

*In-Depth Studies on Some of the Floristic Components of
Baroda and Panchmahal Districts with Reference to
Bioprospecting and Speciation.*

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By

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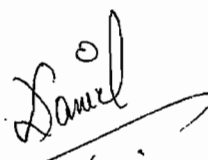
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Certificate

I hereby declare that the thesis entitled "In-Depth Studies on Some of the Floristic Components of Baroda and Panchmahal Districts with Reference to Bioprospecting and Speciation." Submitted to The Maharaja Sayajirao University of Baroda for the award of the Degree of Doctor of Philosophy, is a record of bonafide research carried out by me under the direct supervision of Prof. (Dr.) M. Daniel, Department of Botany, The Maharaja Sayajirao University of Baroda. No part of this thesis has been submitted for the award of any degree or diploma from any other University.


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I certify that the above statement is correct.


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Chapter 1

Introduction

Chapter 1

Introduction

India is a great country with an abundance of flora and fauna as its wealth. These can be utilized for human wellbeing, and therefore, there is a need for proper identification and documentation of the plants and animals. The systematic enumeration of plants in a given area is the flora. The relative abundance of plants, their flowering and fruiting time and utility aspects also are to be properly worked out to prepare the flora. A good flora will aid the proper utilization of the component plants. A flora with elaborative illustrations of all the plants will facilitate greatly the proper recognition of all the plant taxa and that is the reason why the present project is attempted. Therefore, in the present work proper illustrations, description and micromorphological studies have been done on all the plants. This is because, our identification procedures heavily rely on reproductive structures like flowers and fruits, the identification is done only when these structures are present in plants. In other words, the identification of a plant is difficult and cumbersome, in its vegetative state. Since, micromorphological characters are used as aids for identification in many taxonomic treatises, an attempt is done here to collect all the micromorphological characters and present along with the classical description of the plants. These characters have the advantage that, since, they are present in vegetative state throughout the year in all seasons, they aid in identification of the plant any time of the year.

There are very few illustrated floras available in the world. Wight Icon's book (*Illustrations of Plants of Eastern India*, 1856) and *Icones Plantarum* of W. J. Hooker's (1837-1856) are the classic examples of the floras in which detailed sketches of the plants are included. Both these books are very old (more than 150 years) and therefore, a large number of taxa available now are not represented in these books. It is the need of the hour, that such a treatise in which all the locally available plants are presented with

taxonomically correct illustrations. Such a manuscript will make the identification of the plants much easier not only to a student of taxonomy but also to amateur botanist.

Geography

Gujarat state in which the study region lies is situated on the west coast of India and boasts of a long 1,600 km long coastline. The Arabian Sea sweeps off the Western and South-Western frontiers of the state. It is situated between 20° 1' and 24° 7' north latitudes and 68° 4' and 74° 4' east longitudes. Gujarat stretches from Kutch in the West to Daman in the South. In the East, lies the hilly region of the Aravallis, whereas lush green woods, hills, plains and rivers are found in the west. Rajasthan lies towards the northeast of Gujarat, Madhya Pradesh to the east and Maharastra to the southeast.

Gujarat even shares an international border with Pakistan, which lies on the northwest side of the state. Apart from this, there is Gulf of Cambay, situated towards the northeast of Gujarat. The state has 25 districts and is expansive in area. It ranks 9th in area, whereas 10th in population. Once again, it exhibits a wide variety in the landforms. It has extensively fertile alluvial plains, semideserts, marsh lands, grasslands, etc. The state had been also a major trade destination since the ancient times, due to its strategic location.

Topography

Sahyadri hills are situated to the extreme south-east of Gujarat. These hills add a great deal to the forest wealth of Gujarat. Towards north, the Satpura range separates the state from Khandesh tract of Maharashtra. The Aravalli ranges run along the north-eastern fringe of the state. Between these irregularly shaped hills are the alluvial valleys built up by Tapti, Narmada, Mahi, and Sabarmati rivers draining into the Arabian Sea. The Saurashtra Penninsula is connected with mainland by a neck of low lying lands. In this region, there are famous hills of Gir, Girnar, Barda, and Shetrunjaya. Kutch is practically of undulating rocky areas with many small hills and with the Rann of Kutch lying on the northern end consisting of a vast expanse of local mud flats.

Climate

The climate in Gujarat is moist in Southern districts whereas it is dry in northern districts. The average rainfall in Gujarat varies from 33 to 152cms. The southern region of the state has an average rainfall ranging from 76 to 152cms, Dangs district having the highest rainfall of about 190cms. The northern districts have a rainfall varying from 51 to 102cms. The rainfall in the southern highlands of Saurashtra and the Gulf of Cambay is approximately 63 cms while the other parts of Saurashtra have a rainfall less than 63 cms. The semi-desert area of Kutch has a very low average rainfall. Certain areas in Ahmedabad, Mehsana, Banaskantha, Panchmahals, Surendranagar, Jamnagar and Kutch districts face chronic scarcity conditions for want of adequate rains.

In Gujarat also the weather varies with different regions. The place, near the coast has a humid climate whereas the ones in the interiors experience a completely different climate. The Rann of Kutch region experiences extreme climates. The summers are extremely hot while the winters are extremely cold. On the other hand, the coastal regions and the eastern belt of Gujarat experience a mild pleasant climate with moderate rainfall during the monsoons.

On an average, the summers are extremely hot and dry in Gujarat. The day temperature is as high as 46° C while at night it is 34° C. In the winters, the climate is dry. The average temperature during day time is 29° C and 12° C during the night. The days are usually sunny and the sky is clear. The monsoon season extends from mid June to September. Before the monsoon, the temperatures are soaring high with an increased humidity in the air.

Soil

Gujarat shows great variation in its soil. The southern regions of Gujarat have deep black soil whereas the coastal region bears alluvium. The Dang region has red soil. Along with the red soil there is an accumulation of detritus along the lower part of the valleys. Towards the northern region one can notice the change in soil type, whereas the central region including Baroda and Panchmahal district the soil is somewhat sandy with loam

soil. The western region has coarse soil. In Saurashtra and Kutch the soils are formed of sheets of Deccan lava interspersed with trap dykes. Kutch bears a good deal of alluvium. The northern soils are derived from sandstones.

Baroda district

Vadodara district is situated in the eastern part of the state of Gujarat in Western India. Vadodara district covers an area of 7, 794 Km². Geographically, Vadodara is located at 22° 18' North latitude and 73 ° 20' East longitudes. The district is bounded by Panchmahal and Dahod districts to the North, Anand and Kheda districts to the west, Bharuch and Narmada districts to the south, and the state of Madhya Pradesh to the east. The Mahi River passes through the district. The historical city of Baroda was the capital of Baroda Residency, and one of the princely states of India under Bombay Presidency.

Climate

Vadodara features a tropical climate. There are three main seasons: summer, monsoon and winter. Except for the monsoon season, the climate is dry. The weather is hot through the months of March to July- the average summer maximum is 46 °C, and the average minimum is 23 °. From November to February, the average maximum temperature is 30 °C and the average minimum is 15 °C, and the climate is extremely dry. The Southwest monsoon brings a humid climate from mid-June to mid-September. The average rainfall is 93 cm. The land is drained by rivers and thus is a vast alluvial deposit of black soil and red loam.

Panchmahal district

Panchmahal is a neighboring district of Baroda which lies on the Southern side of Gujarat. It is bordered by Dahod district to the north-east & east, Kheda district to the west and Sabarkantha district to the northwest. Geographically Panchmahal is located at 73.15° to 74.75° East (Longitude) 22.30° to 23.23° North (Latitude). Panchmahal covers an area around 5083 sq.km. Panchmahal district is a part of Eastern Hilly region of the

Gujarat state and subdivided into two submicro regions, namely Mahi plain and Forest scrub zone, on the basis of topography, climate, soil and vegetation.

Climate

The climate of the district is characterized by a hot summer and dry season. It is also considered as a drought prone area. The winter season starts from December to February followed by hot season from March to May. The South-monsoon season is from June to September and the post monsoon season from October to November. The mean monthly maximum temperature is 42 °C in the month of May while mean of Minimum temperature is 13.9 °C in the month of month of January. The mean annual precipitation varies from 800 to 1000mm.

The soil is deep black, shallow black, grey brown and mixed red are the types of soil found in the Panchmahal district. The district has undulating topography and hard rocky terrain. Soil depths vary from a few centimeters to 60 cms in some areas. The western parts comprising of Kalol, parts of Halol, Godhra and Lunavada constitute a plain area. It is a part of Mahi river basin. The northern and eastern portions comprising mainly of Lunavada, Santrampur and Jambughoda talukas are covered by hills and forests intercepted by plain cultivated lands and villages situated in the river valley. (Anon. 2007, 2010)

Literature survey

A review of literature reveals that good number of floristic surveys in Gujarat have been conducted from time to time. These surveys includes enlistment of flora and species description, key for identification, assignment of taxonomic or systematic position to taxa and a few studies also includes some ecological aspects. Previously, workers have made important contributions in the field of flora and vegetation of some selected localities in Gujarat. These significant contributions include floras like Flora of Kachchh (Blatter, 1909); Plants of Northern Gujarat (Saxton and Sedgwick, 1918); Revision of the Flora of Bombay Presidency (Blatter and McCann, 1926-1935); Flora of Dangs (Santapau, 1955); Plant Systematics (Sutaria, 1958); Flora of Devgad Hills (Chavan, 1961); Flora of

Saurashtra Vol. I (Santapau, 1962); Flora of Pavagadh Hills (Chavan and Oza, 1966); Flora of Khedbrahma Region (Bhatt, 1969); Vegetation of Dangs district (Jain, 1963); Flora of Gora range of Rajpipla (Bhatt, 1971); Flora of Gujarat State (Shah, 1978); this also includes a sketch of the Flora of Gujarat (Shah *et. al.*, 1981); and Flora of Saurashtra Vol. II and II (Bole and Pathak, 1988).

The extensive survey of literatures revealed many floristic works throughout the Gujarat. In order to understand the flora of the state thoroughly, the state of Gujarat is divided into different regions and the works in these areas are mentioned here. In **Kachchh region**, Rao (1981) worked on Flora of South-Eastern kachchh and noted 12 new records of plants. Bhatt (1993) worked on the flora of western Kachchh and identified 14 new records from this area. Raole (1993) worked on endemic desert taxa with a note on the chromosome number-karyotype of some taxa.

In **North-Gujarat**, Yogi (1970) in his Ph. D. thesis gave an account of Flora of North-Gujarat (Mahudi in Mehsana district) and noted a total of 132 species of Poaceae, 61 species of ethnobotanical interest and 13 rare plants. Bhatt (1971) worked on flora and vegetation of Khedbrahma region in North-Gujarat with a note on the chromosome number. Punjani (1997) noted ethnobotanical studies on tribal areas of district-Sabarkantha.

In **Central Gujarat**, Sabnis (1967) has worked on Flora of Baroda and its environs including an account of the Cyperaceae of Gujarat and noted total 69 species of Cyperaceae. Bedi (1968) in Flora of Ratanmahal and its surroundings recorded 640 plant species. Padate (1973) studied Flora and vegetation of Savli taluka. Karatela (1973) in his study of floristic and phtyosociology of Chhota-udepur forest division, reported total 103 species of Leguminosae and 123 rare plants. Many researchers have worked on the ethno botanical aspects of Central Gujarat, like Thaker (1974) in his Thesis described on account of floristic and ethno botanical studies on Kawant range forest, and noted total 38 species of ethnobotanical interest. Bhatt (1975) in worked on the floristic and phytosociology of Panchmahal district and analysed various communities and identified a total of 81 new plant species. Patil (1980) worked on urban vegetation of Baroda and

reported total 57 plants to be apparently extinct with 16 new records. Anjaria (2002) worked on Flora of Anand district with special reference to tree species.

In **South Gujarat** considerable work had been done on floristics, ecology and ethnobotanical aspects by various workers like Suryanarayan (1969) in Flora of Dangs forests, noted a total of 655 plant species, 30 rare plants and 10 plants of ethnobotanical interest. Patel (1971) studied flora of Valsad and its environs and reported a total of 705 plant species with 191 plant species as cultivated. More (1972) worked on Flora of Pernera Hill, Pardi and Udwada areas and noted total 44 rare plants in the area. Desai (1992) conducted studies on the flora of Bansda forests and enumerated total 702 plant species with 114 plant species of Leguminosae as new records from this area. Yadav (1979) worked on the floristic and phytosociological studies of some parts of South-Gujarat. Joshi (1980) worked on Flora of Surat and its environs, and found 9 new species from this area. Vora (1980) in his thesis on Dharampur identified 151 plant species of ethnobotanical interest and 11 plant species as addition to the flora of South Gujarat. Joshi (1983) studied floristic and phytosociological survey of South-Gujarat Forest with special reference to medicinal plants. Vashi (1985) in his study on floristic, phytosociology and ethnobotany of Umerpada forest enumerated a total 183 plant species of Leguminosae. Contractor (1986) in his thesis on floristics, phytosociology and ethnobotany studies of Vapi and Umargaon forest noted a total of 122 plant species of Leguminosae and 83 plants species as ethnobotanical interest. Bhatt (1987) conducted studies on the flora of Navsari area and enumerated 813 plant species, with 189 plants of ethnobotanical interest and 31 plants as addition to the flora of Navsari. Mac (1987) while studying the flora of Surat, concluded about total 35 plant species are medicinally important and 5 plants as additions to the flora of Surat. Reddy (1987) studied flora of Dharampur and noted 281 plant species of ethnobotanical interest and 12 plant species as additions to the flora of Dharmapur. Pradeepkumar (1998) has worked on the Flora of Shoolpaneshwar Wildlife Santcuary. Gopal (1983) published the ethnobotanical studies and enumerated total 722 plant species of ethnobotanical interest. Umadevi (1988) have worked on medicinal plants of Gujarat and noted 745 plants are medicinal.

Illustrated flora

The scope of an illustrated flora in facilitating identification need not be explained here. But, unfortunately such floras are lacking except for the Wight Icon's monumental work and Hooker's treatise. There appears a near vacuum in this area with an exception of Britton's and Brown's work on "*An illustrated flora of Northern United States and Canada*" which appeared in 1913. Surprisingly, of late, there appears a spurt in the production of illustrated floras as evidenced by the publication of "*Illustrated flora of East Texas*" (2006; Botanical Research Institute of Texas) by Shinnars and Mahler's; "*The illustrated flora of British Columbia* Vol. 1-8 (1998) by Douglas, G.W., G.B. Straley, D.V. Meidinger, and J.Pojar; *Illustrated Flora of Lebanon* by Georges Thome and Henriette Thoem in 2007 (CNRS Publications) and *The Illustrated Moss Flora* by R. Ochrya, Rl Lewis Smith, H. Bednarek Ochrya in 2008 (Cambridge Univ. Press.). There is absolutely no work in this direction anywhere in Asia especially in India. This is the reason why the present project is undertaken, in which all the plants studied are represented by sketches consisting of habit, floral features including parts of the flower and T.S. and fruit characters. Such an attempt is believed to create interest in students of taxonomy as well as for any person interested in plants. In addition, the micromorphological characters such as trichomes, and glands of all the plants in which they are present also are studied and presented here.

Micromorphological characters

Micromorphological characters include all the characters which can be seen under a microscope but otherwise not easily recognizable for the human eye. Trichomes, glands and stomata are the major micromorphological characters used in taxonomy. These characters which are mostly present on the vegetative organs like leaves and stems are present in the plant throughout the year unlike the characters of flowers and fruits which are available only in certain seasons, for a period of one to two months. Therefore, if these characters are used in taxonomy, identification is possible throughout the year. These characters were customarily seldom used earlier in a classical taxonomic treatment

and therefore, received little or no attention from taxonomists. It was Solereder (1908) and Metcalfe and Chalk (1950) who made some significant contributions to the micromorphological characters of plants. Carlquist (1961) and Stace (1984) also had stated that the leaf characters are most varied anatomical features in Angiosperms. Foliar and floral micromorphological characters are considered in segregating the major groups of plants. In fact, the leaf characters are considered as second to those of flowers and fruits in taxonomic studies. Plant morphologists had used many micromorphological characteristics as foliar trichomes to resolve the taxonomic conflicts. (Hardin *et al.*, 1979 ; Fang *et al.*, 1993; Leelavathi *et al.*, 1980; Prabhakar *et al.*, 1985 ; Vijay and Rammaya, 1987 and Vijay Kumar, 1988). Cutler (1978) had stated that apart from the usefulness of those characters in taxonomy they also are used efficiently in the identification of fossil specimens, specifically, the leaf impressions. In addition, to this the epidermal micromorphological features help in authentication of foliar drugs in pharmacognosy where they serve as biomarkers (Gohil *et al.*, 2007). The presence of glandular trichome in many of the medicinal plants is considered indicative on the concentration of the secondary metabolites with pesticidal, pharmacological and fragrant properties.

The trichomes and glands exhibit a wide variety of morphological variations. The trichomes may be glandular or non-glandular, single celled or multicellular, uniseriate, filamentous, branched or unbranched with cellular contents with or without any inclusions. Similarly, the variation in glands and their nature is tremendous. They may be unicellular or multicellular, sessile or stalked. In case of stalked one, the stalk may be unicellular or multicellular, uniseriate or multiseriate. The head of the gland also is of a wide variety, in that, it may be uni or multicellular, discoid or filamentous, branched or unbranched and contained a wide variety of secretions. Thus, both the trichomes and glands offer a large variety of structures which can be systematically used to recognize or characterize a plant. Stomatal types are of limited scope in that the variations are not as large as that of trichomes and glands.

Almost all taxonomists, knowingly or unknowingly, accept the theory of “**Fixity of Species**”. According to them, the plant remains unchanged for centuries and that is why every plant collected is compared with that of the *Flora of British India* or

subsequent floras (which are mostly copies of the Hooker's flora). The variations shown by the populations are generally ignored in a taxonomic survey. In our studies we have found a number of taxa showing many variations in characters from the type specimens mentioned in earlier floras. These variations are passed on from generations to generations and being cumulative may lead to formation of smaller categories (Infraspecific taxa). These infraspecific taxa, with more characters added in course of time, may at a later state lead to the formation of higher categories like species. This is to say that the variations observed in populations are to be noted and studied and this may lead to the recognition of new taxonomic categories or say, species. To sum up, it is the variation in populations which leads to speciation. Therefore, in the present work a serious attempt is undertaken to look at the differences, if any, present in the specimen with that of the recorded description (in floras) of that species. Such a study will unearth the trends of "Speciation" going around us.

Speciation

Speciation is a creative and gradual evolutionary process leading to the built up of species diversity. Understanding the general patterns and process of speciation is fundamental to explain the diversity of life (Mayr, 1963). The question arising here includes the general processes of speciation and how do rates of speciation vary over time and among taxonomic groups and geographical regions? Although fundamental, such questions are difficult to answer because direct observation is usually impossible and many extended views do not have adequate fossil records with which to investigate this topic (Barracough & Nee; 2001).

New species may develop through the mechanism of abrupt selection or gradual speciation. Geographical isolation, ecological shifts and hybridization are considered to be the main processes of speciation. (Barracough and Nee; 2001). These isolation leads to changes in gene flow. Genes that determine species difference can be located and in the same cases isolated (Orr; 2001). There exists a relation between speciation and morphological variation (Benton and Pearson; 2001).

Types of speciation

Speciation may involve phyletic evolution when one species might evolve into something different from its ancestor over a period of time (phyletic speciation). Alternatively, a population belonging to a single species might differentiate into two evolutionary lines through divergent evolution (additive speciation).

- a. Phyletic speciation. The concept of phyletic speciation has been the subject of considerable debate. It is the sequential production of species within a single evolutionary lineage. Species A might, over a period of time, change through species B and C into species D without ever splitting. The new species produced are variously called successional species, paleospecies and allochronic species. The species which have become extinct in the process are termed taxonomic extinctions.
 - b. Additive speciation. Additive speciation is the commonest mode of speciation, which adds to the diversity of living organisms. Mayr (1963) suggested the occurrence of reductive speciation, whereby two previously independent species fuse into a third new species, the former two themselves, becoming extinct. Hybridization, likewise, produces new species but this always leads to addition in the number of species. It is impossible to imagine that two evolutionary species can actually fuse to produce a third species and themselves become extinct. This may happen in a particular region, but not over the entire range of these species.
1. Allopatric speciation: lineage independence and consequent speciation result from geographical separation of lineages, i.e. the actual physical separation of two relatively large populations of a single species. Over a period of time such separation would enable geographical races to develop and maintain gene combinations controlling their morphological and physiological characters.
 2. Allo-parapatric speciation: Such speciation occurs when two populations of an ancestral species are separated, differentiate to a degree that is not sufficient for lineage independence, and then develop lineage independence during a period of parapatry.
 3. Parapatric speciation: This occurs when two populations of an ancestral species differentiate despite the fact that no complete disjunction has occurred. The daughter

species may share a small fraction of their respective ranges and interbreed within this narrow contact zone and yet still differentiate.

4. Stasipatric speciation: This is similar to parapatric speciation except that it results from spontaneous chromosomal modifications. The resultant chromosome arrangement must be fully viable in the homozygous state but of reduced viability in the heterozygous state.
5. Sympatric speciation: This results in the production of new species with no geographical separation of populations, even though most cases of sympatric speciation, such as those resulting from hybridization and apomixes belong to abrupt speciation. The process of ecological sympatric speciation is a slow one of gradual speciation. The ecological differences in the habitats result in adaptive radiations in populations which gradually evolve into new species.

The first sign of speciation is the variations which are observed in a population. Variation is any visible/invisible change from the previously existing conditions. It is an essential ingredient of evolution. Mutation and genetic recombinations are the primary sources of variations within plant population and species, and they form the raw material for natural selection and random genetic drift.

Variation is a characteristic of virtually every group of animal or plant and that is why no two plants and animals are alike in all characters. Organisms show variation in characters that influence their success or failure in the struggle for existence. In a competition between organisms with characters that give them an advantage over their competitors become successful, and these organisms pass these advantageous characters to the next generations.

The variation may be continuous when the individuals of a population are separable by infinitely small differences in any of the attributes. In discontinuous variations, however, there is a distinct gap between two populations, each showing its own specific variation for a particular attribute. The discontinuity between the populations primarily results from isolation in nature. Isolation plays a major role in establishing and widening the gap between the populations, allowing evolution to take its distinct course with no disturbance. Variation in plants includes three fundamental types: developmental, environmental and genetic.

1. Developmental variation: A distinct change in attributes is often found during different stages of development.
2. Environmental variation: Environmental factors often play a major role in shaping the appearance of a plant. The individual of a species often exhibits phenotypic plasticity, expressing different environmental conditions. Such populations are named ecophenes.
3. Genetic variation: Genetic variation may result from mutation or recombination. Mutation is the occurrence of heritable change in the genotype of an organism that was not inherited from its ancestors. It is the ultimate source of variation in a species and replenishes the supply of genetic variability. Recombination is a reassortment of chromosomes, wherein the genetic material from different plants are brought together via fertilization and rearranged by meiosis to produce a new genotype.

Isolating mechanisms: Isolating mechanisms are environmental, behavioural, mechanical, and physiological barriers that prevent two individuals of two species from producing viable offspring.

Isolation is the key factor preventing intermingling of distinct species through prevention of distinct species by preventing hybridization.

In the present work emphasis is given to variations from the standard literature observed in vegetative as well as reproductive features. These variations were recorded here so that further studies wherein population studies should be conducted. These studies could not be conducted for want of time.

Every flora is valued for the utilitarian aspects of the plants. A flora rich in useful plants is a boon to humans because it helps to get a large amount of useful plants at his disposal. Unfortunately, our knowledge of useful plants is mainly based on the ancient knowledge which is passed on to us from the past generations. The fact that the number of useful plants available to us runs to few thousands when we have about three-lakhs plants at our disposal points to the most poor way by which we manage our ecosystem. Bioprospecting is one of the acclaimed methods by which the useful plants could be recognized. It is with this idea in the present project a few plants have been selected for bioprospecting.

Bioprospecting

The demand for huge amounts of medicinal plants is growing at an exponential rate causing some of these species to become increasingly threatened in their natural habitat. With the rapid depletion of our forests impairing the availability of raw drugs, Ayurveda, like other systems of herbal medicines, has reached a very crucial phase. About 50 percent of the tropical forests, the treasure house of plant and animal diversity, has already been destroyed, and the remaining half may not stand the onslaught of man for another decade. This destruction has rendered almost 3-4 thousand species of Indian plants on the verge of extinction. This extensive forest destruction has resulted in the extinction of many valuable medicinal herbs along with many others, which would have been potentially useful later. In fact, we do not have even a rough estimate as to what the loss of such species mean in terms of national economy. It is in this context we have to find the alternate source of the pharmacologically active principles and this search has to be done on plants, which are biologically related to the said drug plants. This process is known as Bioprospecting.

Bioprospecting is the search of specific compound/s in taxonomically related species of the original source plant. Since the plants are grouped/classified based on its similarities in many characters, all the plants of a taxon whether it is a subgenus/genus/tribe/family may have similar biosynthetic pathways and may produce same or similar compounds. So the search for a new or a substitute source should be based on the correct taxonomic relationships.

A correct taxonomic treatise of the taxon in question is the prerequisite to programmes of bioprospecting. Earlier classifications were mainly based on the morphologic similarities. But the recent systems of classification are based on all the characters of the plants such as morphology, embryology, palynology, pollen morphology, cytology, anatomy and phytochemistry. Since even molecular biology is used in assessing inter-relationships among plants, taxonomically related plants will possess the same or similar genes. Chemotaxonomic treatments of families in question will be of immense help here. Thus due to similarity in genetic sequences, biosynthetic pathways also are likely to be more or less the same. This means the taxonomically related plants may produce the same

compound or due to the variations/adaptations which make it a different plant (different identity) may produce slightly different compound.

Once the active molecule(s) (single or mixtures of compounds) of the plants are characterized, it may be possible to find out alternative indigenous plant sources containing the same or related compounds through bio- and chemoprospection. For example, the anti-cancer drug Camptothecine was initially isolated from the Chinese plant *Camptotheca acuminata*. Phytochemical investigation showed that the same compound could be obtained from an abundant Indian plant, *Mappia foetida* (*Nothapodytes foetida*) (Govindachari and Viswanathan, 1972). The discovery of the new source of camptothecine had a great impact in the development of clinically important camptothecine derivatives with improved bioactivity. Another example of bioprospection-based discovery is that of phytoestrogens. It was by chance that estrogenic activity of isoflavones was discovered when it was observed that the sheep, which grazed on sweet clover (*Trifolium subterranean*), developed sterility. The cause of sterility was traced to the presence of isoflavonoids, which are known to function as estrogen antagonists. Recently, it has been found that some of the isoflavonoids stimulate a signal transduction pathway leading to apoptosis and now feature in the cancer chemoprevention and hormone replacement therapy. Soya (*Glycine max*) provides good dietary source of phytoestrogens. Similarly, highly functionalized coumarins, calanolides, isolated from the rare Malaysian plant, *Calophyllum lanigerum* provides examples of non-nucleosidic lead compounds (reverse transcriptase inhibitors) with anti-HIV activities. Bioprospection of the flora reveal the presence calanolide analogs in many Indian species. Chemotaxonomy also plays role towards drug discovery and value addition. The well-known example is that of taxol. Taxol is present in the bark (non-renewable source) of 30-40 year old Western pacific yew, *Taxus brevifolia* that does not occur in India. The Indian species, *Taxus baccata* contains very low levels of taxol but the leaves (renewable source) contain compounds such as baccatin or deacetyl baccatin. In spite of having the basic carbon framework, these compounds do not show appreciable cytotoxicity but can be transformed in to taxol or its derivative by semi-synthetic procedures. This route is followed for the commercial production of taxol and its derivatives. Some other examples of value addition by chemoprospection are: *Gloriosa*

superba as an alternate source of colchicines, *Coptis teeta* and *Coscinium fenestratum* as sources for berberine and *Dalbergia* sp as source of isoflavonoids (phytoestrogens). In spite of their ubiquitous presence, tannins did not attract much attention till recently because of difficulty in isolation and characterization. Remarkable topoisomerase inhibitory activity of an ellagitannin, acutisimin A (Quideau *et al.*, 2003) isolated from red wine, has been reported recently. Acutisimin A and related compounds were isolated earlier from many plants such as *Quercus* sp. Therefore this discovery opens new frontier towards development of topoisomerase inhibitors. Tannins occur widely in plants. It is interesting to find that many of the ayurvedic formulations are prepared from water extracts and are rich in tannins. Thus cues from ethnomedicine, chemotaxonomy and phytochemistry can help in the acceleration of the drug development programs. Banerji (2007) has given a long list of alternate sources for bioactive compounds

Objectives

With all the above mentioned aspects are considered, the present research project and the thesis are planned. The principal objectives of this project are as follows:

- To study the floristic elements of Baroda and Panchmahal districts with special emphasis on all the morphological and micromorphological characters of the plants collected.
- To prepare diagrammatic illustrations of all the plants studied.
- To look for variations, if any, in morphological characters in plants which may give ideas on the probable trends in Speciation.
- Bioprospecting of a few selected plants for useful phytochemicals.
- To prepare an illustrated flora of plants on Baroda and Panchmahals.

With these objectives in mind, about 400 plants were collected from various parts of Baroda and Panchmahal districts and have been studied for their taxonomic characters critically and compared with the standard descriptions available in floras. Micromorphological characters like stomata and trichomes, both glandular and non-glandular, are also studied in detail and line-drawings are prepared for each and every

plant studied. In addition, the variations, if any, existing in plants was noted. Ten plants which are taxonomically closer to useful plants have been screened for their phytochemicals.

Chapter 2

Materials and Methods

Materials and Methods

A. Taxonomic studies

Extensive collection were conducted from various areas of Baroda and Panchmahal districts such as M S university campus, Harni, Timbi, Sevasi, Ajwa-nimeta, Savli, Sindhroad, Chhota-udepur, Rajpipla, Kawant region, Bodeli, Lunawada, Santrampur, Jambughoda, Pavagadh Hills, Halol etc., at all seasons. At the time of visits care was taken to collect as many plants as possible so that duplicates may be available. Every specimen was collected with their flowers and fruits also if available. Herbaceous plants were collected entire i.e., with their root-systems. Along with this field diaries were prepared with useful notes, which include-state of plant, habitat of the plant, locality form which plant was collected.

Specimens collected were brought to the laboratory. All these plants were carefully studied and identified with help of references to Hooker's Flora, Cook's Flora and other Floras. After the proper identification, elaborative illustrations were made which include whole morphology and micromorphology of the plants. The specimens identified by reference to various Floras were checked and compared with the specimens in the herbarium. Herbariums were made from the specimens, by pressing, poisoning, and labeling them. These specimens are deposited in the "BARO, The herbarium of Dept. of Botany, M S University Baroda."

B. Micromorphology

Micromorphological studies were carried out on fresh materials. Fresh leaves were washed and small fragments of leaves were taken from the middle region of the mature leaves. Washed leaf fragments were first boiled in 90% alcohol for about 3-5 minutes to remove chlorophyll, then washed 2-3 times in water, then again boiled with 10% KOH solution (Wallis, 1957) for 2-3 minutes and washed 4-5 times in water and kept in clean water to remove all traces of the clearing agent. Both the epidermal layers were stripped off gently from the mesophyll tissue with their help of pointed needle and forceps. The epidermal peels were washed in water, stained with Toluidine blue (0.5%) prepared in

aqueous borax (Trump, 1961) and mounted in 50% glycerine; the margins of the cover slips were sealed with DPX (Johansen, 1940). The slides were examined under the microscope and Camera Lucida sketches were drawn at 400x magnification and the sizes were measured using an ocular micrometer. The quantitative data were based on the average of 20 readings.

C. Phytochemical studies

Of the 11 plants taken up for bioprospecting studies, two plants *Balanites aegyptiaca* and *Aloe barbadensis* were studied for their seed oils; three plants *Ageratum houstonianum*, *Stemodia serrata* and *Stemodia viscosa* for their volatile oil; one plant *Alternanthera bettzickiana* for its steroid; *Bombax ceiba* for their mucilages; *Aloe barbadensis* flowers for their quinones and *Alternanthera bettzickiana*, *A. sessilis*, *Hygrophila schulli* and *Riedleia corchorifolia* for their flavonoids. The methods followed for the extraction and isolation of the phytochemicals are the following:

1. Fixed oils.

a. Extraction of fixed oil:

10 g of a dry finely powdered sample is taken in an extraction thimble of Soxhlet's apparatus and is extracted with light petroleum (40-60°) for 3-4 hrs. The thimble is taken out, dried and the contents are finely ground in a mortar. The material is again transferred to the thimble and extraction continued for one hour more. After cooling, the solvent is distilled off and oil present is dried by keeping it at 100 °C for 30 min and weighed. From this percentage amount of oil calculated.

b. Analysis of fatty acids

The fatty acids of the oil are analysed by converting them to FAME (Fatty acid methyl esters) and separating them by argenated TLC. The methyl esters are prepared by transmethylation of the oil by refluxing it for 90 min. with methanol: benzene: H₂SO₄ (20:10:1). Argenated TLC is prepared by using 5% AgNO₃ with Silica gel. The solvent system used for TLC separation was toluene: ethyl acetate (70:30, v/v). The methyl esters

were visualized by spraying the chromatograms with 20% sulphuric acids and heating the plates at 110 °C for five minutes. The fatty acids are identified by co-chromatography with authentic samples.

2. Volatile oils:

The volatile oils are extracted by steam distillation. In this process, the fresh plant material was taken in a round bottom flask, covered with the water and attached with the splash and condenser and kept in a sand bath for distillation. When the water distilled, over the volatile oil also got distilled and collected as a separate upper layer in the receiver. The water and the oil in the fraction were transferred to a separating funnel and to this solvent ether were added and the whole mixture was shaken thoroughly. The volatile oil gets extracted in the upper ether layer which was then collected. The ether layer was then evaporated to get the volatile oil. Now, this oil was spotted on thin layer chromatograms of silica gel G. the chromatograms were developed in benzene as the irrigating solvent. The developed chromatograms were then sprayed with vanillin-sulphuric acid (spraying the plates with a solution of 5% ethanolic sulphuric acid, followed by an overspray of 1% ethanolic vanillin) and the plates were then heated at 110°C. When the monoterpenes they have distinctive colours, standard monoterpenes isolated from authentic sources were used to co-chromatograph to confirm the identity of the monoterpenes.

3. Steroids

For extraction of steroids dried plant material is extracted with methanol in a soxhlet's apparatus for 24 hrs. The extract is concentrated and the water soluble is filtered out. The water soluble extract is hydrolysed with 2N HCl for 1 hour. The precipitated aglycones which include the steroids are extracted out with ethyl acetate using a separating funnel. The ethyl acetate soluble fraction is spotted on TLC plates and the plates are developed in hexane-ethyl acetate (1:1). The steroids are visualized by spraying the plates with Liebermann-Burchard reagent (prepared by adding 5ml acetic anhydride and 5 ml concentrate sulphuric acid to 50ml absolute ethanol.) or 50% sulphuric acid. The plates are then heated on a hot plate at 110 °C for 5 min. when the steroids develop distinctive

colors. The steroids are identified by co-chromatography with authentic standard samples.

4. Mucilage

A known weight of the powdered material was boiled in water for 2-3 hours. The water extract was then filtered through cheese cloth and filtrate was collected and concentrated to a small amount. To this concentrated extract, excess methanol was added when the mucilages got precipitated. This setup was kept overnight, when the precipitate settle down at the bottom, the supernatant was decanted and the residue was centrifuged, when the mucilage settle down at the bottom. This residue was qualitatively transferred to a preweighed beaker and kept in an oven for 48 hours. The increasing the weight of the beaker denoted the weight of mucilage. For finding out the sugars components of the mucilage, the dry residue (mucilage) was dissolved in minimum water. To this solution 72% sulphuric acid was added and kept for hydrolysis for 48 hours. After 48 hours, the acidic extract was neutralized with BaCO_3 . The neutralized extract was concentrated to dryness and spotted in Whattman No. 1 filter paper along with standard sugars. The developing solvent was BAW. The developed chromatograms were then sprayed with aniline hydrogen phthalate and the chromatograms were heated on a hot plate at 110°C . The developed sugars were identified by their R_f values and colour reactions.

5. Flavonoids:

The procedures followed in the present work for the extraction, isolation and identification of flavonoids are described below.

Fifty grams of leaf power was extracted in a Soxhlet's apparatus with methanol for 48hrs till the plant material became colourless. The methanolic extract was concentrated to dryness in a water bath. 25-30 ml of water was added to the dry residue and the water soluble phenolic glycosides were filtered out. The filtrate was hydrolysed in a water-bath for one hour using 7% HCl. This hydrolysate was extracted with diethyl ether/solvent ether, whereby the aglycones got separated into ether fraction (fraction A). The remaining aqueous fraction was further hydrolysed for another 10 hours to ensure the complete hydrolysis of all the O-glycosides. Aglycones were once again extracted into diethyl

ether (fraction B) and the residual aqueous fraction was neutralized and evaporated for the analysis of glycoflavones.

Ether fractions A and B were combined and analysed for aglycones using standard procedures (Harborne, 1984; Mabry *et al*; Markham, 1982). The combined concentrated extract was banded on Whatman No. 1 paper & chromatographed along with quercetin as the reference sample. The sample system employed were Forestal (Con.HCl: acetic acid: water; 30:30:10) or 30% glacial acetic acid. The developed chromatograms were dried in air and the visibly color compounds were marked out. These chromatograms were observed in the ultra-violet light (360 nm) and the bands were noted. Duplicate chromatograms were then sprayed with 10% Na₂CO₃ and 1% FeCl₃ and the color changes were reported. R_q (RF relative to quercetin) values were calculated for all the compounds. The bands of the compounds were cut out from unsprayed chromatograms and were eluted with spectroscopic grade methanol. The UV absorption spectra of these compounds were recorded in methanol using 'Perkin- Elmer Lambda 25 UV/Vis' spectrophotometer. The bathochromic & hypsochromic shifts induced by the addition of various reagents were studied. The reagents used and there preparation are given below (Mabry *et al*, 1970).

Sodium methoxide (NaOMe): Freshly cut sodium metal (2.5) gm was added cautiously in small portion to spectroscopic methanol (100ml). The solution was stored in a tightly closed glass bottle.

Aluminium chloride (AlCl₃): Five grams of fresh anhydrous AR grade AlCl₃ (which appeared yellow-green and reacted violently when mixed with water) were added cautiously to spectroscopic methanol (100ml), formed initially, dissolved after about 24 hrs.

Hydrochloric acid (HCl): Concentrated AR grade HCl (50ml) was mixed with distilled water (100ml) and the solution was stored in glass stoppered bottle.

Sodium acetate (NaOAc): Anhydrous powdered AR grade NaOAc was used.

Boric acid (H₃BO₃): Anhydrous powdered AR grade H₃BO₃ was used.

The concentrations of the sample solution prepared by eluting chromatogram strips were adjusted so that the optical density (OD) fell in the region of 0.6 to 0.8. The methanol spectrum was taken using 5 ml of this stock solution. A reference solution was

prepared by extracting a piece of blank chromatographic paper from the same chromatogram with spectroscopic methanol. The NaOMe spectrum was measured immediately after the addition of three drops of NaOMe stock solution to the flavonoidal solution used for methanol spectrum. The solution was then discarded. The AlCl_3 spectrum was then measured immediately after the addition of six ml of AlCl_3 stock solution to 5 ml of fresh stock solution of the flavonoids. AlCl_3 /HCl spectrum was recorded next, after the addition of 3 drops of the HCl solution to the solution containing AlCl_3 . The solution was then discarded. For NaOAc spectrum, excess coarsely powdered anhydrous AR grade NaOAc was added by shaking the cuvette containing 5 ml of fresh solution of the flavonoids, till about a 2mm layer of NaOAc remained at the bottom of the cuvette. The spectrum was then recorded 2 minutes of the addition of NaOAc. NaOAc/ H_3Bo_3 spectrum was taken after sufficient H_3Bo_3 was added to give a saturated solution. The solution was discarded after recording the spectrum. The structure of flavonoid was established by its absorption maxima (λ_{max}), shape of the curves, shifts (both bathochromic & hypsochromic) with different reagents AlCl_3 , AlCl_3 /HCl, NaOAc/ H_3Bo_3 , NaOMe (Mabry et al; 1970), color reactions and Rf values. The identification was confirmed by co - chromatography with authentic samples.

Normally, a flavonoid is linked to a sugar by O-glycosidic bonds, which are easily hydrolysed by mineral acids. But there is another type of bonding in which sugars are linked to aglycone by C-C bonds. The latter group of compounds, known as C-glycosides (glycoflavones) is generally observed among flavones. They are resistant to normal methods of hydrolysis and will remain in the aqueous layer when hydrolysed extract was extracted with ether to remove aglycones. The procedures followed for isolating glycoflavones are described below:-

The aqueous fraction remaining after the separation of aglycones was neutralized by the addition of anhydrous Na_2CO_3 / BaCO_3 and concentrated to dryness. When BaCO_3 was used, barium chloride got precipitated and was filtered out. This filtrate was concentrated to dryness. To this dried residue, ethanol was added to dissolve the glycoflavones. The alcoholic filtrate was concentrated, and was banded on Whatman No.1 paper and the chromatogram was developed in water as solvent system. Glycoflavones were visualized by their colour in UV & with 10% aqueous Na_2CO_3 spray.

Further analysis and identification were done by measuring the λ max and spectral shifts and co=chromatography with authentic samples. Biflavones were extracted with other flavonoids in methanol. But they were fractionated from the aqueous extract (prepared after concentrating the methanolic extract) using solvent ether or ethyl acetate. The individual biflavones were separated in paper using 30% acetic acid and Forestal or 15% acetic acid.

Chapter 3

Results

Results

The results obtained in the research project are presented under two sections;

- A. The taxonomic descriptions of plants along with the micromorphological characters, and**
- B. Bioprospecting**

A. The taxonomic descriptions and micromorphological characters of the plants studied

The taxonomic descriptions and micromorphological characters of the plants studied are given below; the plants are arranged following the classification proposed by G. Bentham and J. D. Hooker in their *Genera Plantarum* (1862-1883).

Annonaceae

1. *Annona reticulata* Linn. *Sp. Pl.* (1753) p. 537.

This also is a small tree with membranous leaves upto 15 cm long, oblong-lanceolate, minutely pellucido-punctate, the upper surface glabrous, the lower with a few scattered hairs. Flowers 2-4 borne on lateral pedicels. Sepals 3 small, valvate, 0.5 cm long, broadly ovate, acute, tomentose. Petals usually 6, valvate, in 2 series; the exterior 3 cm long by 0.6 cm broad, tomentose on both surfaces; the interior minute, shorter than the sepals. Stamens many, the produced connective ovoid at top. Carpels many; ovule 1, erect; style oblong. Fruit subglobose, roughish outside, yellowish-red; areoles pentagonal, lightly marked. Seeds smooth, blackish. (Fig. 1)

Vernacular name: Ramphal.

Flowers: October-March.

Micromorphology (Fig. 1)

The plant showed presence of unicellular, non-glandular, elongated thick walled trichome with a pointed end and a rounded base.

Stomata were both tetracytic and anomocytic types, though the latter was more common.

D/1260.

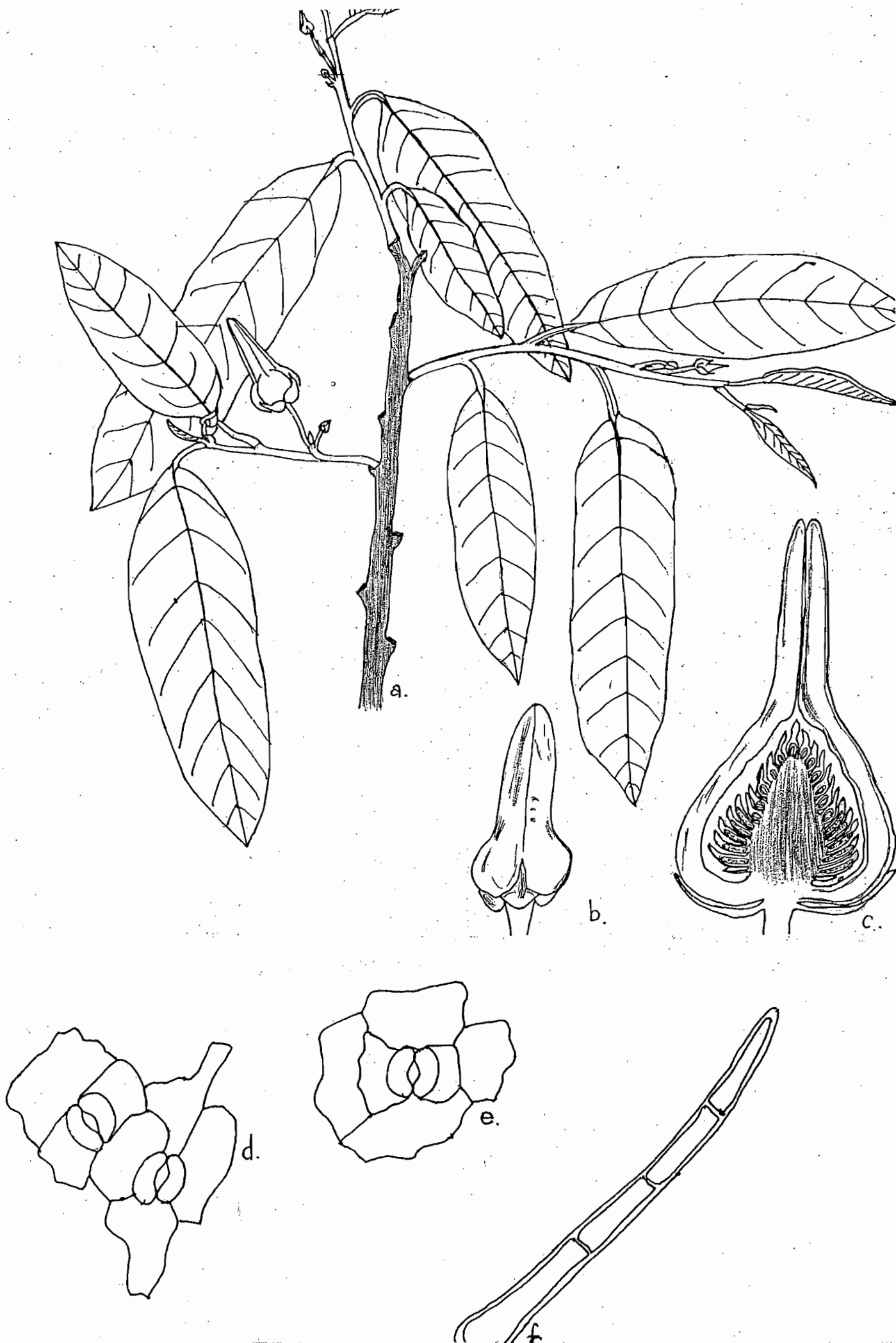


Fig. 1. *Annona reticulata* L., a. habit, b. flower, c. L.S. of flower, d. anomocytic stomata, e. tetracytic stomata, f. multicellular uniseriate trichome.

2. *Annona squamosa* Linn. *Sp. Pl.* (1753) p. 537.

This is a tree about 6-8 m high. Leaves oblong-lanceolate upto 8 cm long, glaucous and pubescent beneath. Flowers small, borne solitary or in groups of 2-4, on short, extra-axillary branchlets; pedicels bracteate below the middle. Sepals 3, minute, triangular, pubescent. Petals pubescent on both surfaces; the exterior about 2.5 cm; the interior minute or sometimes wanting. Fruit globose etaerio, 5-10 cm in diameter, yellowish-green when ripe, easily broken into large pieces; areoles well-marked, granulate or tuberculate, 5-6-gonous; pulp sweet. Seeds brownish-black, many, smooth. (Fig. 2)

Vernacular name: Sitaphal.

Flowers: May-July.

Micromorphology (Fig. 2)

The plant showed presence of unicellular, non-glandular, elongated, thick walled trichome with round base.

Stomata were anomocytic.

D/211.

3. *Artabotrys odoratissimus* R. Br. in *Bot. Reg.* (1820) t. 423.

This is a scandent shrub, with long leaves (up to 18cm), oblong-lanceolate, shortly acuminate, glabrous, shining, acute at the base. Flowers yellow, highly fragrant, solitary or in pairs, 3-4 cm long on long pedicels. Sepals small, connate below, ovate, acute, tips reflexed. Petals lanceolate above the saccate base, clothed with appressed silky hairs. Fruit an etaerio of 6-10 obovoid, glabrous, yellow drupes. Seeds oblong, a little flattened, deeply grooved on one side. (Fig. 3)

Vernacular name: Nagchampo.

Flowers: Throughout year.

Micromorphology (Fig. 3)

Whole plant was glabrous except for the petals.

Stomata were anomocytic.

D/312.

Menispermaceae

1. *Cissampelos pareira* Linn. *Sp. Pl.* (1753) p. 1031.

A twiner, this shrub possesses pubescent peltate leaves upto 10 cm in. in diameter, orbicular or reniform, often slightly broader than long, cordate or truncate at the base, mucronate, margins ciliate; petiole long, pubescent. Flowers minute, yellowish. Male flowers: pedicelled in axillary cymes; peduncles filiform, 2 cm long, pubescent; bracts small, subulate. Sepals 4, hairy outside, obovate-oblong, concave. Petals combined into a cyathiform corolla, hairy without, glabrous within, half the length of the sepals. Filaments longer than the corolla. Female flowers in elongate, solitary or twin, axillary racemes born on very short pedicels. Bracts foliaceous, nearly sessile, orbicular, mucronate, usually softly villous, ciliate, persistent. Sepal 1, ovate-oblong, villous on the outside. Petal 1,

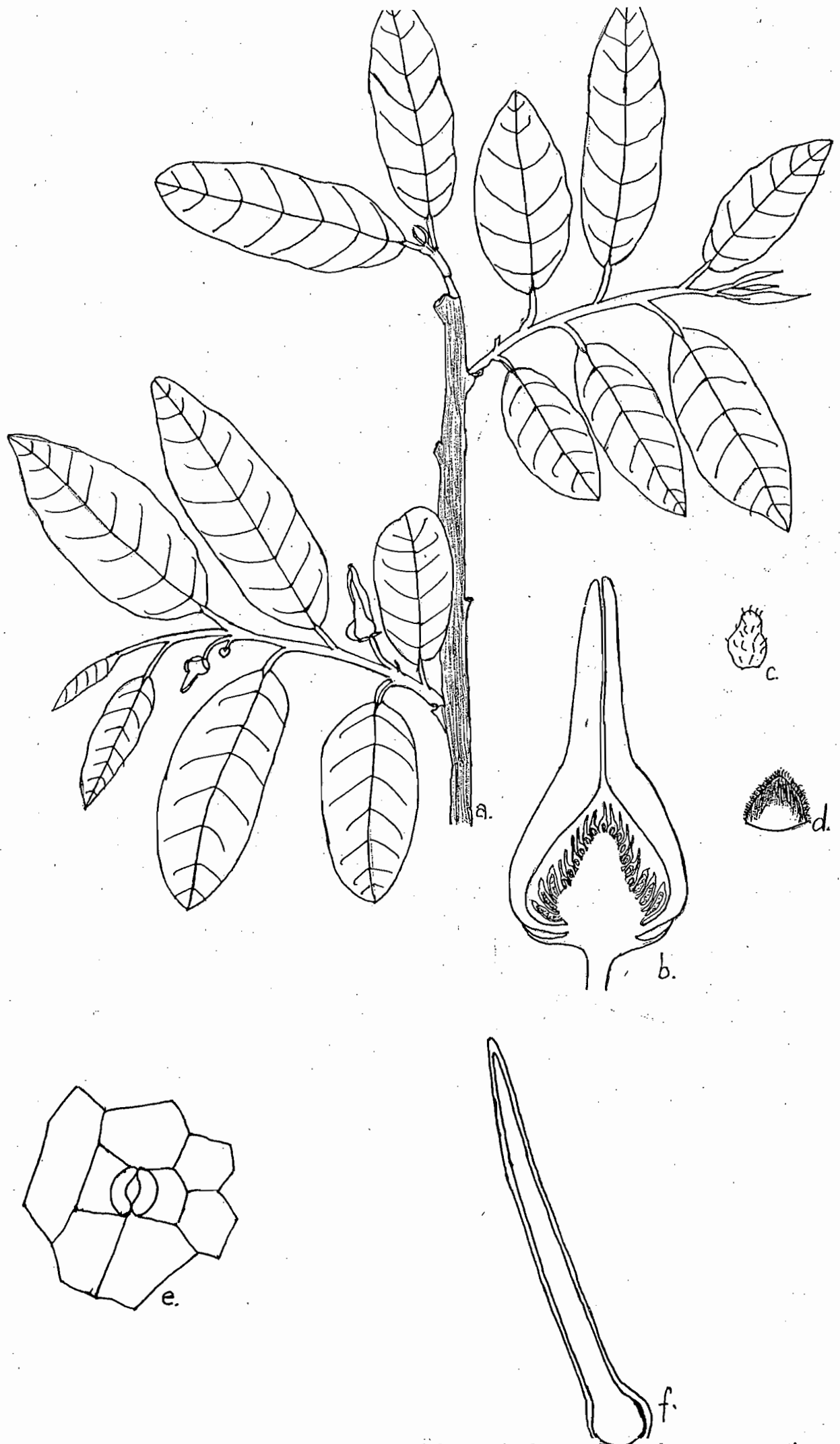


Fig. 2. *Annona squamosa* L., a. habit, b. L.S. of flower, c. bract, d. sepal, e. anomocytic stomata, f. unicellular trichome.

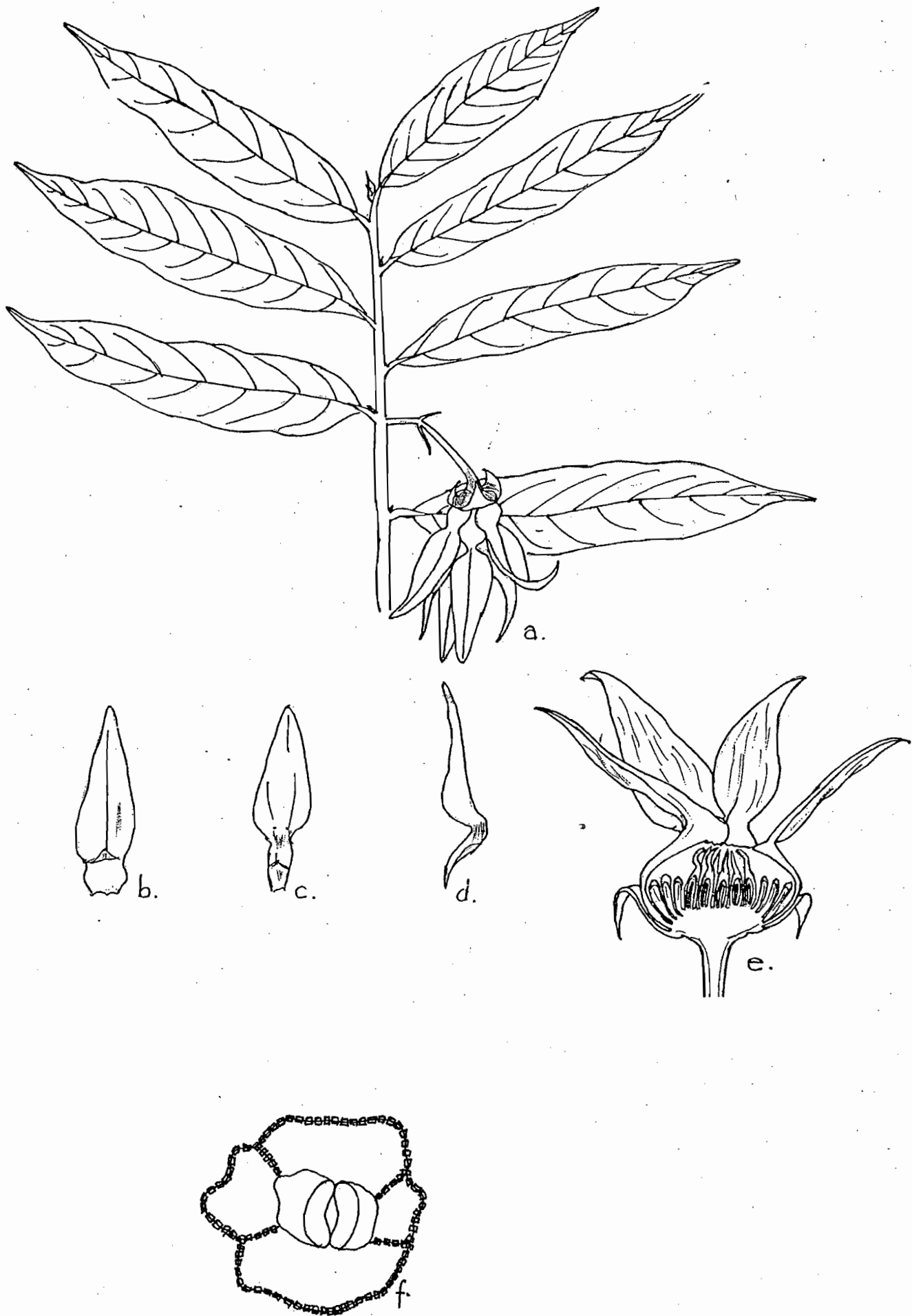


Fig. 3. *Artabotrys odoratissimus* Br., a. habit, b. outer petal, c. inner petal, d. side view of inner petal, e. L.S. of flower, f. tetracytic stomata.

subrotund, about half the length of the sepal. Drupe subglobose, compressed, hairy, red; endocarp transversely ridged. (Fig. 4)

Vernacular name: Venivel.

Flowers: July- September.

Micromorphology (Fig. 4)

Anomocytic stomata with rosette of subsidiary cells and non-glandular two-celled uniseriate trichome.

D/599, 992, 1179.

2. *Cocculus hirsutus* (Linn.) Diels in Engler, *Pflanzen*. IV. 94: 236. 1910.

A climbing undershrubs, often densely pubescent-tomentose. Leaves 9 cm long and 7 cm broad, ovate or ovate-oblong, sometimes 3-5-lobed, base subcordate with basal 3-5 nerves. Male flowers: sepals hairy, the outer 3, oblong-lanceolate, 2 mm long and 0.8 mm broad, the inner 3 broadly ovate. Petals ovate-oblong. Female flowers 1-3, on axillary pedicels, rarely racemed; bracts minute, linear. Drupe dark purple, endocarp annular or ribbed with a prominent dorsal crest, perforated. (Fig. 5)

Vernacular name: Vevdi.

Flowers: February-March.

Micromorphology (Fig. 5)

Non-glandular multicellular uniseriate trichome with many cells and thick wall.

Stomata anomocytic and paracytic.

D/460, 461, 669.

3. *Tinospora cordifolia* Miers, in *Ann. & Mag. Nat. Hist. Ser. 2*, V. 7 (1851) p. 38,

This extensive glabrous climber has a corky, grooved bark. Leaves membranous, 7-nerved, 10 cm long, roundish or subdeltoid with a cordate sinus at base. Petioles up to 9 cm long, along with racemes often much longer than the leaves, axillary, terminal or from the old wood. Flowers yellow, the male fascicled, the females usually solitary; bracts lanceolate-subulate, the lower sometimes foliaceous. Male flowers with 3 outer ovate-oblong sepals; the 3 inner larger, membranous, suborbicular, concave. Petals each loosely embracing a stamen, claw, lamina subtrilobed, reflexed at the apex. Stamens 6; filaments free; anther cells dehiscing longitudinally by an oblique, almost marginal slit. Female flowers similar to male flowers. Staminodes 6, clavate. Ovaries 3; stigmas forked. Drupes 1-3, dorsally convex, ventrally nearly flat, red, size of a large pea; style-scar subterminal. (Fig. 6)

Vernacular name: Gulvel.

Flowers: March-June.

Micromorphology (Fig. 6)

Non-glandular unicellular trichome with broad lumen and thick wall. Along with this glandular unicellular ellipsoid trichome was also observed. Stomata anomocytic.

D/1261.

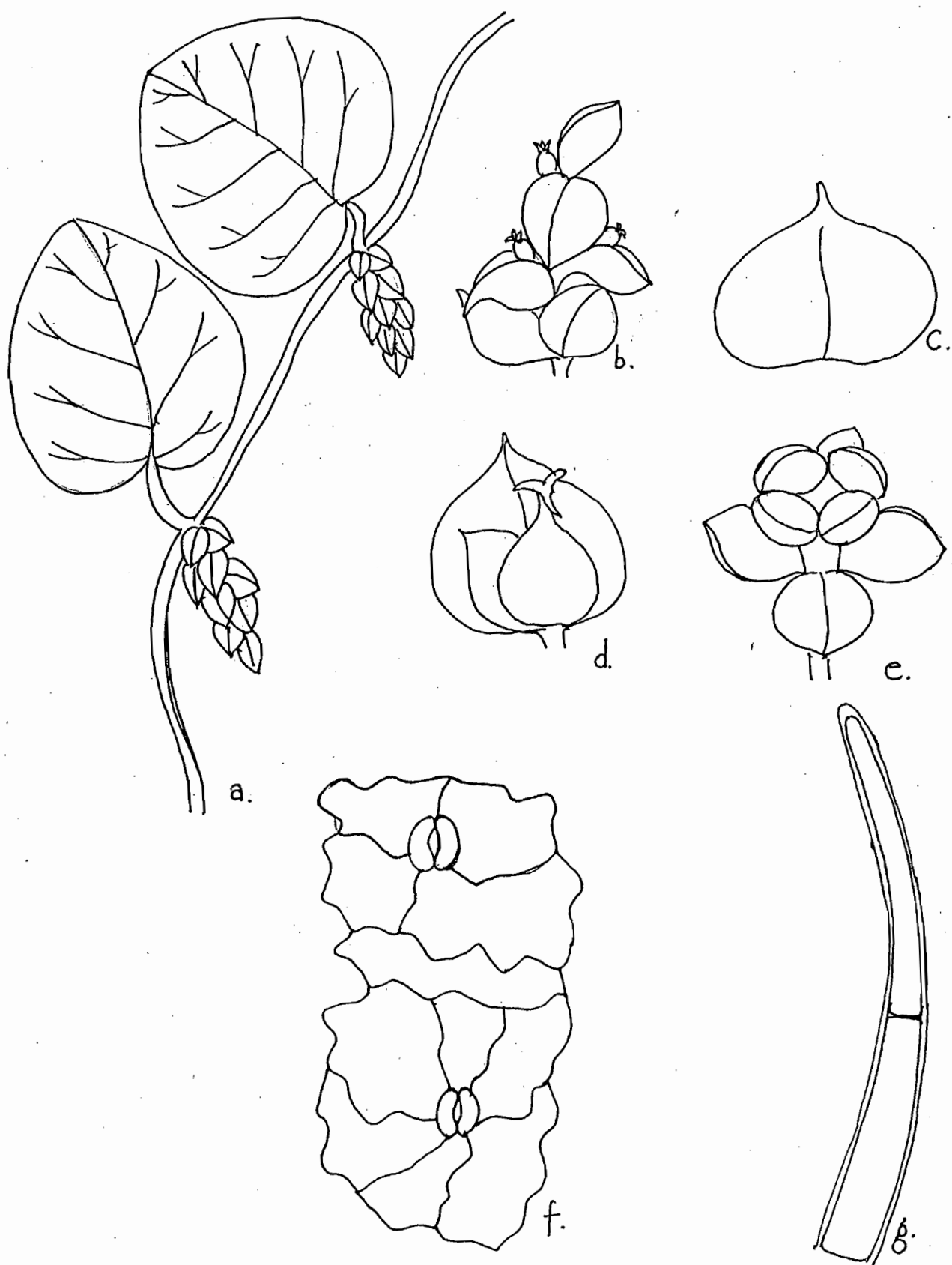


Fig. 4. *Cissampelos pariera* L., a. habit, b. inflorescence, c. bract, d. female flower, e. male flower, f. anomocytic stomata with rosette of subsidiary cells, g. two-celled uniseriate trichome with thick wall.

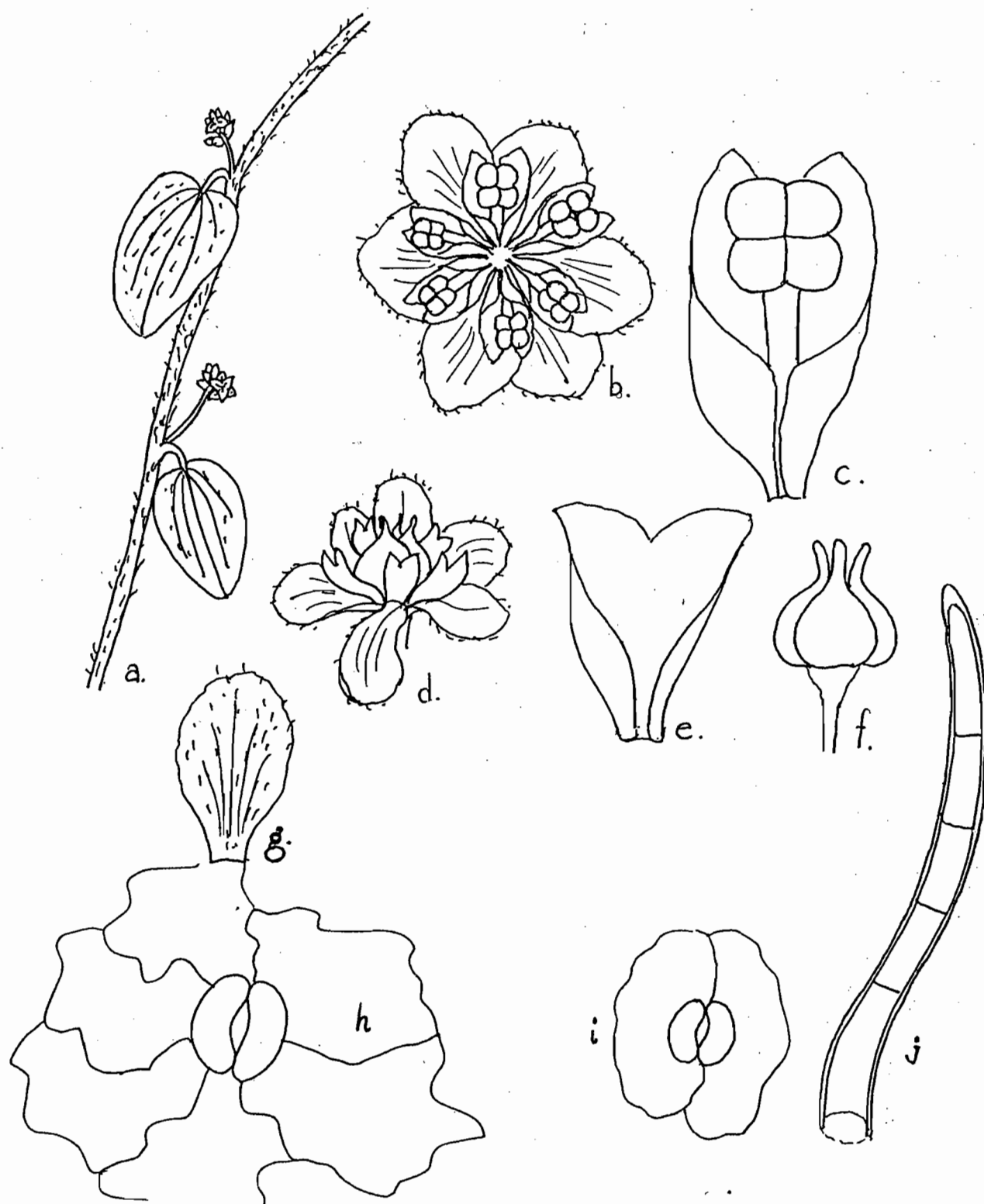


Fig. 5. *Cocculus hirsutus* L., a. habit, b. male flower c. stamen with petal, d. female flower, e. petal of female flower, f. gynoecium, g. sepal, h. anomocytic stomata, i. paracytic stomata, j. multicellular uniseriate trichome.

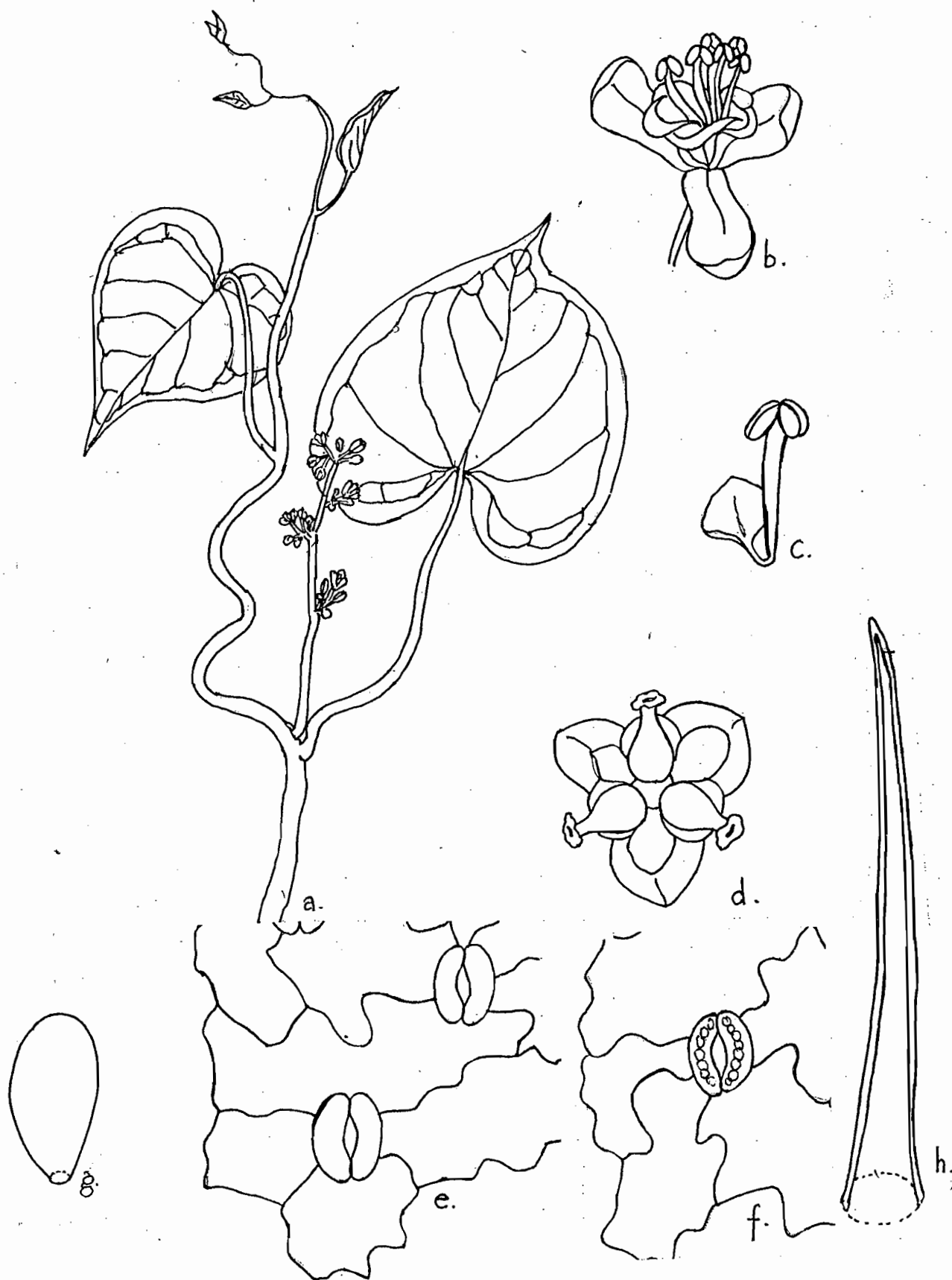


Fig. 6. *Tinospora cordifolia* (Willd.) Miers. ex. Hk. f., a. habit, b. male flower, c. stamen with petal, d. female flower, e & f. anomocytic stomata, g. unicellular club-shaped gland, h. unicellular acicular trichome with broad lumen.

Nymphaeaceae

1. *Nymphaea alba* L., *Sp. Pl.* 510. 1753.

Large herbs with creeping rootstock. Leaves upto 25 cm in diameter, suborbiculate, lobes contiguous. Flowers expanded, large, floating on long radical scapes. Sepals 4, adnate to the base of the disk; sepals linear or ovate-oblong, nerves reticulate. Petals light yellow, about 10, in many series, outer linear-oblong; inner successively transformed into stamens, all adnate to the disk. Filaments petaloid; anthers small, linear, slits introrse. Ovaries many, in 1 series, sunk in the fleshy disk and with it forming a many-celled ovary crowned by the connate radiating furrowed stigma, stigmatic rays 10; ovules many. Fruit a spongy berry ripening under water. Seeds minute, buried in pulp, enclosed in a sac-like fleshy aril. (Fig. 7)

Variation observed: in standard descriptions, the color of the flower is reported to be white, and the number of stigmatic rays were 16, but in my specimen I found with light yellow colored flower and the number of stigmatic rays were only 10.

Flowers: June-August.

Micromorphology (Fig. 7)

Stomata were of anomocytic type.

D/212.

2. *Nymphaea stellata* Willd., *Sp. Pl.* 2. (1799) p. 1153.

Perennial aquatic herbs with small corms. Leaves rotundate, 10 cm across, entire or sinuate margined, glabrous beneath. Flowers 5 cm across, blue, sometimes purple. Sepals 4 inserted almost at the base of the torus. Petals numerous, the inner gradually passing into stamens, spiral, the upper most being almost superior. Stamens appendaged. Carpels many whorled, sank in the torus and forming a syncarpous ovary with concave top and radiating stigmas. (Fig. 8)

Vernacular name: Lal poyanu.

Flowers: August-March.

Micromorphology (Fig. 8)

Stomata anomocytic. Leaf glabrous.

D/1262.

Papaveraceae

1. *Argemone mexicana* Linn. *Sp. Pl.* (1753) p. 508.

A prickly laticiferous herb, about 1.5 m high, divaricately branched. Leaves semi-amplexicaul, sessile, upto 15 cm long, sinuato-pinnatifid; the segments inciso-dentate, spiny on the margins; prickles very sharp, yellow. Flowers yellow; peduncles prickly. Sepals 2-3, concave, nearly valvate in aestivation, prickly outside, horned at the apex, very caducous. Petals 3-4 cm long, twice as many as the sepals, imbricate in 2 series, more or less crumpled in bud, obovate, cuneiform, yellow with darker parallel veins,

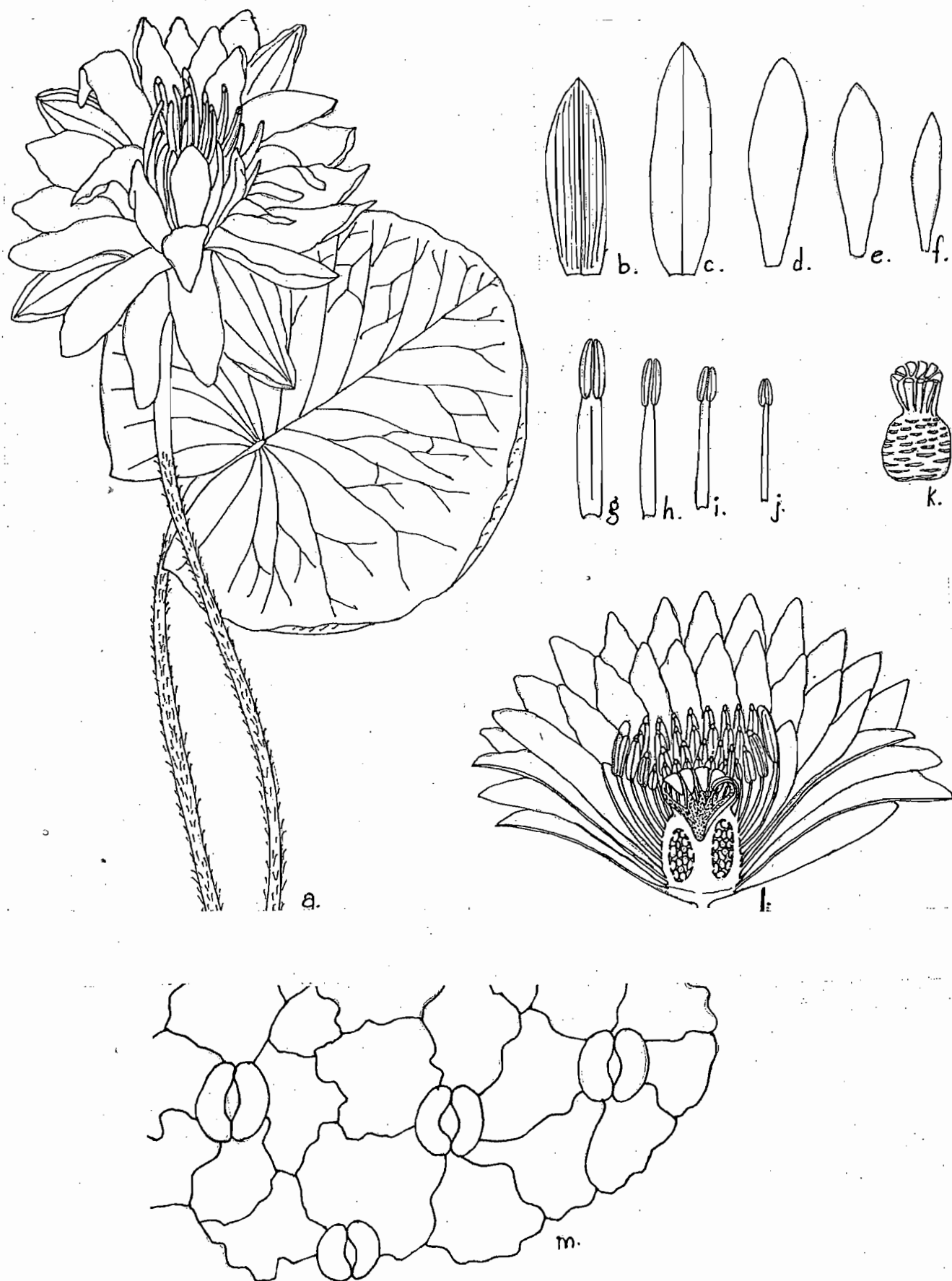


Fig. 7. *Nymphaea alba* L., a. habit, b. sepal, c-f. transitional stages from sepal to petals, g-j. stamens, k. gynoecium, l. L.S. of flower, m. anomocytic stomata.

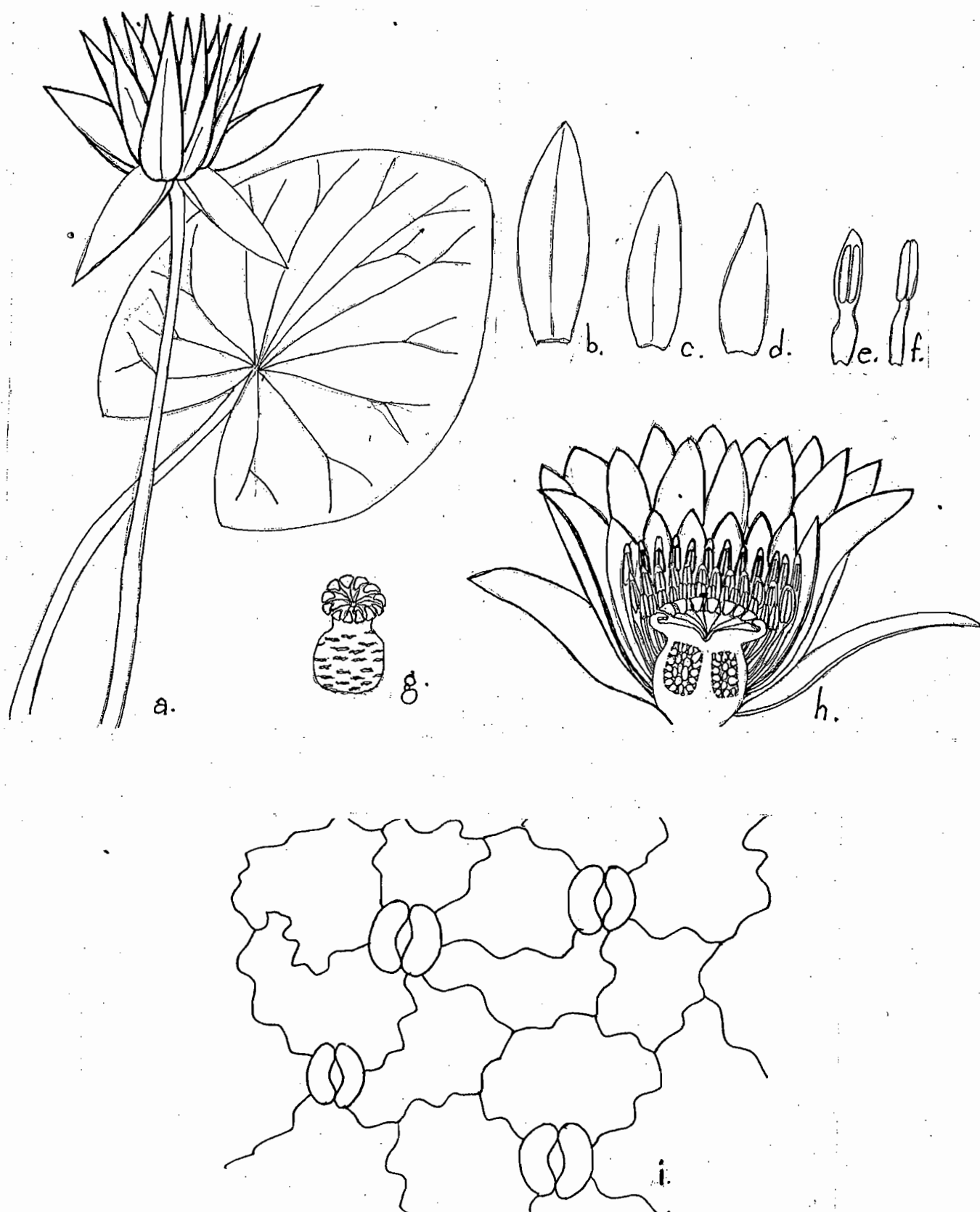


Fig. 8. *Nymphaea stellata* Willd., a. habit, b sepal, c & d. petals, e-f. stamens, g. gynoecium, h. L.S. of flower, i. anomocytic stomata.

deciduous; bracts foliaceous. Stamens numerous. Ovary one celled, covered with soft spines; ovules many on 4-7 parietal placenta, style absent, stigma red, 4-7 lobed. Capsules oblong or elliptic, prickly. Seeds blackish-brown, deeply reticulato-scrobiculate. (Fig. 9)

Vernacular name: Darudi.

Flowers all the year.

Micromorphology (Fig. 9)

Whole plant was glabrous.

Stomata were of anomocytic only.

D/235.

Brassicaceae

1. *Brassica juncea* (Linn.) Czern. et Coss. in *Czern., Conspect. Fl. Chark.* 8. 1859.

An erect annual branched herb upto 200 cm tall. Lower leaves distinctly stalked, lyrate-pinnatifid; margin irregularly and coarsely dentate; middle leaves more or less simple, oblong-ovate, dentate; upper leaves oblong-linear, acute, narrowed at the base into a short stalk, entire or subentire. Racemes 20-40-flowered. Flowers golden yellow; pedicel 5-8 mm long, increasing up to 15 mm in fruit, glabrous, ascending. Sepals oblong, subequal, apex rounded or obtuse, yellowish, glabrous. Petals obovate, clawed, apex rounded. Stamens; anthers obtuse with apex often curved. Siliquae 25-50 mm long, linear, subtetragonous, suberect. Seeds 10-20 in each locule. (Fig. 10)

Vernacular name: Rai.

Flowers: March-May.

Micromorphology (Fig. 10)

Trichome non-glandular unicellular with broad lumen and thick wall.

Stomata anisocytic and anomocytic.

D/1263.

Capparaceae

1. *Cadaba indica* Lam. *Encyc.* V. 1 (1783) p. 544.

A straggling, much-branched shrub with terete stem. The older stem is smooth, purplish whereas, the younger pubescent, yellowish-brown. Leaves simple, entire, upto 4 cm long, elliptic-oblong, mucronate. Flowers dirty white, in few-flowered, terminal, 1-sided racemes, the upper flowers corymbose; bract 1 at the base of pedicel. Sepals subequal, ovate-oblong. Petals spatulate; clawed. Disk prolonged into a funnel-shaped process, expanded and toothed at the apex, mouth oblique. Stamens 4, inserted about half way up the gynophore, much exserted. Gynophore about 2 cm long. Ovary oblong; style 0. Fruit



Fig. 9. *Argemone mexicana* L., a. habit, b. gynoecium, c. sepal, d. L.S. of flower, e. anomocytic stomata.

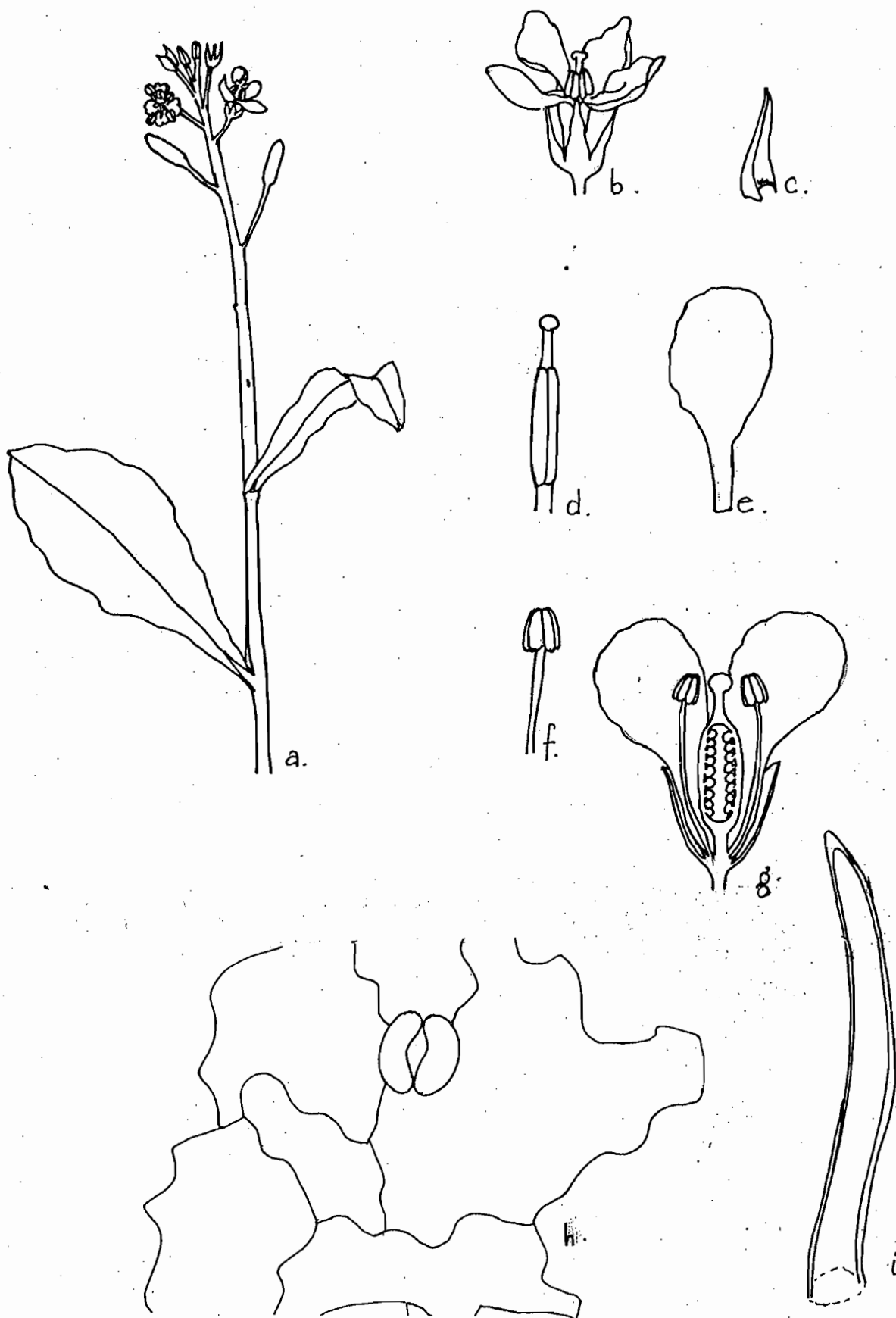


Fig. 10. *Brassica juncea* Hk.f. & T., a. habit, b. flower, c. bract, d. gynoecium, e. petal, f. stamen, g. L.S. of flower, h. anisocytic stomata, i. unicellular trichome.

dehiscent, cylindric, irregularly torulose. Seeds numerous, striate, surrounded by an orange-red aril. (Fig. 11)

Vernacular name: Batkani.

Flowers: November-March.

Micromorphology (Fig. 12)

Multicellular, non-glandular, trichomes were present on the leaves and the younger stems of the plant. Trichome was distinguished into a peltate 5 celled head and the stalk was multicellular, uniseriate at the top and biseriate at the base.

Stomata were of different types which included diacytic, tetracytic, anisocytic and anomocytic. The anomocytic and anisocytic were in majority.

D/490.

2. *Capparis aphylla* Roth, Nov. Pl. Sp. (1821) p. 238.

A straggling glabrous branched shrub with green, smooth and terete stem. Leaves, on the young shoots only (the older branches leafless), less than 1.5 cm long, linear-oblong, spinous-pointed; petioles very short; stipular thorns long, sharp, straight, orange-yellow. Flowers in many-flowered corymbs borne from the old branches or from short lateral shoots. Sepals four, the outer pubescent, ciliate, the lower sepal very saccate, the upper much smaller, ovate-oblong, concave; inner sepals elliptic, with floccose margins. Petals four, narrow-oblong, stamens 10 to many, red, inserted at the torus at the base of 1.5 cm long gynophore. Ovary borne on the top of the gynophore, ovules many on parietal placenta. Fruit globular, size of a small cherry, glabrous, beaked. (Fig. 13)

Vernacular name: Kerdo.

Flowers: November-March.

D/1041, 1198.

3. *Capparis sepiaria* Linn. System. ed. 10 (1759) p. 1071.

A much-branched, spiny woody climber; young shoots more or less pubescent. Leaves 2-4 by 1-2 cm, oblong-elliptic or obovate, obtuse, emarginated, rarely acute, the younger more or less pubescent, the older glabrous; petioles long, pubescent; stipular spines hooked. Flowers white, small, in dense short-peduncled or in sessile umbels; pedicels filiform. Sepals 4, free in 2 series, imbricate. Petals 4, clawed, claw hairy, imbricate. Stamens usually many, inserted on the torus at the base of a long gynophore, anthers basifixed, anther cells oblong. Gynophore upto 1 cm long, filiform. Ovary ovoid, pointed, glabrous or very minutely pubescent, borne at the tip of a long gynophore. Fruit globose, smooth, black when ripe. (Fig. 14)

Vernacular name: Kanthar.

Flowers: March-May.

Micromorphology (Fig. 15)

The trichome present on the leaf was non-glandular, 2 celled, uniseriate, the upper cell linear, elongated, pointed at the tip, thick walled with narrow lumen, and the lower cell forming a single celled stalk. Same type of trichome was present on the calyx also. Petal showed presence of two types of glandular trichomes, one unicellular, elongated, and thin



Fig. 11. *Cadaba indica* Lam., a. habit, b. flower, c. L.S. of flower.

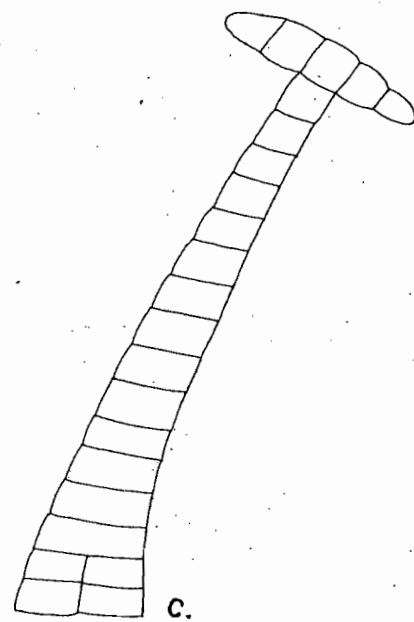
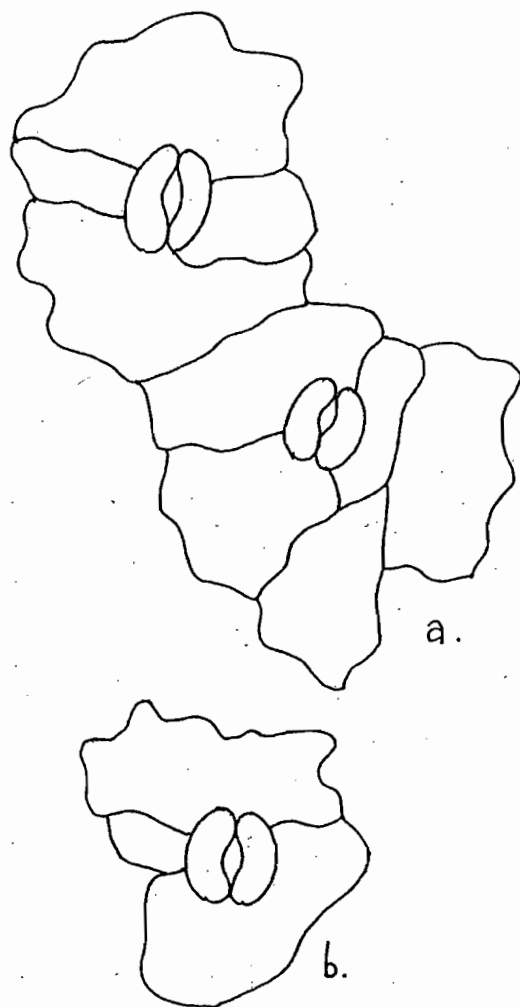


Fig. 12. *Cadaba indica* Lam., a. tetracytic and anisocytic stomata, b. anisocytic stomata, c. multicellular T-shaped gland.

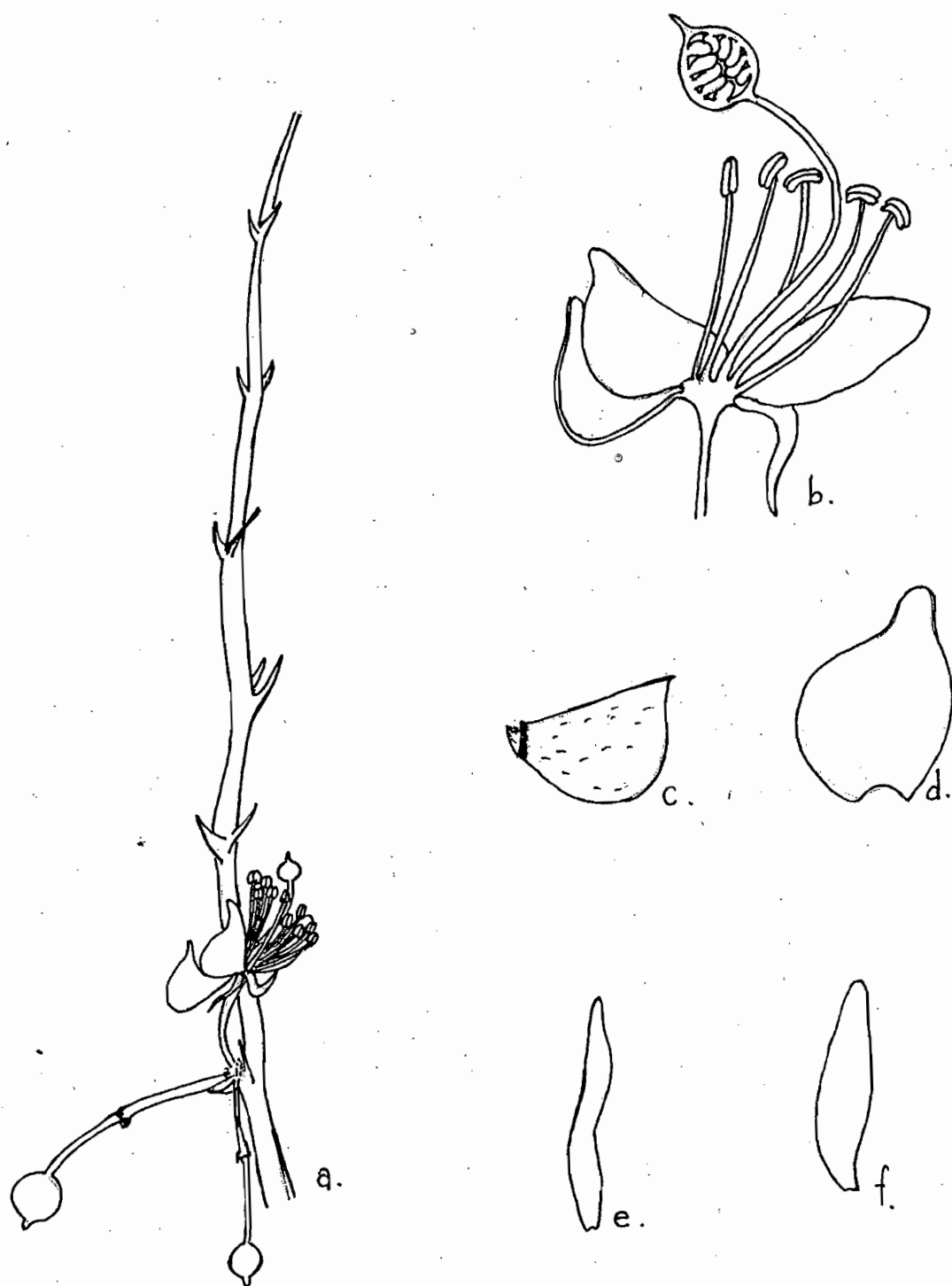


Fig. 13. *Capparis aphylla* Roth., a. habit, b. L.S. of flower, c. sepal, d. petal, e. bract, f. bracteole.

