, Sept. 1903, *Prain* s.n. (CAL); Thangu, 3965 m, 22.4.1945, *Biswas* 6933 (CAL); Tsomgo, 4th June, *Bor & Kirat Ram* 19763 (DD); Yeumtong, 3355 m, May 85, *King* s.n. (DD); Yumathang, 3565 m, 5.9.1933, *General Secretary to H. H. Maharaja* 1145 (DD); Zemmu Valley, 3900 m, 11.7. 1909, *Smith & Cave* 1183 (CAL); Zemmu Valley, 5030 m, 16.7. 1909, *Smith & Cave* 1557 (CAL).

NEPAL: Arung Valley, Chhoyang Khola, W. of Num, 3900 m, 22.6.1956, *Stainton* 743 (KATH); Chhulema, Dolakha Dist., 3800 m, 20.7.1977, *Rajbhandari & Roy* 1643 (KATH); Hile Chok-Ghopte (Tal Pokhari), 3450 m, 12.6.1972, *Kanai, Ohashi, Iwatsuki, Ohba, Iwatsuki, Shakya* 1475 (KATH); Honghu Khola, 27°30'N, 86°45'E, 4200 m, 2.7.1984, *McCosh* 348 (KATH); Iama, Chungbu-Samdan, 4250 m, 24.6.1972, *Kanai, Ohashi, Iwatsuki, Ohba, Iwatsuki, Shakya* 1702 (KATH); Kangra La, 3700 m, 17.6.1969, *Shrestha* 15716 (KATH); Kangra La, 3939 m, 27°25' N (Lat.), 88°03' E (Long.), 17.7.69, *Williams* 703 (BM); Lamjung Himal, 4090 m, 16.9.1954, *Stainton, Sykes, Williams* 8643 (BM); Mulkharka (C. Nepal), 3900 m, 1.7.1970, *Kanai & Shakya* 67221 (KATH); Rambrong, Lamjung Himal, 3600 m, 29.6.1954, *Stainton, Sykes & Williams* 6041 (KATH); Topke-gola, 3600 m, 4.7.1971, *Beer* 8267 (KATH); Tori dwari, 3900 m, 4.7.1966, *Shrestha* 21 (KATH).

TIBET: Bue-tang, 18 miles N. W. Chumbi, 8.7.1878, *Dungboo* s.n. (CAL); Valley around Chumbi, Aug. 1914, *Walsh Esqr* 63 (CAL); Doshong La, Kongbo, 3939 m, 17.8.1947, *Ludlow, Sherriff &*

Elliot 14383 (CAL); Gochung, 4.7.03, *Younghusband* 5 (CAL); Ley-roug, 2.7.1884, *King's Collector* 539 (CAL); Mee-rik-la, 27.6.1884, *King's Collector* 336 & 337 (CAL); Phari plain & the upper Chumbi Valley, end of May 1904, *Walsh Esqr* 146 (CAL); below Tangu, 3333-3939 m, 1.7.1903, *Younghusband* s.n. (CAL).

M. sinuata

INDIA: SIKKIM: above Changu, 3810 m, *Smith* 3147 (CAL); Kupup, Sherabthung, 3965 m, *Annonymous* 148 (CAL); Ney-go-la, 4575 m, *King* s.n. (CAL).

NEPAL: Way down to Gleopte (Langtang), 3000-3500 m, 28.7.1967, *Malla* 9551B (KATH); Iswa Khola, 4090 m, 6.9.1975, *Beer* 25429 (BM); Rambrong, Lamjung Himal, 3900 m, 3.6.1954, *Stainton, Sykes, Williams* 6103 (BM, KATH); Ratopokhari to Topkegola, 3800 m, 29.7.1971, *Shrestha & Joshi* 359 (KATH).

M. superba

INDIA: SIKKIM: Damthung, to Charithang, 25.7.38, *Tabla* 1381 & 1214 (DD).

BHUTAN: Ho-Ko-Chu, 16.6.1884, *Dungboo* 280 (CAL).