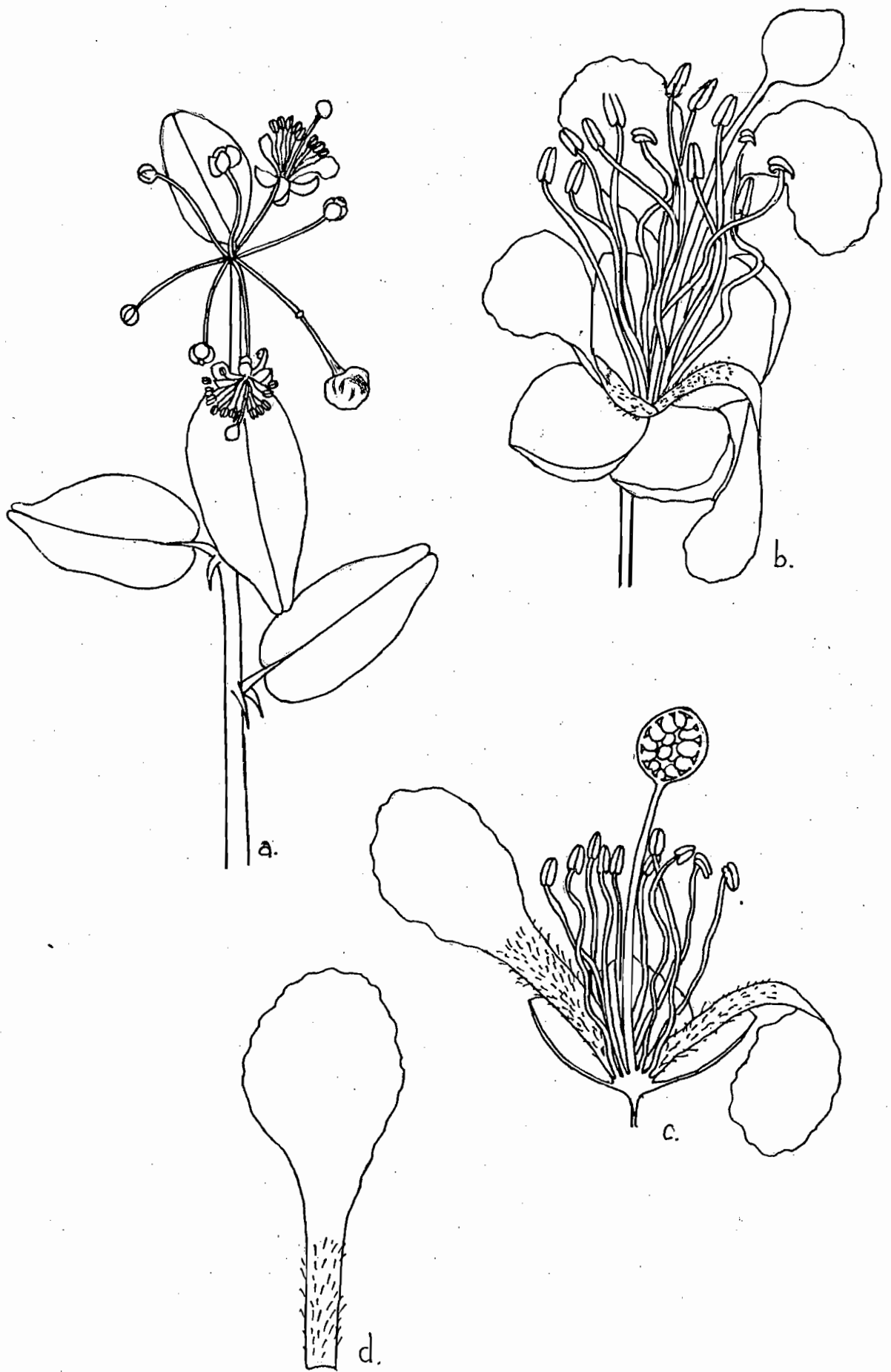


Fig. 14. *Capparis sepiaria* L., a. habit, b. flower, c. L.S. of flower, d. petal.

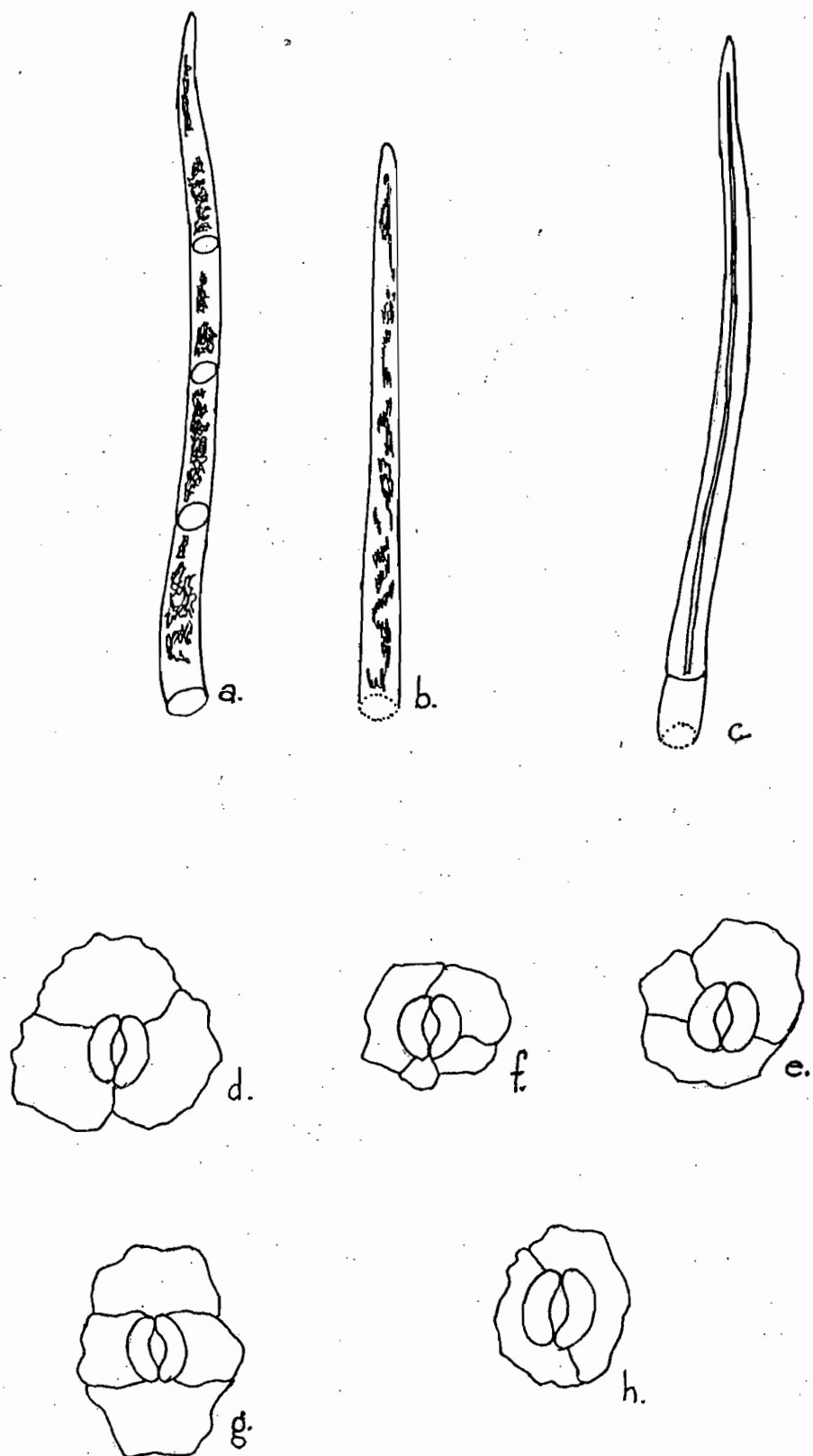


Fig. 15. *Capparis sepiaria* L., a. multicellular uniseriate gland on corolla, b. unicellular gland on corolla, c. 2-celled uniseriate trichome with narrow lumen on calyx and leaf, d & e. anisocytic stomata, f. anomocytic stomata, g. tetracytic stomata, h. oblique paracytic stomata.

walled whereas the other multicellular, unbranched, uniseriate, thin walled and contained secretory substances inside.

Stomata were of various types; anisocytic, tetracytic, oblique paracytic, and anomocytic; but the most common types were anisocytic and anomocytic.

D/361.

4. *Cleome gynandra* L. *Sp. Pl.* 671. 1753.

(*Gynandropsis pentaphylla* DC.)

An erect annual branched herb, upto 50 cm tall, often glandular hairy. Leaves petiolate, 3-7-foliolate; leaflets obovate to elliptic, slightly acuminate, finely crenate; petiole about 10 cm long. Inflorescence up to 30 cm long, bracteate. Flowers mostly white or pinkish. Sepals 4, ovate to lanceolate, glandular. Petals 4, obovate and long clawed. Androphore 15-25 mm long; stamens usually about 10, verticillate, subequal, spreading conspicuously from a long androphore, filaments often pinkish or lilac. Gynophore 10-20 mm long. Style 1-2 mm long. Fruit capsular, linear, glandular-pubescent, finely and obliquely striated, many seeded. Seeds finely longitudinally striated, dark-brown. (Fig. 16)

Vernacular name: Ghandhatu.

Flowers: Throughout the year.

Micromorphology (Fig. 17)

The trichome was glandular multicellular differentiated into multicellular head and multicellular biserial stalk.

Stomata anomocytic.

D/679, 936, 1049.

5. *Cleome viscosa* Linn. *Sp. Pl.* (1753) p. 672.

An erect branched annual with grooved, densely clothed stem. Plant about 1 m high and whole plant is clothed with glandular hairs. Leaves 3-5 foliolate; petioles of the lower leaves upto 5 cm long, gradually becoming shorter upwards. Leaflets elliptic-oblong or obovate, acute or obtuse, the terminal the largest; petiolules short, hairy. Flowers yellow, axillary, growing out into a lax raceme; pedicels slender, hairy. Sepals 4, oblong-lanceolate, glandular-pubescent outside. Petals 4, oblong-obovate, veined. Stamens 10-20. Ovary with a very short gynophore; ovules many, on 2

parietal placentas; style short. Capsules erect, hairy, obliquely striate, compressed, tapering towards both ends. Seeds brown-black when ripe, finely transversely striate, subglobose. (Fig. 18)

Vernacular name: Pilitilvani.

Flowers: September-June.

Micromorphology (Fig. 19)

Whole plant is covered with hairs. The trichomes observed were glandular multicellular differentiated into multicellular head and multicellular biserial stalk as well as simple glandular unbranched filamentous multicellular uniseriate trichome.

Stomata anomocytic.

D/1049.



Fig. 16. *Cleome gynandra* L., a. habit, b. flower, c. L.S. of flower.

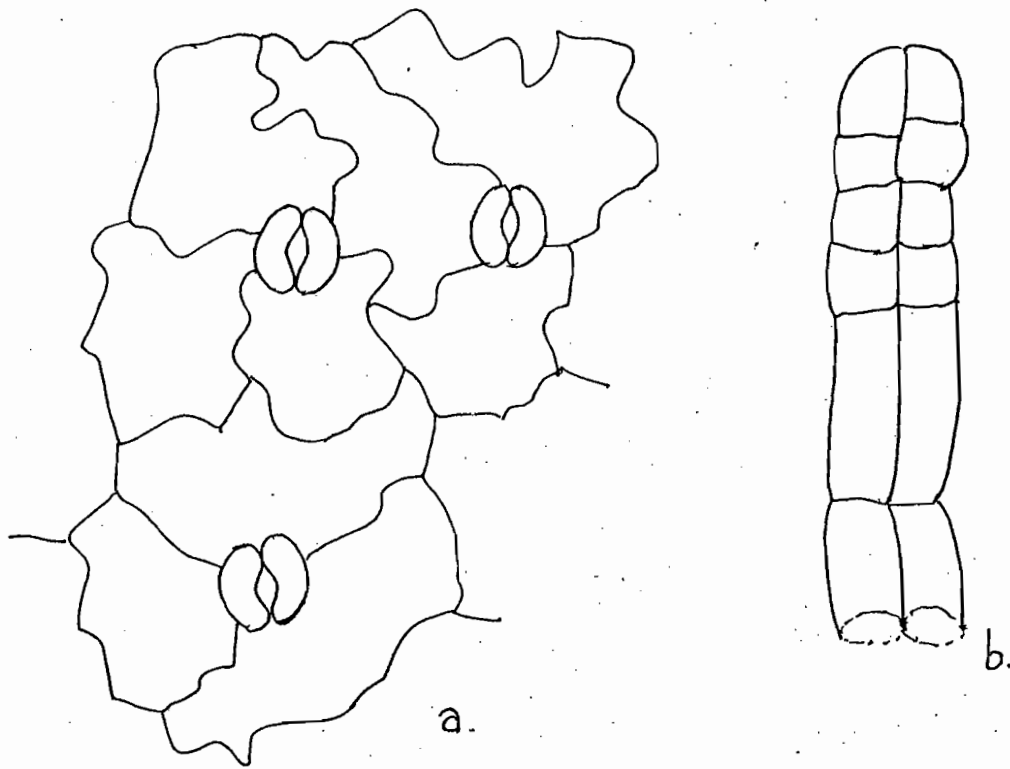


Fig. 17. *Cleome gynandra* L., a. anomocytic stomata, b. multicellular gland having 8-16 celled head and biseriate stalk.

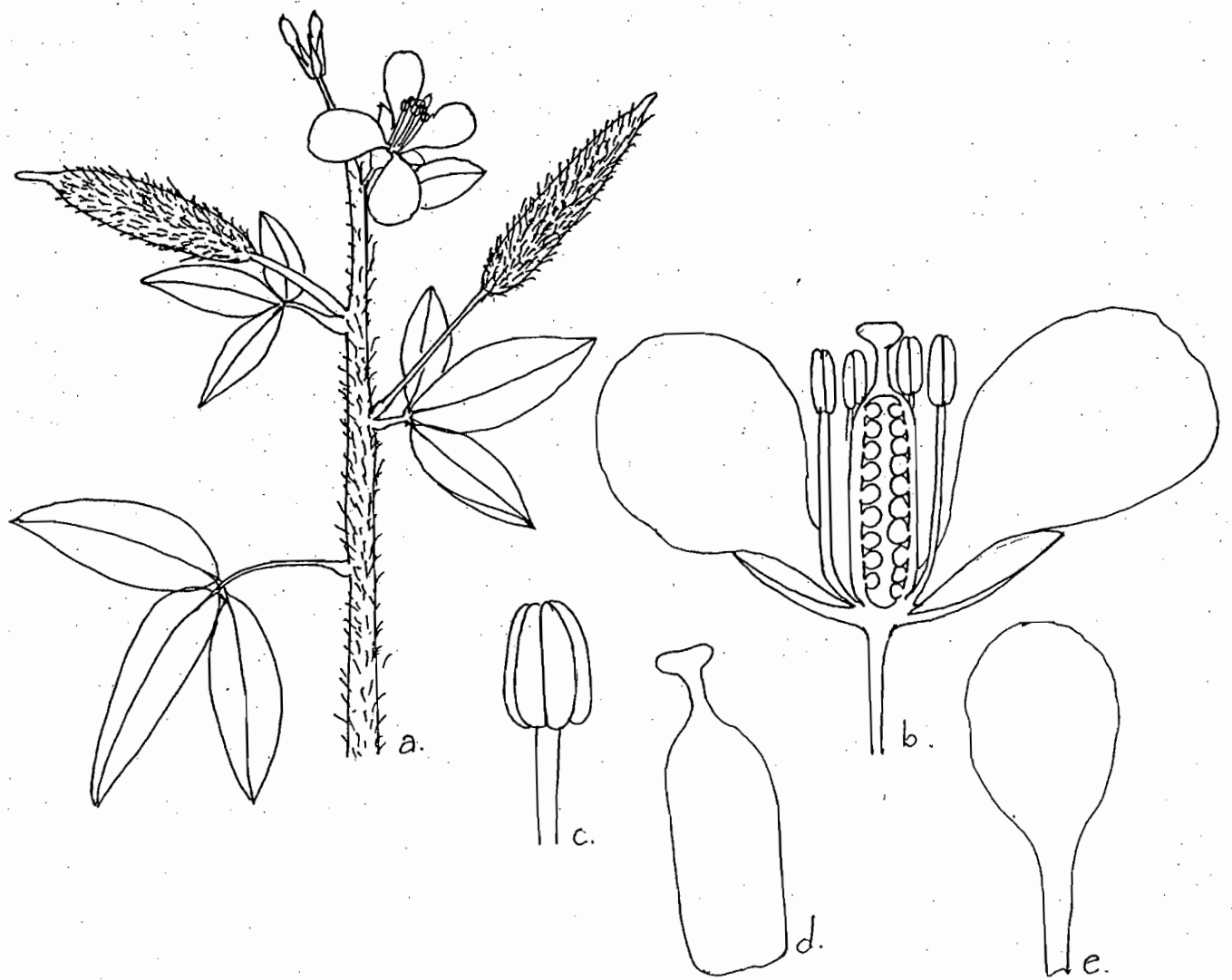


Fig. 18. *Cleome viscosa* L., a. habit, b. L.S. of flower, c. stamen, d. gynoecium, e. petal.

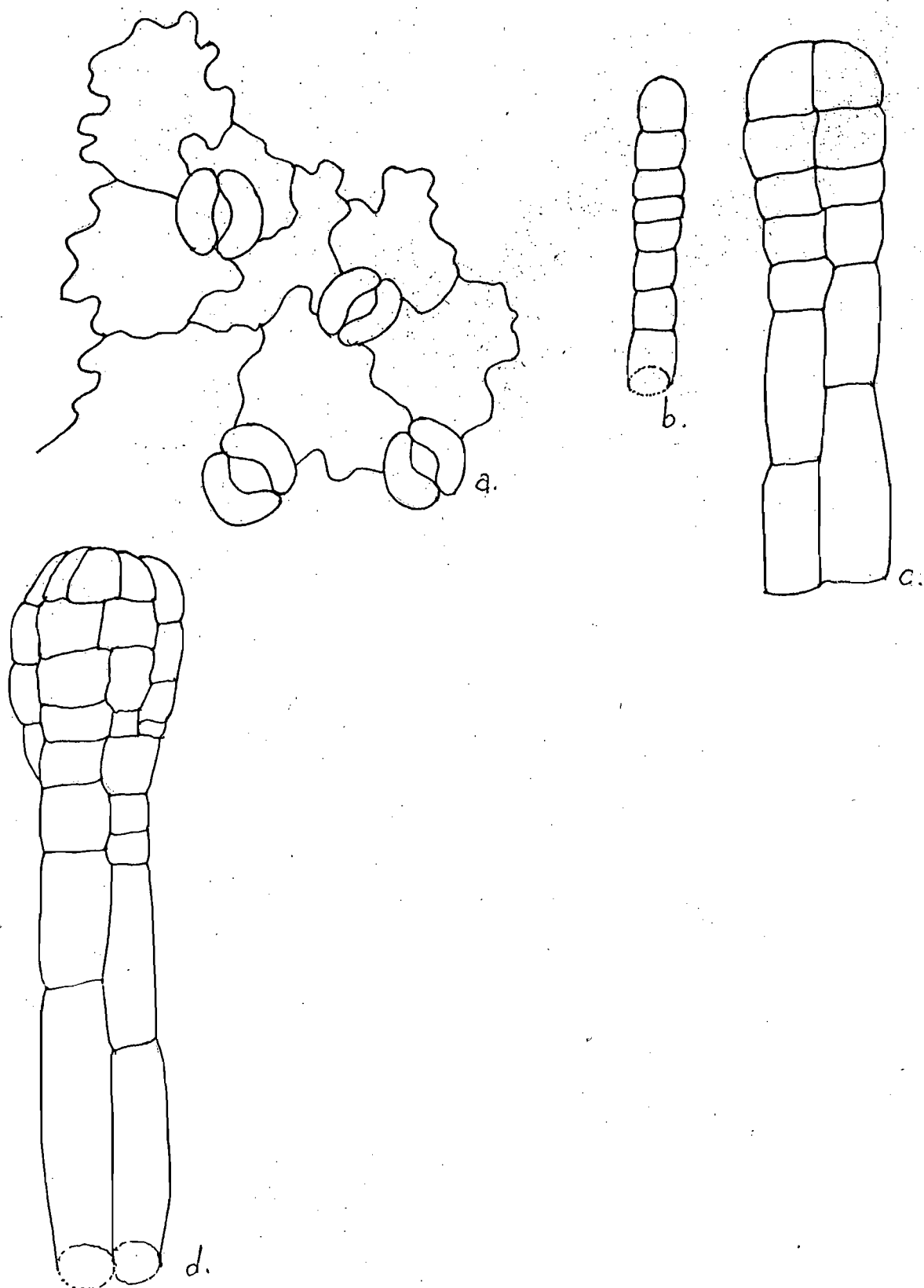


Fig. 19. *Cleome viscosa* L., a. anomocytic stomata, b. multicellular uniseriate gland on leaf, c. multicellular gland differentiated into 8-16 celled head and biseriate stalk on leaf, d. multicellular gland having a multicellular head and biseriate stalk found on calyx and stem.

6. *Crataeva religiosa* Forst. f. *Prodr.* (1786) p. 35.

A small tree with a much-branched head. Leaves deciduous, 3-foliolate; Leaflets upto 15 cm long, ovate, lanceolate or obovate, acute or acuminate, attenuated at the base, entire, glabrous on both surfaces, pale beneath and reticulately veined, the lateral leaflets oblique at the base. Flowers many, in dense terminal corymbs, greenish-white. Sepals petaloid, small, distant, ovate, acute. Petals clawed 2.5 cm long. Stamens longer than the petals, spreading. Gynophore nearly 5 cm long, terete, smooth. Ovary ellipsoid; stigma flat. Fruit a globose or ovoid, woody, smooth or scurfy berry, borne on the thickened gynophore. Seeds imbedded in pulp, nearly smooth, brown. (Fig. 20)

Vernacular name: Vayvarno.

Flowers: January-May.

Micromorphology (Fig. 20)

Whole plant was glabrous.

Stomata were of anomocytic type.

D/255.

7. *Maerua ovalifolia* Camb. in *Jacquemont, Voy. Bot.* (1844) p. 23.

A climbing woody shrub with divaricate branches; bark smooth, pale. Leaves 2.5- 5 by 1-2.5 cm, elliptic-oblong, mucronate, glabrous. Flowers in corymbs, greenish-white, terminal or on lateral shoots. Bract 1 at the base of each pedicel, small, ovate. Calyx-lobes ovate, hooded at the apex, with a short horn behind the hood. Petals ovate-lanceolate, acute, with slightly undulate margins. Stamens many, inserted on the torus. Gynophore 2 cm long. Ovary cylindric, truncate; style 0; stigma large. Fruit pale brown, constricted between seeds. Seeds brown, globose, echinulate. (Fig. 21)

Vernacular name: Hemkhand.

Flowering season: November-March.

Micromorphology (Fig. 21)

Whole plant was glabrous.

Stomata were of anisocytic, anomocytic and tetracytic type; anomocytic type of stomata was in majority.

D/315.

Violaceae

1. *Ionidium heterophyllum* Ventenat, *Jard. de la Malm.* (1803).

A small suffrutescent perennial herb about 30 cm high with many diffuse or ascending branches. Leaves linear or lanceolate, 4-5 cm long, subsessile, entire or with serrated margins. Flowers red, axillary, solitary; bracts small, above the middle of the pedicel. Sepals lanceolate, very acute, keeled. Petals 5 unequal, the 2 upper ones oblong, slightly longer than the sepals, the 2 lateral longer, falcate, the lowest much larger than the others, having an orbicular or obovate limb with a long claw which is curved behind into a short spur. Anthers connate or free, 2 or 4 of them gibbous or spurred at the back. Style

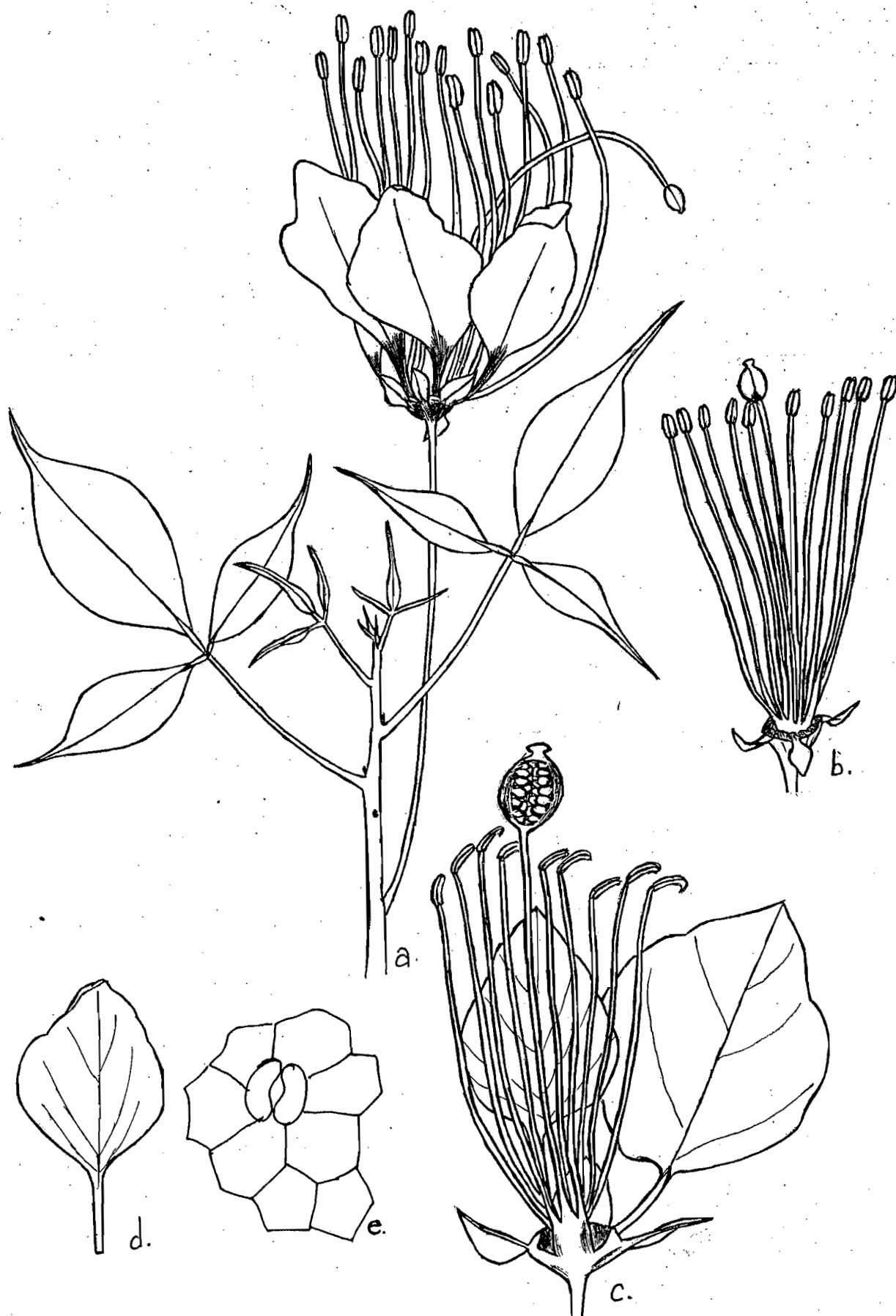


Fig. 20. *Crataeva religiosa* Forst., a. habit, b. gynoecium and stamens, c. L.S. of flower, d. petal, e. anomocytic stomata.

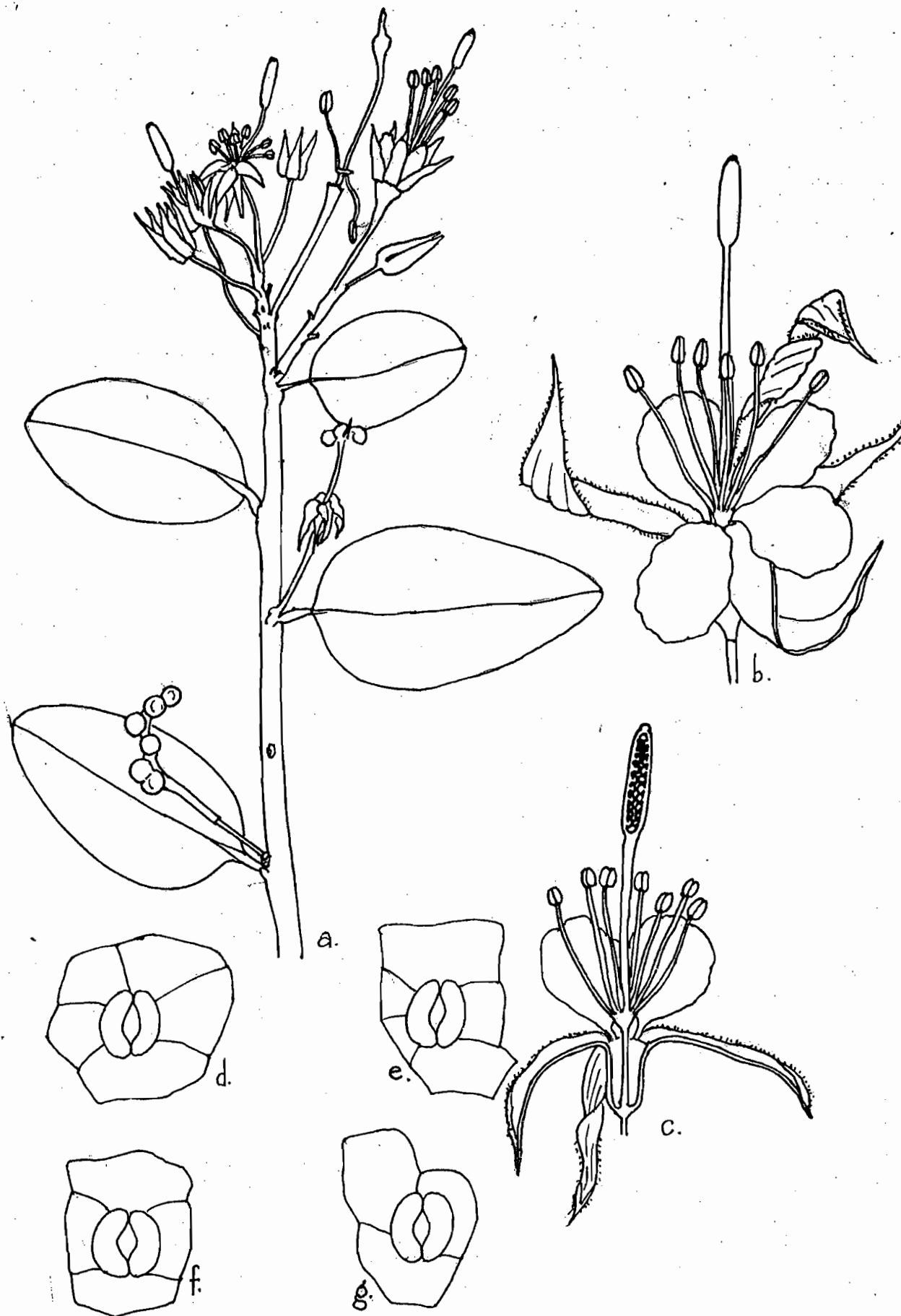


Fig. 21. *Maerua ovalifolia* Camb., a. habit, b. flower, c. L.S. of flower, d & e. anomocytic stomata, f. tetracytic stomata, g. anisocytic stomata.

clavate; stigma oblique. Capsules subglobose. Seeds ovoid, acute, longitudinally striate, yellowish-white. (Fig. 22)

Vernacular name: Ratanpurus.

Flowers: July-November.

Micromorphology (Fig. 23)

Whole plant was glabrous.

Stomata were of two types: paracytic and anisocytic.

D/931.

Bixaceae

1. *Cochlospermum gossypium* DC. *Prodr.* V. 1 (1824) p. 527

A small branched tree, upto 6 m high bark smooth, ash-colored. Leaves scattered about the ends of the branchlets, palmately 3-5 lobed, glabrous above. Petioles upto 15 cm long, pubescent when young. Flowers 15 cm. in diameter, in terminal subcorymbose panicles, bright yellow, appearing before the leaves; pedicels stout, about 10 cm. long, grooved and twisted, pubescent. Sepals 5, unequal, oblong, concave, silky outside. Petals 5, obovate, deeply emarginated. Stamens many, inserted on an eglandular disk; anthers oblong or linear, sometimes apiculate beyond the cells. Ovary globose; ovules many, on 3-5 parietal placentas; style simple; stigma minutely denticulate. Capsules long, obovoid, striate outside. Seeds cochleate, covered with white silky wool. (Fig. 24)

Flowers: February- April.

Micromorphology (Fig. 25)

Whole plant was glabrous.

Stomata were of anomocytic type.

D/368.

Polygalaceae

1. *Polygala chinensis* Linn. *Sp. Pl.* (1753) p. 704.

(*Polygala arvensis* Willd.)

An erect branched annual reaching upto 25 cm high, pubescent. Leaves variable, upto 4 cm long, obovate, coriaceous, ciliate, mucronate; petioles hairy. Flowers yellow, in axillary or extra-axillary, short, almost capitate, few-flowered racemes; crest of a single tubular appendage multifid only at the apex; bracts small, membranous. Outer sepals broadly ovate acuminate, with membranous, ciliate margins. Wings herbaceous, oblique, ovate-oblong, acuminate, with narrow, membranous margins ciliate towards the base, longer than the capsule. Capsules orbicular-oblong, strongly ciliate, narrowly margined. Seeds hairy; strophiole glabrous, rounded at the apex furnished with 3 membranous basal appendages. (Fig. 26)

Vernacular name: Pili bhoyasan.

Flowering season: October-March.

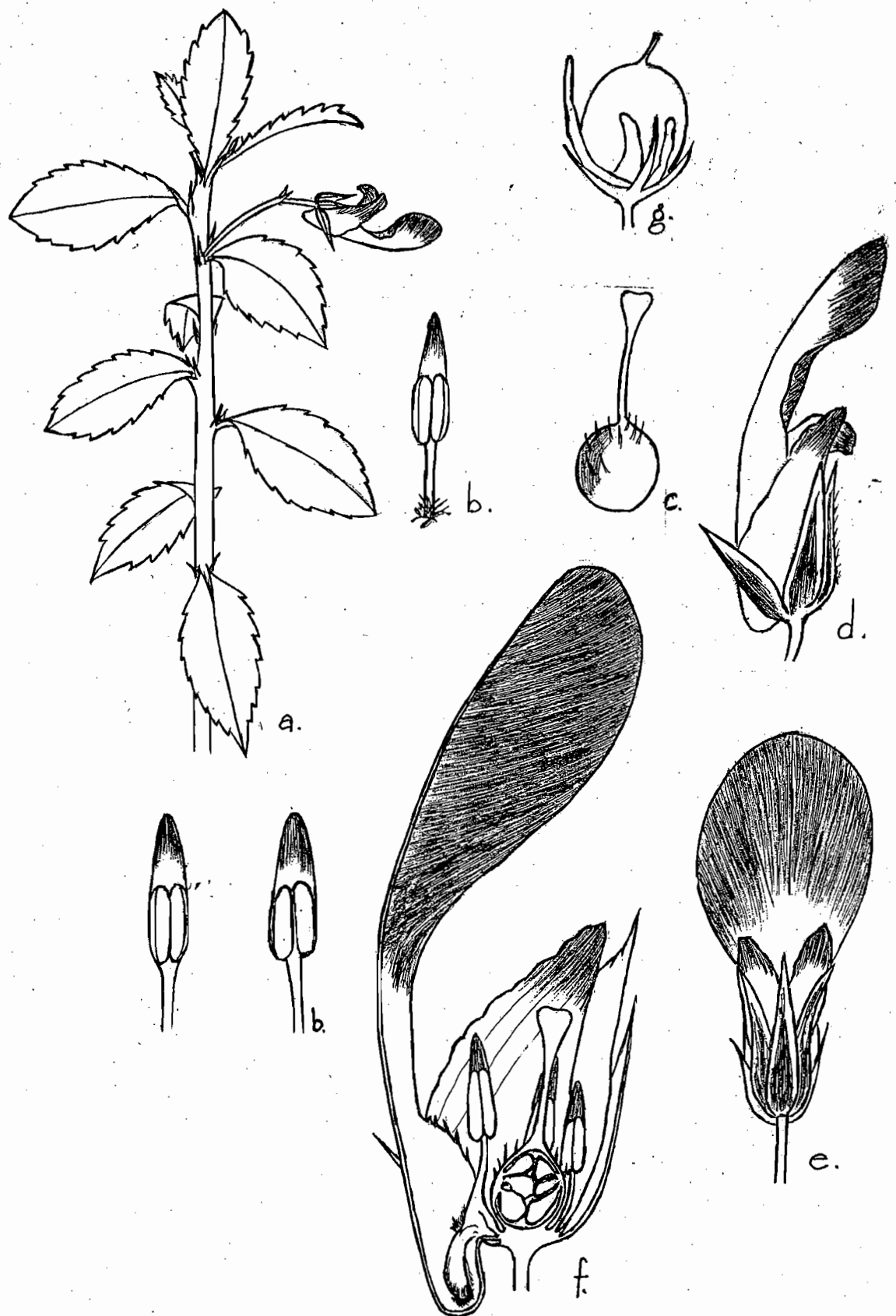


Fig. 22. *Ionidium heterophyllum* Vent., a. habit, b. stamen c. gynoecium, d. flower - side view, e. flower - top view, f. L.S. of flower, g. fruit.

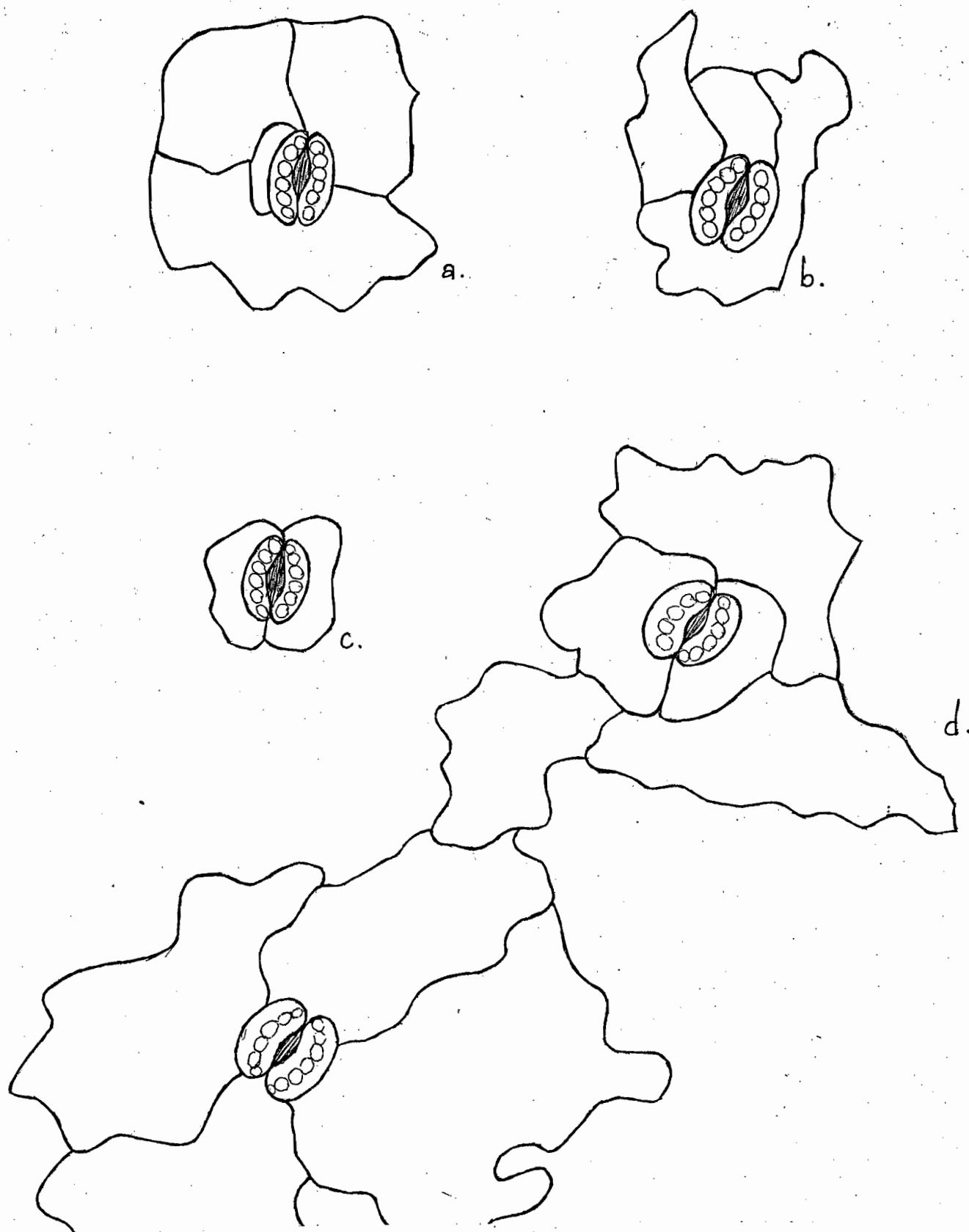


Fig. 23. *Ionidium heterophyllum* Vent., a & b. anisocytic stomata, c. paracytic stomata, d. paracytic and anomocytic stomata.

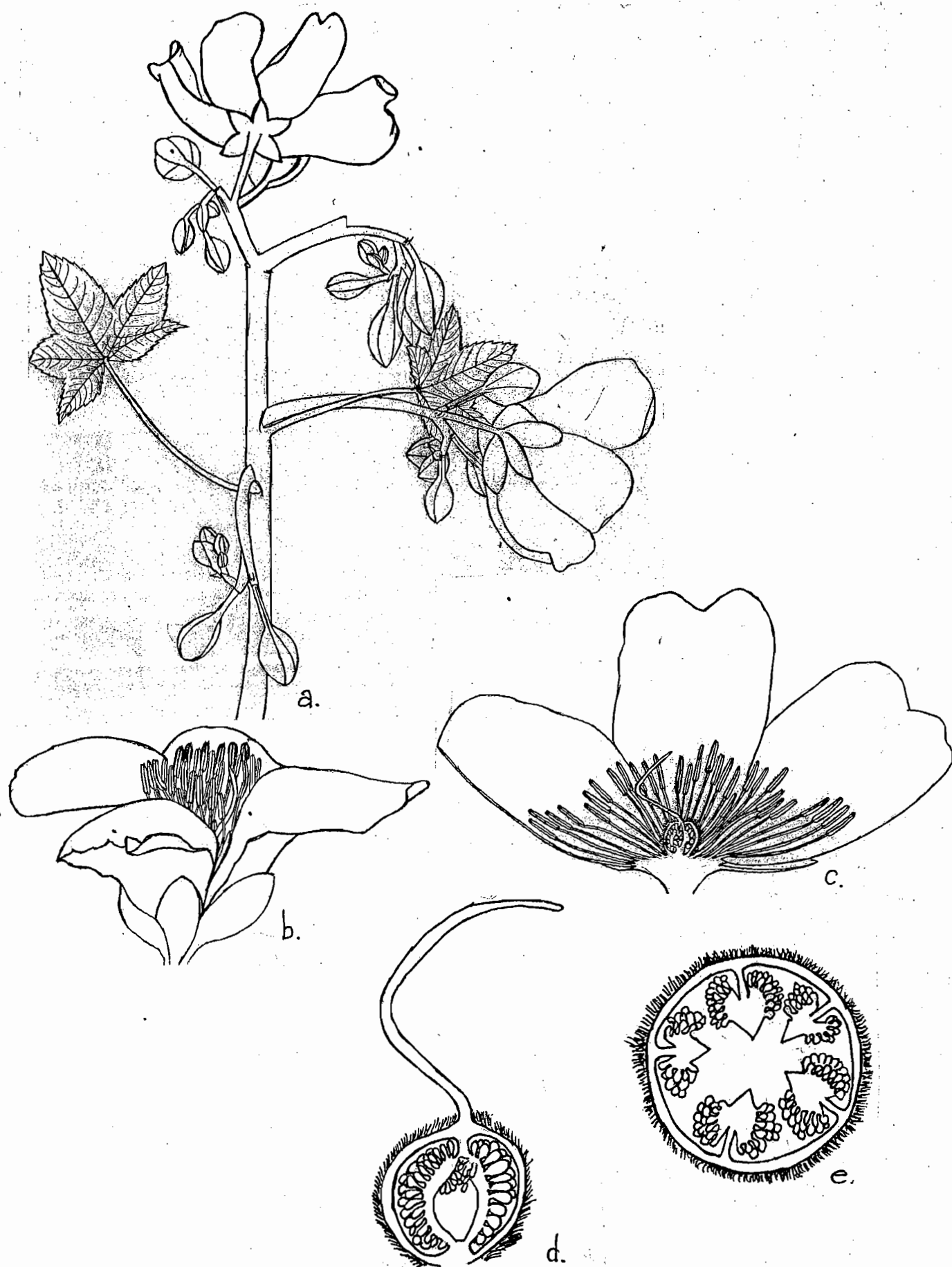


Fig. 24. *Cochlospermum gossypium* DC., a. habit, b. flower, c. L.S. of flower, d. L.S. of ovary, e. T.S. of ovary.

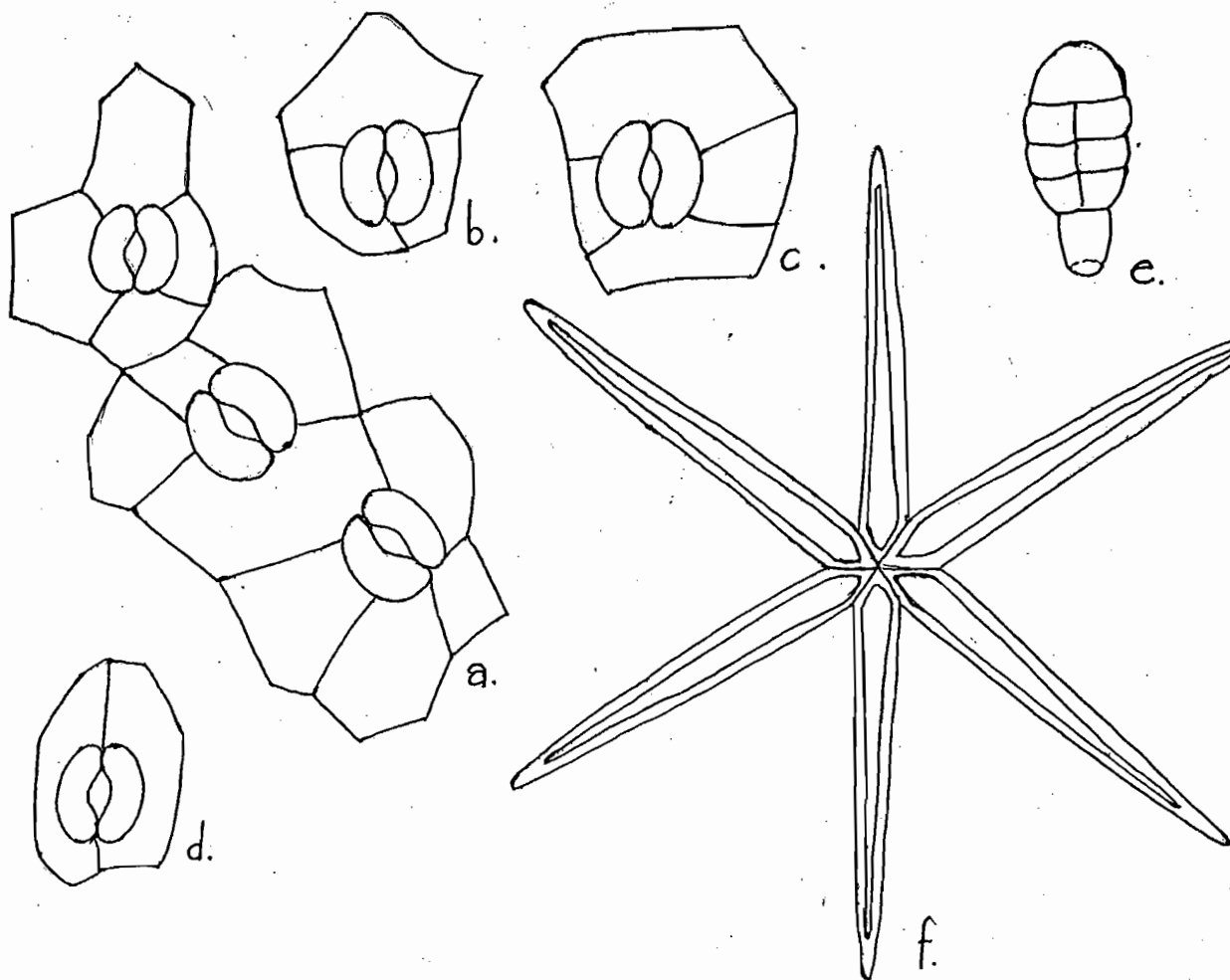


Fig. 25. *Cochlospermum gossypium* DC., a. anomocytic stomata, b. anisocytic stomata, c. tetracytic stomata, d. paracytic stomata, e. glandular multicellular trichome differentiated into 8-16 celled head and a single celled stalk, f. stellate hair.

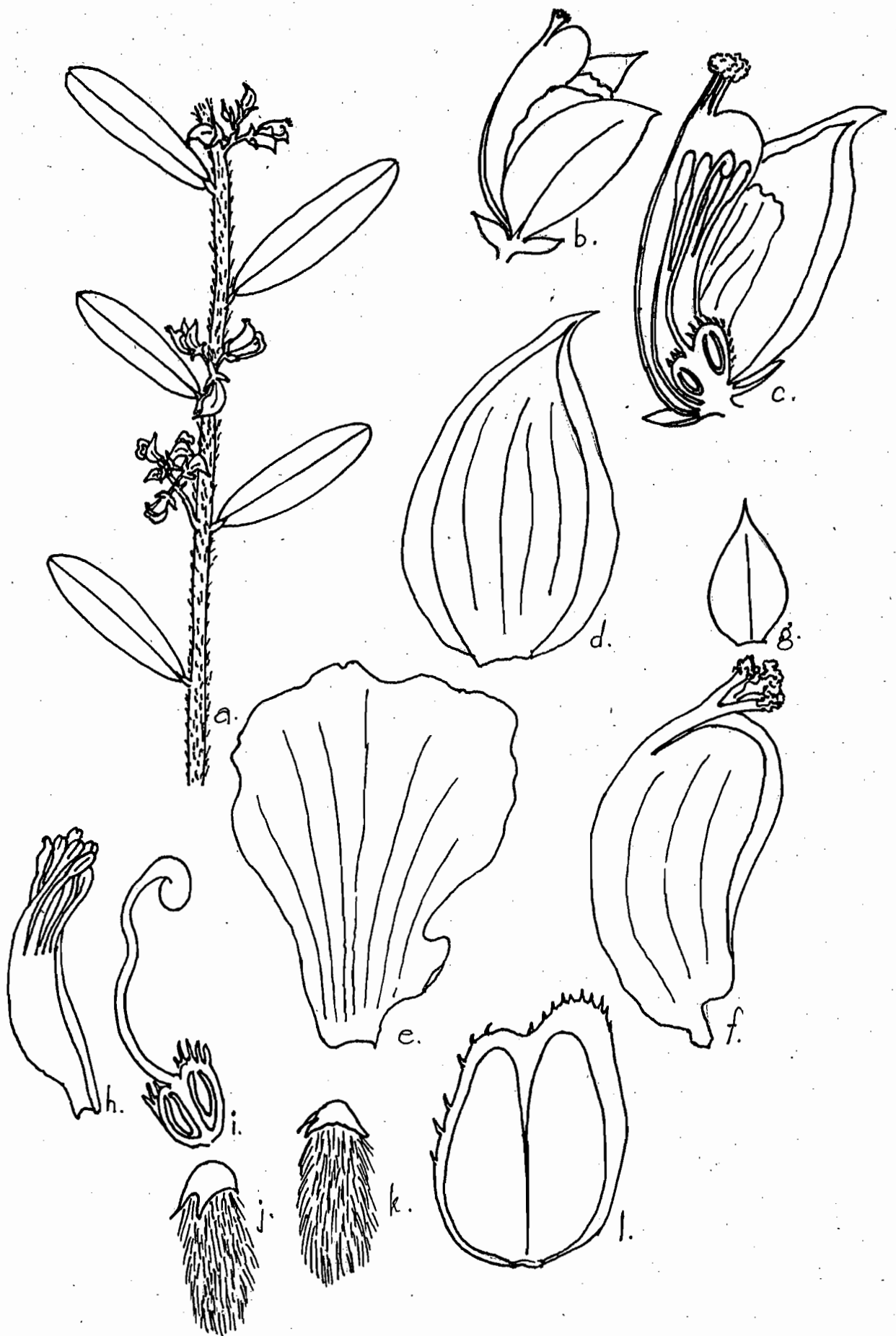


Fig. 26. *Polygala chinensis* L., a. habit, b. flower, c. L.S. of flower, d-e. petals, f. petal with a crest, g. sepal, h. stamen, i. L.S. of ovary, j-k. seed with a strophiole, l. fruit.

Micromorphology (Fig. 27)

Leaf, stem and ovary showed presence of unicellular, non-glandular elongated trichome with thick wall and warts on its surface. Some of these unicellular trichomes were curved and short.

Stomata were of anomocytic type.

D/376.

2. *Polygala erioptera* DC. Prodr. V. 1 (1824) p. 326.

A branched annual reaching upto 40 cm high. Leaves about 4 cm long, very variable in form, from oblong-obovate to very narrow linear, clothed on both surfaces with minute simple hairs. Flowers pink, in axillary or extra-axillary few-flowered racemes; crest dorsal, of many bifid or linear filaments arranged in 2 bundles; bracts minute, ovate. Outer sepals ovate, pubescent. Wings long, obliquely ovate-oblong, pubescent, with a strong, green midrib and membranous, ciliate margins. Petals 3, united at the base with the staminal sheath, the lower one keeled and generally crested. Capsules oblong-elliptic, pubescent, ciliate, obliquely emarginated. Seeds oblong, densely pilose; strophiole galeate, horny, smooth and shining or sometimes with a few hairs, obscurely 3-lobed. (Fig. 28)

Vernacular name: Patsan.

Flowers: July-October.

Micromorphology (Fig. 28)

Trichomes in all the parts were unicellular, non-glandular, thick walled, elongated and pointed.

Stomata were of anomocytic type.

D/095, 492.

Caryophyllaceae

1. *Polycarpaea corymbosa* Lam. Tab. Encyc. et Method. V. 2. (1800) p. 129

An erect, annual herb about 45 cm high. Stem sometimes woody below and dichotomously branched. Leaves upto 2 cm long, narrow-linear, mucronate; stipules lanceolate, 1-nerved. Flowers numerous, small, in terminal cymes forming flat-topped heads, showy, white or purple; bracts silvery white, margin serrated. Sepals 5, lanceolate, very acute, silvery-white or colored, much exceeding the petals and capsule. Petals 5, entire, obovate, less than $\frac{1}{2}$ the length of the sepals. Stamens 5; anthers oblong, basifixed. Ovary 1-celled; ovules many in free central placentation; style short, 3 grooved. Capsules very small, brown. (Fig. 29)

Vernacular name: Jangali soa.

Flowers: September-February.

Micromorphology (Fig. 29)

Whole plant was hoary pubescent due to unicellular, non-glandular trichomes, which were elongate, acicular and thick walled with a somewhat broad lumen.

Stomata were of anomocytic type.

D/483.

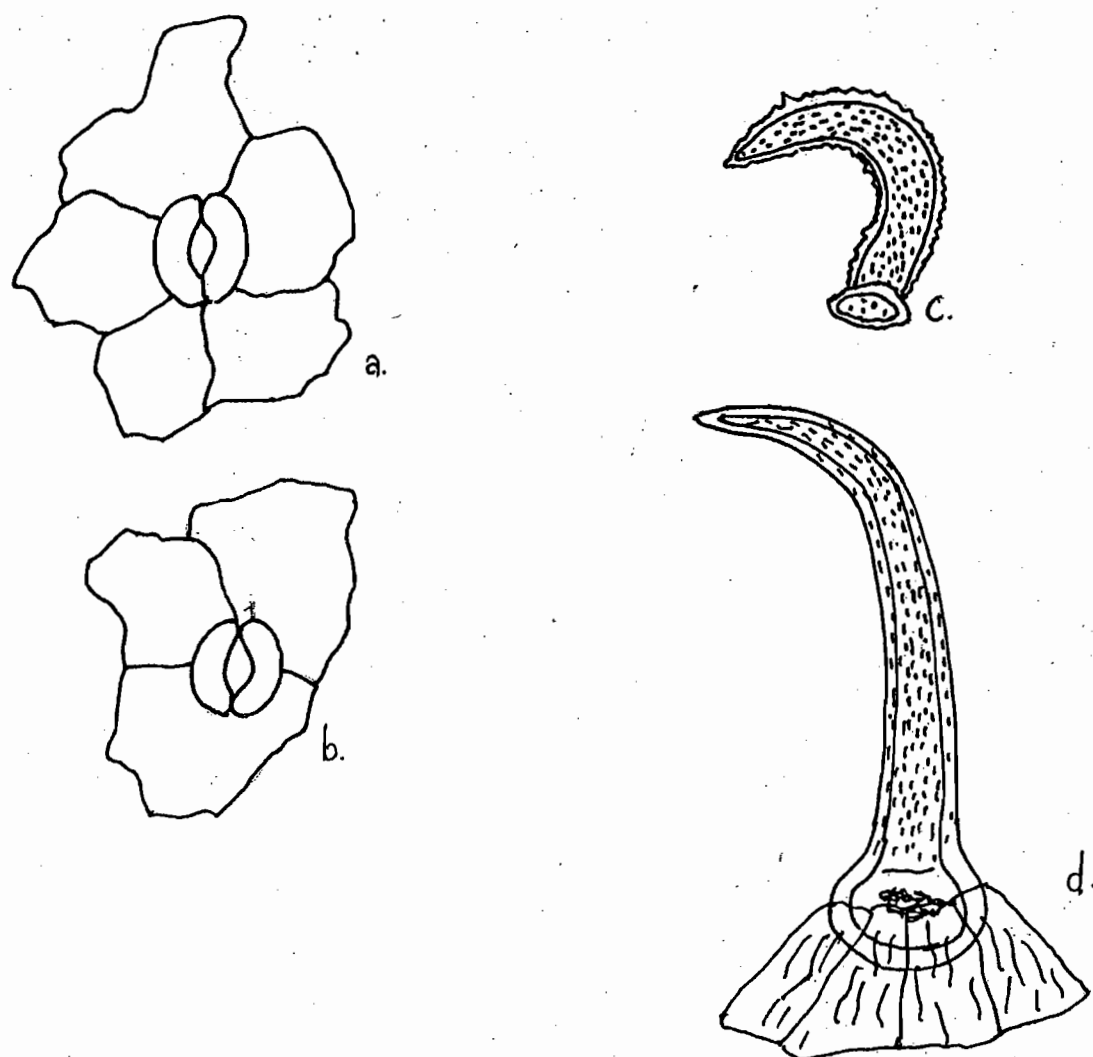


Fig. 27. *Polygala chinensis* L., a, anomocytic stomata, b, anisocytic stomata, c, curved unicellular trichome with pitted wall, d, unicellular gland with pitted wall.

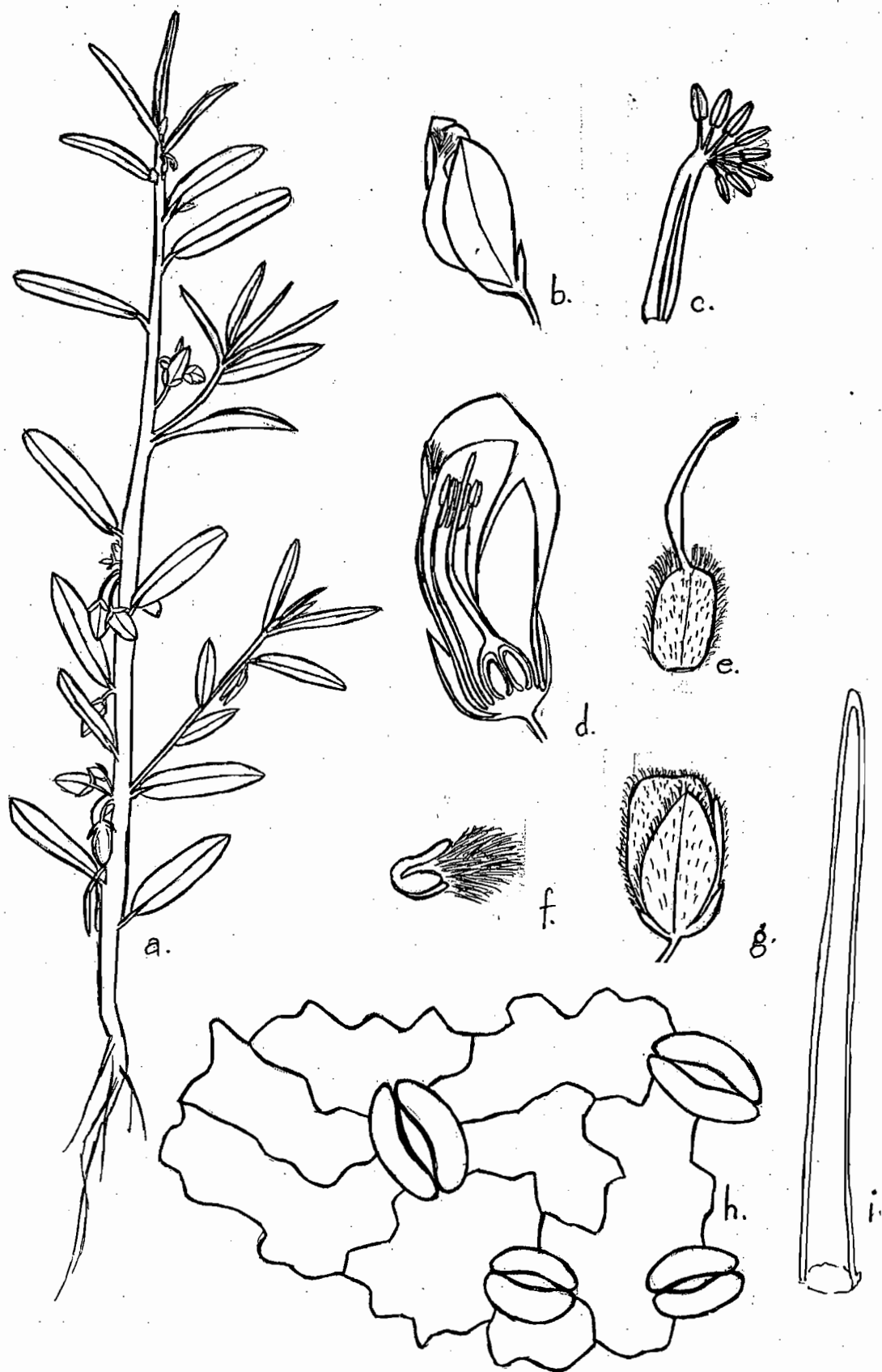


Fig. 28. *Polygala erioptera* Lam., a. habit, b. flower, c. stamens monadelphous, d. L.S. of flower, e. gynoecium, f. seed with a strophiole, g. fruit, h. anomocytic stomata, i. unicellular acicular trichome with large lumen.

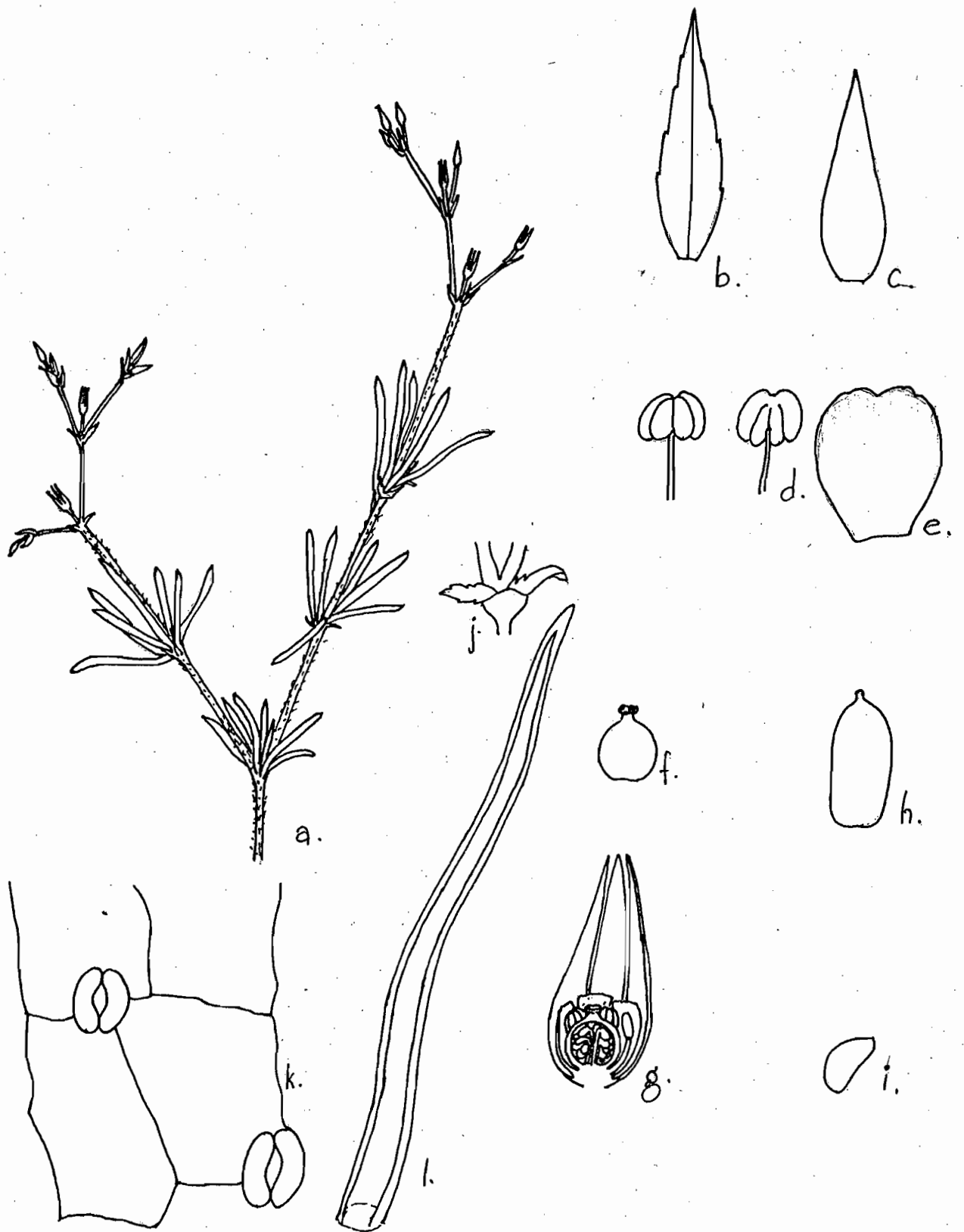


Fig. 29. *Polycarpaea corymbosa* Lam., a. habit, b. bract, c. sepal, d. stamen, e. petal, f. gynoecium, g. L.S. of flower, h. fruit, i. seed, j. stipules, k. anomocytic stomata, l. unicellular acicular trichome with large lumen.

2. *Spergula arvensis* Linn. *Sp. Pl.* (1753) p. 440.

An annual reaching upto 45 cm high; stems geniculate, branched from the root. Leaves in false whorls, 1-4 cm long, linear-subulate, semiterete, grooved beneath, rather fleshy. Flowers white, up to 1 cm in diameter in terminal, subumbellate cymes; pedicels spreading or deflexed. Sepals 5, ovate, obtuse, with very narrow, membranous margins. Petals 5, entire. Stamens 10. Ovary 1-celled; ovules many; styles 3-4. Capsules subglobose, 3-valved. Seeds tubercled, narrowly margined. (Fig. 30)

Variation observed: in the floras styles were reported 5 and capsules 5-valved but in our specimen, the style were mostly 3-4 and capsules 3-valved.

Flowers: January-March.

Micromorphology (Fig. 30)

Whole plant was glabrous.

Stomata were anomocytic.

D/ 891.

Portulacaceae

1. *Portulaca oleracea* Linn. *Sp. Pl.* (1753) p. 445.

A succulent annual prostrate herb upto 30 cm long, reddish, swollen at the nodes, quite glabrous. Leaves fleshy, subsessile, upto 2.5 cm long, alternate or subopposite, cuneiform, truncate at the apex, spangled when fresh with glistening dots, margins reddish. Flowers few in sessile terminal heads. Sepals 2, unequal, obtuse. Petals 5, obovate, yellow. Stamens 8-12; anthers oblong, basifixed. Ovary globose, one celled; Style 3-8 (often 5) partite. Capsules ovoid, circumsciss. Seeds numerous, black, concentrically striate and granulate. (Fig. 31)

Vernacular name: Chini gulab.

Flowers: October-May.

Micromorphology (Fig. 31)

Whole plant was glabrous.

Stomata were paracytic.

D/681.

2. *Talinum portulacifolium* (Forssk.) Asch. ex Schweinf. *Bull. Herb. Boissier, sér. 2*, 4: 172. 1896.

(*Talinum cuneifolium* Willd.)

A glabrous erect succulent shrub, attaining a height of a few meters. Leaves 3-5 by 1-3 cm, fleshy, obovate, cuneate, attenuated into the petiole, entire or emarginated, the uppermost mucronate. Flowers in terminal panicles, purple; pedicel curved; bracts acute, deciduous. Sepals-2, ovate-orbicular, with 3 green veins, apiculate veined. Petals obovate – oblong with an acute apex. Stamens- 10, dorsifixed. Ovary subglobose; style 3-fid. Capsules crustaceous, globose, glabrous, about the size of a pea. Seeds reniform, compressed, concentrically striate. (Fig. 32)

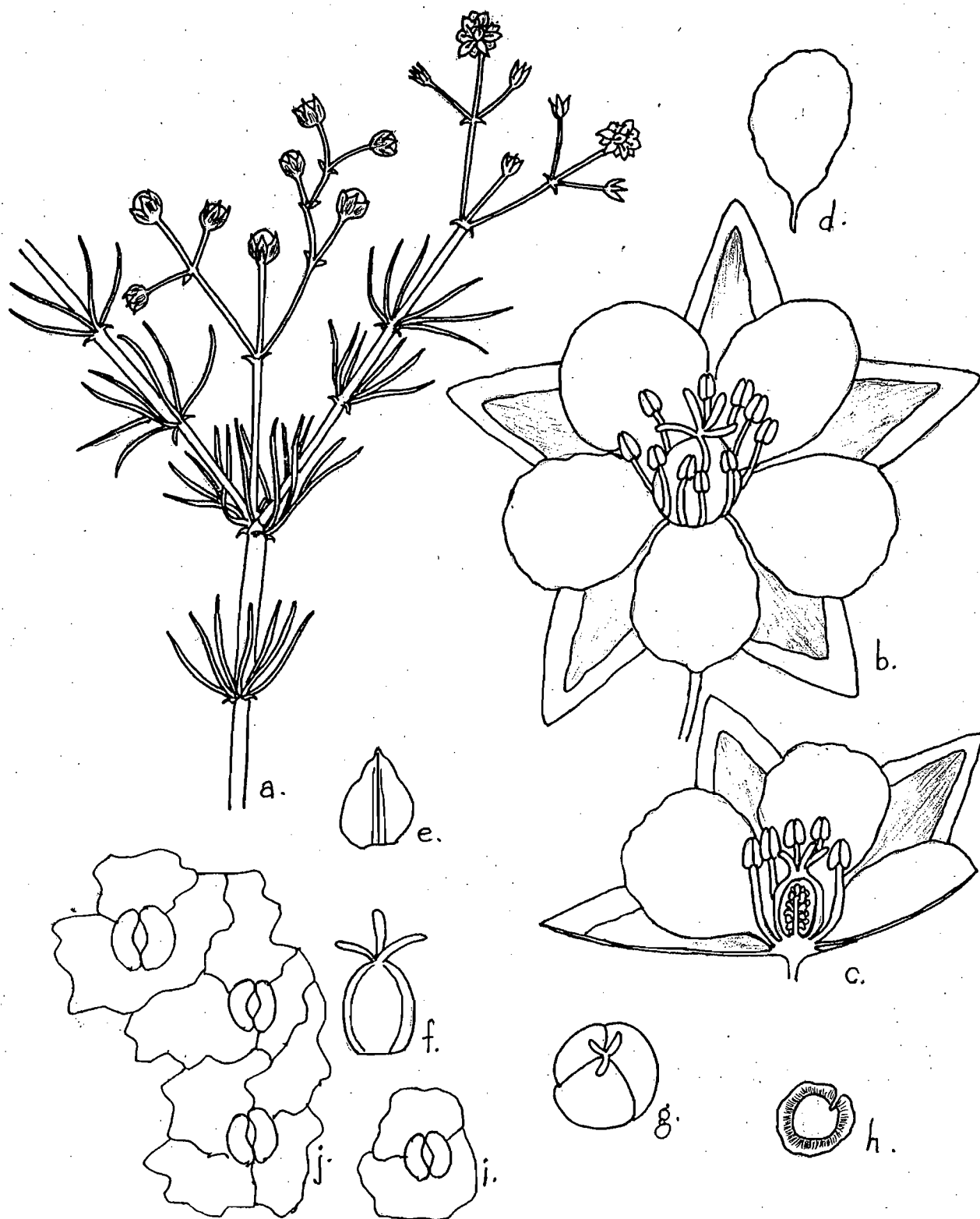


Fig. 30. *Spergula arvensis* L., a. habit, b. flower, c. L.S. of flower, d. petal, e. sepal, f. gynoecium, g. fruit, h. seed. i. diacytic stomata, j. anomocytic stomata.

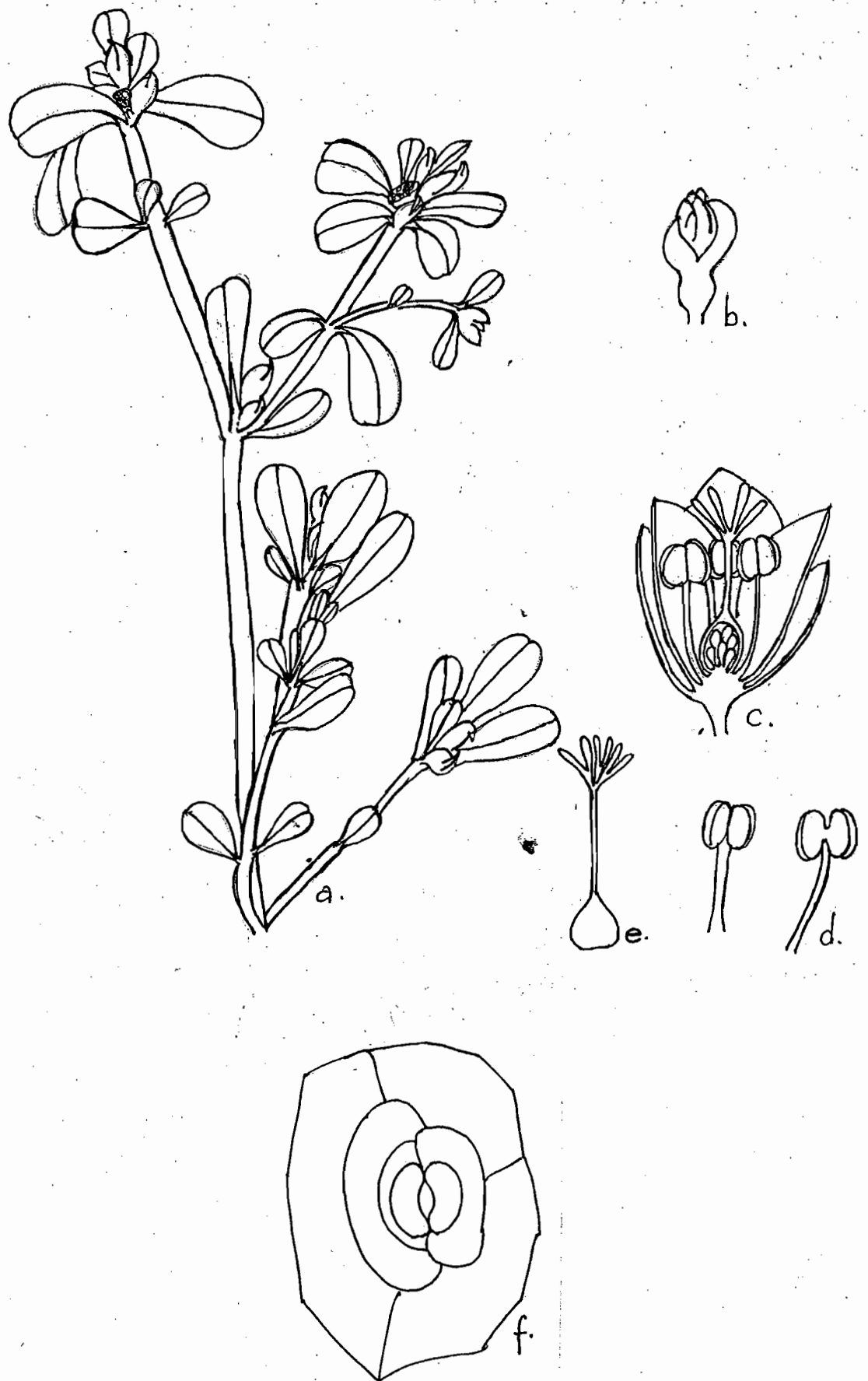


Fig. 31. *Portulaca oleracea* L., a. habit, b. flower, c. L.S. of flower, d. stamens, e. gynoecium, f. paracytic stomata.

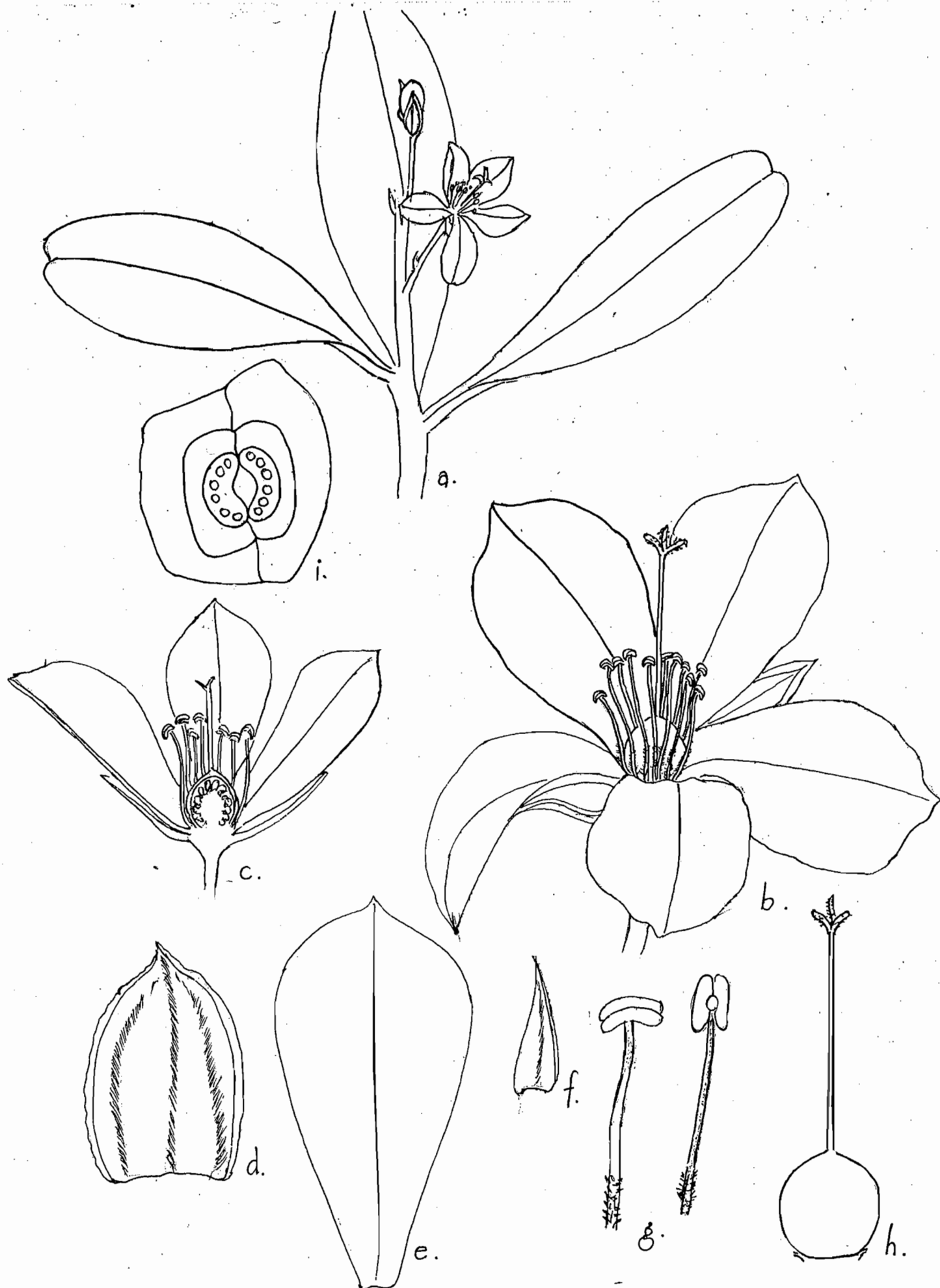


Fig. 32. *Talinum portulacifolium* (Forsk.) Asch. ex Schweinf., a. habit, b. flower, c. L.S. of flower, d. sepal, e. petal, f. bract, g. stamen, h. gynoecium, i. paracytic stomata.

Flowers: November.

Micromorphology (Fig. 32)

Whole plant was glabrous except for the stamens where there were hairs at the base.

Stomata were paracytic.

D/1264.

Tamaricaceae

1. *Tamarix gallica* Linn. *Sp. Pl.* (1753) p. 270

A branched shrub or small tree. Leaves very small subulate-acute from a triangular semi-amplexicaul base, at first imbricate, afterwards distant. Flowers numerous, crowded, in slender lateral and terminal paniced spike-like racemes; bracts very acute, immediately beneath the flowers. Sepals 5, triangular-ovate, margins minutely denticulate. Petals oblong, often notched at the top, pink. Disk 5-lobed; lobes entire or nearly so. Stamens 5, inserted at the margins of the middle of the lobes of the disk; anthers divaricate at the apex, connective projected into a conical shape above at the top of the anther cells. Ovary trigonous, truncate at top; styles 3. Capsules conical, tapering, pale pink. Seeds with white hairs. (Fig. 33)

Flowers: December-March.

Micromorphology (Fig. 33)

Stomata were of three types: anomocytic, paracytic, anisocytic. Among these anomocytic types of stomata were in majority.

D/107.

Elatinaceae

1. *Bergia odorata* Edgew. in *Journ. Asiat. Soc. Beng.* V. 7. (1838) p. 765.

A decumbent or spreading glandular shrub upto 60 cm long. Leaves subsessile, often fascicled in the axils; stipules linear. Flowers solitary or in axillary fascicles of 2-6 or 8; pedicels about as long as the sepals. Sepals ovate, acute. Petals obovate-oblong, entire. Stamens 10. Ovary ovoid, sulcate, narrowed into the styles; styles 5 long. Capsules 5-celled. Seeds minute, numerous, slightly curved, dark brown, shining. (Fig. 34)

Vernacular name: Lavariu.

Flowers: October-November.

Micromorphology (Fig. 35)

Both non-glandular and glandular types of trichomes are present. Non-glandular trichome is unicellular, conical with thick wall, broad lumen filled with some ergastic substances and base flat, whereas glandular trichome is multicellular differentiated into multicellular head and multicellular triseriate stalk.

Stomata tetracytic and anomocytic.

D/672, 751.

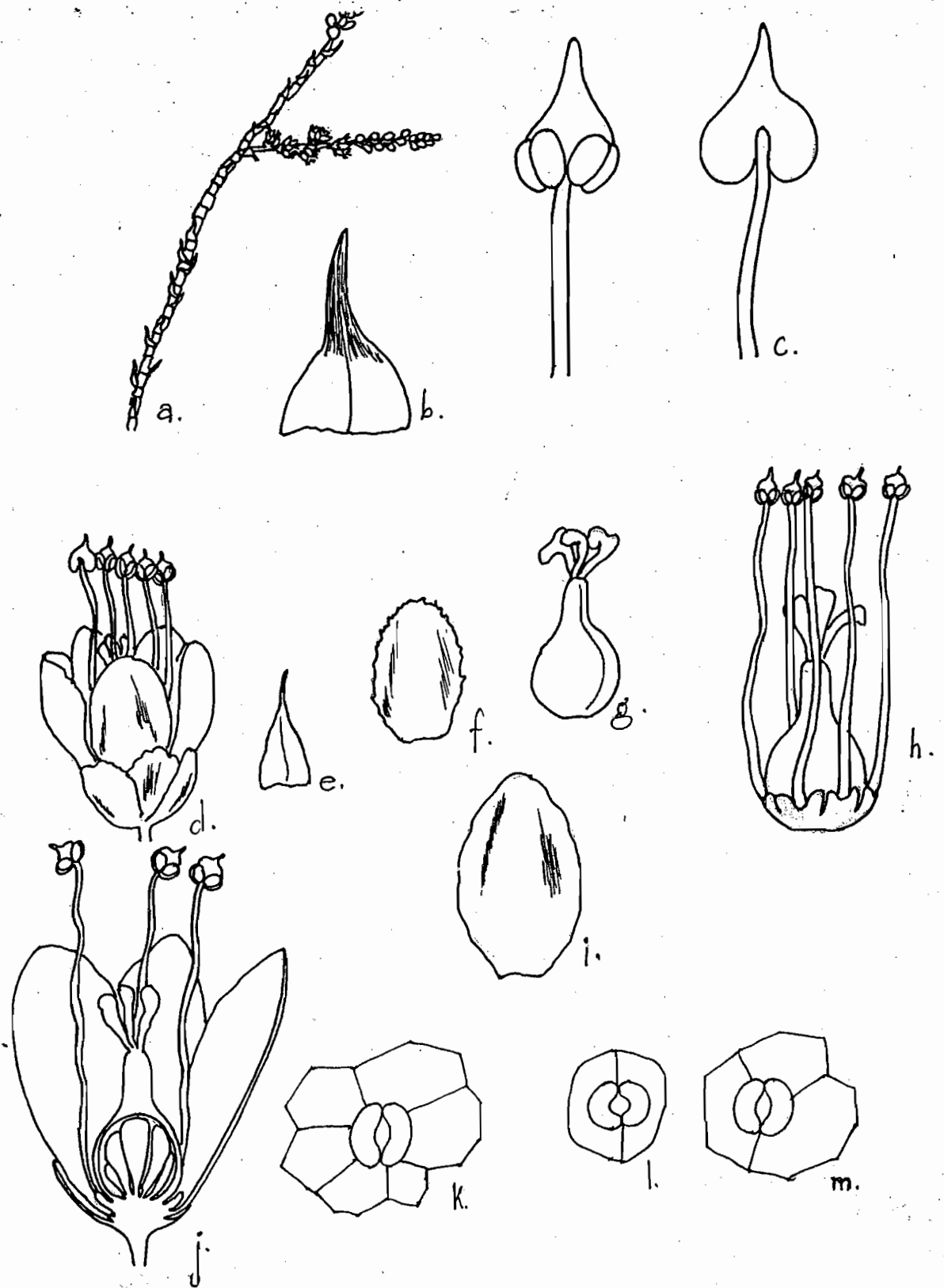


Fig. 33. *Tamarix gallica* L., a. habit, b. leaf, c. stamen, d. flower, e. bract, f. sepal, g. gynoecium, h. stamen and gynoecium along with disc, i. petal, j. L.S. of flower. k. anomocytic stomata, l. paracytic stomata, m. anisocytic stomata.

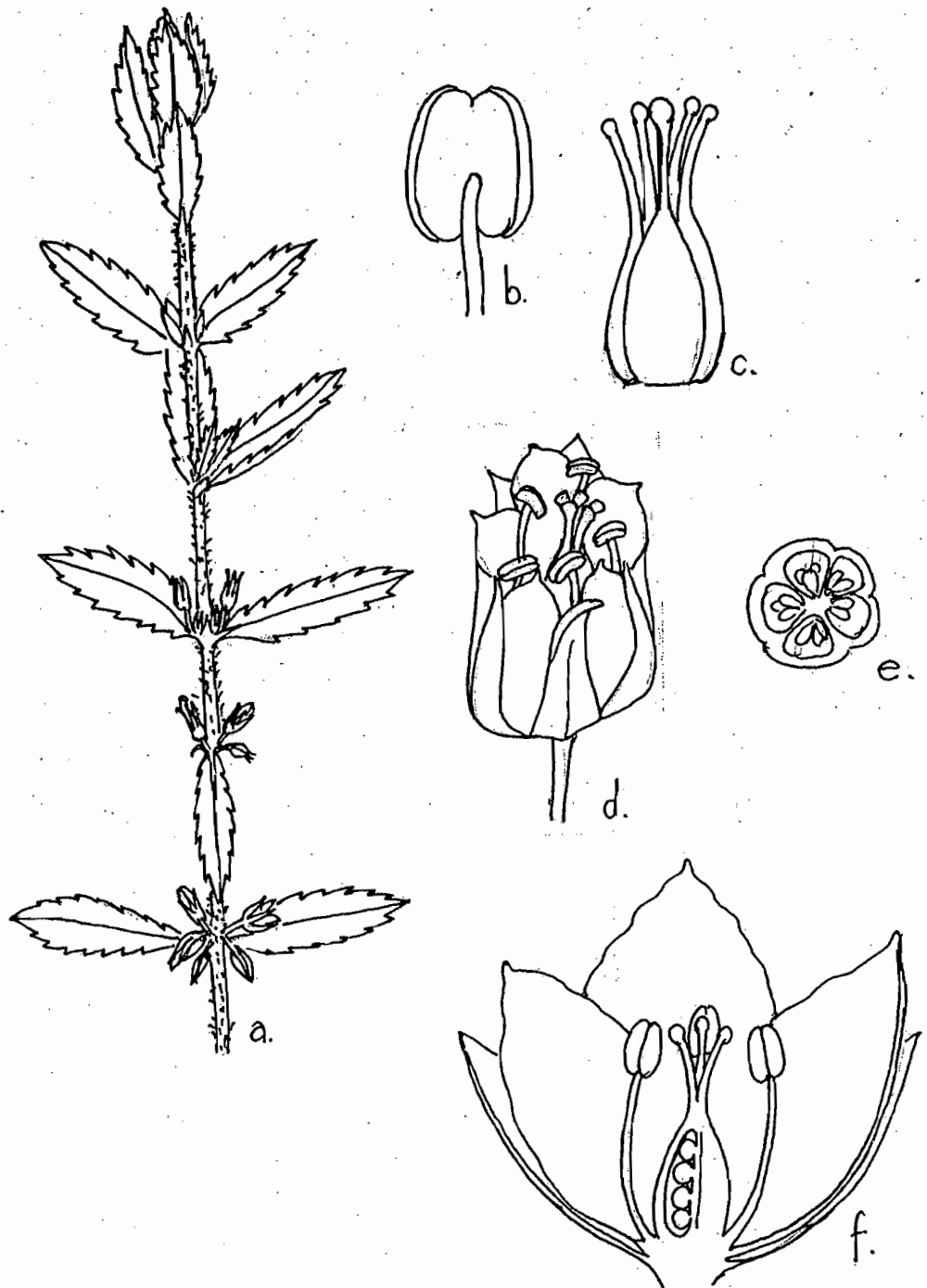


Fig. 34. *Bergia odorata* Edgew., a. habit, b. stamen, c. gynoecium, d. flower, e. T.S. of ovary, f. L.S. of flower.

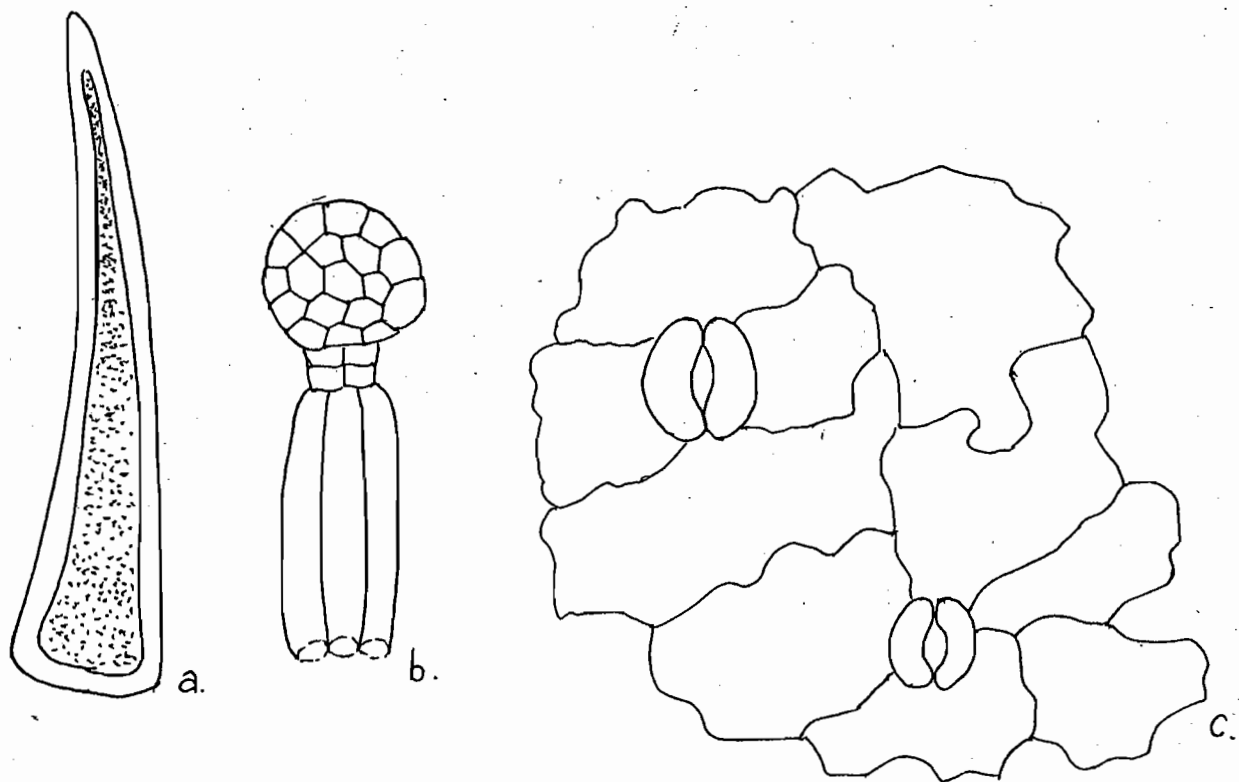


Fig. 35. *Bergia odorata* Edgew., a. glandular unicellular conical trichome with broad lumen having ergastic substances b. multicellular gland differentiated into multicellular head and triseriate stalk c. tetracytic and anomocytic type of stomata.

Clusiaceae

1. *Garcinia indica* Choiss. in DC. *Prodr.* V. 1 (1824) p. 561.

A small tree with oblong-lanceolate leaves. Flowers unisexual, axillary or terminal, solitary or in spreading fascicles, usually tetramerous flowers were seen: rarely pentamerous flowers occur; bracts scale-like, deciduous. Sepals 1 cm long, decussate, thick and fleshy. Petals 4, thick, a little longer than the sepals. Male flowers 3-8 in axillary and terminal fascicles. Stamens very numerous, on a short column; anthers 2-celled, dehiscing longitudinally. Female flowers sessile or very shortly pedicelled, solitary or 2-3 together, the fascicles not peduncled. Staminalodes in 4 bundles, arranged crosswise, each bundle containing 2-7 staminalodes in one or more rows. Ovary 4-8 celled; stigma sessile. Fruit globose, 3-4 cm in diameter, purple throughout. Seeds 5-8, compressed, embedded in pulp. (Fig. 36)

Vernacular name: Kokam.

Flowers: November-May.

Micromorphology (Fig. 37)

Leaves, sepals and petals contained unicellular, unbranched, non-glandular trichomes which were T-shaped (peltate) with unequal arms. Sometimes the stalk was at the end with a small protuberance representing an arm. These were thick walled, with a lumen containing ergastic substances.

Stomata were of cyclocytic type.

D/113.

Malvaceae

1. *Abutilon indicum* Sweet. *Hort. Brit.* V. 1. (1827) p. 54.

A tomentose suffrutescent with leaves up to 5 cm, cordate, acuminate, toothed, rarely subtrilobate; petiole upto 7 cm long; stipules 1 cm long, linear, acute deflexed. Pedicels often 5 cm. long, axillary, solitary, jointed very near the top. Calyx lobes ovate, apiculate. Corolla about 3 cm. in diameter, yellow; staminal tube hairy at the base; filaments long. Fruit a schizocarp with mericarps usually 15-20, longer than the calyx, with a distinct small acute point, hairy, ultimately shining, dark brown; styles as many as the carpels. Seeds brown-black, densely and minutely scrobiculate. (Fig. 38)

Vernacular name: Khapat.

Flowers: June-November.

Micromorphology (Fig. 39)

Two types of non-glandular trichomes were present in this plant; one was stellate hair with 5-8 arms and another one was unicellular with round base, narrow lumen and thick wall.

Stomata were anisocytic, anomocytic and diacytic types.

D/474.

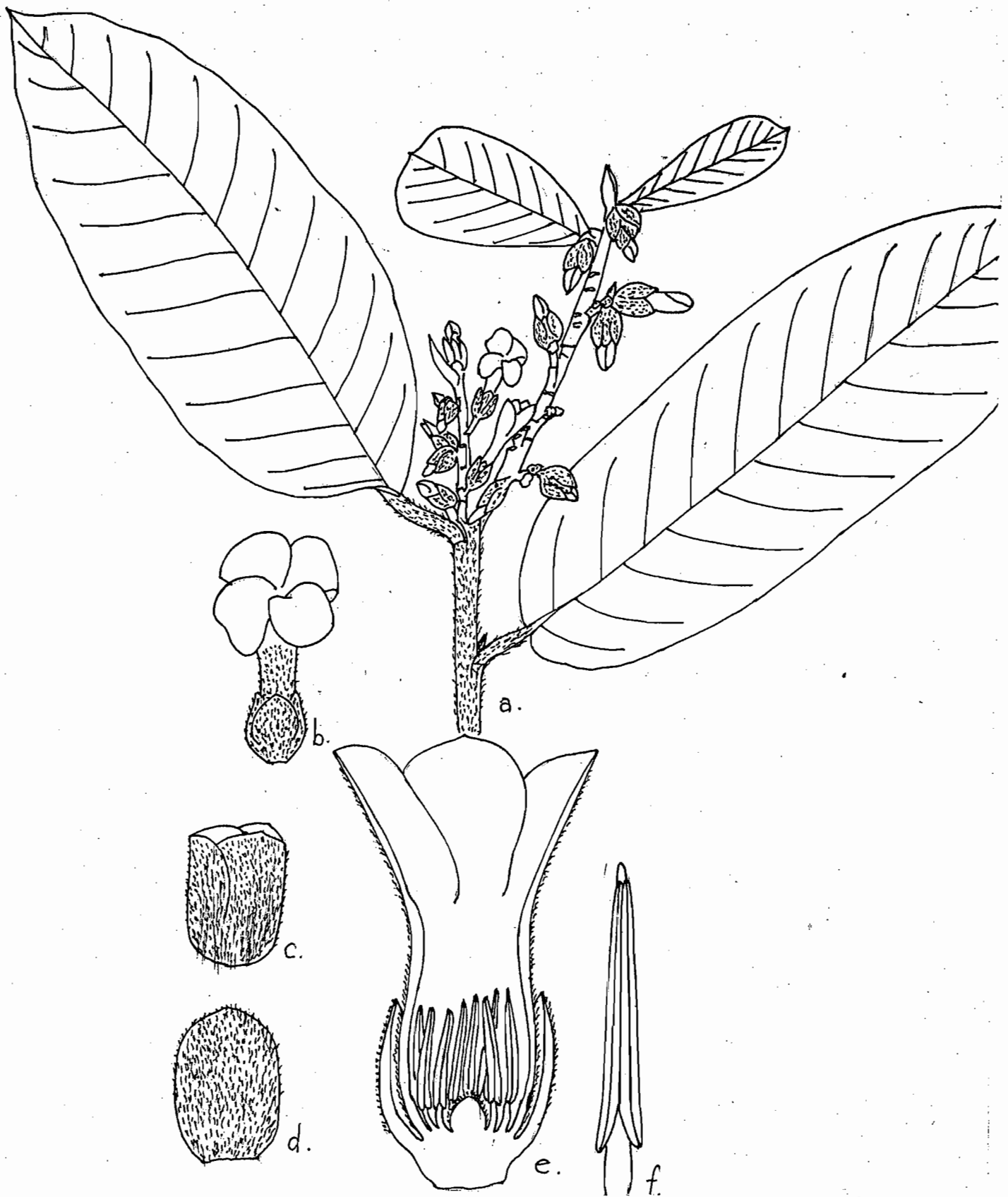


Fig. 36. *Garcinia indica* Choiss., a. habit, b. male flower, c. calyx, d. bract, e. L.S. of flower, f. stamen.

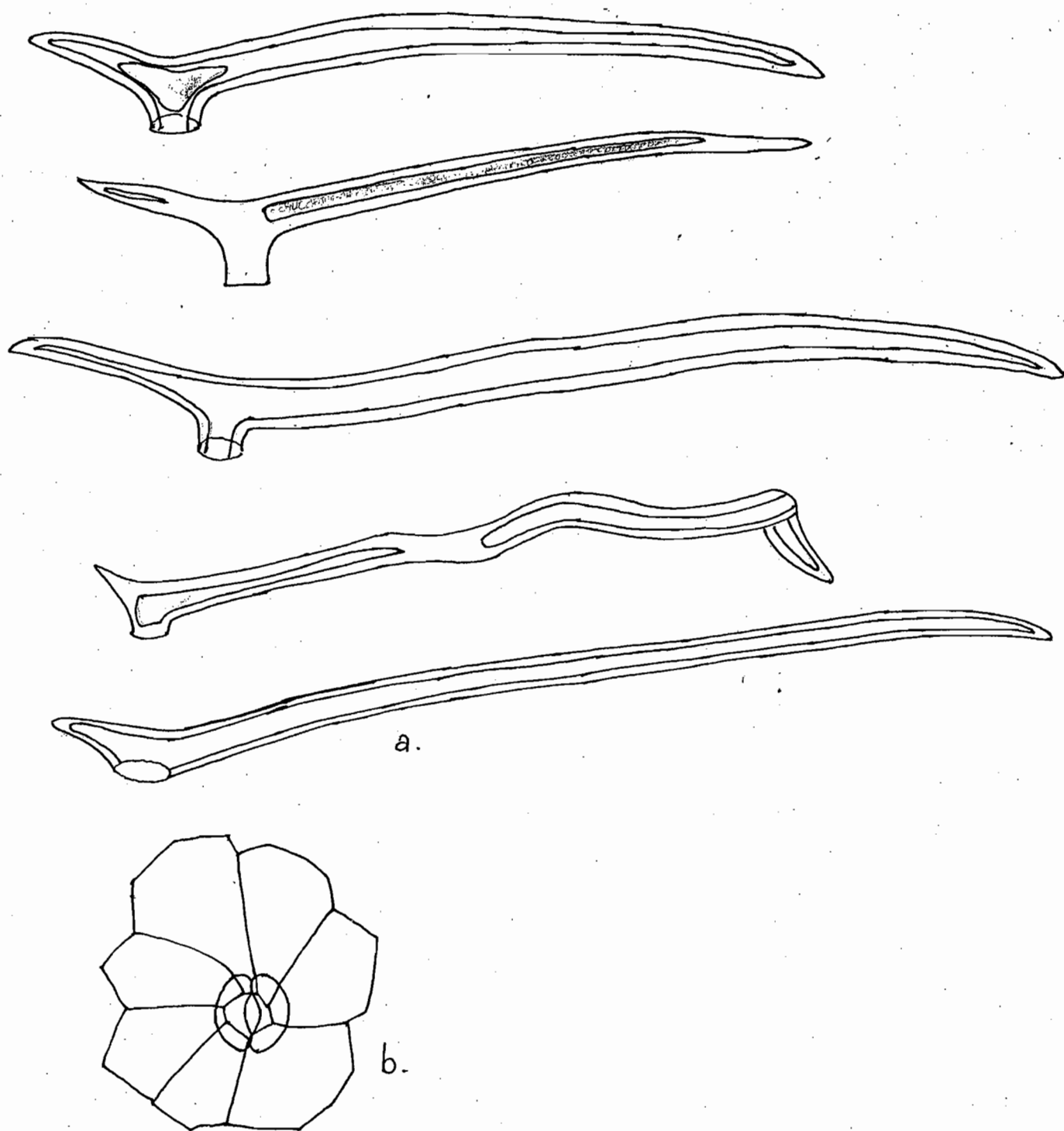


Fig. 37. *Garcinia indica* Choiss., a. medifixed hairs with one arm short, b. anomocytic stomata.

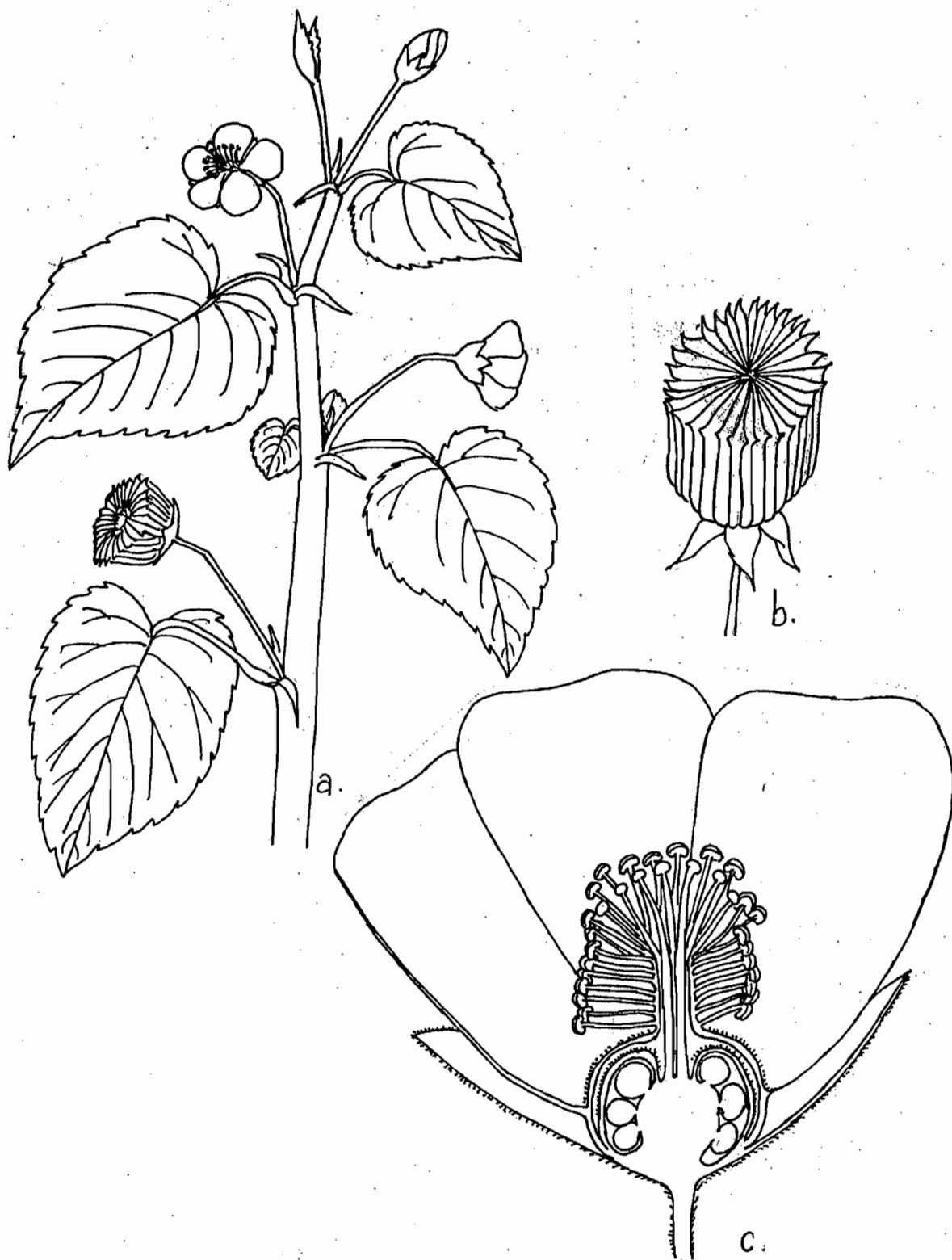


Fig. 38. *Abutilon indicum* Sweet., a. habit, b. fruit, c. L.S. of flower.

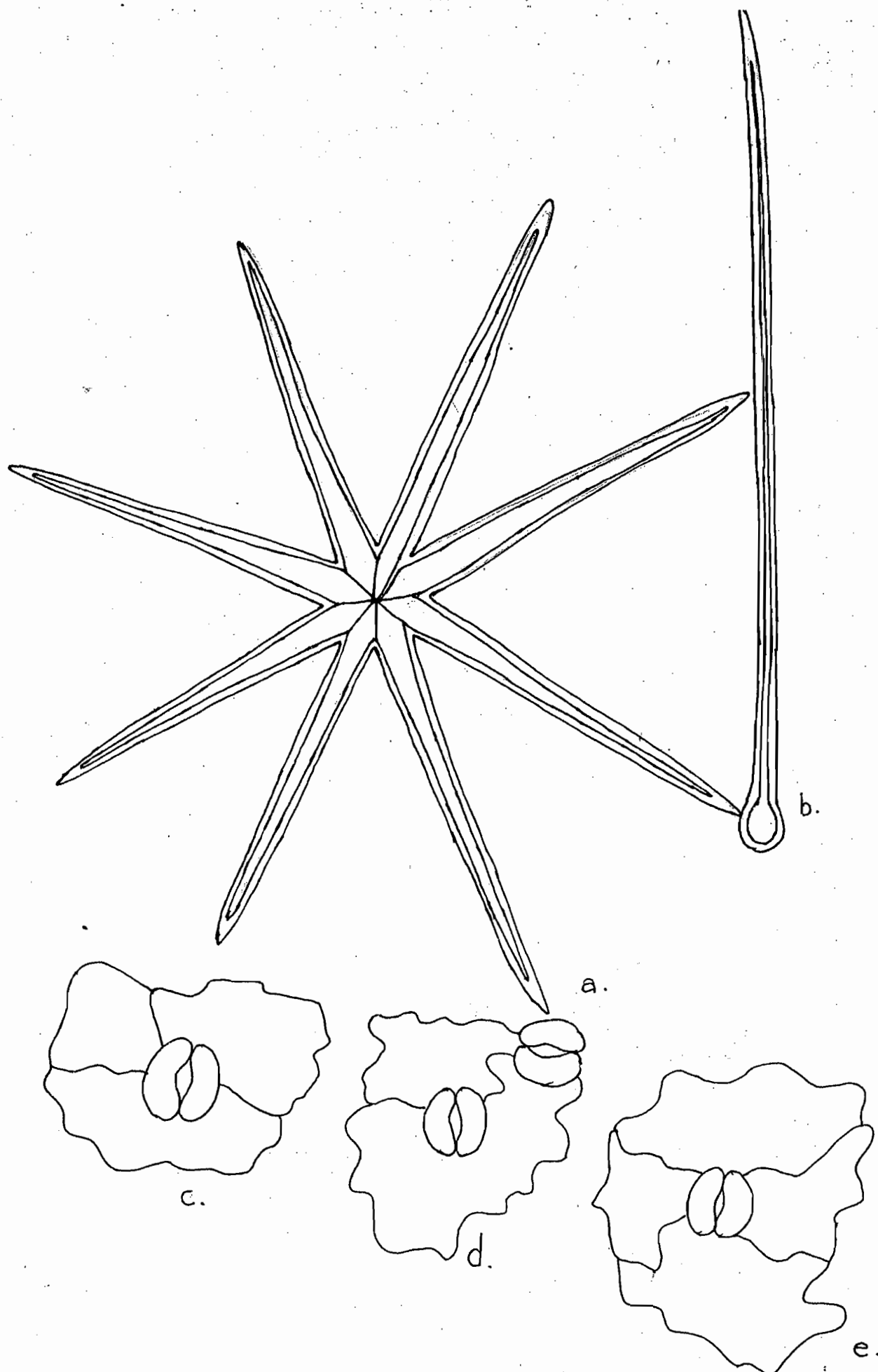


Fig. 39. *Abutilon indicum* Sweet., a. stellate hair with 8 arms, b. unicellular non-glandular trichome with round base, c. anisocytic stomata, d. anomocytic stomata, e. tetracytic stomata.

2. *Hibiscus micranthus* Linn. f. *Suppl.* (1781) p. 308.

An erect branched shrub. Leaves about 5 cm long, more or less scabrid and hairy, ovate, acute or obtuse, serrate; petioles about 2 cm long, often very short towards the top of the plant; stipules subulate, hairy. Pedicels longer than the petioles, reaching upto 3 cm long, slender, jointed above the middle. Involucral bracts 6, filiform, hairy. Calyx 5, short, deeply divided; lobes lanceolate, hairy. Corolla small, pink or pink and white, stellately hairy outside. Stamens in tufts on the staminal tube. Ovary 5-celled; ovules 3 in each cell; styles 5, more or less connate; stigma capitate. Capsules globose. Seeds reniform, cottony. (Fig. 40)

Vernacular name: Chanak bhindo.

Flowers: September-January.

Micromorphology (Fig. 41)

Both glandular and non-glandular types of trichomes were present in this plant; non-glandular trichomes had one stellate hair with 5-arms and another was unicellular trichome with broad lumen.

Stomata were of anisocytic, anomocytic and paracytic types.

D/298.

3. *Hibiscus solandra* L'Her. *Stirp.* V. 1. (1784) p. 103, t. 49.

An erect branched herb with orbicular-ovate, obtuse or acute leaf. Leaves often palmately lobed. Petioles upto 4 cm long, slender. Flowers arranged in a terminal lax raceme; pedicels 3-4 cm long, jointed near the top. Calyx divided to about the middle, pubescent; lobes lanceolate, prominently 3-nerved. Involucral bracts 0. Corolla white, petals obovate. Staminal tube truncate; filaments numerous. Ovary 5-celled; ovules 3 or more at the apex; style slender, stigma as many as ovary cells, and hairy. Capsules slightly hairy, ovoid, somewhat wrinkled, beaked; beak short, hairy. Seeds smooth, blackish. (Fig. 42)

Vernacular name: Tali.

Flowers- October-November.

Micromorphology (Fig. 43)

Whole plant was pubescent or coarsely hispid. Leaf showed two types of trichomes, one was stellate and second was two celled, non-glandular, elongated, uniseriate trichome with curved long lower cell and the upper small slightly curved and pointed cell was present on the top of the lower curved cell. These trichomes were thin walled. The stipule showed unicellular, elongated trichome. Calyx showed presence of three types of trichomes. The first two were similar to those present in the leaf. The third was three celled, non-glandular and uniseriate. Corolla showed presence of unicellular, glandular, elongated, conical, thick walled trichome with substances in the lumen.

Stomata were of paracytic, diacytic and paracytic. Among these the anisocytic type was more common.

D/560, 577, 578, 579, 580.

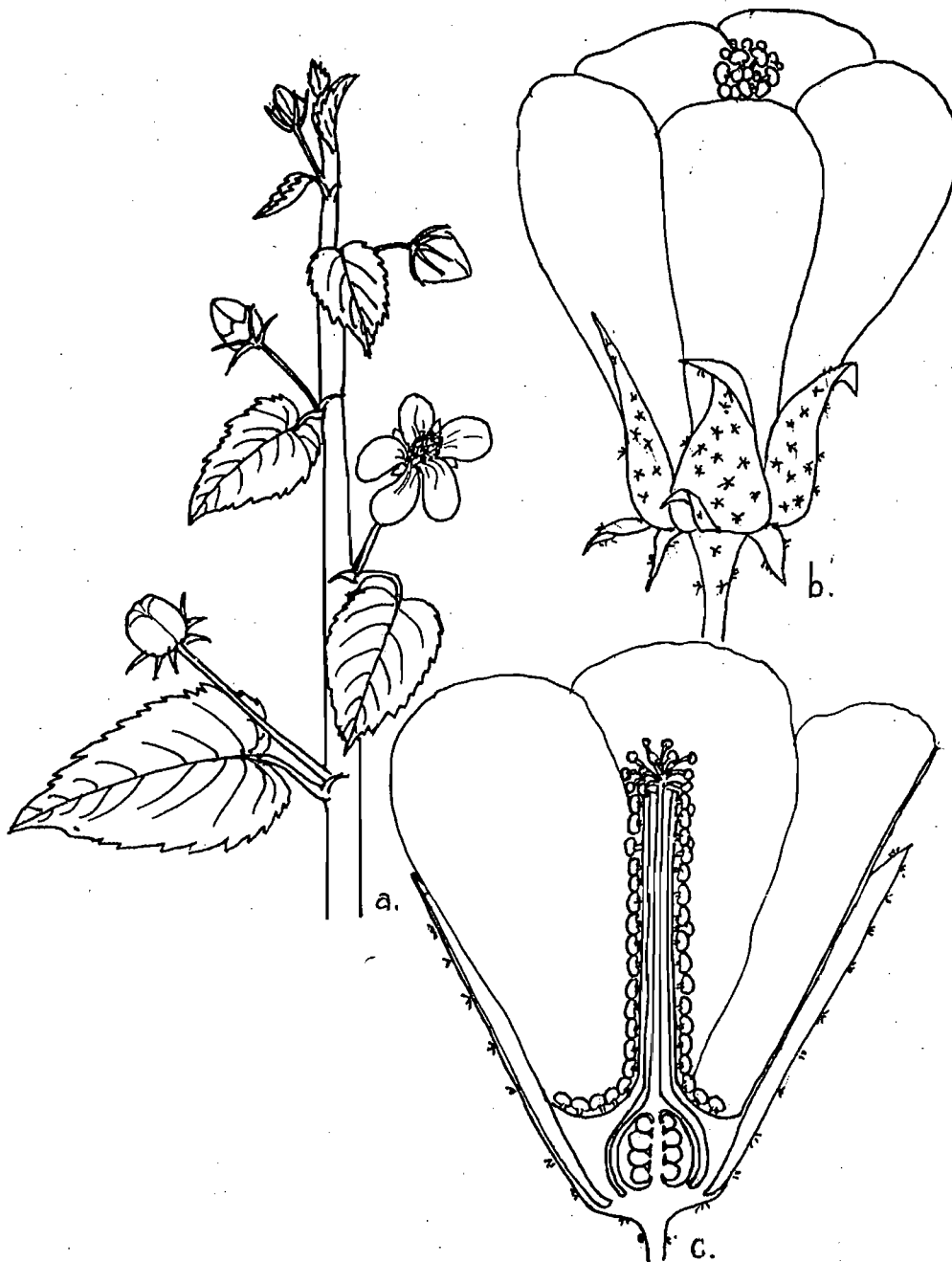


Fig. 40. *Hibiscus micranthus* L., f. a. habit, b. flower, c. L.S. of flower.

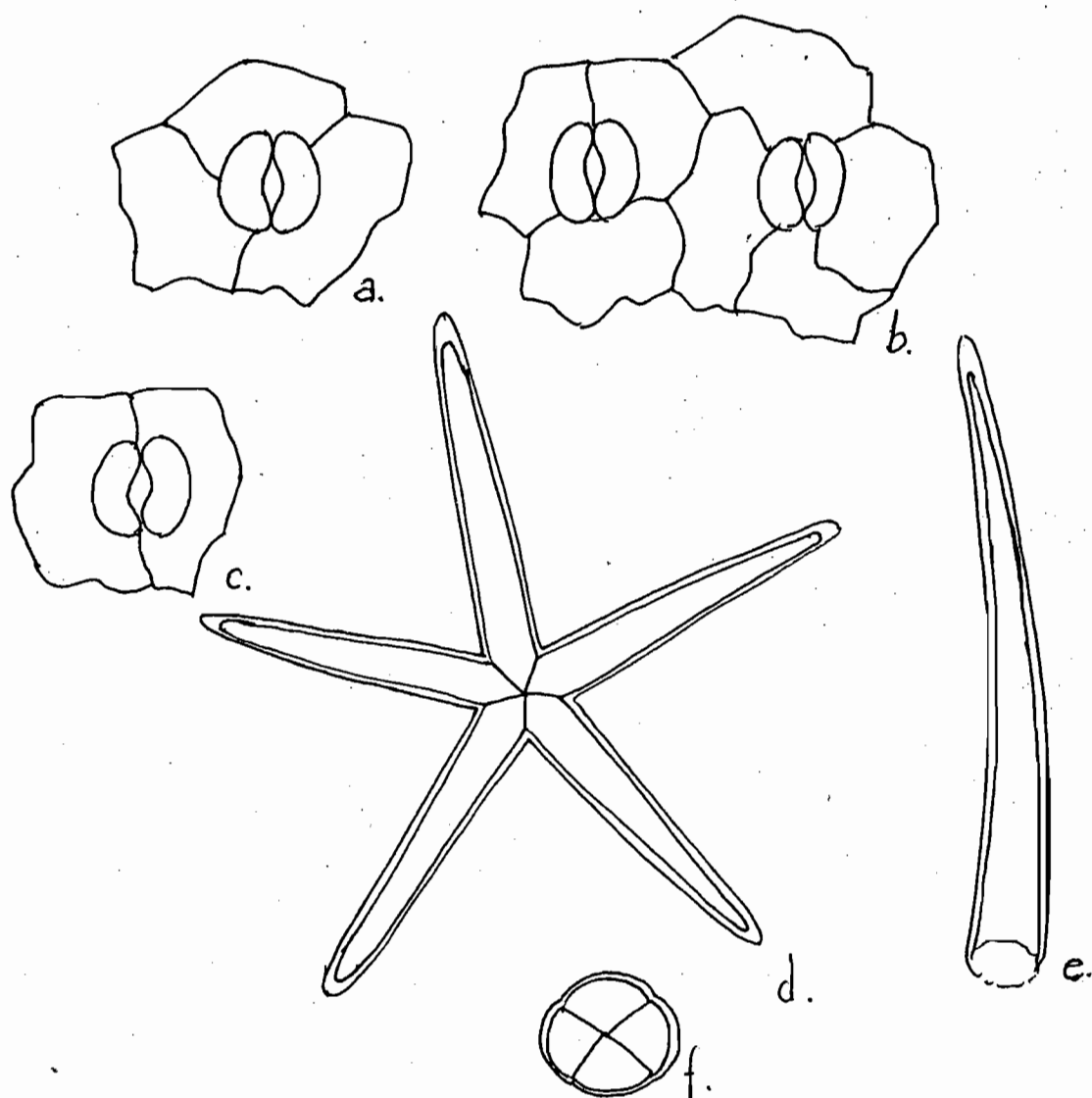


Fig. 41. *Hibiscus micranthus* L., f. a. anisocytic stomata, b. anisocytic and anomocytic stomata, c. paracytic stomata, d. stellate hair with 5 arms, e. unicellular acicular trichome with broad lumen, f. sessile 4-celled gland.

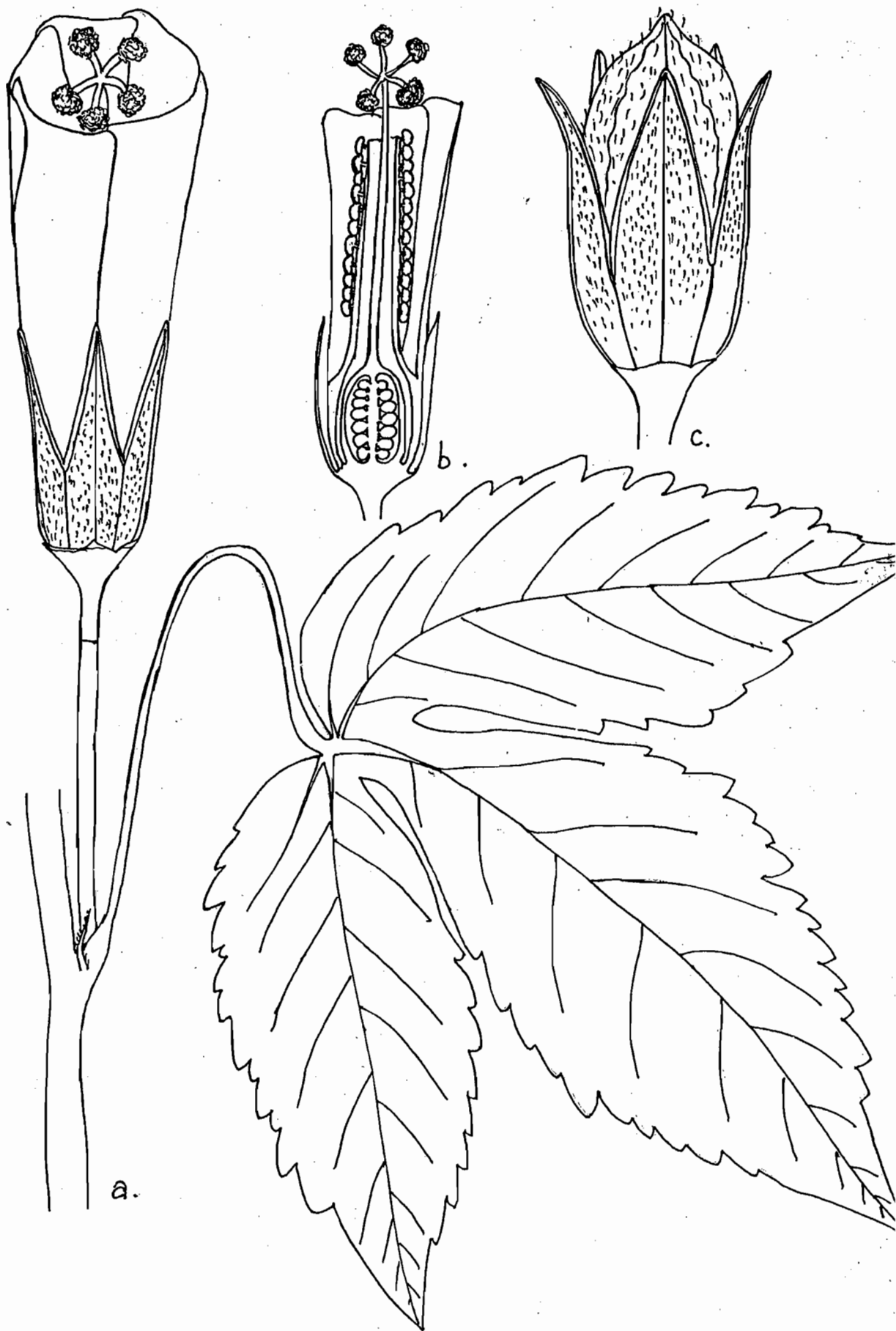


Fig. 42. *Hibiscus solandra* L'Her., a. habit, b. L.S. of flower, c. fruit.

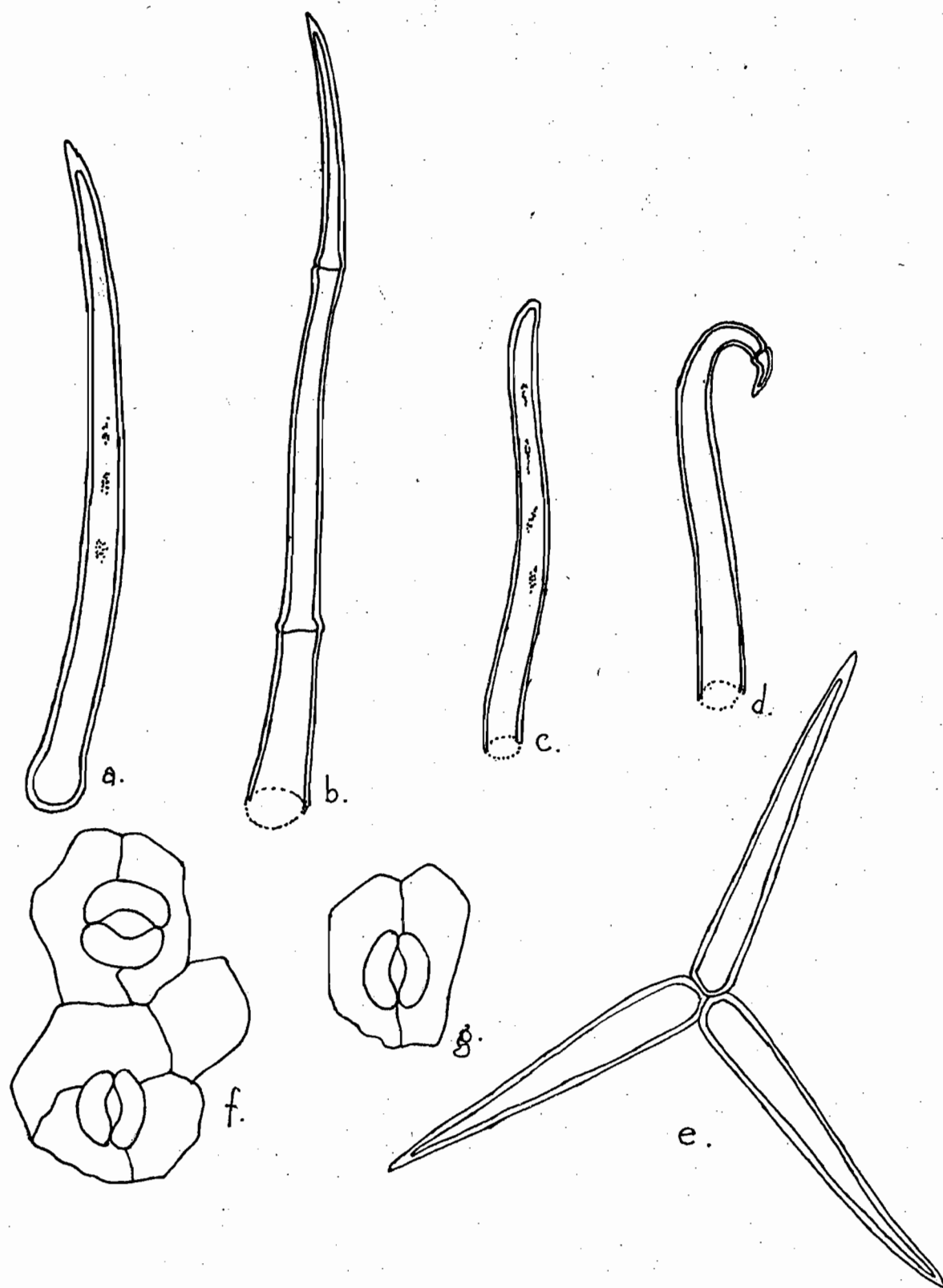


Fig. 43. *Hibiscus solandra* L'Her., a. glandular unicellular trichome with broad lumen, b. non-glandular 3-celled uniseriate trichome, c. glandular unicellular trichome, d. non-glandular 2-celled uniseriate trichome with upper cell small and hooked, e. stellate hair with 3-arms, f. diacytic and anisocytic stomata, g. paracytic stomata.

4. *Hibiscus vitifolius* Linn. *Sp.Pl.*(1753) p. 696.

A herbaceous plant, more or less hairy and tomentose. Leaves cordate, 3-7 lobed; lobes acute or acuminate, crenate, serrate; petioles 5-8 cm long, hairy. The flower axillary, solitary or clustered at the ends of the branches, jointed about the middle. Involucral bracts 7-12, free, upto 1 cm long, linear, hairy. Calyx 2 cm long, ovate, acute, 3-5 nerved. Corolla 5-7 cm across, yellow with a purple centre. Staminal-tube truncate, filaments numerous. Ovary 5-celled, 5 lobed, hairy; ovules many in each cell; style connate, filiform; stigma 5 capitate. Capsules apiculate, 5 winged, the wings reticulately veined. Seeds brown, minutely tubercled. (Fig. 44)

Vernacular name: Van kapas.

Flowers- October-December.

Micromorphology (Fig. 45)

Whole plant was hairy and tomentose with both simple, unicellular, non-glandular, elongated trichome with thick wall and stellate hairs with 4 thick walled arms.

Stomata were of anisocytic type.

D/199

5. *Malachra capitata* Linn. *Syst. ed. 12, V. 2* (1767) p. 458.

A coarsely hispid annual. Leaves cordate, 5-8 cm long; petioles jointed below the blade; stipules often 2-3 branched. Pedicels upto 6 cm long, carrying a 4- leaved involucre, 3 upper the leaves are equal, the fourth smaller and attached higher up than the others. Involucral leaves with stiff bristles on the margins and on the nerves beneath, variously lobed and toothed, with a white spot at the base and with 2 opposite ciliate appendages. Flowers subsessile, 4-6 within the involucre, yellow. Calyx membranous; lobes ovate, prominently margined, the midrib produced into a long bristly point. Petal 5. Staminal-tube short, truncate or 5-toothed at the apex; filaments numerous. Carpels 5, cells 1-ovuled; styles 10, wedge-shaped on the inner side, white when ripe, reticulated with brown veins. Seeds smooth, brown-black. (Fig. 46)

Vernacular name: Pardeshi bhindi.

Flowers: September-December.

Micromorphology (Fig. 47)

Whole plant was hispid. The trichomes on leaves were stellate, with 5 arms and thick walls. Multicellular, glandular, unbranched, nectaries were present on the petals. These nectaries were differentiated into a distinct 7-8 celled head and a unicellular or uniseriate multicellular stalk. On the calyx unicellular, non-glandular, elongated, trichomes with round bottom were observed.

Stomata were of anisocytic and paracytic, of which the former was in majority.

D/381.

6. *Malvastrum coromandelianum* (L.) Garcke in *Bonplandia* 5: 295. 1857.

Annual herbs or undershrub, 0.3-1 m high. Leaves simple ovate-oblong or suborbicular, 2-6 cm long, serrate-dentate, penninerved. Flowers solitary, axillary, or in axillary clusters. Epicalyx lobes 3, small, linear-lanceolate, slightly adnate to the calyx. Calyx

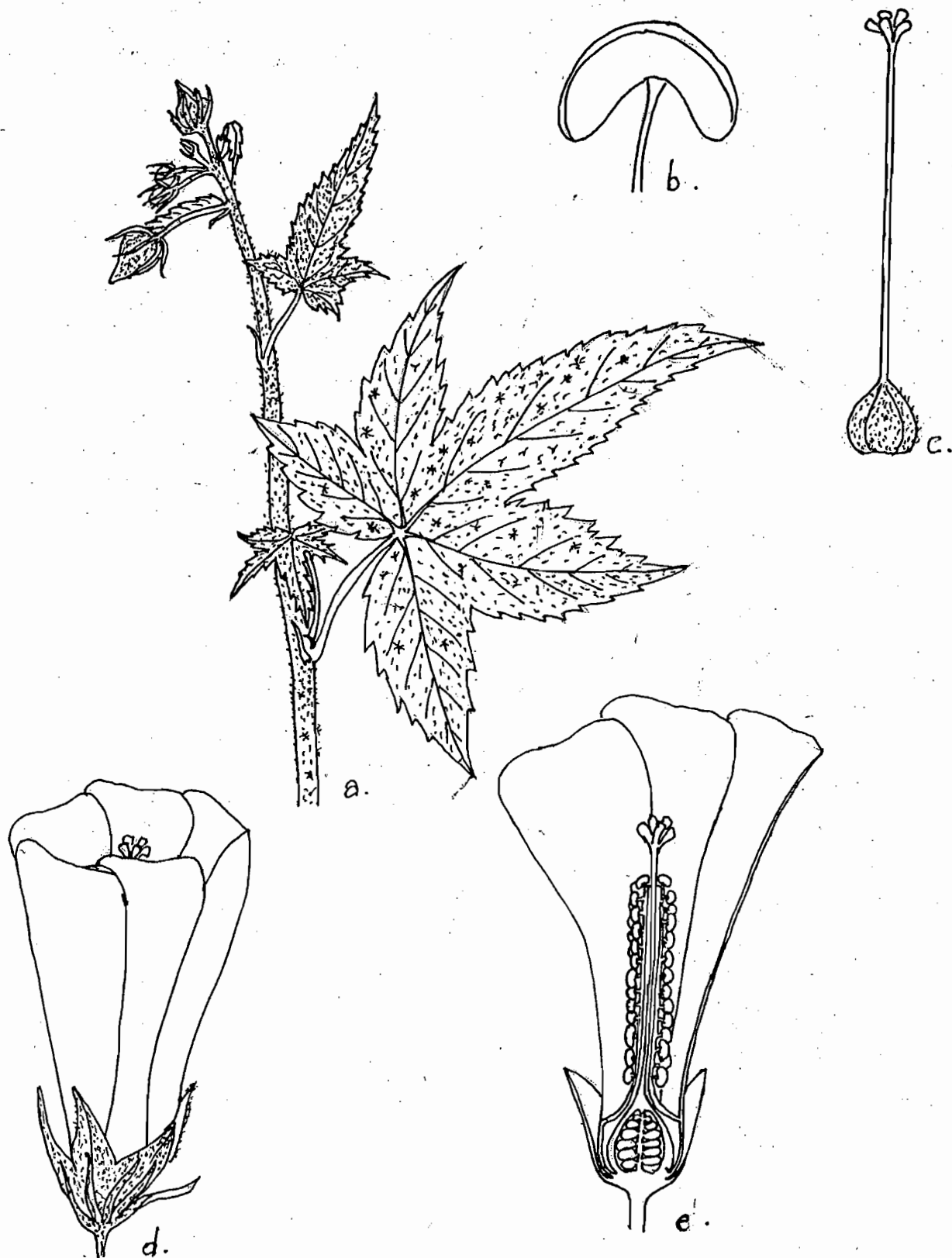


Fig. 44. *Hibiscus vitifolius* L., a. habit, b. stamen, c. gynoecium, d. flower, e. L.S. of flower.

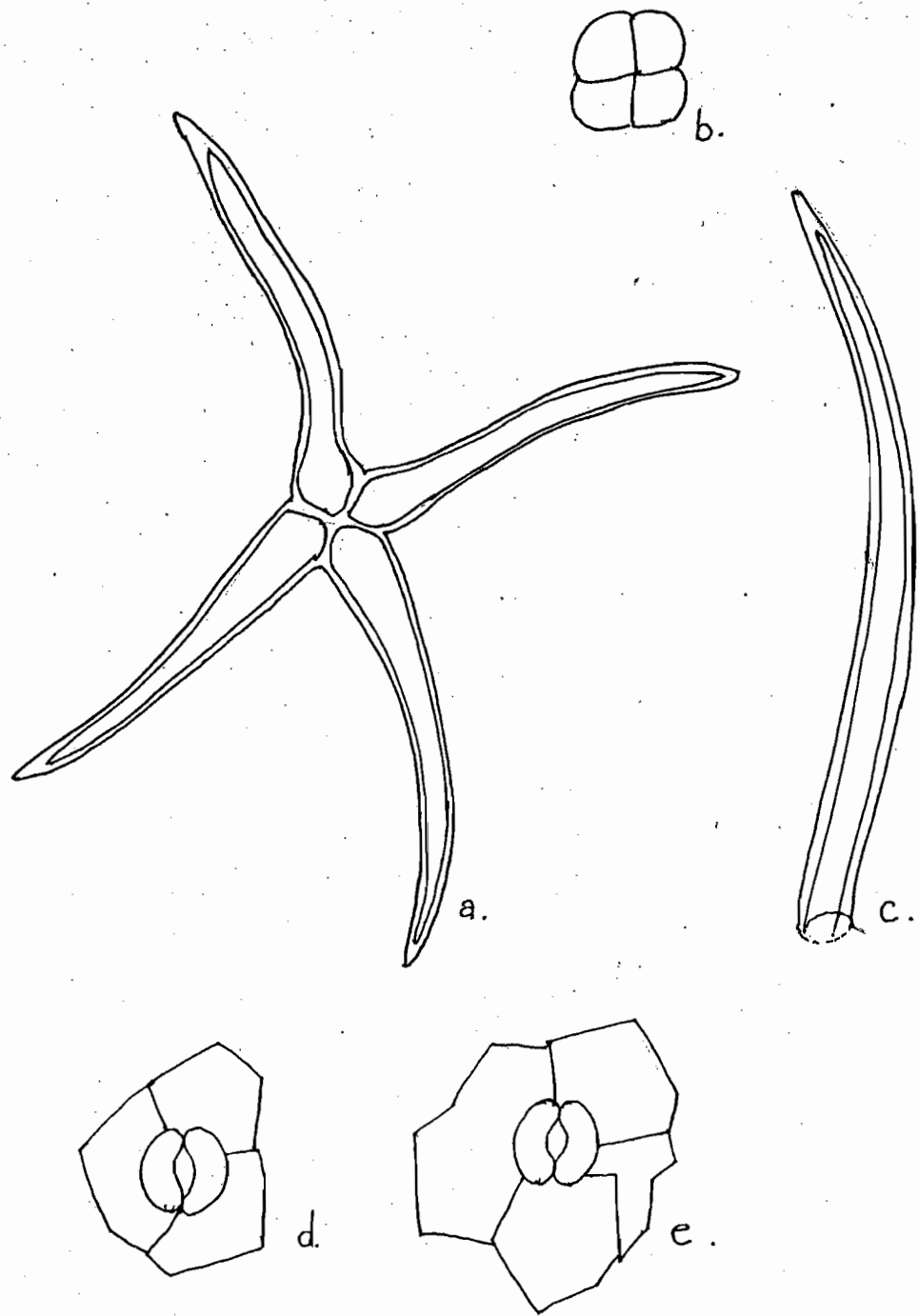


Fig. 45. *Hibiscus vitifolius* L., a. stellate hair with 4 arms, b. sessile 4-celled gland, c. unicellular trichome with thick lumen, d. anisocytic stomata, e. anomocytic stomata.

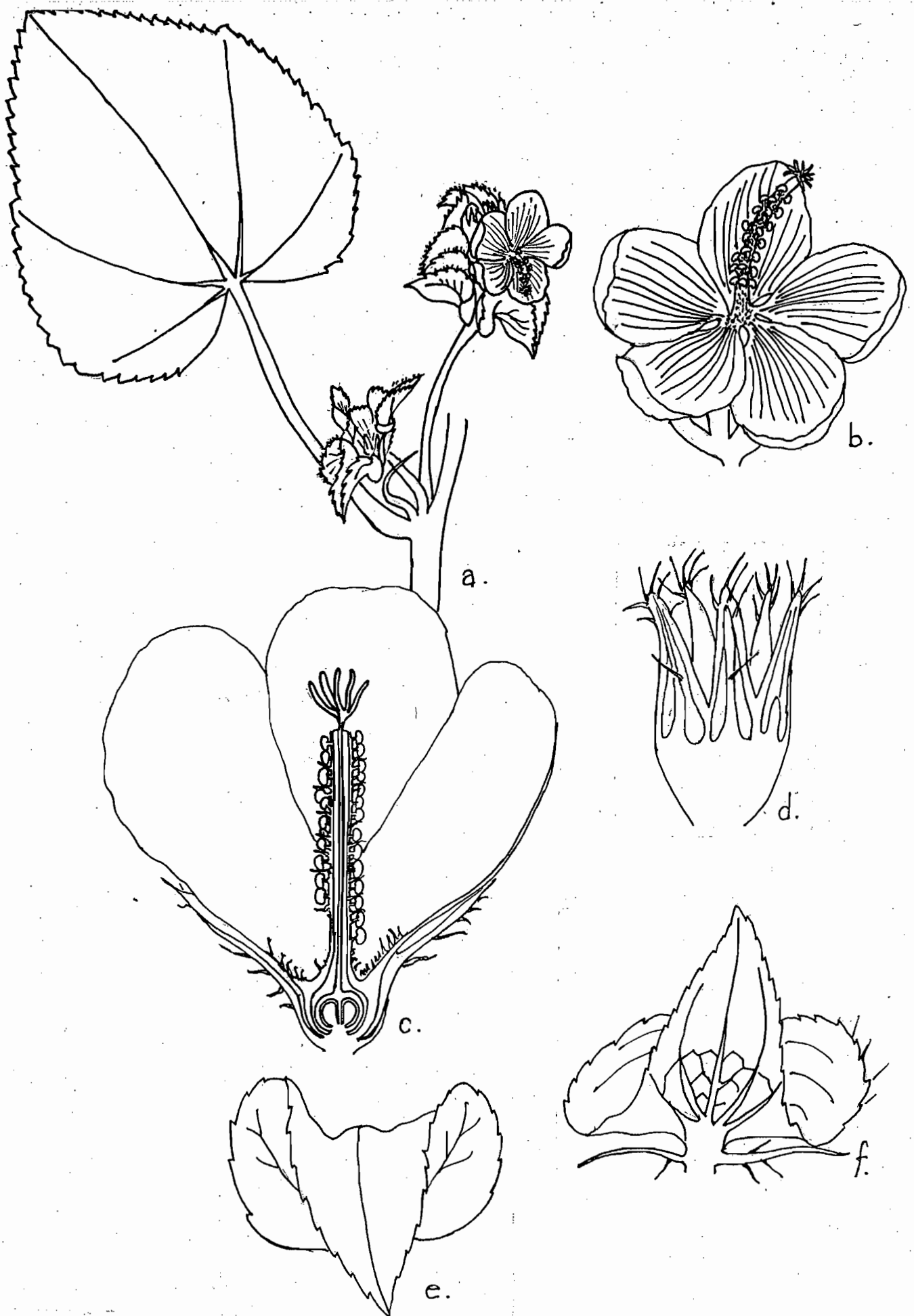


Fig. 46. *Malachra capitata* L., a. habit, b. flower, c. L.S. of flower, d. calyx, e & f. bracts.

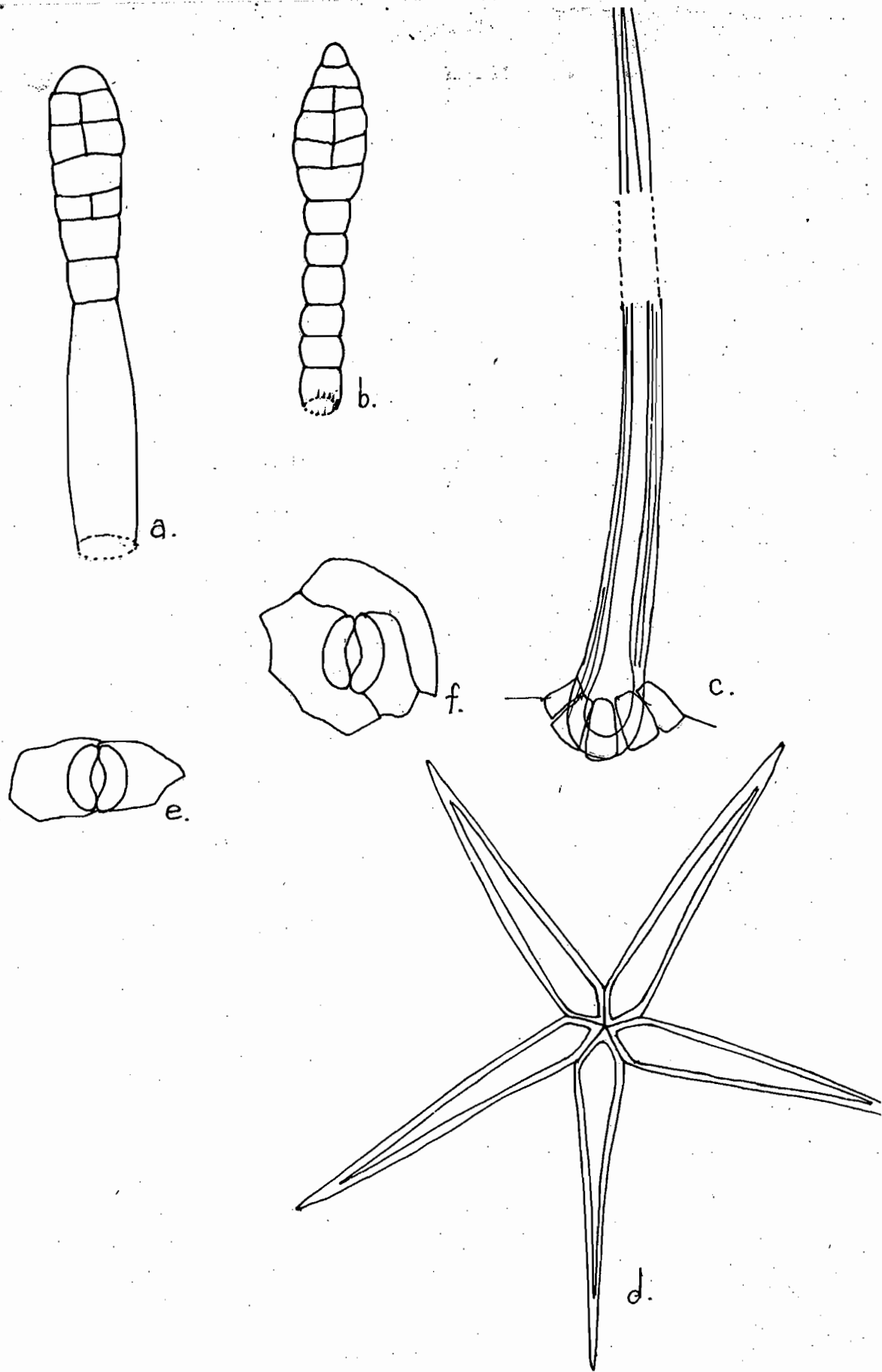


Fig. 47. *Malachra capitata* L., a. multicellular gland differentiated to a multicellular head and a long unicellular stalk, b. multicellular gland with a multicellular head and uniseriate stalk, c. unicellular trichome with stratified wall and large lumen, d. stellate hair with 5 arms, e. paracytic stomata, f. anisocytic stomata.

campanulate, ovate deltoid segments. Corolla 15 mm across, small, rotate, yellow; petals spatulate. Staminal column conical, shorter than the petals. Carpels and styles 10-15; ovule solitary; styles connate at the base. Schizocarps discoid; mericarps 10-14, curved, shortly awned at the tip and with 2 awns dorsally at the middle; seed solitary in each cell, reniform. (Fig. 48)

Vernacular name: Red malvastrum.

Flowers: October- January.

Micromorphology (Fig. 48)

There were both type of trichomes present in the plant, i.e., glandular and non-glandular. Non-glandular trichomes include stellate hairs with five-arms and a unicellular, acicular trichome with a swollen base. Glandular trichome was sessile two-celled.

Stomata were anisocytic, tetracytic and diacytic type.

D/399

7. *Sida acuta* Burm. *Fl. Ind.* (1768) p. 147.

A branched shrub with leaves 5-6 cm long. Leaves lanceolate, with rounded base, sharply serrate, glabrous on both sides. Pedicels 1-2 in each axil, shorter or longer than the petiole, jointed about the middle. Calyx lobes-5, triangular, acute, connate below for 1/3-1/2 their length. Corolla nearly twice as long as the calyx, yellow; petals connate at the base with the staminal tube. Staminal tube divided at the top into numerous antheriferous filaments. Ovary of 5-9 celled; ovule 1 in each cell, pendulous; styles as many as the carpels; stigmas terminal. Fruit strongly reticulated, toothed on the dorsal margins; awns 2, nearly linear. Seeds smooth, black. (Fig. 49)

Vernacular name: Bala.

Flowers: August-February.

Micromorphology (Fig. 50)

Stellate hairs with five-arms were the only type of trichomes observed.

Stomata were of anisocytic, tetracytic, anomocytic, and paracytic type.

D/145.

8. *Sida rhombifolia* Linn. var. *rhomboidea* Roxb. *Hort. Beng.* 50

A perennial shrub with scattered stellate hairs or glabrous. Leaves polymorphous, leaves rhomboid, hoary beneath, peduncles jointed at the base stipules linear-setaceous, longer than the petiole. Peduncle rarely less than twice as long as the petiole, axillary or clustered at the ends of the branches. Flowers yellow, rarely white. Sepals deltoid or acuminate. Carpels smooth or reticulate, 10, awned or not, as long as the calyx. (Fig. 51)

Vernacular name: Bala.

Flowers: September-March.

Micromorphology (Fig. 51)

Whole plant was covered by stellate hairs and unicellular, non-glandular, pointed trichomes.

Stomata were of anisocytic type.

D/160.

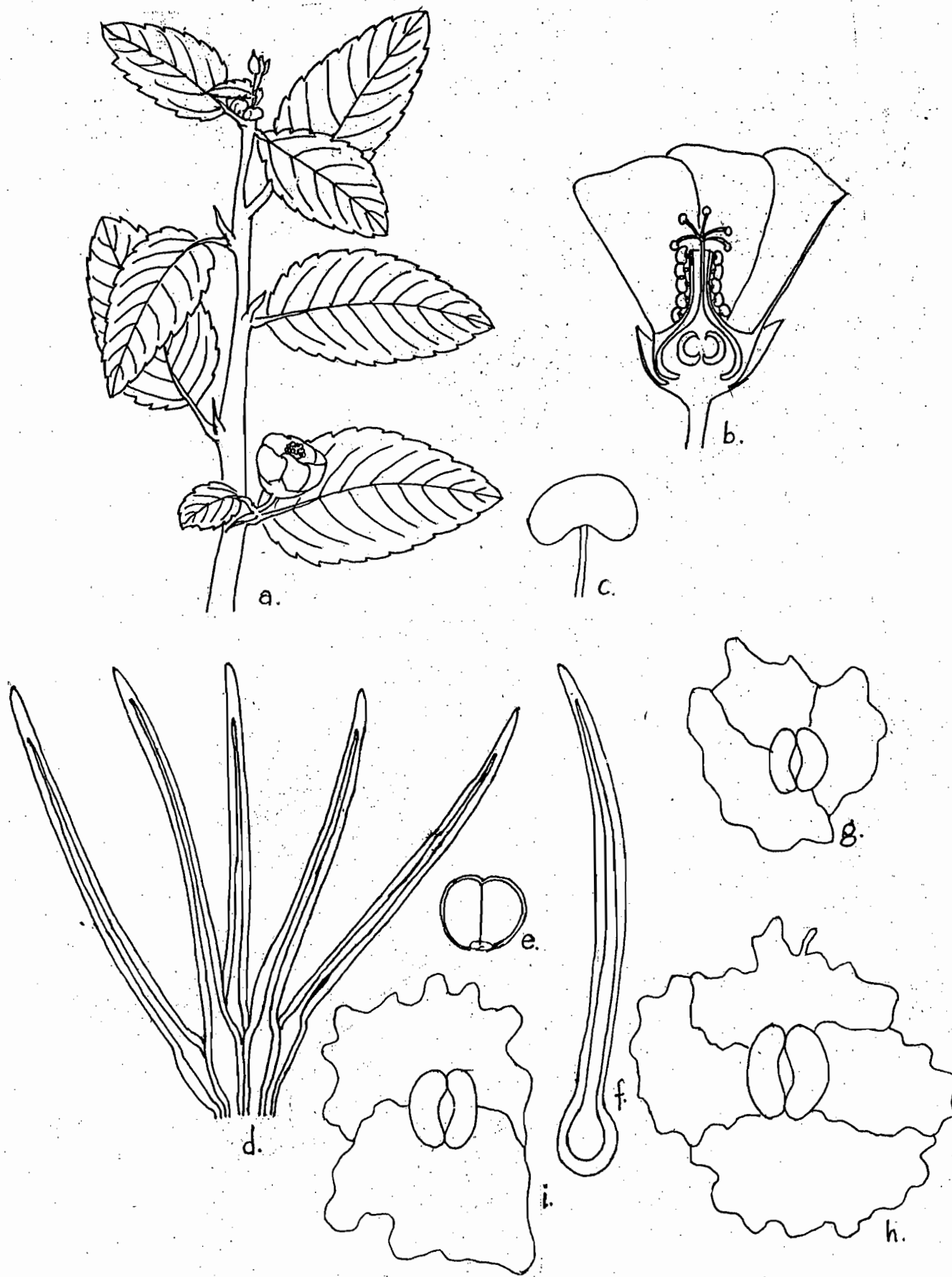


Fig. 48. *Malvastrum coromandelianum* (L.) Garcke., a. habit, b. L.S. of flower, c. stamen, d. stellate hair with 5 arms and a stalk, e. 2-celled sessile gland, f. unicellular trichome, g. anisocytic stomata, h. tetracytic stomata, i. diacytic stomata.



Fig. 49. *Sida acuta* Burm., a. habit, b. flower -side view, c. flower -top view, d. L.S. of flower.

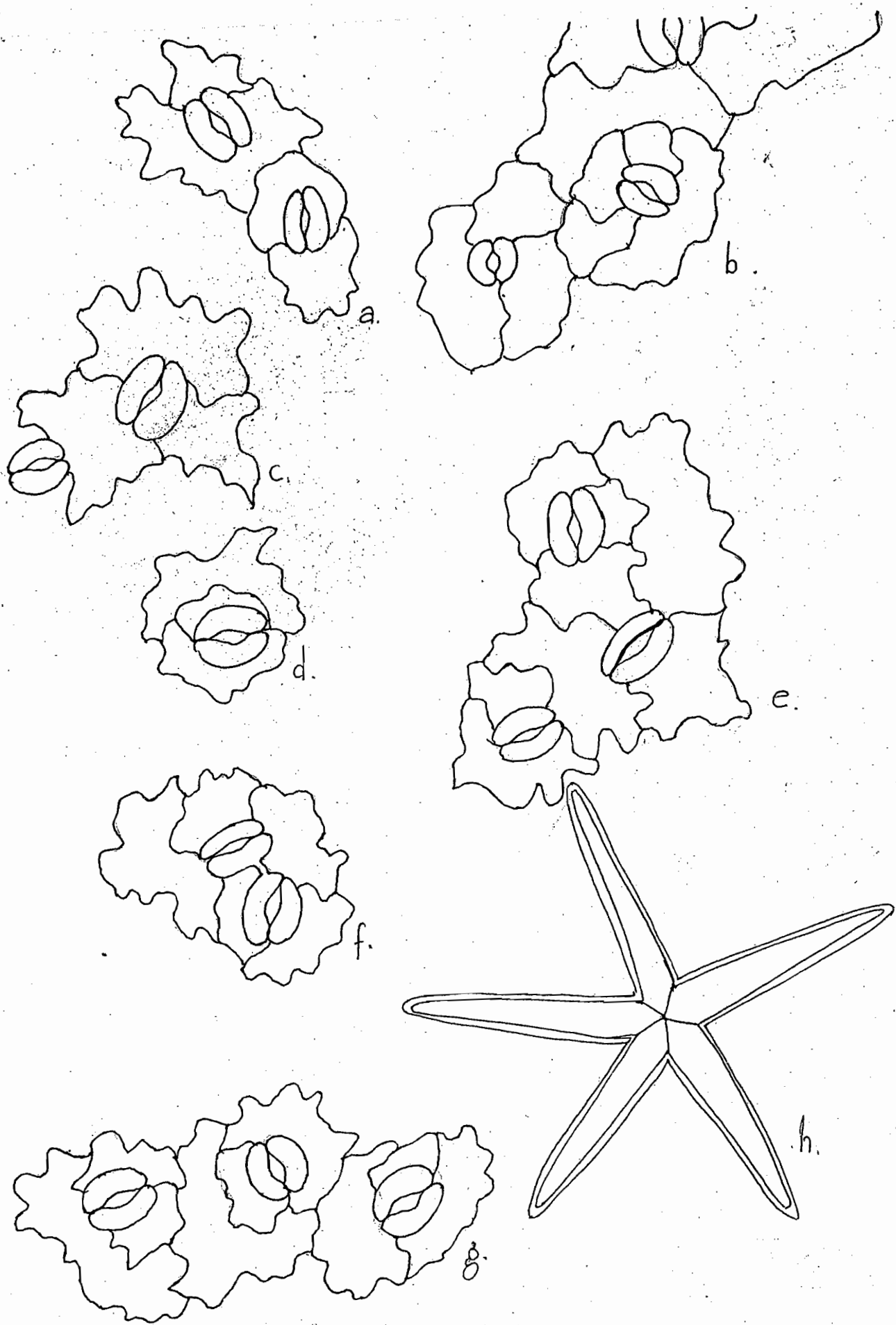


Fig. 50. *Sida acuta* Burm., a. diacytic stomata, b. anisocytic and tetracytic stomata, c. anomocytic stomata, d. paracytic stomata, e. anisocytic and anomocytic stomata, f. sister stomata connected through a channel, g. anisocytic and paracytic stomata, h. stellate hair with 5-arms.

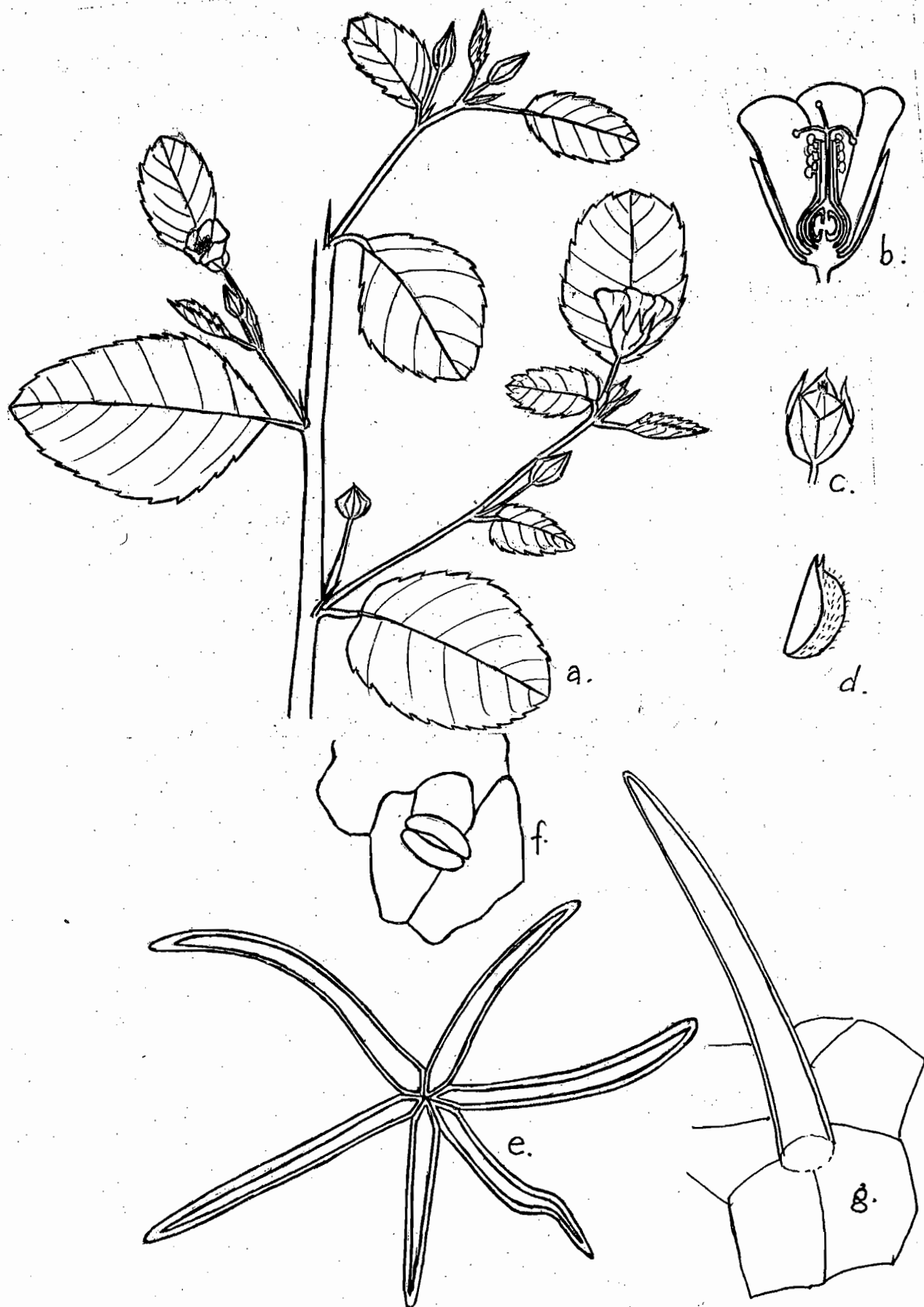


Fig. 51. *Sida rhombifolia* Mast., a. habit, b. L.S. of flower, c. fruit, d. mericarp, e. stellate hair with 6-arms, f. anisocytic stomata, g. unicellular trichome with broad lumen.

9. *Sida veronicifolia* Lam. *Encyc. V. 1* (1783) p. 5.

A perennial much-branched prostrate or trailing herb. Leaves upto 5 cm long, cordate, ovate, acute or acuminate, serrate, sparsely clothed with stellate hairs. Pedicels slender, axillary, solitary or twin, jointed a little above the middle. Calyx 5-angled, hairy; lobes triangular, acute or acuminate. Corolla pale-yellow, petals slightly connate at the base and with the staminal tube. Staminal tube divided at the top into numerous antheriferous filaments. Carpels 5, smooth, not reticulated, mucous or with a small slightly 2-lipped beak, not cuspidate. Seeds brown, glabrous. (Fig. 52)

Flowers: October-November.

Micromorphology (Fig. 53)

There were both glandular and non-glandular trichomes present. The glandular one were multicellular differentiated into a multicellular head and a single celled stalk; whereas, non-glandular include stellate hairs with five-arms and acicular, unicellular trichome.

Stomata were anisocytic, obliquely paracytic and anomocytic type.

D/139.

Bombacaceae

1. *Bombax ceiba* Linn., *Sp.Pl.* 311. 1753.

A tall tree with branches covered by small hard conical prickles. Leaves palmately compound with a long petiole; stipules triangular, caducous. Leaflets 5-7, elliptic-lanceolate, unequal. Inflorescence many fascicles of 1-4 flowers borne, at the end of branches. Flowers large, red. Calyx 3-lobed, cup-shaped, smooth outside, densely silky within. Petals twisted in bud, stellate tomentose outside, pubescent inside, usually recurved. Stamens polyadelphous, united at base in 6 phalanges, each of 11-15 stamens, the inner-most phalange surrounding the pistil is composed of 15 stamens of which 5-innermost are the largest and forked; filaments flattened at base; anthers long, violet. Ovary conical, covered with silky hairs; style simple; stigmas 5, filiform. Capsule 10-12.5 cm long; oblong, woody, 5 valved, finely tomentose. Seeds brown, smooth, obovoid, embedded in silky white wool. (Fig. 54)

Vernacular name: Shimlo.

Flowering season: December-March.

Micromorphology (Fig. 55)

The plant showed presence of a multicellular gland differentiated into a multicellular head and a single celled stalk. Non-glandular trichome was differentiated into a six-armed stellate hair and acicular, unicellular trichome.

Stomata were of paracytic, anisocytic type.

D/239.

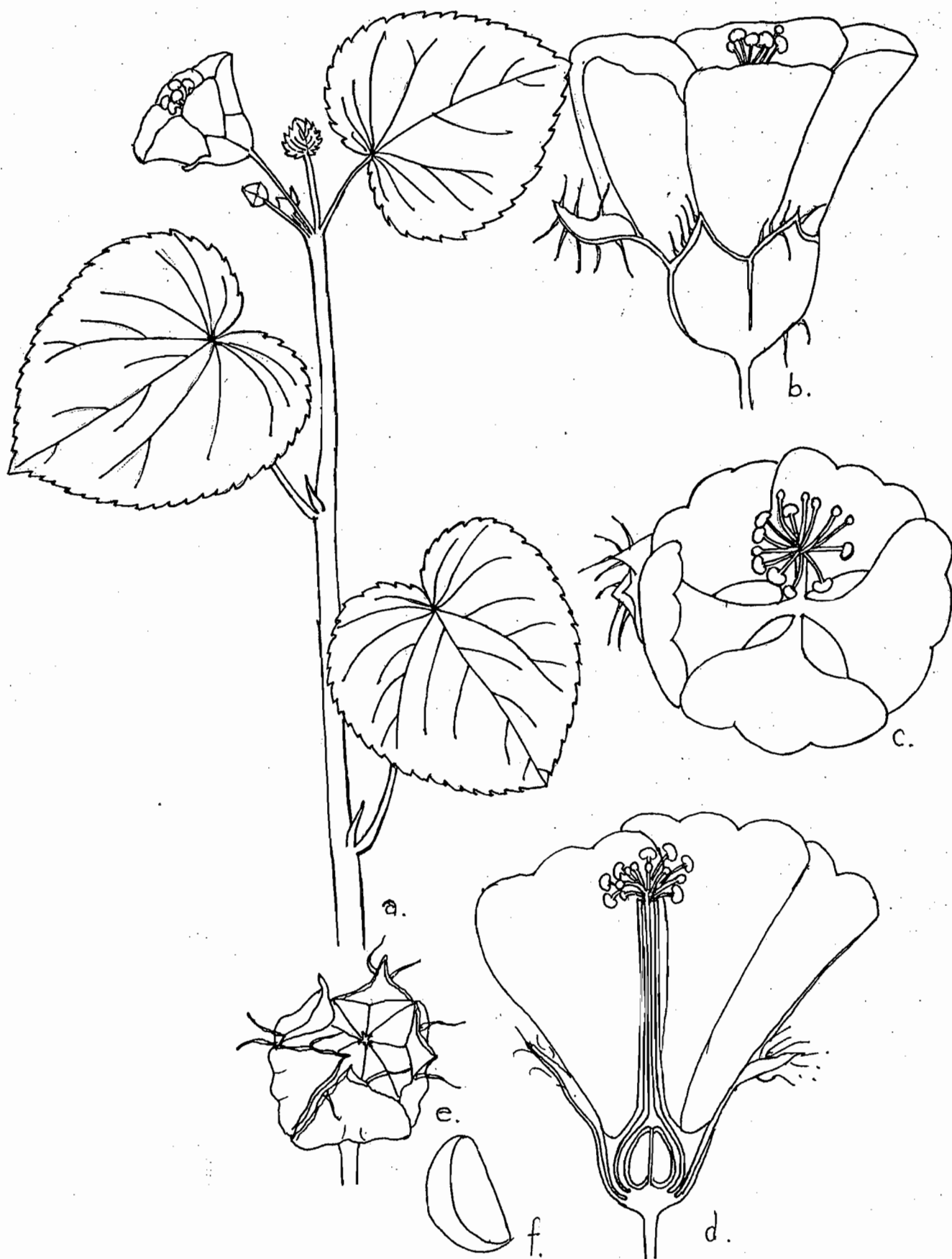


Fig. 52. *Sida veronicifolia* Lam., a. habit, b. flower (side view), c. flower (top view), d. L.S. of flower, e. fruit, f. seed.

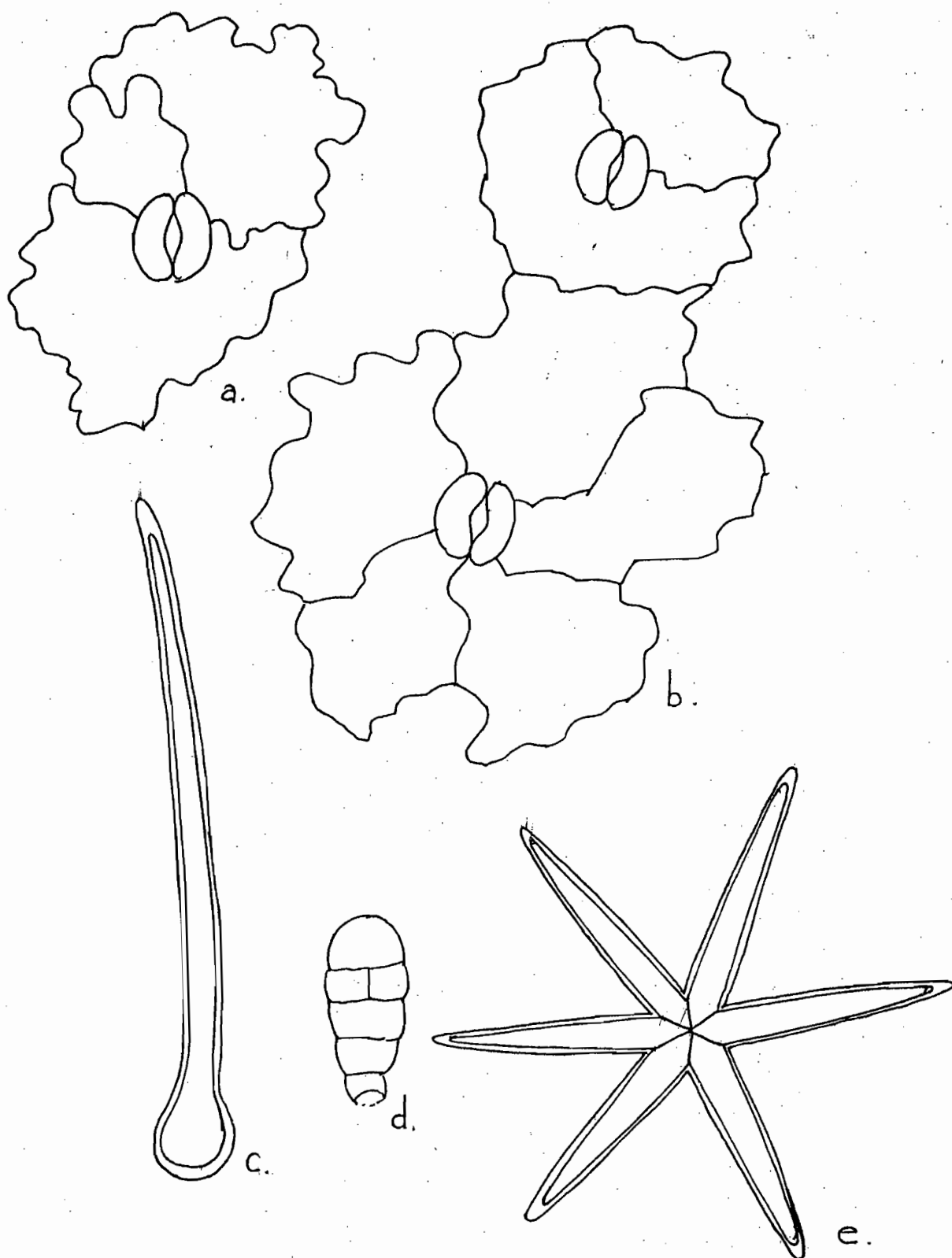


Fig. 53. *Sida veronicifolia* Lam., a. anisocytic stomata, b. paracytic and anomocytic stomata, c. unicellular acicular trichome with round base and broad lumen, d. multicellular gland differentiated into multicellular head and a single celled stalk, e. stellate hair with 6-arms.

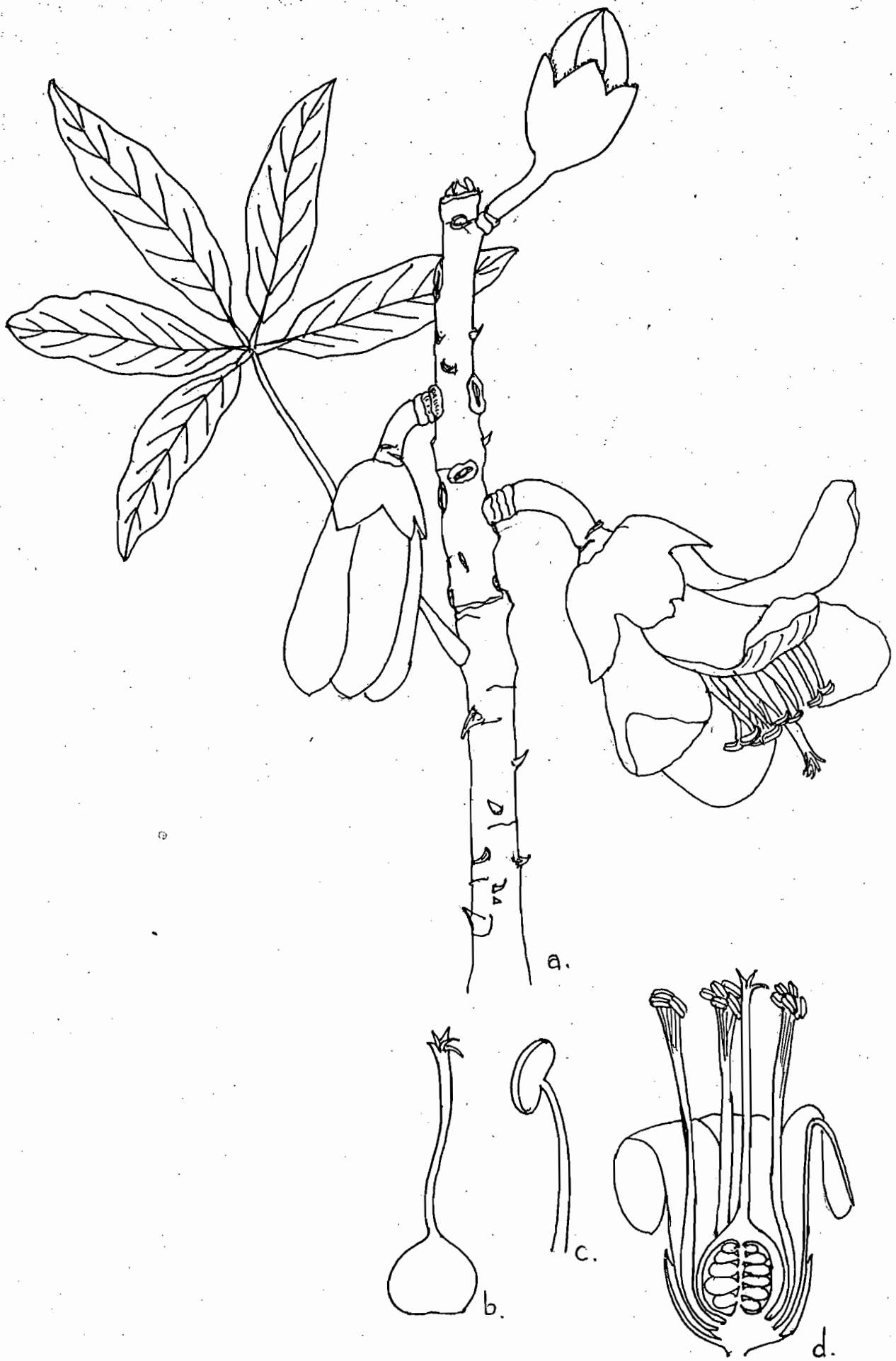


Fig. 54. *Bombax ceiba* L., a. habit, b. gynoecium, c. stamen, d. L.S. of flower.

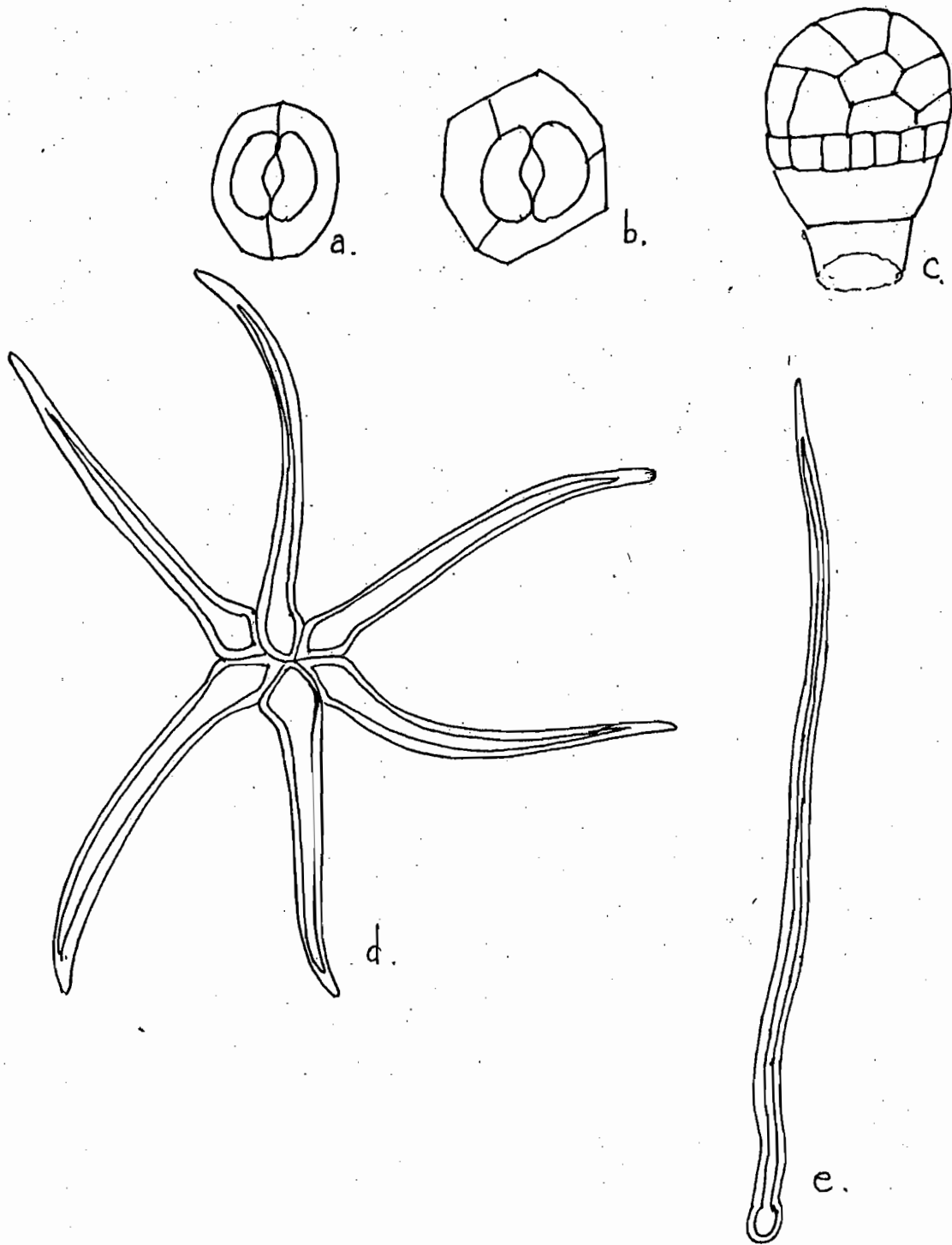


Fig. 55. *Bombax ceiba* L., a. paracytic stomata, b. anisocytic stomata, c. gland with multicellular head and a large single celled stalk, d. stellate hair with 6-arms, e. unicellular trichome with a narrow lumen and small base.

Sterculiaceae

1. *Guazuma ulmifolia* Lam., *Encycl.Meth.Bot.* 3:52. 1789.

(*Guazuma tomentosa* H.B. & K.)

A medium sized tree, 8-10 m tall. Leaves ovate, or ovate-oblong or lanceolate, up to 10 cm long, oblique, acuminate, somewhat scabrous above and velvety below. Inflorescence axillary or terminal, many-flowered, thyrsiform cyme. Flowers small, yellow. Sepals 3-5, elliptic-lanceolate or ovate, basally connate, tomentose outside, nearly glabrous within, reflexed. Petals obovate with a terminal appendage, puberulous outside. Stamens concealed in the cucullate petals, anthers orange or reddish. Capsule globose or oblong-ellipsoid, black, tuberculate. (Fig. 56)

Vernacular name: Khoto rudraksh.

Flowers: March-May; September-December.

Micromorphology (Fig. 57)

Two types of non-glandular trichome were observed, one stellate hairs and another acicular, unicellular one.

Stomata were of anisocytic and anomocytic type.

D/267.

2. *Helicteris isora* Linn. *Sp. Pl.* 963. 1753

A small tree with a fissured bark. Leaves large ovate, orbicular, abruptly acuminate, serrate, sparsely scabrous to tomentose; nerves 5 from base; stipules small. Flowers reddish turning purplish-grey, slightly falcate, about 8 cm long; 8-9 flowered cymes. Calyx 1.5 cm long, tomentose. Petals reflexed, clawed at the base, glandular near base, staminal column fused with gynophore, styles bent near top, stigma recurved. Capsules 5cm long, elongated, spirally twisted; seeds black, 6-angled. (Fig. 58)

Vernacular name: Maradsing.

Flowers: August- October.

Micromorphology (Fig. 59)

Only stellate hairs with five-arms were observed in this plant.

Stomata were of anisocytic, tetracytic, and anomocytic type.

D/149.

3. *Kavalama urens* (Roxb.) Raf. *Sylva Telluriana* 72. 1838.

(*Sterculia urens* Roxb.)

A large tree with straight erect trunk with bark white, smooth. Leaves about 20 cm long, crowding at the ends of the branches, shallowly palmately lobed, glabrous or nearly so above, velvety beneath; lobes 5, caudate-acuminate, base cordate; petioles terete, velvety-tomentose. Flowers yellow, numerous, the hermaphrodite or female mixed with many males, in much-branched glandular-pubescent branches. Calyx campanulate; lobes oblong, acute, with a small hairy gland at the base of each lobe. Male flowers: staminal-

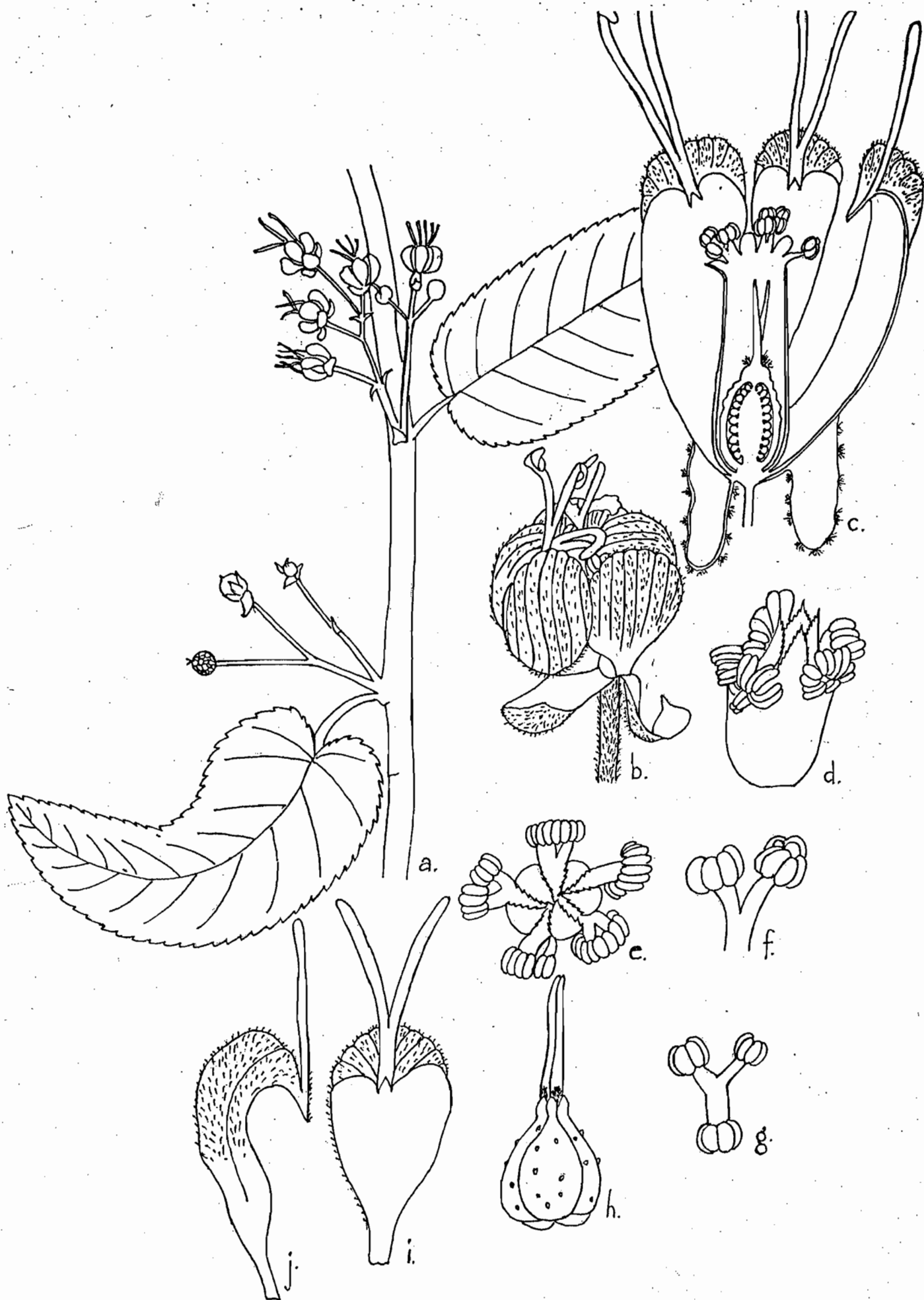


Fig. 56: *Guazuma ulmifolia* Lam., a. habit, b. flower, c. L.S. of flower, d. staminal column, e. staminal column -top view, f & g. gynoecium, i. petal (front view), j. petal (side view).

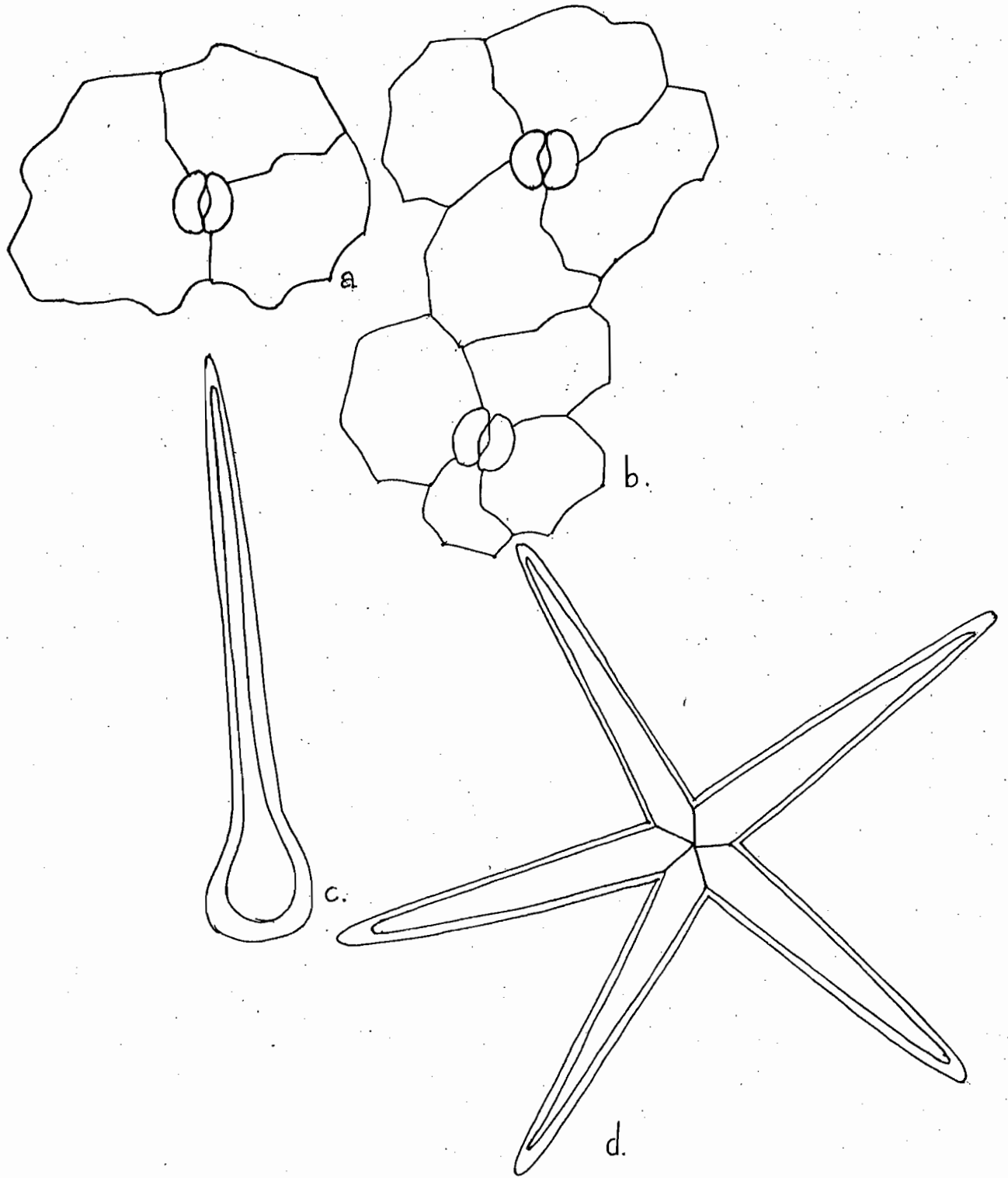


Fig. 57. *Guazuma ulmifolia* Lam., a. anisocytic stomata, b. anomocytic stomata, c. unicellular trichome, d. stellate hair with 5-arms.