M. villosa

INDIA: WEST BENGAL: Darjeeling, Phallot, 3355-3660 m, *Kurz* s.n. (DD); Singalila, 3050 m, 7.10.1870, *Clarke* 12582 & 13376 A (CAL); Singalila, 3355 m, Aug. 1901, *Rojers* s.n. (CAL); Singalila, 3355 m, Oct. 1904 *Burkill* 25275 (CAL). SIKKIM: Barfonchey (Cholu Range), 3355 m, 26.9.1892, *Gammie* 1298 (CAL); Changu, 3810 m, 21.10.1928, *Annonymous* 498 (CAL); Changu, 3660 m, 17.8.1933, *General Secretary to H. H. The Maharaja* 1111 (DD); Dzongri, 1888, *King* s.n. (CAL); Inindsardara, 3660 m, July 1887, *King* s.n. (CAL); Karponang, 3355 m, 13.6.1932, *G. Secretary of Sikkim Estate* s.n. (CAL); Karponang, Changath, 3200 m, 22.9.1926, *Annonymous* 173 (CAL); Karponang, 2900 m, *Chatterjee* 154 (CAL); Lachung Valley, Aug. 1892, *Gammie* s.n. (CAL, DD); Laglep, 3000 m, 26.6.1913, *Cooper* 6 (KATH); Laglep, Changu, 2700-3000 m, 20.8.1913, *Cooper* 555 (KATH); Meguthang to Nayathang, 3505 m, 8.6.1954, *Mitra* 9649 (CAL); Neaora, 3660 m, Sept. 1898, *Annonymous* 11872 (CAL); Phedap, Oct. 1908, *Ribu* 280 (CAL); Thangu, 3965 m, 22.5. 1945, *Biswas* s.n. (CAL); Tsomgo, 3660 m, 9.5.1945, *Bor* &

Kirat Ram, 18602 (DD); Tsomgo, 3050-3660 m, 25.6.1945, *Bor & Kirat Ram* 20595 (DD); Yakla, 3050 m, 16.10.1869, *Clarke* 10045 (CAL); Sikkim, 3050 m, *Hooker* s.n. (CAL); 7.8.1877, *King* 4470 (CAL); 3.8.1877, *King* 4505 (CAL); Sikkim aal Nepal Frontr., 4270 m, June 1888, *King* s.n. (DD).

NEPAL: Arun Valley, Maghang Khola, E. of Num, 3200 m, 1.7.1956, *Stainton* 805 (KATH).

TIBET: 5.11.1903, *Younghusband* s.n. (CAL).

Papaver decaisnei

PAKISTAN: Kuram Valley, 1879, *Aitchison* 138 (CAL).

BELUCHISTAN: Shelabagh, Khojak Pass, 11.4.88, *Anonymous* 8365 (CAL); Surkhat Valley, 1830 m, 28.4.1889, *Lace* 3983 (CAL).

AFGHANISTAN: *Griffith* 1408 (CAL).

P. dubium

INDIA: JAMMU & KASHMIR : Munsbal, 1675 m, 30.5.58, *Raizada's Coll.* 26352 (DD); Pampore, 1750 m, 10.6.1959, *Rao* 9385 (BSD, CAL). HIMACHAL PRADESH: Bashahr, Sarahan, 2400 m, 26.5.1952, *Nair* 21887 and 21893 (BSD); Urni, 2300 m, 30.5.1962, *Nair* 22148 (BSD); Jeori, 1550 m, 25.5.1962, *Nair* 21820 (BSD); Kinnaur Dist., Kalpa, 2990 m, 3.6.1972, *Janardhanan* 47625 (BSD & CAL); Kalpa, Bashahr, 2725 m, 6.6. 1962, *Nair* 22318 (BSD); Pangi, 3 km beyond P.W.D. Rest house, Kinnaur Dist., 2825 m, 5.6.1972, *Janardhanan* 47722 (BSD); Sangla, above Tehisil office, Baspa Valley, 2650 m, 15.5.1972, *Janardhanan* 46746 (BSD). PUNJAB: Kulur, Parbatti Valley, near Tosnal village, at about 2590 m, 4.6.1934, *Parkinson* 4052 (DD); Panjab Himalaya, May 1884, *Cuningham* s.n. (CAL). UTTAR PRADESH: Garhwal, Bagnigar, 1800 m, 29.4.1967, *Bhattacharya* 35171 (BSD); Mandoli, 1960 m, 30.4.1967, *Bhattacharya* 37212 (BSD); on the way to Nagnath, 29.4.1963, *Malhotra* 27265 (BSD); Garhwal, *Falconer* 113 (CAL); Jaunsan, Cult. ground near Kathyam, 1830-2135 m, 12.5.93, *Duthie* 12933 (CAL); Moussourie, 1869, *King* s.n. (CAL); Kumaon, Jeolikote, 1220 m, 5.2.1913, *Gill* 547 (CAL); Simla, Cornfield near Ghaniss, 1372 m, April 1886, *Jhonson* s.n. (CAL); Cornfields, below Boileauganj, 1830 m, 21.4.1878, *Gamble* 5878B (DD); Simla, 1710 m, 17.5.76, *Gamble* 42330 (CAL); Tehri-Garhwal, Lacu-

batech, in Cult. ground, 1830-2135 m, 18.5.97, *Duthie* 19825 (CAL & DD); Wheat fields near Khatyar, 2135 m, April 1938, *Bor* 11731 (DD).