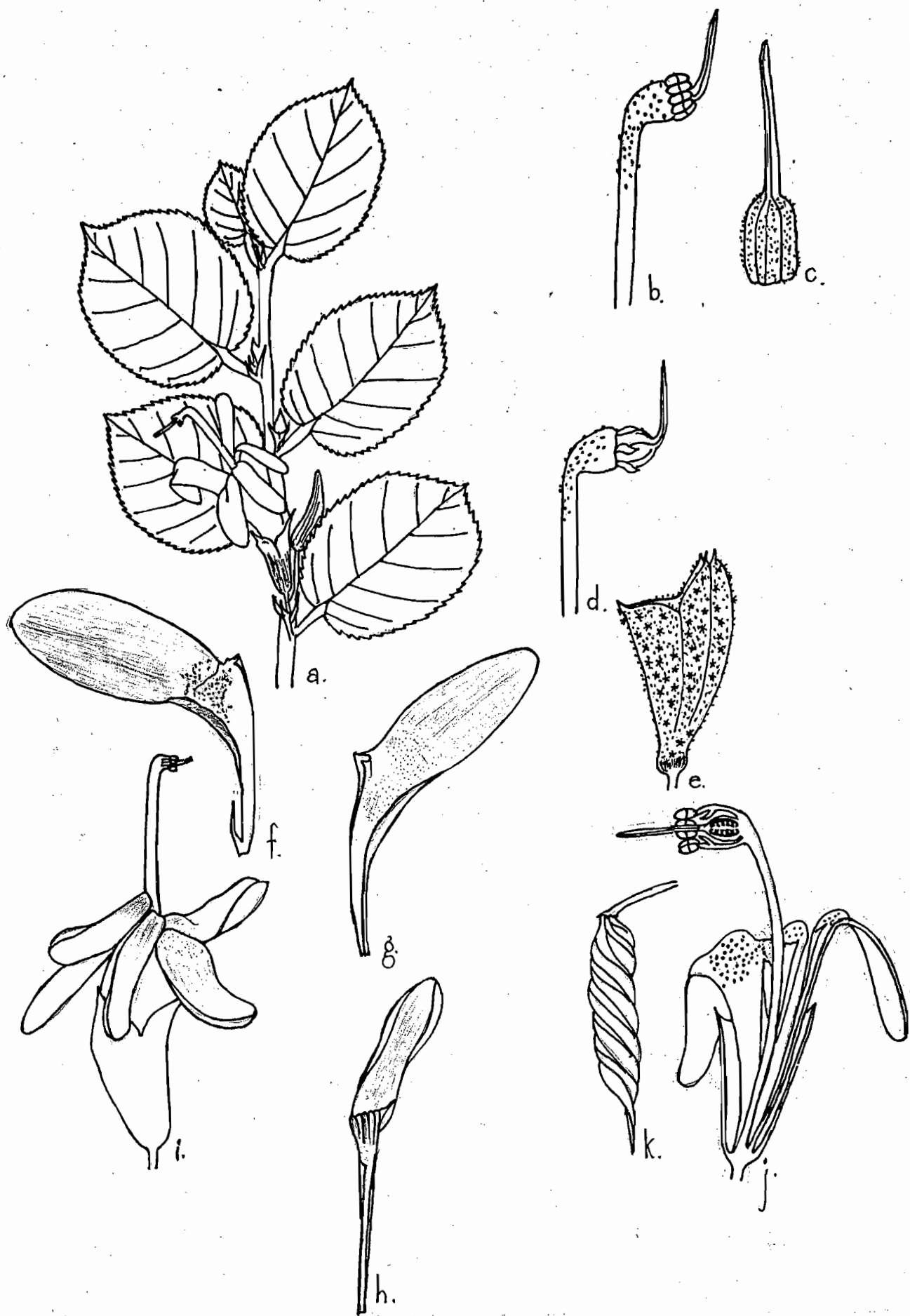


Fig. 58. *Helicteris isora* L., a. habit, b. staminal column, c. gynoecium, d. staminal column with gynoecium and stamens removed, e. calyx, f-h. petals, i. flower, j. L.S. of flower, k. fruit.

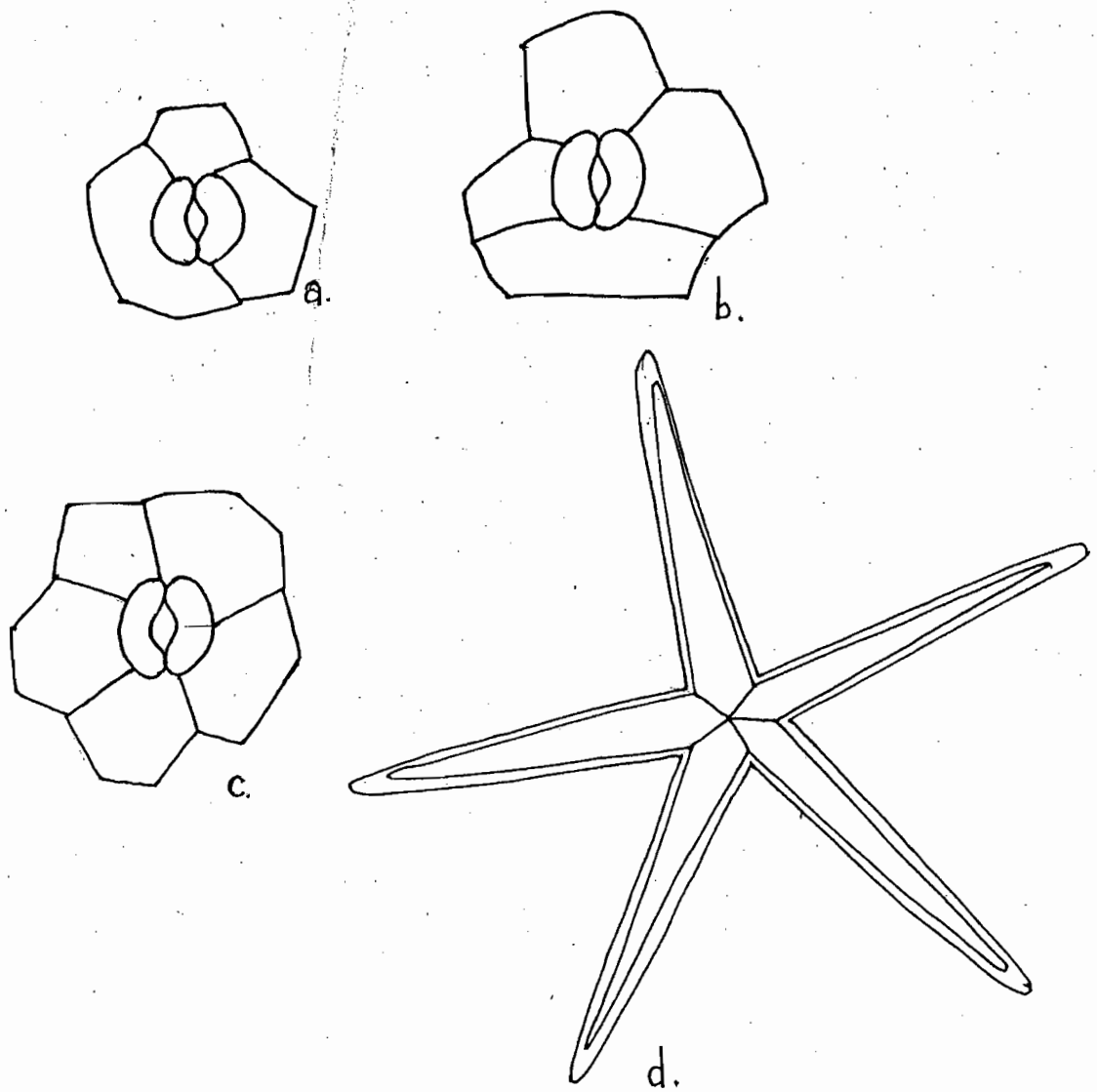


Fig. 59. *Helicteris isora* L., a. anisocytic stomata, b. tetracytic stomata, c. anomocytic stomata, d. stellate hairs with 5-arms.

column short; filaments 10; hermaphrodite flowers: carpels usually 5, on a short stout gynophore; style short, thick, hairy; stigmas 5. stamens in a ring round the carpels. Follicles 4-6, ovoid-oblong, 1 in. long, densely pubescent, the pubescence mixed with stinging hairs. Seeds 3-6, oblong, black. (Fig. 60)

Vernacular name: Kadai.

Flower: December-February.

Micromorphology (Fig. 61)

Calyx showed presence of stellate hairs and multicellular, glandular, stinging trichomes with a broad oval-spherical multicellular base with an acicular multicellular, uniseriate awn like structure.

Only anomocytic types of stomata were observed.

D/600, 1190, 1212-1213.

4. *Kleinhovia hospita* Linn. *Sp. Pl.* ed. 2 (1763) p. 1365.

A middle-sized tree; young shoots and panicles tomentose. Leaves broadly ovate or suborbicular, palmately 3-5 nerved; petioles upto 10 cm long; stipules linear. Flowers rosy, in large terminal panicles. Sepals 5, linear. Petals 5, unequal, shorter than the sepals. Staminal-column elongate, adnate to the gynophore, dilated above into a 5-fid bell-shaped cup, the divisions each with 3 anthers, and alternate teeth without anthers; anthers shortly stalked, cells divaricate, distinct. Ovary inserted within the dilated apex of the staminal-column, 5-lobes, 5-celled; ovules 3-4 in each cell. Capsules membranous, inflated, turbinate 5-lobed, loculicidally 5-valved. Seeds usually 1 in each cell, roundish, tubercled. (Fig. 62)

Flowers: July-August.

Micromorphology (Fig. 63)

There was a multicellular, uniseriate trichome which was flattened as a filament attached with a basal cell.

The stomata were of anisocytic and anomocytic type.

D/ 558, 559.

5. *Riedleia corchorifolia* DC. *Prodr.* V. 1, p. 491.

(*Melochia corchorifolia* Linn.)

An erect branched herb with glabrous stems and branches. Leaves vary variable in size and shape, 2.5-8 cm long, ovate-oblong, acute, serrate; petioles upto 3 cm long, slender; stipules lanceolate, ciliate. Flowers pink, subsessile, densely crowded in terminal clusters; Involucral bracts lanceolate-subulate, hairy. Calyx 5-fid or 5-toothed, campanulate or inflated, sepals lanceolate, ciliate. Petals oblong-cuneate, truncate. Stamens 5, opposite the petals, connate at the base; anther cells parallel. Ovary sessile, 5-celled united at the base. Capsules depressed-globose; loculicidally 5-valved; valves sparingly hairy. Seeds angular mottled black and grey. (Fig. 64)

Vernacular name: Chunga khapat.

Flowers: September-December.

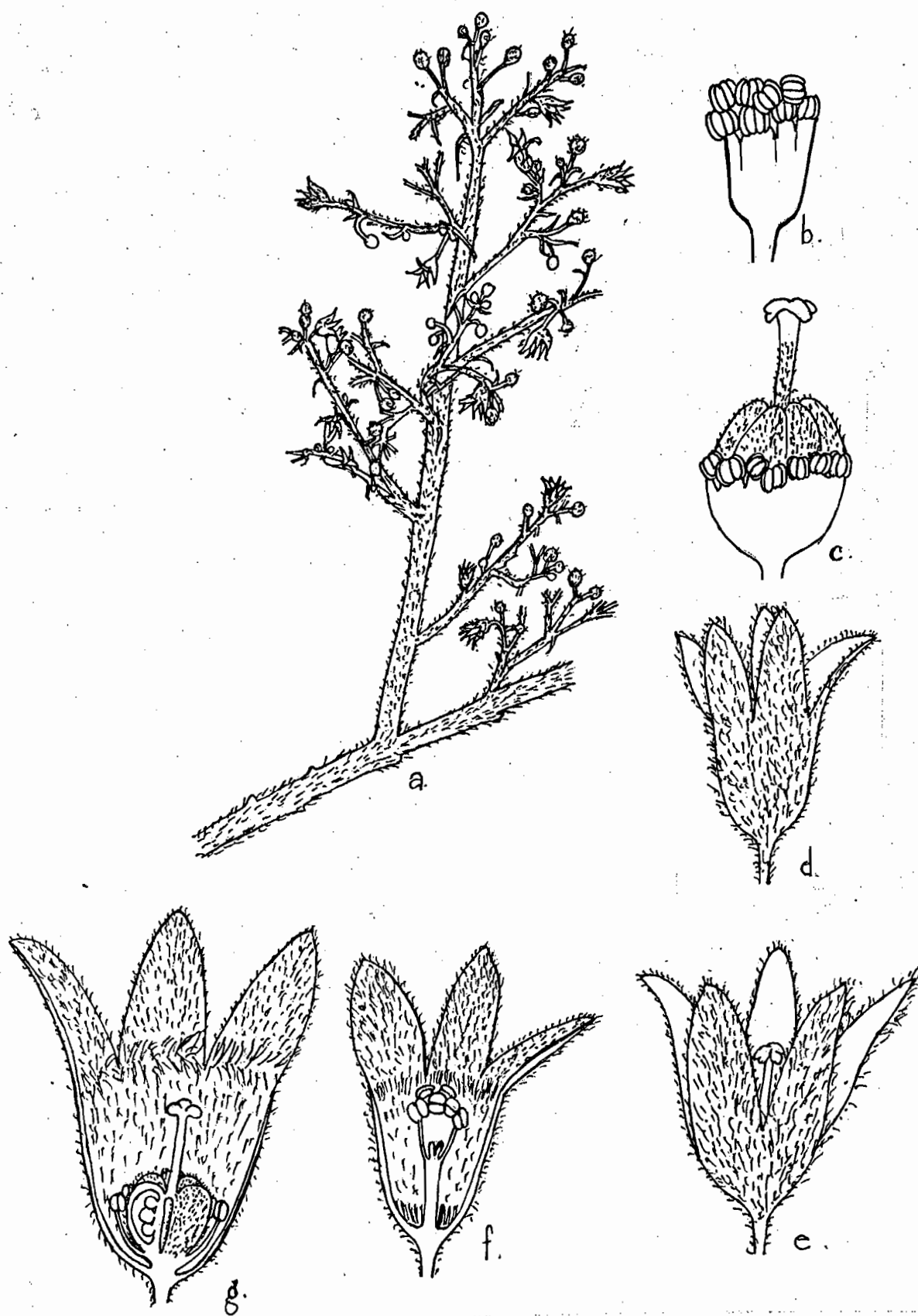


Fig. 60. *Kavalama urens* Raf., a. habit, b. staminal column c. staminal column with gynoecium d. male flower, e. female flower, f. L.S. of male flower, g. L.S. of female flower.

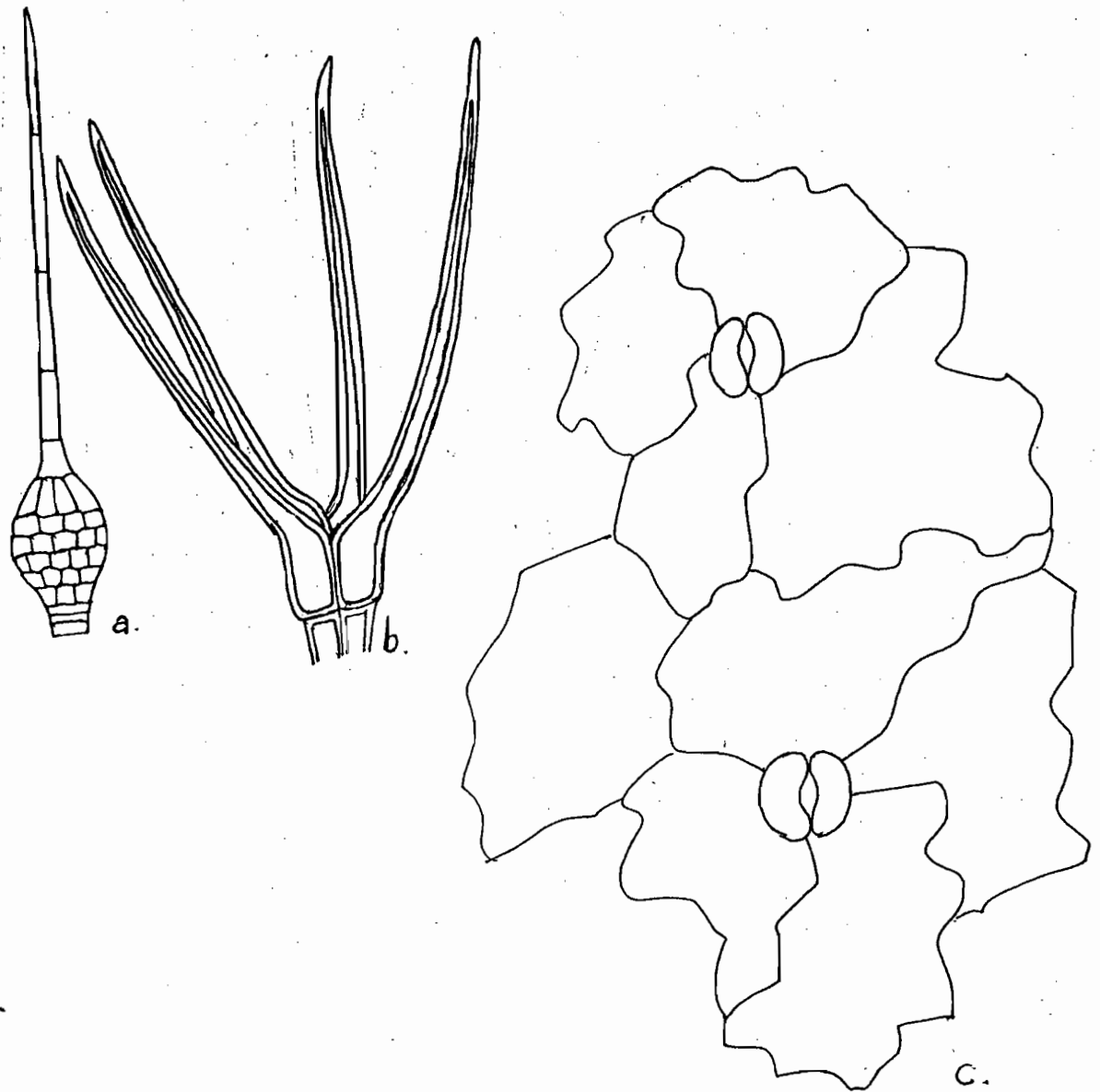


Fig. 61. *Kavalama urens* Raf., a. multicellular gland with an apical filamentous structure, b. stellate hairs with 4-arms and a stalk, c. anomocytic stomata.

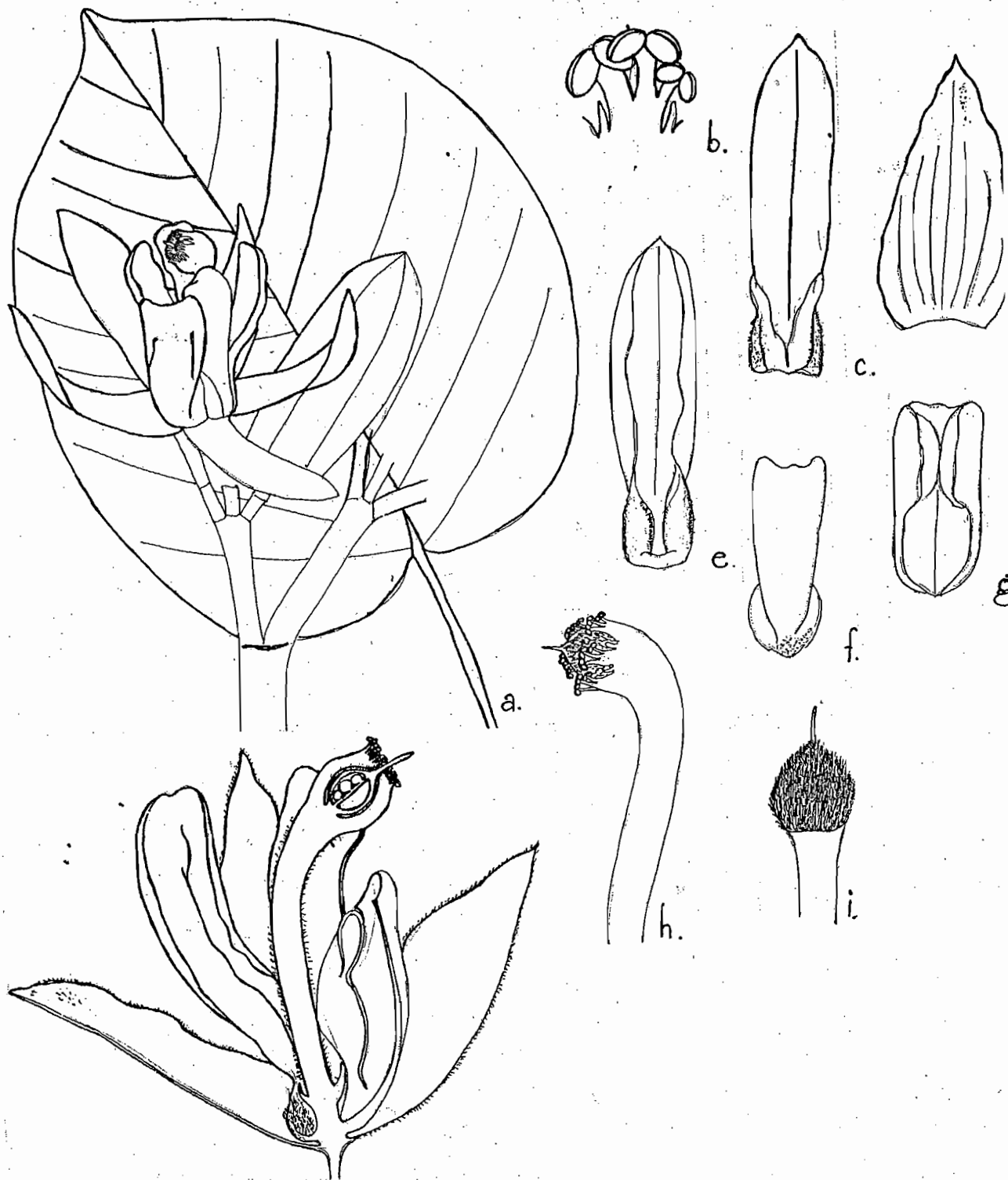


Fig. 62. *Kleinhovia hospita* L., a. habit, b. stamen, c & e. petals, d. sepal, f. back side - smallest petal, g. inner side-smallest petal, h. staminal column with gynoecium, i. gynoecium.

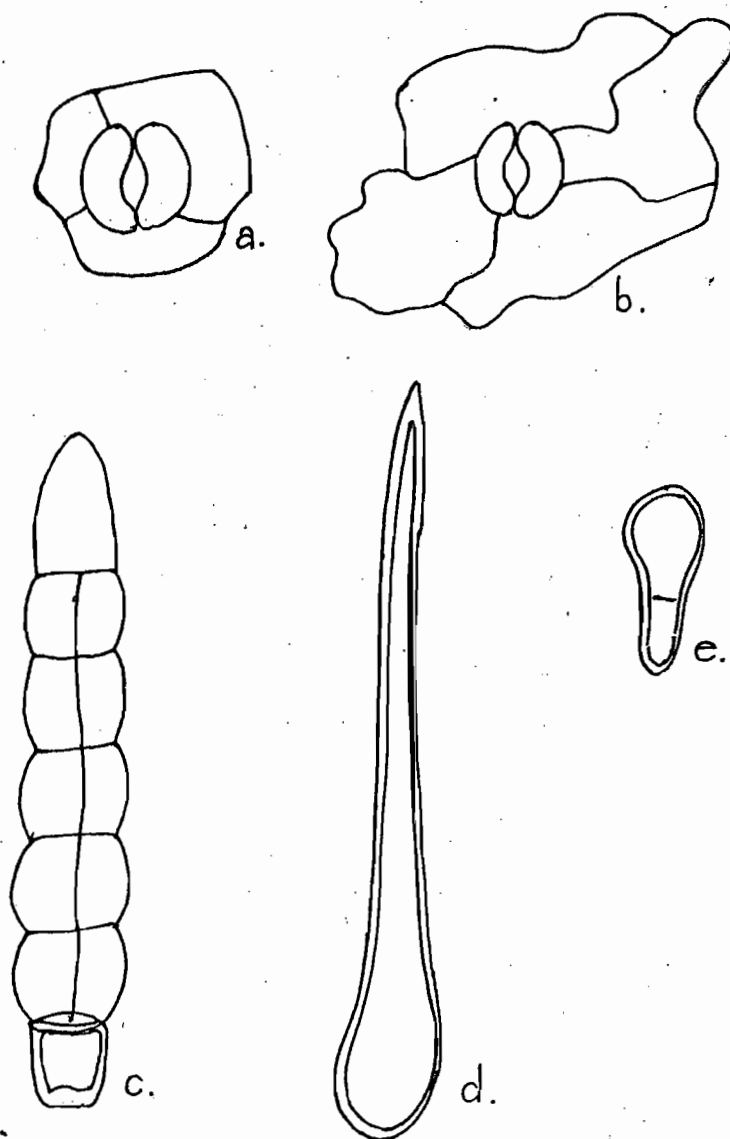


Fig. 63. *Kleinhovia hospita* L., a. anisocytic stomata, b. anomocytic stomata, c. multicellular glandular trichome differentiated into a multicellular biserial head with a single apical cell and a stalk of thick walled cell, d. unicellular trichome, e. 2-celled club shaped gland.

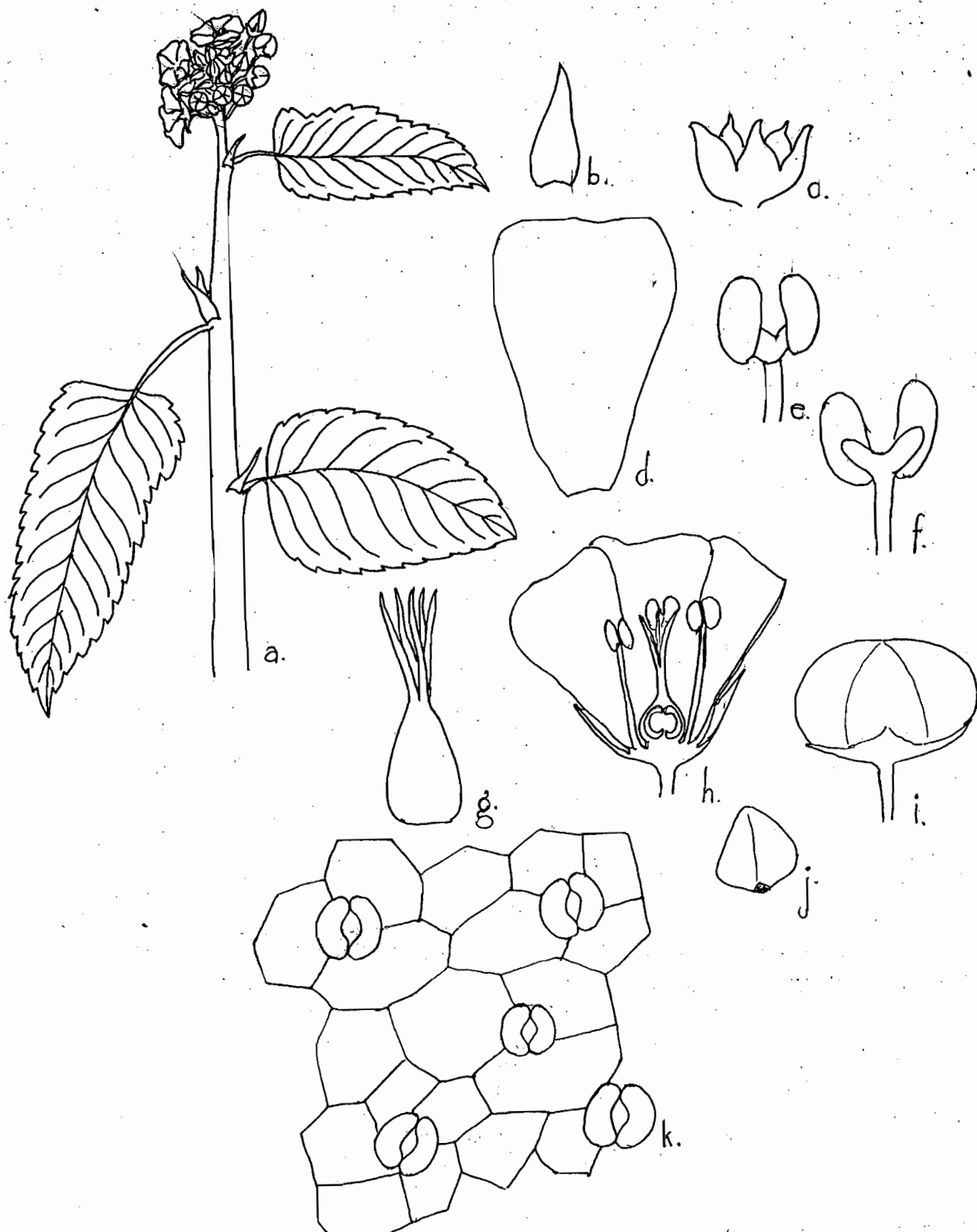


Fig. 64. *Riedleia corchorifolia* DC., a. habit, b. stipule, c. calyx, d. petal, e. stamen, f. stamen (back side), g. gynoecium, h. L.S. of flower, i. fruit, j. seed, k. anomocytic stomata.

Micromorphology (Fig. 64)

Whole plant was glabrous.

Stomata were of anomocytic.

D/488.

Tiliaceae

1. *Corchorus aestuans* L., *Syst. Nat.*, ed. 10. 2: 1079. 1759.

(*Corchorus acutangulus* Lam.)

A much branched annual. Leaves 2.5- 8 cm long, ovate, acute, serrate, the lower glabrous, base each side usually produced into filiform appendage, glabrous, base rounded; petioles long, slender, hairy; stipules lanceolate, acicular. Flowers small, in leaf-opposed cymes; bracts filiform; pedicels 2-3, short. Sepals linear-oblong, apiculate. Petals spatulate, a little longer than the sepals. Stamens 10. Gynoecium tricarpeal, trilobular with many ovules in axile placentation; style short; stigma hollow. Capsules 2-5 cm long, erect, stout, cylindric, truncate, 6-angled (3 of the angles winged); valves 3-4, spreading or recurved. Seeds truncate, dark brown. (Fig. 65)

Vernacular name: Chunch.

Flowers: August-November.

Micromorphology (Fig. 65)

Whole plant was more or less pubescent. Stem showed the presence of unicellular, acicular, non-glandular trichome with the rounded base embedded in epidermis. The wall of the trichome was thick and longitudinally striated. Leaf showed presence of glandular, multicellular trichome, distinctly differentiated into 4- 8 celled head and a single celled stalk.

Stomata were of three types: anisocytic, anomocytic, paracytic.

D/440, 1218, 1238.

2. *Corchorus capsularis* Linn. *Sp. Pl.* (1753) p. 529.

A very tall annual with glabrous stem and branches. Leaves lanceolate, 8-10 cm long, serrate, the lower serratures on each side usually prolonged into a filiform appendage, base rounded or acute; petioles reaching 4 cm long; stipules filiform. Flowers in short cymes; buds obovoid, apiculate. Sepals 5, obovate, acuminate. Petals 5, obovate, slightly clawed. Stamens numerous, anther cells oblong, dorsifixed. Ovary 5-celled, on a short torus, many ovules in each cell on axile placentation; style long, stigma 5. Capsules subglobose, not beaked, depressed, broader than long, ridged and muricated, 5-valved; valves woody, without transverse septa. Seeds few in each cell, wedge-shaped, smooth, brown. (Fig. 66)

Vernacular name: Chunch.

Flowers: September-November.

Micromorphology (Fig. 66)

Leaf showed presence of multicellular, glandular trichome which was differentiated into a 4-6 celled head and a unicellular stalk. The cells of head were arranged in two

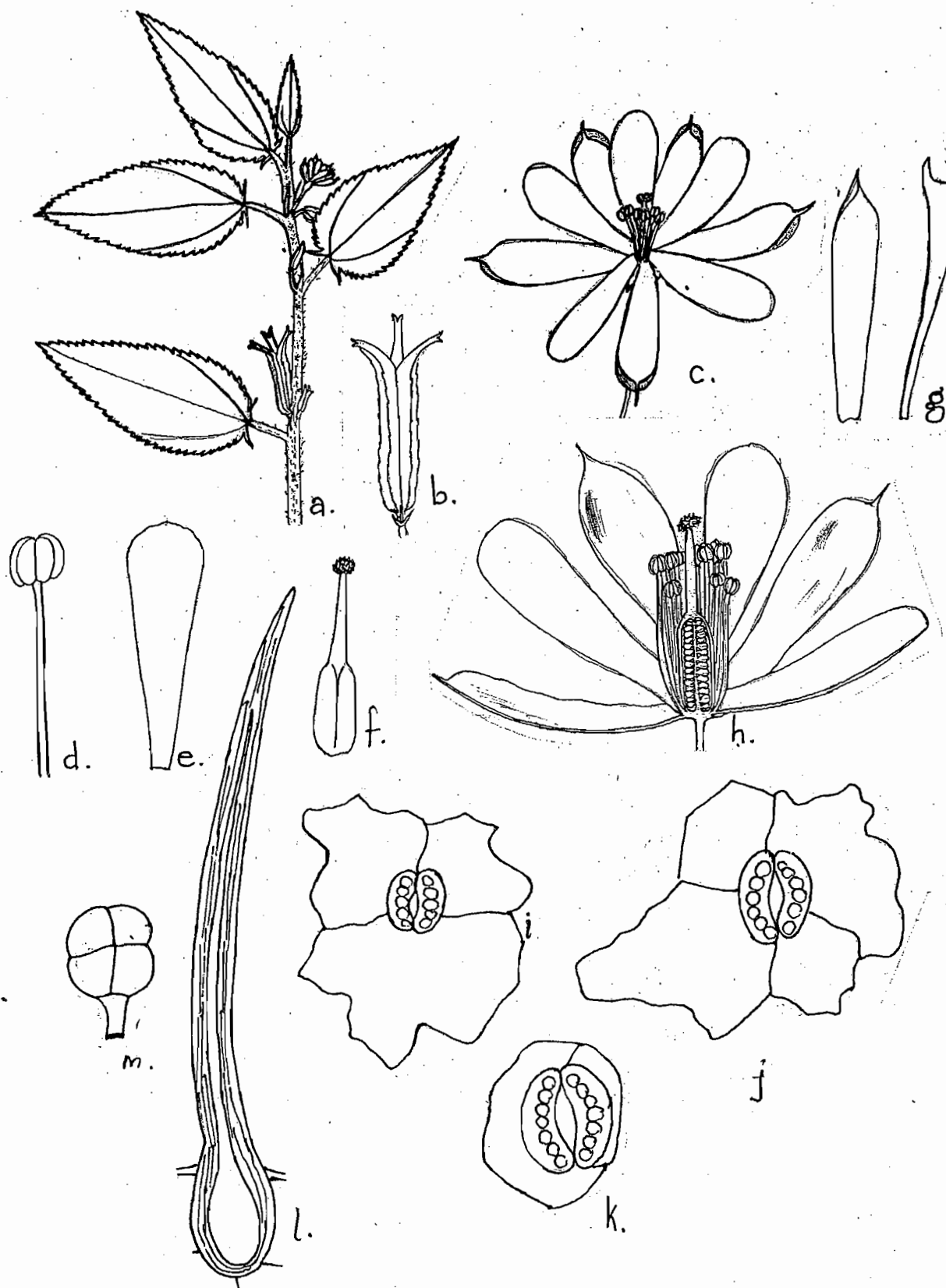


Fig. 65. *Corchorus aestuans* L., a. habit, b. fruit, c. flower, d. stamen, e. petal, f. gynoecium, g. sepal (side view), h. L.S. of flower, i. anisocytic stomata, j. tetracytic stomata, k. oblique paracytic stomata, l. unicellular trichome with striated thick wall, m. multicellular gland with 4-celled head and a single celled stalk.

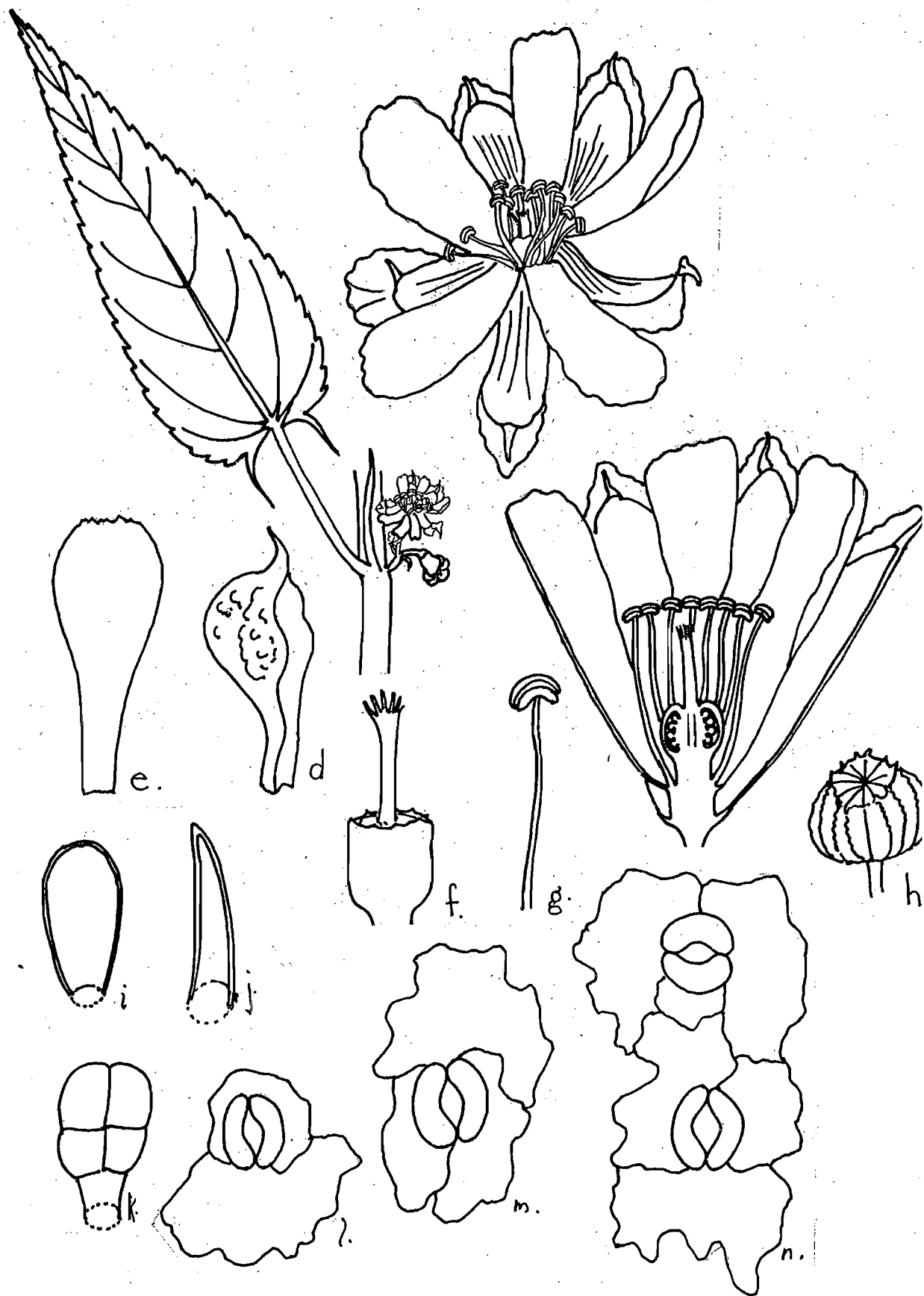


Fig. 66. *Corchorus capsularis* L., a. habit, b. flower, c. L.S. of flower, d. sepal, e. petal, f. calyx with gynoecium, g. stamen, h. capsule, i. unicellular club shaped glandular trichome, j. unicellular conical trichome, k. multicellular glandular trichome with 4-cells head and a single celled stalk, l. diacytic stomata, m. anisocytic stomata, n. anomocytic stomata.

tiers. Sepals contain unicellular, elongated pointed trichomes on the outside and unicellular sepaline nectaries on the inner side.

Stomata were of anomocytic, anisocytic, and diacytic types of which the first type was more common.

D/369.

3. *Corchorus olitorius* Linn. Mantiss. (1767) p. 77.

A branched more or less hairy annual. Leaves 2.5-10 cm long, elliptic or oblong-lanceolate, acute or obtuse, serrate (the lower serratures often destitute of filiform appendages); stipules lanceolate-subulate. Flowers in short cymes; buds ovoid or obovoid apiculate; bracts lanceolate-subulate, hairy. Sepals linear-oblong, acuminate. Petals oblong, slightly longer than the sepals. Capsules 5-8 cm long, with a short erect beak, hairy when young with stiff stellate hairs, scabrous when old, 3-4 angled, 3-4 valved; valves with transverse partitions between the seeds. Seeds trigonous, black. (Fig. 67)

Vernacular name: Kagagisodo

Flowers: September-November.

Micromorphology (Fig. 68)

Leaf showed presence of multicellular, glandular trichome which was differentiated into a multicellular 6-8 celled head and a unicellular stalk. The cells in head were arranged in 2-3 tiers.

Stomata were of anomocytic and anisocytic type. Among these anomocytic types of stomata were in majority.

D/720-721.

4. *Corchorus trilocularis* Linn. Mantiss. (1767) p. 77.

An annual with more or less hairy stem and branches. Leaves 2.5- 10 cm, elliptic or oblong-lanceolate, acute or obtuse, serrate (the lower serratures often destitute of filiform appendages), somewhat rough below, base rounded or cuneate; petioles pilose; stipules lanceolate-subulate. Flowers in short cymes; buds ovoid or obovoid apiculate; bracts lanceolate-subulate; peduncles very short, leaf-opposed, hairy; pedicels very short, pubescent; sepals linear-oblong, acuminate. Petals oblong, slightly longer than the sepals. Stamens numerous, anthers dorsifixed. Capsules cylindrical, upto 5-6 cm long, with a short erect beak, glabrous, 3-4 valved; valves with transverse partitions between the seeds. Seeds 4 angled, black, truncate at both the ends. (Fig. 69)

Variations observed: in floras capsules is said to be three-four angled, and hairy when young with stiff stellate hairs. Seeds were described as trigonous. In my specimen, capsule was found to be cylindrical (not 3-4 angled) and seeds were truncate at both ends.

Vernacular name: Ubhi munderi.

Flowers: October-February.

Micromorphology (Fig. 70)

Whole plant was glabrous except leaves. The leaf showed presence of multicellular, glandular trichome, which was differentiated into a multicellular head and a single celled stalk. The cells of head were arranged in 3-4 tiers wherein each tier consisted of two cells.

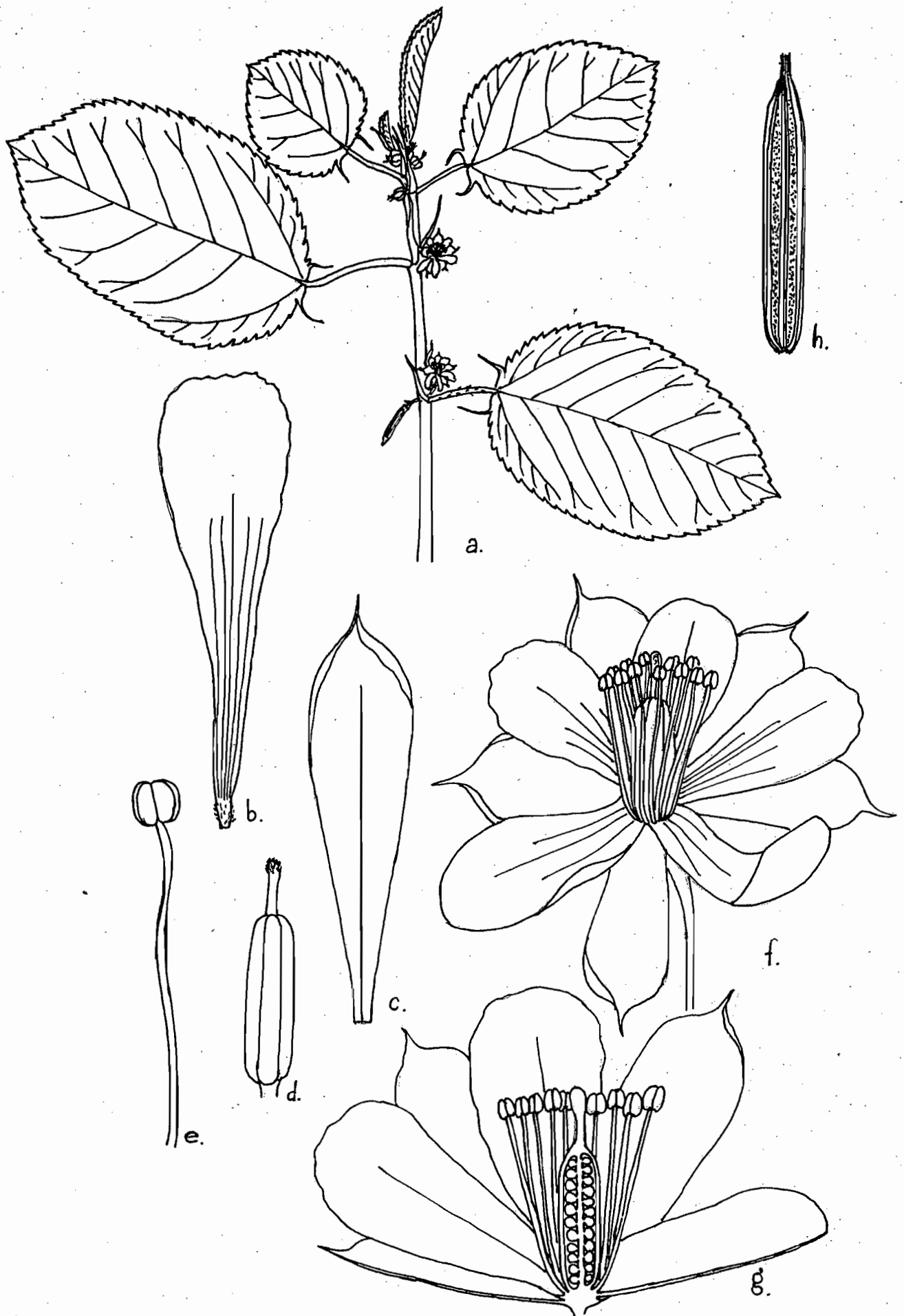


Fig. 67. *Corchorus olitorius* L., a. habit, b. petal, c. sepal, d. gynoecium, e. stamen, f. flower, g. L.S. of flower.

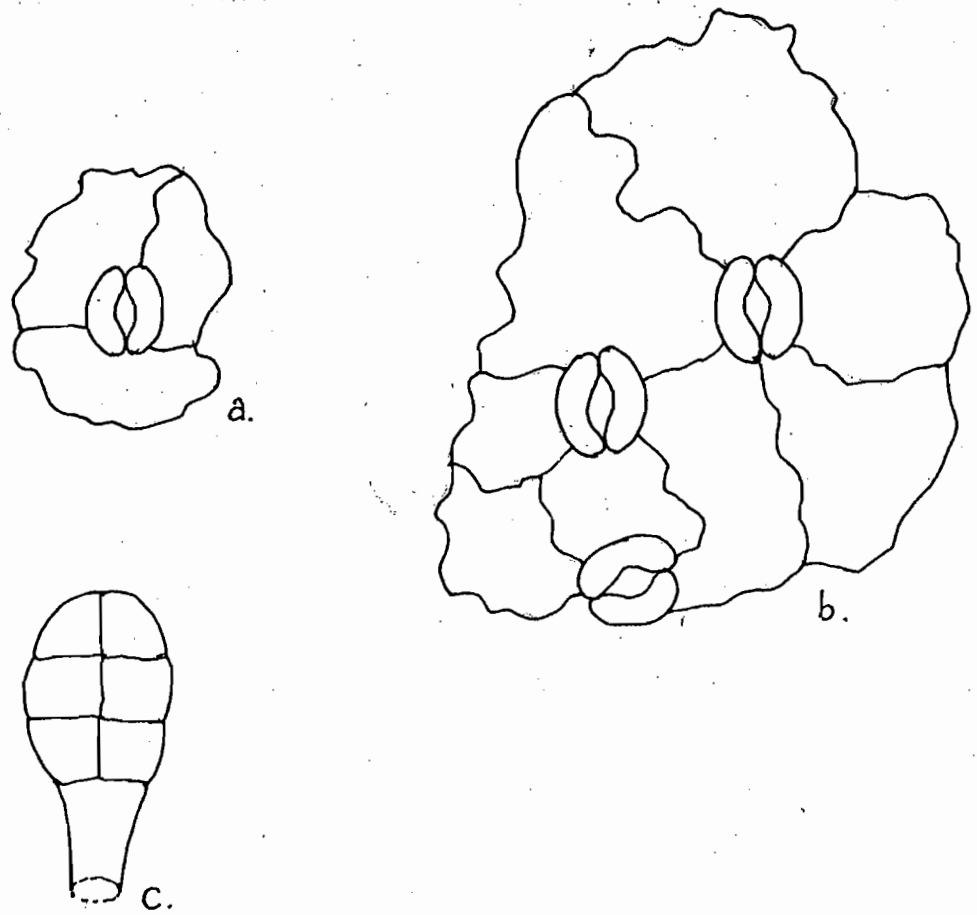


Fig. 68. *Corchorus olitorius* L., a. anisocytic stomata, b. anomocytic stomata c. multicellular glandular trichome having a head of 3-tiers of 4-cells each and a single celled stalk.

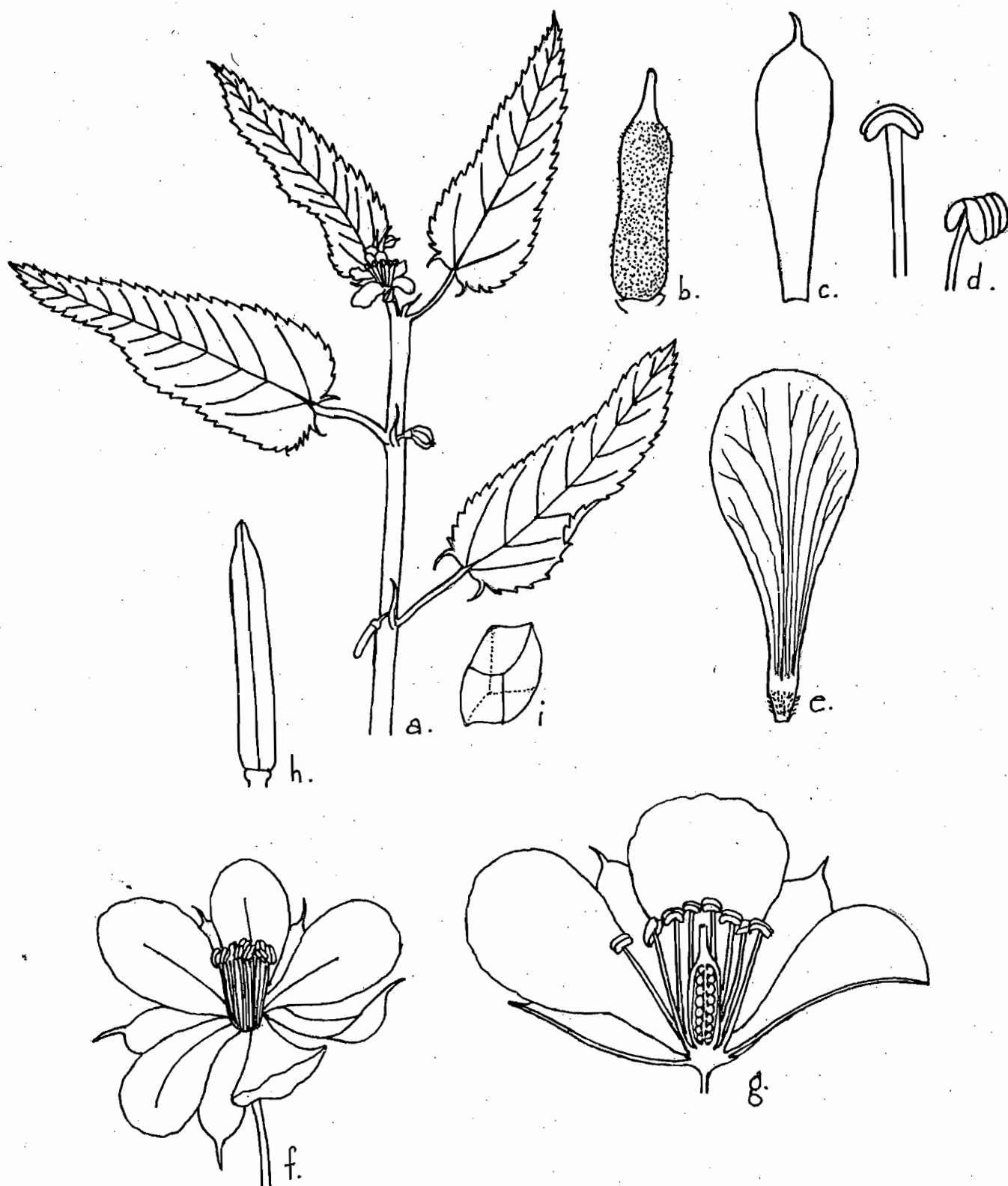


Fig. 69. *Corchorus trilocularis* L., a. habit, b. gynoeceium, c. sepal, d. stamen, e. petal, f. flower, g. L.S. of flower, h. capsule, i. seed.

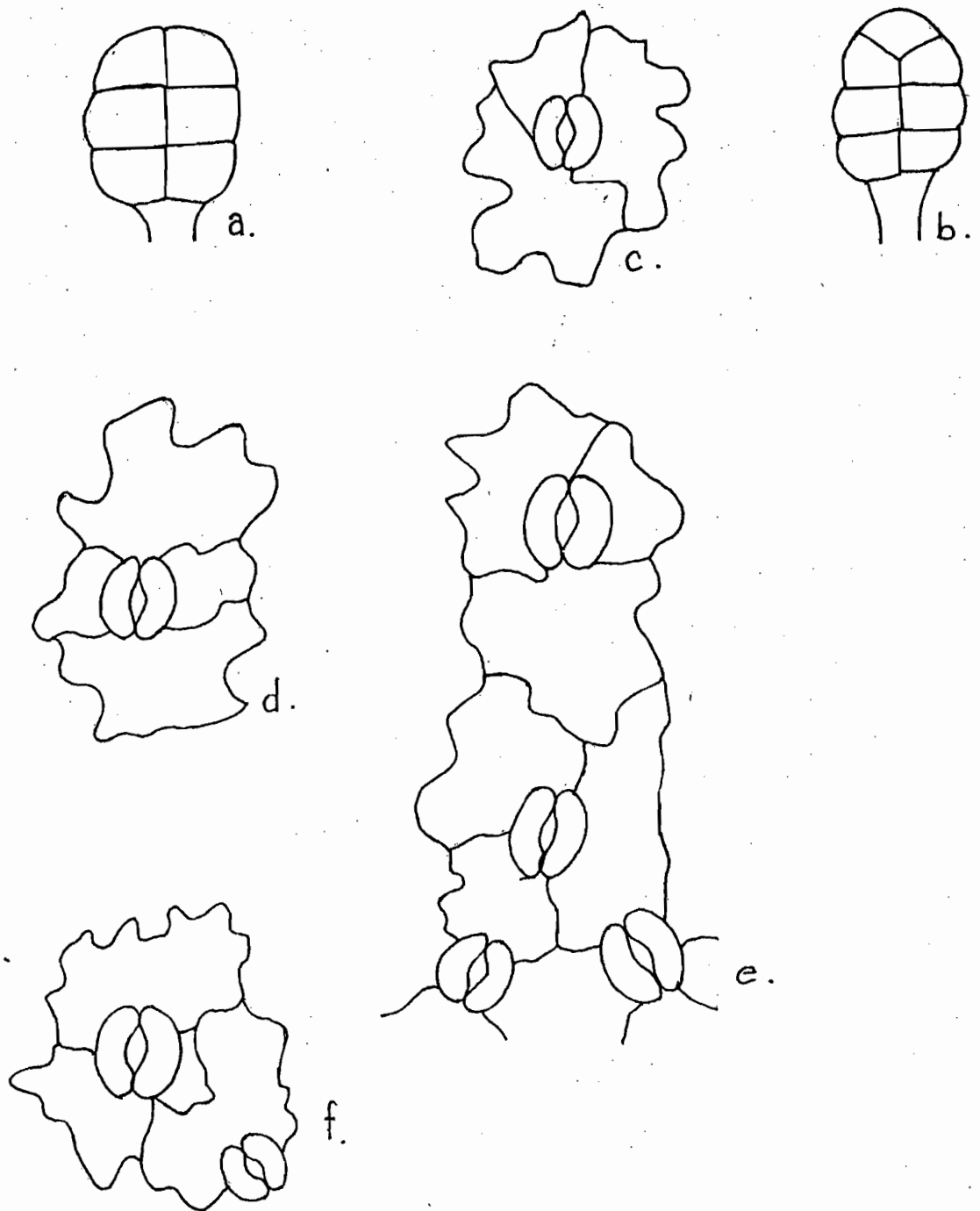


Fig. 70. *Corchorus trilocularis* L., a. multicellular glandular trichome having a head of 3-tiers of 4-cells each and a single celled stalk, b. a trichome similar to the previous one but with an apical cell, c & f. anisocytic stomata, d. tetracytic stomata e. anomocytic stomata.

Though stomata were of anomocytic, anisocytic, tetracytic types, the former two were most common.

D/718-719, 966.

5. *Grewia salvifolia* Heyne, ex. Roth, *Nov. Pl. Sp.* p. 239 (1821).

A small tree, 2-3 m high with hoary-pubescent branches. Leaves 4-6 cm long ovate-oblong or lanceolate, 3-nerved, minutely serrate or subentire, hoary-tomentose; stipules 1 cm long, subulate. Flowers in small umbels; buds ovoid-oblong, striate; peduncles 1-3, less than 1 cm long; pedicels usually 3 on each peduncle, stellately tomentose, thickened at the top; bracts lanceolate. Sepals 5 distinct, linear-oblong. Petals 5, usually with a gland at the base within, yellow, more or less acute, divided at the tip to unequal halves, gland hairy, one-fourth the length of the petal. Torus short, glabrous except at the apex beneath the ovary; style exceeding the stamens; stigma 4-lobed, lobes deflexed. Drupes 1 cm across, sparsely pubescent, 1-4 (usually 2-) lobed. (Fig. 71)

Variations observed: in floras, the petal were reported to be obtuse and notched, the gland at the base of the petal reach at one-third of the petal. But, the plant I have dissected, the petals were more or less acute, divided at the tip to unequal halves. The gland was shorter and reached only one-fourth the length of the petal.

Vernacular name: Sisoti.

Flowers: June-August.

Micromorphology (Fig. 72)

Whole plants showed presence of stellate hairs.

Stomata are of four types: diacytic, anisocytic, anomocytic and cyclocytic.

D/399-400, 800- 802, 804.

6. *Triumfetta pentandra* A. Rich. in Guill. & Perr., *Fl. Senegamb. Tent.* 1:93.t.19. (1831)

An erect branched annual herb with stellate hairs on stem. Basal leaves rhomboid-ovate, palmately 3-lobed, terminal ones ovate-lanceolate, acuminate-acute, and unequally coarsely serrate. Cymes antiphyllous. Flowers small, 3mm, yellow sepals lorate, cuculate, and awned at the apex. Petals spatulate obtuse. Stamens 5, rarely upto 10. Carpels 2; ovary oblong, 2-loculed, hairy, stigma 4-lobed. Capsule oblong, densely tomentose with uncinat spines. (Fig. 73)

Vernacular name: Zipti.

Flowering season: September-January.

Micromorphology (Fig. 74)

Glandular and non-glandular two types of trichomes were present in the plant. Single celled, sessile gland and 2-3 celled glands differentiated into single celled head or 2-celled head and a single celled stalk were included among the glandular one. The non-glandular trichome showed presence of 4-armed stellate hair and acicular unicellular trichome.

D/487, 736, 856, 993-994.

7. *Triumfetta rotundifolia* Lam. *Encyc. V.* 3 (1789) p. 421.

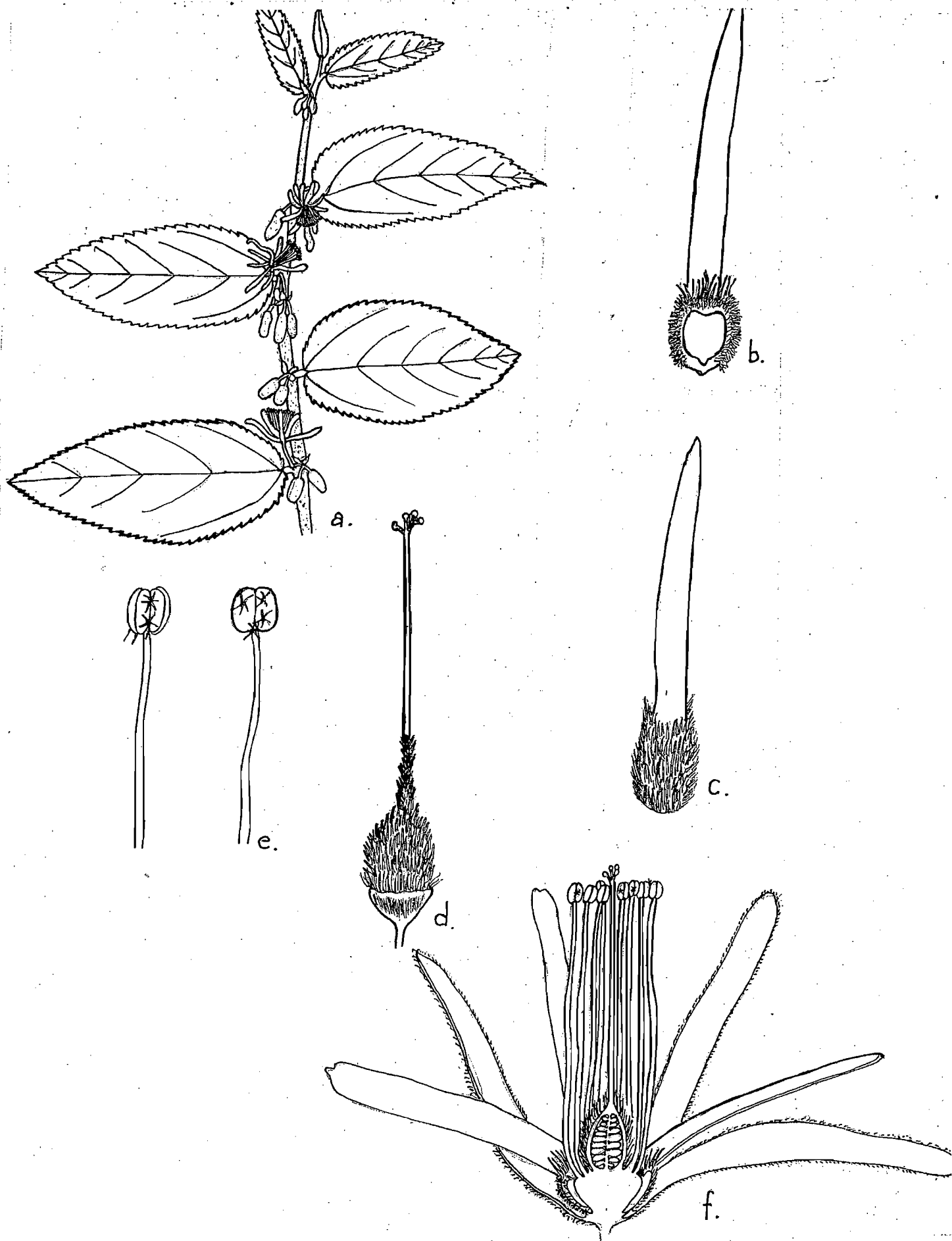


Fig. 71. *Grewia salvifolia* Heyne ex Roth., a. habit, b. petal (inner side), c. petal (outer side), d. gynoecium, e. stamen, f. L.S. of flower.

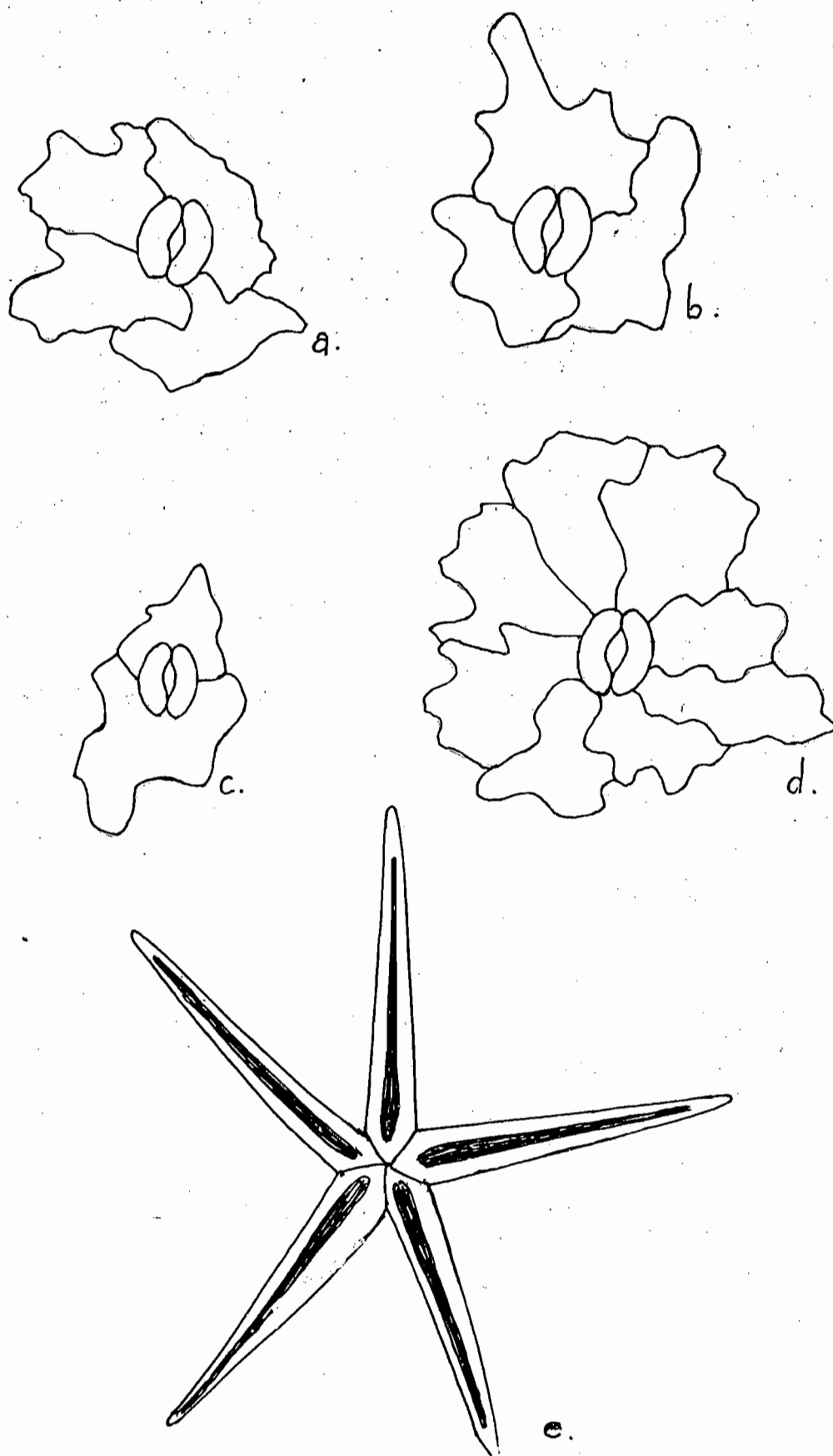


Fig. 72. *Grewia salvifolia* Heyne ex Roth., a. tetracytic stomata, b. anisocytic stomata, c. diacytic stomata, d. cyclocytic stomata, e. stellate hairs with 5-arms.

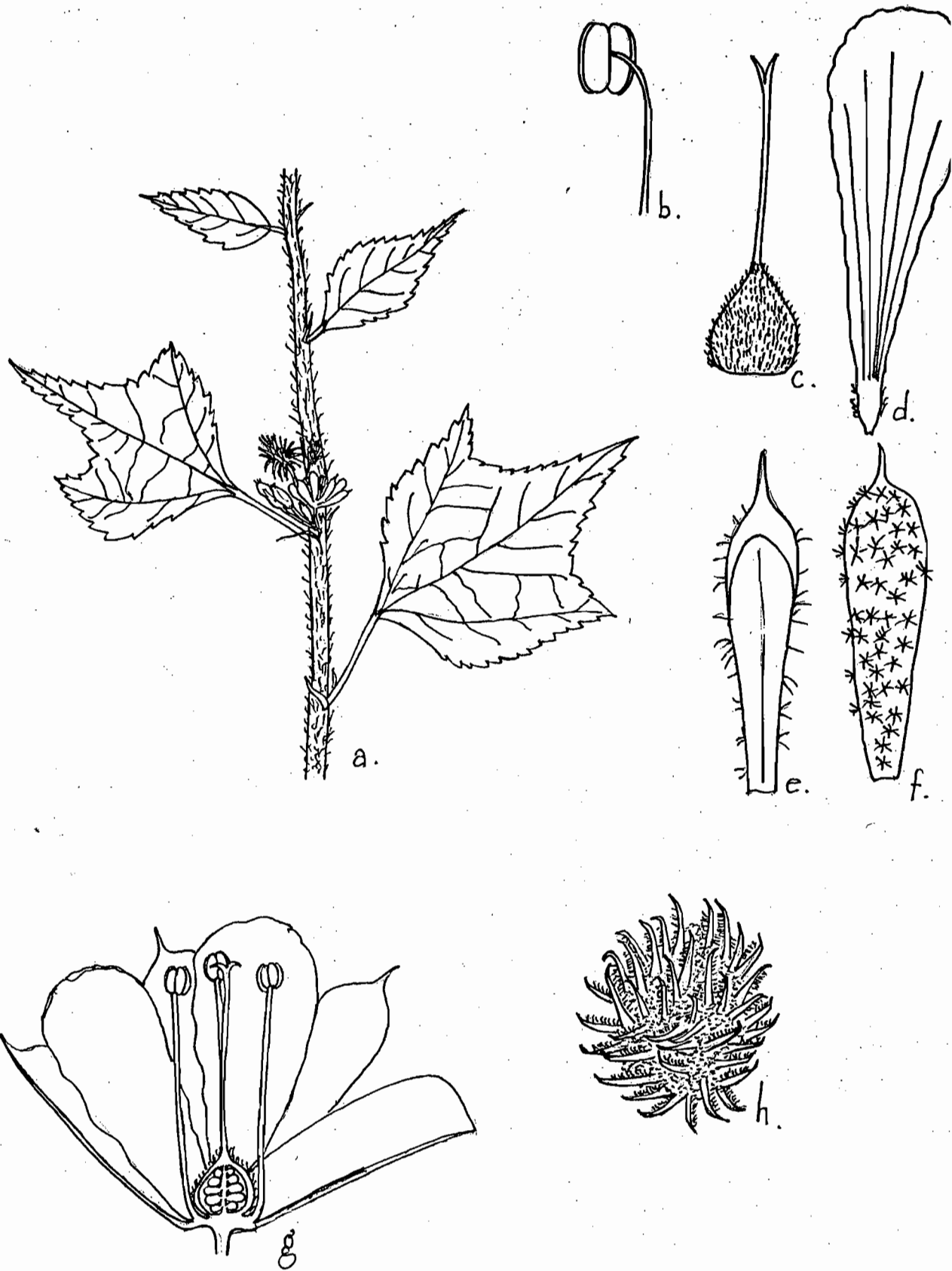


Fig. 73. *Triumfetta pentandra* A. Rich., a. habit, b. stamen, c. gynoecium, d. petal. e. sepal (inner side), f. sepal (outer side), g. L.S. of flower, h. fruit.

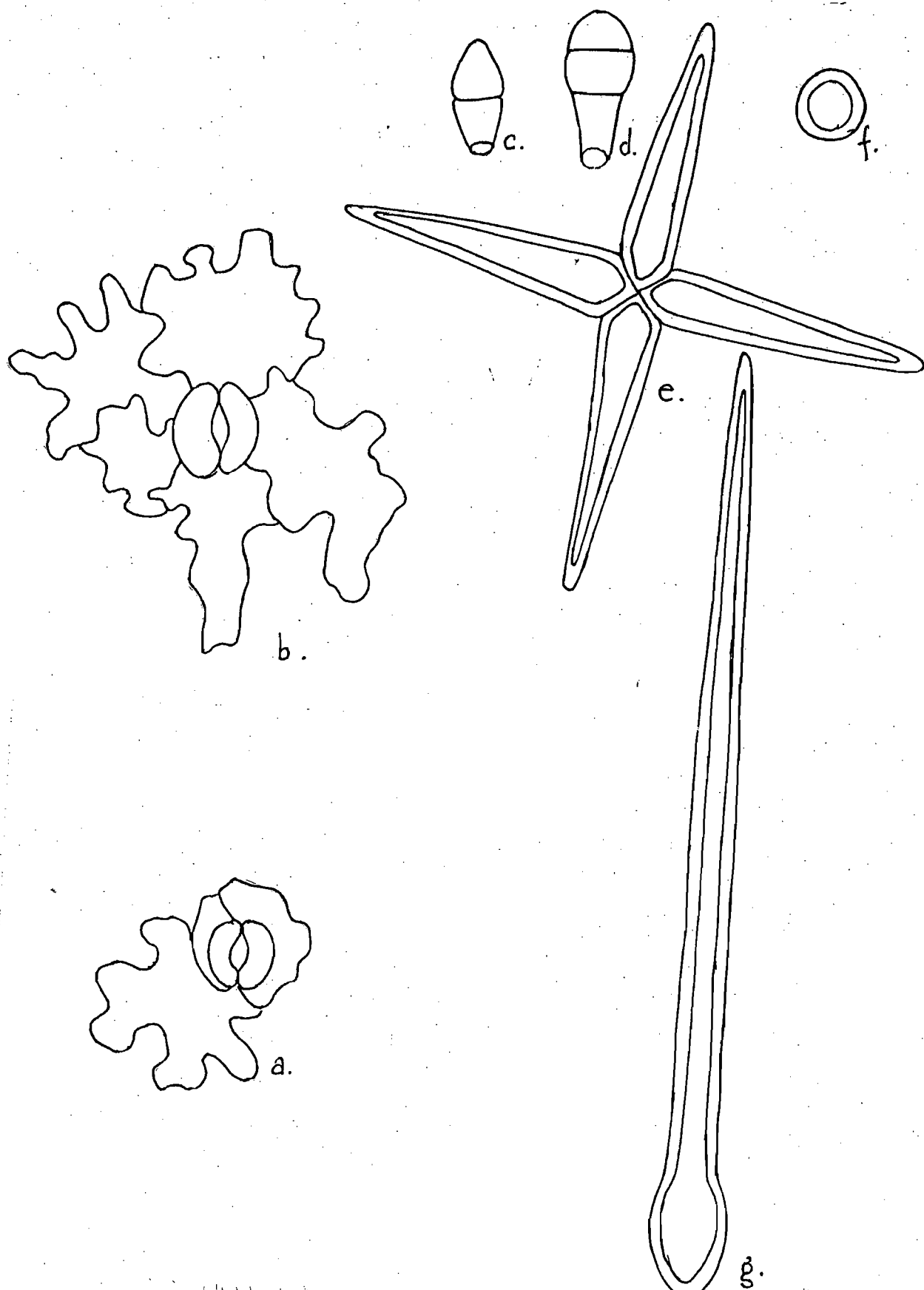


Fig. 74. *Triumfetta pentandra* A. Rich., a. anisocytic stomata, b. anomocytic stomata, c. two-celled gland, d. multicellular gland with two-celled head and a single celled stalk, e. stellate hair with 4-arms, f. single celled gland, g. unicellular acicular trichome.

Suffructicose herb with stellate pubescence. Leaves orbicular, 2-4 cm in diameter, irregularly toothed, glabrous or stellately hairy above, softly grey-tomentose beneath, base rounded or cuneate, 3-5 nerved; stipules subulate. Flowers small, in interrupted racemes; buds oblong, clavate, 5-pointed, grey-tomentose. Sepals linear-oblong, apiculate, stellately pubescent outside. Petals a little shorter than the sepals, obovate, ciliate at the base. Stamens 15-25, inserted on a glandular torus, free, anthers basifixed. Ovary 5-celled; hairy. Fruit ovoid, pubescent beneath the spines; spines dilated at the base, pubescent, the bristle points hooked, transparent. (Fig. 75)

Vernacular name: Zipto.

Flowers: August-February.

Micromorphology (Fig. 76)

Whole plant was pubescent with stellate hairs and unicellular trichomes. Stellate trichomes were present on the stem and leaf whereas unicellular trichomes, which were elongated, thick walled and non-glandular, were present on the leaves and petals. In addition a multicellular, glandular type of trichome was present on the leaf. This was biserial, differentiated into an elongated almost oblong head and a small stalk. The cells here were thick walled.

Though three types of stomata, diacytic, anisocytic and tetracytic types were present, the anomocytic type of stomata was commonly seen. The presence of sister stomata was another feature seen here.

D/674, 984-985.

Malpighiaceae

1. *Tristellateia australasiae* A. Rich. in *Dumont d'Urville, Voy. Astrolabe*. 2: 159. 1834.

A shrub with dark brown bark. Leaves opposite, superposed, elliptic-oblong, acute-obtuse. Flowers in terminal or axillary racemes. Flowers yellow, hermaphrodite. Sepals 5, distinct, with an unequal two subulate glands on each sepal. Petals 5, clawed, crumpled in bud, distinct. Stamens 10, anthers oblong, filaments broad, connective swollen, in some of the stamens one of the anther cell was aborted. Ovary hairy, raised on short torus, 3 celled, single ovule in each cell on axile placentation, style 3, stigma clavate. (Fig. 77)

Flowers: December-February.

Micromorphology (Fig. 78)

Whole plant, except leaves, was glabrous. The leaf showed presence of medifixed hairs. The surface of medifixed hair was wavy.

Stomata were anomocytic.

D/129, 663, 995.

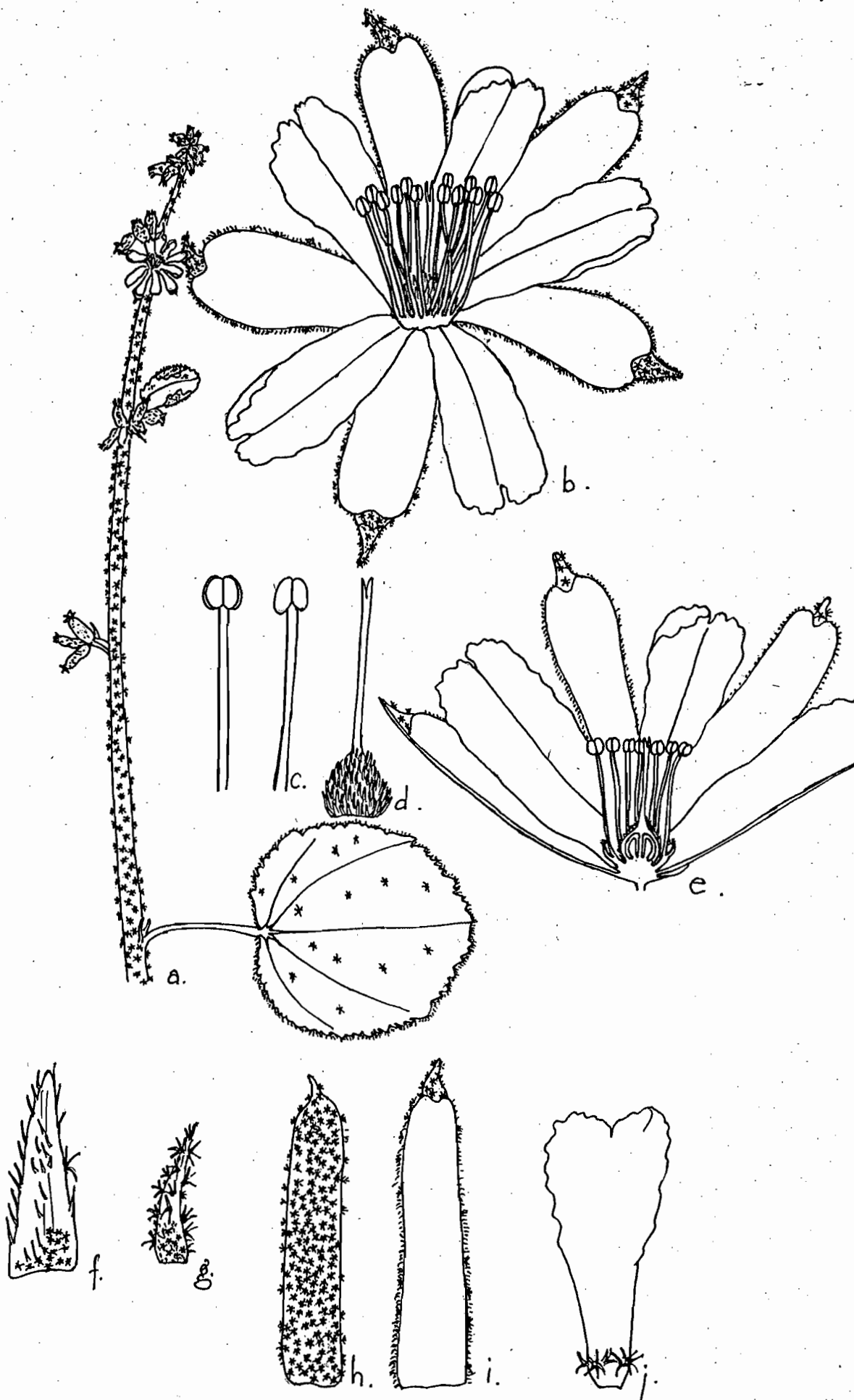


Fig. 75. *Triumfetta rotundifolia* Lam., a. habit, b. flower, c. L.S. of flower, d. gynoecium, e. L.S. of flower, f. stipule, g. bract, h. sepal (outer side), i. sepal (inner side) j. petal with a notch.

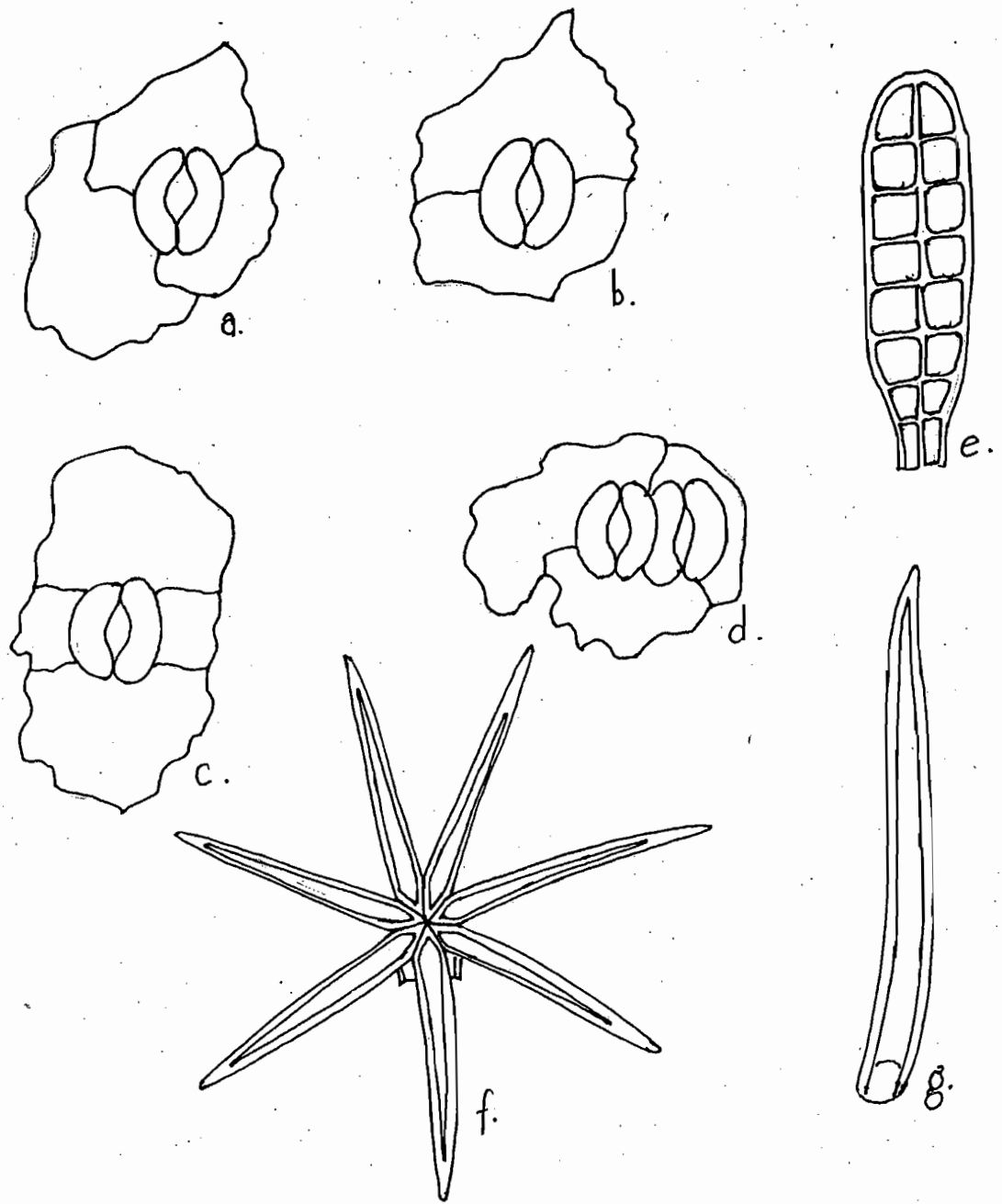


Fig. 76. *Triumfetta rotundifolia* Lam., a. anisocytic stomata b. diacytic stomata c. tetracytic stomata, d. sister stomata e. multicellular glandular trichome differentiated into multicellular biserial head and a biserial stalk, f. stellate hairs with 7 arms, g. unicellular trichome with broad lumen and pointed tip.

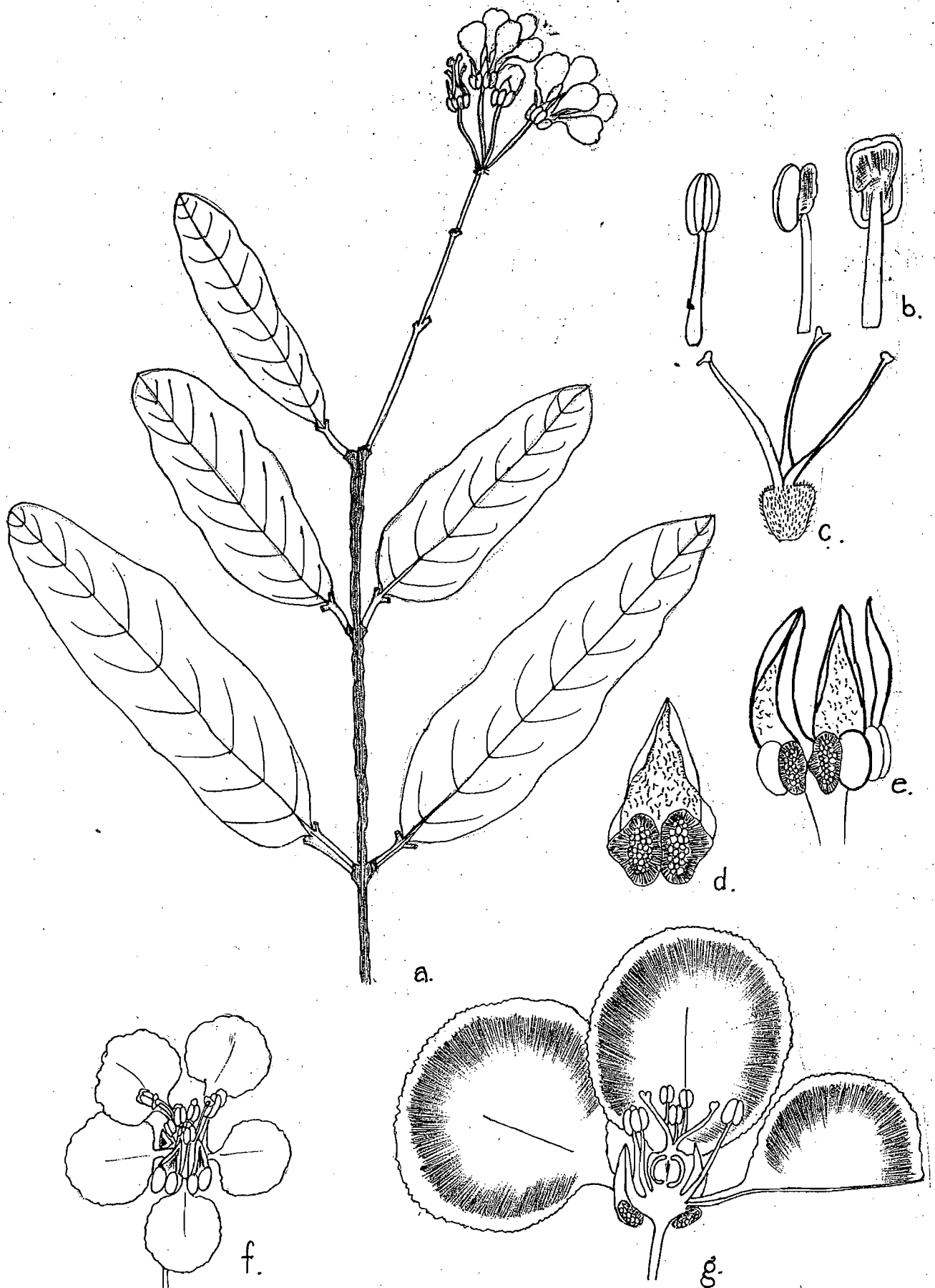


Fig. 77. *Tristellateia australasiae* A. Rich., a. habit, b. stamen, c. gynoecium, d. sepal with two subulate glands at the base, e. calyx, f. flower, g. L.S. of flower.

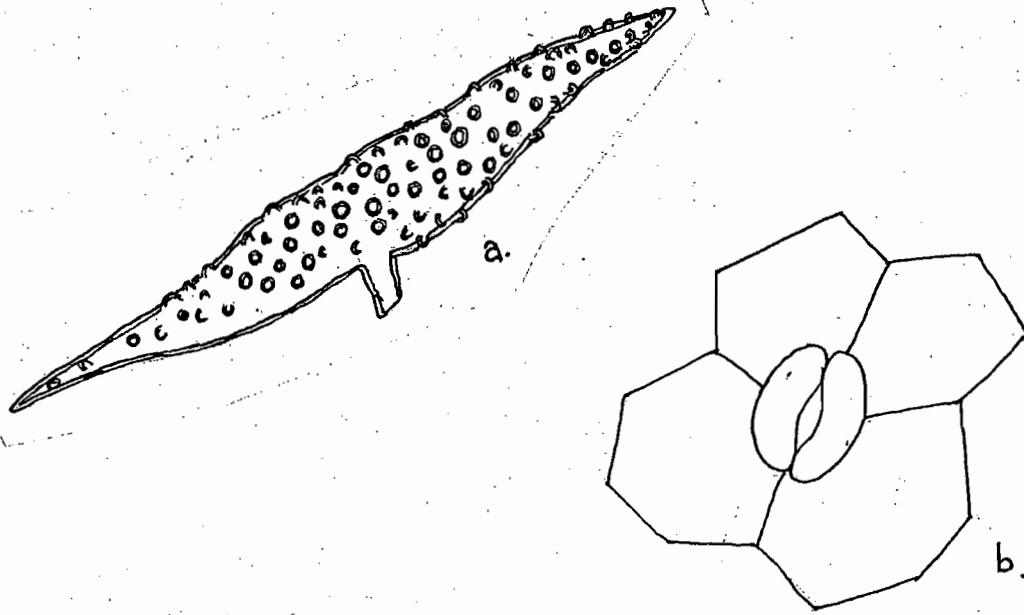


Fig. 78. *Tristellateia australasiae* A. Rich., a. medifixed warty hair, b. tetracytic stomata.

Zygophyllaceae

1. *Tribulus rajasthanensis* Bhandari et Sharma in *Bot. Notiser*, 129 : 367. 1976.

A diffusely prostrate perennial herb with many stems from a woody rootstock. Leaves 2-5 cm long, opposite, always unequal at the node. Leaflets oblong-ovate, petiolulate, oblique, mucronulate, densely pubescent beneath. Stipules falcate, persistent. Flowers yellow. Peduncle upto 9 cm long, pubescent. Sepals linear-lanceolate, villous. Petals broadly obovate-cuneate. Stamens 8-10; anthers ovate-oblong. Ovary with bulbous-based bristly hairs directed upwards. Style cylindrical. Stigma pyramidal. Interstaminal glands not connate. Extrastaminal glands round. Fruit breaking up into 5 cocci, each with two, divergent spines inserted almost centrally, and with 20-25 unequal, smaller secondary ones, crested as well as dispersed at the back and often reaching half the length of the main spines; every spine terminated by a tuberculate bristle much longer than the spine itself. (Fig. 79)

Vernacular name: Gokhru.

Flowers throughout the year.

Micromorphology (Fig. 80)

Whole plant was pubescent. Almost all the parts of the plant showed presence of unicellular, non-glandular, and elongated trichome with rounded base, and thick wavy walls. Same type of trichome was present on the ovary as well.

Three types of stomata were present on the leaf. Anomocytic, anisocytic and tetracytic; anomocytic being most common type of the stomata observed in this plant.

D/1056.

2. *Tribulus terrestris* Linn. *Sp. Pl.* (1753) p. 387.

A procumbent herb with pilose stems and branches, young parts silky-villose. Leaves stipulate, opposite, pinnate, one of each pair usually smaller than the other, hairy; stipules lanceolate; leaflets 3-6 pairs, oblong, mucronate, base rounded oblique; petiolules short, pilose. Flowers yellow, axillary, solitary. Sepals lanceolate. Petals oblong-obovate; claw short. Disk 5-lobed. Stamens 10, inserted on the base of the disc, the longer opposite to the petals, the 5 shorter with a small gland outside; anthers oblong, basifixed. Ovary bristly; style short, stout, stigmatic lobes large. Fruit globose, consisting of 5 hairy, often muriculate woody cocci, each with 2 pairs of hard sharp spines, one pair longer than the other. Seeds several in each coccus, with transverse partitions between them. (Fig. 81)

Vernacular name: Bethu.

Flowers throughout the year.

Micromorphology (Fig. 82)

Whole plant was pilose. The stems and leaves showed the presence of unicellular, non-glandular, elongated, somewhat thin walled, trichome with a round base. The sepals and ovary showed the same trichome but here the base of the trichome was embedded in epidermal cells of the ovary walls.

Stomata were of anomocytic type.

D/733.

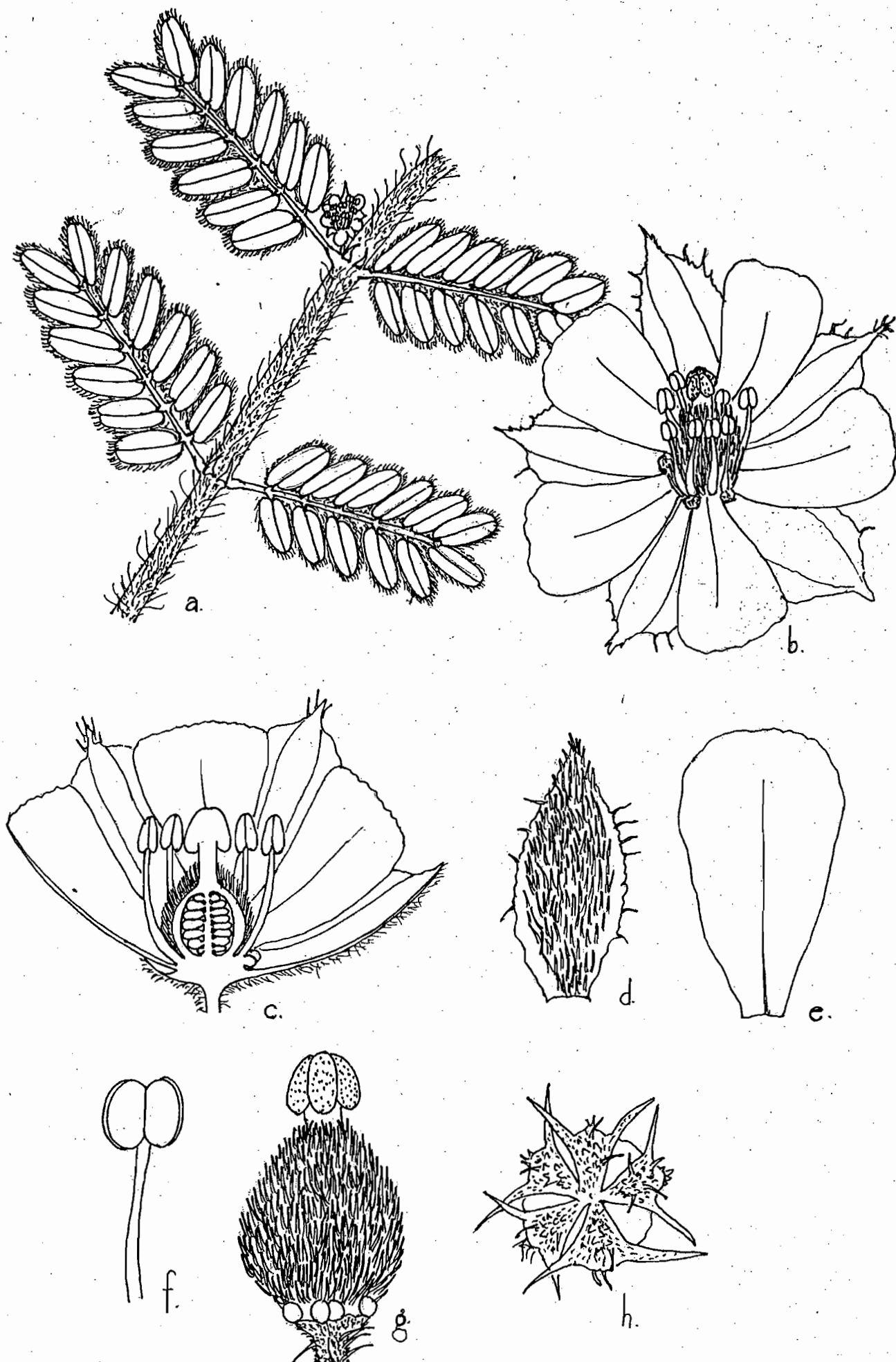


Fig. 79. *Tribulus rajasthanensis* Bhandari., a. habit, b. flower, c. L.S. of flower, d. sepal, e. petal, f. stamen, g. gynoeceium, h. capsule.

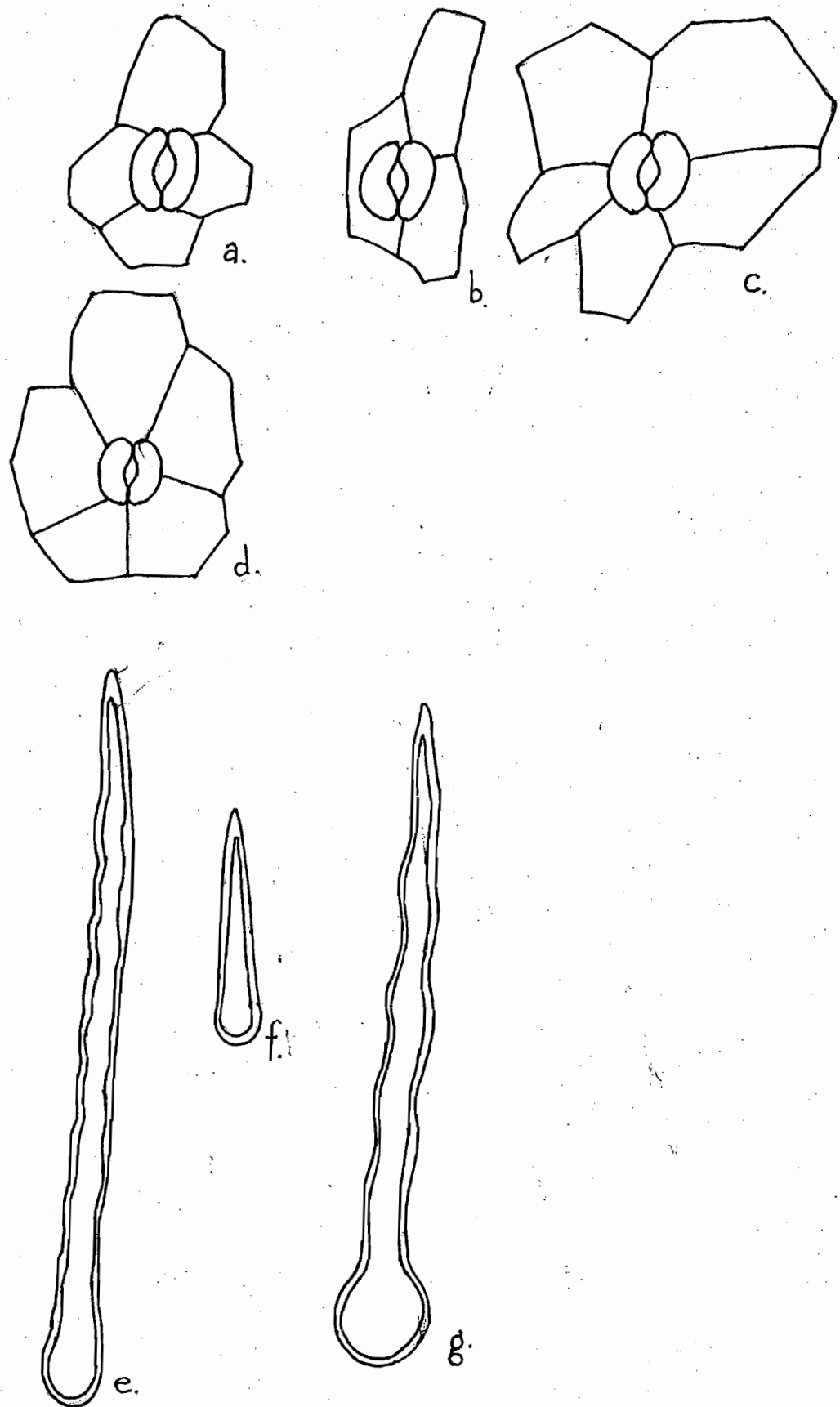


Fig. 80. *Tribulus rajasthanensis* Bhandari., a. tetracytic stomata, b. anisocytic stomata, c & d. anomocytic stomata, e & g. unicellular trichome with thick wall, broad lumen and round base, f. unicellular conical trichome.

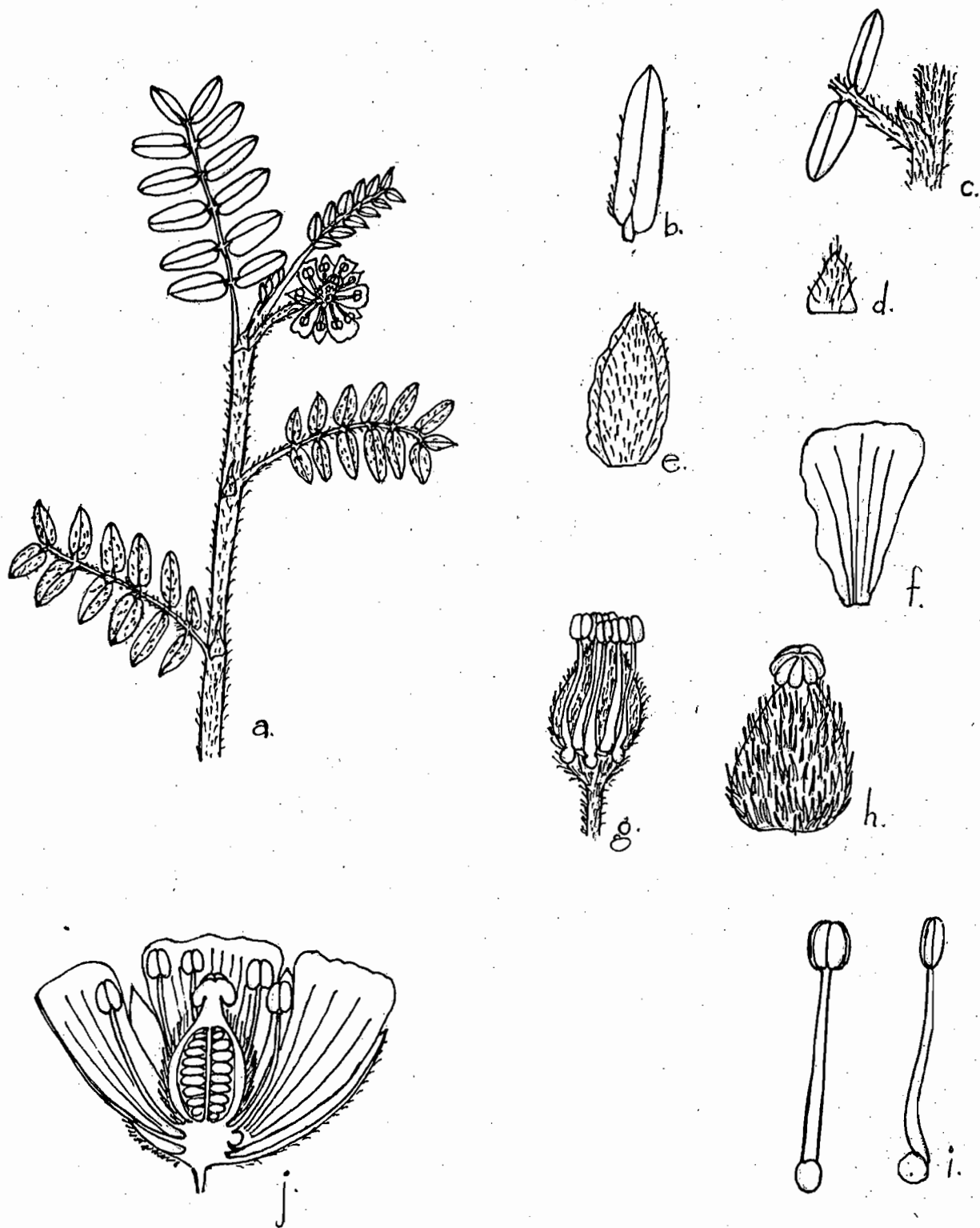


Fig. 81. *Tribulus terrestris* L., a. habit, b. leaf, c. stipule, d. bract, e. sepal, f. petal, g. stamen with disc and gynoecium, h. gynoecium, i. stamen with disc at the base, j. L.S. of flower.

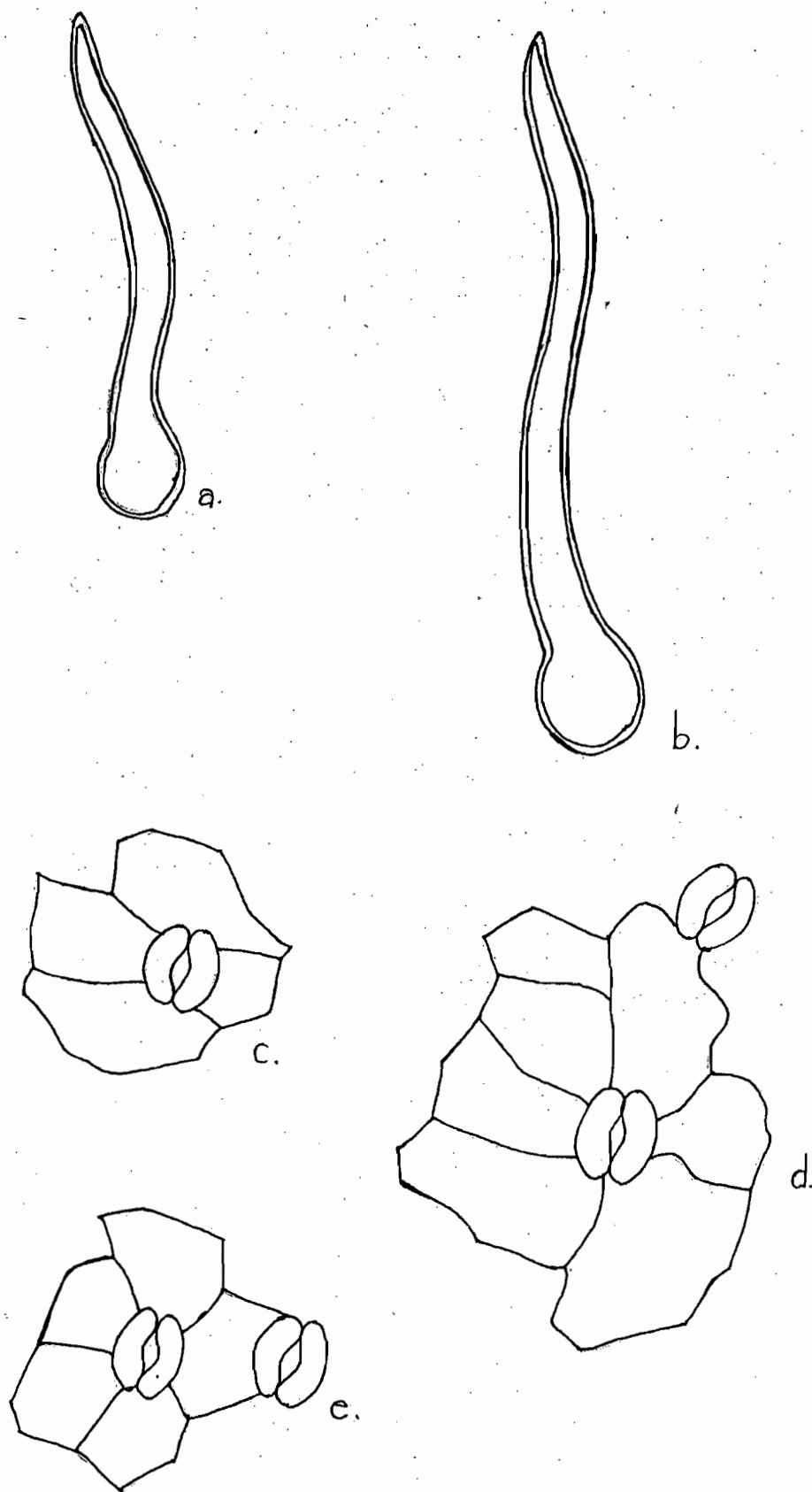


Fig. 82. *Tribulus terrestris* L., a & b. unicellular trichome with broad lumen c. tetracytic stomata, d & e. anomocytic stomata.

Geraniaceae

1. *Averrhoa carambola* Linn. *Sp. Pl.* (1753) p. 428.

A small tree with close drooping branches. Leaves alternate with 5-11 leaflets upto 7 cm. long, ovate-oblong, acuminate, entire, glabrous, or pubescent above, glaucous and glabrous beneath, base oblique, acute; petiolules short, stout, pubescent. Flowers in short racemes chiefly axillary or sometimes springing from the bark. Sepals 5, imbricate, glabrous. Petals 5, more than twice as long as the sepals, oblong-obovate, variegated white and purple. Stamens 10, of which 5 are shorter and without anthers, or sometimes 1 or 2 of these longer and antheriferous; filaments dilated at the base. Ovary 5 lobed, 5-celled; ovules numerous; styles 5, distinct; stigma capitate. Fruit oblong, acutely angled, yellow. Seeds arillate. (Fig. 83)

Vernacular name: Karmara.

Flowers: May-August.

Micromorphology (Fig. 83)

Leaf showed unicellular, non glandular, short, thick walled trichome with a narrow lumen. Petal contained glandular trichome differentiated into a 3-4 celled head and a multicellular uniseriate stalk.

Stomata were of anomocytic, tetracytic and anisocytic. Among these anomocytic were in majority.

D/313.

2. *Biophytum sensitivum* DC. *Prod. V.* 1 (1824) p. 690.

An erect annual with leaves sensitive to stimulus, crowded into a rosette on the top of the stem 4-8 cm long; petiole short; rhachis slender, glabrous or hairy; leaflets opposite, 1 cm long, 6-15 pairs (the terminal pair the largest, the pairs becoming smaller downwards), oblong, obliquely rounded and apiculate at the apex, subsessile, glabrous, paler beneath. Flowers yellow; peduncles many, up to 10 cm long, slender; pedicels many; bracts lanceolate, small, crowded beneath the pedicels. Sepals 5, imbricate, lanceolate, acute, with parallel nerves. Corolla much exceeding the sepals; petals 5, connate into a salver-shaped corolla, lobes rounded, spreading. Stamens 10, distinct; anthers oblong, dorsifixed, filaments free, the 5 inner longer. Ovary 5-celled; styles 5, style nearly glabrous; stigmas notched at the apex. Capsules ellipsoid, apiculate; cells few-seeded. Seeds ovoid, transversely striate. (Fig. 84)

Variations observed: in classical texts the plant is said to have, dimorphic flowers, but in my specimen, all the flowers were found to be similar.

Vernacular name: Lajari.

Flowers: October-January.

Micromorphology (Fig. 84)

Leaf showed two types of trichomes. One was unicellular, non-glandular, elongated, conical and thick walled. The second was a multicellular, glandular trichome differentiated into a unicellular head and a multicellular, uniseriate stalk.

Stomata were anomocytic.

D/567, 748, 749, 850.

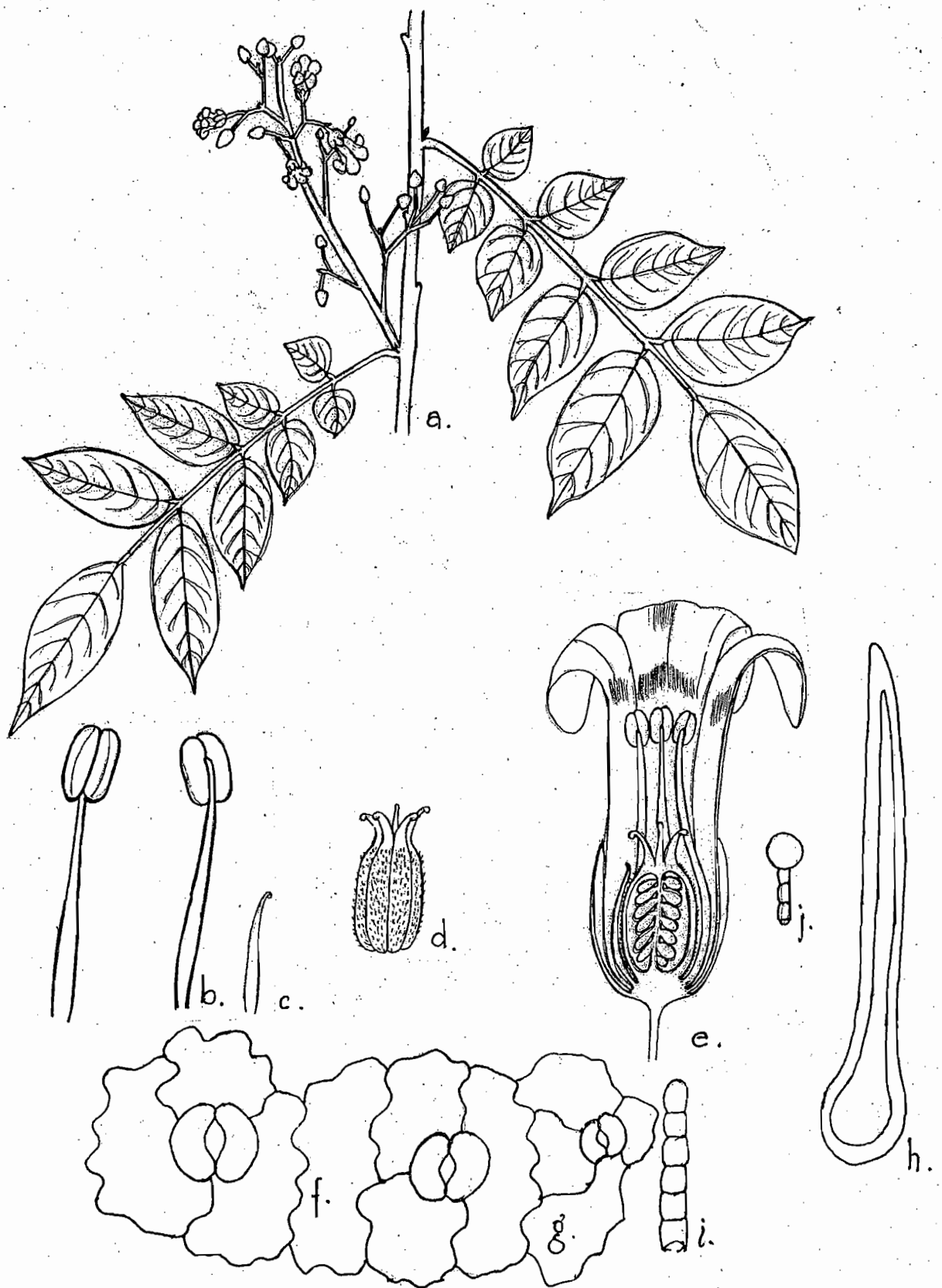


Fig. 83. *Averrhoa carambola* L., a. habit, b. stamen, c. staminode d. gynoecium e. L. S. of flower, f. anisocytic stomata g. anomocytic stomata, h. unicellular trichome with broad lumen, i. multicellular uniseriate gland present in flower, j. gland with a single celled head and uniseriate stalk.

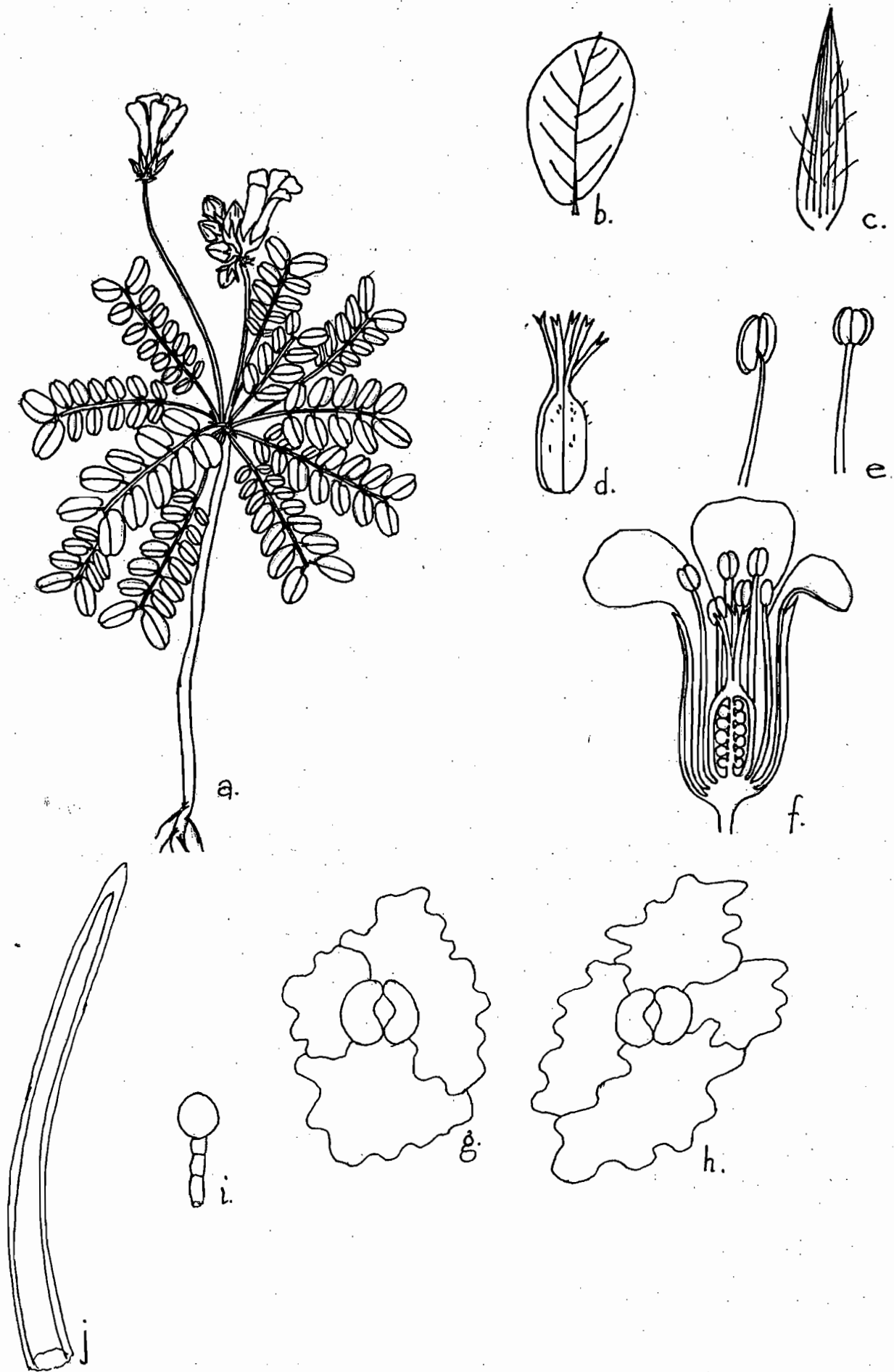


Fig. 84. *Biophytum sensitivum* DC., a. habit, b. leaf, c. sepal, d. gynoecium, e. stamen, f. L.S. of flower, g. anisocytic stomata, h. tetracytic stomata, i. glandular trichome having a large single-celled head and a uniseriate stalk, j. unicellular trichome with a blunt tip and a broad lumen.

3. *Oxalis corniculata* Linn. *Sp. Pl.* (1753) p. 435.

A small pubescent procumbent hairy herb with stems rooting with palmately 3-foliolate, alternate leaves; petioles 4 cm long; stipules oblong, adnate to the petiole; leaflets upto 3 cm long, obcordate, cuneate at the base, articulated. Flowers axillary, subumbellate; peduncles solitary, up to 8 cm long, articulated, deflexed in fruit; bracts beneath the pedicels lanceolate; pedicels shows articulations at the base. Sepals oblong, appressedly hairy outside. Petals yellow, oblong. Stamens 10, united at the base, all antheriferous. Ovary 5-lobed, 5-celled; ovules 1-many in each cell; styles 5, distinct; stigma not papillose, terminal. Capsules 2 cm long, loculicidally valves; linear-oblong, 5-angled, shortly beaked, tomentose. Seeds numerous, arillate, broadly ovoid, acute, transversely striate, brown. (Fig. 85)

Variations observed: in floras the stigma of this plant is said to be papillose, but here our specimen were found to have stigmas which were not papillose. In addition, a number of articulation resembling that of bone joints are seen in both pedicels and petioles.

Vernacular name: Changeri.

Flowering season: October - May.

Micromorphology (Fig. 86)

The plant showed presence of unicellular, non-glandular trichome with thick and warty wall.

The stomata were of anomocytic type.

D/466, 467, 468, 1040.

Rutaceae

1. *Feronia elephantum* Corr.in *Trans. Linn. Soc. V. 5* (1800) p. 225.

A moderate-sized tree with straight sharp strong spines 1-4 cm long. Leaves alternate, imparipinnate; petiole and rachis narrowly winged; leaflets 3-9, opposite, upto 5 cm long, cuneate or obovate, tip often crenulate. Flowers small, numerous, red, in lateral or terminal pubescent panicles, male and female flowers often in the same panicle. Calyx small, 5-6 lobed; lobes triangular. Petals 5-6, free, elliptic-oblong, spreading or deflexed. Stamens 10-12, 1-seriate; filaments equal, subulate, densely hairy at the base within; anthers large, linear-oblong, anther slightly curved. Ovary glabrous, 1-celled, ovules many; stigma. Fruit globose, hard; pericarp woody, rough, grey colored. Seeds embedded in an edible pulp. (Fig. 87)

Vernacular name: Kothu.

Flowers: April-August.

Micromorphology (Fig.87)

Whole plant was glabrous except filaments which were densely hairy at the base.

Stomata were anomocytic type.

D/1196.

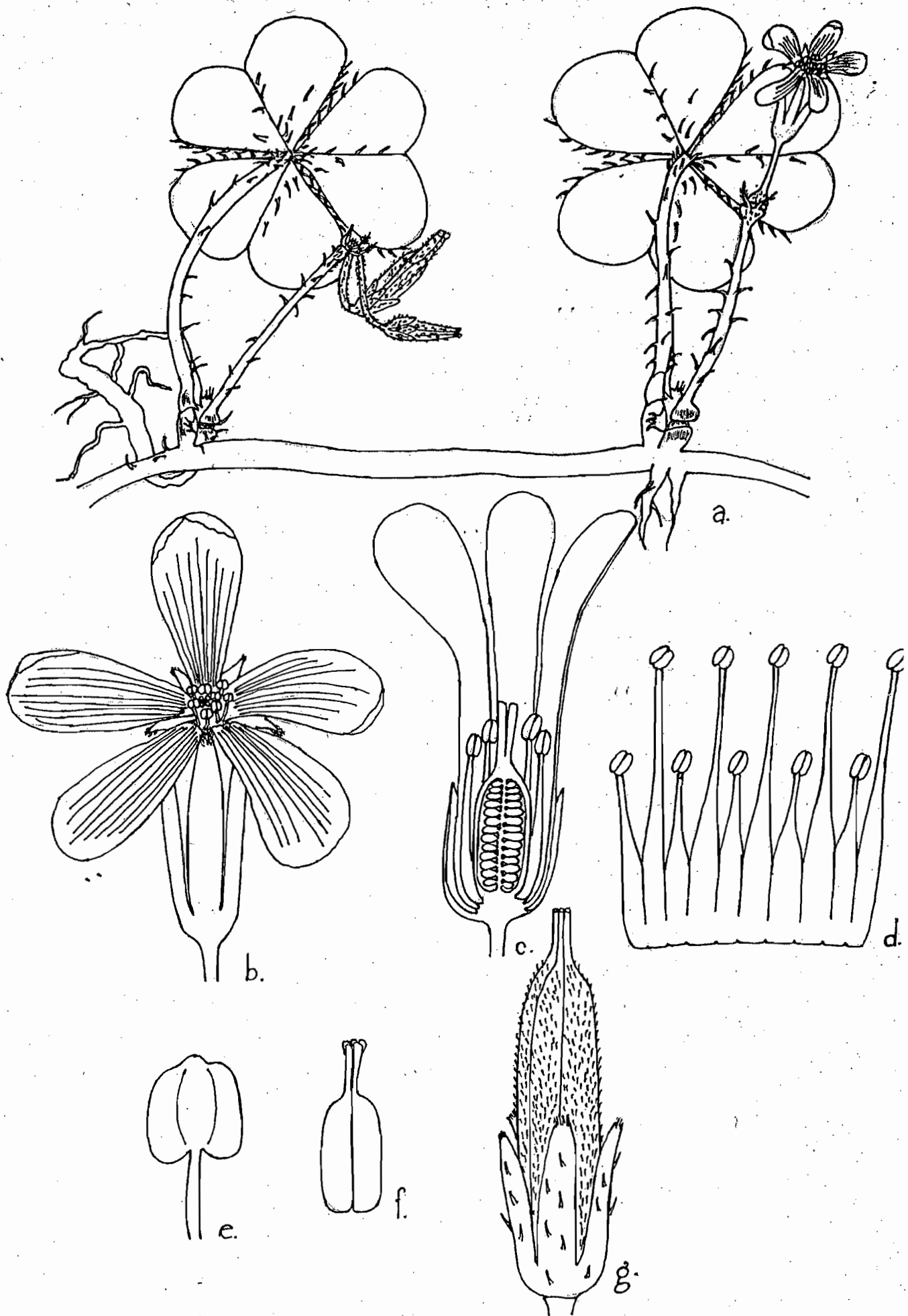


Fig. 85. *Oxalis corniculata* L., a. habit, b. flower, c. L.S. of flower, d. monadelphous stamens, e. single stamen, f. gynoeceum, g. capsule.

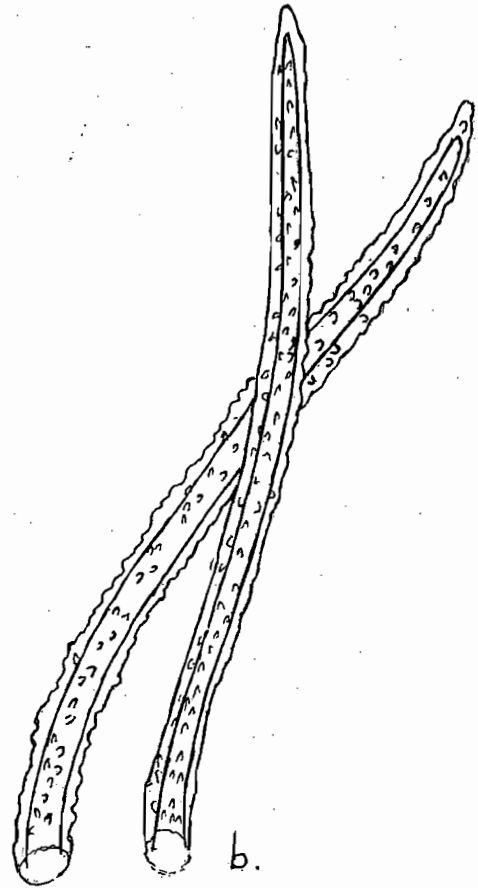
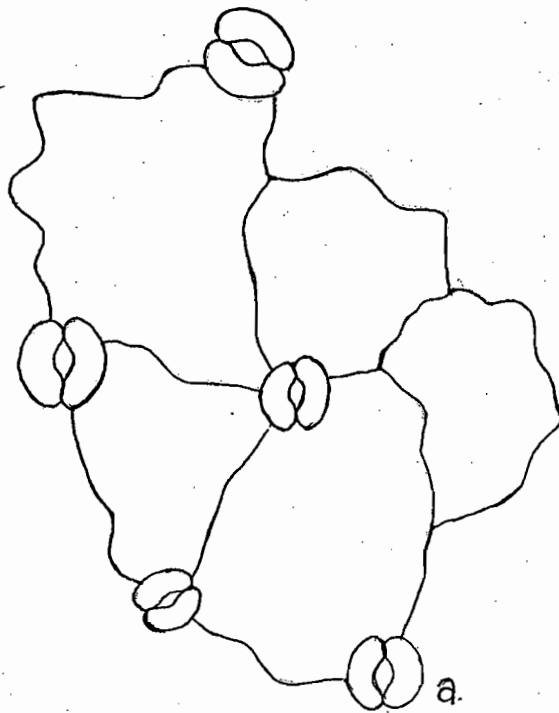


Fig. 86. *Oxalis corniculata* L., a. anomocytic stomata, b. unicellular trichome with warty wall and broad lumen.

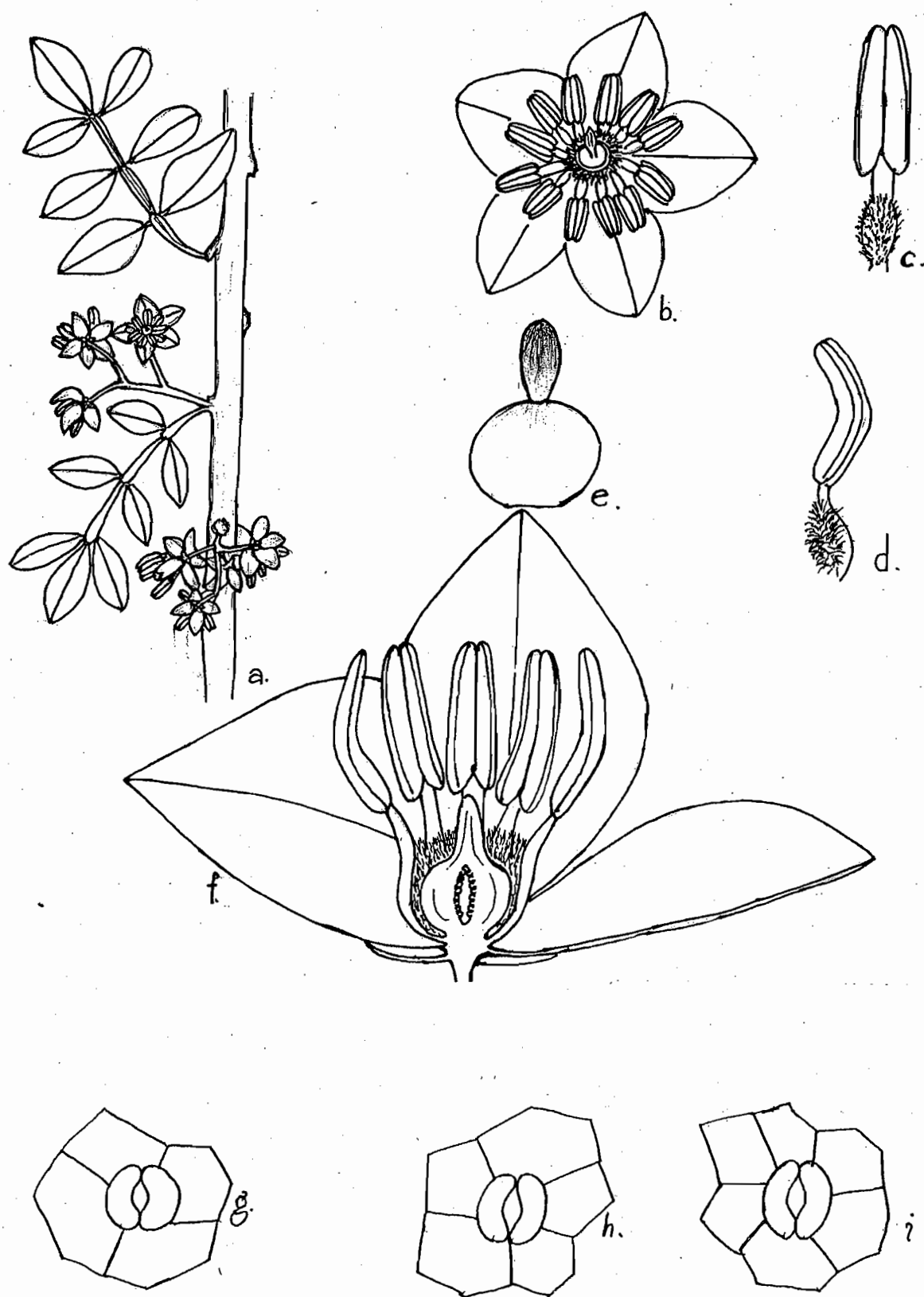


Fig. 87. *Feronia elephantum* Corr., a. habit, b. flower, c. stamen, d. stamen (side view), e. gynoecium, f. L.S. of flower, g. anisocytic stomata, h& i. anomocytic stomata.

2. *Triphasia aurantiola* Lour. *Fl. Cochinch. V. 1* (1790) p. 153.

A spinous straggling branched shrub. Leaves alternate, 3-foliolate; leaflets thick and soft, ovate-elliptic, tip rounded, notched, crenulate, closely gland-dotted, glabrous, base cuneate; petiolules short. Flowers fragrant, solitary or in 2-3 flowered peduncled cymes; pedicels very short. Calyx 3-lobed; lobes broadly ovate or suborbicular, ciliolate. Petals 3, linear-oblong, rounded at the tip, upto 1.5 cm. long, white. Stamens 6, free, subequal; filaments subulate, dilated at the base. Disk fleshy, annular. Ovary seated on the disk, ovoid, 3-celled; ovule 1 in each cell; style slender, at length deciduous; stigma capitate or 3-lobed. Fruit ellipsoid, upto 1.5 cm long, fleshy, apiculate, gland-dotted. (Fig. 88)

Micromorphology (Fig. 89)

Whole plant was glabrous.

Stomata were anomocytic, tetracytic and cyclocytic type.

D/1194.

Simaroubaceae

1. *Ailanthus excelsa* Roxb. *Cor. Pl. V. 1* (1795) p. 24, t. 23.

A tree 20-30 m high. Leaves alternate, pinnate; unequally or equally pinnate, usually 20-30 cm, the younger tomentose, leaflets 8-14 pairs, alternate or subopposite, very variable in shape, 10-15 cm long, coarsely and irregularly toothed or sublobate, very unequal at the base; petiolules upto 5 cm long. Flowers in large lax branched terminal or axillary panicles; pedicels long, slender. Calyx-lobes ovate-triangular, imbricate. Petals 5, spreading, induplicato-valvate, ovate-lanceolate, glabrous, reflexed. Disk 10-lobed. Stamens 10 in the male, 2-3 in the hermaphrodite and 0 in the female flowers, inserted at the base of the disk. Ovary 2-5 partite, ovule 1 in each cell; styles free. Fruit a samara 4 - 6 cm long, lanceolate, acute at the both ends, reddish-brown, twisted near the base, many-nerved, the nerves reticulate above the seed. Seeds solitary in the centre of the samara. (Fig. 90)

Vernacular name: Arduso.

Flowers: January-July.

Micromorphology (Fig. 90)

Leaf and ovary showed presence of unicellular, non-glandular, elongated, thick walled pointed trichome with a round base.

Stomata were anomocytic.

D/76

Ochnaceae

1. *Ochna squarrosa* Linn. *Sp. Pl. ed. 2* (1762) p. 731.

A shrub or small tree. Leaves upto 13 cm long, alternate, oblong-lanceolate, usually acute, finely serrulate, quite glabrous, base narrowed into a short petiole; stipules 2, lanceolate. Flowers fragrant, yellow, in umbellate panicles on the old wood; pedicels jointed. Sepals 5, imbricate, coriaceous, 1.5 cm long, elliptic-oblong, with close parallel

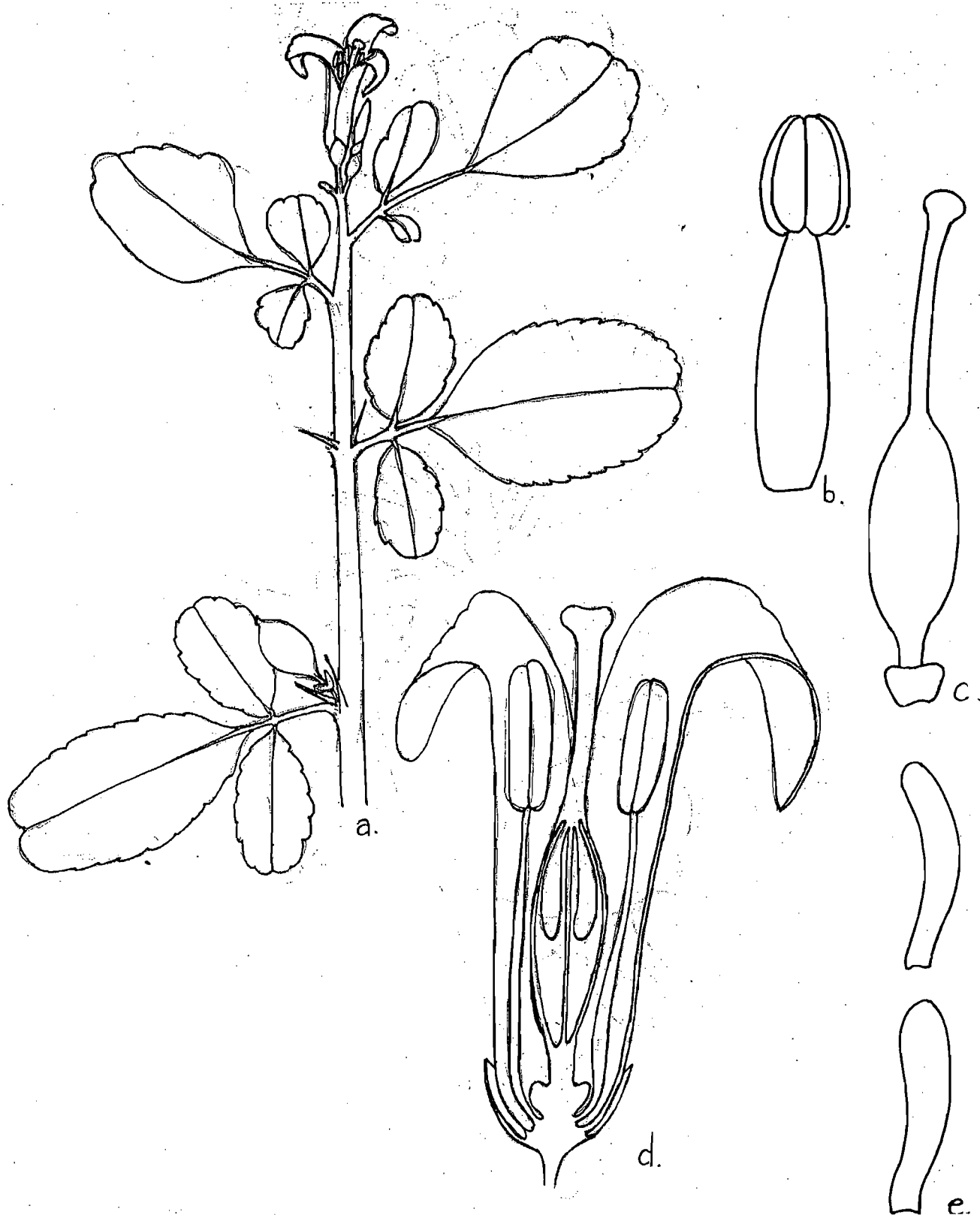


Fig. 88. *Triphasia aurantiola* Lour. a. habit, b. stamen, c. gynoecium, d. L.S. of flower, e. petals.

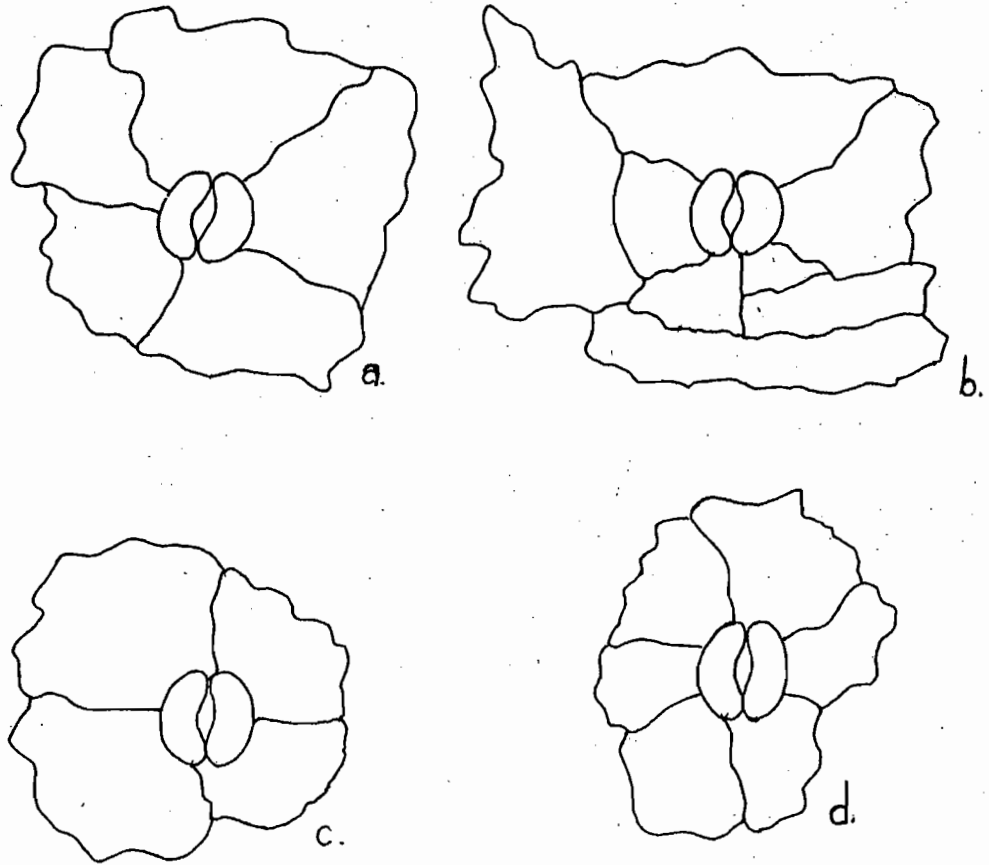


Fig. 89. *Triphasia aurantiola* Lour. a & b. anomocytic stomata, c. tetracytic stomata, d. cyclocytic stomata.

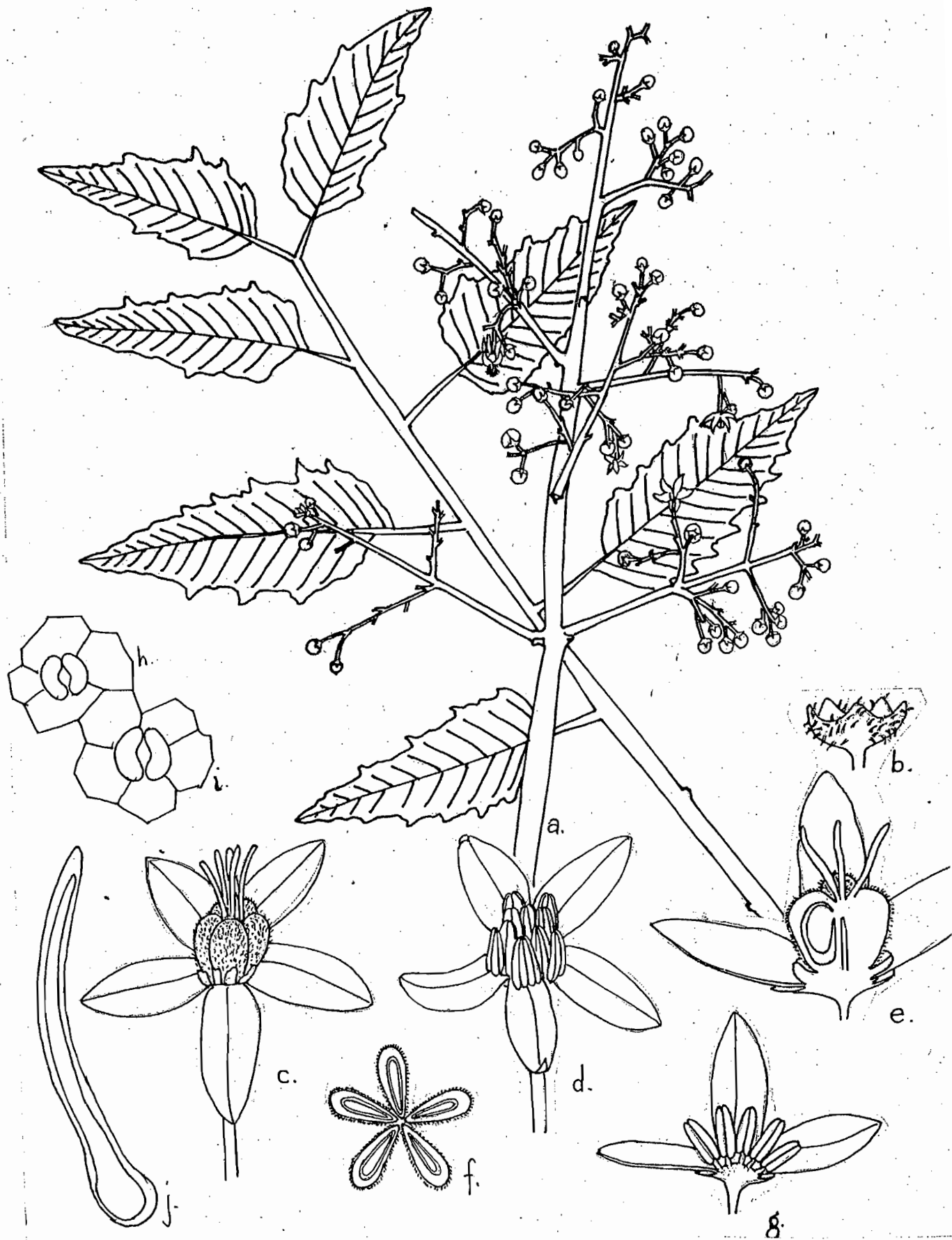


Fig. 90. *Ailanthus excelsa* Roxb. a. habit, b. calyx, c. female flower, d. male flower, e. L.S. of female flower, f. T.S. of gynoecium, g. L.S. of male flower, h & i. anomocytic stomata j. unicellular trichome with thick wall and round base.

veins. Petals 5-12. Disk lobed. Stamens indefinite, inserted at the base of the disk, deciduous; filaments very short; anthers long, linear. Ovary 1-celled, deeply 3-10-lobed; lobes obtuse; ovule solitary in each cell, axile; styles connate, longer than the stamens. Fruit of 3-6 drupes, oblong-ovoid, sessile, black, and surrounded by the persistent calyx. (Fig. 91)

Vernacular name: Kanak champa.

Flowers: February-April.

Micromorphology (Fig. 92)

Whole plant was glabrous.

Stomata were of anisocytic, tetracytic and anomocytic.

D/217.

Meliaceae

1. *Azadirachta indica* A. Juss. in. *Mem, Mus. Par. V. 19* (1830) p. 221.

A large tree reaching upto 20 m high, with a straight trunk. Leaves simply pinnate, upto 40 cm long, crowded near the ends of the branches; leaflets 9-12, subopposite obliquely lanceolate, sometimes falcate, acuminate, serrate, glabrous on both surfaces, base inequilateral, acute; petiolules very short. Flowers white, fragrant, in branched panicles; bracts lanceolate, caducous. Calyx 5 partite, divided almost to the base; lobes rotund-ovate. Petal 5, obovate-oblong. Staminal-tube obconic, the laciniae truncate and toothed at the apex; anthers 10, at the apex, sessile, opposite the laciniae, apiculate. Disk 0. Ovary glabrous, 3-celled; ovules 2 in each cell; stigma 3-toothed, included in the tube. Drupes the shape of an olive, 1-2 cm long, glabrous, 1-seeded. (Fig. 93)

Vernacular name: Limdo.

Flowers: March-May.

Micromorphology (Fig. 94)

Whole plant was glabrous except sepals and staminal-tube which showed presence of unicellular, glandular, elongated, somewhat thick walled trichome.

Stomata were anomocytic.

D/120

Celastraceae

1. *Celastrus paniculata* Willd. *Sp. Pl. V. 1* (1797) p. 1125.

An unarmed climbing shrub with young branches usually covered with pale lenticular warts. Leaves alternate, upto 10 cm long broadly elliptic or ovate, shortly acuminate. Flowers yellowish- or greenish-white, unisexual, in terminal pyramidal panicles upto 15 cm long; bracts small, lanceolate. Calyx lobes semiorbicular. Petals oblong, rounded at the apex. Male flowers: stamens inserted on the margin of the disk; anthers oblong, rudimentary ovary small, subconical, slightly 3-toothed at the apex. Female flowers: ovary globose, narrowed into a short stout style; stigma large, 3-lobed. Stamens inserted

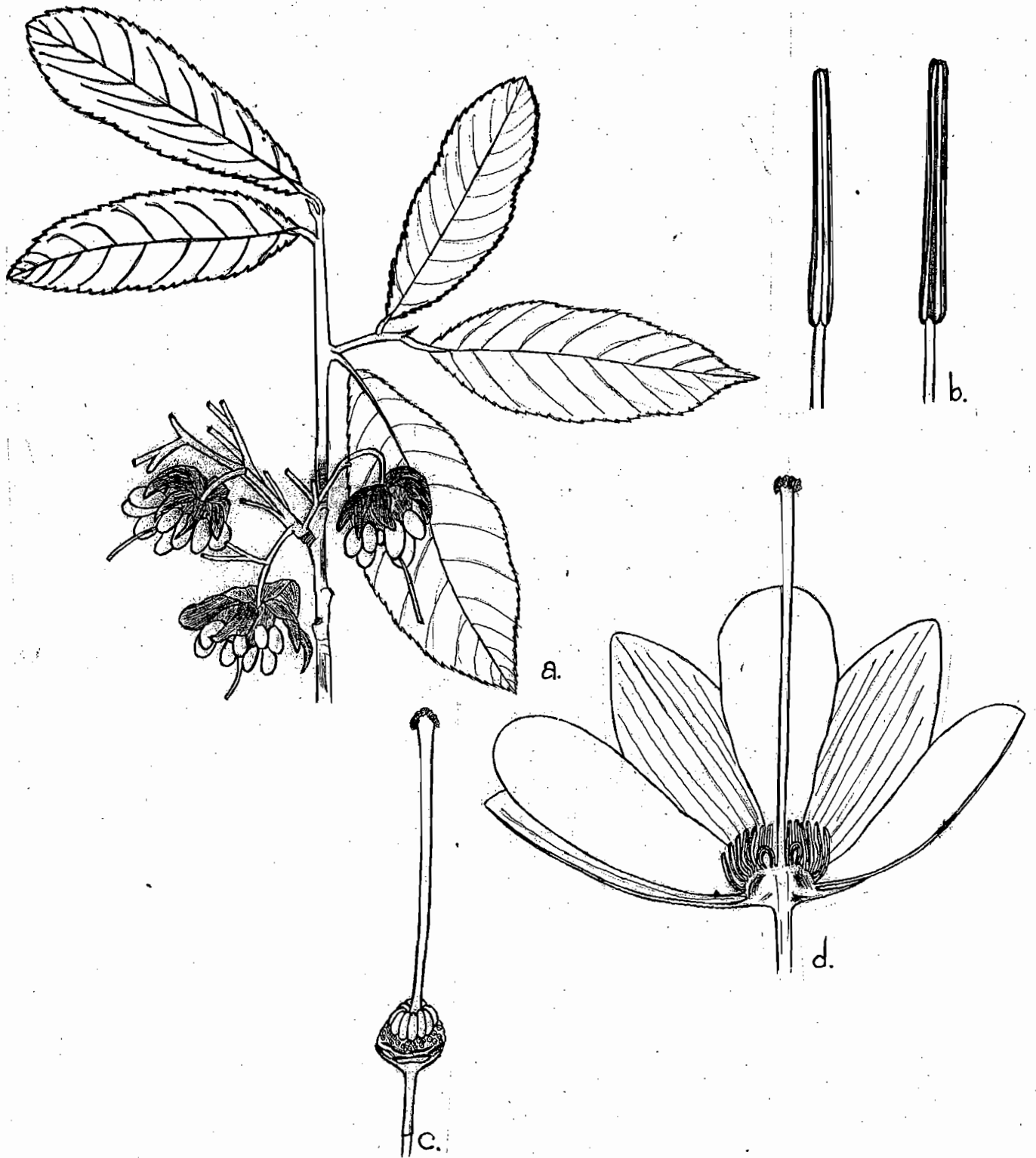


Fig. 91. *Ochna squarrosa* L. a. habit, b. stamen, c. gynoecium, d. L.S. of flower.

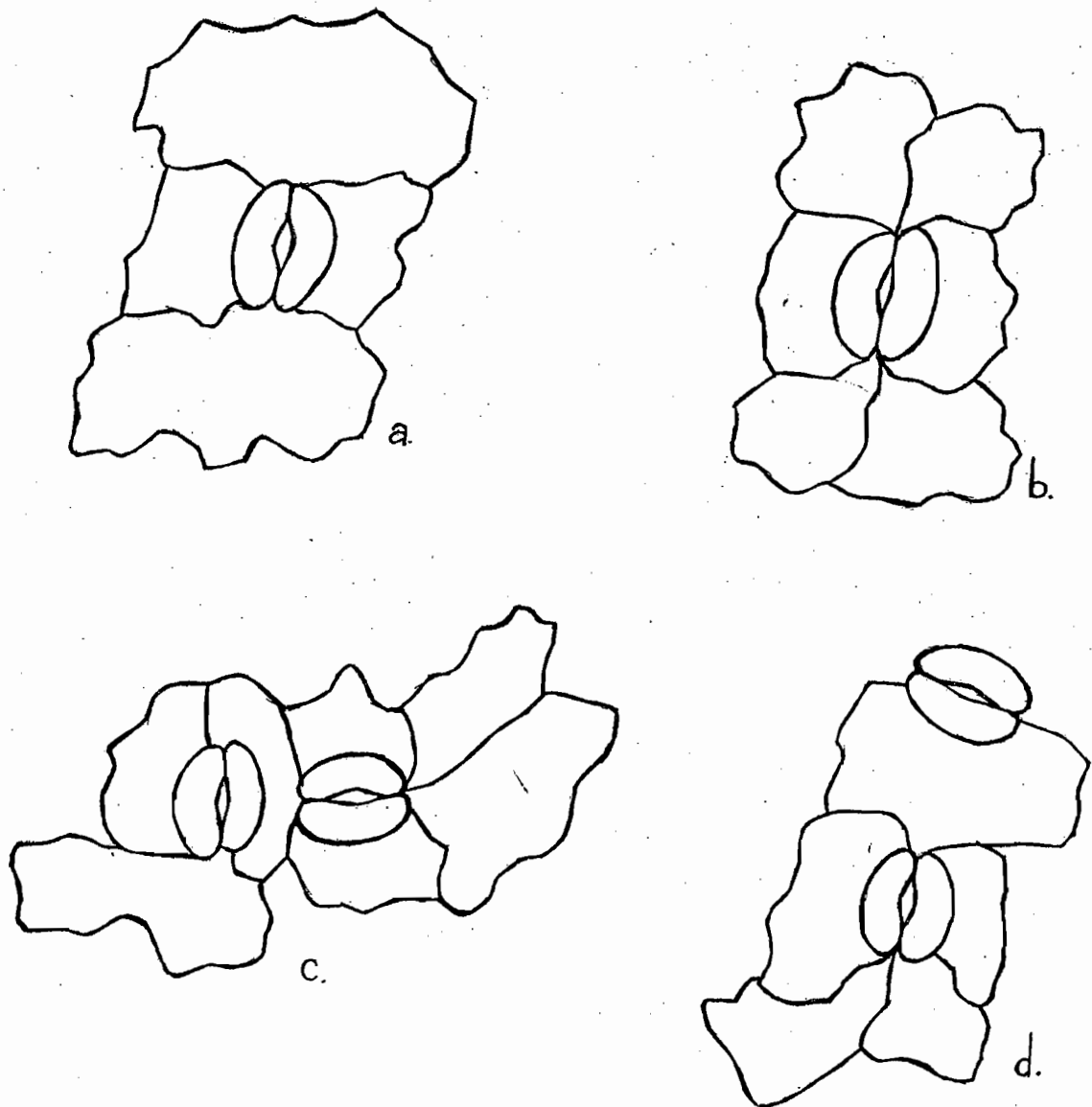


Fig. 92. *Ochna squarrosa* L. a. tetracytic stomata, b. paracytic stomata, c. anisocytic stomata, d. anomocytic stomata.

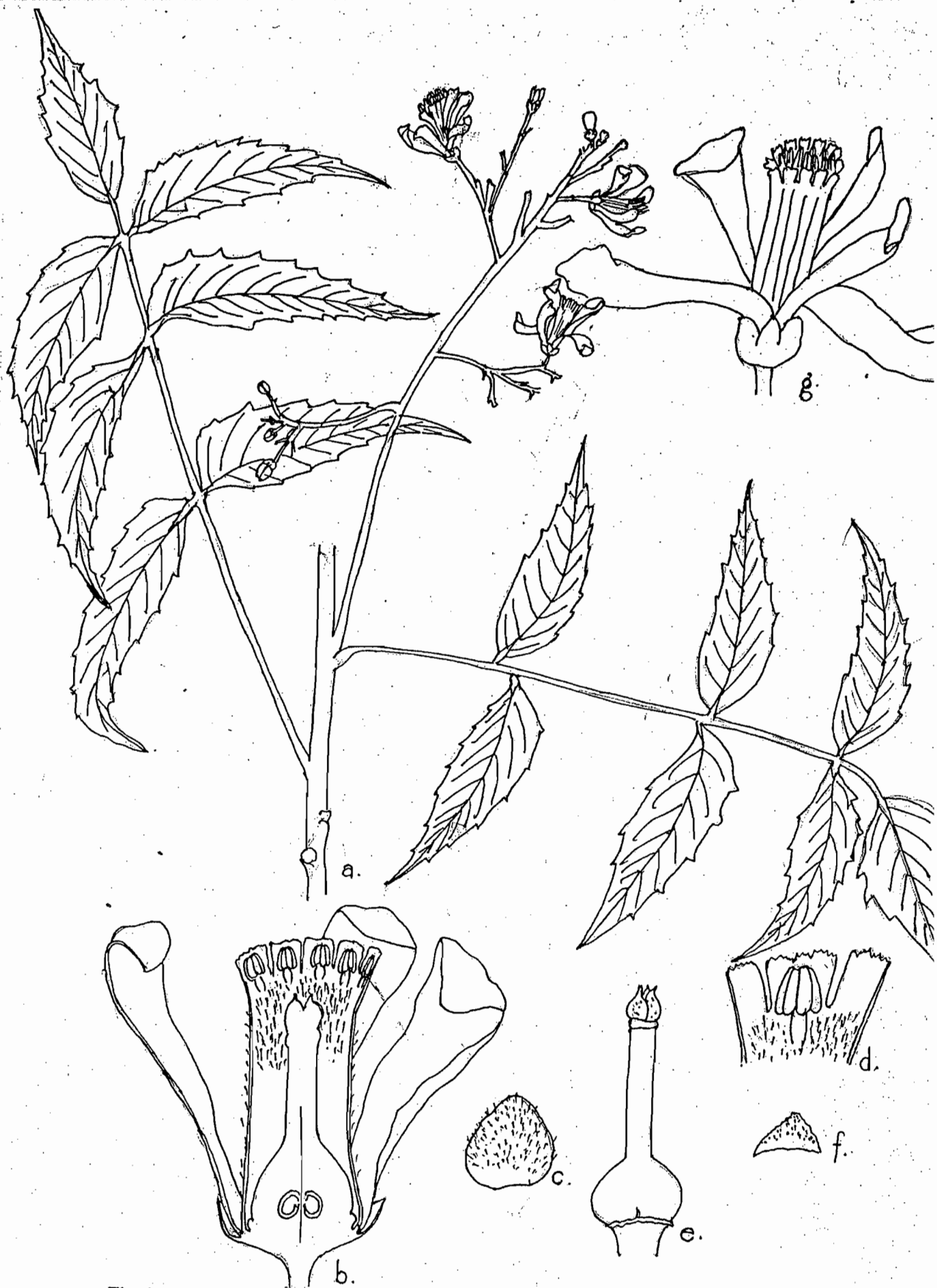


Fig. 93. *Azadirachta indica* A. Juss. a. habit, b. L.S. of flower, c. sepal, d. anther attached to inside the staminal tube, e. gynoecium, f. bract.

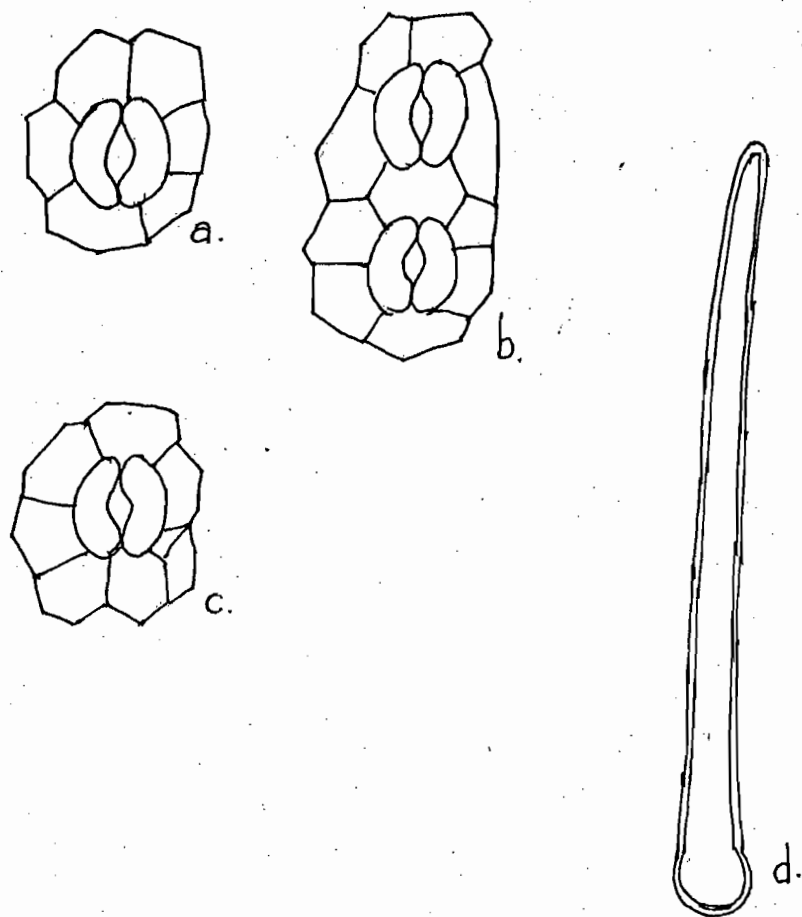


Fig. 94. *Azadirachta indica* A. Juss., a. cylocytic stomata, b & c. anomocytic stomata, d. unicellular trichome with broad lumen.

on the edge of the disk which was larger than the disk in the male flowers; anthers small, without pollen, ovate, acute or subtriangular. Capsules upto 1 cm in diameter, subglobose, bright yellow, transversely wrinkled, 3-valved, Seeds often solitary, ovoid, and completely enveloped in a scarlet fleshy aril. (Fig. 95)

Vernacular name: Mal kangani.

Flowers: November-February.

Micromorphology (Fig. 95)

Whole plant was glabrous.

Stomata were tetracytic, anomocytic, and anisocytic types.

D/593.

2. *Euonymus indicus* Heyne, ex Wall, in Roxb. *Fl. Ind.* (ed. Carey) V. 2. (1824) p. 409.

A small tree with coriaceous leaves coriaceous reaching upto 10 cm long, elliptic or oblong-lanceolate, sometimes shortly acuminate, usually entire, glabrous on both surfaces, smooth and shining above; petioles small; stipules linear-subulate, very caducous. Flowers axillary, solitary or in peduncled umbellate cymes; peduncles 1-2; pedicels 1-3, glabrous, when more than 1 and on the top of a peduncle. Calyx 4-5 fid, glabrous, fleshy, deeply divided; lobes semicircular, entire. Petals reddish, orbicular-oblong, fringed at the apex. Stamens inserted on the disk near its margin; filaments short, flattened. Disk 5-lobed, fleshy. Ovary sunk in the disk. Fruit obovoid-clavate, 5-winged. (Fig. 96)

Flowers: December-February.

Micromorphology (Fig. 96)

Stomata were of anomocytic type only.

D/218

**3. *Gymnosporia montana* Benth. *Fl. Austral.* V. 1 (1863) p. 400.
(*Celastrus Montana* Roth.)**

A small tree with young branches often spinescent at the extremities and bearing leaves and flowers. Leaves coriaceous, about 3-5 cm long, elliptic or obovate, usually rounded at the apex, entire or crenulate. Flowers in axillary furcately-branched cymes; peduncles slender, solitary or fascicled; pedicels filiform, jointed below the middle; bracts small, lanceolate, acute. Calyx-lobes broadly elliptic-oblong, rounded at the apex. Petals elliptic-oblong. Filaments flattened and dilated at the base. Disk fleshy, 10-lobed. Ovary glabrous, orbicular; style in the fertile flowers deeply 2-3 cleft. Capsules about as large as a good-sized peppercorn or small pea, purple when ripe. Seeds glabrous, chestnut-brown, rugose, arillate. (Fig. 97)

Vernacular name: Vigo.

Flowers: June-December.

Micromorphology (Fig. 97)

The whole plant was glabrous.

Stomata were of anomocytic type.

D/494, 656, 957, 1137-1138, 1227.

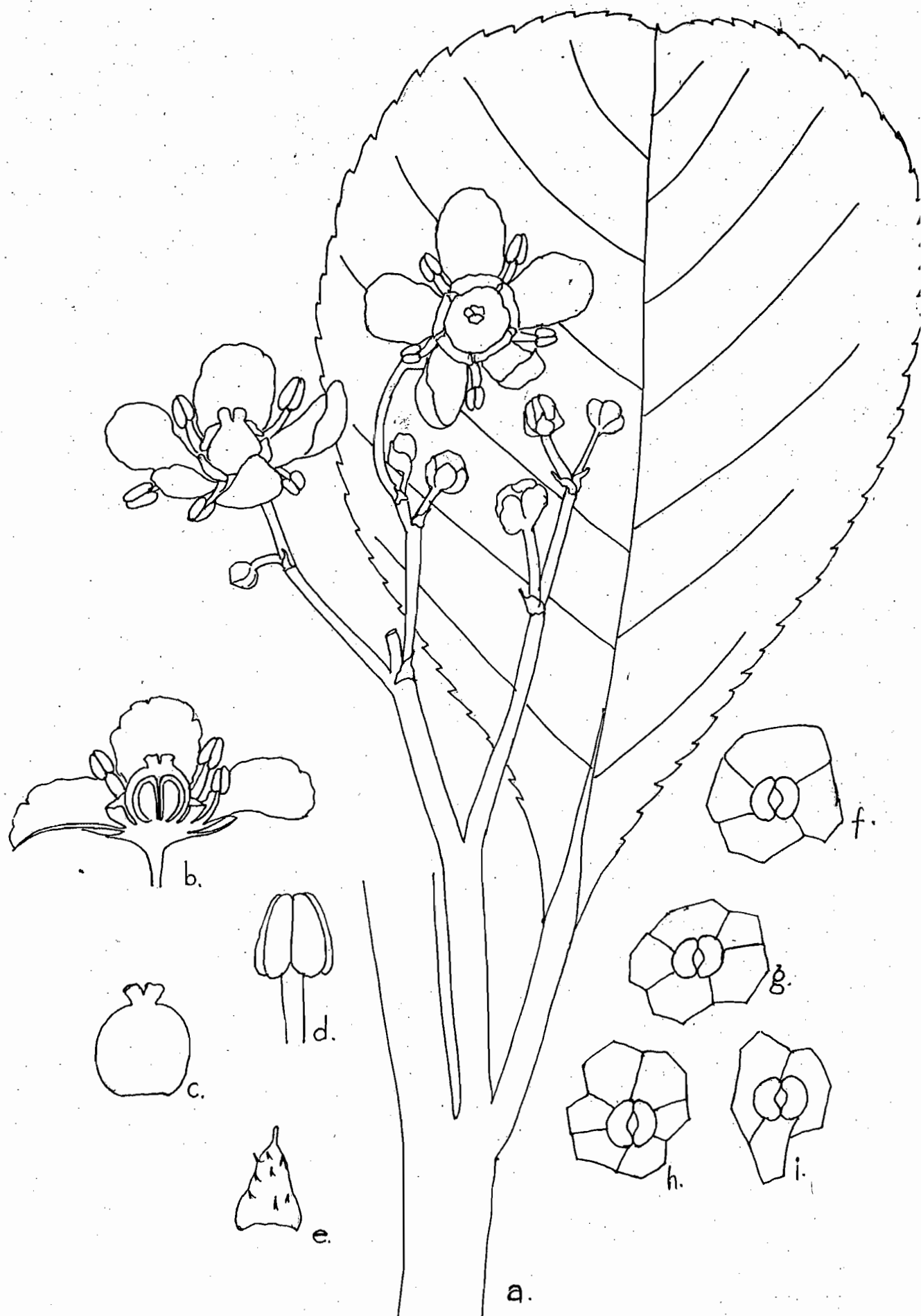


Fig. 95. *Celastrus paniculata* Willd. a. habit, b. L.S. of flower, c. gynoecium with bilobed stigma, d. stamen, e. bract, f. tetracytic stomata, g & h. anomocytic stomata, i. anisocytic stomata.



Fig. 96. *Euonymus indicus* Heyne. a. habit, b. L.S. of flower, c. anomocytic stomata.

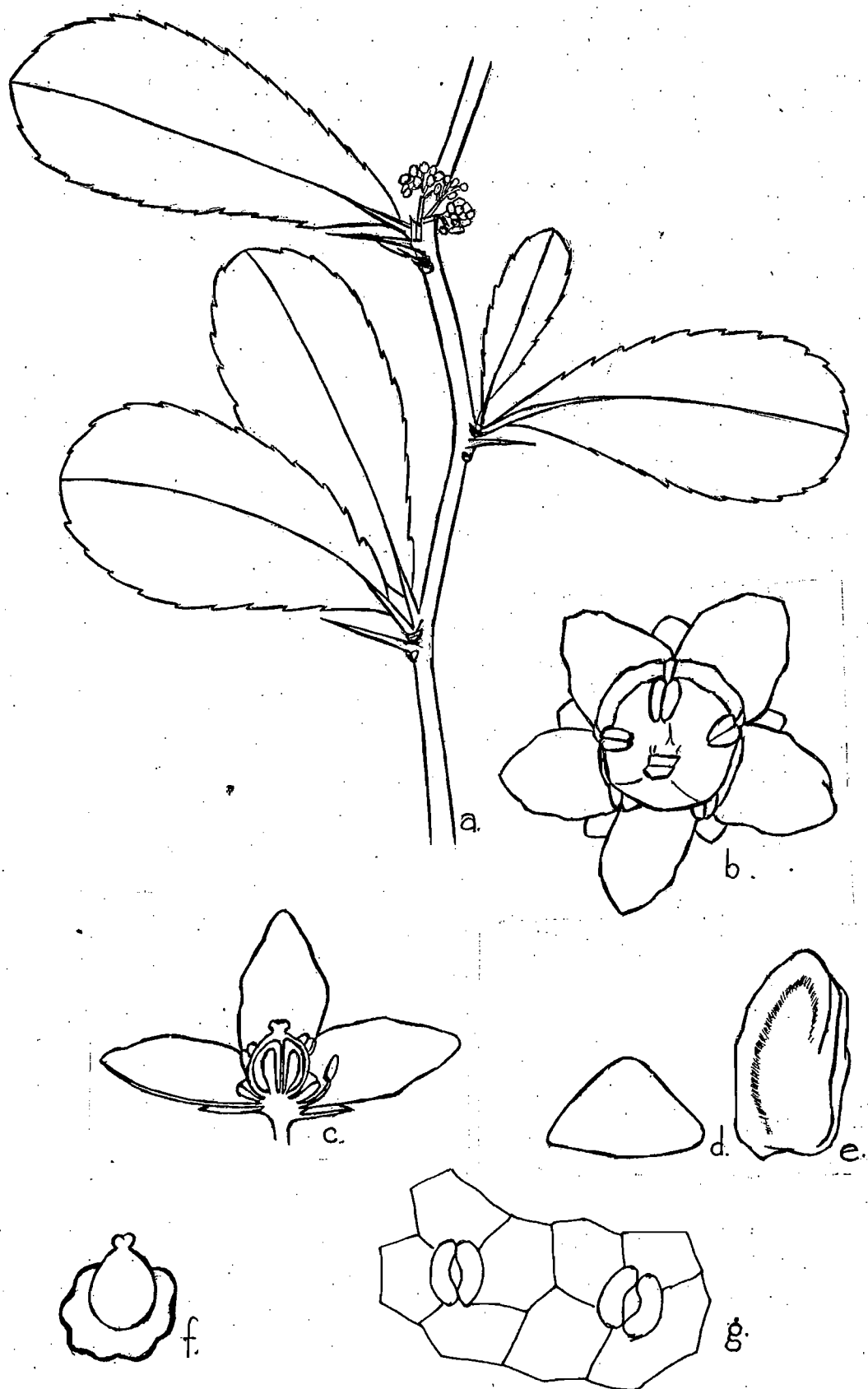


Fig. 97. *Gymnosporia montana* Bth. a. habit, b. flower, c. L.S. of flower, d. sepal, e. petal, f. gynoecium seated on the disc, g. anomocytic stomata.

Rhamnaceae

1. *Ziziphus jujuba* Lamk. *Encyc. V. 3* (1789) p. 318.

A small branched tree with young branches softly pubescent. Leaves reaching upto 6 cm long, ovate-elliptic, rounded at both ends, irregularly denticulate, glabrous above, covered beneath with a dense whitish tomentum, strongly 3-nerved from the base; prickles solitary or in pairs. Flowers greenish-yellow, in small axillary cymes. Calyx pubescent, cleft about half way down; lobes triangular, prominently keeled on the inner face for about half their length. Petals cucullate, rounded at the apex, deflexed with the stamens between the calyx-lobes; pedicels short, hairy. Stamens 5, enclosed in the petals. Disk with 10 grooved lobes. Ovary about half sunk in the disk, ovoid; styles 2, connate for about half their length. Drupes edible, globose, fleshy, smooth, yellow or orange when ripe; stone 1-2 celled.

Vernacular name: Bor. (Fig. 98)

Flowers: September-October.

Micromorphology (Fig. 98)

The trichome was unicellular with broad lumen and round base.

Stomata were of anomocytic and tetracytic types.

D/431.

2. *Zizyphus trinervia* Roxb. *Hort. Beng.* (1814) p. 17

(*Zizyphus glabrata* Wight.)

A small tree with leaves elliptic, subobtusate, often mucronate, serrated reaching upto 8 cms. Long; prominently 3-nerved from the base, glabrous, shining, base more or less oblique; stipules filiform, caducous; flowers greenish-yellow, in axillary peduncled cymes scarcely 1 cm long. Calyx lobes triangular, keeled within, deflexed. Petals small, shorter than the recurved stamens, obtriangular, cuneate. Disk 10-lobed. Filaments flattened. Ovary 2-celled; styles 2, united to the middle. Fruit 1 cm in diameter, globose or obovoid, somewhat rugose, 1-2 celled, yellow when ripe. (Fig. 99)

Vernacular name: Bor ni jat.

Flowers: November-January.

Micromorphology (Fig. 100)

The plant showed presence of unicellular, non-glandular, elongated trichome with a round bottom and narrow lumen filled with ergastic substances.

Stomata were of anomocytic type.

D/585, 1061.

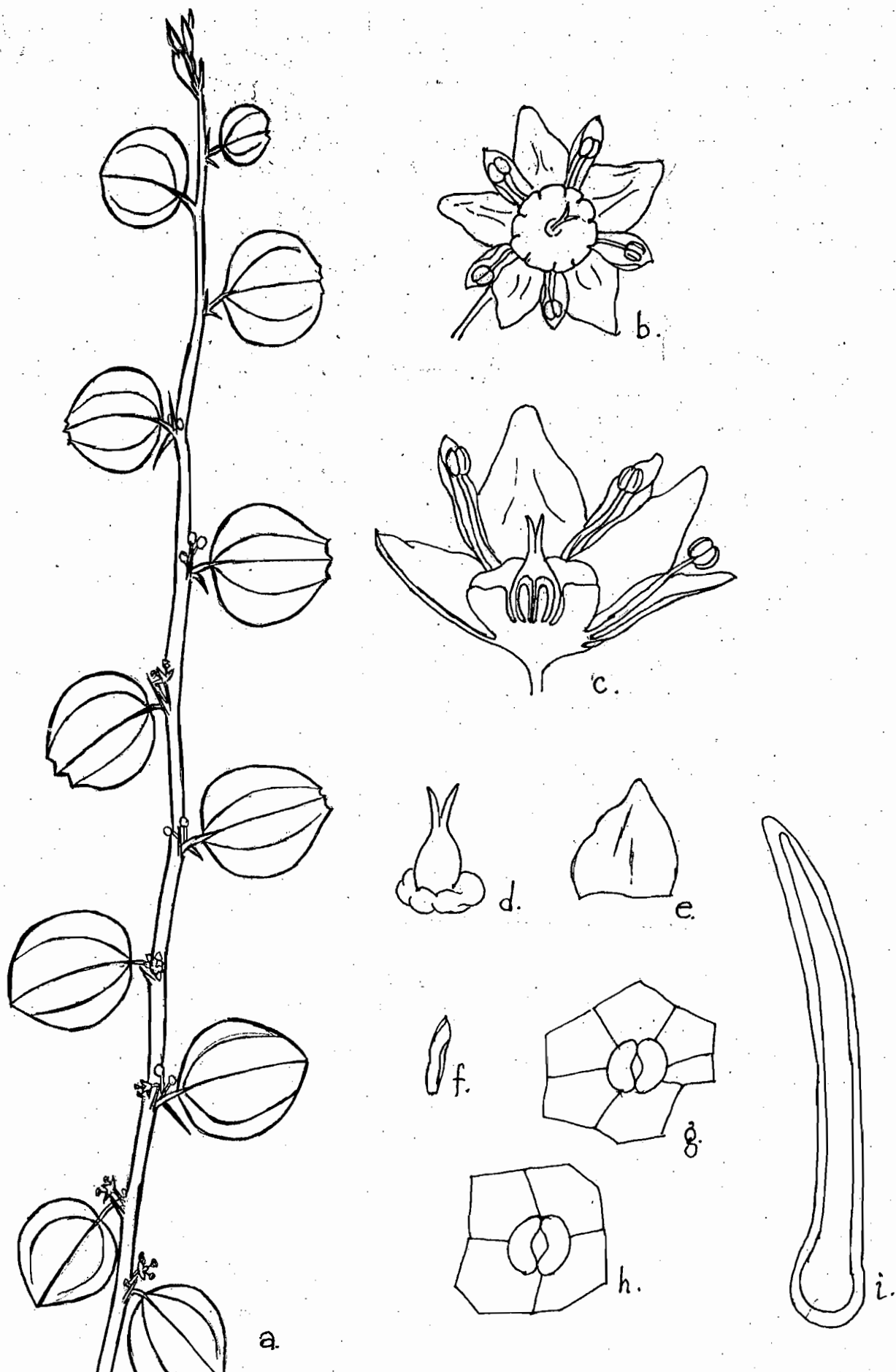


Fig. 98. *Ziziphus jujuba* Lam. a. habit, b. flower, c. L.S. of flower, d. gynoecium embedded half in the disc, e. sepal, f. petal, g. anomocytic stomata, h. tetracytic stomata, i. unicellular trichome with broad lumen and round base.

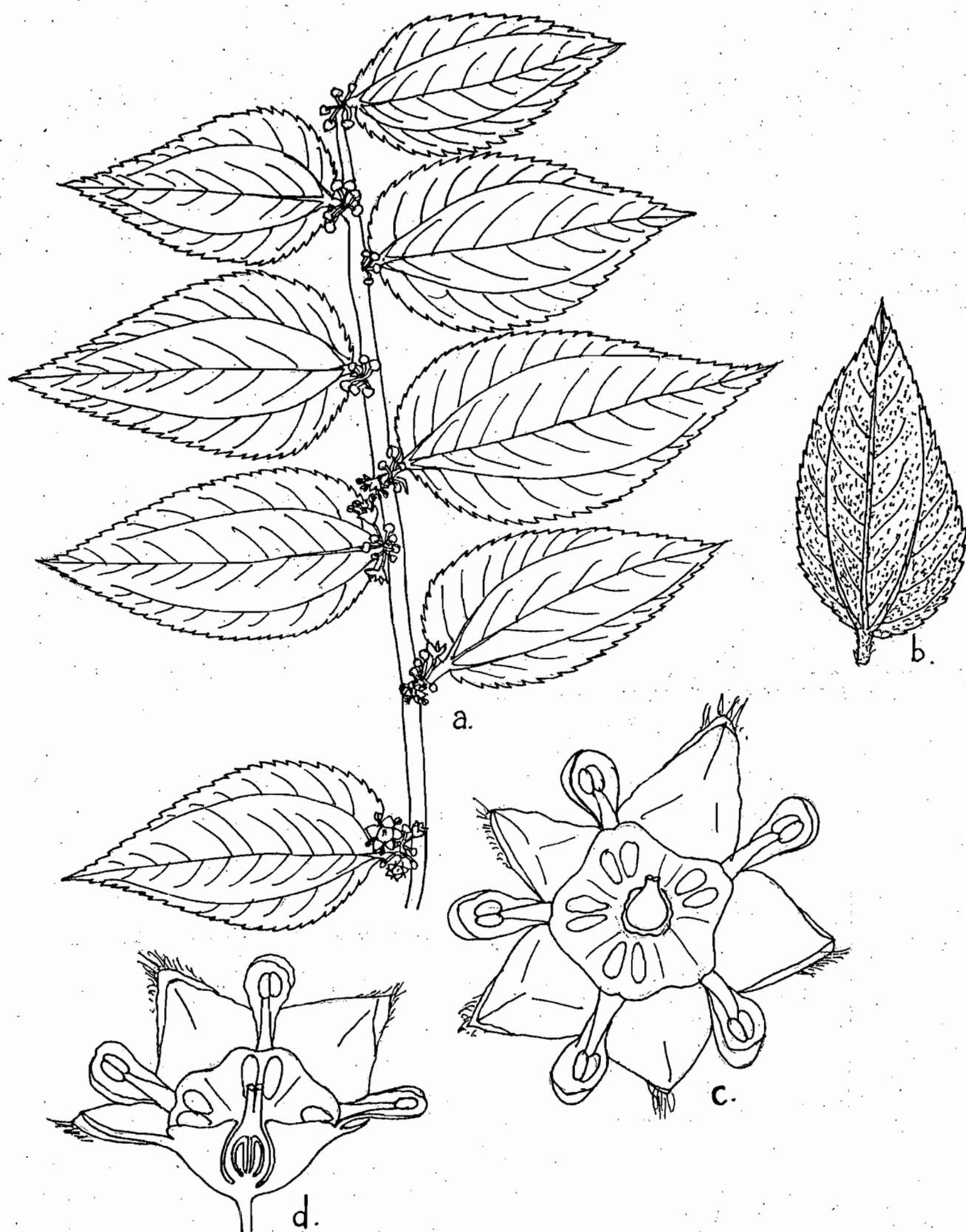


Fig. 99. *Ziziphus trinervia* Roxb. a. habit, b. leaf, c. flower, d. L.S. of flower.

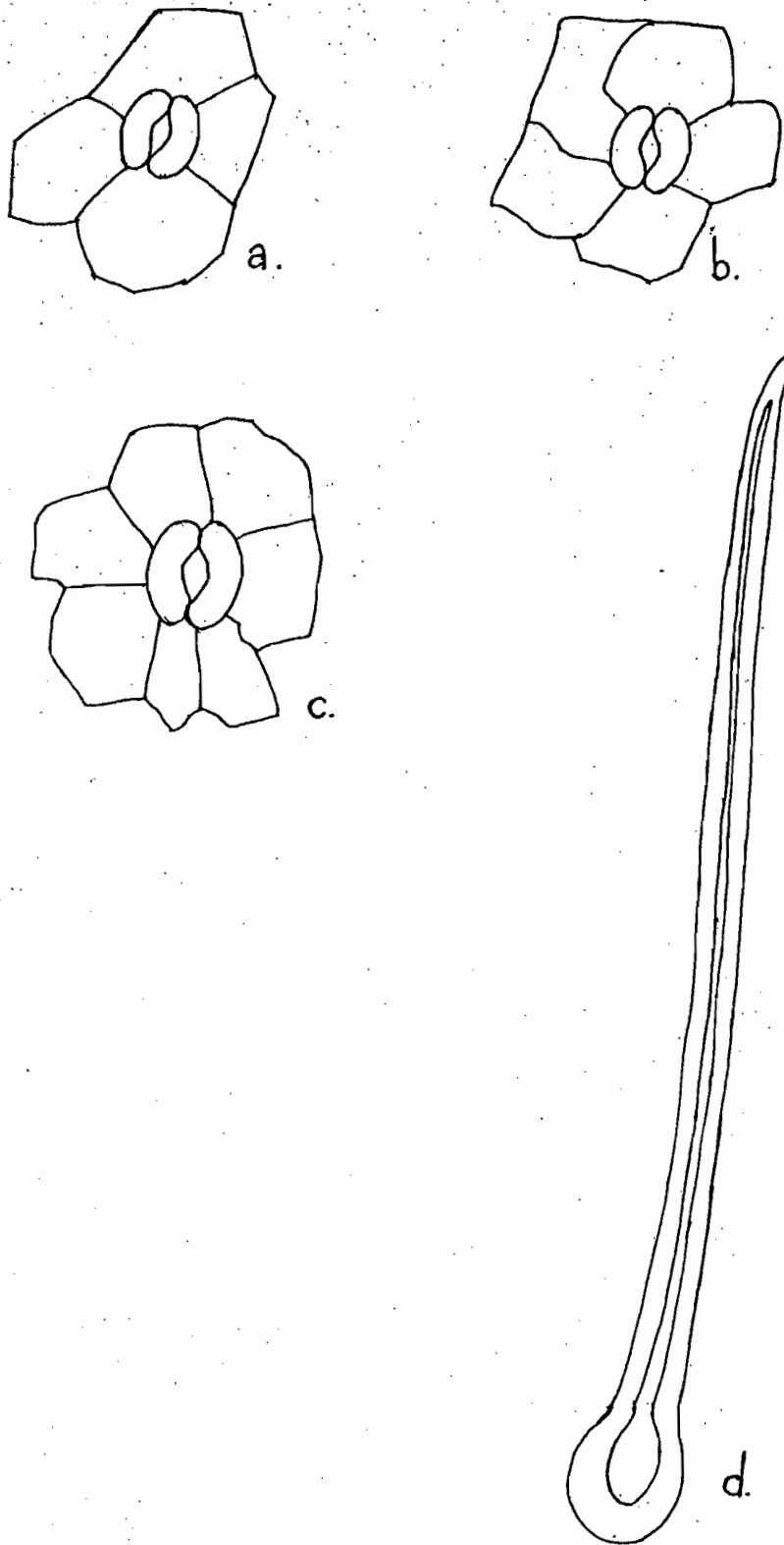


Fig. 100. *Ziziphus trinervia* Roxb. a. tetracytic stomata, b & c. cyclocytic stomata, d. unicellular trichome with very thick wall, narrow lumen and round base.

Vitaceae

1. *Cissus quadrangularis* Linn., *Mant.* 39. 1767.

A perennial glabrous herbaceous climber with thick, succulent, quadrangular stem having winged angles. Tendril long, slender, simple. Leaves simple ovate, entire or cordate, serrulate dentate, 3-lobed, terminal lobe triangular, glabrous on both sides, reaching upto 5 cms.; stipules ovate deciduous. Inflorescence a compound umbelliform cymes, peduncle upto 2.5 cms. long. Flower pink and white, hypanthium cuplike, truncate or obscurely lobed, green. Petals 4, distinct, ovate-oblong, acute, hooded at apex. Disc longer than the ovary. Ovary glabrous, style slender subulate, stigma small. Berry globose, red, succulent, very acidic, 1 seeded. Seed obovoid smooth. (Fig. 101)

Vernacular name: Hadsankad.

Flowers: June-September.

Micromorphology (Fig. 101)

The plant was glabrous.

There were two types of stomata, anisocytic and tetracytic types.

D/138.

2. *Vitis trifolia* Linn. *Sp. Pl.* (1753) p. 203.