NEPAL: Ganger (W. Nepal), 2900 m, 20.6.1965, *Shrestha* 4229 (KATH).

P. hybridum:

PAKISTAN: Hazara, below 608 m, *Stewart* s.n. (CAL); Hazara, Haripur, *ca.* 456 m, 18.3.1887, *Das* 6294 (CAL); Hazara, Mansehra, 16.5.1897, *Gnayat* 21122 (CAL); Punjab, Sept. 1892, *Aitchison* 63 (CAL).

P. macrostomum

INDIA: KASHMIR: Kauri Valley, 3050 m, 24.8.1892, *Duthie* 12575 (DD); Srinagar, Near Batwara, 1525-1830 m, 8.5.1892, *Duthie* 10838 (CAL); Srinagar, 1615 m, 2.7.1891, *Gammie* s.n. (CAL); Srinagar, 1735 m, 2.7.1891, *Gammie* s.n. (DD); Srinagar, 12.4.1885, *Drummond* 1233 (DD); Ramoo, 1830 m, 10.7.1876, *Clarke* 285430 (CAL).

P. nudicaule

INDIA: JAMMU AND KASHMIR: Baltistan, Karpucha nullah, 3965-4270 m, 10.7.1892, *Duthie* s.n. (CAL); Burjil pass, 3660 m, 1.8.1876, *Clarke* 29929 (CAL); Burzil pass, 3965 m, 14.9.1893, *Duthie* 14037 (DD); Gadsar, 3355 m, 8.9.1909, *Keshavanand* 1472 (DD); Gilgit, Nittar Valley, 3050-3660 m, 4.8.1892, *Duthie* s.n. (CAL); Kamra Valley, near Kalapasu, 3355-3660 m, 25.8.1892, *Duthie* s.n. (DD); Kargah Valley, above Tilail, 3965-4270 m, 30.8.1893, *Duthie* s.n. (CAL); Ladak, Jauskar, *Keyde* s.n. (CAL); Ladak, Khardungla, 5185 m, 19.9.1955, *Abrol* 4490 (CAL); Ladak, Khardbongla, 4575-4880 m, Aug. 1905, *Meebold* 3011 (CAL); Ladak, 4575-5185 m, *Thomson* s.n. (CAL); Liddar Valley, Kathoi, 28.8.1901, *Gnayat* 25482 (DD); Below Mahagunas Pass, 3800 m, 4.9.1972, *Rau* 50327 (BSD); Near Mahagunas Pass, 4110 m, 16.9.1954, *Vaid* s.n. (DD); Panchtarni on way, 3800 m, 26.7.1966, *Nair* 36997 (BSD); Sangan Valley, 3955 m, 27.7.1893, *Duthie* 13274 (DD); North Sonamarg, 3355-3965 m, 15.8.1913, *Koebel* 126 (CAL); Kashmir, 3355-4270 m, *Drummond* 14, 824 (CAL). HIMACHAL PRADESH: Panji, 3355-5030 m, 1879, *Heyde* s.n. (CAL); 3505 m, 13.6.1880, *Aitchison* 139 (CAL).

P. pavonium

PAKISTAN: Hazara, 456 m, 20.3.1887, *Das* 6295 (CAL); Wana, 1370 m, 1.5.1895, *Duthie* 15630 (CAL).

BELUCHISTAN: Doobund, *Annonymous* 944 (CAL); Kanozai, 2.5.1896, *Harsukh* 18764 (CAL); Khyber stream bed, 1898, *Milne* 137 (CAL); Rilla Abdulla, 12.4.88, *Duthie* 8564 (CAL); Sheto, 1525 m, 19.4.89, *Lace* 3543 (CAL).

AFGHANISTAN: Hari-rud Valley, April 1885, *Aitchison* 269 (CAL); Kuchlak, *Annonymous* 418 (CAL).

TURKISTAN: Bajandai pr. Kuldscha, 610-1220 m, 6.5.1879, *Regel* s.n. (CAL).

U.S.S.R.: Turkomenia, *Antonow* s.n. (CAL); Turkomenia, 1909, *Bornmiller* s.n. (CAL).

P. rhoeas

INDIA: HIMACHAL PRADESH: Chambah, 8.6.1864, *Brondis* 4336 (CAL & DD). PUNJAB: Khanna, Ambala Dist., 10.3.1966, *Nair* 35980 (BSD). UTTAR PRADESH: Dehra Dun, Bindal (office compound), 10.4.1965, *Babu* 35079 (BSD); Dehra Dun, B. Garden (Cult.), April 1958, *Raizada* s.n. 130025 (DD), Mussorie, *King* s.n. (CAL); Mussorie, Municipal Garden, 1980 m, 5.6.1961, *Saxena* 1959 (DD); Saharanpur, April 1877, *Duthie* s.n. (DD); Saharanpur Garden, March 1885, *Annonymous* s.n. (DD). WEST BENGAL: Darjeeling, Cult. in Horto Botanic Darjeeling, *Annonymous* s.n. (CAL).

P. somniferum

INDIA: HARYANA: Sirsa, 6.3.1896, *Prain* s.n. (CAL). UTTAR PRADESH: Banda, 1.3.1901, *Bell* 48 (CAL); Dehra Dun, Chandbagh, 15.3.1924, *Gupta* s.n. (DD); Dehra Dun, F.R.I., 26.4.1950, *Raizada* s.n. (DD); Etawah, *Ghune* s.n. (CAL); Khurja, 20.4.1963, *Singh* 25554 (BSD); Simla, Baghe to Sangri, 2900-3050 m, 31.5.1888, *Brown* 7245 (DD). SIKKIM: Above Chongthang, 2135 m, May 85, *King* s.n. (CAL). ASSAM: Balek to Lokpur, 9.3.1912, *R.E.P.* 36977 (CAL). MANIPUR: Muripur, Poor crop sparely seen in the Valley, 610-915 m, April 1882, *Watt* 7208 (CAL). MAHARASHTRA: Poona, Garden, 580 m, 20.2.1956, *Varak* 3300 (DD). TAMILNADU: Oota-

camund, 1856, *Annonymous* s.n. (CAL); Saraon Bath, Meja Road, 16.3.1896, *Prain* s.n. (CAL); Bhatedwa, Meja Road, 16.3.1896, *Prain* s.n. (CAL).

Roemeria hybrida ssp. *dodecandra*

PAKISTAN: BELUCHISTAN: *Lace* 3578 (CAL); Fort Sandemann, 5.5.79, *Harsukh* 20452 (CAL).

AFGHANISTAN: *Griffith* s.n. (CAL); Harirud Valley, 12.4.1885, *Aitchison* 209 (CAL); Khyber Pass, 1060 m, 13.4. 1897, *Johnston* 94 (CAL).

IRAN: Persia borealis, *Pichler* s.n. (CAL).

ARAB: Petrea, 1846, *Rard* s.n. (CAL); Petrea, March 1846, *Boissier* s.n. (CAL).

MESOPOTAMIA: Biredjik, Hasehnadi, 28.4.1888, *Annonymous* 456 & 581 (CAL); Fathah, March 1919, *Calder* 2090 (CAL); Shargat, Ashar, 5.3.19, *Calder* 1869 (CAL).

EGYPT: Sinai, 12.4.1835, *Schimper* 169 (CAL).

U.S.S.R.: Turkomania, *Antonow* 13 (CAL).

R. refracta

PAKISTAN: BELUCHISTAN: *Doobund* 945 (CAL); Gilgit, 1885, *Giles* s.n. (CAL).

AFGHANISTAN: *Griffith* 1409 (CAL, proparte left ward specimens); Badghis, Haritud Valley,1.5.1885, *Aitchison* 1004 (CAL); Kuram Valley, 1879, *Aitchison* 242 (CAL); Kuram Valley, Para Chenar, 13.4.1894, *Hursukh* 14741 (CAL).

BIBLIOGRAPHY

Baillon, H.E. 1871. Monographie des Papaveracees al-des Capparidacees, Paris.

Barthlott, W. 1981. Epidermal and seed surface characters of plants: systematic applicability and some evolutionary aspects. *Nord. J. Bot.* 1: 345-355.

Basilevskaya, N.A. 1931. Principal botanic-systematical groups on the opium Poppy, *Papaver somniferum*. *Bull. Appl. Bot.* 25: 185-196. In Russian.

Bentham, G. and Hooker, J.D. 1862. Genera plantarum. William Pamplin [id.], Lovell Reeve & Co., London.

Brisson, J.D. & Peterson, R.L. 1976. A critical review of the use of scanning electron microscopy (Part VII) Vol. II. Proceedings of the workshop on Plant Science Applications of SEM, III, Research Institute. Chicago, Illinois, U.S.A.

Caturan, T. J. 1951. On the pollen of the Caucasian representatives of the Papaveraceae. *Nauchn. T. Erevansk. Gos. Univ., Ser. Biol. Nauk.*, 33(2): 63-75.

Corner, E.J.H. 1976. The seeds of Dicotylendons, Cambridge University Press, Cambridge Vol. 1 & 2.

Clark, C. & Jernstedt, J.A. 1978. Systematic studies of *Eschscholtzia* (Papaveraceae) II seed coat microsculpturing. *Systematic Botany* 3: 386-402.

Cronquist, A. 1968. The Evolution and Classification of Flowering plants. Houghton Mifflin, New York.