A herbaceous branched climber with slender branched tendrils. Leaves 3-foliolate; petioles 2-5 cm long; leaflets thick, reaching upto 5 cms. long, ovate-lanceolate or obovate, acute or obtuse, crenate-serrate, more or less pubescent on both surfaces; main nerves 5-6 pairs; stipules ovate. Flowers in branched divaricate pubescent long-peduncled cymes. Calyx small, entire, funnel shaped, truncate or 4-lobed. Petals 4, oblong, rounded at the apex, hooded, pubescent outside. Stamens 4, opposite to the petals, subulate; anthers free, short, 2-celled, introrse. Disk cup-shaped, truncate with a plicate margin. Ovary sunk in the disk, 2-6 celled; ovules 1-2 in each cells; style conical; stigma capitate. Berry turbinate, fleshy, 1-2 cm long, 2-4 seeded. Seeds triangular, rounded and rugose on the back, cuneate on the face. (Fig. 102)

Flowers: August-October.

Micromorphology (Fig. 103)

It showed multicellular, uniseriate, non-glandular, unbranched trichome with thick wall.

Stomata were anomocytic and anisocytic.

D/156

Sapindaceae

1. *Cardiospermum halicacabum* Linn. *Sp. Pl.* (1753) p. 366.

An perennial branched climber with branched thin, wiry tendril. Leaves alternate, deltoid, 2-ternate; segments of the leaves lanceolate, inciso-serrate. Flowers irregular, white, in few-flowered umbellate cymes; peduncles slender, provided beneath the cyme with 2

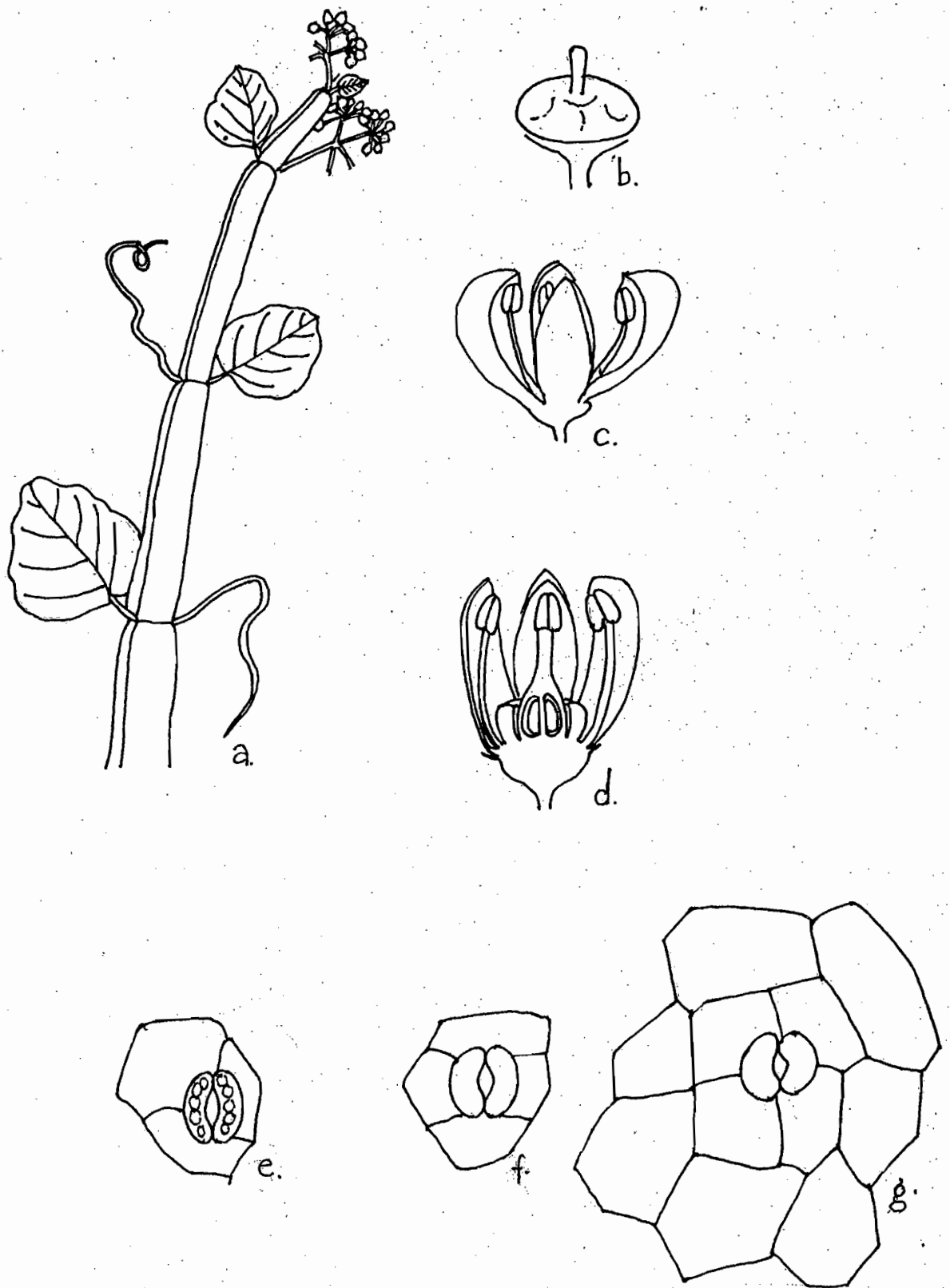


Fig. 101. *Cissus quadrangularis* L. a. habit, b. gynoecium embedded in the disc, c. flower, d. L.S. of flower, e. anisocytic stomata, f & g. tetracytic stomata.

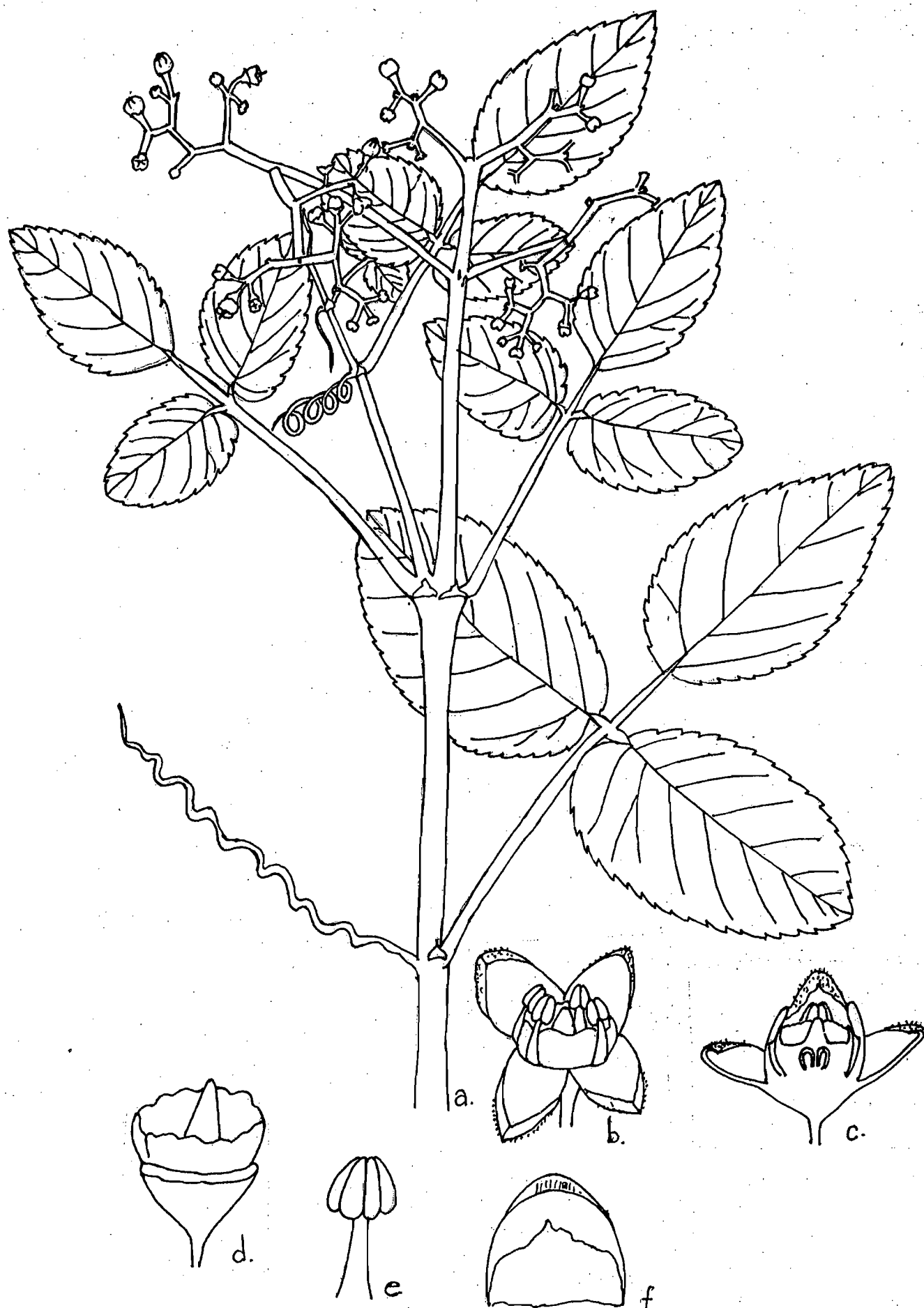


Fig. 102. *Vitis trifolia* Cooke. a. habit, b. flower, c. L.S. of flower, d. gynoecium sunken in the disc, e. stamen, f. sepal.

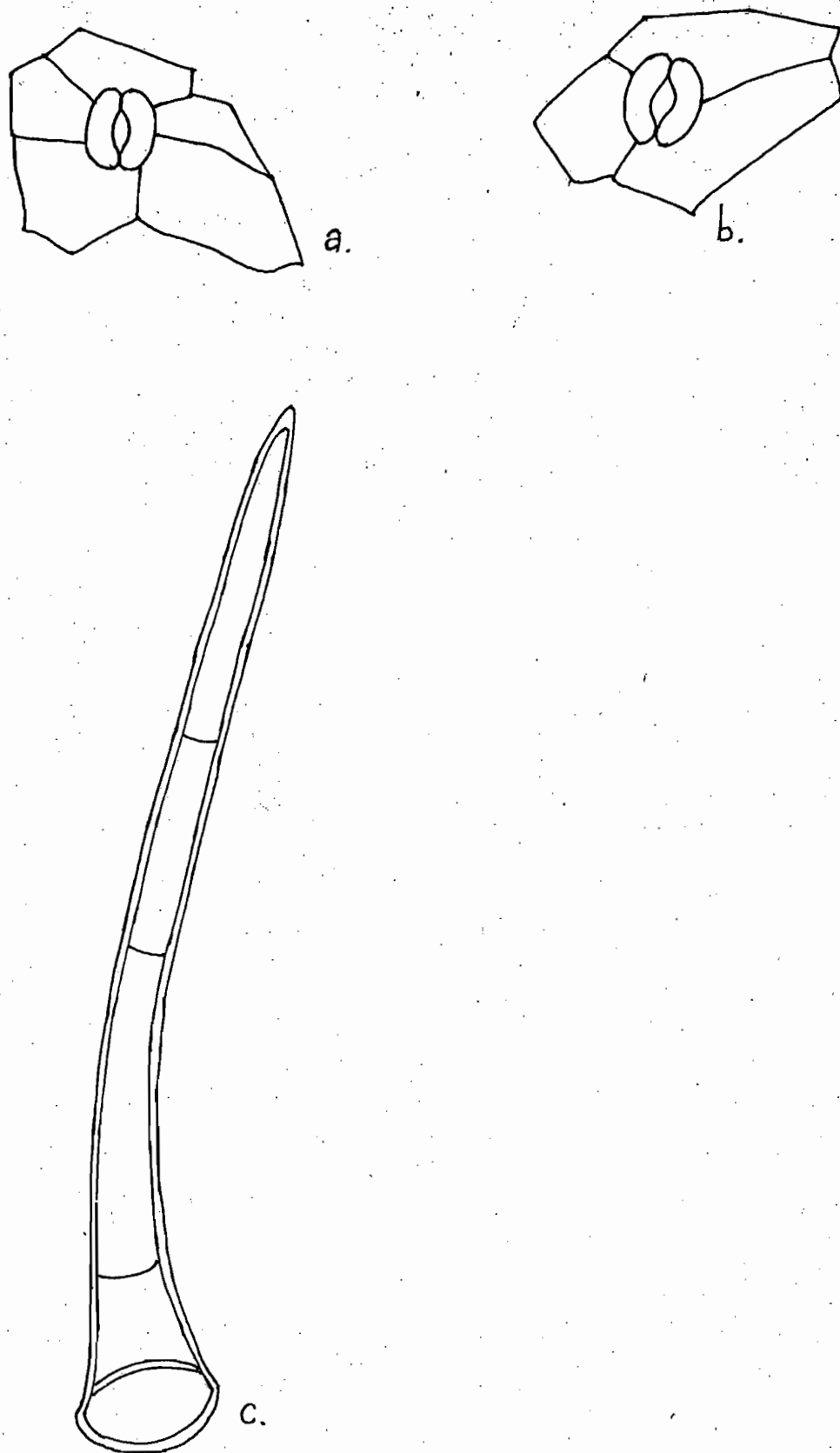


Fig. 103. *Vitis trifolia* Cooke. a. anomocytic stomata, b. anisocytic stomata, c. multicellular uniseriate trichome with a long apical cell and blunt apical cell and swollen basal cell.

opposite usually circinate tendrils. Sepals 4, imbricate. Outer sepal rounded, obovate; inner sepals larger than the outer, rounded, membranous. Petals 4, arranged in pairs, the two upper furnished with a large scale below the base of each, the 2 lower smaller, each furnished with a small crested scale. Disk made of 2 glands opposite the lower petals. Stamens 8; filaments unequal. Ovary 3-fid. Capsules pyriform, trigonous, truncate at top, winged at the angles, bladdery, veined. Seeds globose, black, with a small white heart-shaped aril. (Fig. 104)

Vernacular name: Trigharivel.

Flowers: August-February.

Micromorphology (Fig. 105)

The plant showed presence of unicellular, non-glandular, elongated, trichome with thick wall and broad lumen.

Stomata were of anomocytic type.

D/1183.

Anacardiaceae

1. *Anacardium occidentale* Linn. *Sp. Pl.* (1753) p. 383.

A small branched tree with a short thick crooked trunk; branches terete, glabrous. Leaves alternate, coriaceous, reaching upto 6 cm long, obovate or elliptic, glabrous, finely reticulately veined, base cuneate; main nerves 10-12 pairs, prominent beneath. Panicles terminal, the branches cymose; bract ovate, nerved, puberulous outside. Flowers polygamous. Calyx 5-partite, deciduous; sepals lanceolate, puberulous outside. Petals linear-lanceolate, deflexed from the middle, minutely puberulous outside. Stamens about 9, one longer than the others, the longer one exerted beyond the recurved petals. Ovary attenuated into a subulate style. Fruit reniform, its pedicel large, flesy, dark-colored. (Fig. 106)

Vernacular name: Kaju.

Flowers: January-March.

Micromorphology (Fig. 106)

The trichomes were unicellular with blunt tip and broad lumen.

Two types of stomata were observed anomocytic and anisocytic types.

2. *Buchanania lanzan* Spreng. in *Schrader, Journ.* V. 4 (1801) p. 234.

A large tree 18 m. high, with straight trunk and young branches clothed with silky hairs. Leaves thickly coriaceous, reaching upto 10 cm long., broadly oblong, obtuse, sometimes emarginated, glabrescent above, villous beneath, reticulately veined, base rounded; main nerves 10-12 pairs. Flowers small, sessile, greenish white, in terminal and axillary panicles; bracts small, caduceus. Calyx lobes 3-5 toothed, short, broadly ovate, ciliate. Petals 4-5, ovate-oblong, subacute. Disk fleshy. Stamens 10; filaments flattened; anthers about as long as the filaments. Ovaries: 1-perfect, conical, villous, the other 4 reduced to cylindrical filaments. Drupes obliquely lentiform, black; stone hard, 2-valved. (Fig. 107)



Fig. 104. *Cardiospermum halicacabum* L. a. habit, b & c. flowers, d. large petal with a scale, e. small petal with a scale, f & g. stamen, h. gynoecium with trifid stigma, i. L.S. of flower, j. fruit, k. seed with aril.

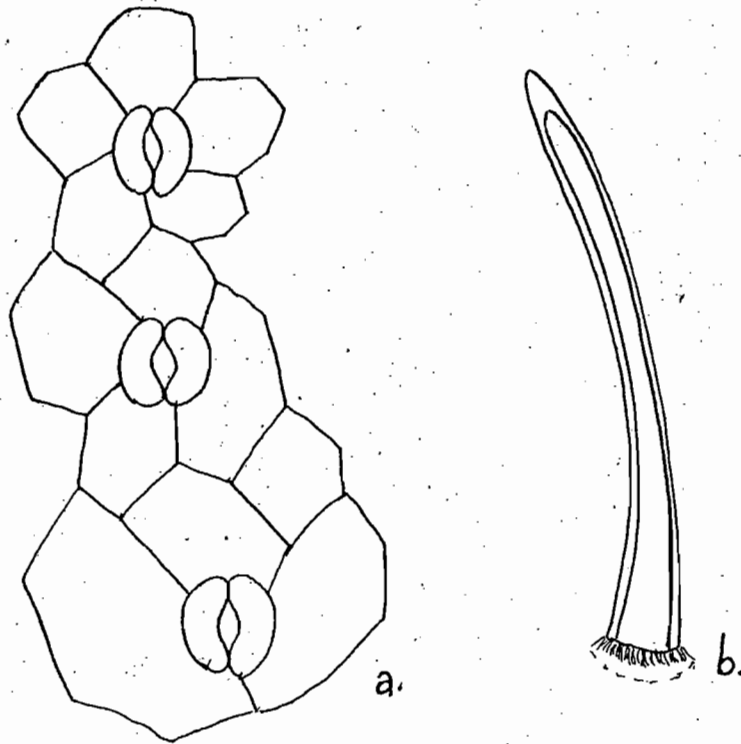


Fig. 105. *Cardiospermum halicacabum* L. a. anomocytic stomata, b. unicellular trichome with blunt tip and broad lumen.

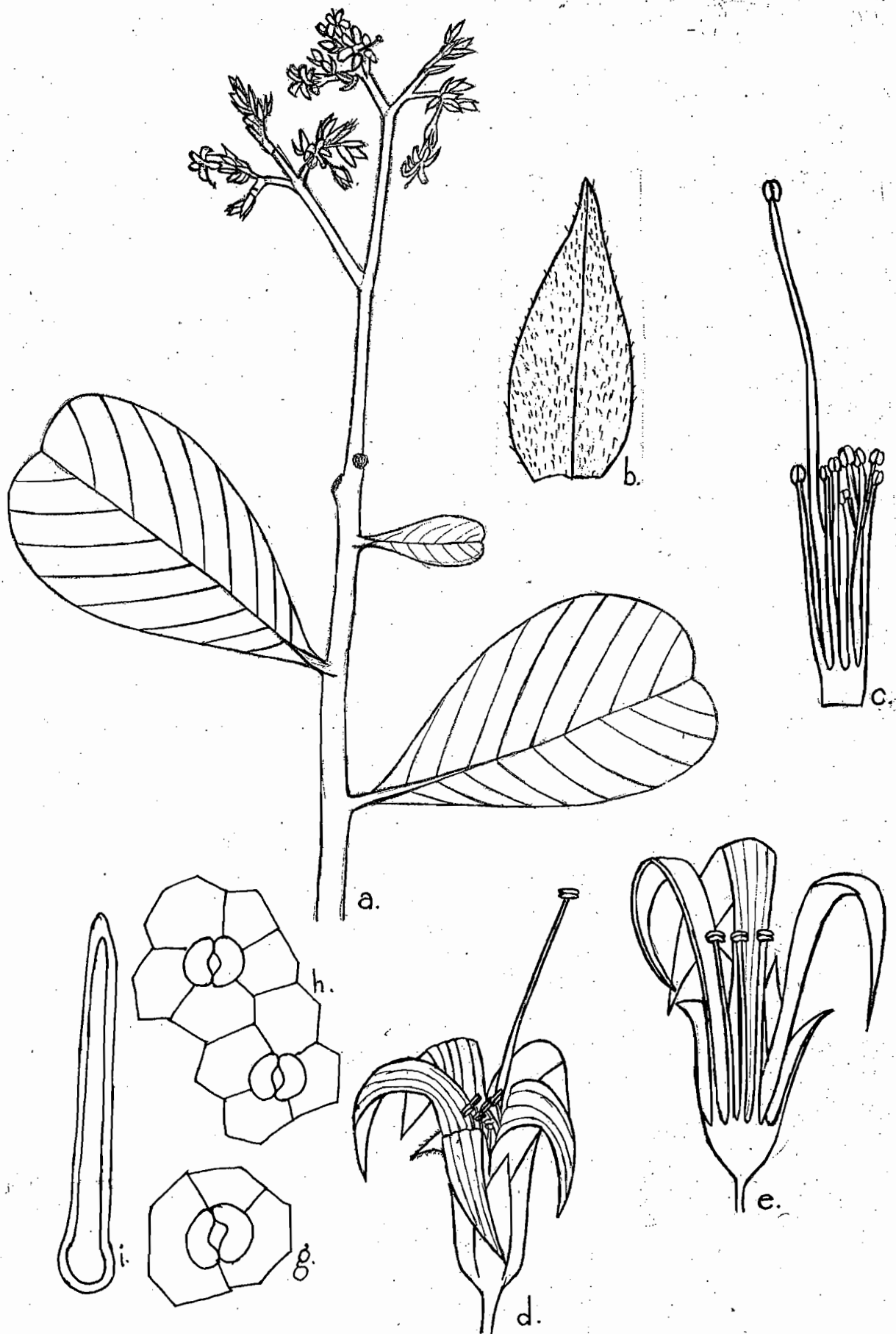


Fig. 106. *Anacardium occidentale* L. a. habit, b. bract, c. stamens connate at the base and one very long, exserted, d. male flower, e. L.S. of male flower, f. L.S. of bisexual flower, g. anomocytic stomata, h. anisocytic stomata, i. unicellular trichome with blunt tip and broad lumen.

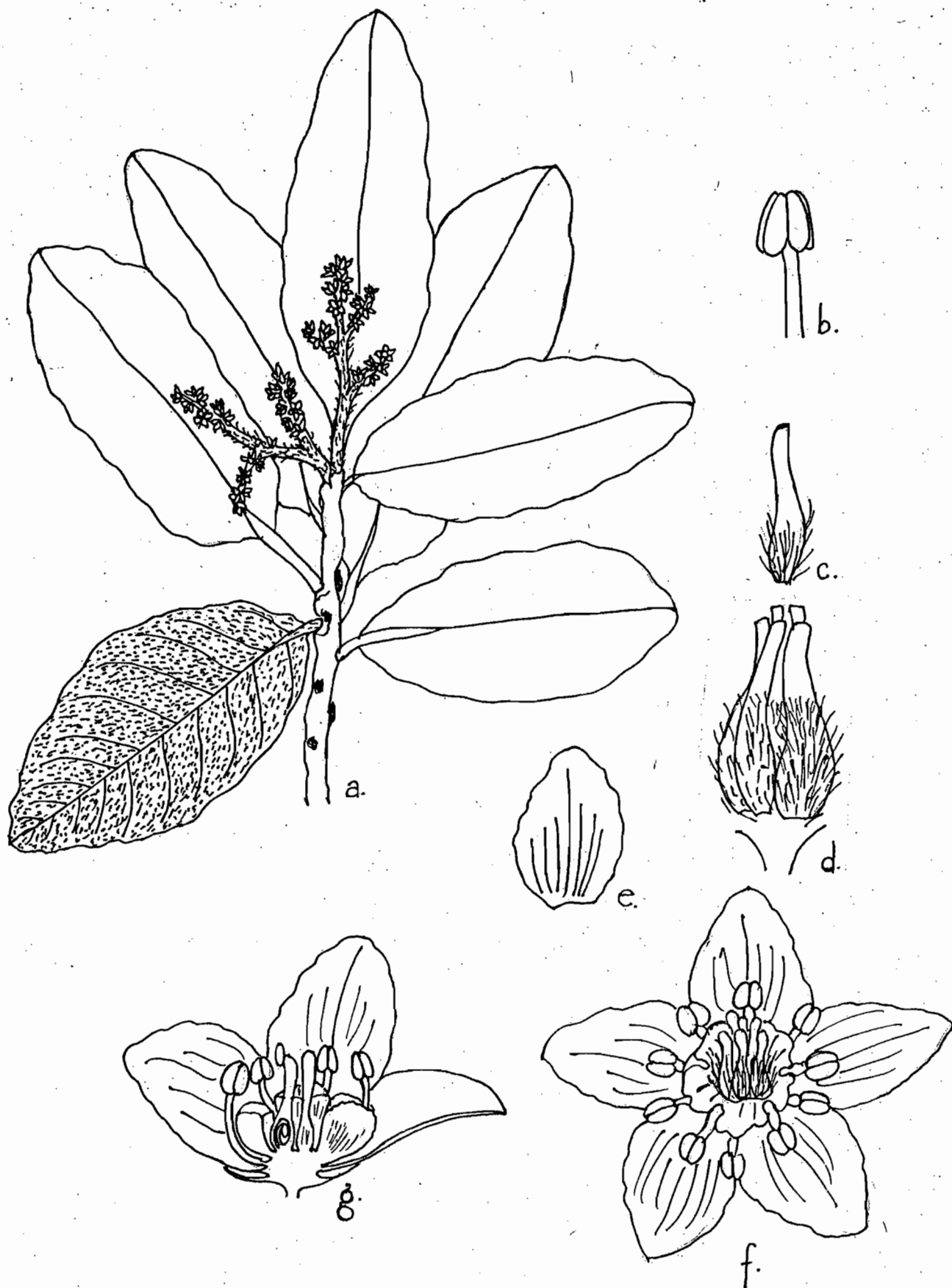


Fig. 107. *Buchanania lanzan* Spr. a. habit, b. stamen, c. carpel, d. gynoeceium, e. petal, f. flower, g. L.S. of flower.

Vernacular name: Charoli.

Flowers: January- March.

Micromorphology (Fig. 108)

The trichomes were unicellular filamentous trichome.

Stomata were of anisocytic, paracytic and anomocytic types.

D/738.

3. *Mangifera indica* Linn. *Sp. Pl.* (1753) p. 200.

A large spreading evergreen tree reaching 20 m in height, all parts glabrous except the inflorescence. Leaves alternate, crowded at the ends of the branches, coriaceous, about 10 cms. long, oblong-lanceolate, acute, shining, entire, the margins often undulate, base narrowed; petioles upto 5 cm. Flower monoecious, arranged in large pubescent panicles; pedicels short, thick; bracteoles ovate, small. Calyx 4-5 partite, sepals ovate, pubescent outside, shorter than the petals. Petals 4-5, oblong, subacute, reflexed, glabrous, with 3 strong orange-colored ridges on the inner face. Disk fleshy, 5-lobed. Stamen 1; filament subulate; anther purple. Ovary glabrous, sessile, 1-celled, oblique; ovule pendulous. Drupes large, fleshy, obliquely pyriform or subovoid, subcompressed, about 17 cm long; stone compressed, fibrous, very hard. (Fig. 109)

Vernacular name: Ambo.

Flowers: January-February.

Micromorphology (Fig. 110)

There were both glandular and non-glandular trichomes. The glandular trichome was with a head of four tiers of four cells each a single celled stalk and the non-glandular trichome was unicellular long pointed with a thick wall.

Stomata were of anisocytic and anomocytic types.

D/219.

Moringaceae

1. *Moringa pterygosperma* Gaertn. *Fruct.* V. 2 (1791) p. 314.

A middle-sized branched tree with corky bark. Leaves usually 3-pinnate, sometimes reaching upto 50 cm long; rhachis slender, thickened and articulated at the base; pinnae and pinnules opposite, deciduous, ultimate leaflets: lateral elliptic, the terminal obovate and slightly larger than the lateral ones; nerves obscure. Flowers white, in large puberulous panicles. Calyx cup shaped, 5-cleft, lobes linear-lanceolate reflexed, puberulous outside. Petals 5, unequal, spatulate, veined, the upper smaller, the lateral ascending, the anterior the larger. Disk lining. Stamens 5, fertile, alternating with 5-7 antherless ones; filaments villous at the base. Ovary oblong, villous; style cylindric. Pods reaching upto 38 cm long, 9-ribbed. (Fig. 111)

Vernacular name: Sargavo.

Flowers: January-April.

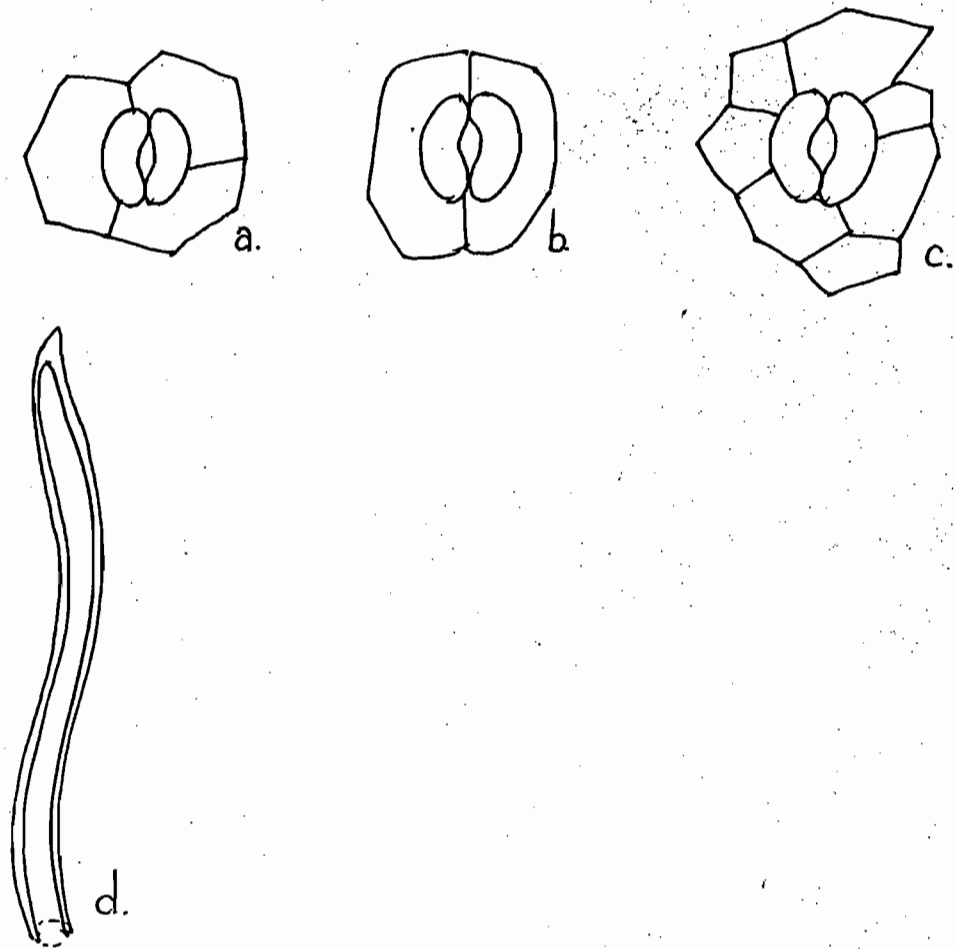


Fig. 108. *Buchanania lanzan* Spr. a. anisocytic stomata, b. paracytic stomata, c. anomocytic stomata, d. unicellular trichome.

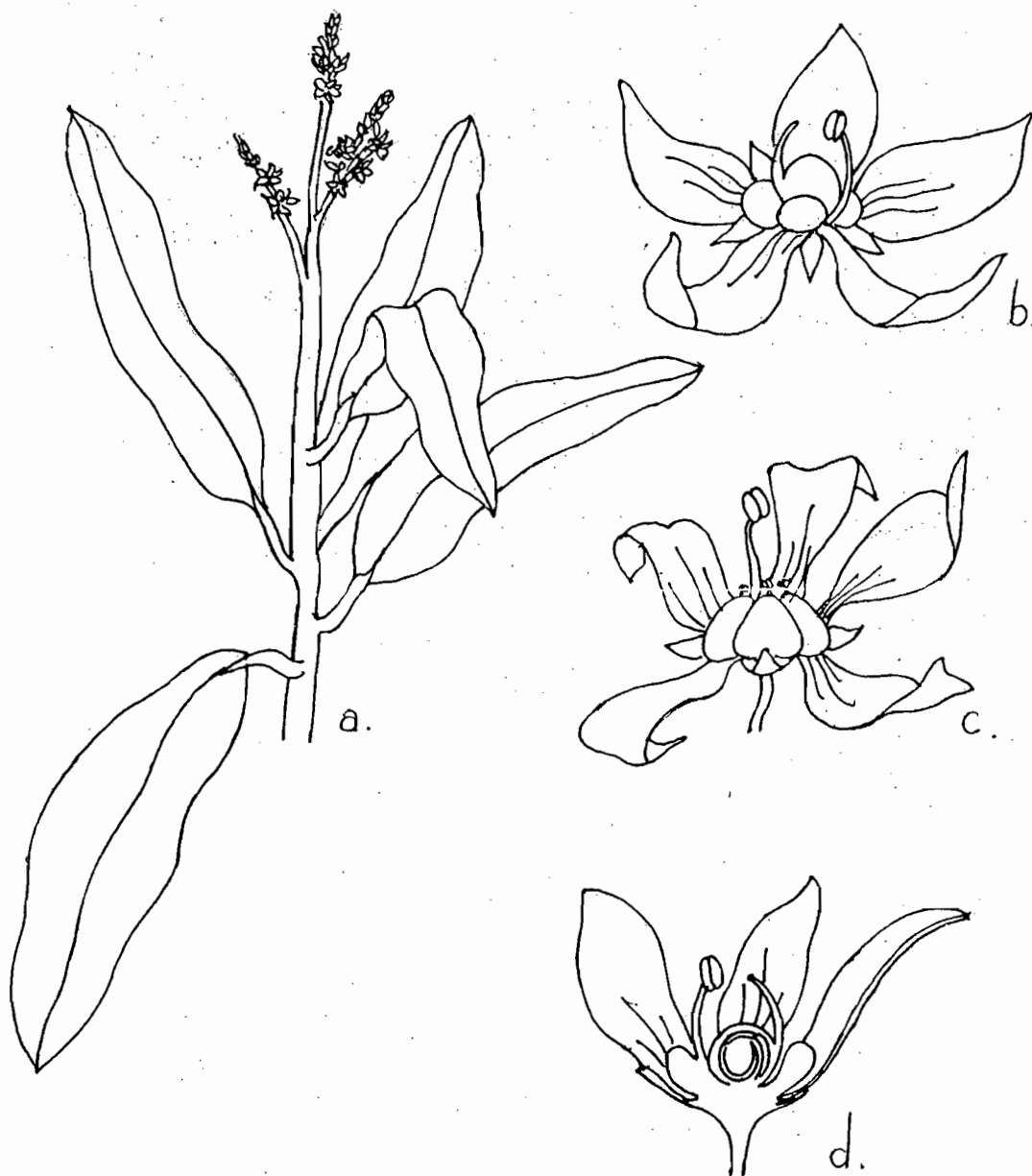


Fig. 109. *Mangifera indica* L. a. habit, b. bisexual flower, c. male flower, d. L.S. of bisexual flower.

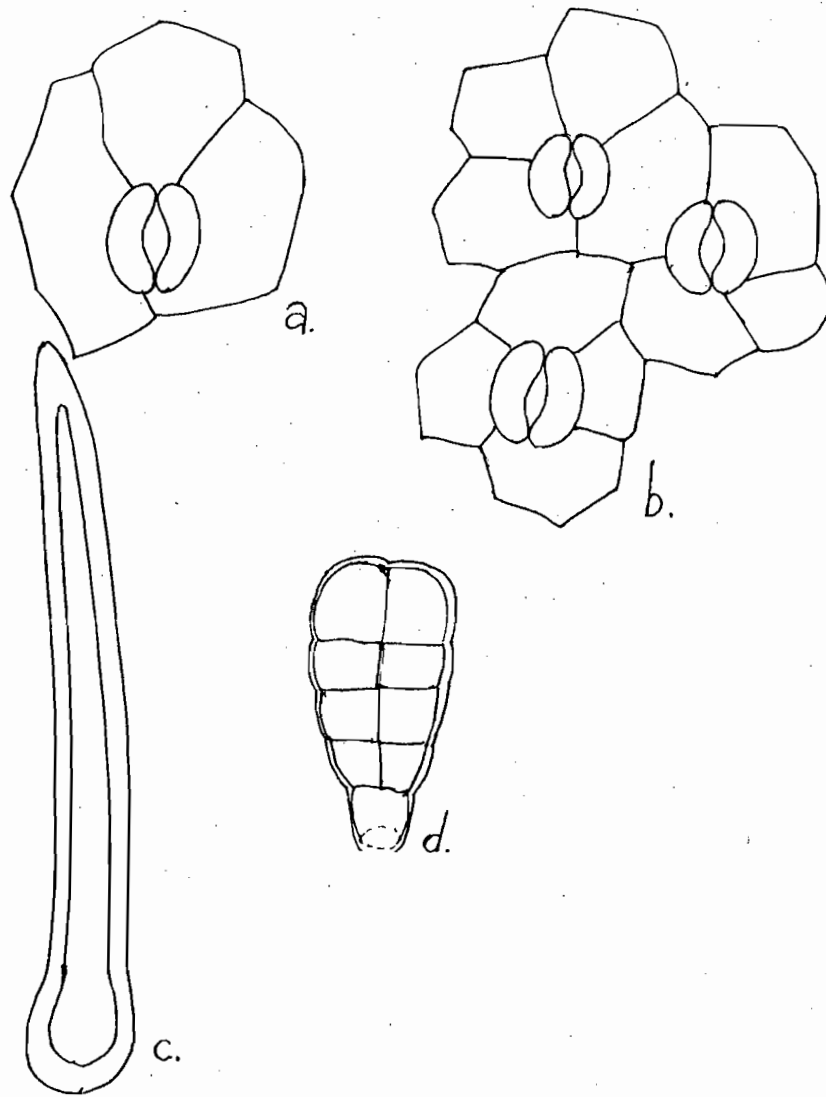


Fig. 110. *Mangifera indica* L. a. anisocytic stomata, b. anomocytic stomata, c. unicellular trichome, d. glandular trichome with a head of four tiers of four cells each a single celled stalk.

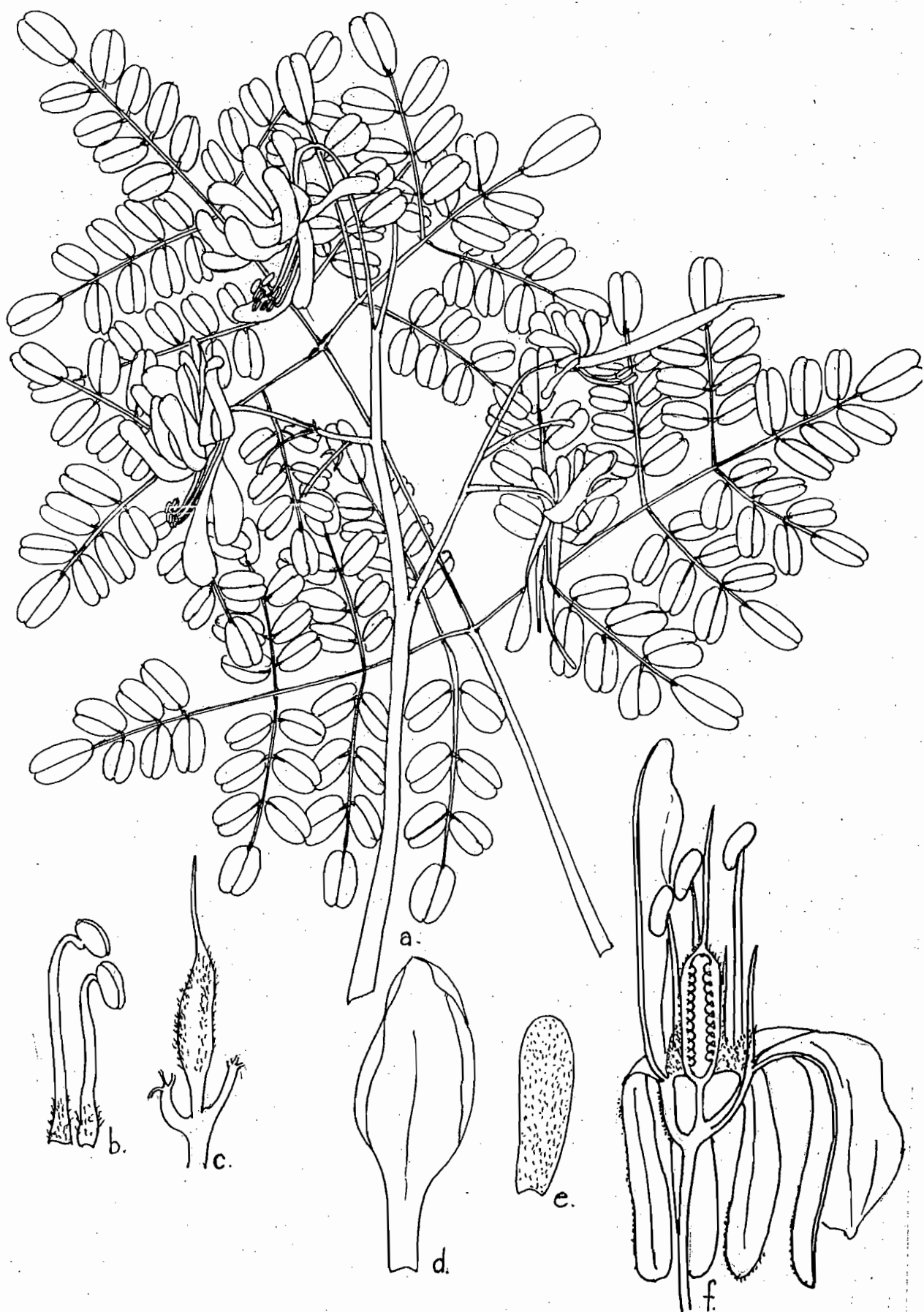


Fig. 111. *Moringa pterygosperma* Gaertn. a. habit, b. stamen declinate and one-celled, c. gynoecium with a cup-shaped thalamus, d. petal, e. sepal, f. L.S. of flower.

Micromorphology (Fig. 112)

Two types of trichomes were present; one glandular unicellular with a thin wall and broad base another was non-glandular unicellular trichome with thick walls.

Stomata were anisocytic and anomocytic types.

D/953.

Fabaceae

1. *Aeschynomene indica* Linn. *Sp. Pl.* (1753) p. 713.

This much branched annual undershrub reaches a height of 1m and possesses imparipinnate leaves. The rachis is long, studded with minute glandular excrecences almost amounting to prickles; stipules scarious, lanceolate, acuminate, Leaflets alternate, many subsessile, set obliquely on the rachis and overlapping, linear, obtuse, apiculate, glabrous, unequal-sided, thin, 1-nerved, the uppermost smallest. Flowers in 1-4 flowered axillary racemes; peduncles about 3 cm long, and as well as the pedicels, glandular, often viscid; pedicels filiform; bracts foliaceous, bristle-toothed; bracteoles linear-oblong, acute. Calyx thinly membranous, glabrous; upper lip bifid; lower lip minutely 3-toothed. Corolla yellow; standard veined with purple, orbicular, shortly clawed; wings obliquely obovate or oblong, equaling the standard; keel not beaked. Stamens in 2 bundles of 5 each; anthers uniform. Ovary stalked, 2-many ovulate; style incurved; stigma terminal. Pods slightly curved or nearly straight; upper sutures straight, the lower more or less indented; joints 6-10, readily separating, smooth or slightly papillose. (Fig. 113)

Vernacular name: Paragdodi.

Flowers: August-December.

Micromorphology (Fig. 113)

The plant was glabrous and no trichomes were observed on the leaf.

Stomata were of anisocytic, tetracytic and paracytic types.

D/670, 960, 1173.

2. *Alhagi camelorum* Fisch. *Ind. Hort. Gorenk.* ed. 2 (1812) p. 72.

A low erect armed shrub reaching to the height of 4 cms. long. Leaves simple, coriaceous, upto 1 cm long, obovate-oblong, obtuse, apiculate, glabrous or puberulous, base cuneate; petioles very short; stipules minute, subulate. Flowers 5-8 on a spine; pedicels short, slender. Calyx glabrous, long; teeth short, triangular. Corolla a little more than twice as long as the calyx; standard obovate-oblong, auricled at the base above the claw, glabrous; wings falcate-oblong, free; keel incurved, obtuse, about equaling the standard and the wings. Stamens diadelphous; anthers uniform. Ovary glabrous, stalked; ovules many; style filiform, incurved, glabrous; stigma small, terminal. Pods upto 3 cm long, usually falcate, more or less, contracted between the seeds, glabrous. Seeds blackish-brown, smooth, polished. (Fig. 114)

Vernacular name: Jawasiyo.

Flowers: March-June.

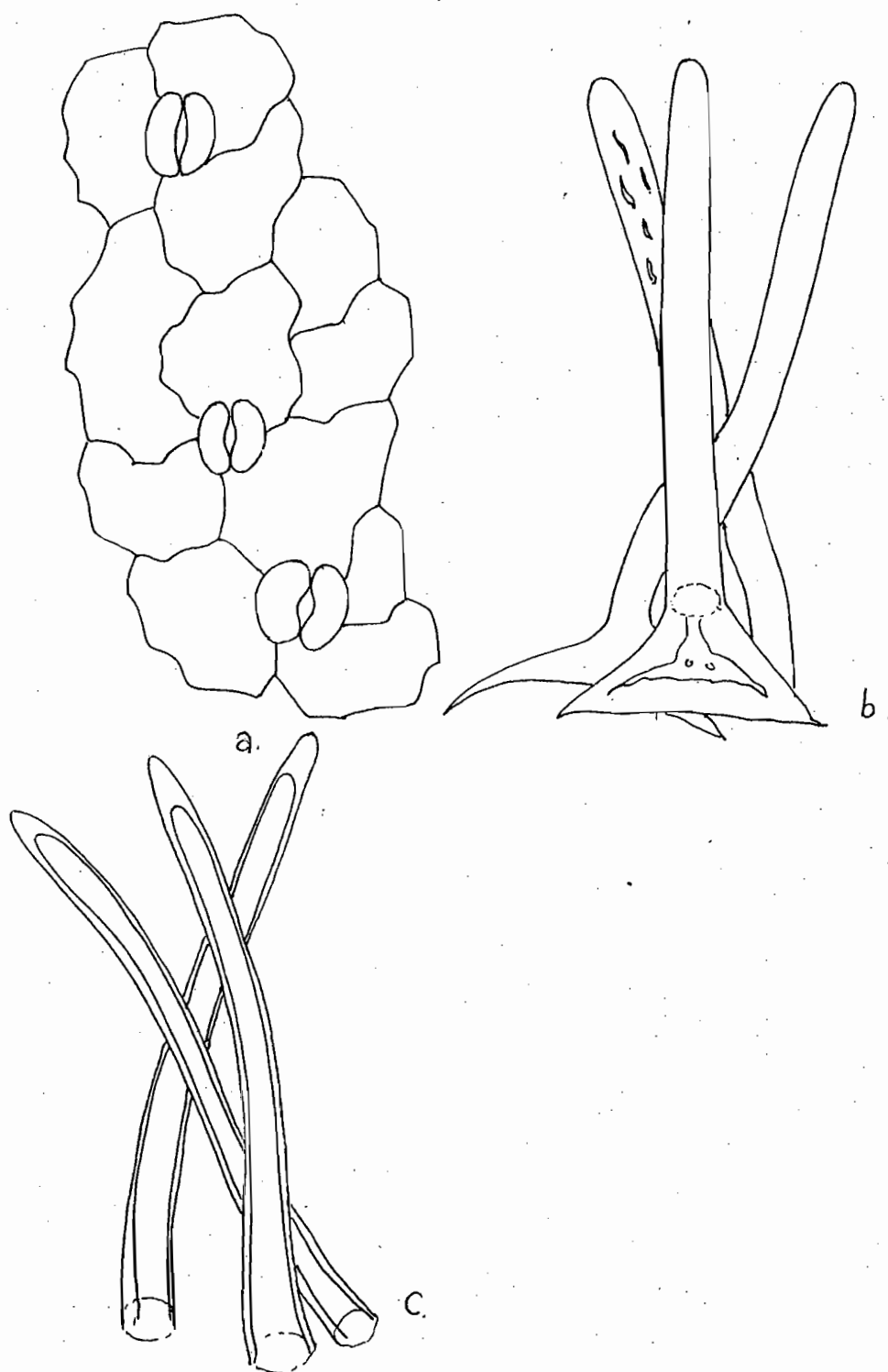


Fig. 112. *Moringa pterygosperma* Gaertn. a. anisocytic and anomocytic stomata, b. glandular unicellular trichome with a thin wall and a triangular base, c. unicellular trichome with thick walls.

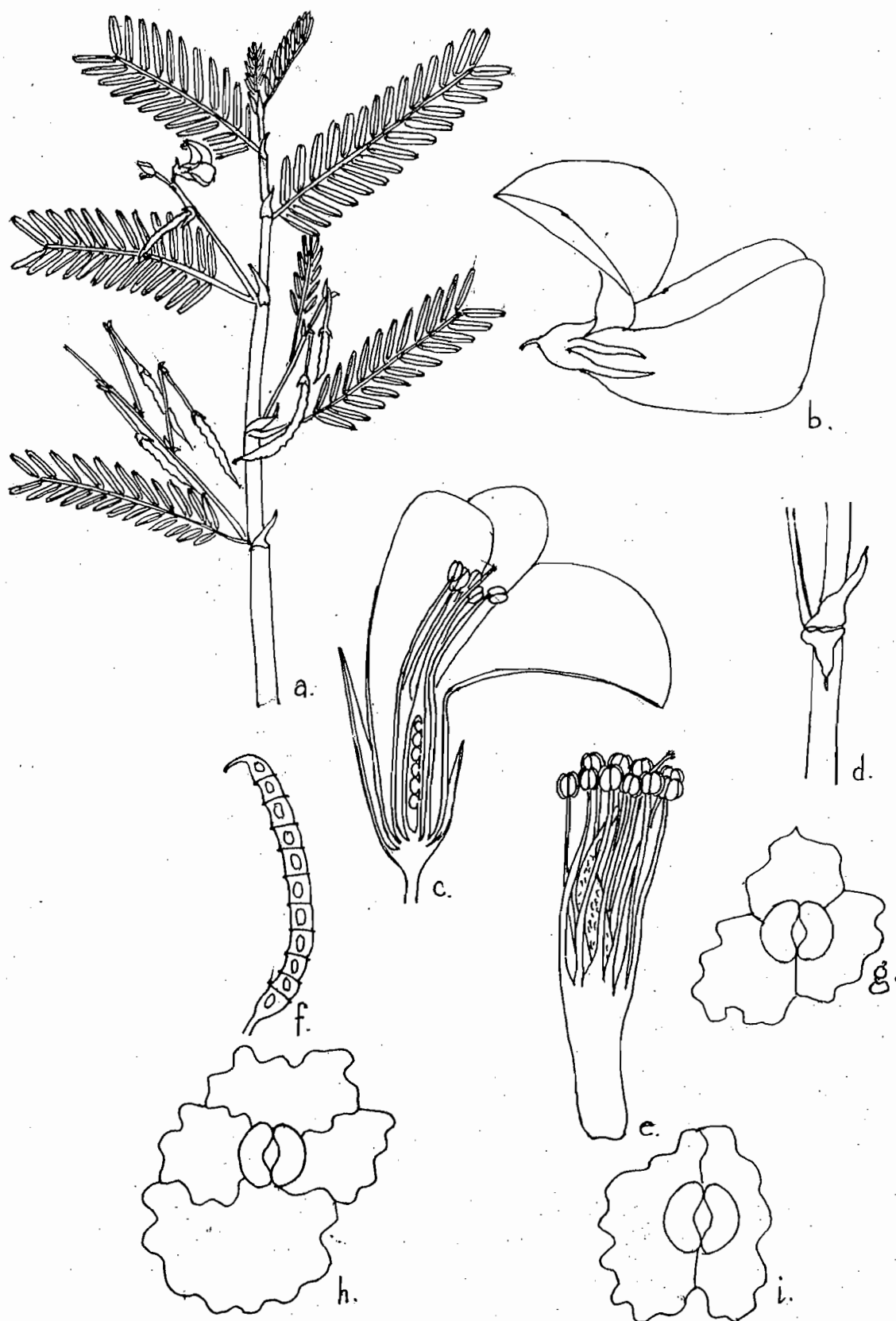


Fig. 113. *Aeschynomene indica* L., a. habit, b. flower, c. L.S. of flower, d. stipule, e. stamens and gynoecium, f. lomentum, g. anisocytic stomata, h. tetracytic stomata, i. paracytic stomata.

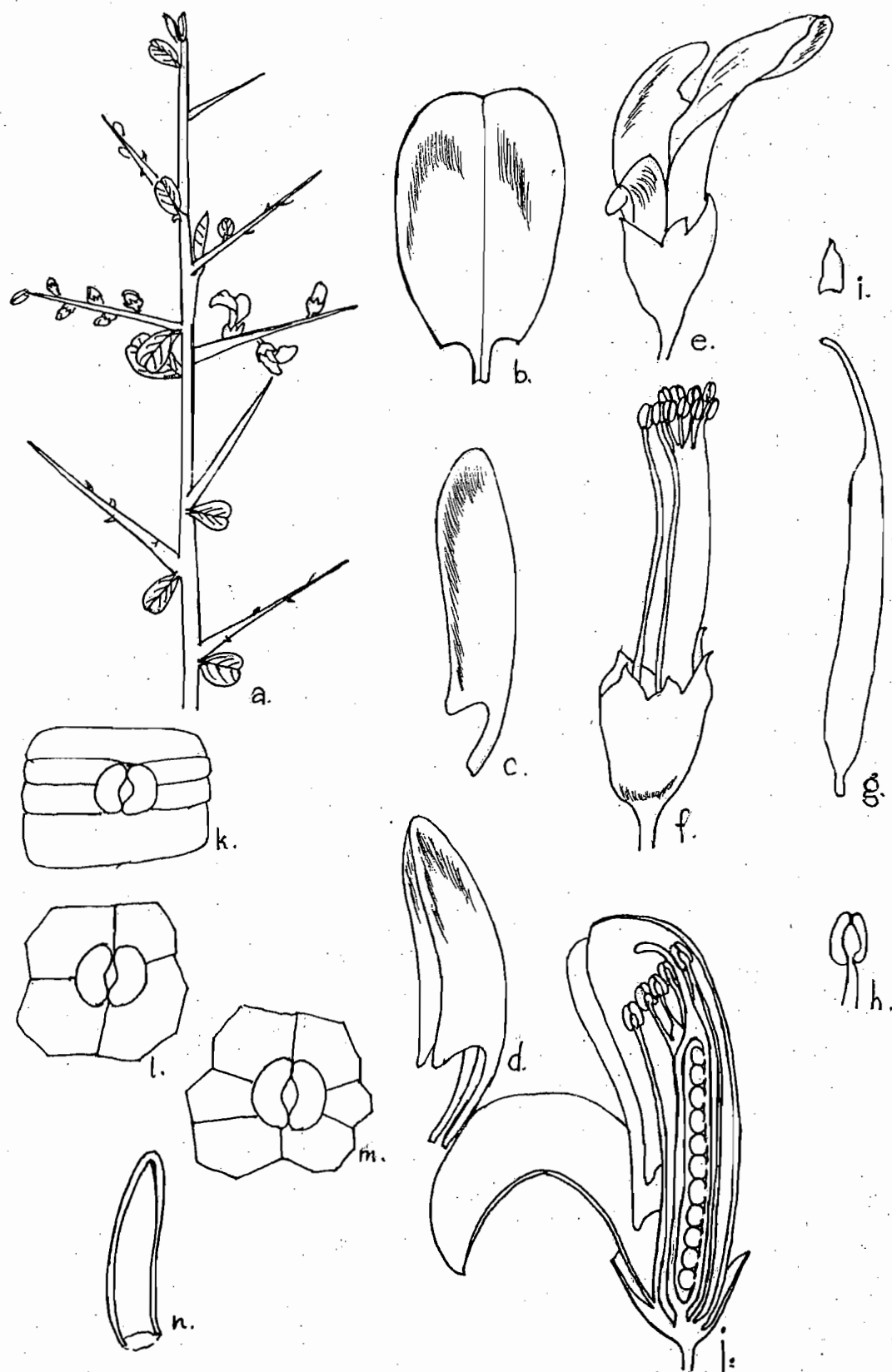


Fig. 114. *Alhagi camelorum* Fisch. a. habit, b. standard petal, c. lateral petal, d. keel, e. flower, f. calyx with diadelphous stamens, g. gynoeccium, h. anther i. bract, j. L.S. of flower, k. anomocytic stomata l. tetracytic stomata, m. cyclocytic stomata, n. unicellular club-shaped gland.

Micromorphology (Fig. 114)

The plant showed presence of unicellular, non-glandular, elongate trichome with a rounded apex.

Stomata were hexacytic, and anomocytic.

D/826, 827, 828.

3. *Alysicarpus vaginalis* DC. Prodr. V. 2 (1825) p. 353.

A diffuse suffruticose herb with numerous stem and ascending to a length of 1 m. Leaves 1-foliate; petioles upto 1 cm long; stipules scarious, often exceeding 1.25 cm long, ovate acuminate, striate, straw-colored, persistent. Leaflets upto 6 cm, lanceolate, ovate-oblong, apiculate, glabrous, base usually cordate. Flowers in 6-12 flowered racemes upto 8 cm long. Calyx slightly longer than the first joint of the pod. Corolla pinkish, included; standard obovate or orbicular, narrowed into the claw; wings obliquely oblong, adhering to the keel, slightly curved, obtuse, usually appendiculate. Stamens diadelphous; anthers uniform. Ovary sessile; ovules numerous; style incurved; stigma capitate. Pods upto 2 cm long, obscurely moniliform, apiculate; joints 4-8, longer than broad. (Fig. 115)

Vernacular name: Gaddar samervo.

Flowers: August-October.

Micromorphology (Fig. 115)

The plant showed presence of unicellular, non-glandular, elongated, pointed trichome with thick wall and a round bottom.

Stomata were tetracytic and anomocytic.

D/1227-1228.

4. *Butea frondosa* Konig. ex Roxb. as. Res. V. 3 (1792) p. 469

An erect branched tree with crooked trunk reaching a height of 17 m. Leaves 3-foliate; petioles upto 15 cm long; stipules linear-lanceolate, deciduous. Leaflets coriaceous (the terminal upto 20 cm long and about as broad as long, broadly obovate from a cuneate base, the lateral smaller, upto 15 cm long, obliquely rounded at the base, inequilateral) all obtuse, finely silky beneath. Flowers in racemes 15 cm long, pedicels about twice as long as the calyx, densely brown-velvety; bracts and bracteoles small, deciduous. Calyx 1 cm long, dark olive-green, densely velvety outside, clothed with silky hairs within; teeth short, the 2 upper connate, the 3 lower equal, deltoid. Corolla orange, 4-5 cm long, clothed outside with silky silvery hairs, standard petal 2.5 cm broad, ovate; keel semicircular, beaked, veined. Stamens diadelphous; anthers uniform. Ovary shortly stalked; ovules 2; style incurved, beardless; stigma very small. Pods stalked, 13-20 by 3-5 cm, thickened at the sutures. (Fig. 116)

Vernacular name: Khakharo.

Flowers: February-March.

Micromorphology (Fig. 116)

The plant showed unicellular, non-glandular, elongated trichome which was thick walled.

Stomata were anomocytic.

D/157

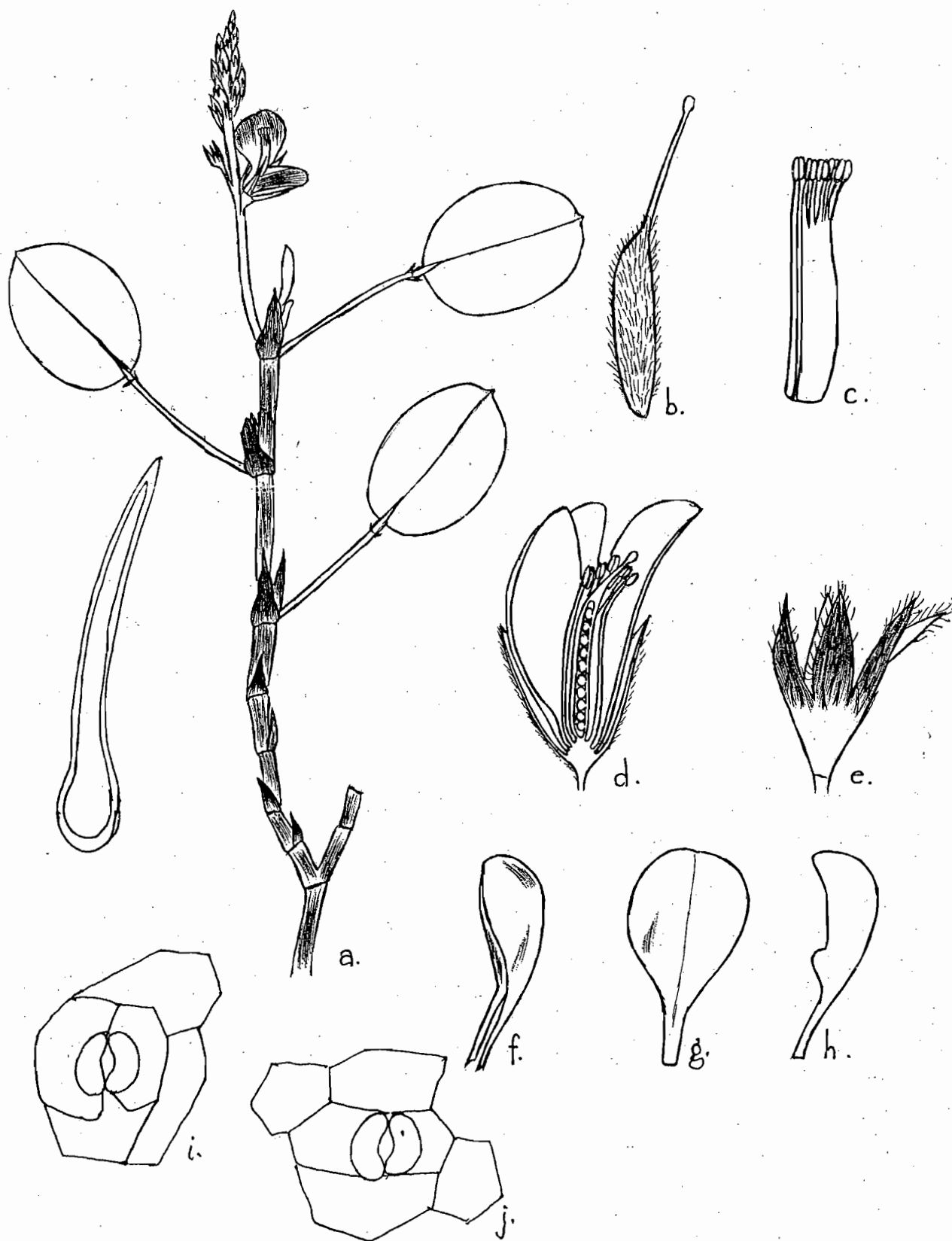


Fig. 115. *Alysicarpus vaginalis* DC., a. habit, b. gynoecium, c. diadelphous stamens, d. L.S. of flower, e. calyx, f. keel petal, g. standard petal, h. wing petal, i. anisocytic stomata, j. tetracytic stomata, k. unicellular trichome with broad lumen and round base.



Fig. 116. *Butea frondosa* Konig. ex Roxb., a. habit, b. diadelphous stamens, c. gynoeceium, d. L.S. of flower, e. anisocytic and anomocytic stomata, f. unicellular trichome.

5. *Canavalia ensiformis* DC. Prodr. V. (1825) p. 404

A perennial or biennial twiner with stout, glabrous stem and branches. Leaves upto 30 cms long; petioles 15 cms long, glabrous; stipules triangular, deciduous. Leaflets membranous, upto 15 cm long, ovate, shortly acuminate, glabrous on both surfaces; stipels subulate, caducous. Flowers in lax 12-20 flowered axillary racemes; pedicels usually in pairs; bracteoles ovate, caducous. Calyx limb 2-lipped, the upper lip oblong, notched, the lower lip shortly 3-toothed. Corolla upto 4 cms long, lilac; standard suborbicular; wings narrow, equaling the incurved obtuse or obtusely-rostrate keel. Anthers uniform. Ovary obscurely stalked; ovules many; style incurved, beardless; stigma terminal. Pods upto 30 cm long, slightly incurved. Seeds 8-20, reddish brown or white. (Fig. 117)

Vernacular name: Tarvardi.

Flowers: August-October.

Micromorphology (Fig. 118)

Whole plant was glabrous.

Stomata were anisocytic, anomocytic and paracytic types.

D/1233.

6. *Clitoria ternatea* Linn. Sp. Pl. (1753) p. 753.

A perennial pubescent twining herb. Leaves imparipinnate; stipules linear, acute. Leaflets 5 – 7, subcoriaceous, upto 5 cms, elliptic-oblong, obtuse, with a few short appressed hairs; stipels filiform. Flowers axillary, solitary; pedicels upto 1.5 cm long; bracts small, linear; bracteoles upto 1.5 cm long, roundish, obtuse. Corolla 1 about 2.5 cm long; standard bright-blue or sometimes white, with an orange centre. Pods upto 9 cms. long., flattened, nearly straight, sharply beaked, sparsely appressedly hairy. Seeds 6-10, yellowish-brown, smooth. (Fig. 119)

Vernacular name: Garni.

Flowers: June-January.

Micromorphology (Fig. 119)

Unicellular glandular trichomes with thin wall and some inclusions were observed.

Stomata were anisocytic, tetracytic and paracytic types.

D/1052.

**7. *Cracca tenuis* (Wall.) Kuntze, Revis. Gen. Pl. 1: 175 1891.
(*Tephrosia tenuis* Wall.)**

A annual herb with slender, terete hairy stem reaching upto 30 cms. long. Leaves simple, upto 4 cm long, linear, narrowed at the apex, slightly hairy above, silky beneath, narrowed at the base; midribs prominent on the under surface; nerves obscure; stipules long, subulate. Flowers solitary or 2 together in the axils of the leaves; pedicels long, filiform. Calyx silky; teeth lanceolate-subulate. Corolla 0.5 cm long, at first bluish, afterwards turning yellow; standard long-clawed, pubescent at the back; wings obovate. Pods upto 3 cm long, thinly clothed with appressed hairs. Seeds 6-10. ((Fig. 120)

Vernacular name: Sani Sarpankhi.

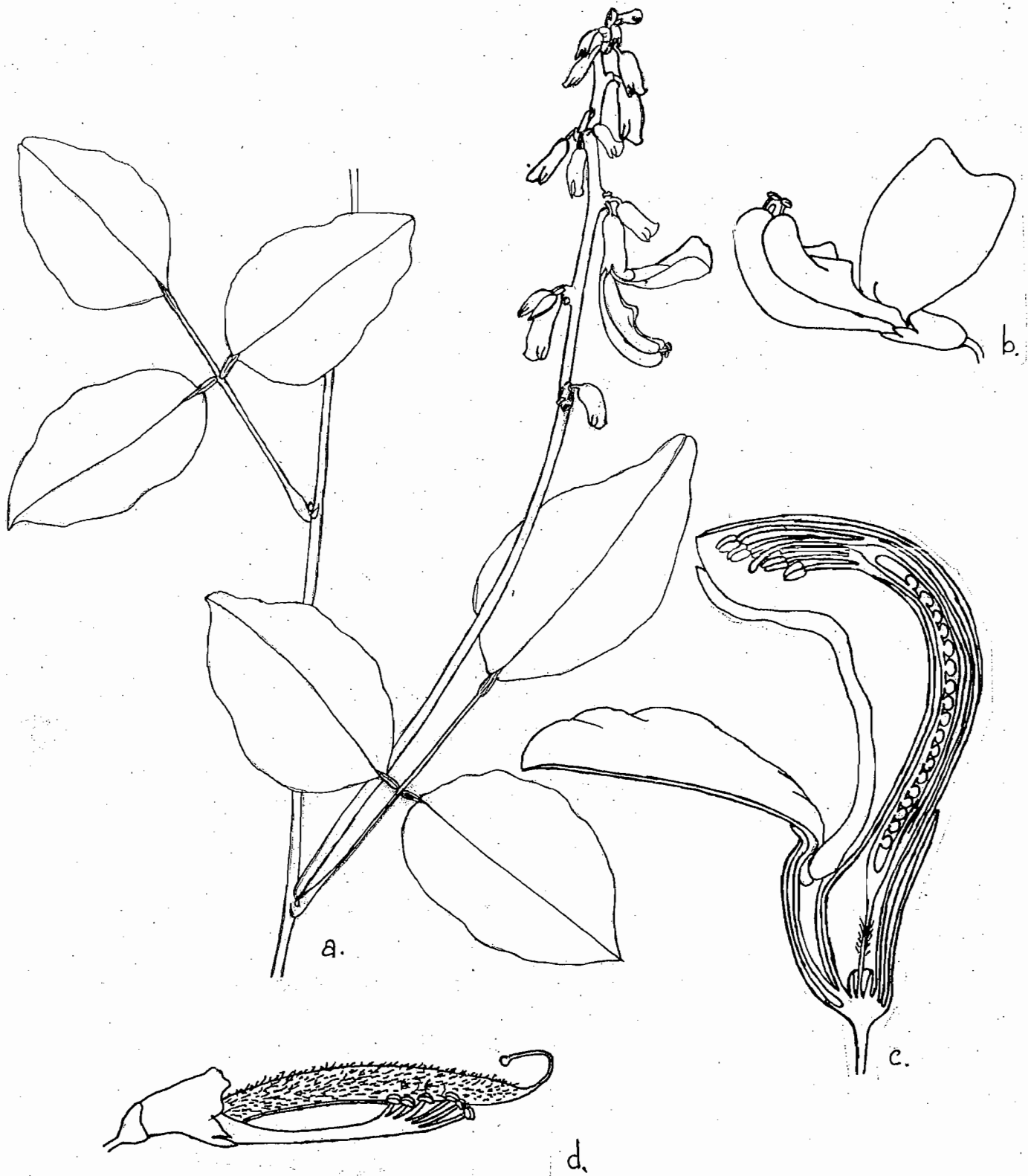


Fig. 117. *Canavalia ensiformis* DC. a. habit, flower, c. L.S. of flower, d. a young fruit.

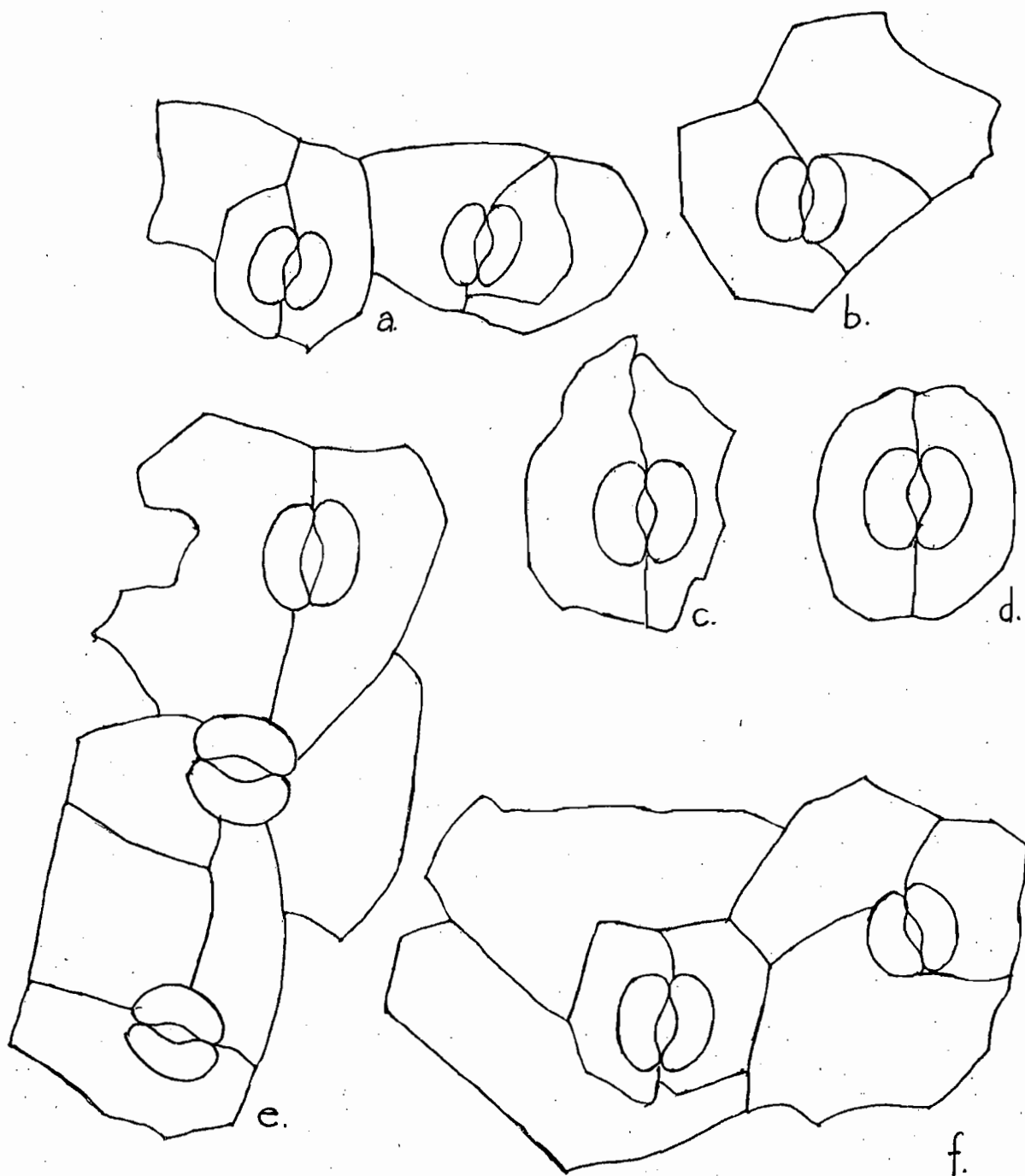


Fig. 118. *Canavalia ensiformis* DC. a, c-f. paracytic stomata, b & f. anisocytic stomata.

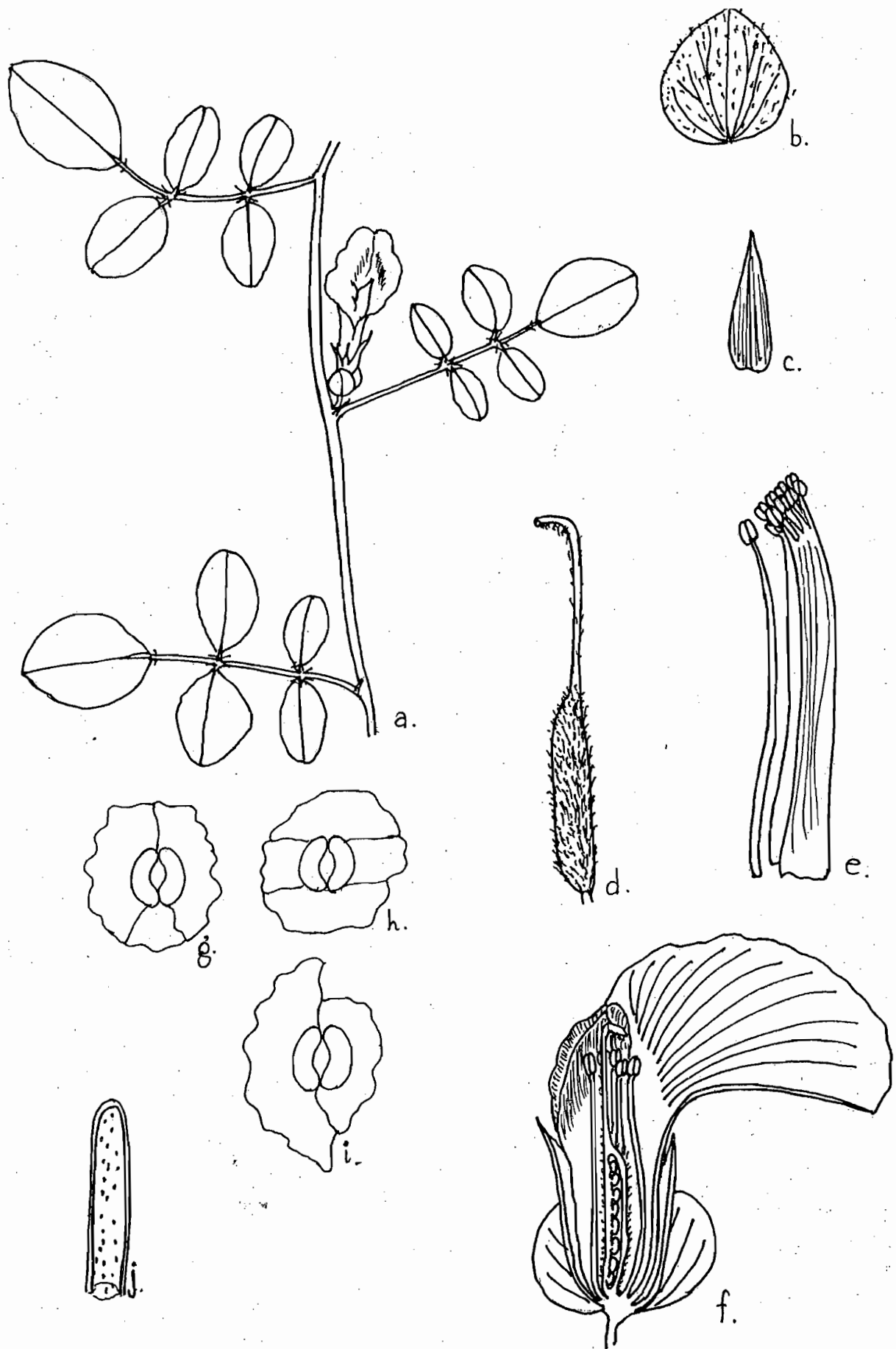


Fig. 119. *Clitoria ternatea* L. a. habit, b. bract, c. sepal, d. gynoecium, e. stamen, f. L.S. of flower, g. anisocytic stomata, h. tetracytic stomata, i. paracytic stomata, j. unicellular glandular trichome with some inclusions.

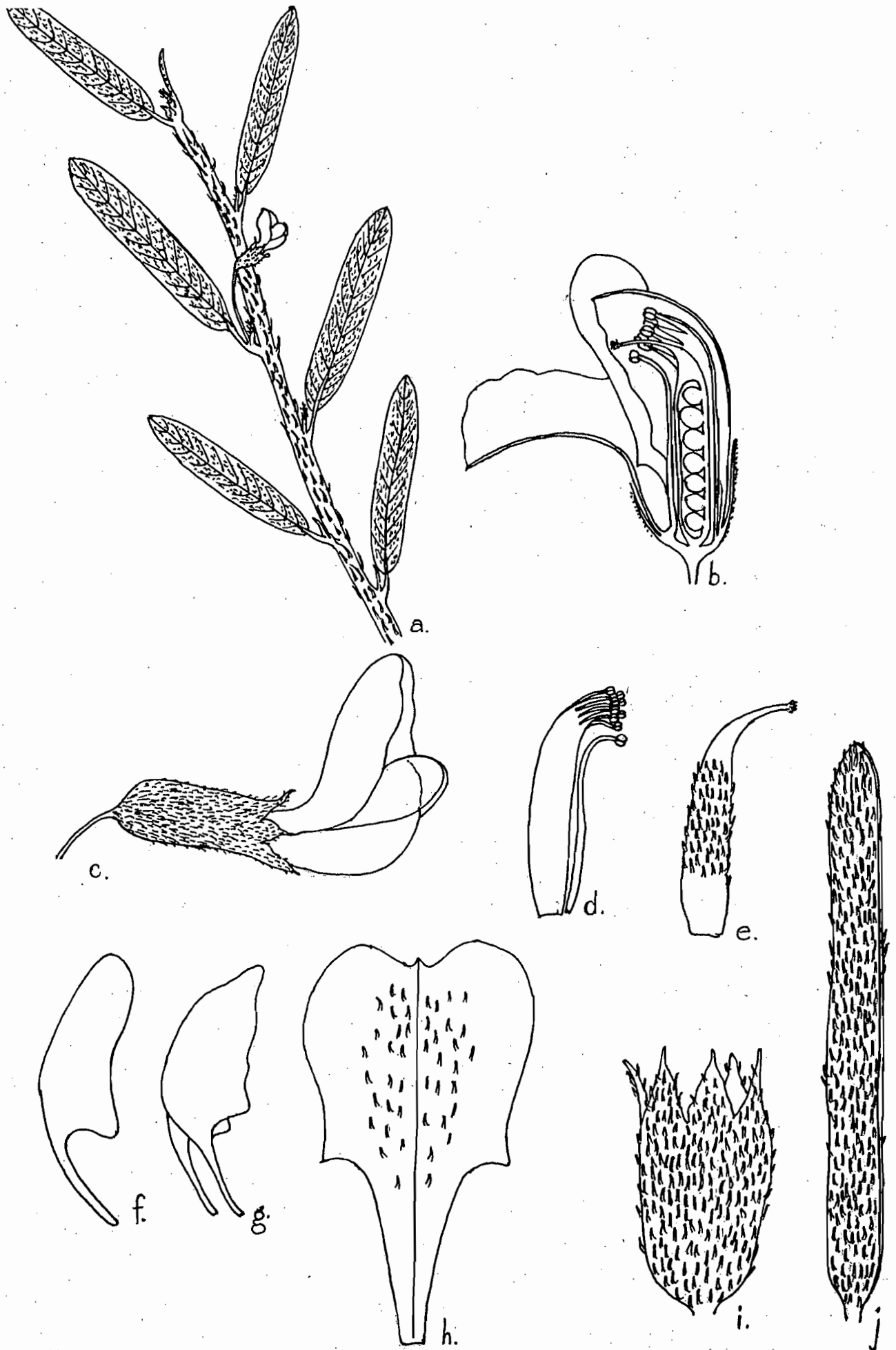


Fig. 120. *Cracca tenuis* (Wall.) Kuntze, a. habit, b. L.S. of flower, c. flower, d. diadelphous stamens, e. gynoecium, f. wing petal, g. keel petals, h. standard petal, i. calyx, j. fruit.

Flowers: September-October.

Micromorphology (Fig. 121)

The plant showed presence of unicellular, non-glandular, elongated trichome with thick wall and warty surface.

Stomata were anisocytic and anomocytic types.

D/375, 854, 1092- 1095, 1166.

8. *Crotalaria hirsuta* Willd. *Sp. Pl.* 3:978. (1803)

An erect or diffuse perennial herb, upto 1m high, clothed with softly spreading hairs. Branches slightly arched. Leaves simple, broadly ovate acute, about 5cm long, rounded or slightly oblique at base and mucronate at apex; stipules linear, minute, reflexed. Racemes short peduncled, up to 5 cm long, 2-3 flowered. Peduncles slender, often leafy, clothed with short spreading hairs. Bracts lanceolate, minut. Corolla yellow, standard with purple spots, exserted. Pods sessile, oblong, clothed with short brown spreading hairs. (Fig. 122)

Vernacular name: Fatakio

Flowering season: August-October.

Micromorphology (Fig. 122)

Non-glandular unicellular trichome with broad lumen and blunt tip were seen.

Stomata were diacytic, anisocytic and paracytic types.

D/142.

9. *Crotalaria leptostachya* Benth. in Hook. *Lond. Journ. Bot.* V. 2 (1843) p. 562.

A stiff erect branched shrub with tetragonous stem and branches. Leaves membranous, upto 15 cms. long, oblong-lanceolate, acute, apiculate, thinly clothed with hairs; petioles very short; stipules minute, deciduous. Flowers in elongate many-flowered racemes upto 26 cms. long; pedicels short; bracts small, subulate, hairy. Calyx tube very short; teeth long, triangular, acute, the 2 upper divaricate, slightly broader and a little more deeply cleft than the 3 lower ones. Corolla yellow, not exserted; standard suborbicular. Pods with seeds 4-6. (Fig. 123)

Vernacular name: Zipta.

Flowers: September- November.

Micromorphology (Fig. 124)

Non-glandular unicellular trichome with broad lumen and blunt tip were seen.

Stomata were of only anomocytic type.

D/974-976.

10. *Crotalaria medicaginea* Lam. *Encyc. Method.* V. 2 (1786) p. 201.

A perennial branched herb scarcely reaching 30 cm. Leaves 3-foliolate; petioles upto 0.5 cm long; stipules minute, filiform. Leaflets upto 1 cm, oblanceolate, rounded, apiculate. Flowers in terminal and leaf-opposed 2-6 flowered racemes; peduncles longer than the leaves, filiform; bracts linear-subulate. Calyx-tube; teeth linear or lanceolate, shortly

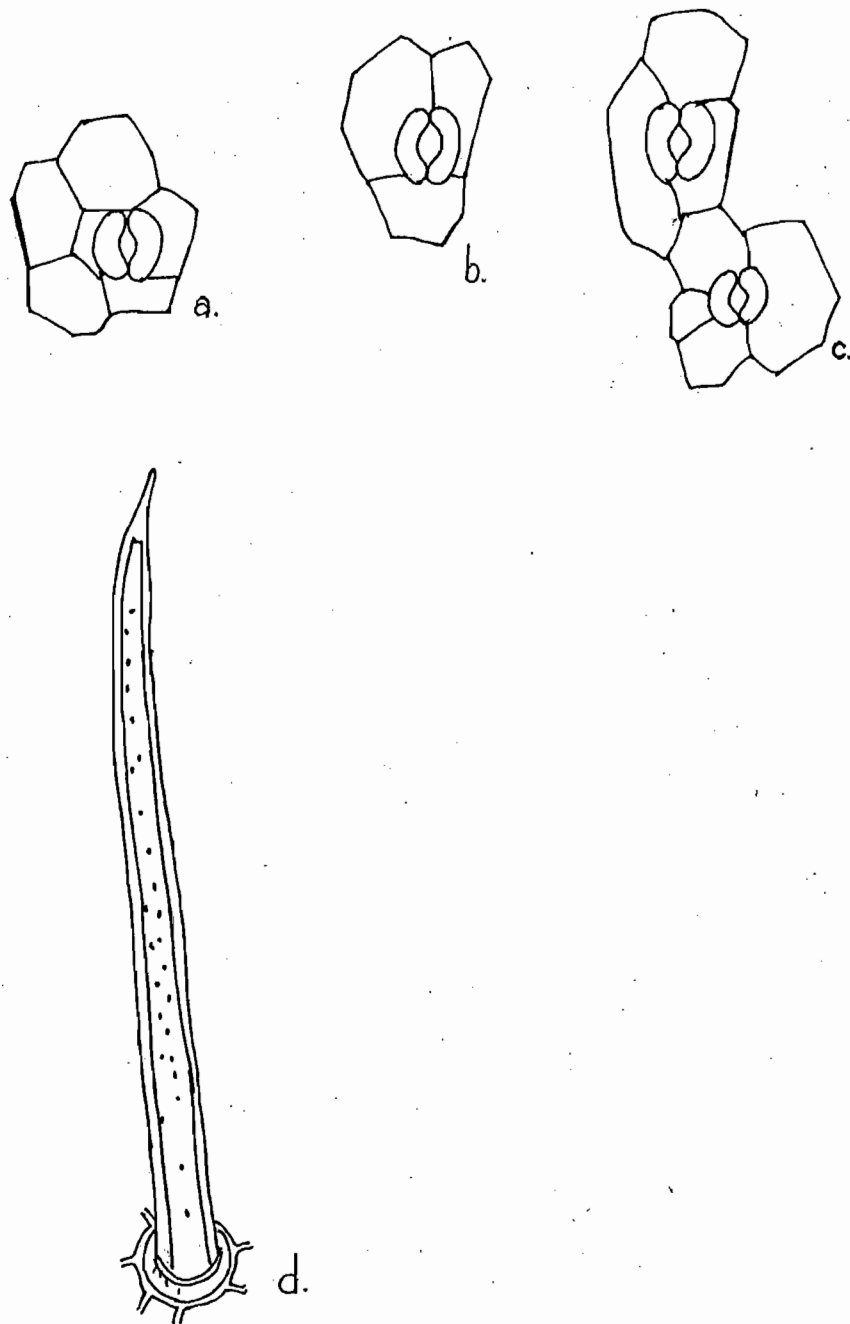


Fig. 121. *Cracca tenuis* (Wall.) Kuntze, a. tetracytic stomata, b. anisocytic stomata, c. anomocytic stomata, d. unicellular trichome with pitted wall.

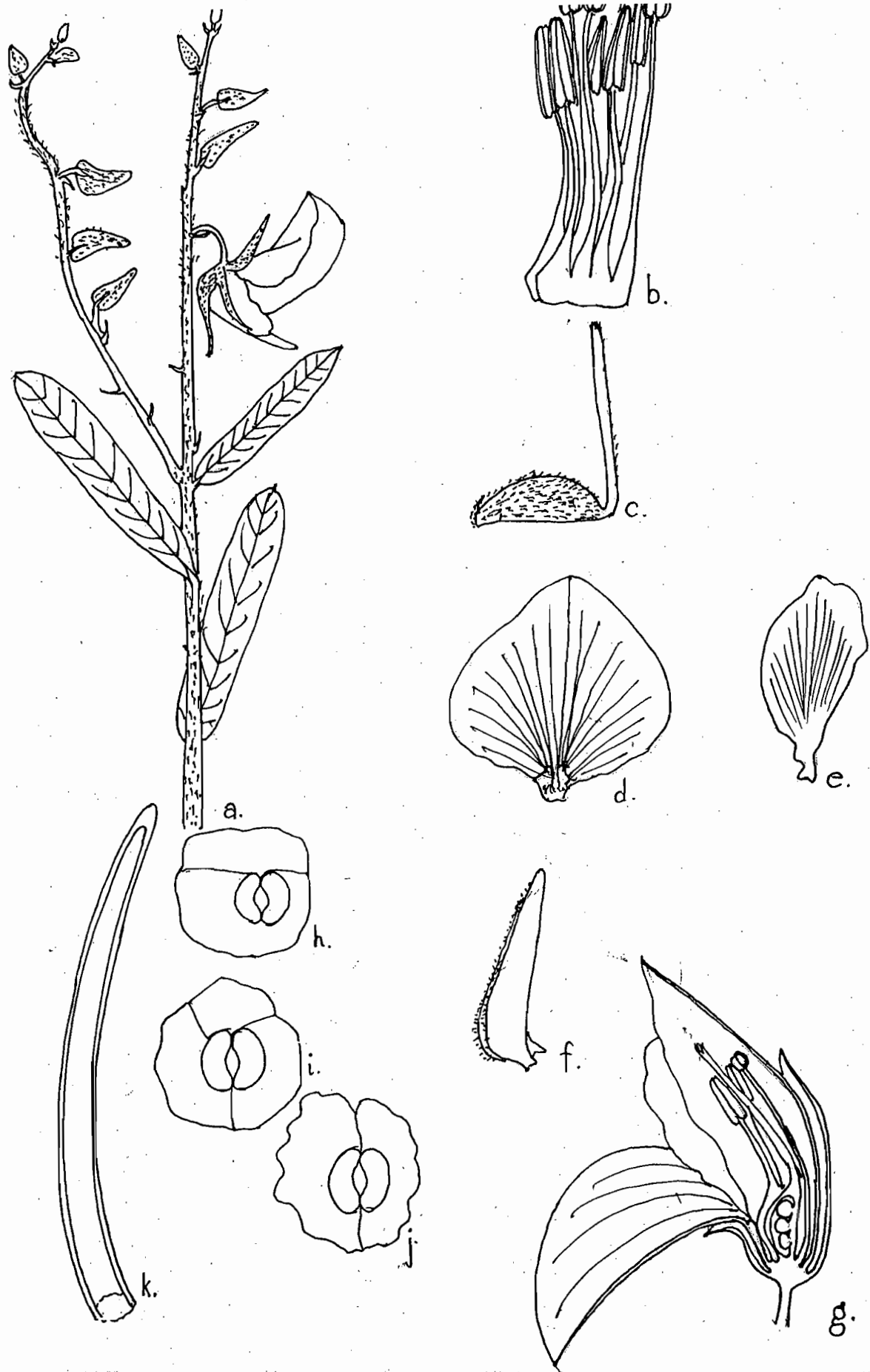


Fig. 122. *Crotalaria hirsuta* Willd., a. habit, b. monadelphous stamens, c. gynoecium, d. standard petal, e. wing petal, f. keel petal, g. L.S. of flower, h. diacytic stomata (subsidiary cells at the pole of the guard cells), i. anisocytic stomata, j. paracytic stomata, k. unicellular trichome.

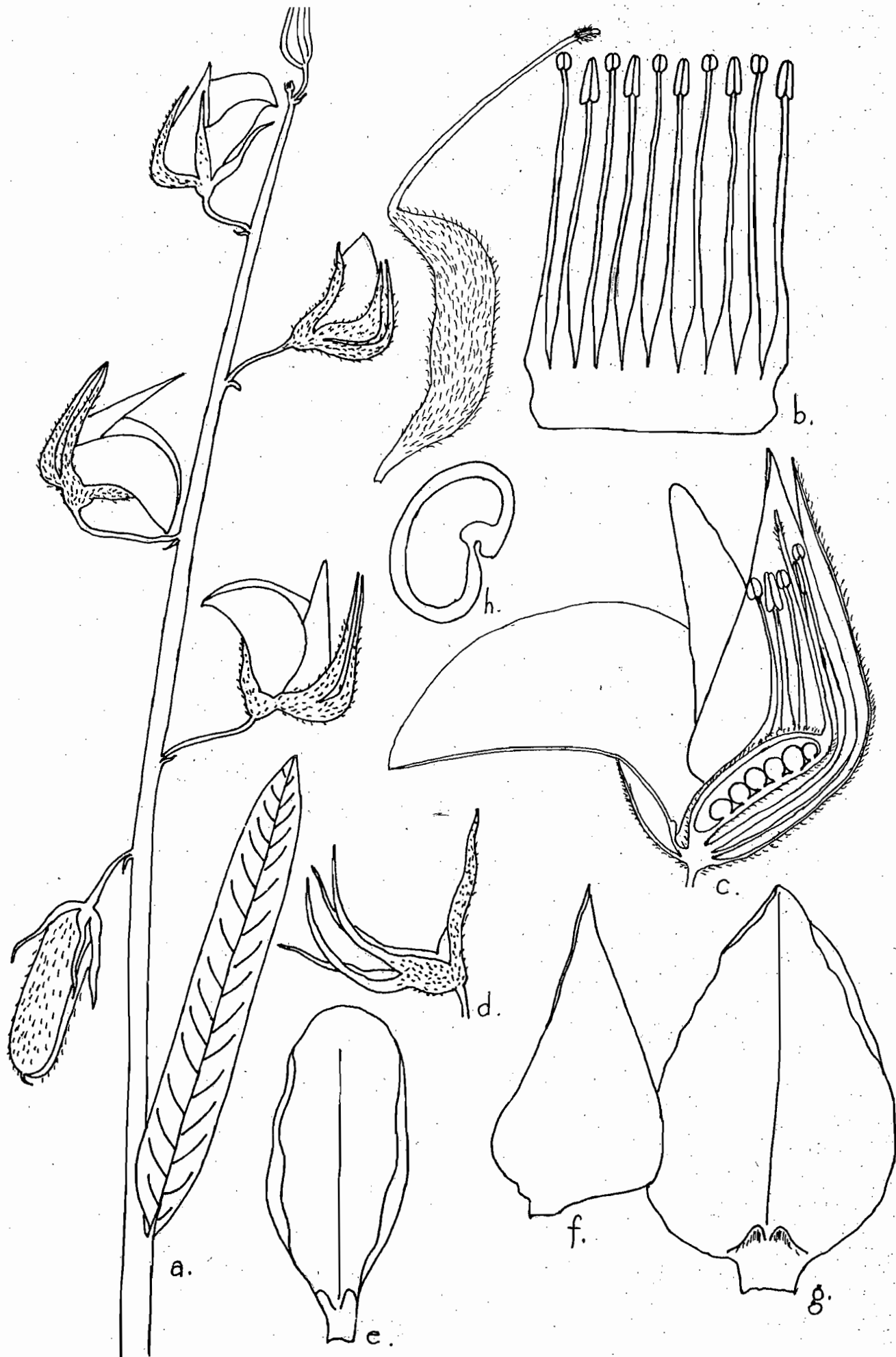


Fig. 123. *Crotalaria leptostachya* Bth., a. habit, b. monadelphous stamens, c. L.S. of flower, d. calyx, e. wing petal, f. keel petal, g. standard petal, h. gynoeceium, i. seed.