Dalhlgren, R. 1975. (with Hansen, B., Jakobsen, A., Larsen, K.) A system of classification of the angiosperm to be used to demonstrate the distribution of characters. *Bot. Notsier* 128: 119-147.

Darlington, C. D. and Wylie, A. P. 1955. Chromosome Atlas of flowering Plants. G. Allen Unwin Ltd., London.

Debnath, H. S. & Nayar, M.P. 1980. On monostrosity in *Argemone mexicana* L. (Papaveraceae). *Bull. Bot. Surv. India* Vol. 22 (1-4): 180-181.

Debnath, H. S. & Nayar. M.P. 1984. Papaveraceae & Hypecoaceae, Fasicles of Flora of India 17: 1-46.

De Candolle, A.P. 1824. Papaveraceae, Prodromus systematis Naturalis Regni vegetabilis, 1: 117-124.

Don, D. 1825. Prodr. Fl. Nepal. 197.

Drake, J. 1976. Plant portraits; *Meconopsis horridula* Hook. f. et Thom. *Olart. Bull. Alp. Gard. Soc.* 44 (3): 225-229.

Duke, J.A. 1973. Utilization of *Papaver*. *Econ. Bot.* 27: 390-400.

———— ——, Gunn, C.R., Teppit, E.E., Read, C.F., Solt, M.L. & Ierrall, E.E. 1973. Annotated bibliography on Opium and Oriental poppies and related species. [Washington D.C.] USDA 1-349.

Elkan, L. 1837. Tentamen Monographia generis Papaver. Konigsberg. 1-36.

Engler, A., and Diels, L. 1936. Syllebus der Pflanzenfamilien. Ed. 11 Berlin.

Erdtman, G. 1952. Pollen morphology and plant taxonomy, Angiosperms. I., Almquist & Wiksell, Stockholm.

———— 1963. in Preston, R.D. Advances in Botanical Research 1: 149-208. Academic Press, London.

———— 1969. Handbook of palynology. An introduction to the study of pollen grains and spores. Copenhagen: Munksgaard.

Ernst, Wallace R. 1962. The genera of Papaveraceae and Fumariaceae in the south eastern United States. *Journ. Arn. Arb.* 43: 315-343.

Faegri, K. & Iversen, J. 1950. Text book of modern pollen analysis, Ejnar Munksgaard. Copenhagen.

Fairbairn, J.W. & Williams, E.M. 1978. Meconic acid as a chemotaxonomic marker in the Papaveraceae. *Phytochemistry* 17 (12): 2087-2089.

Fedde, F. 1905. Die geographische Verbreitung der Papaveraceae. Engler, *Bot. Jahrb.* 36: *Beibl.* 81: 28-43.

———— 1909. Papaveraceae, Hypecoideae & Papaveroideae. In: Engler, Pflanzenr. 40 (IV, 104): 1-430, fig. 1-43.

Fedde, F. 1936. Papaveraceae. *In* Die Natürlichen Pflanzenfamilien. Edited by A. Engler and K. Prantl. Bd. 17b: 1-145. Duncker & Humblot, Berlin.

——————— 1936. Papaveraceae: Hypecoideae et Papaveraceae-Papaveroideae. W. Engleman, Leipzig.

Feinbrun, N. 1963. Taxonomic studies on *Papaver* sect. Orthorhoedes of Palestine and some other Mediterranean countries. *Israel Journ. Bot.* 12: 74-96.

Fulton, C.C. 1944. The Opium poppy and other poppies, i-v, 1-85. Publ. U.S. Treasury Dept., Bureau of Narcotics. Mainly chemical properties includes botanical information.

Gerard, J. 1597. The herball or generall historie of plantes.

Gleason, H.A. 1952. The New Britton and Brown Illustrated Flora of the Northeastern United States and adjacent Canada. The New Botanical Garden, Bronx, New York.

Goldblatt, P. 1974. Biosystematic studies in *Papaver* section *Oxylana*. *Ann. Mevsouri Bot. Gard.* 61(2): 264-296. Chrom. nos., Key.

Grover, I.S. & Malik, C.P. 1969. Karyological studies in some *Papaver* species. *Genetica Iberica* 21: 105-113.

——— ··· 1970. Cytogenetical relationships in some *Argemone* and *Papaver*. Ph.D. Thesis. University of Udaipur, India 1-237.

—, ·· ———, Mangat, G.S. & Malik, C.P. 1974. Cytogenetical evolution within some Papaver species. *In:* Kachroo, P. *ed. Advancing Frontiers in Cytogenetics*: 244-248. Chrom. nos.

Gunn, C.R. & Seldin, M.J. 1976. Seeds and fruits of North American Papaveraceae. *U.S. Dep. Agric. Techn. Bull.*, No. 1517:96.

——·· · ——— 1980. Seeds and fruits of Papaveraceae and Fumariaceae. *Seed Sci. Techn.*, 8 (1): 3-58.

Hakim, S.A.E. 1970. Death, cardia-myopathy, symptomless glaucema and cancer from edible oils containing Argemone. *Maharashtra Med. Journ.* 17: 1-24.

Harrow, R.L. 1930. Notes on *Meconopsis*. *New Fl. Silva* 2: 147-153. fig. 55-59. general notes.

Hegnauer, R. 1969. Chemical evidence for the classification of some plant taxa-In: Harborne, J.B. & Swain, T. (eds.). Perspectives in phytochemistry. Academic, London. pp. 121-138.

Henderson, D.M. 1965. The pollen morphology of *Meconopsis*. *Grana Palynologica* 6.2: 191-208.

———— 1972. The hybrid pollen of *Meconopsis* × *cookei*. *Grana* 12: 52-56.

Hooker, J.D. & Thomson, T. 1855. Papaveraceae. Flora Indica 1: 248-257.

———— 1872. Flora of British India vol. 1: 116.

Hooker, W.J. 1852. *Meconopsis wallichii*. *Curt. Bot. Mag.* 78: tab. 4668.

Hrishi, N.J. 1960. Cytogenetical studies on *Papaver somniferum* L. and *Papaver setigerum* DC. and their hybrids. *Genetica* 31: 1-130.

Hutchinson, J. 1921. The genera of the Fumariaceae and their distribution. *Kew Bull.* 97-115.

———— 1925. The genera of Papaveraceae. *Kew Bull.* 1925: 161-168. Key to genera.

———— 1959. The families of Flowering plants, 2 volumes. Oxford University Press, Oxford.

Irving, W. 1923. The *Meconopsis* family. *Garden* 87: 70-171.

Jafri, S.M.H. & Qaiser, M. 1974. Papaveraceae. Flora West Pakistan no. 61: 1-32. fig. 6. map 1.

Jain, S.K. and Sastry, A.R.K. 1980. Threatened plants of India, A state-of-the Art Report. Department of Science and Technology, New Delhi. p. 25.

Johnston, M.C. 1976. A new species of prickly poppy from Mexico. *Wrightia* 5(7): 259-260.

Jussieu, A.L. De 1791. Genera plantarum secundum ordines naturales disposita.

Kalis, A.J. 1979. Papaveraceae. The Northwest European Pollen Flora, 20. *Rev. Palaeobot. palynol.* 28: 209-260.

Kapoor, L.D. & Sharma, B.M. 1963. *Argemone mexicana* L.-organography and floral anatomy with reference to the laticiferous system. *Phytomorphology* 13: 444-459.

Kaul, A.K., Gohil, R.N., Sharma, M.C. & Kapoor, H.K. 1972. Genetic stocks of Kashmir Papavers: I. Plant morphology, chromosome numbers and meiosis. *Nucleus* 15(2): 117-123. Chrom. nos.

Kaul, M.L.H. 1969. Studies on *Argemone mexicana* Linn. 4. Phenology, dispersal and stomata. *Proc. Nat. Acad. Sci. India* 39: 121-128.

——— ——— 1972. Studies on *Argemone mexicana* Linn.: 6. Pollen morphology, floral biology and pollination mechanism. *Proc. Indian Acad. Sci.* B. 75(2): 86-93.

Kingdon-Ward, F. 1926. The blue poppies. *The Garden* 90: 96-97, 115-116.

——— ——— 1926. The genus *Meconopsis*. *Gard. Chron.* III 79: 252-253, 306-308, 340, 438-439, 459-460.

——— ——— 1926. Notes on the genus *Meconopsis* with some additional species from Tibet. *Ann. Bot.* 40: 535-546.

——— ——— 1927. The blue poppies. *Gardening Illustrated* 49: 608-609.

——— ——— 1928. Burmese species of *Meconopsis*. *Ann. Bot.* 42: 855-862.

Kinger, R.W. 1973. Sectional nomenclature in *Papaver* L. *Taxon* 22(516): 579-582.

Knaben, G. 1959. On the evolution of the *radicatum* group of the *scopiflore* Papavers as studied in 70 & 56 chromosome species. Part A. Cytotaxonomical aspects. *Opera Botanica* 2(3): 1-74.

Koopmanis, A. 1955. A trisomic *Papaver rhoeas*. *Genetica* 28: 35-41.

——— 1970. Species differentiation in *Papaver dubium*. *New Phytologist* 69: 1121-1130.

Layka, S. 1975. Les characters de L' endexine Chez les Papaveracees (Endexine characters of Papaveraceae). *Bull. Soc. Bot. France* 122: 103-107.

——— 1975. Polymorphisme pollinique dans le genre *Glaucium* (Papaveraceae). In Centre National de la Recherche Scientifique. La flore du bassin mediterraneén 289-301.