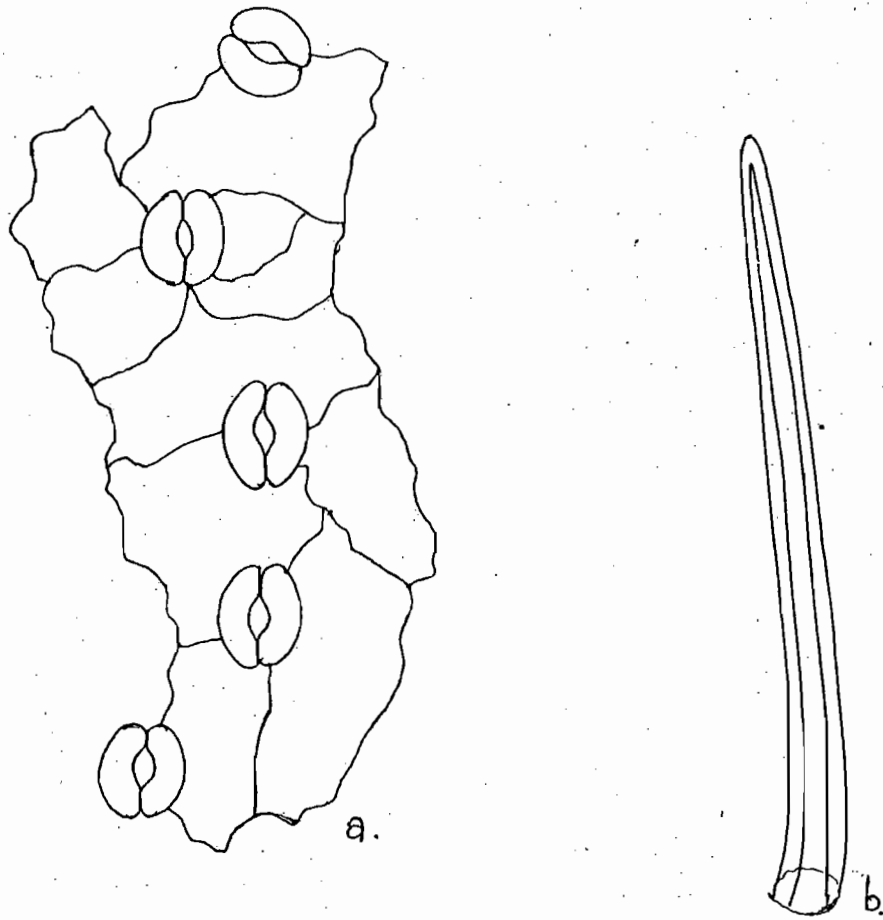


Fig. 124. *Crotalaria leptostachya* Bth. a. anomocytic stomata, b. unicellular trichome with thick wall.

connate into 2 lips; teeth triangular, acute, exceeding the campanulate tube, the two upper a little broader. Corolla yellow; standard orbicular, shortly clawed; wings obovate or oblong; keel broad, equaling the wings, its petals jointed down the back, much incurved, distinctly beaked. Anthers dimorphous. Ovary shortly stalked, 1-ovulate; style long, abruptly incurved at the base, more or less bearded upwards; stigma minute, oblique. Pods obliquely subglobose, beaked.

Variety. *neglecta* Baker. in Fl. B. I. V. 2, p. 81.

Branches more ascending than in the type. Leaflets larger, retuse or rounded, apiculate or not. Racemes 6-9 flowered. (Fig. 125)

Vernacular name: Ranmethi.

Flowers: July-November.

Micromorphology (Fig. 126)

The plant showed presence of unicellular, non-glandular, elongated trichome with warty surface.

Stomata were of anomocytic types.

D/310

11. *Crotalaria retusa* Linn. Sp. Pl. (1753) p. 715.

A robust pubescent undershrub with striate branches and stem reaching upto 1.5 m high. Leaves upto 8 cm long., oblanceolate-oblong, sometimes mucronate; petioles very short; stipules subulate. Flowers numerous, in erect terminal racemes 15-30 cm long; bracts subulate, 1 at the base of each pedicel and 2 much smaller about half way up. Calyx upto 1 cm long; tube campanulate; upper teeth ovate, acute, divaricate, connate near the base only, the 3 lower teeth much narrower, triangular, acuminate, connate about half way up. Corolla much exserted, about 2.5 cm long, yellow with a purple tinge; standard suborbicular, conspicuously veined, with a strong rib down the middle of the back. Pods upto 4 cm long, stalked, linear-oblong. Seeds 15-20. (Fig. 127)

Vernacular name: Ghughra.

Flowers: September-November.

Micromorphology (Fig. 127)

The plant showed presence of unicellular, non-glandular, short trichome with broad lumen and narrow base.

Stomata were of anisocytic and anomocytic types.

D/361

12. *Crotalaria verrucosa* L., Sp. Pl. 2: 715. 1753.

A short branched undershrub reaching upto 1.5 m high. Leaves 5-15 cm long, oblong-lanceolate, acute, mucronate, finely silky beneath; stipules leafy, persistent. Flowers in elongate terminal upto 50 flowered racemes reaching upto 30 cm long; pedicels longer than the calyx, with 1 large foliaceous ovate-acute bract at the base of each pedicel and a pair of minute subulate bracts on each pedicel below the middle. Calyx 1 cm long; tube campanulate; upper teeth large, triangular, the 3 lower teeth smaller, linear-lanceolate, acute. Corolla yellow with a purplish tinge; standard broadly ovate, with a strong midrib at the back. Pods glabrous, linear-oblong, stalked, 2.5-5 cm long. Seeds 20-30. (Fig. 128)



Fig. 125. *Crotalaria medicaginea* Lam., a. habit, b. flower, c. L.S. of flower, d. gynoecium, e. monadelphous stamens, f. standard petal, g. wing petal, h. keel petal, i. stipule, j. bract, k. leaf, l. fruit.

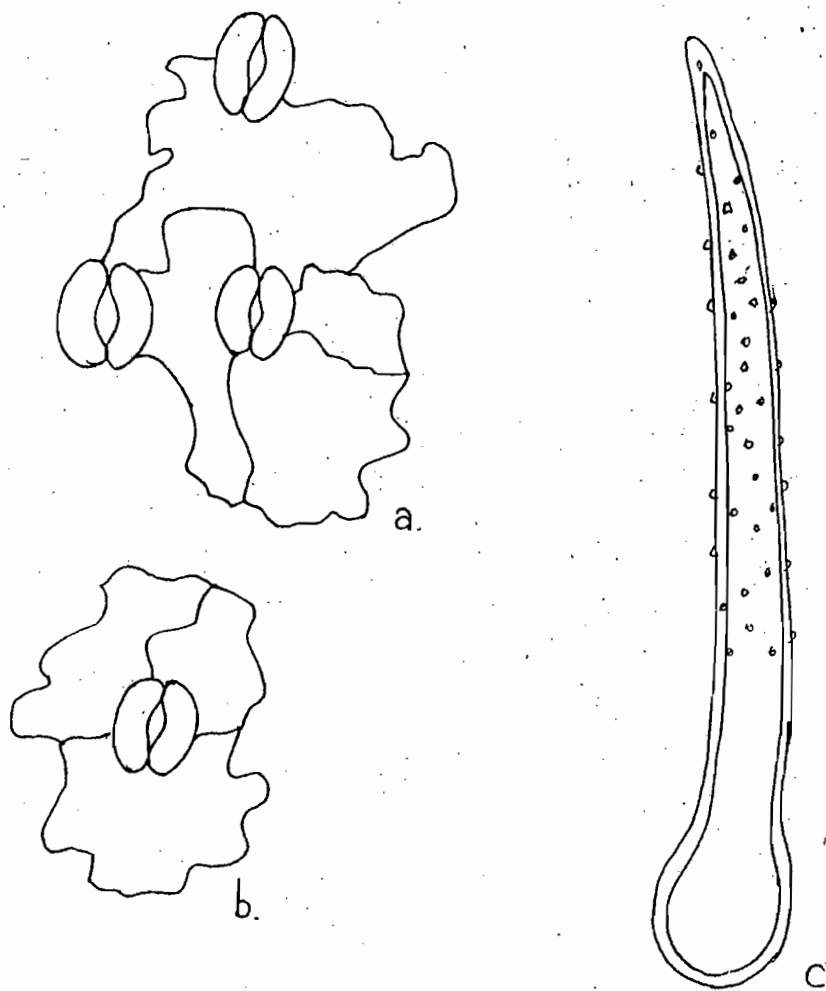


Fig. 126. *Crotalaria medicaginea* Lam. a. anomocytic stomata, b. anisocytic stomata, c. unicellular trichome with warty wall and broad lumen.

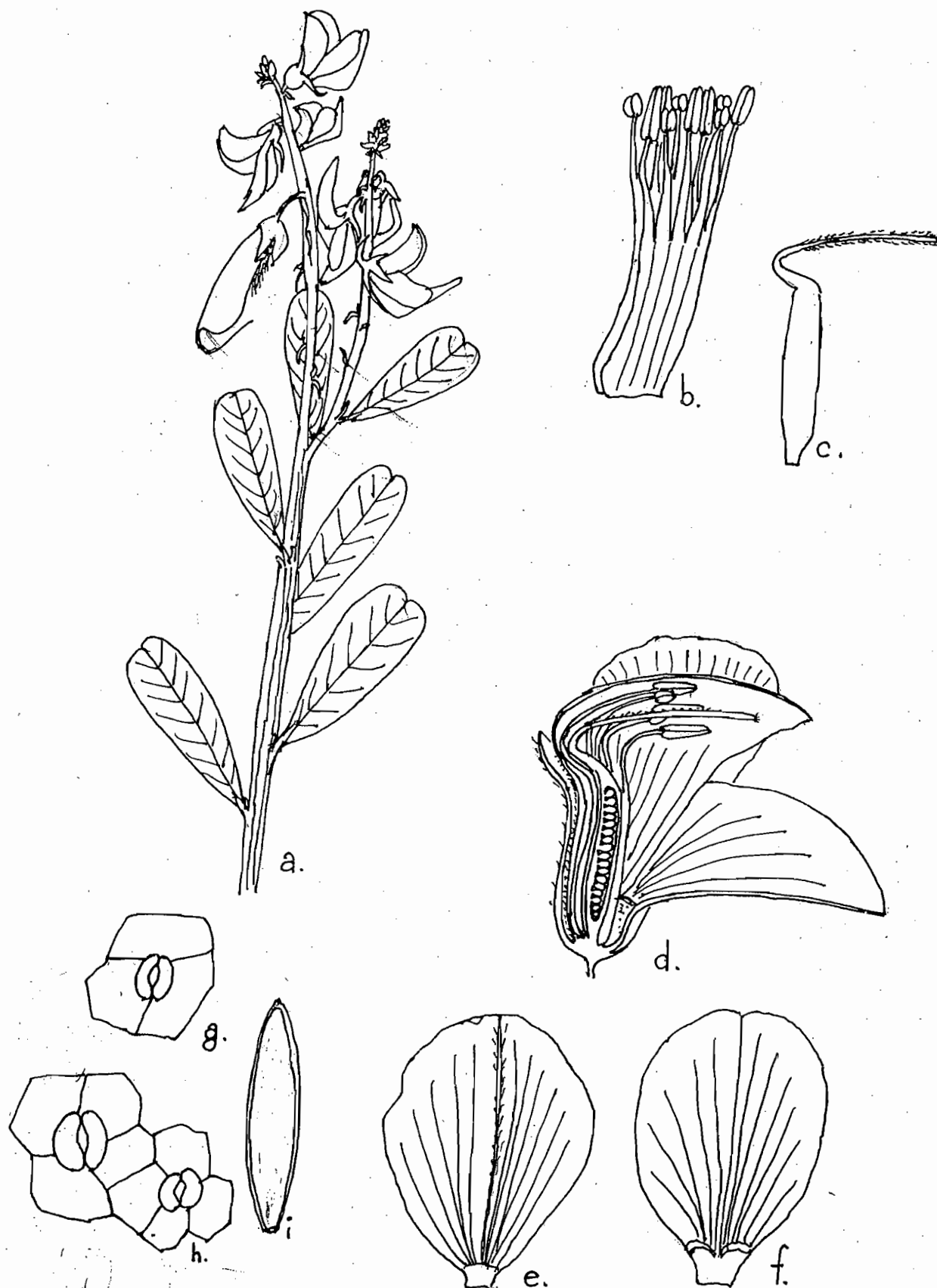


Fig. 127. *Crotalaria retusa* L. a. habit, b. monadelphous stamens, c. gynoeceium, d. L. S. of flower, e-f. standard petal, g. anisocytic stomata, h. anisocytic stomata and anomocytic stomata, i. unicellular club shaped gland with thin wall and broad lumen.

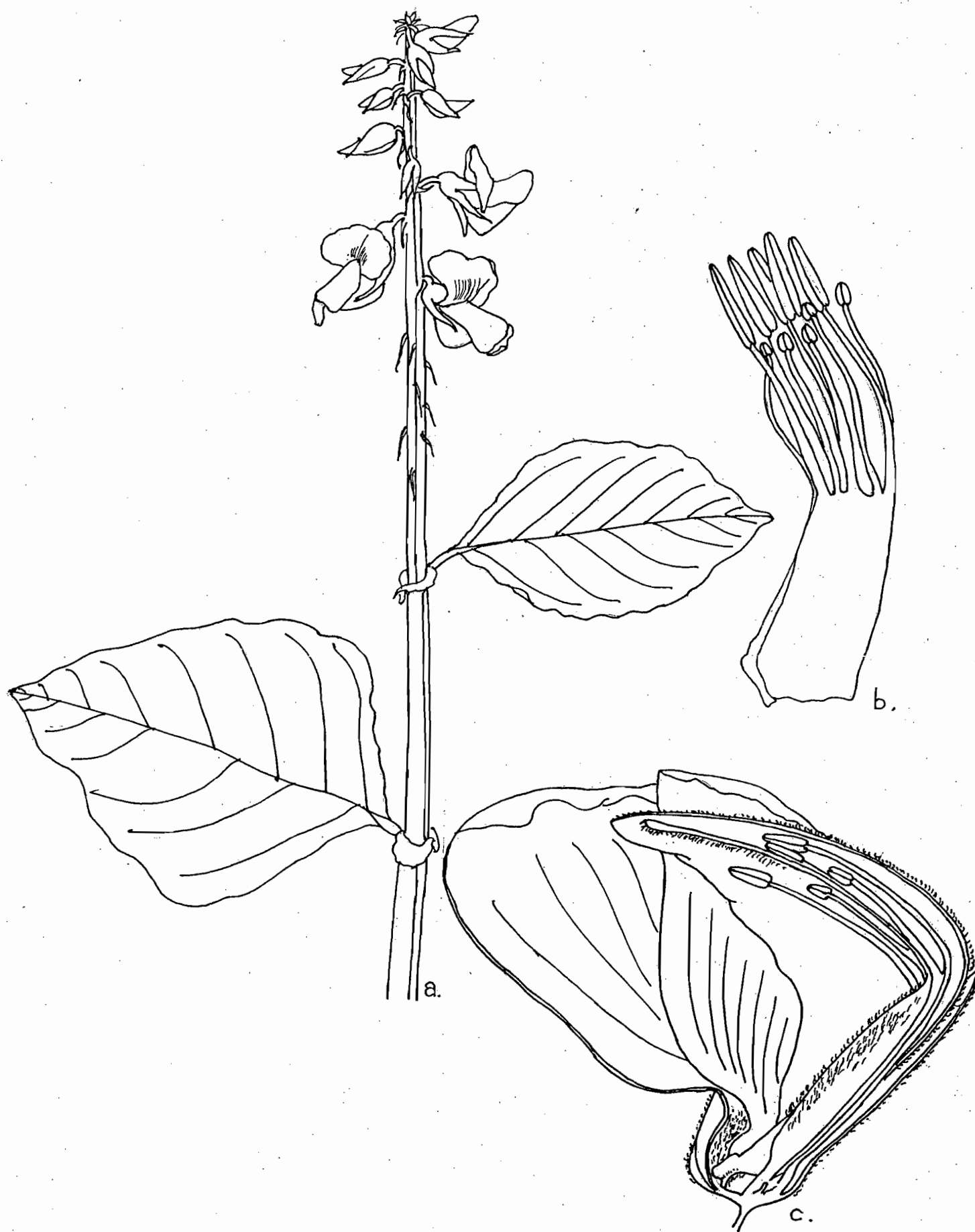


Fig. 128. *Crotalaria verrucosa* L. a. habit, b. monadelphous stamens, c. L.S. of flower.

Vernacular name: Bansana.

Flowers: October-December.

Micromorphology (Fig. 129)

The plant showed presence of unicellular, non-glandular, elongated, warty trichome with thin wall and broad lumen.

Stomata were of anomocytic and anisocytic types.

D/139

13. *Desmodium gangeticum* DC. Prodr. V. 2 (1825) p. 327.

A branched undershrub upto 1.5 m high with stem and branches irregularly angled. Leaves 1-foliolate; petioles 2 cm long; stipules scarious, upto 1 cm long, linear-subulate, striate at the base. Leaflets membranous, upto 13 cm long, ovate-oblong, slightly acuminate, clothed with dense soft hairs beneath; main nerves 8-12 pairs. Flowers in terminal and axillary racemes upto 30 cm long; pedicels filiform, pubescent; bracts subulate; bracteoles minute. Calyx hairy; teeth triangular, longer the campanulate tube. Corolla 0.5 cm long, violet or white; standard broad, cuneate at the base. Pods with 6-8 joints, indehiscent. (Fig.130)

Vernacular name: Ekpani-panda.

Flowers: May-July.

Micromorphology (Fig. 130)

Stomata were of anomocytic type

D/432- 433, 561, 1229.

14. *Desmodium triflorum* DC. Prodr. V. 2 (1825) p. 334.

A small branched prostrate perennial trailing herb with slender stem slender upto 56 cms. long. Leaves 3-foliolate; stipules ovate, acuminate, persistent. Leaflets membranous, obovate, cuneate, truncate or emarginated, rarely rounded, more or less hairy beneath. Flowers 1-5, fascicled in the axils of the leaves; bracts ovate, acute, ciliate; bracteoles minute. Calyx teeth lanceolate, longer than the campanulate tube, ciliate with long white hairs. Corolla pink; exserted; standard broadly obovate, cuneate, produced into a long slender claw; wings obliquely oblong, more or less adhering to the keel; keel obtuse. Anthers uniform. Ovary stalked, usually formed of several 1-seeded indehiscent joints, the faces compressed, the upper suture rarely splitting open, the joints usually separating. Pods with 3-5 joints. (Fig. 131)

Vernacular name: Zino-pandadio.

Flowers: August-October.

Micromorphology (Fig. 131)

There were both glandular and non-glandular trichomes. The gland was multicellular with a 2-celled head and unicellular stalk, and non-glandular were unicellular hooked trichome and 2-celled uniseriate trichome with a lower broad cell and a long apical cell with a pointed tip.

Stomata were of anisocytic and paracytic types.

D/339

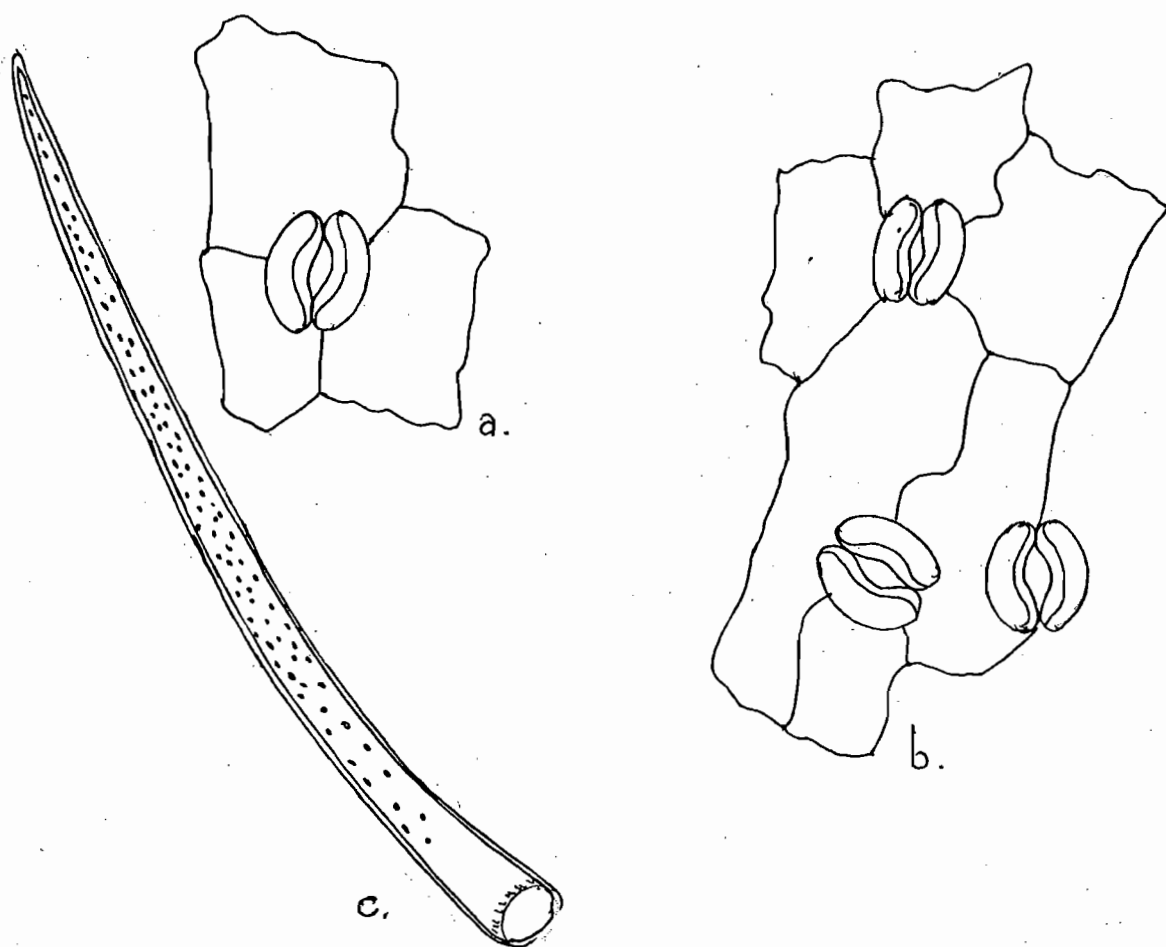


Fig. 129. *Crotalaria verrucosa* L. a. anisocytic stomata, b. anomocytic stomata, c. unicellular trichome with warty wall.

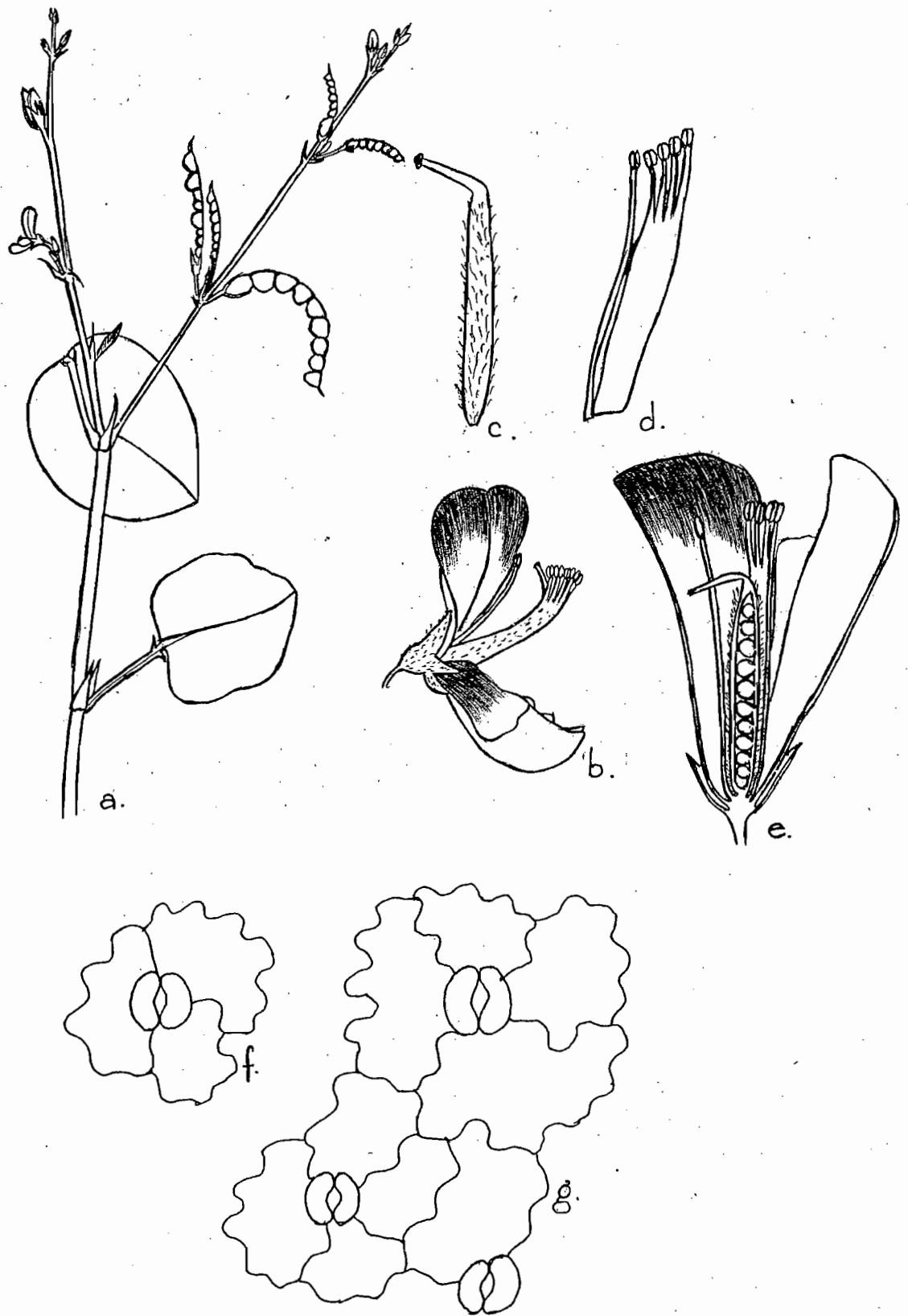


Fig. 130. *Desmodium gangeticum* DC., a. habit, b. flower, c. gynoecium, d. stamen, e. L.S. of flower, f. anisocytic stomata, g. anomocytic stomata.

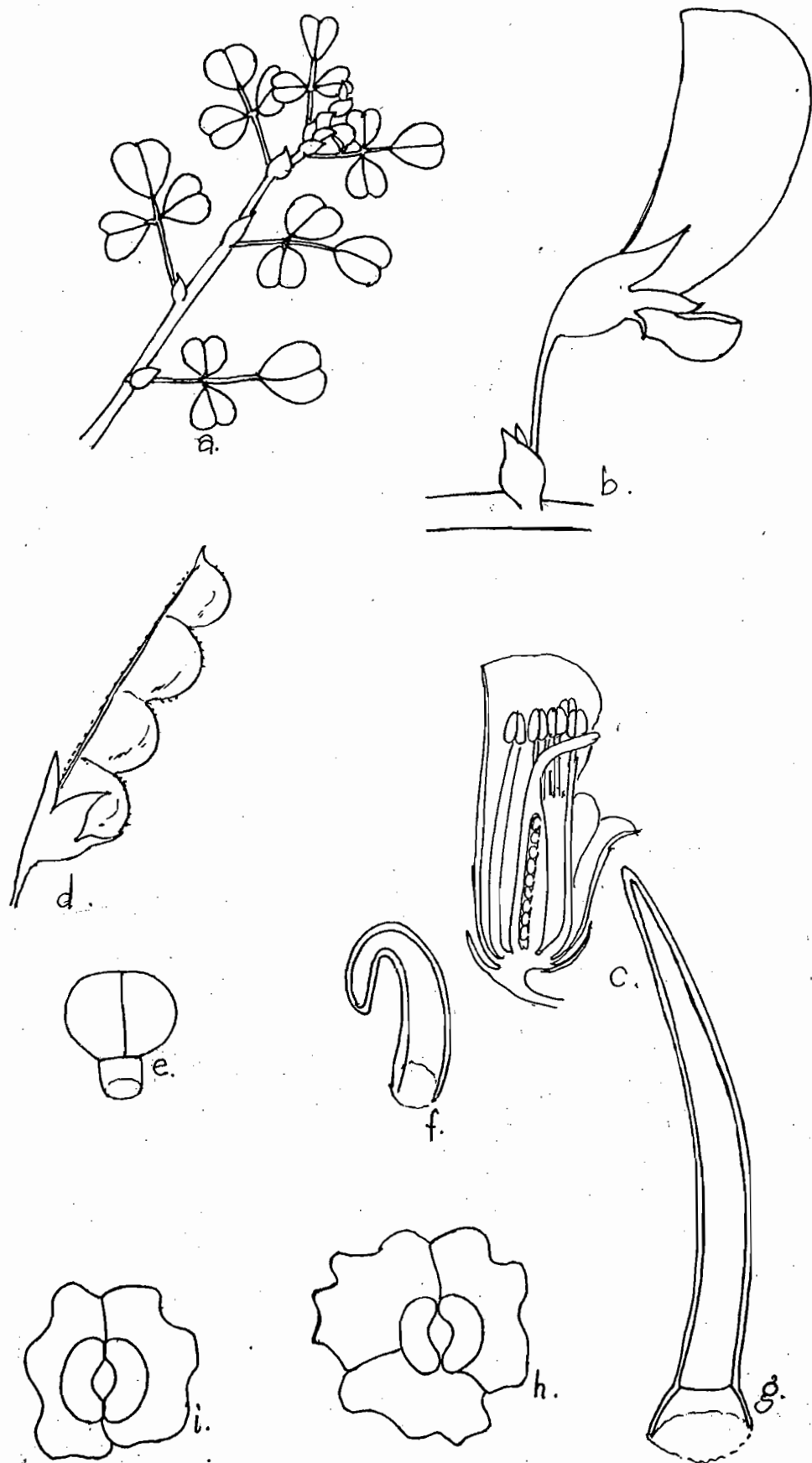


Fig. 131. *Desmodium triflorum* DC., a. habit, b. flower, c. L.S. of flower, d. fruit, e. multicellular gland with a 2-celled head and unicellular stalk, f. unicellular hooked trichome, g. 2-celled uniseriate trichome with a lower broad cell and a long apical cell with a pointed tip, h. anisocytic stomata, i. paracytic stomata.

15. *Desmodium velutinum* (Willd.) DC., *Prodr.* 2: 228. (1825)

Undershrubs or shrubs reaching upto 0.5-2 m high with branches rather terete, fulvous tomentose. Leaves 1-foliolate; leaflets broadly ovate, 7-15 long, truncate or cordate at base, obtuse, or rounded at apex, appressed hairy above, tomentose beneath. Flowers in 5-30 cm long racemes. Calyx turbinate, upper lobes bifid and often connate, the lower 3 toothed. Corolla purple, exserted; standard shortly clawed, obovate or orbicular; wings obliquely oblong, adnate to the keel. Stamens diadelphous. Ovary stipitate, many ovuled. Pods 3-6 jointed, falcate, densely clothed with minute hooked hairs, indented along both sutures. (Fig. 132)

Vernacular name: Praniparni

Flowers: August-January.

Micromorphology (Fig. 133)

There were both glandular and non-glandular trichomes. The glandular trichomes were 1) 3-celled gland with a 2-celled head and a stalk cell and 2) multicellular with 8-12 celled head and a single stalk cell. The non-glandular trichomes were 1) 3-celled uniseriate trichome with a short basal cell and 2) 2-celled trichome with a long pitted upper cell and a broad basal cell.

Stomata were of tetracytic, paracytic, oblique paracytic and anisocytic types.

D/220.

16. *Dolichos lablab* Linn. *Sp. Pl.* 725. 1753.

Annual or perennial climbing herbs. Leaves pinnately 3-foliolate, stipulate; petioles upto 18 cm long; leaflets broadly ovate, acuminate, 12 cms. long, glabrous or pubescent. Flowers axillary, peduncled; pedicels fascicled. Calyx 3-6 mm long, teeth deltoid. Corolla much exserted, purple or white; standard 12- 15 mm long, auriculate with appendages; keel incurved, rostrate. Stamens diadelphous. Ovary nearly sessile; style bearded along inner edge; stigma terminal. Pods flat, strap shaped, up to 10 cm, 2-5 seeded. (Fig. 134)

Vernacular name: Jungali papdi.

Flower and fruits: November-April.

Micromorphology (Fig. 135)

There were both glandular and non-glandular trichomes. The glands were of two types 1) with four celled head and a single celled stalk and 2) with 8-12 celled head and a single stalk cell. The non-glandular trichomes were of three types; 1) unicellular trichome with a hooked tip, 2) uniseriate 3-celled trichome with a very long pointed upper cell and two short lower cells, 3) unicellular trichome with thick walls and pointed tip.

Stomata were of paracytic, and anisocytic types.

D/177

17. *Goniogyna hirta* (Willd.) Ali., in *Taxon* 16: 463. 1967.

(*Heylandia latebrosa* DC.)

A prostrate, hairy, much-branched herb reaching 60 cm long, slender. Leaves numerous, simple, subsessile, ovate, subacute, hairy on both surfaces, obliquely cordate at the base.

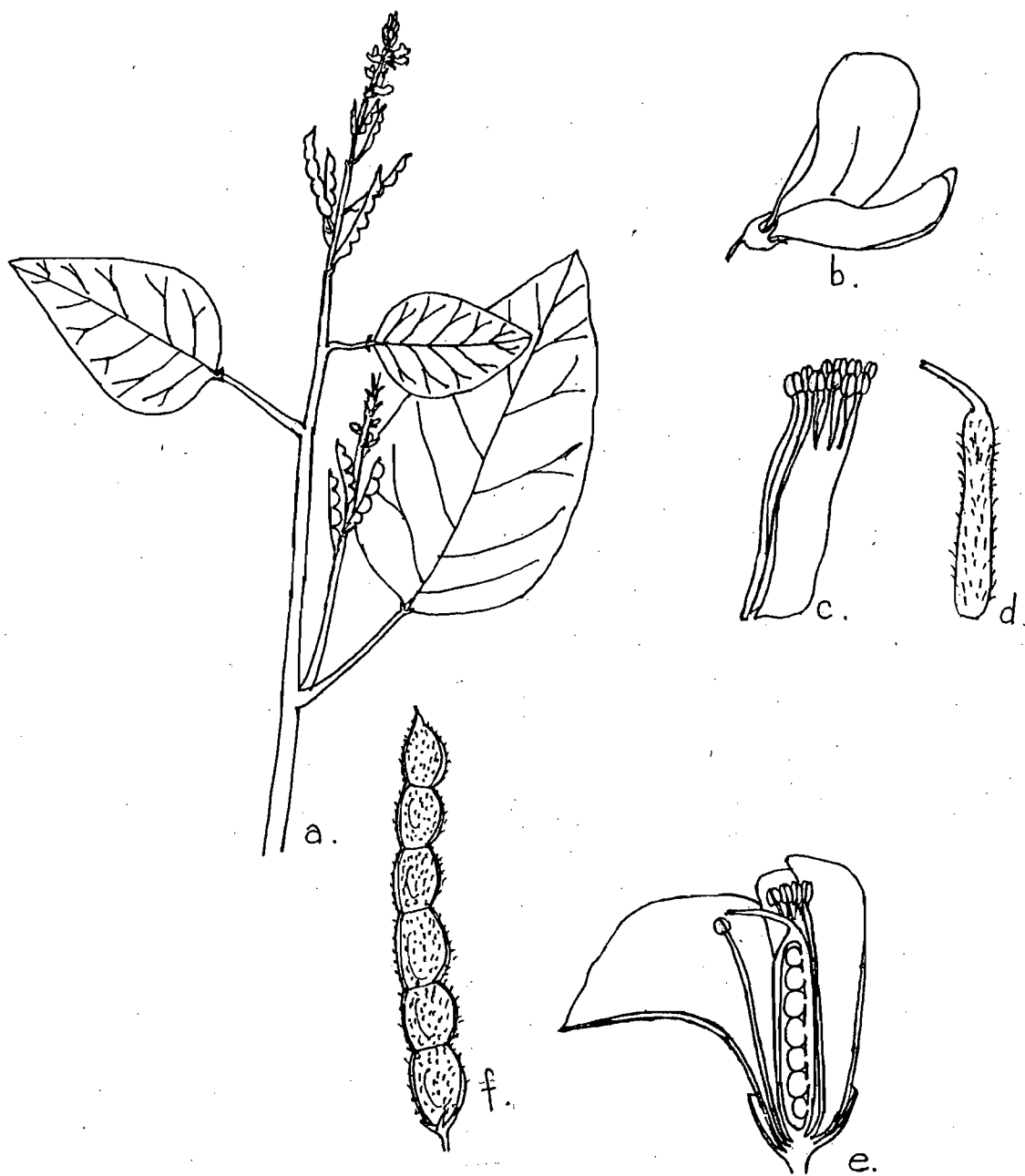


Fig. 132. *Desmodium velutinum* (Willd.) DC. a. habit, b. flower, c. diadelphous stamens, d. gynoecium, e. L.S. of flower, f. fruit.

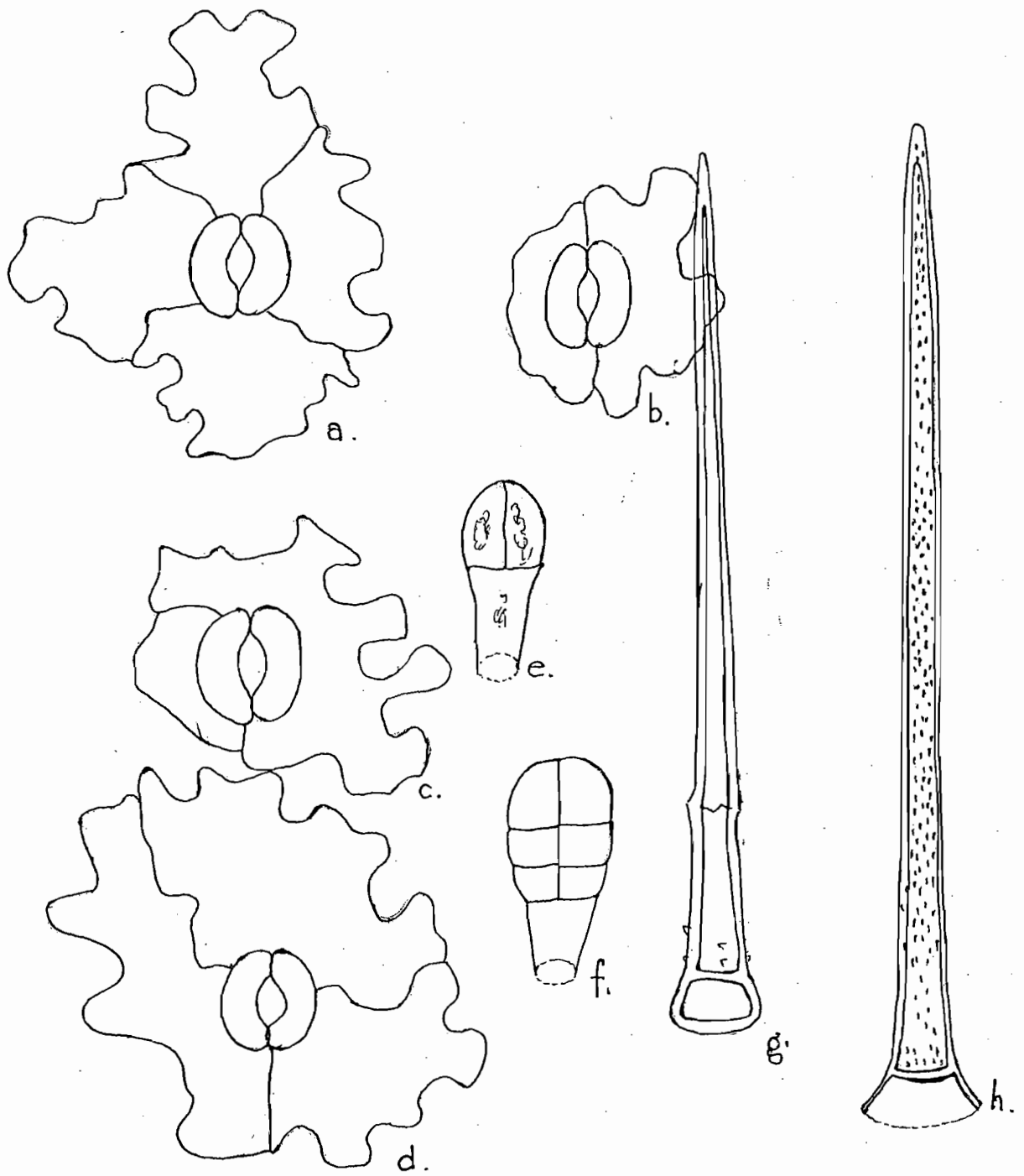


Fig. 133. *Desmodium velutinum* (Willd.) DC. a. tetracytic stomata, b. paracytic stomata, c. oblique paracytic stomata, d. anisocytic stomata, e. 3-celled gland with a 2-celled head and a stalk cell, f. multicellular gland with 8-12 celled head and a single stalk cell, g. 3-celled uniseriate trichome with a short basal cell, h. 2-celled trichome with a long pitted upper cell and a broad basal cell.

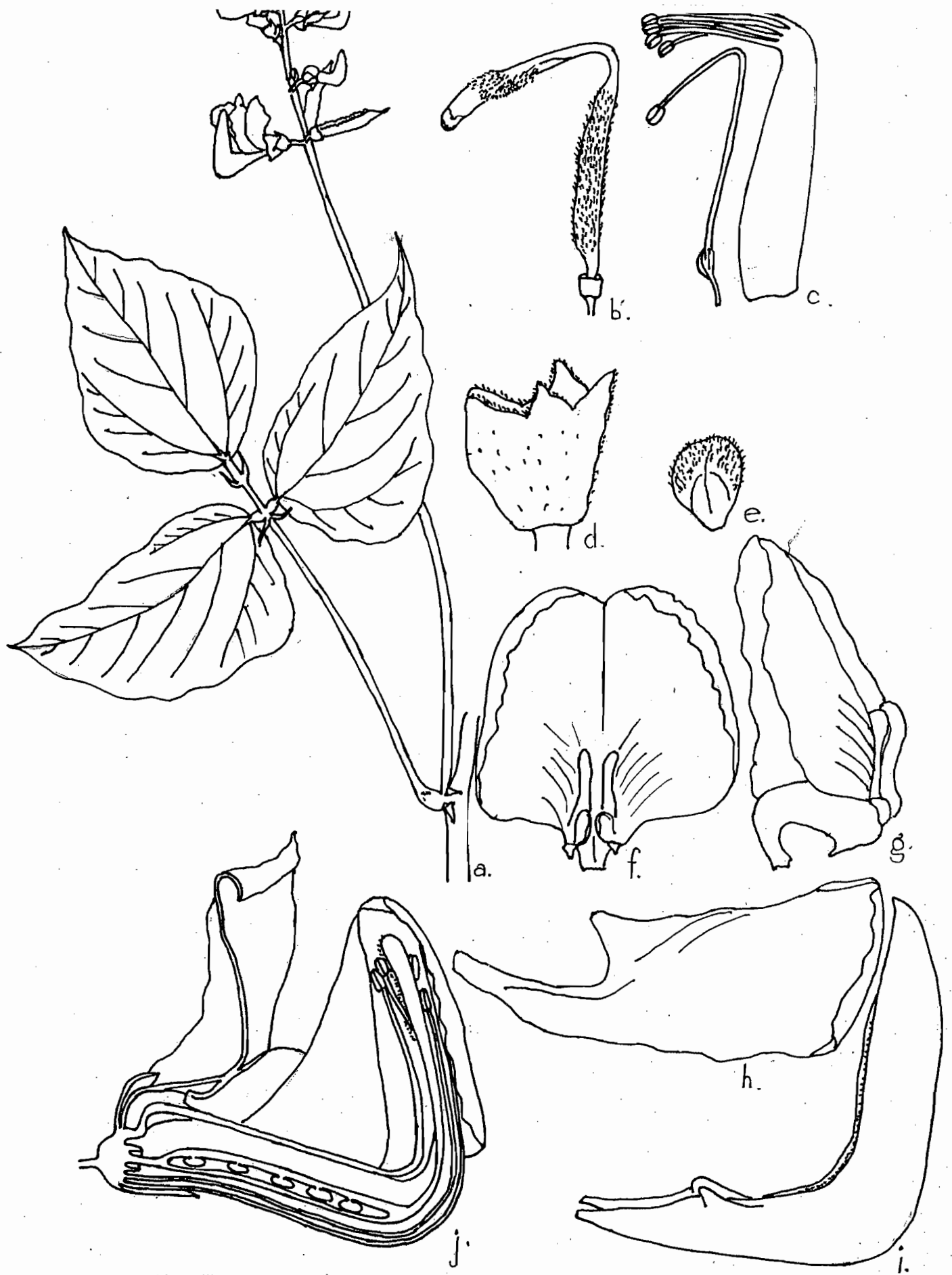


Fig. 134. *Dolichos lablab* L. a. habit, b. gynoecium, c. diadelphous stamens, d. calyx, e. bract, f. standard petal (front view), g. standard petal (side view), h. wing petal, i. keel j. L.S. of flower.

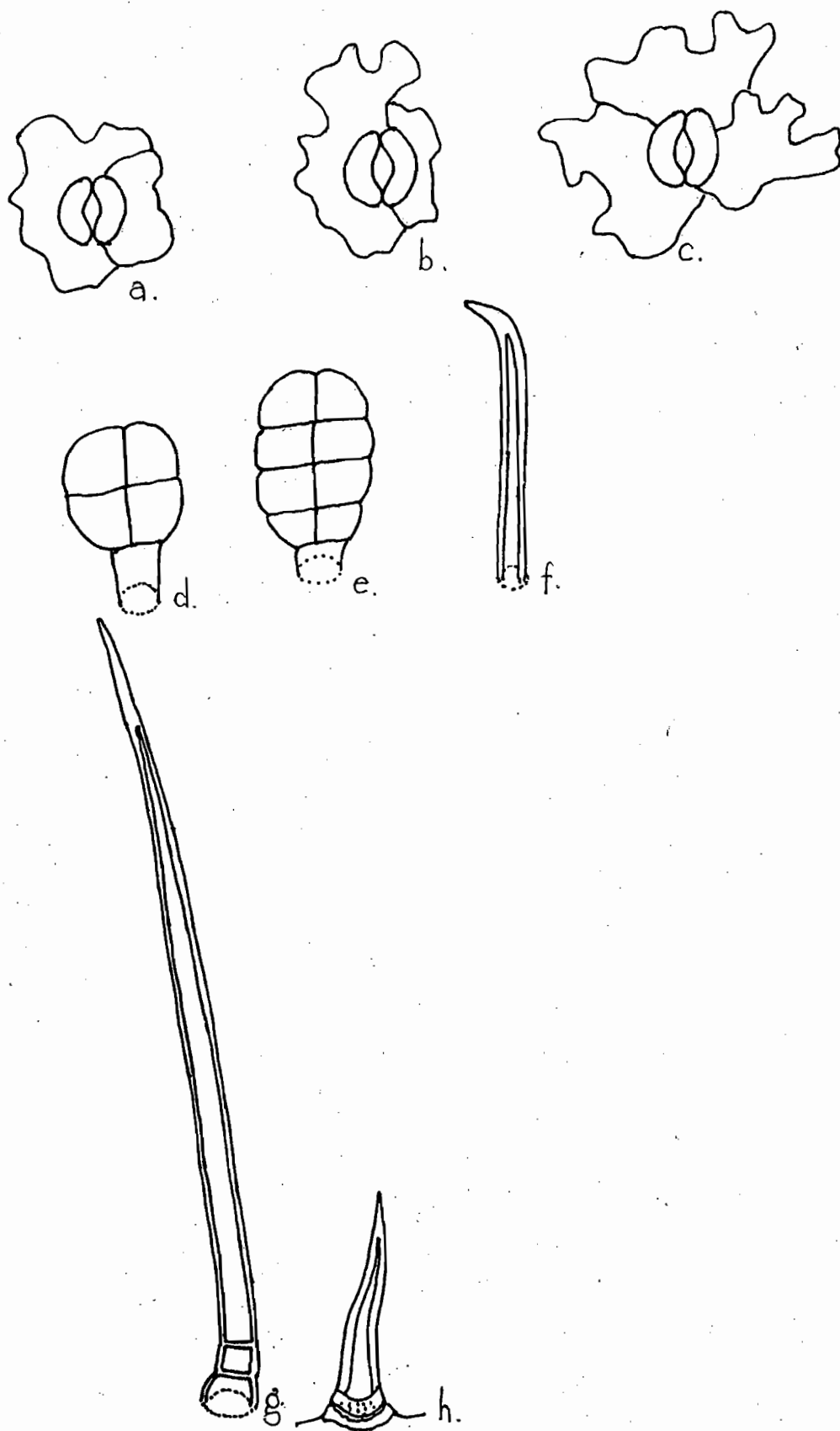


Fig. 135. *Dolichos lablab* L. a & b. paracytic stomata, c. anisocytic stomata, d. gland with four celled head and a single celled stalk, e. gland with 8-12 celled head and a single stalk cell, f. unicellular trichome with a hooked tip, g. uniseriate 3-celled trichome with a very long pointed upper cell and two short lower cells, h. unicellular trichome with thick walls and pointed tip.

Flower in the axils of most of the leaves, solitary, subsessile. Calyx-tube turbinate, the 2 upper lobes slightly connate, the lower much deeper cleft, segments acute. Corolla yellow, standard suborbicular, bearing two outgrowths at the base; wings obovate-oblong; keel-petals joined along the back, narrowed into an incurved beak. Anthers dimorphous. Ovary sessile; ovules 2; style abruptly inflexed above the ovary; stigma terminal. Pods silky, surrounded at the base by the persistent calyx and tipped by the style, slightly hairy, flattened, pale-brown. (Fig. 136)

Additional characters: The projections or outgrowths at the base of the standard petal are not recorded earlier.

Vernacular name: Adidyo.

Flowers: February-June.

Micromorphology (Fig. 137)

Only two non-glandular trichomes were seen. They were 1) unicellular long trichome and 2) unicellular short trichome.

Stomata were of paracytic, anisocytic and tetracytic types.

D/181, 711-712.

18. *Indigofera cordifolia* Heyne. ex Roth. *Nov. Pl. Sp.* (1821) p. 357

A diffuse copiously branched annual, usually more or less clothed with long white hairs; stems 8-25 cm long, the young ones pubescent, the older nearly glabrous. Leaves simple, upto 1.2 cm long, subsessile, broadly ovate-cordate, subobtuse, mucronate, hairy on both sides, densely beneath; stipules minute, setaceous. Flowers in dense 4-8 flowered heads. Calyx hairy outside; tube short; teeth linear, acute, hairy. Corolla bright red; standard spathulate; wings oblong, slightly adherent to the keel; keel erect, spurred on each side near the base. Pods cylindric, oblong straight, 0.6 cm long, densely pubescent. Seeds 2, yellow. (Fig. 138)

Vernacular name: Gadargari.

Flowers: August-December.

Micromorphology (Fig. 139)

The whole plant showed presence of medifixed warty hairs; some of these medifixed hairs had one very short arm as compared to the other arm. Along with these a unicellular, non-glandular, elongate hair was also present with a thick wall.

Stomata were of anisocytic type.

D/471-472, 562, 589.

19. *Indigofera linnaei* Ali., in *Bot. Notis.* 3:549. 1958.

(*Indigofera enneaphylla* L.)

A much branched trailing prostrate annual or biennial herb with stem upto 35 cm long, sparsely clothed with white appressed hair. Leaves upto 1.5 cm long, 7-9 foliolate, nearly sessile; stipules scarious, ovate, long-cuspidate. Flowers small, in short-peduncled 10-20 flowered spicate heads about 1 cm long; bracts scarious, ovate, acuminate, persistent. Calyx hairy outside; teeth long, setaceous. Corolla bright red, slightly exserted. Pods cylindric, more or less clothed with white appressed hair. Seeds 2, globose. (Fig. 140)

Vernacular name: Fatakiya.

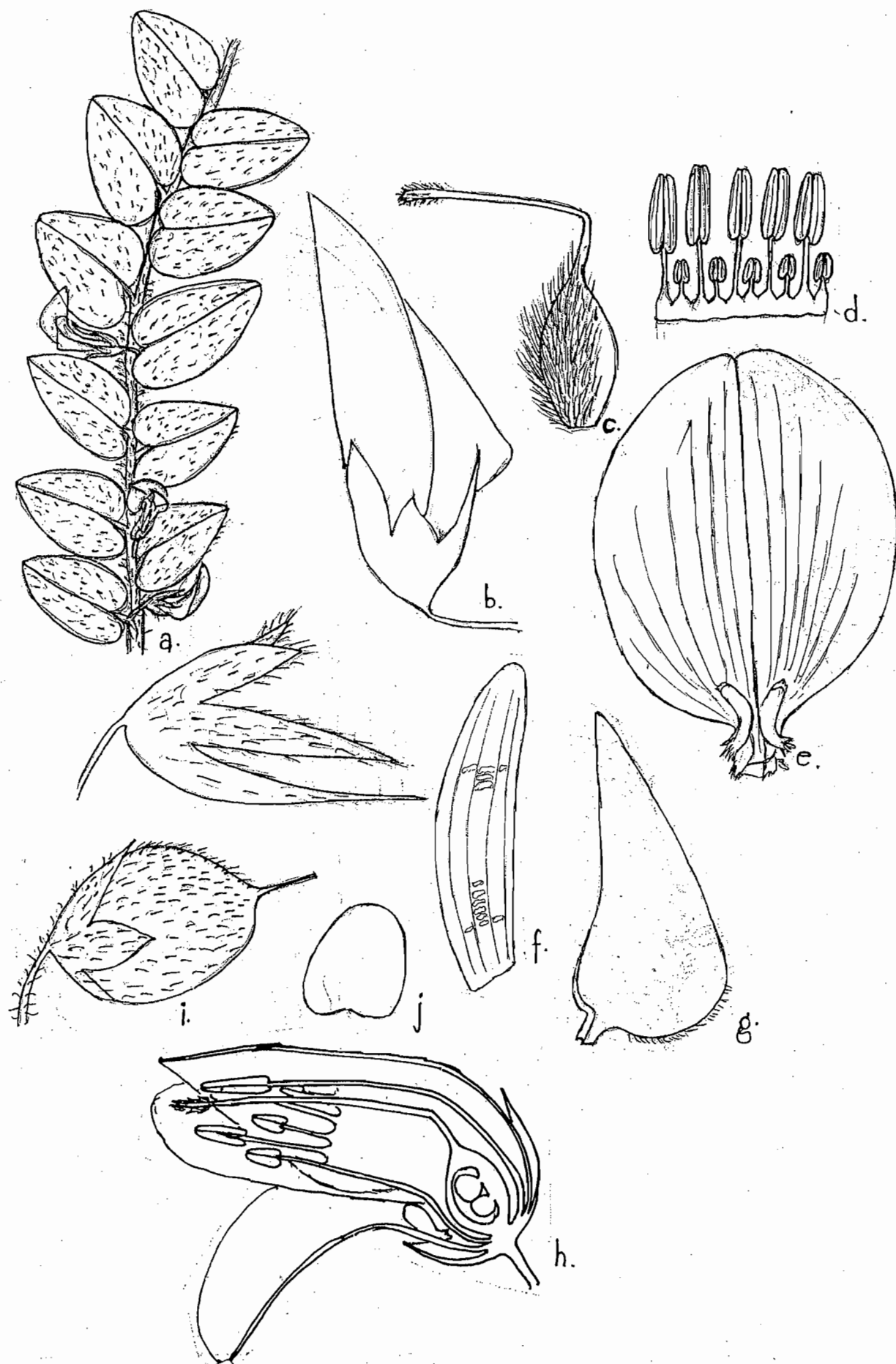


Fig. 136. *Goniogyna hirta* (Willd.) Ali. a. habit, b. flower, c. gynoecium, d. dimorphic stamens, e. standard petal, f. wing petal, g. keel petals, h. L.S. of flower, i. fruit, j. seed, k. calyx.

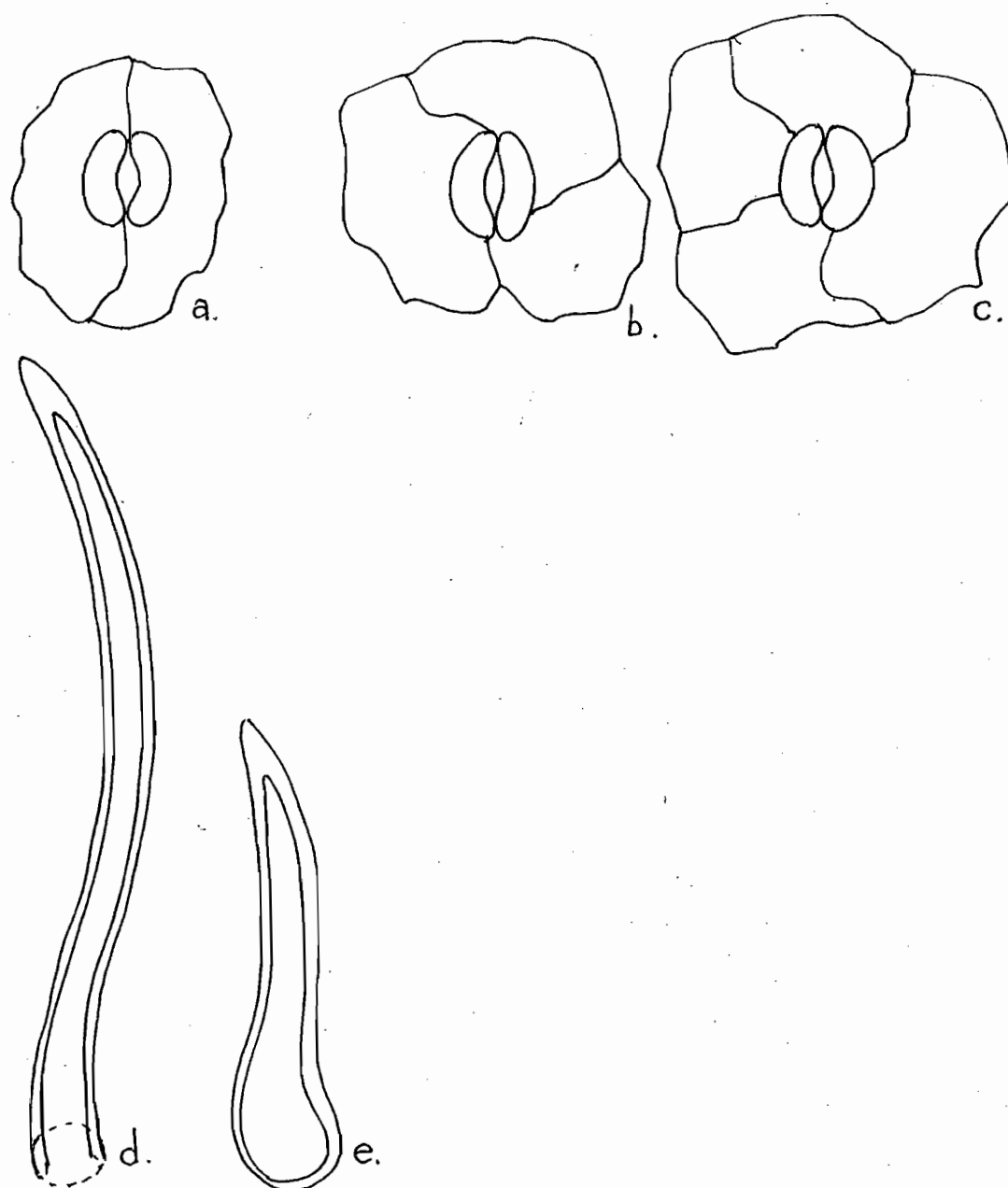


Fig. 137. *Goniogyna hirta* (Willd.) Ali. a. paracytic stomata, b. anisocytic stomata, c. tetracytic stomata, d. unicellular long trichome, e. unicellular short trichome.

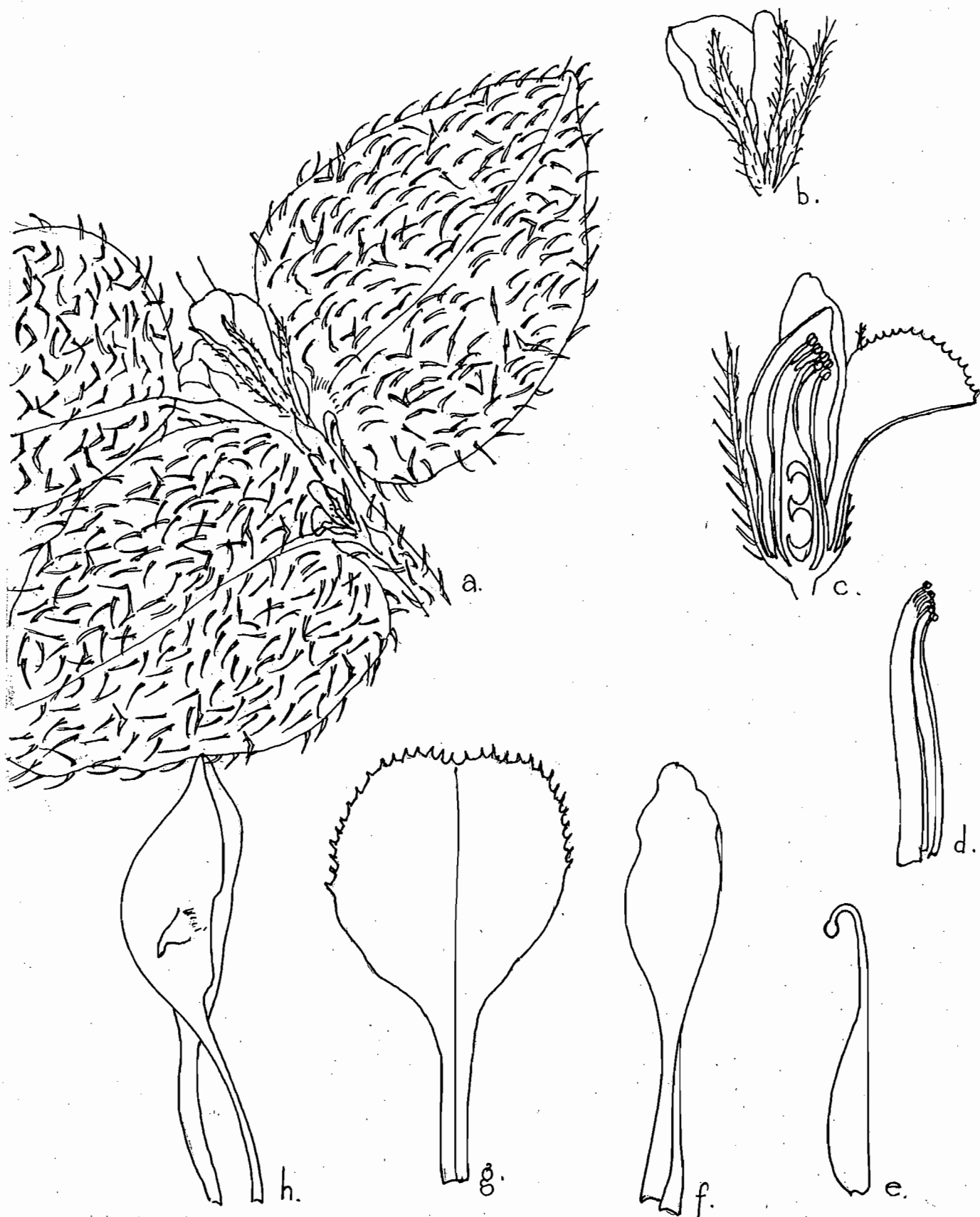


Fig. 138. *Indigofera cordifolia* Heyne ex Roth., a. habit, b. flower, c. L.S. of flower, d. diadelphous stamens, e. gynoecium, f. wing petal, g. standard petal, h. keel petals.

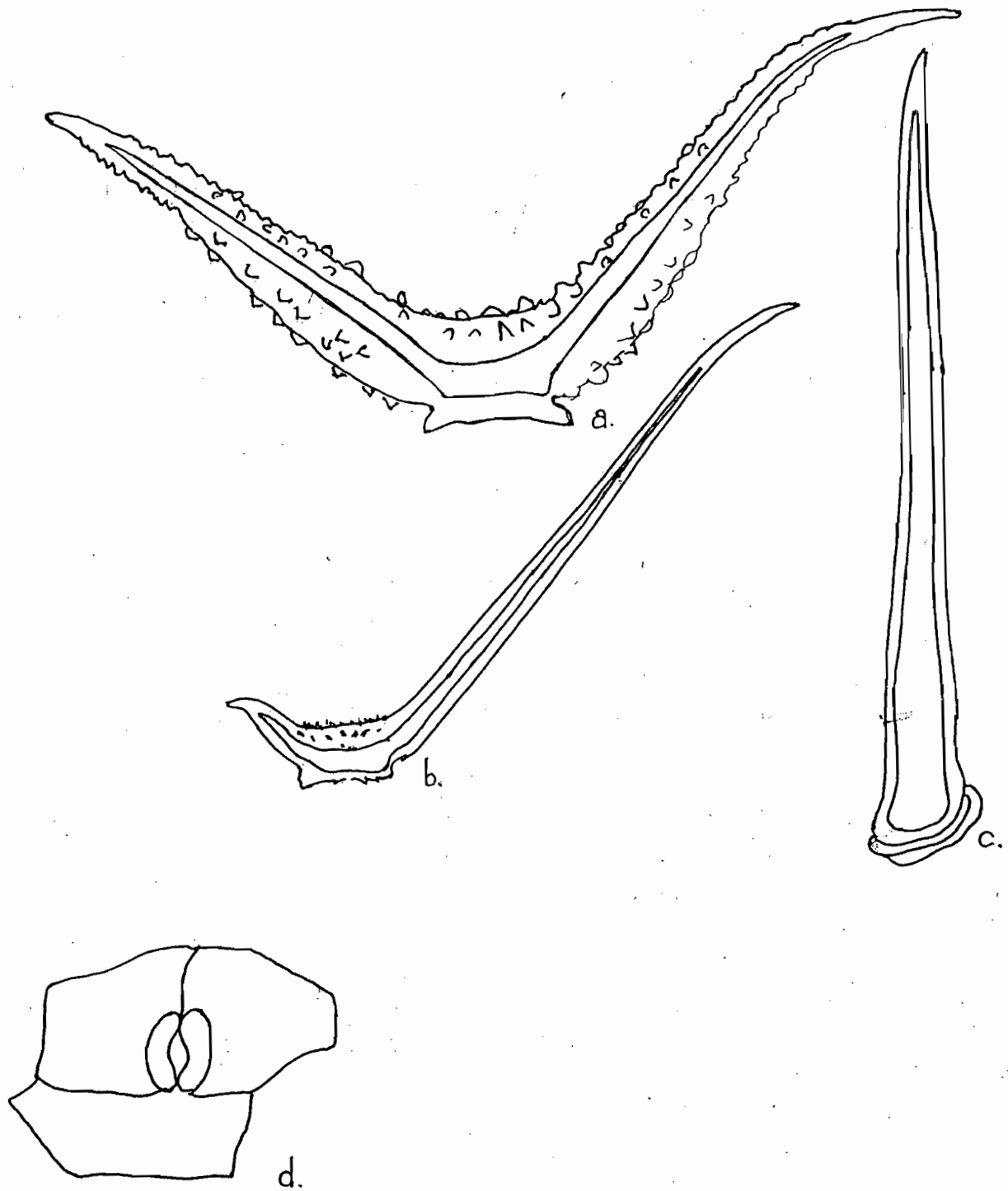


Fig. 139. *Indigofera cordifolia* Heyne ex Roth., a. medifixed hair with thick warty wall and broad lumen, b. medifixed hair with warty wall and one short arm, c. unicellular trichome with smooth wall, d. anisocytic stomata.

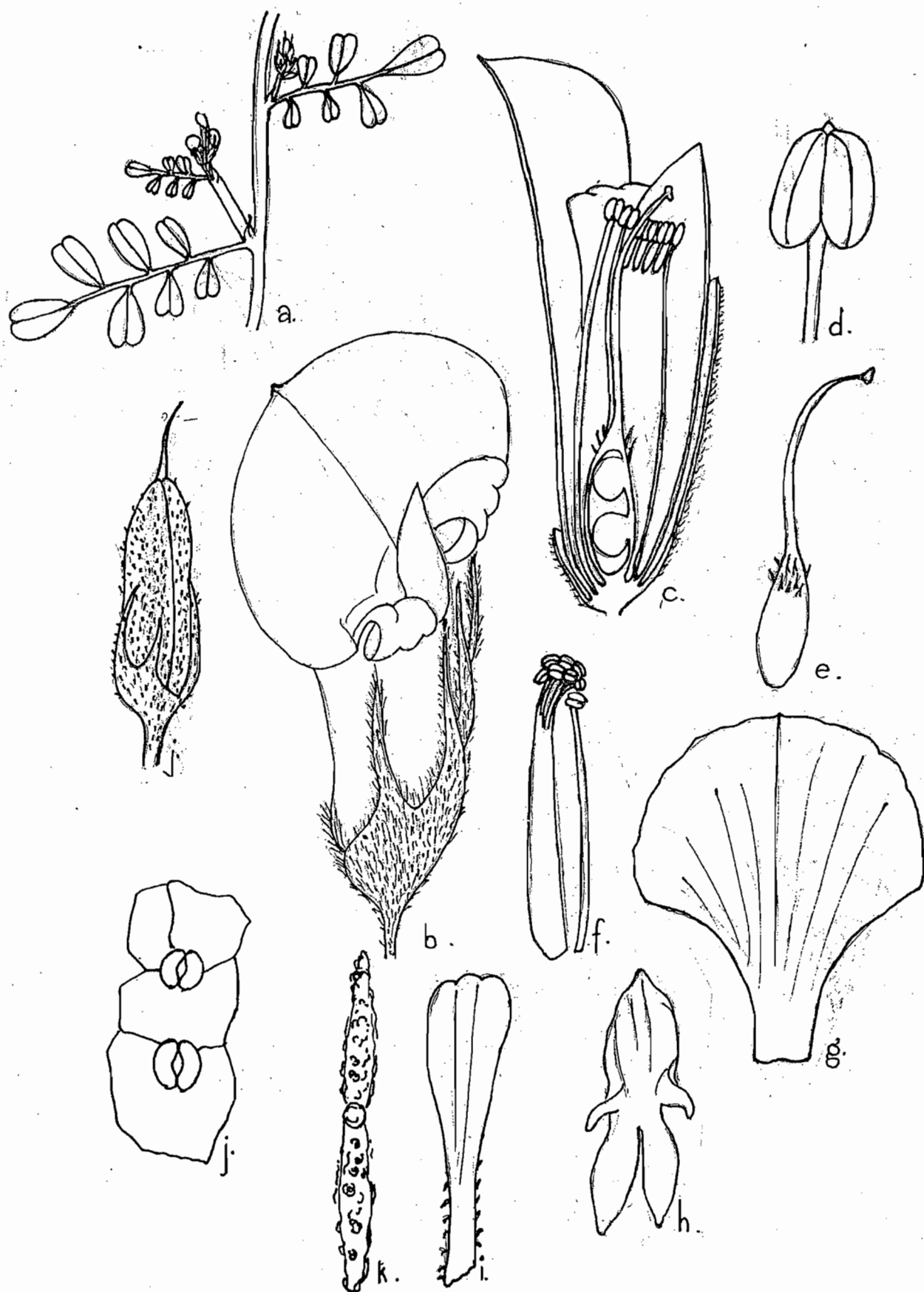


Fig. 140. *Indigofera linnaei* Ali., a. habit, b. flower, c. L.S. of flower, d. diadelphous stamens, e. gynoeceium, f. diadelphous stamens, g. standard petal, h. keel petals, i. wing petal, j. fruit, h. anisocytic and diacytic stomata, l. medifixed hair with thick warty wall.

Flowers: July-October.

Micromorphology (Fig. 140)

The medifixed hair was with a warty wall.

Stomata were diacytic and anisocytic types.

D/554-555, 582.

20. *Indigofera tinctoria* Linn. *Sp. Pl.* (1753) p. 751.

A shrub 1.5-2 m high with terete more or less angular branches, slightly silvery from fine appressed hairs. Leaves upto 7 cm long; stipules subulate. Leaflets 9-13, opposite, membranous, oblong or oblanceolate, apiculate, thinly clothed with appressed hairs beneath; those of the terminal slightly larger. Flowers numerous, in lax spicate racemes 5-10 cm long. Calyx long, hairy outside; teeth triangular, acute. Corolla pink, upto 1 cm long; standard pubescent at the back. Pods upto 4 cm long, linear, slightly curved, apiculate, thickened at the sutures, glabrous, not torulose. Seeds 8-12. (Fig. 141)

Vernacular name: Gali.

Flowers: November-December.

Micromorphology (Fig. 141)

Medifixed hairs were more or less spindle shaped with small warts on the thick walls.

Stomata were of anisocytic and anomocytic types.

D/846, 847, 1042.

21. *Indigofera trita* L. f. *Supple. Pl.* (1781) p. 335.

An undershrub upto 1m. high with hoary hairy branches. Leaves 3- foliolate; petioles upto 1 cm long; stipules small, setaceous. Leaflets: the lateral ones opposite, the terminal stalked, all obovate-oblong, slightly emarginated, clothed with fine appressed grey hairs. Flowers in short sessile or stalked 6-12 flowered spicate racemes. Calyx hairy outside; teeth linear-lanceolate. Corolla salmon-colored; standard orbicular, hairy on the back. Pods divaricate or sometimes deflexed, rigid, straight, 4- gonous, spine-pointed, not torulose, silvery with fine appressed hairs. Seeds 6-10, oblong, truncate at both ends. (Fig. 142)

Vernacular name: Adbau gali.

Flowers: February- March.

Micromorphology (Fig. 143)

The medifixed hairs were with large warty projections and a swollen central portion.

Stomata were of anisocytic and anomocytic types.

D/336

22. *Melilotus indica* All. *Fl. Pedem.* V. 1 (1785) p. 308.

Melilotus parviflora Desf. *Fl. Atlant.* V. 2 (1800) p. 192.

An erect annual herb branched herb reaching upto 18 cm high. Leaves 3-foliate; petioles very slender; stipules lanceolate, adnate to the petiole. Leaflets toothed, oblanceolate, rounded, truncate at the apex, with a few scattered hairs on both sides. Flowers in slender spicate close racemes; pedicels short, deflexed; bracts subulate. Calyx

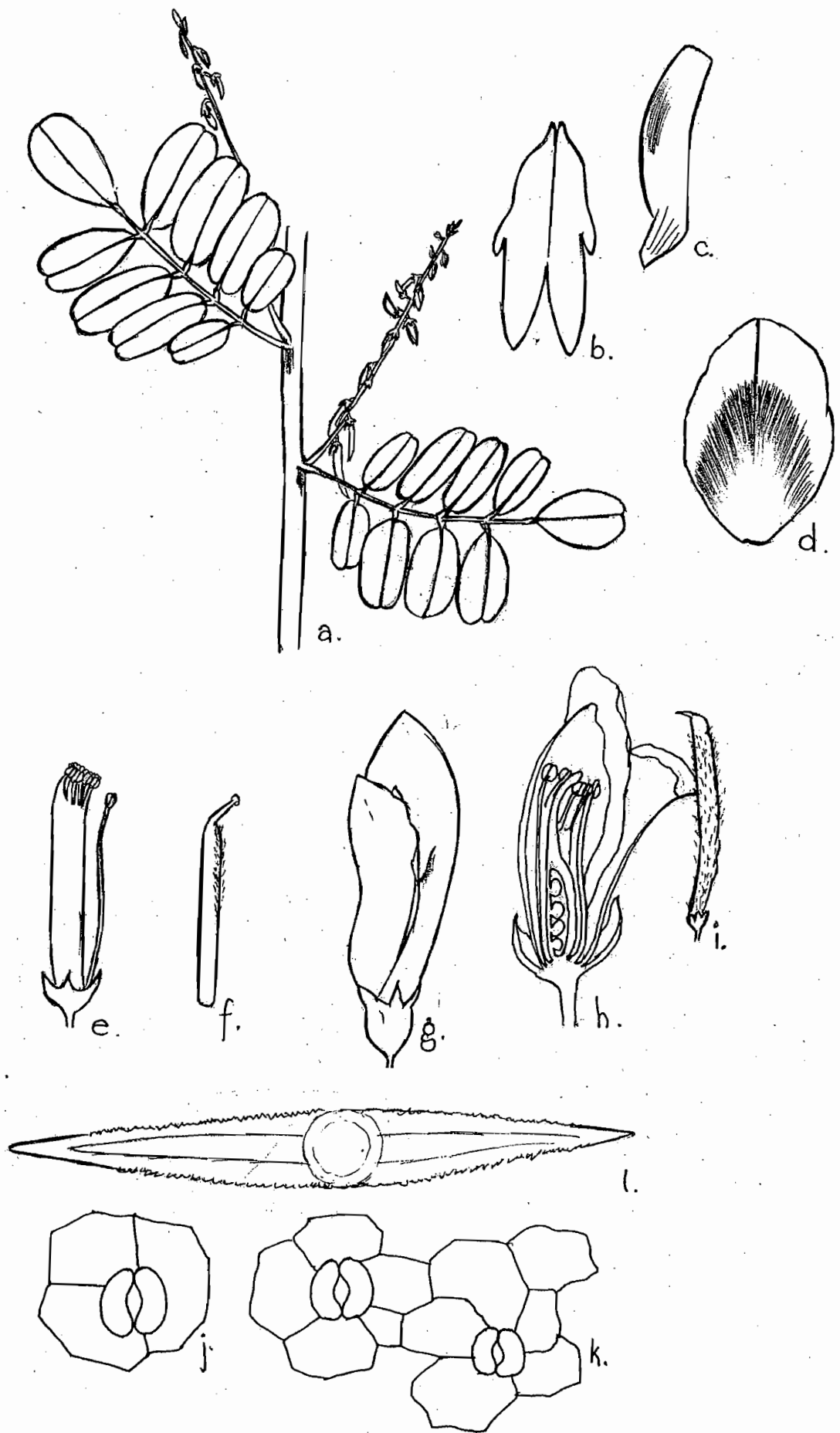


Fig. 141. *Indigofera tinctoria* L. a. habit, b. keel petals, c. wing petal, d. standard petal, e. diadelphous stamens, f. gynoecium, g. flower, h. L.S. of flower, i. fruit, j. anisocytic stomata and anomocytic stomata, k. anomocytic stomata, l. medifixed hair with thick warty wall.

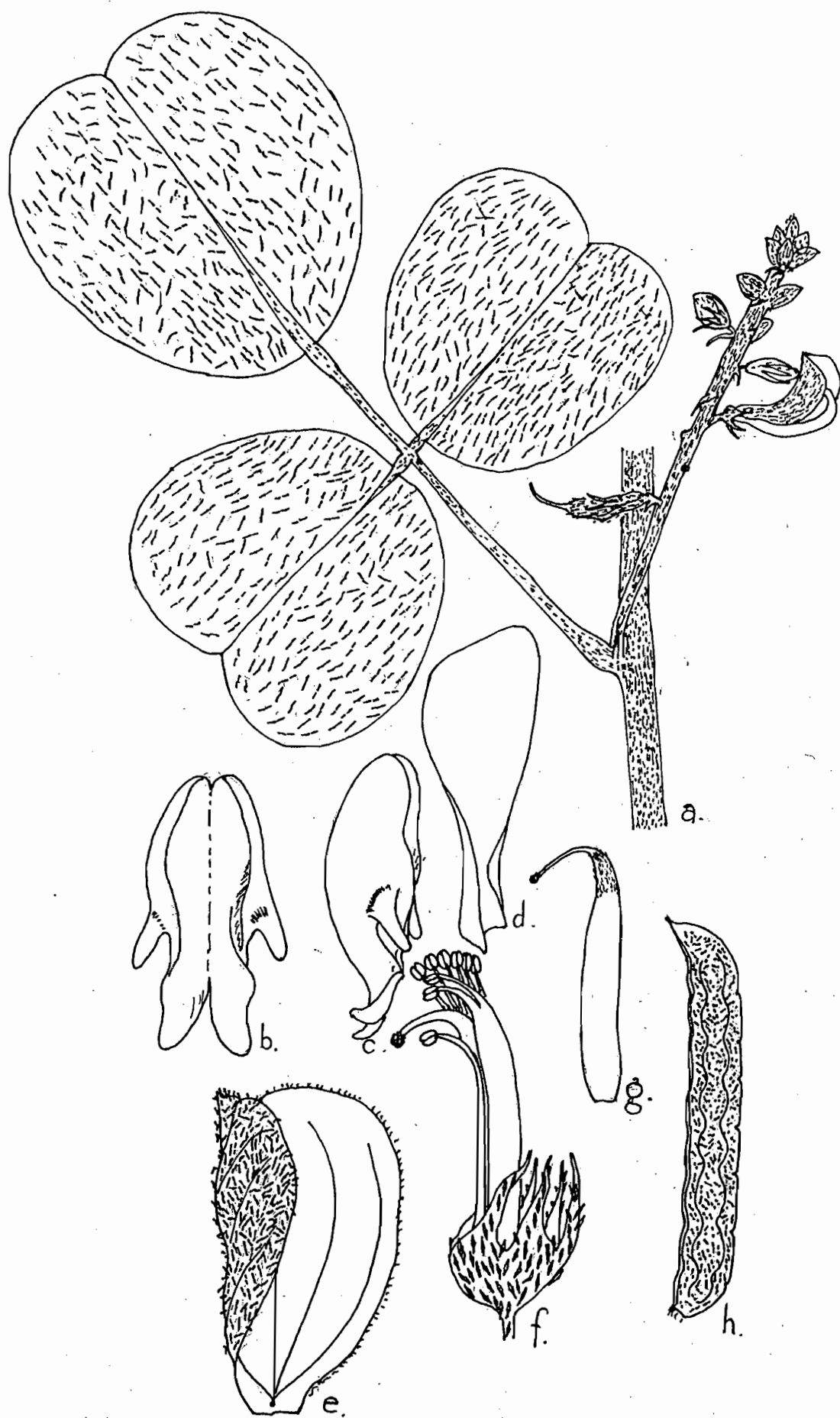


Fig. 142. *Indigofera trita* L., a. habit, b & c. keel petals, d. wing petal, e. standard petal, f. diadelphous stamens, g. gynoecium, h. fruit.

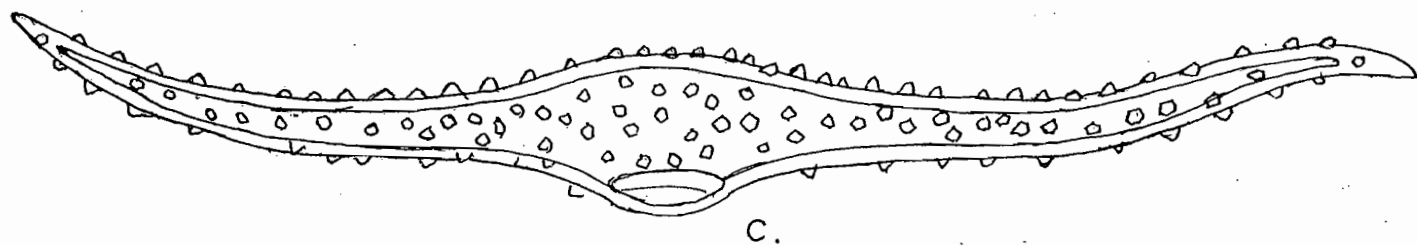
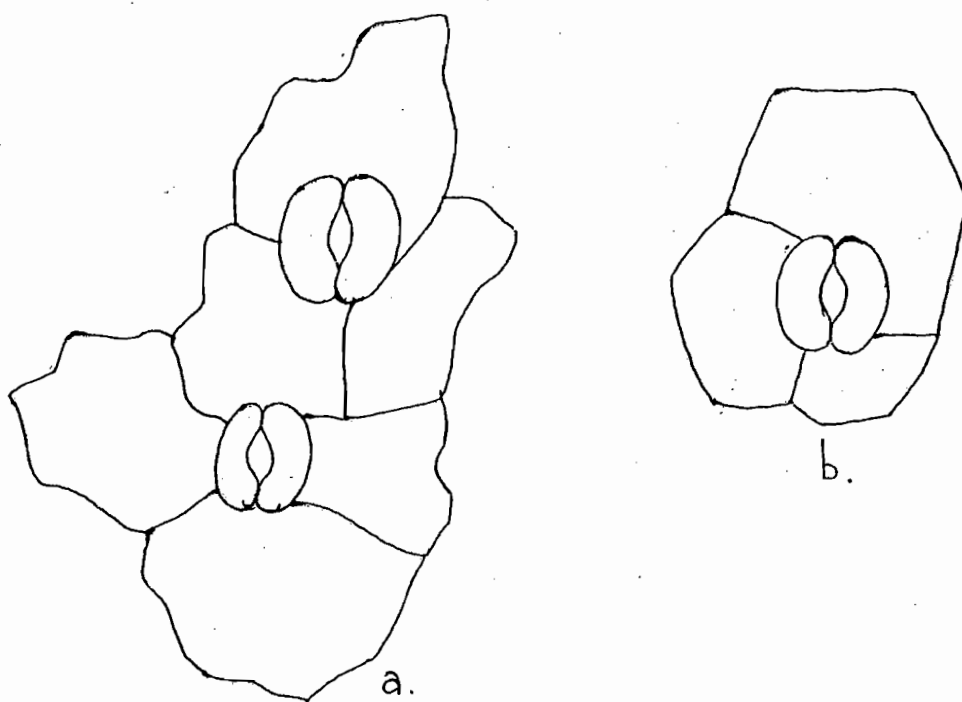


Fig. 143. *Indigofera trita* L., a. anisocytic stomata and anomocytic stomata, b. anisocytic stomata, c. medifixed hair with warty wall, broad lumen and inflated central region.

teeth triangular. Corolla yellow; standard obovate, subsessile; wings obtuse; keel shorter than the wings, obtuse. Stamens diadelphous; anthers uniform. Ovary sessile or stalked; ovules few; style filiform, incurved. Pods ellipsoid; seed 1, oblong-ellipsoid, compressed, brown. (Fig. 144)

Vernacular name: Jangli methi ni jat.

Flowers: January-March.

Micromorphology (Fig. 144)

Leaf showed presence of unicellular, elongated, thick walled trichome with a round base. Stomata were diacytic and anomocytic, among which anomocytic were in majority.

D/664.

23. *Mucuna pruriens* DC. Prodr. V. 2 (1825) p. 405.

An annual branched hairy twiner. Leaves 3-foliotae; petioles upto 10 cm long, appressedly silky; stipules lanceolate. Leaflets membranous, upto 13 cm long (the terminal leaflets rhomboid-ovate, the lateral leaflets with truncate base, very inequilateral, the lower side greatly dilated), mucronate, densely clothed with silvery-grey hairs beneath. Flowers in elongate 6-30 flower racemes upto 30 cm long; bracts 1 cm long, lanceolate, hairy, caducous; bracteoles caducous. Calyx silky and. with a few irritant bristles outside; tube campanulate; upper teeth completely connate into a triangular lip equaling the tube, lateral teeth lanceolate as long as the tube, the lower tooth lanceolate and slightly longer. Corolla purple; keel slightly incurved; standard more than half as long as the rostrate keel, which usually slightly exceeds the wings. Pods upto 8 cm long, falcately curved on both ends, somewhat like the letter S, densely clothed with persistent irritant bristles which are at first pale-brown, afterwards steel-grey. Seed 5-6. (Fig. 145)

Vernacular name: Kauncha.

Flowers: August-December.

Micromorphology (Fig. 146)

There were three types of trichomes observed on the plant. Leaf showed unicellular, non-glandular, elongated, thin-walled trichome with broad lumen. Stem showed unicellular, non-glandular trichome with warty surface and calyx showed unicellular, non-glandular, elongated trichome with thick minutely tuberculated surface.

Stomata were anomocytic and paracytic.

D/389

24. *Pongamia pinnata* (L.) Pierre, Fl. For. Cochinch. 385. 1899

A medium sized tree with spreading glabrous branches forming dense canopy. Leaves imparipinnate, reaching upto the length of 25 cm long; leaflets 5-7, ovate-oblong, acuminate at apex. Flowers in peduncled axillary racemes. Calyx brown, subtruncate, obscurely toothed. Corolla white, tinged with pink; standard appendiculate at base, shortly clawed; wings adnate to keel. Ovary sub-sessile, 2-ovuled; style incurved; stigma capitate. Pods woody, obliquely-oblong, shortly beaked, 4-5 cm long. Seeds 1-2, reniform, dirty white, with brown streaks. (Fig. 147)

Vernacular name: Karanj.

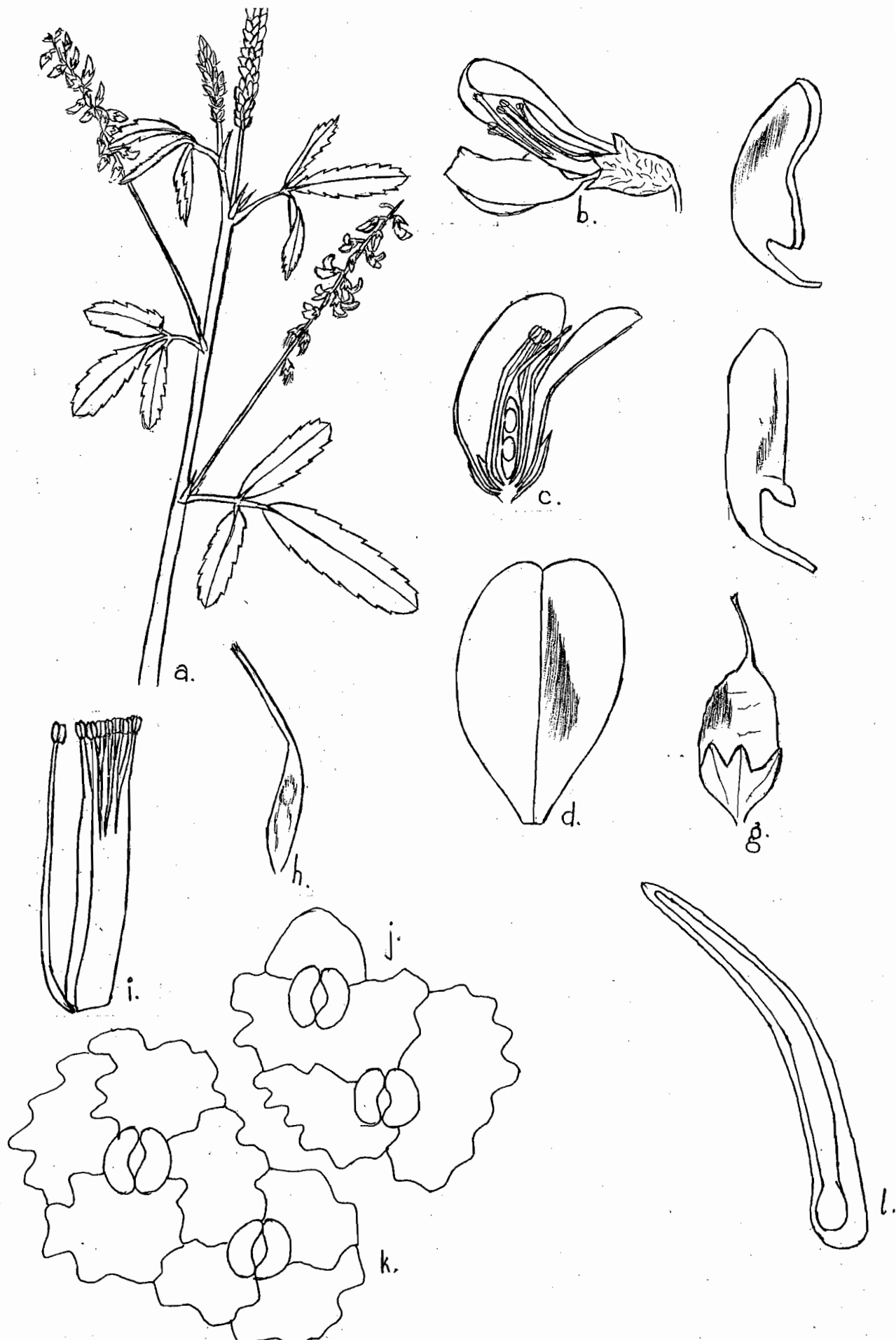


Fig. 144. *Melilotus indica* All., a. habit, b. flower, c. L.S. of flower, d. standard petal, e. keel petals, f. wing petal, g. fruit, h. gynoecium, i. diadelphous stamens, j. diacytic stomata, k. anomocytic stomata, l. unicellular acicular trichome.

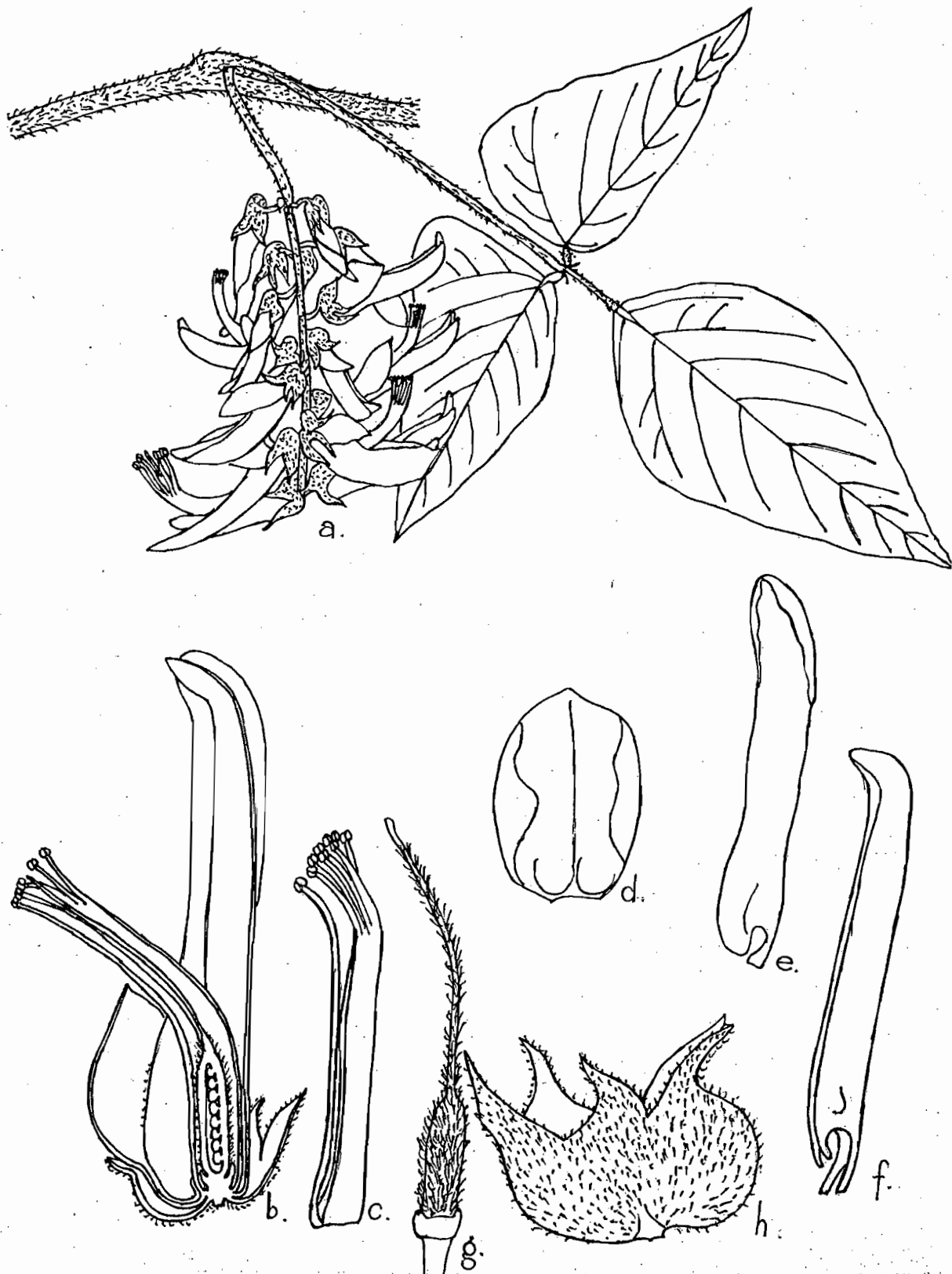


Fig. 145. *Mucuna pruriens* Baker., a. habit, b. L.S. of flower, c. diadelphous stamens, d. standard petal, e. wing petal, f. keel petals, g. gynoecium, h. calyx.