——— 1976. Les methodes modernes de la palynologie appliques a l' etude des Papaverales These d' Etat. Montpellier pp. 318.

——— 1976. Le polymorphisme pollinique dans le genre Argemone (Papaveraceae). *Pollen Spores* 18(3): 351-375.

Linnaeus, C. 1753. Species plantarum.

Madalaski, J. 1955. Florae polonicae terrarum que adiacentium iconographia. *Acad. Sci. Polon.* 9(1): 13.

Malik, C.P. & Grover, I.S. 1973. The genus Argemone: 2. Cytogenetic relationships of *A. ochroleuca* ssp. *ochroleuca* (2n=56) and same diploid (2n=28) Argemone species. *Theer. Appl. Genet.* 43(7): 329-334.

——— & ——— 1973. Cytogenetic studies in *Papaver*: 2 Hybrids among species with 7 as the haploid chromosome number. *Caryologia* 26(1): 13-25.

——— & Mary, T.N. 1973. Cytogenetic studies in *Papaver* IV. Trisomic in Garden poppy. *Chromosome Information Service* 15: 34-35.

——— 1974. Cytogenetical evolution and speciation in Argemone. In: Kachroo, P. *ed: Advancing frontiers in Cytogenetics:* 318-326.

——— & Mary, T.N. 1974. The genus Argemone: 2. Cytogenetics of additional hybrid combinations. *Chromosome Inform. Serv.* no. 16: 10. 1974.

Malik, C.P. & Mary, T.N. 1975. Cytogenetic studies in *Papaver*: 6. Chromosome relationships between Papaver species of the section Orthorhoeades (*P. syriacum* f. adpresso setulosus and *P. rhoeas* and their amphiploids). *Cytologia* 40(2): 333-345. Chrom. nos.

- - ---, — --- & Grover, I.S. 1979. Cytogenetic studies in *Papaver* 5. Cytogenetic studies on *P. somniferum* × *P. setigarum* hybrids and amphidiploids. *Cytologia* 44(1): 59-69. Chrom. nos.

Mary, T.N. & Malik, C.P. 1973. Cytogenetic studies in Papaver-3 Induced polyploids in some Papaver species. *Chromosome Inform. Serv.* No. 15: 27-29. Chrom. nos.

---------- -, Grover, I.S. & Malik, C.P. 1974. The genus Argemone: 3. Cytological studies in some autotetraploids. *Chromosome Inform. Serv.* No. 16. 11-12.

Melchoir, H. 1964. Engler's Syllabus der Pflanzenfamilien. 11 Band. Gebruder. Borntraeger, Berlin.

Metcalfe, C.R. and Chalk, L. 1957. Anatomy of the Dicotyledons 1. 74-78.

Moltet, S. 1912. *Meconopsis wallichii Rev. Hort.* (Paris) 1912: 203-206, 1 pl.

Moore, P.D. & Webb, J.A. 1978. An Illustrated guide to pollen analysis, Hodder and Stoughton. London-Sydney-Auckland-Toronto.

Nair, P.K.K. 1962. Pollen morphology with reference to the geographical distribution of *Argemone mexicana*. Lloydia 25(2): 123-129.

Nessler, C.L. & Mahlberg, P.C. 1976. Laticifers in the stamens of *Papaver somniferum* L. *Planta* 129(1): 83-85.

Newton, W.C.F. 1929. The inheritance of flower colour in *Papaver rhoeas* and related forms. *Journ. Genet.* 21: 389-404.

Novek, J. 1979. [Taxonomic revision of Papaver section *Macrantha*] *Preslia* 51(4): 341-348.

Ownbey, G.B. 1958. Monograph of the genus *Argemone* from North America and the West Indies. *Mem. Torrey Bot. Club* 21(1): 1-149.

Ownbey, G.B. 1961. The genus *Argemone* in South America and Hawaii. *Brittonia* 13: 91-109.

Popov, M.C. in Komarov, V.L. 1937. Papaveraceae. Flora of the U.S.S.R. Vol. 7. 573.

Prain, D. 1894. Noviciae Indicae. 7. Description of a new species of *Meconopsis* from Sikkim. *Journ. As. Soc. Beng.* n.s. 11, 63: 81-82.

——— (1894) 1895. Noviciae Indicae. 9. Some additional Papaveraceae. *Journ. As. Soc. Beng.* n. ser. 11. 64: 303-327.

——————— 1895. An account of the genus *Argemone*. *Journ. Bot.* 33: 19-35. 176-178.

——————— 1895. A revision of the genus *Chelidonium*. *Bull. Herb. Boiss.* 3. 570-587.

——————— 1905. The species of *Meconopsis*. *Gard. Chron.* III. 37: 369-370. fig. 157.

——————— 1906. A review of the genera *Meconopsis* and *Cathcartia*. *Ann. Bot.* 20: 323-370, tab. 24-25.

——————— 1907. *Meconopsis punicea*. *Curtis's Bot. Mag.* 133: pl. 8119. Nature of Tibet & W. China.

——————— 1907. Meconopsis, Papaveracearum genus speciebus nonnullis aucta. *Fedde Rep.* 4: 217-222.

——————— 1915. Some additional species of *Meconopsis*. *Kew Bull.* 1915: 129-177, t. 2.

Pseisner, R.M. & Sharmma, M. 1980. The spirobenzylisoquinoline alkaloids *J. Nat. Prod.* 43: 305-318.

Rachele, Linda, D. 1974. Pollen morphology of the Papaveraceae of the north-eastern United States and Canada. *Bull. Tor. Bot. Club* 101.3: 152-159.

Rose, J.N. 1903. The Mexican species of *Argemone*. *Contr. U.S. Nat. Herb.* 8: 23-27.

Sagdullagiva, A.L. 1959. Pollen morphology of Papaveraceae: (In Russian). *Problems Botaniques Acad. Sci. Moscae* 4: 11-51.

Stapf, O. 1933. *Meconopsis grandis*. *Curtis's Bot. Mag.* 156: pl. 9298.

Steenes, C.G.G.J. Van. 1954. Papaveraceae. In: Van Steenes. *Fl. Males.* 1. 5: 114-117, fig. 1-2.

Stermitz, F.R. & Rapaport, R. 1961. The biosynthesis of Opium alkaloids. *Amer. Chem. Soc.* 83: 4045.

———— 1968. Alkaloid chemistry and the systematics of *Papaver* and *Argemone*. *Recent Advances Phytochem.* 1: 161-183.

Takhtajan, A. 1954. A translation of Essays on the Evolutionary Morphology of Plants. Washington, p. 1-139.

——— 1966. Systema et Phylogeniae Magnoliophytorum. Soviet Sciences Press, Moscow & Leningrad.

——— 1969. Flowering plants Origin & Dispersal, Oliver & Boyd: Edinburgh.

Tarnavschi, I.T. and Mitrouin, N. 1960. Recherches sur la morphoiogie du pollen des familles de Papaveraceae et Resedaceae de l'ordre des Rhoedales. *Acad. Rep. Populare Romine, Studii Cercetari Boil. Ser. Biol. Veg.*, 12(4): 402-423.

Taylor, G. 1929. The status of *Meconopsis baileyi*. *Gard. Chron.* III 85: 66.

——— & Cox, E.H.M. 1934. An account of the genus *Meconopsis* i-x, 1-130, pl. 1-29. Monographie.

——— 1937. New or otherwise interesting *Meconopsis*. *New Fl. & Sylva* 9: 155-162, Includes *M. sherriffii*

——— 1973. Meconopsis collections of George Forrest. *Journ. Scott. Rock Card. Club* 13(3): 244-246.

Thorne, R. 1968. Synopsis of a putatively phylogenetic classification of the flowering plants. *Aliso* 6.4: 57-66.

Thorne, R.F. 1983. Proposed New realignments in the angiosperms.-*Nord. J. Bot.* 3: 85-117.

Tournefort, J.P. de. 1694. Elemens de botanique.

——— 1700. Institutiones rei herbariae.

Vent, W. & Mory, B. 1973. Butrage Zur Kenntnis der Sippenstruktur der Gattungen *Glaucium* Adans. und *Dicranostigma* Hook. f. et Thompson (Papaveraceae). *Gleditschia* 1: 33-41. Chrom. nos.

Vesselovskaya, M.A. 1933. The Poppy, its classification and its importance as an deiferous crop. *Bull. Appl. Bot. & Pl. Breed. Suppl.* 56: [1-2], 1-213, 1-xxii, pl. 1-3, fig. 1-58.

Vilmorin, Andre de 1933. *Meconopsis baileyi. Rev. Hort.* (Paris) 105: 516. A general and horticultural descriptions.

Walker, J.W. 1971. Pollen morphology, phytogeography and phylogeny of Annonaceae. *Contrb. Gray Herb.* No. 202: 1-130.

Williams, L.H.J. 1972. *Meconopsis taylorii*, a new species from Nepal. *Trans. Bot. Soc. Edenb.* 41(3): 347-349.

Wilson, E.H. 1905. A beautiful new hardy flower (*Meconopsis integrifolia*). *Garden* 67: 286-287.

———— 1905. *Meconopsis integrifolia. Gard. Chron.* III. 37: 291, fig. 121.

Worsdell, W.C. 1915. (The) Principles of Plant teratology, 1: 1-13. London.

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