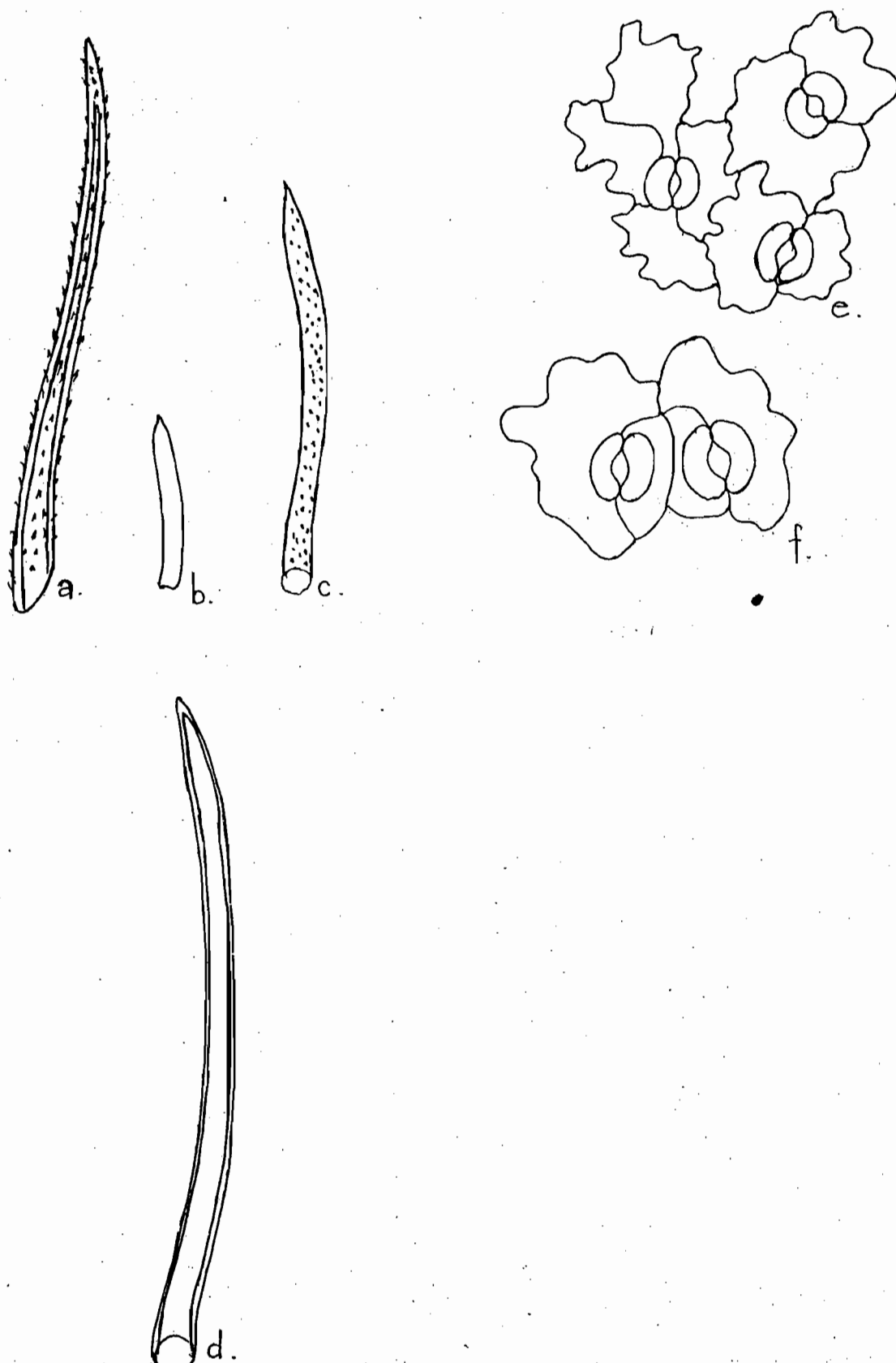


Fig. 146. *Mucuna pruriens* Baker., a. unicellular acicular trichome with thick wall and warty surface, b. unicellular trichome with a smooth thin wall, c. unicellular trichome with pitted walls, d. unicellular trichome filamentous trichome with blunt tip and broad lumen, e. paracytic and anomocytic stomata, f. paracytic sister stomata.

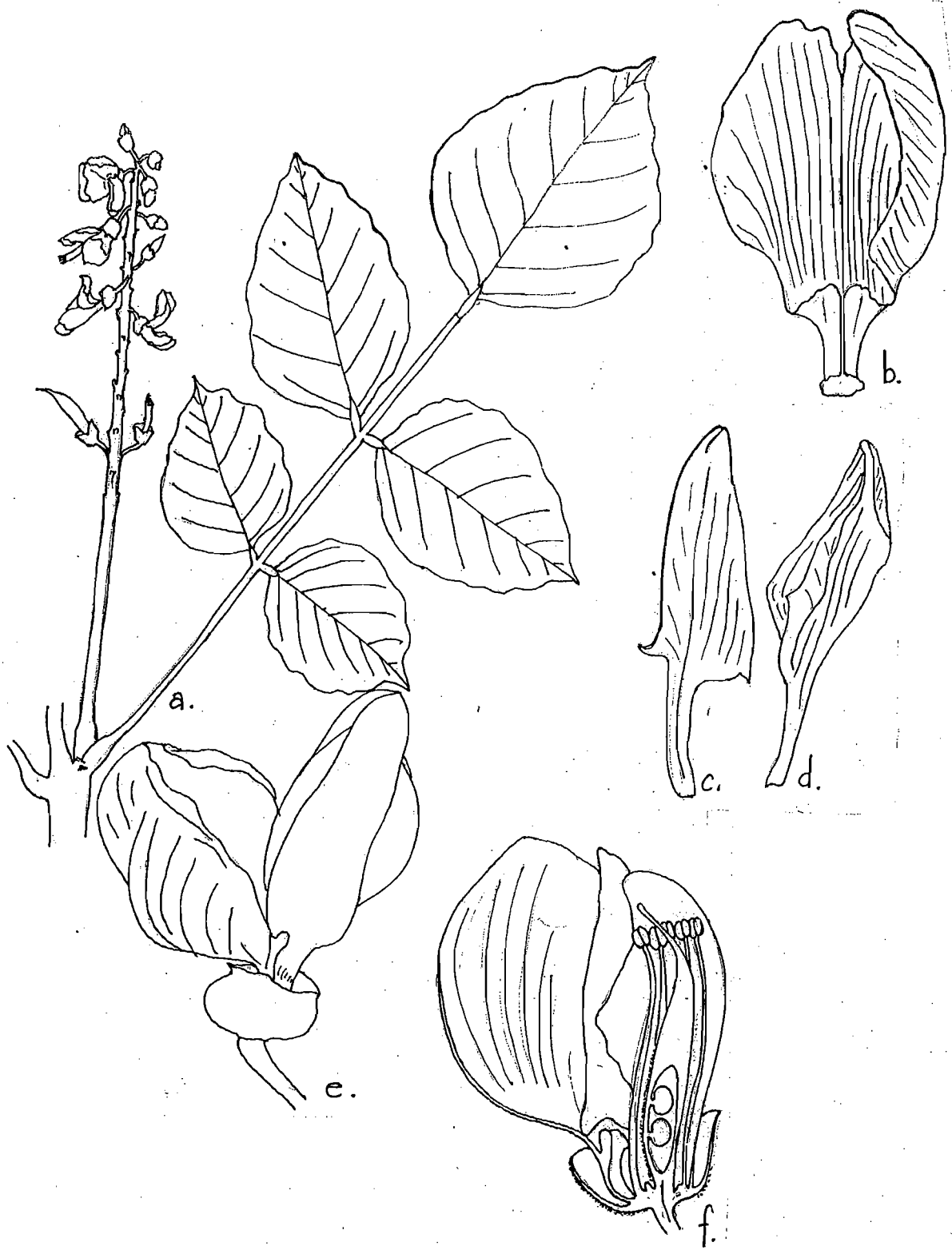


Fig. 147. *Pongamia pinnata* (L.) Pierre., a. habit, b. standard petal, c. wing petal, d. keel petal, e. flower, f. L.S. of flower.

Flowers: February-June.

Micromorphology (Fig. 148)

The trichomes were two celled with a upper cell long acicular with broad lumen, and blunt tip. The basal cell was small.

Stomata were anomocytic, paracytic and diacytic types.

D/743.

25. *Rhynchosia bracteata* Benth. ex. Baker, in Hook. f. *Fl. Brit. Ind.*, 2:225. 1876.

A twining herb with stems and branches finely striate, clothed with velvety pubescence. Leaves 3-foliolate; leaflet rhomboid-ovate or rhomboid- obovate, obtuse, apiculate, pubescent on the veins and conspicuously dotted beneath, base cuneate. Flowers in axillary 6-12 flowered lax racemes usually exceeding the leaves; pedicels very short. Calyx teeth about twice as long as the tube, linear-subulate. Corolla yellow. (Fig. 149)

Flowers: September- January.

Micromorphology (Fig. 149)

The trichomes of leaf and stem were two-celled with a lower broad short cell and long acicular distal cell.

Stomata were anisocytic and paracytic types.

D/581, 822, 823, 824, 825.

26. *Sesbania aculeata* Poir. *Encyc. V. 7* (1806) p. 128

(*Sesbania aculeatus* Pers.)

A branched annual reaching 3 m or more in height; stems semiwoody; branches and leaf-rhachises more or less prickly. Leaves pinnate, reaching 30 cm in length; stipules membranous, acuminate, caducous. Leaflets 20-50 pairs, close, upto 1 cm, linear-oblong, obtuse, strongly mucronate, glabrous, base acute. Flowers in lax axillary 3-6 flowered drooping racemes. Calyx long, campanulate, shallowly 2-lipped or 5-toothed; teeth deltoid. Corolla upto 1.5 cm long, yellow, much exserted; standard orbicular, usually with red dots on the back of the glabrous standard; wings falcate-oblong; keel obtuse and recurved. Stamens diadelphous; anthers uniform. Ovary many-ovulate; style incurved; stigma small, capitate. Pods 15-25 cm long, slightly falcate, beaked. (Fig. 150)

Vernacular name: Ikad.

Flowers: September-October.

Micromorphology (Fig. 150)

Whole plant was glabrous.

Stomata were of anomocytic and anisocytic types.

D/479, 934, 1035.

27. *Sesbania grandiflora* (L.) Poir. in *Lamk. Encycl. Menth.* 7: 127. 1806.

A tree with soft-wood, reaching upto 10 m high with virgate cylindrical branches. Leaves upto 30 cm long, paripinnate; leaflets 10-30 pairs, linear-oblong, obtuse, upto 4 cm; stipules minute, deciduous. Flowers in 5-8 cm long, borne in 2-4 flowered axillary racemes. Calyx somewhat 2-lipped. Corolla white, upto 10 cms. long; standard orbicular;

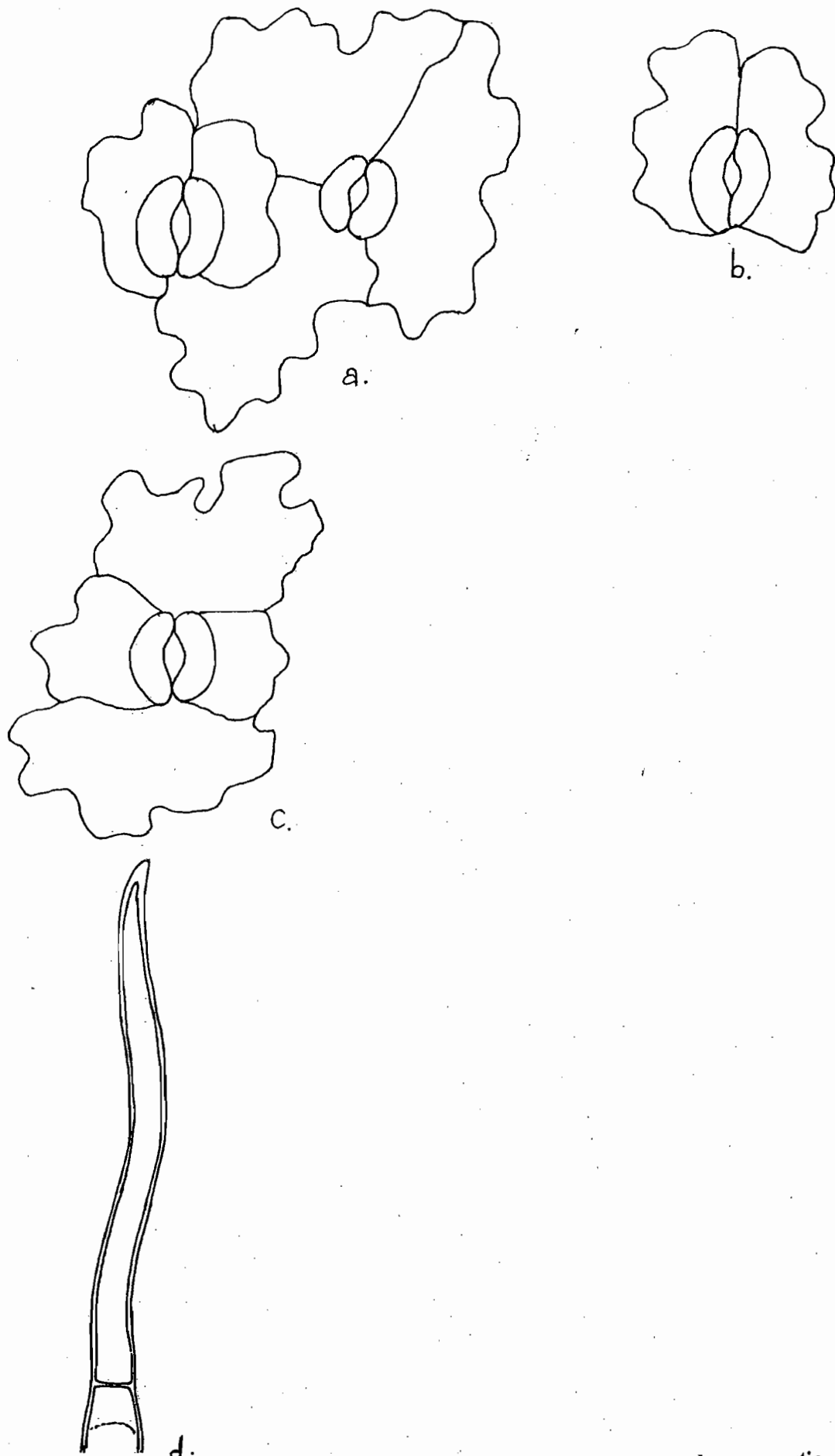


Fig. 148. *Pongamia pinnata* (L.) Pierre., a. anomocytic stomata, b. paracytic stomata, c. tetracytic stomata, d. two celled trichome with a basal small cell and long broad upper cell.

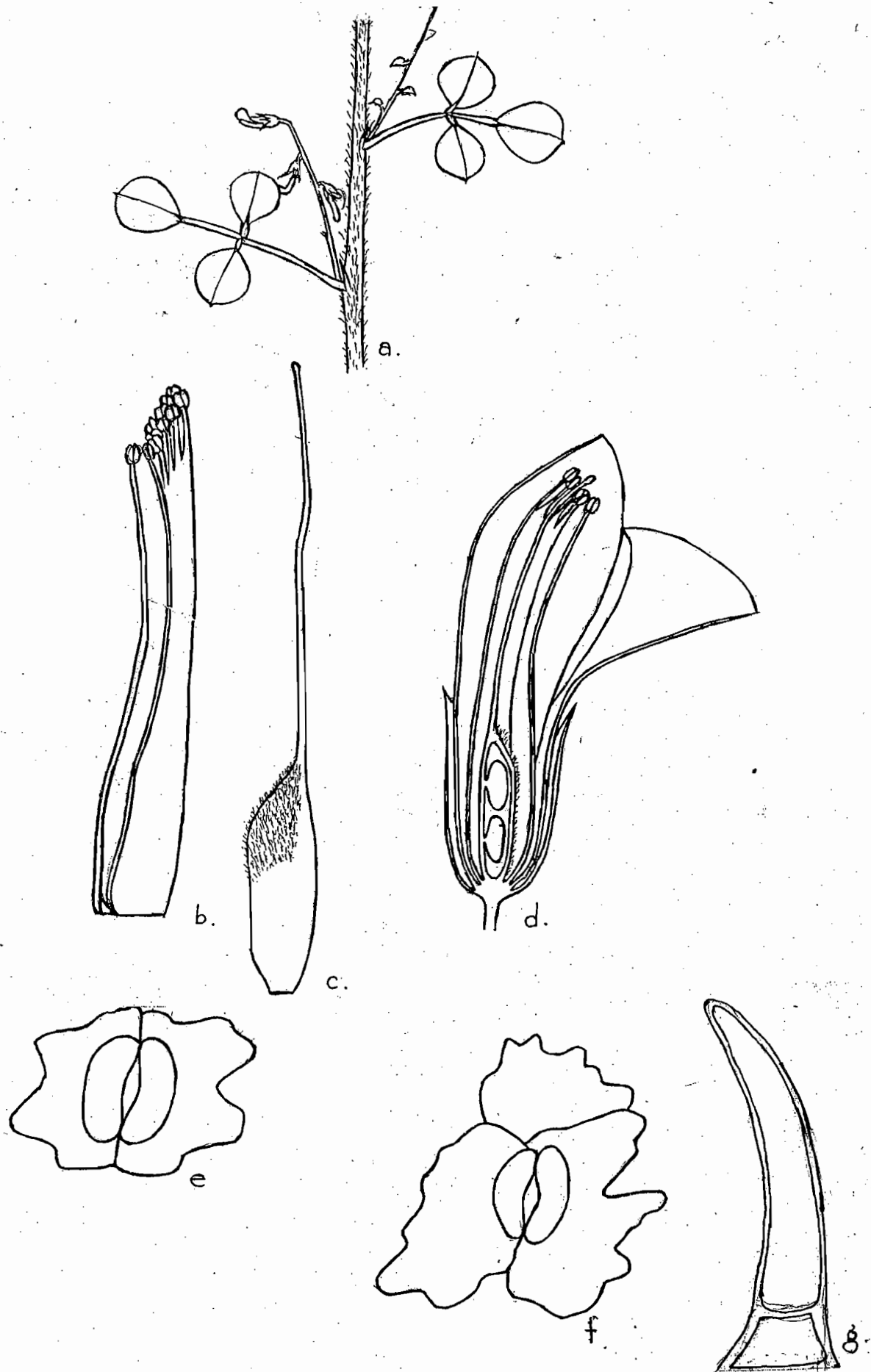


Fig. 149. *Rhynchosia bracteata* Bth. ex. Baker, a. habit, b. diadelphous stamens, c. gynoecium, d. L.S. of flower, e. paracytic stomata, f. anisocytic stomata, g. two-celled trichome with an apical long pointed cell and a basal broad cell.

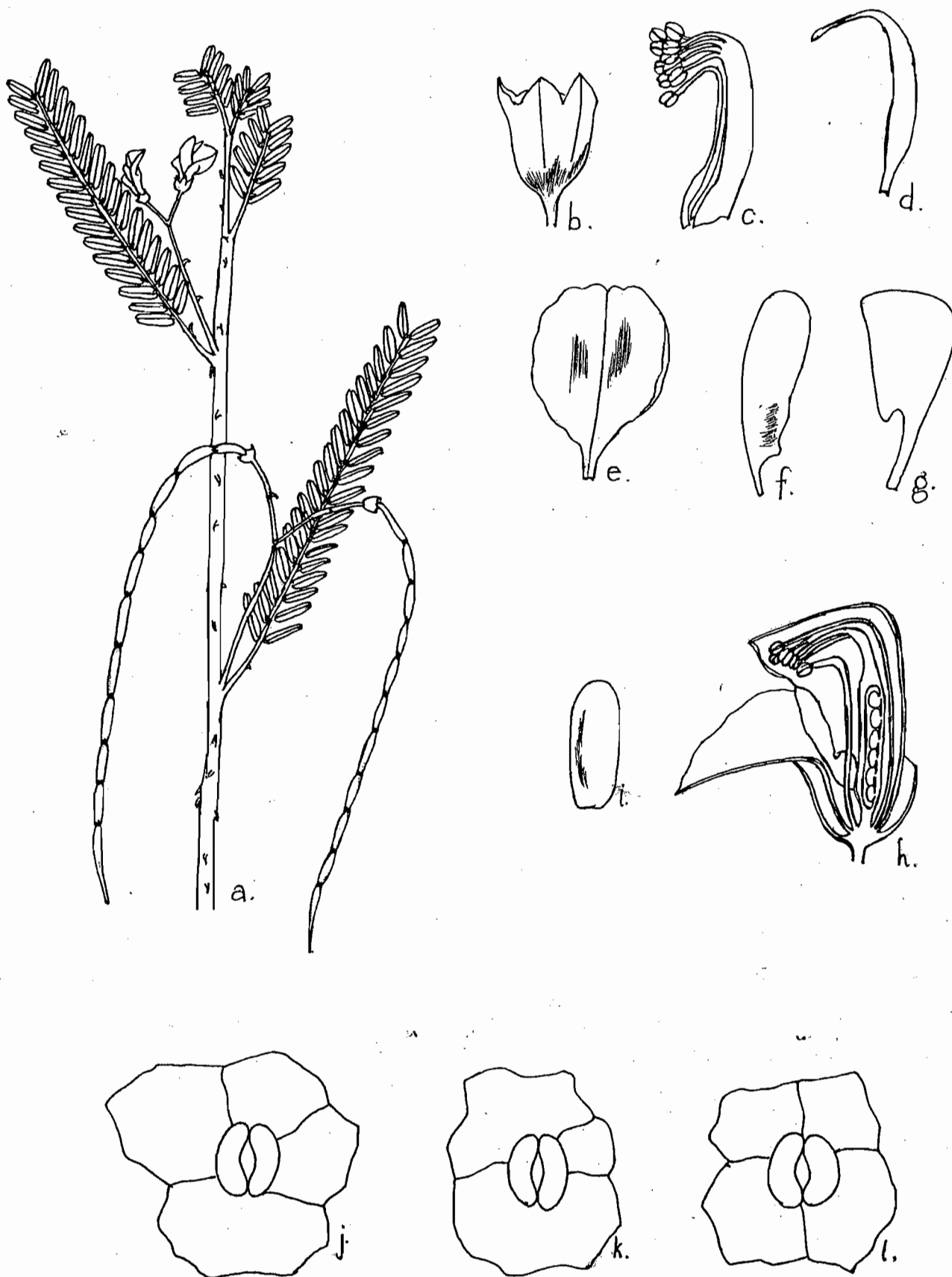


Fig. 150. *Sesbania aculeata* (Willd.) Pers. a. habit, b. calyx, c. diadelphous stamens, d. gynoeceium, e. standard petal, f. wing petal, g. keel petal, h. L.S. of flower, i. seed, j. tetracytic stomata, k. anisocytic stomata, l. anomocytic stomata.

wings falcate-oblong; keel obtuse. Stamens diadelphous. Ovary stipitate, many-ovuled; style filiform. Pods slightly falcate; 30-45 cm long, many-seeded, markedly thickened along sutures. (Fig. 151)

Vernacular name: Agathio.

Flowers: August-September.

Micromorphology (Fig. 152)

Unicellular trichomes with an oblique thickening at the base were located.

Stomata were of anisocytic, diacytic and tetracytic types.

D/351

28. *Stylosanthes hamatus* Taub. in *Verh. Bot Brand* 32:22 (1980)

(*Stylosanthes mucronata* Willd.)

A much branched, low, diffuse, perennial undershrub with teret, stiff ascending branches. Leaves trifoliate, stipules scarious, strongly nerved, adnate to the petiole for half their length, terminating above in 2 spreading theeth. Leaflet elliptic-oblong 4 by 20 mm, or lanceolate, pale green, pubescent on lower surface. Terminal leaflet a little larger than lateral ones, all acute and mucronate at the apex, glabrous above, slightly pubescent, strongly nerved, base subacute; the terminal with a petiole about 4- mm long. Flowers solitary or few in sessile terminal heads in the axils of leaf like stipulate bracts. Bracts persistent, striated. Calyx tubular; the upper connate lobes ciliate at the apex. Corolla yellowish. Pods flattened, 1-2 jointed, very short, concealed by the persistent bracts, hooked at the apex with the persistent base of the style, joints pubescent with raised veins. (Fig. 153)

Flowers: September-february.

Micromorphology (Fig. 154)

Three-celled uniseriate trichome with an apical pointed cell, a middle rectangular cell showing inclusions and a basal stalk cell was present.

Stomata were of paracytic type only. The epidermal cells surrounding the stomata contained a large number of prismatic crystals.

D/942-943, 1131.

29. *Tephrosia purpurea* Pers. *Syn. Pl.* V. 2 (1807) p. 329.

A hairy copiously branched herbaceous perennial 30-60 cm high with spreading branches. Leaves upto 10 cms. long; stipules linear-subulate, nerved. Leaflets 11-21, oblanceolate, obtuse or retuse, mucronate, clothed with fine appressed silky hairs beneath; nerves close, ascending, slender conspicuous on both surfaces. Flowers in leaf-opposed lax racemes of 8-12 cm long; pedicels slender; bracts subulate. Calyx thinly silky; teeth triangular-subulate. Corolla pink; standard orbicular; wings obovate. Stamens diadelphous; anthers uniform. Ovary sessile; ovules many; style flattened; stigma penicillate. Pods 3-5 cm long, slightly curved, mucronate, at first thinly hairy. Seeds 5-6. (Fig. 155)

Vernacular name: Sarpankho.

Flowers: October-January.

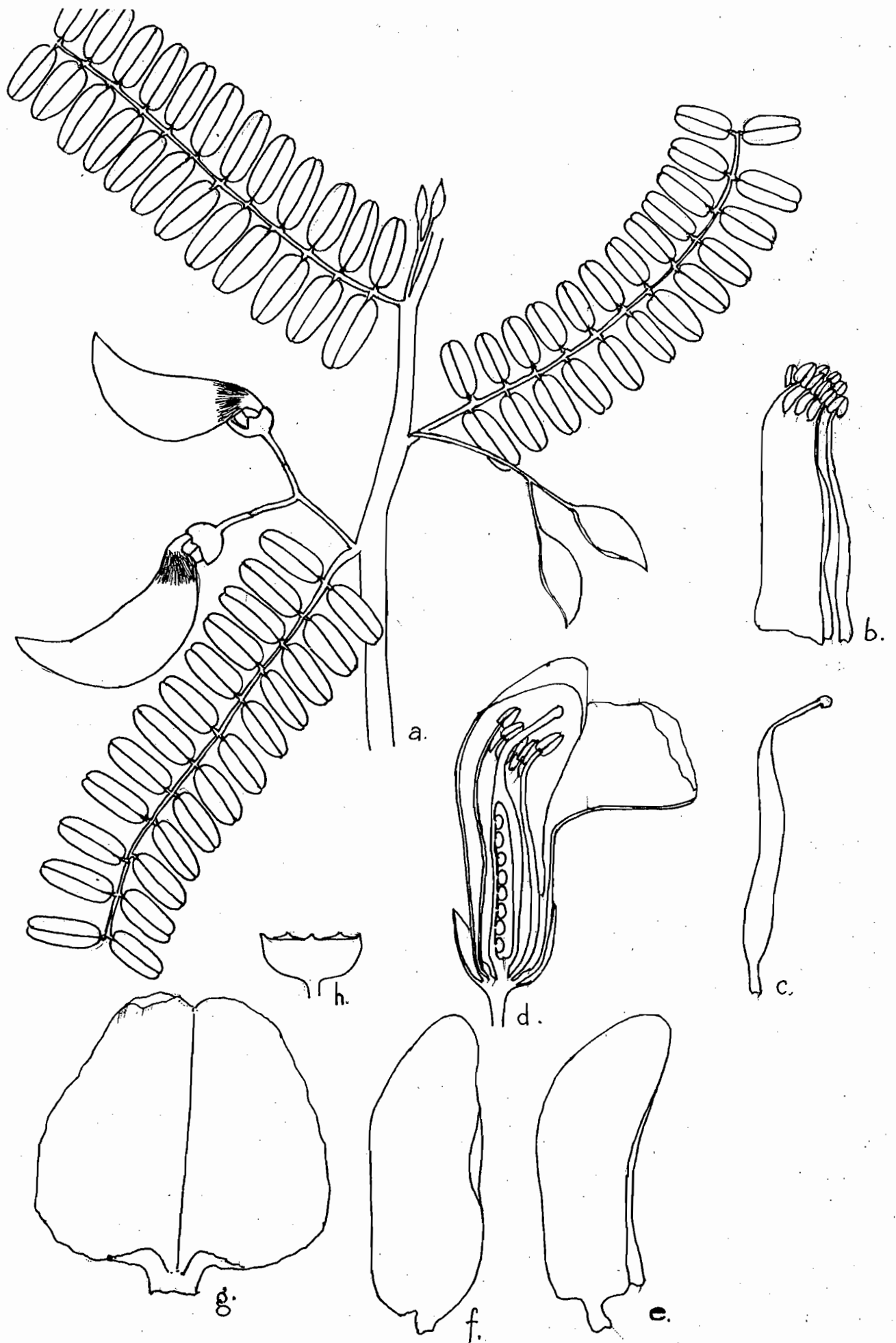


Fig. 151. *Sesbania grandiflora* (L.) Pers. a. habit, b. diadelphous stamens, c. gynœcium, d. L.S. of flower, e. keel petal, f. wing petal, g. standard petal, h. calyx.

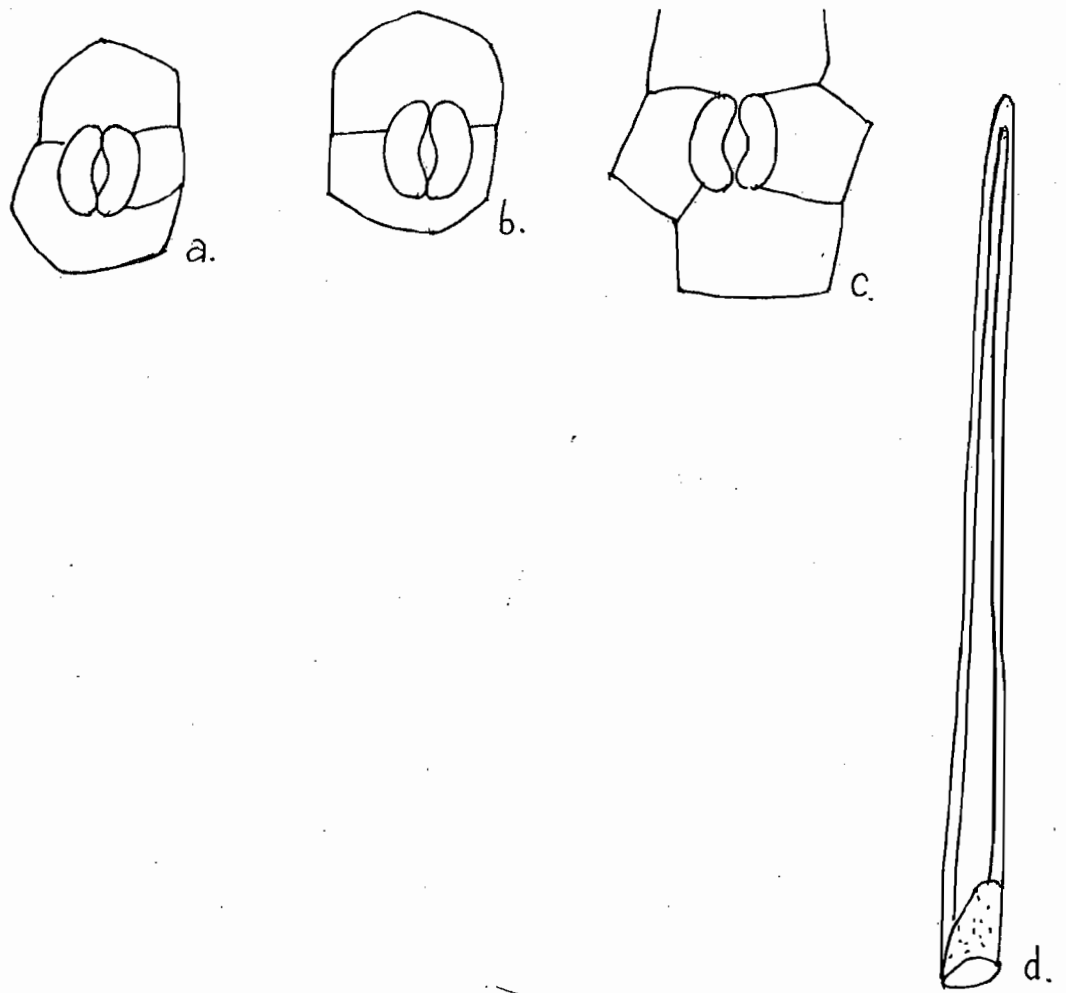


Fig. 152. *Sesbania grandiflora* (L.) Pers. a. anisocytic stomata, b. diacytic stomata, c. tetracytic stomata, d. unicellular trichome with oblique thickening at the base.

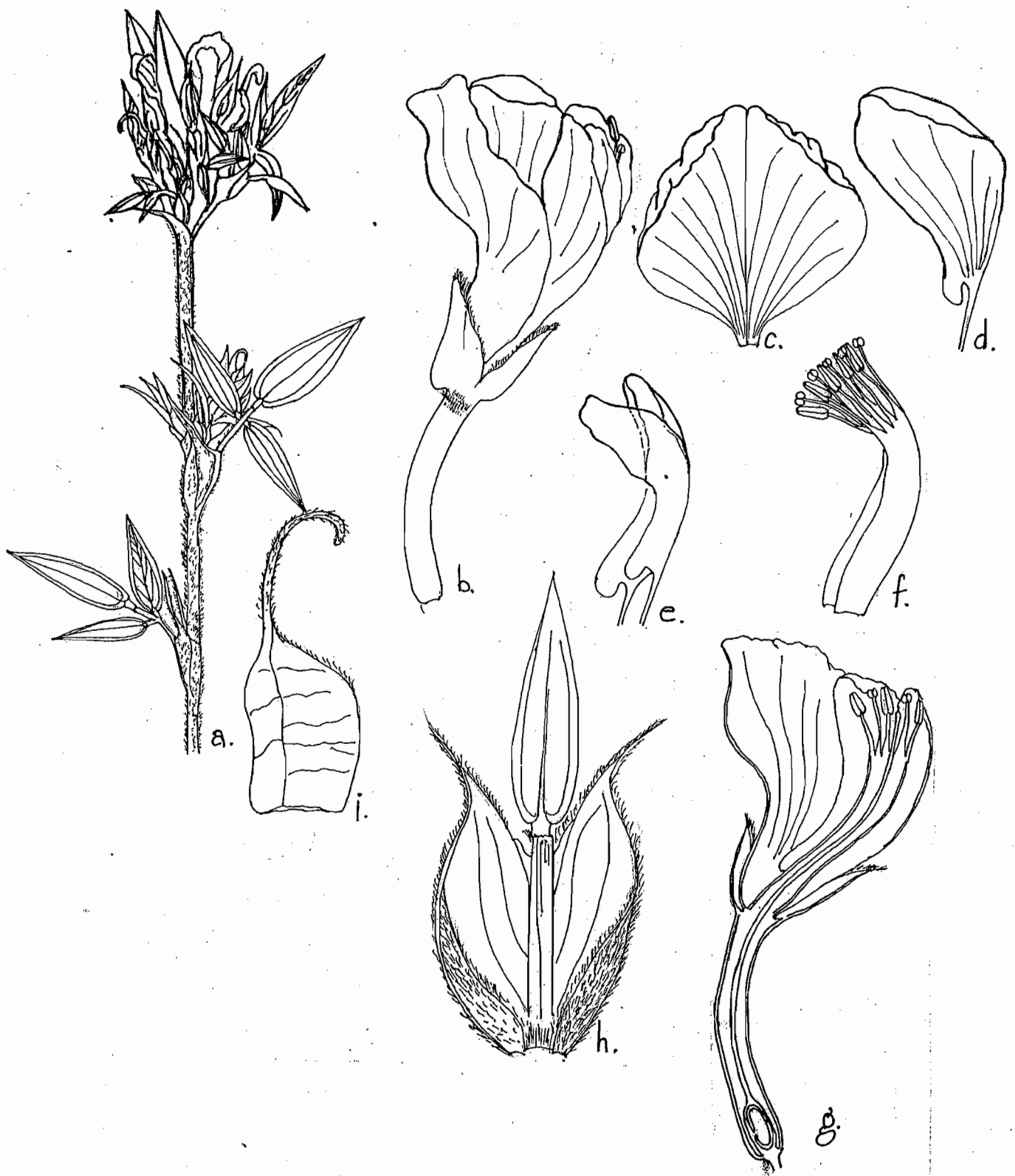


Fig. 153. *Stylosanthes hamatus* Taub. a. habit, b. flower, c. standard petal, d. wing petal, e. keel petals, f. monadelphous stamens, g. L.S. of flower, h. back side of the leaf showing two adnate stipules, i. fruit.

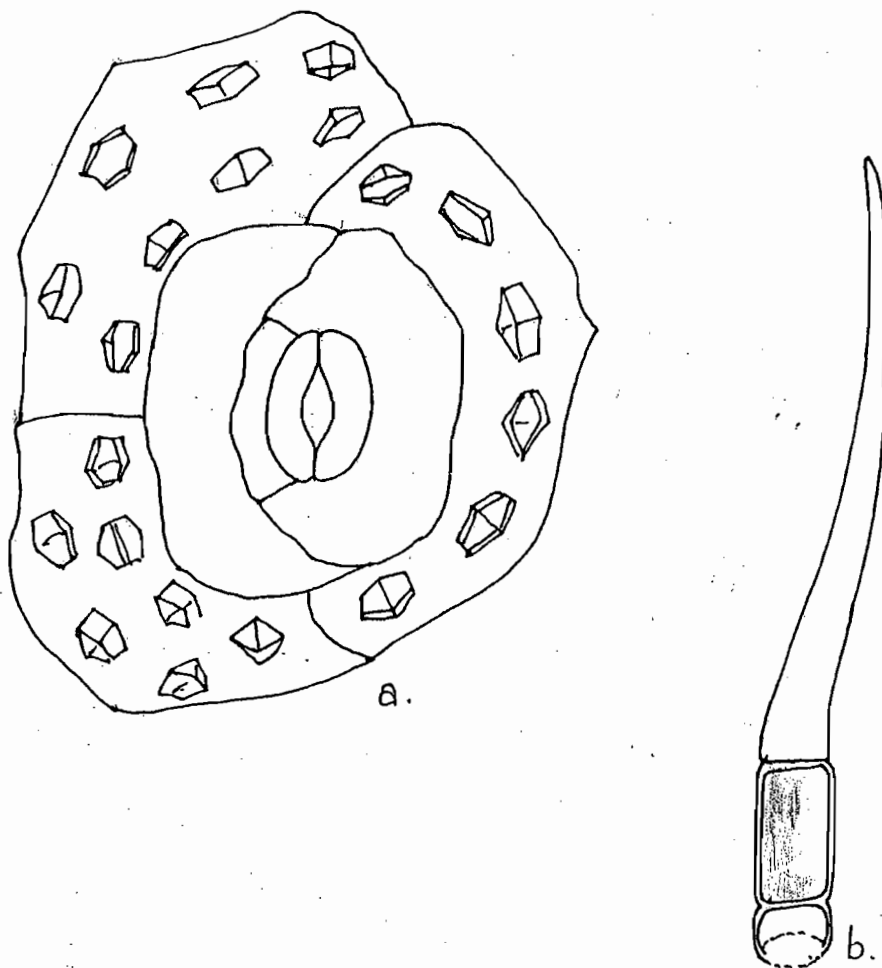


Fig. 154. *Stylosanthes hamatus* Taub. a. paracytic stomata, b. three-celled uniseriate trichome with an apical pointed cell, a middle rectangular cell showing inclusions and a basal stalk cell.

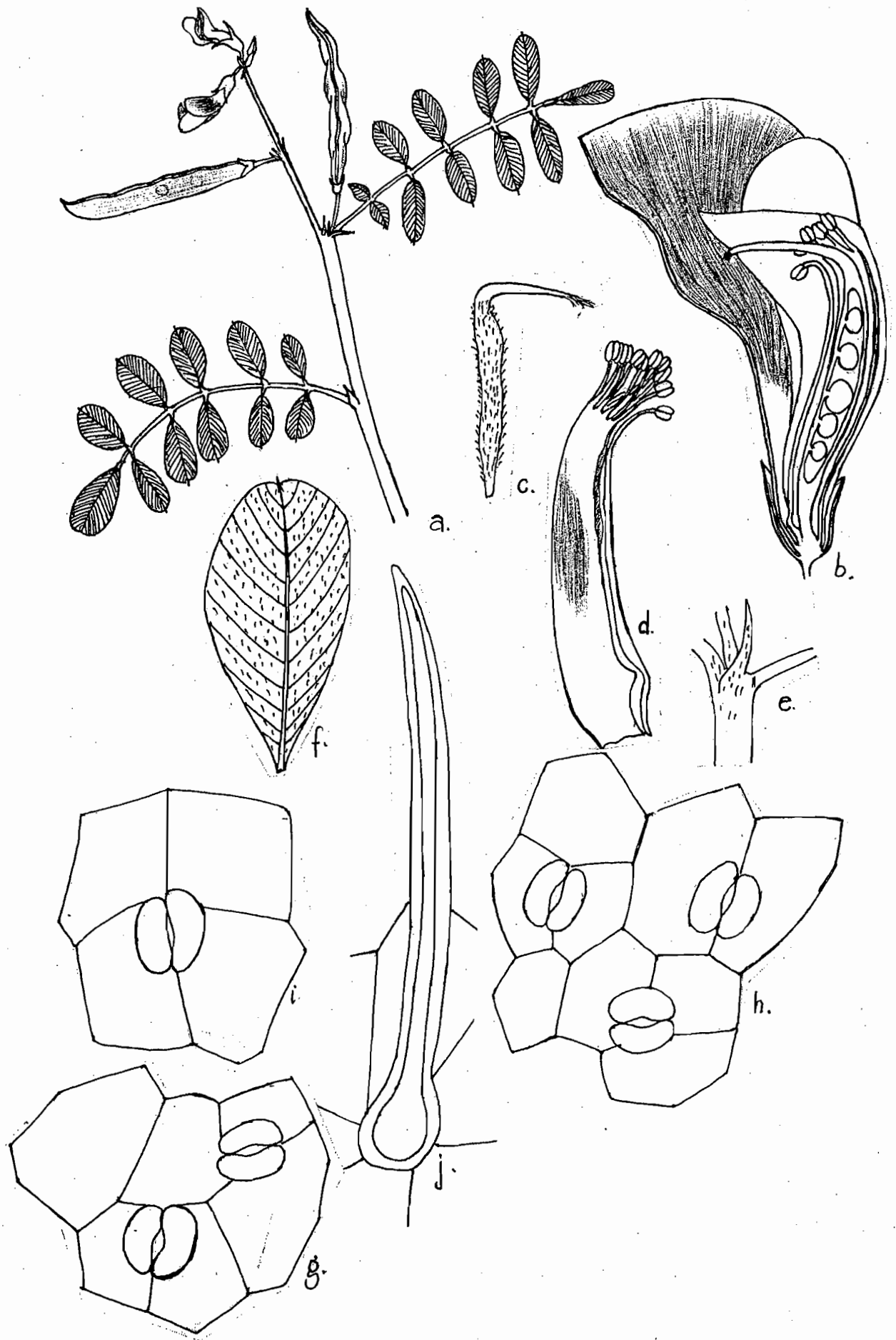


Fig. 155. *Tephrosia purpurea* Pers. a. habit, b. L.S. of flower, c. gynoecium, d. diadelphous stamens, e. stipule, f. leaf, g. anomocytic stomata, h. paracytic and anisocytic stomata, i. tetracytic stomata, j. unicellular trichome with thick wall and round base.

Micromorphology (Fig. 155)

The plant showed unicellular, non-glandular, elongated trichome with thick wall and a round base.

Stomata were of anomocytic, anisocytic and paracytic types.

D/321, 329, 584, 1033.

30. *Tephrosia villosa* Pers. Syn. Pl. V 2 (1807) p. 329.

A branched perennial herb clothed with white appressed hairs. Leaves nearly sessile, upto upto 8 cm long; stipules linear-lanceolate, acute, deflexed. Leaflets 11-19, grey-green, oblanceolate, usually emarginated and mucronate, silky beneath. Flowers large, in lax elongate racemes 15 cm in length; pedicels very short; bracts linear-subulate, plumose. Calyx teeth linear-subulate, densely hairy. Corolla red; standard equaling the calyx, suborbicular, silky on the back. Style flattened, glabrous; stigma penicillate. Pods persistently velvety with dense spreading hairs, mucronate, falcately curved upwards. Seeds 6-8. (Fig. 156)

Vernacular name: Runchhalo sarpankho.

Flowers: July-September.

Micromorphology (Fig. 157)

There were two types of trichomes, 1) unicellular trichome with pitted wall and hooked from the base, and 2) two-celled uniseriate trichome with small basal cell.

Stomata were of anisocytic, paracytic, anomocytic and tetracytic types.

D/ 805, 806, 807, 809, 810, 811.

31. *Teramnus labialis* Spreng. Syst. V. 3 (1826) p. 235.

A widely spreading twining herb with slender stems, more or less appressedly hairy. Leaves 3-foliolate; petioles upto 2.5 cm long; stipules ovate-lanceolate, acute, deciduous. Leaflets membranous or subcoriaceous, ovate-oblong, subacute, apiculate, slightly appressedly hairy beneath. Flowers in axillary few-flowered lax racemes upto 14 cm long, solitary or fascicled along a slender more or less hairy rhachis; bracts linear-lanceolate; bracteoles subulate. Calyx teeth lanceolate, as long as the campanulate tube. Corolla reddish; standard obovate; wings narrow, adhering to the keel; keel shorter than the wings, almost straight, obtuse. Alternate anthers small, abortive. Ovary sessile; ovules many; style short, thick, beardless; stigma capitate. Pods slightly incurved, with a short stout beak bent upwards so as to form nearly a right angle with the pod. Seeds 8-12, dark-brown. (Fig. 158)

Vernacular name: Valiyo-velo.

Flowers: August-October.

Micromorphology (Fig. 159)

Three-celled club shaped gland was present.

Stomata were of anisocytic type.

D/451, 688, 1241.

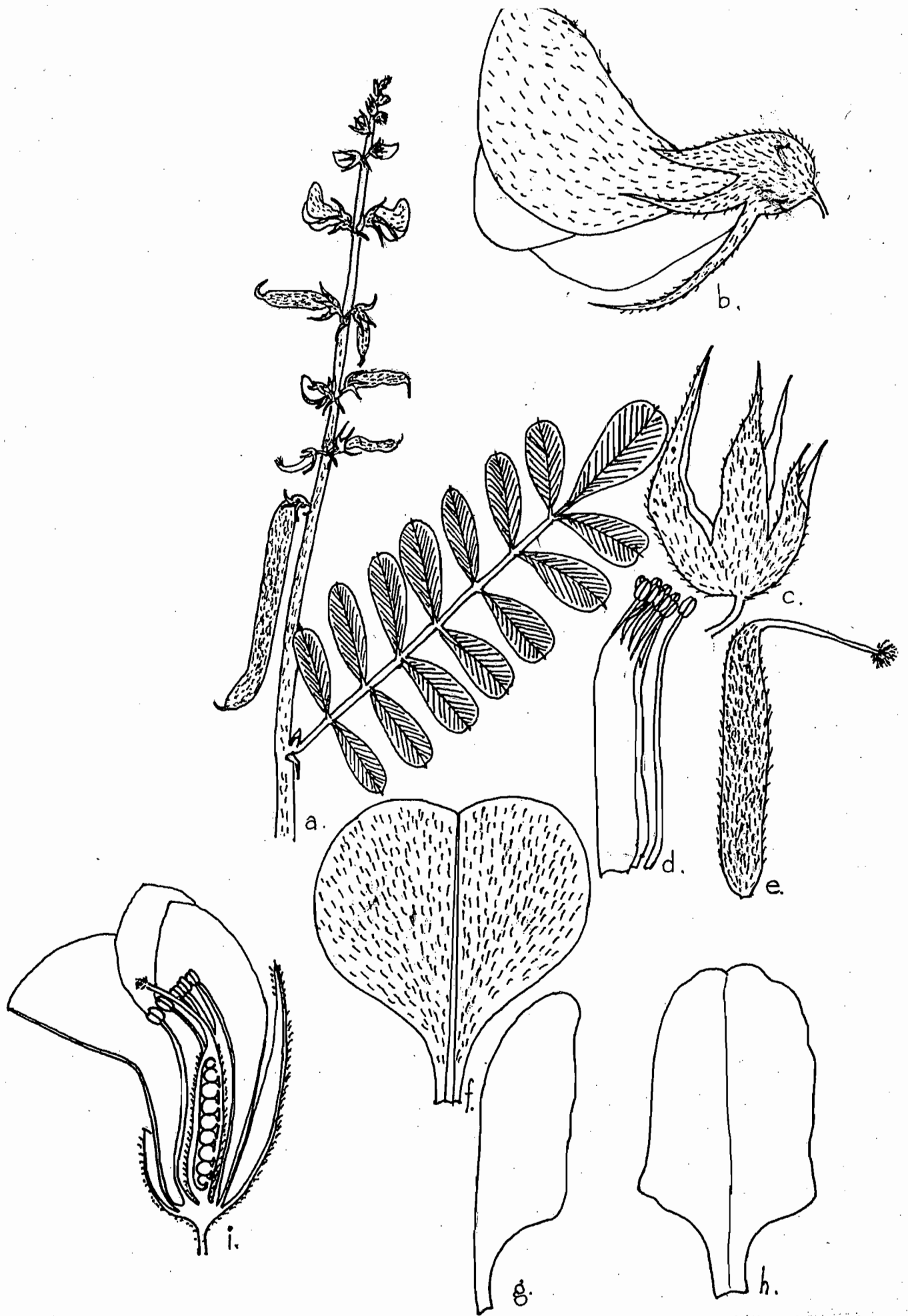


Fig. 156. *Tephrosia villosa* Pers. a. habit, b. flower, c. calyx, d. diadelphous stamens, e. gynoeceium, f. standard petal, g. wing petal, h. keel petal, i. L.S. of flower.

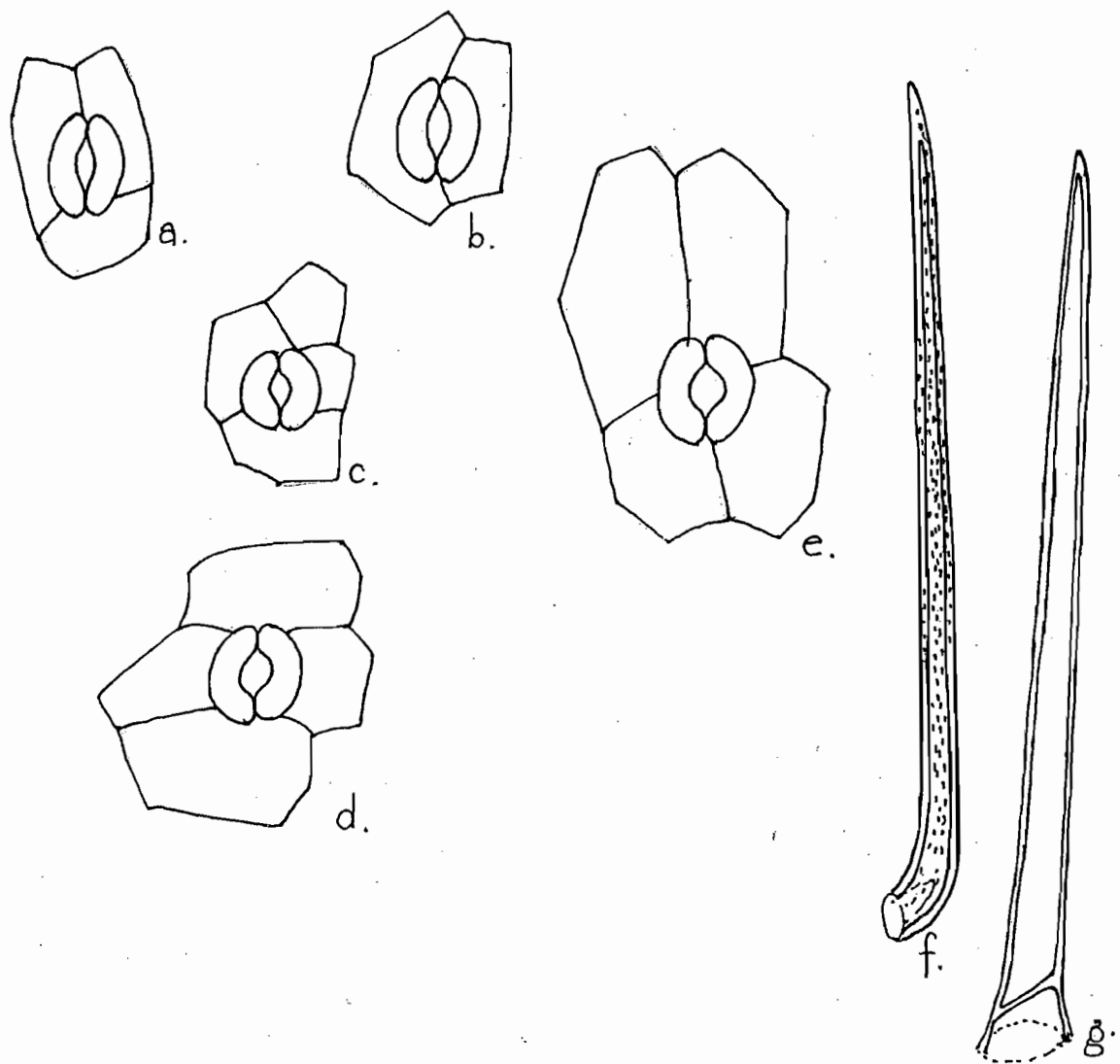


Fig. 157. *Tephrosia villosa* Pers. a. anisocytic stomata, b. paracytic stomata, c. anomocytic stomata, d. tetracytic stomata, e. anomocytic stomata, f. unicellular trichome with pitted wall and hooked from the base, g. two-celled uniseriate trichome with small basal cell.

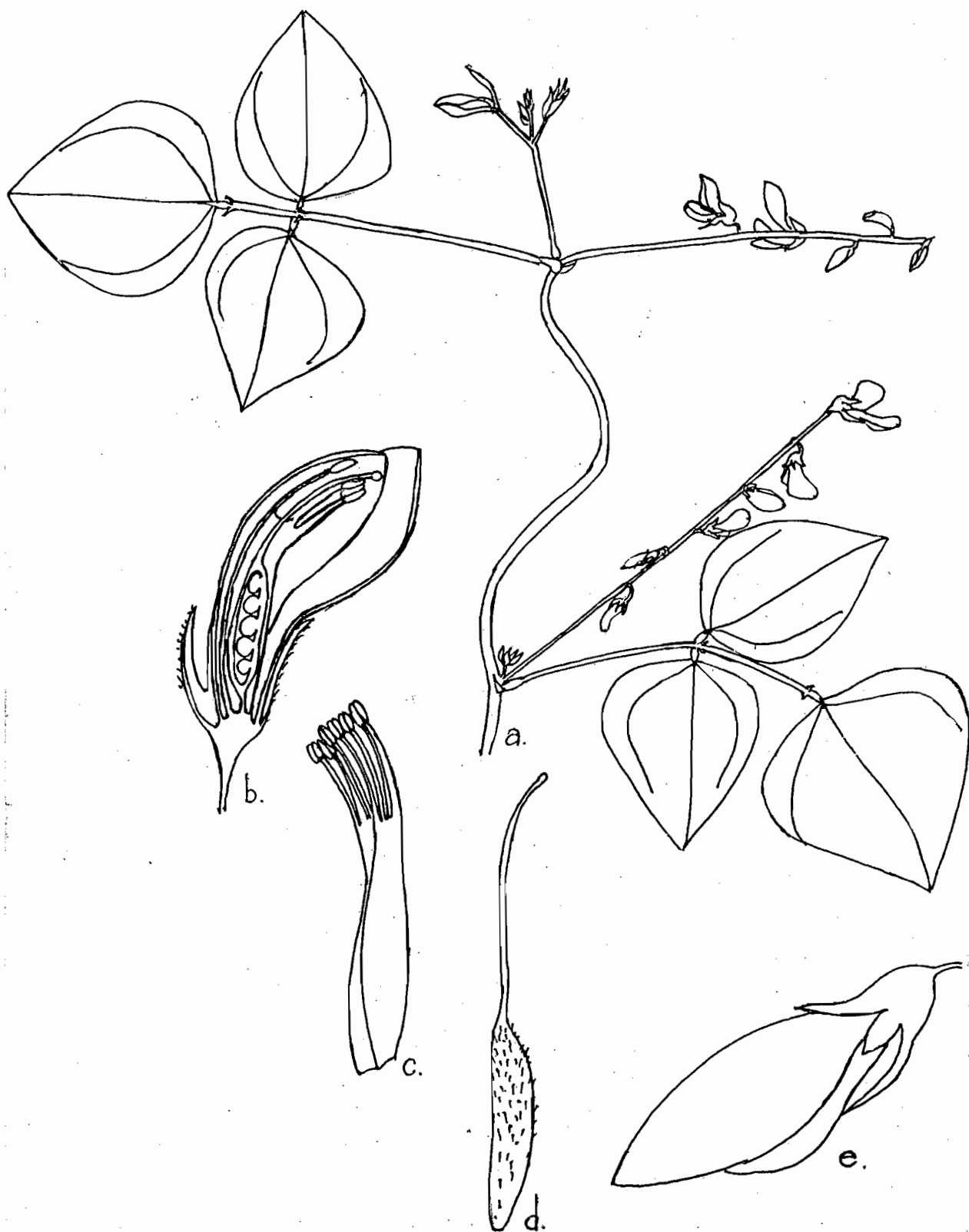


Fig. 158. *Teramnus labialis* Spr. a. habit, b. L.S. of flower, c. monadelphous stamens, d. gynoecium, e. flower.

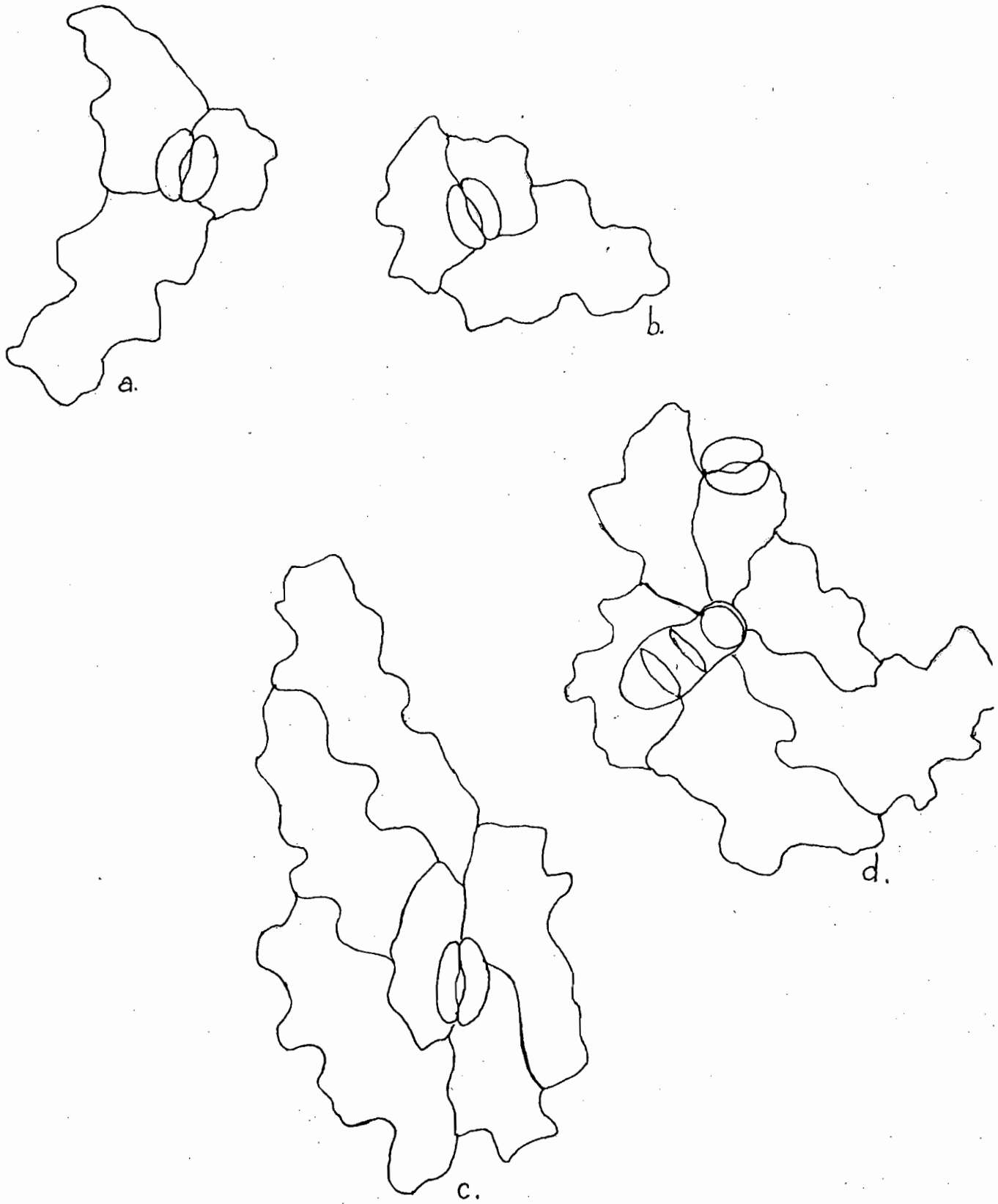


Fig. 159. *Teramnus labialis* Spr. a-c. anisocytic stomata, d. three-celled club shaped gland.

Caesalpiniaceae

1. *Bauhinia purpurea* Linn. *Sp. Pl.* (1753) p. 375.

An erect branched tree 7-10 m high. Leaves 10-12 cm in diameter, roundish, about as broad as long, divided $\frac{1}{3}$ - $\frac{1}{2}$ the way down into 2 obtuse or subacute lobes, faintly puberulous beneath, base cordate; main nerves 9-11; petioles upto 3 cm long, glabrous; stipules triangular-oblong, acute, pubescent, deciduous. Flowers in terminal and axillary few-flowered corymbosa racemes; bracts beneath the pedicels triangular, acute, pubescent; pedicels pubescent; 2-bracteolate below the middle. Calyx-tube slightly dilated upwards; limb upto 2 cm long, splitting into 2 coriaceous segments slightly divided at the apex into 5 short teeth. Petals 5 upto 5 cms. long, subequal, erect, imbricate, the upper inner, oblanceolate, acute, with a long claw, white, rose or purple. Stamens 5, all stamens fertile, staminodes absent. Ovary with long stalk; ovules 16-20; style long; stigma oblique, peltate. Pods upto 30 cm, flat. Seeds 12-16, oblong-ellipsoid. (Fig. 160)

Variation observed: in all the floras, this plant is described having three fertile stamens and 2-7 staminodes, but in all my specimens, there were only 5-fertile stamens and staminodes were absent.

Vernacular name: Shevta Kanch.

Flowers: September-November.

Micromorphology (Fig. 160)

The plant showed presence of multicellular, uniseriate, non-glandular, thick walled and warty trichome.

Stomata were of anomocytic and tetracytic type.

D/349

2. *Bauhinia tomentosa* Linn. *Sp. Pl.* (1753) p. 375.

An erect branched shrub. Leaves broader than long, 3-5 cm by 4-6 cm, divided a little less than $\frac{1}{2}$ way down into 2 rounded lobes, pubescent beneath, base subcordate; main nerves 7 from the base; petioles thickened at both ends. Flowers usually in pairs, on short axillary or leaf-opposed peduncles; bracts linear; pedicels long, 2-bracteolate. Calyx limb 1.5 cm long, broadly ovate, spathaceous. Petals 4-5 cm long, much imbricated, obovate-spathulate, yellow, the upper with a purple blotch on the face. Stamens 10, all fertile, subequal. Ovary stalked; style long; stigma peltate. Pods stalked, upto 13 cm long, flat. Seeds 8-12, oblong. (Fig. 161)

Vernacular name: Tamilo.

Flowers: November-January.

Micromorphology (Fig. 162)

Leaf showed presence of multicellular, uniseriate, unbranched and non-glandular trichome with thick walls. Calyx and ovary showed presence of multicellular, uniseriate, unbranched, non-glandular, curved trichome with warty surface and containing brownish substance.

Stomata were anomocytic, anisocytic and paracytic.

D/69



Fig. 160. *Bauhinia purpurea* L. a. habit, b. stamens, c. gynoecium, d. L.S. of flower, e. flower, f. anisocytic stomata and anomocytic stomata, g. tetracytic stomata, h. multicellular uniseriate trichome with thick and warty wall.

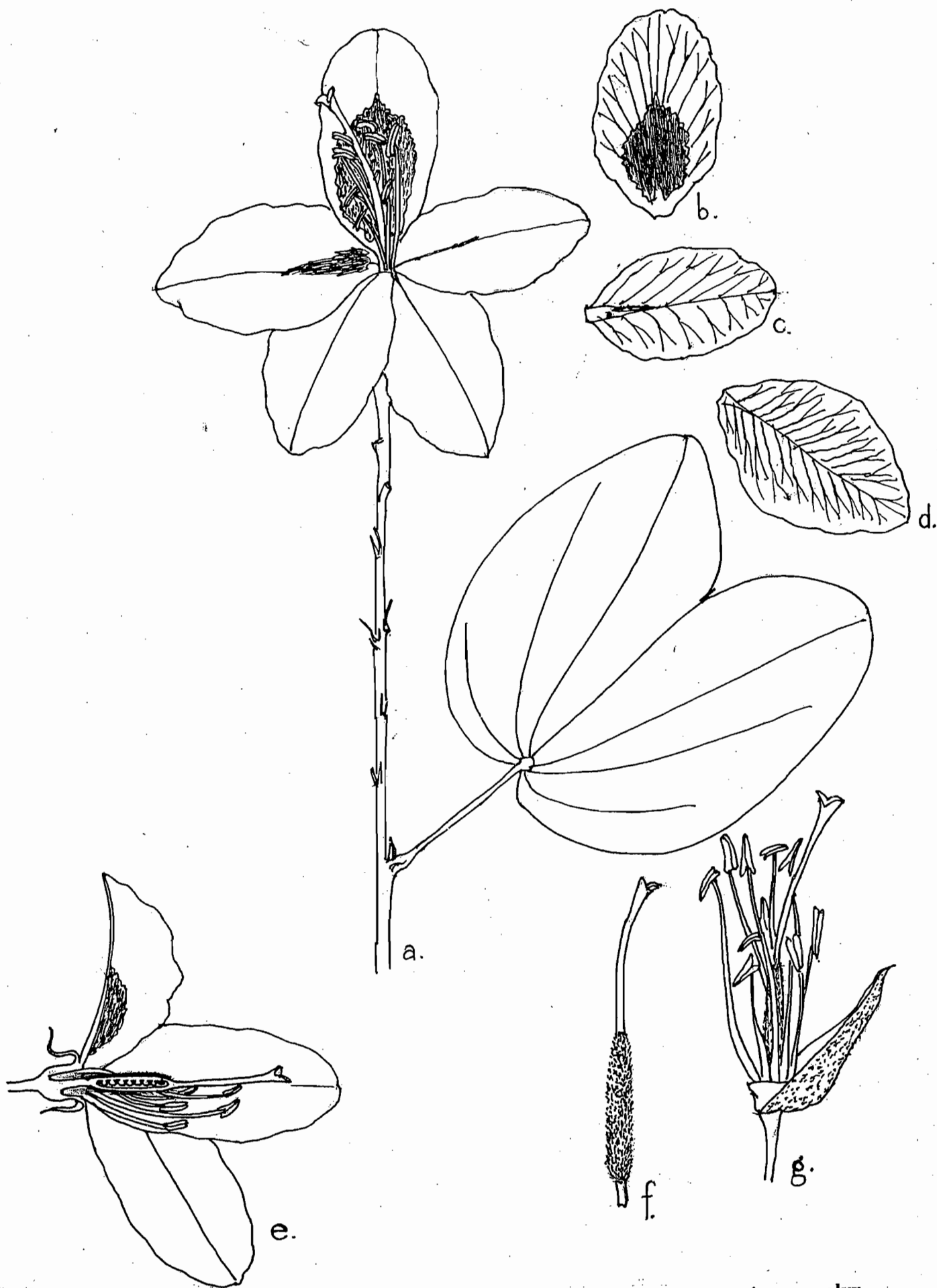


Fig. 161 *Bauhinia tomentosa* L. a. habit, b-d. petals, c. L.S. of flower, f. gynoecium, g. calyx with gynoecium and stamens.

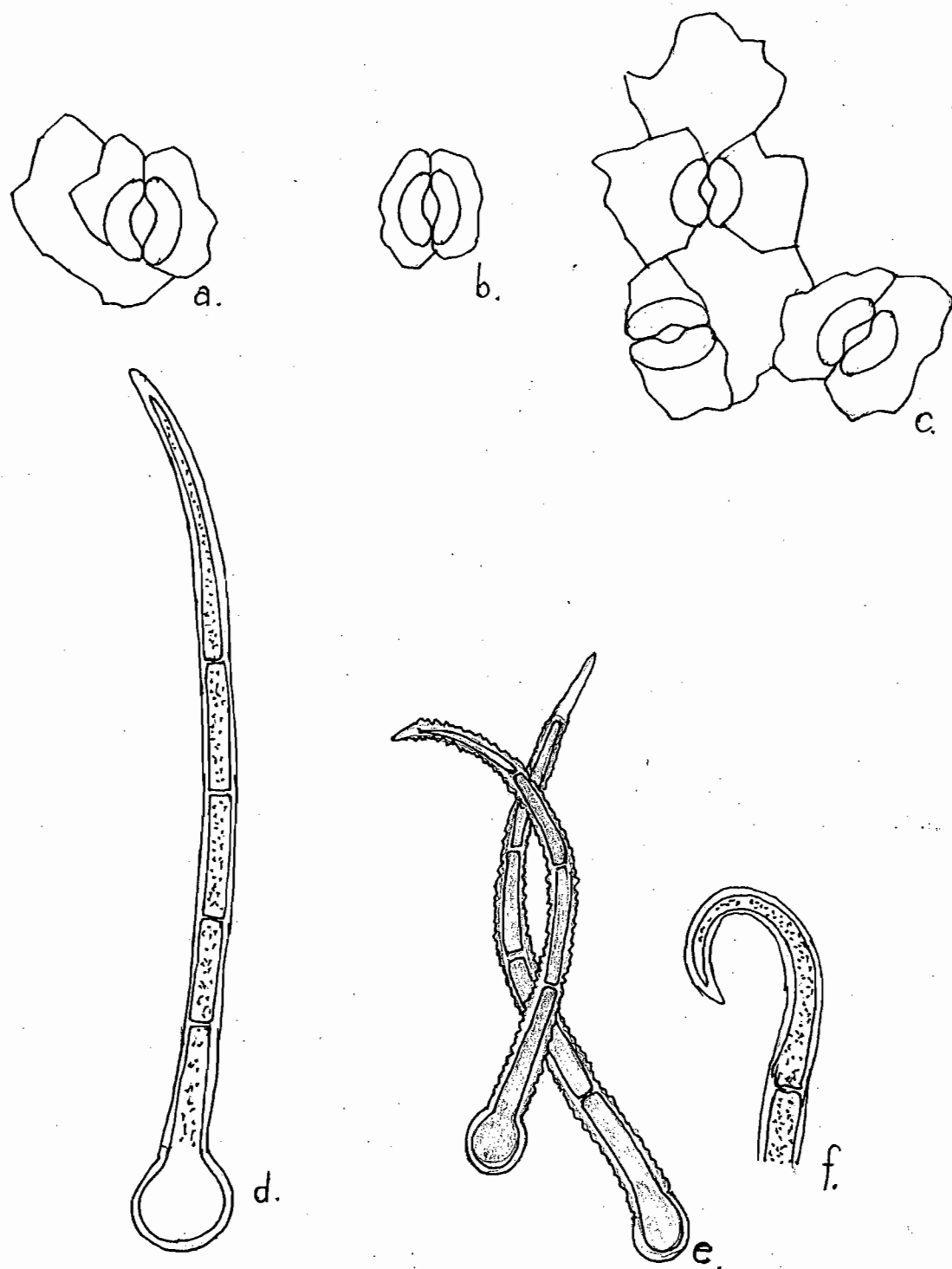


Fig. 162. *Bauhinia tomentosa* L. a. anisocytic stomata, b. paracytic stomata, c. paracytic and anomocytic stomata, d. multicellular uniseriate trichome with thick smooth wall, and round basal cell, e. multicellular uniseriate trichome with thick warty wall and coloured inclusions, f. two-celled uniseriate trichome with hooked apical cell.

3. *Cassia fistula* Linn. *Sp.Pl.* (1753) p. 377

A tree with straight trunk, smooth and dark-brown bark reaching upto 12 m high. Leaves upto 40 cm long; main rachis pubescent; stipules minute, linear-oblong, pubescent. Leaflets 4-8 pairs, ovate-oblong, acute, the midrib densely pubescent on the underside. Flowers in lax hanging racemes reaching upto a length of 50 cm. Pedicels slender, pubescent or glabrous. Calyx 1 cm long, divided to the base, segments oblong, obtuse. Corolla 4 cm across, yellow; petals 5, subequal, obovate, shortly clawed, veined. Stamens 10, the 3 lowest the longest with very long curved filaments and oblong anthers dehiscing longitudinally, the 4 lateral with short straight filaments and versatile anthers opening by pores at the base, the remaining 3 much smaller, erect with indehiscent anthers. Pods upto 60 cm long, pendulous, cylindric, brown-black, indehiscent, with numerous seeds immersed in a dark-colored sweetish pulp, and completely separated by transverse dissepiments. Seeds broadly ovate. (Fig. 163)

Vernacular name: Garmalo.

Flowers: March-May.

Micromorphology (Fig. 164)

The leaves, pedicels, and peduncles were pubescent with unicellular, linear, non-glandular trichome with thick wall and large lumen and a round swollen base.

Stomata were anomocytic type.

D/149

4. *Parkinsonia aculeata* Linn. *Sp. Pl.* (1753) p. 375

A glabrous bush or small tree armed with sharp woody spines which represent the rachises of the 2-pinnate leaves. Pinnae 1-3 pairs, reaching to a length of 30 cms. long, the rachis much flattened, striate. Stipules spinescent. Leaflets numerous, minute, oblanceolate, obtuse. Flowers in lax axillary racemes shorter than the leaves; pedicels upto 1.5 cm long, slender. Calyx 1 cm long divided nearly to the base; segments oblong, obtuse. Corolla yellow; petals upto 2 cm long, broadly obovate or suborbicular, with a short stout villous claw, veined. Stamens free; filaments flattened and densely villous at the base; anthers uniform, versatile. Ovary shortly stalked; silky-villous; ovules many. Pods upto 10 cm, moniliform, attenuated at both ends, finely veined. Seeds 1-6. (Fig. 165)

Vernacular name: Rambaval.

Flowers: January-March.

Micromorphology (Fig. 165)

There were three types of trichomes: 1) unicellular, non-glandular with smooth walls. 2) unicellular, non-glandular with warty walls. 3) two celled, elongate, non-glandular, pointed trichome.

D/1188-1189.

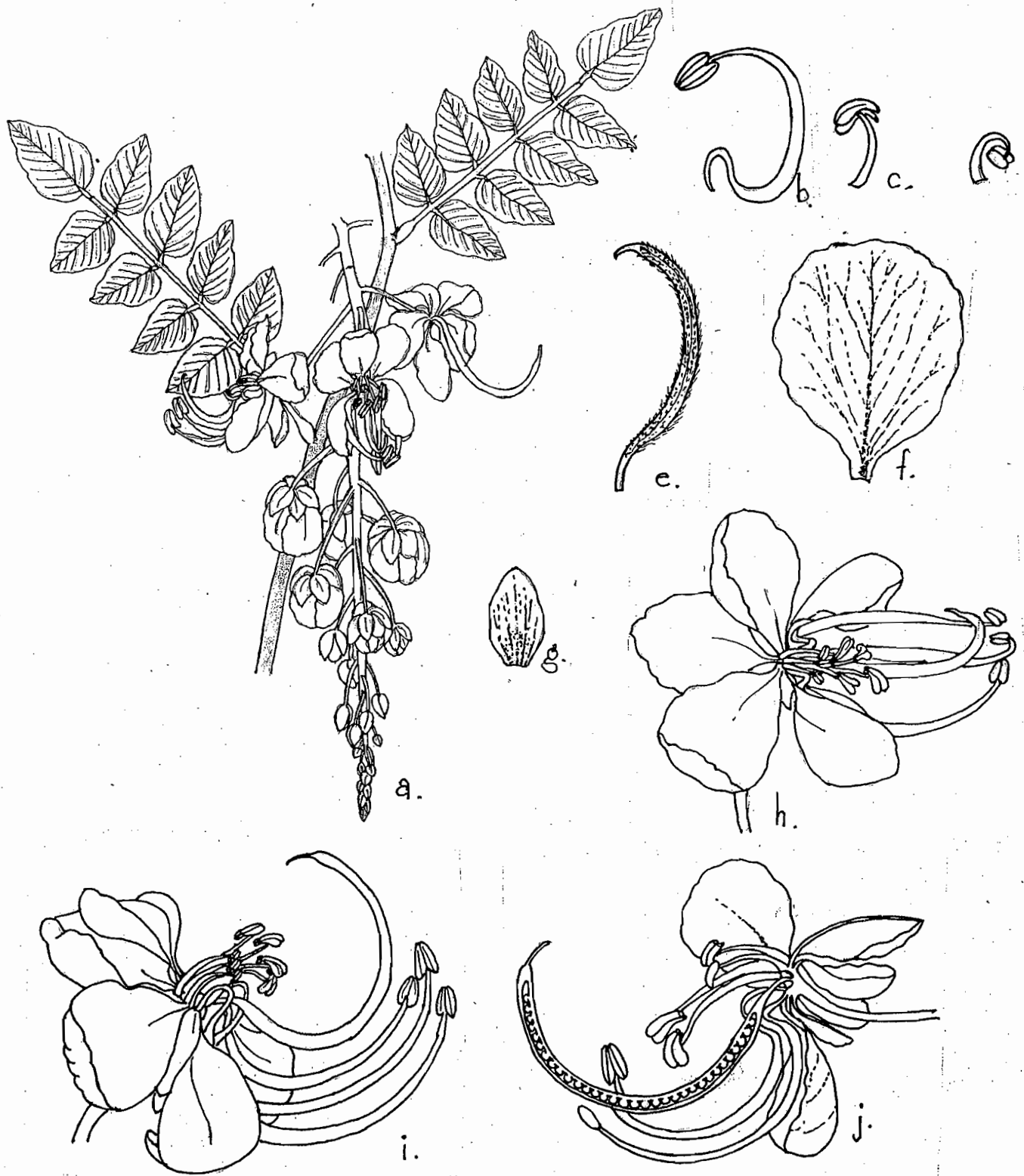


Fig. 163. *Cassia fistula* L., a. habit, b-d. stamens, e. gynoecium, f. petal, g. bract, h-i. flower, j. L.S. of flower.

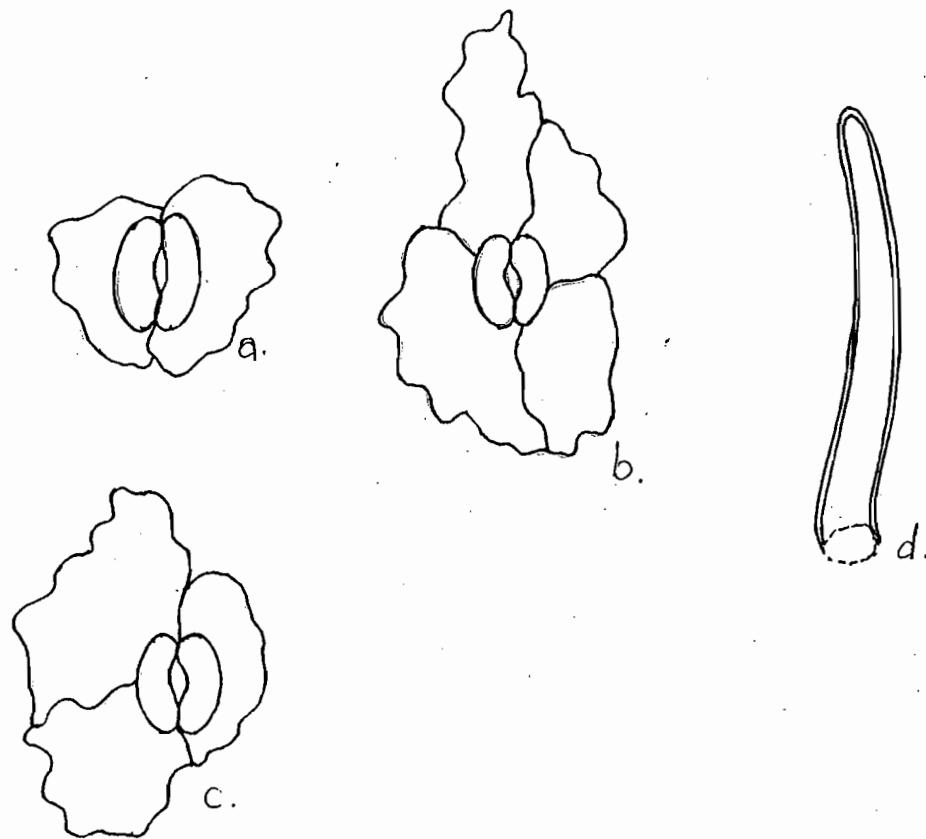


Fig. 164. *Cassia fistula* L., a. paracytic stomata, b. anomocytic stomata, c. anisocytic stomata, d. unicellular trichome.

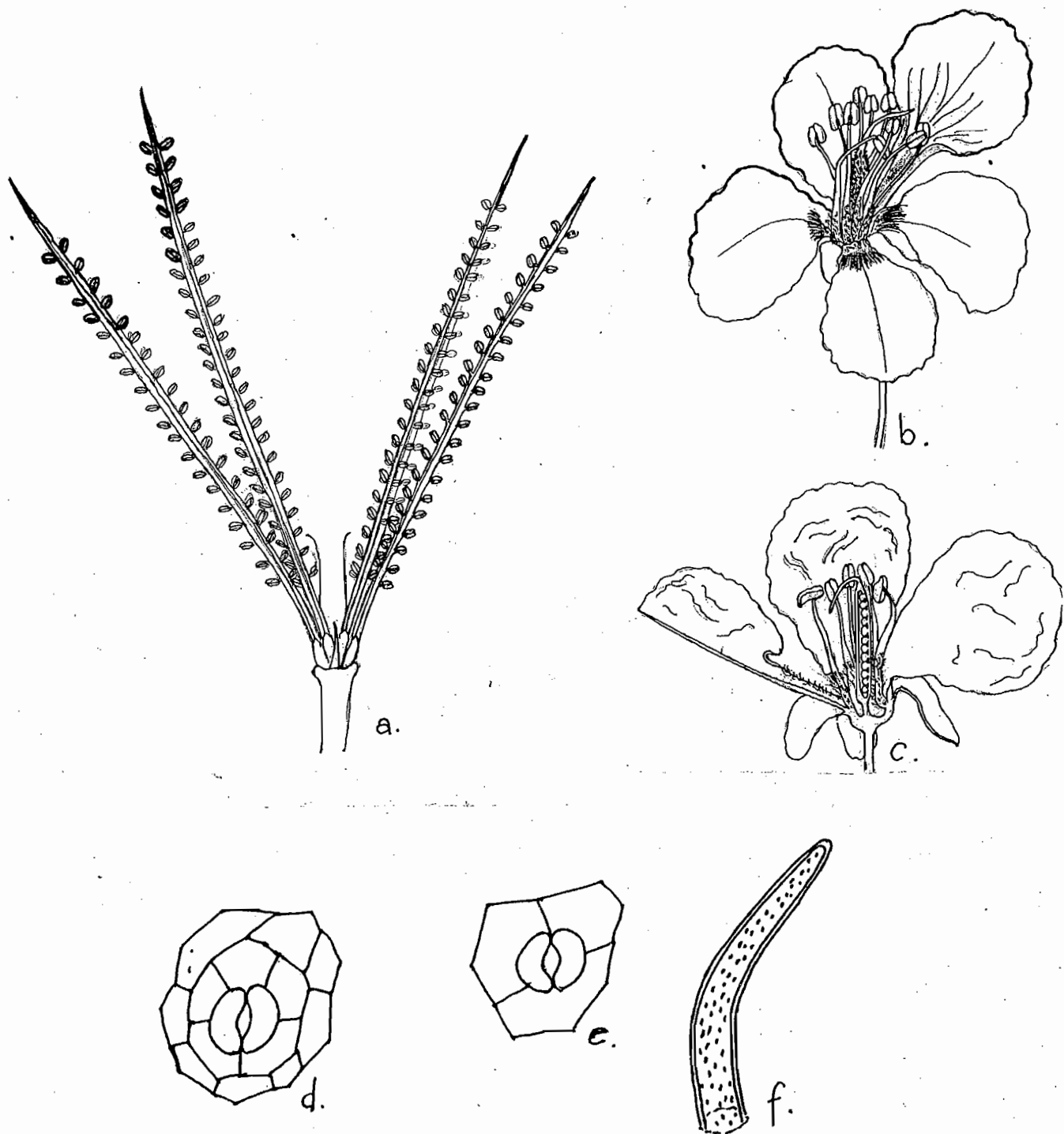


Fig. 165. *Parkinsonia aculeata* L. a. habit, b. flower, c. L.S. of flower, d. cyclocytic stomata, e. anisocytic stomata, f. unicellular trichome with thick warty wall.

5. *Saraca indica* Linn. Mantiss. (1767) p. 98.

A glabrous brached tree 7-10 m high. Leaves upto 25 cm long; rhachis corky at the base; petioles very short; stipules intrapetiolar, completely united, scarious, ovate-oblong, obtuse, parallel-nerved. Leaflets 4-6 pairs, upto 20 cms., oblong-lanceolate, acute. Flowers in dense axillary corymbs upto 10 cm across; peduncles stout; pedicel long, red; bracts ovate, subacute; bracteoles 2, spatulate-oblong, subacute, ciliolate, amplexicaul, colored. Calyx passing from yellow to orange and finally red; tube long, cylindric, solid at the base; segments 4, oblong or obovate- oblong. Petals 0. Stamens 7 or 8, much exserted; filaments filiform, thrice as long as the calyx-segments; anthers purple. Ovary pubescent, especially on the sutures; style curved into a ring. Pods black, upto 25 cms. long, linear-oblong, tapering to both ends. Seeds 4-8, ellipsoid-oblong, 3 cm long, slightly compressed. (Fig. 166)

Vernacular name: Asoka.

Flowers: December-May.

Micromorphology (Fig. 166)

Whole plant was glabrous except for anthers and ovary.

Stomata were paracytic type.

D/249

**6. *Senna alata* (L.) Roxburgh, *Fl. Ind.*, ed. 2: 349. 1832.
(*Cassia alata* L.)**

A shrub 1-5 m tall with stem marked with leaf scars and persistent stipules. Stipules persistent, auriculate. Petiole upto 5 cm long, rachis upto 60 cm long, leaflets 8-24 pairs, upto 15 cm long, 2-7 cm wide, oblong-elliptic, top rounded or slightly notched. Raceme upto 70 cm long; bracts 3 cm long, caducous. Flowers yellow. Sepals 2 cm long. Petals 2 cm long, slightly clawed. Stamens 9 or 10, all functional. Pod straight with 2 longitudinal wings, 40-60 seeded. (Fig. 167)

Flowers: October-December.

Micromorphology (Fig. 167)

Unicellular filamentous trichomes with a broad lumen were seen in the plant.

Stomata were of paracytic and anomocytic types.

D/128.

**7. *Senna auriculata* (L.) Roxb. *Fl. India*. V. 2, p. 340.
(*Cassia auriculata* L.)**

A tall much branched shrub with smooth reddish-brown bark and finely pubescent branchlets. Leaves upto 15 cm long; rhachis with an erect linear gland between each pair of leaflets; stipules foliaceous, reflexed, rotundato-reniform. Leaflets 8-12 pairs, oblong-obovate, mucronate, finely downy. Flowers large, reaching upto 5 cms. across, in terminal and axillary corymbose racemes; bracts ovate, acuminate, caducous. Calyx segments concave. Petals with long claws, crisped on the margin, bright yellow, veined



Fig. 166. *Saraca indica* L. a. habit, b. L.S. of flower, c. flower, d. paracytic stomata.

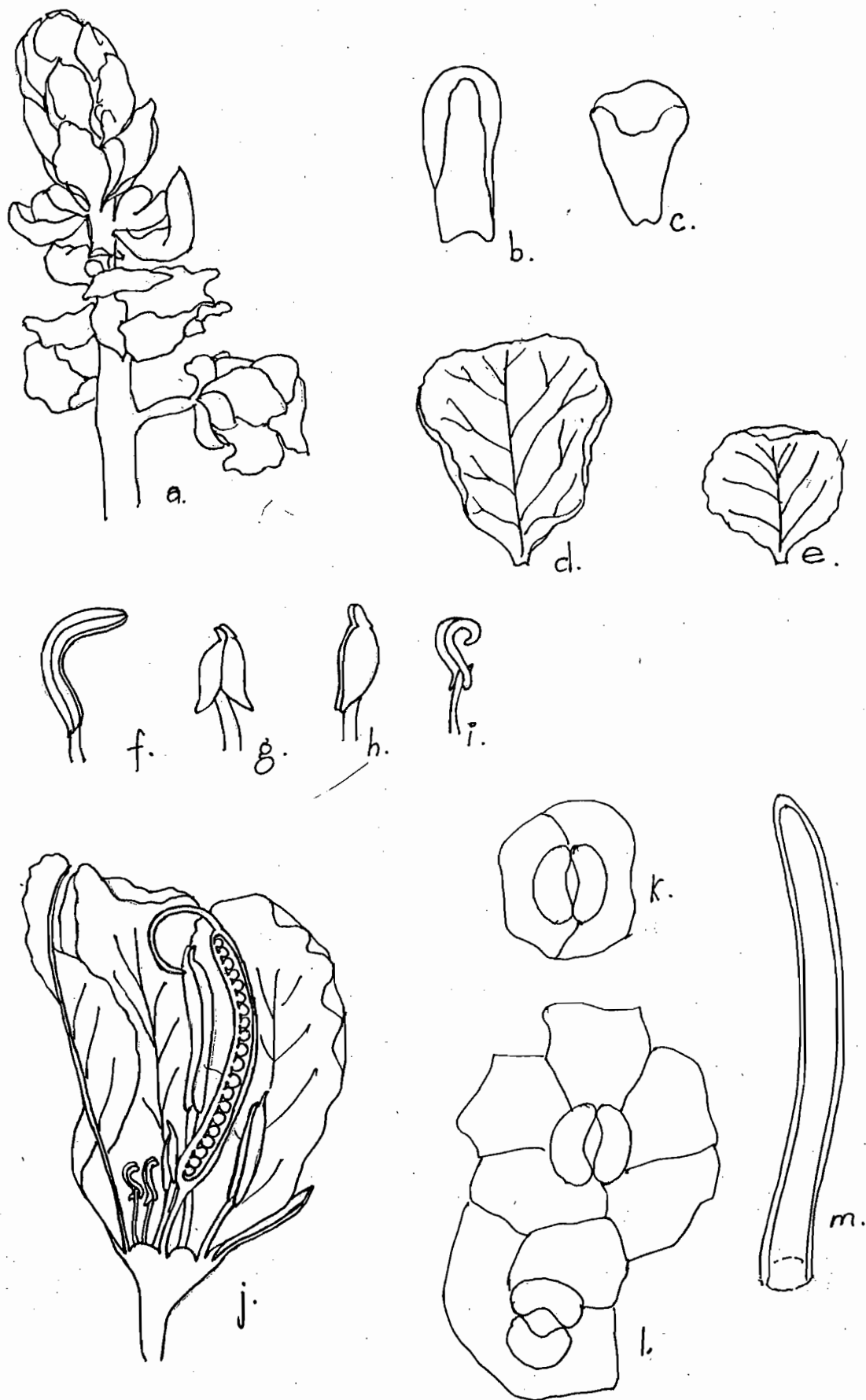


Fig. 167. *Senna alata* (L.) Roxb. a. habit, b. bract, c. sepal, d-e. petals, f-i. stamens, j. L.S. of flower, k. paracytic stomata, l. anomocytic stomata, m. unicellular trichome.

with orange. Stamens 10, of which 3 upper are reduced to staminodes, the remaining 7 perfect, of which the 3 lower are larger than the 4 lateral ones. Pods oblong, obtuse, mucronate, pale brown, deeply depressed between the seeds 10-20. (Fig. 168)

Vernacular name: Aval.

Flowers : January-July.

Micromorphology (Fig. 168)

Unicellular filamentous trichomes with a broad lumen were seen in the plant.

Stomata were of paracytic, anisocytic and anomocytic types.

D/671.

8. *Senna obtusifolia* (L.) H. S. Irwin & Barneby, R.C. *Memoirs New York Botanical Garden* 35: 98. 1982

(*Cassia tora* L.)

An annual herb reaching upto 1 m. high. Leaves upto 12 cm long; rhachis grooved, more or less pubescent, with a conical gland between each of the 2 lowest pairs of leaflets; stipules linear-subulate, caducous. Leaflets 3 pairs, opposite, obovate-oblong, base somewhat oblique; main nerves 8-10 pairs. Flowers usually in subsessile pairs in the axils of the leaves. Calyx divided to the base; segments ovate, acute, spreading. Petals 5, pale-yellow, oblong, obtuse, the upper petal 2-lobed, the others entire. Stamens 10, the 3 uppers reduced to small staminodes, the remaining 7 perfect, subequal. Ovary sessile, ovules many; style elongate; stigma terminal. Pods upto 25 cm long, subtetragonous, obliquely septate. Seeds 25-30, rhombohedral. (Fig. 169)

Vernacular name: Kuvandiyo.

Flowers: November-December.

Micromorphology (Fig. 169)

multicellular uniseriate trichome with thick wall and inclusions was present.

The stomata was paracytic.

D/118.

9. *Senna occidentalis* Link. *Handbuch* 2:140. 1829

(*Cassia occidentalis* L.)

A branched diffuse (usually annual) undershrub reaching to a height of 2 m. Branches subglabrous, furrowed, often purplish. Leaves reaching upto 20 cm long; rhachis with a single sessile gland near its base. Leaflets 3-5 pairs, ovate-lanceolate, acute, faintly pubescent beneath. Flowers in short-peduncled few-flowered racemes, corymbose, axillary and forming a terminal panicle; pedicels spreading; bracts 1 cm long, ovate, acuminate, caducous, white with a pink tinge. Calyx divided to the base. Corolla yellow; segments oblong, obtuse. Stamens 10, of which the 4-6 are reduced to staminodes. Ovary sessile, ovules many in marginal placentation; style short; stigma terminal. Pods upto 30 cm. Seeds 20-30. (Fig. 170)

Variation observed: in our specimen there were 4-6 staminodes, whereas in standard description the number of staminodes were 3.

Vernacular name: Kasundro.

Flowers; January-March.

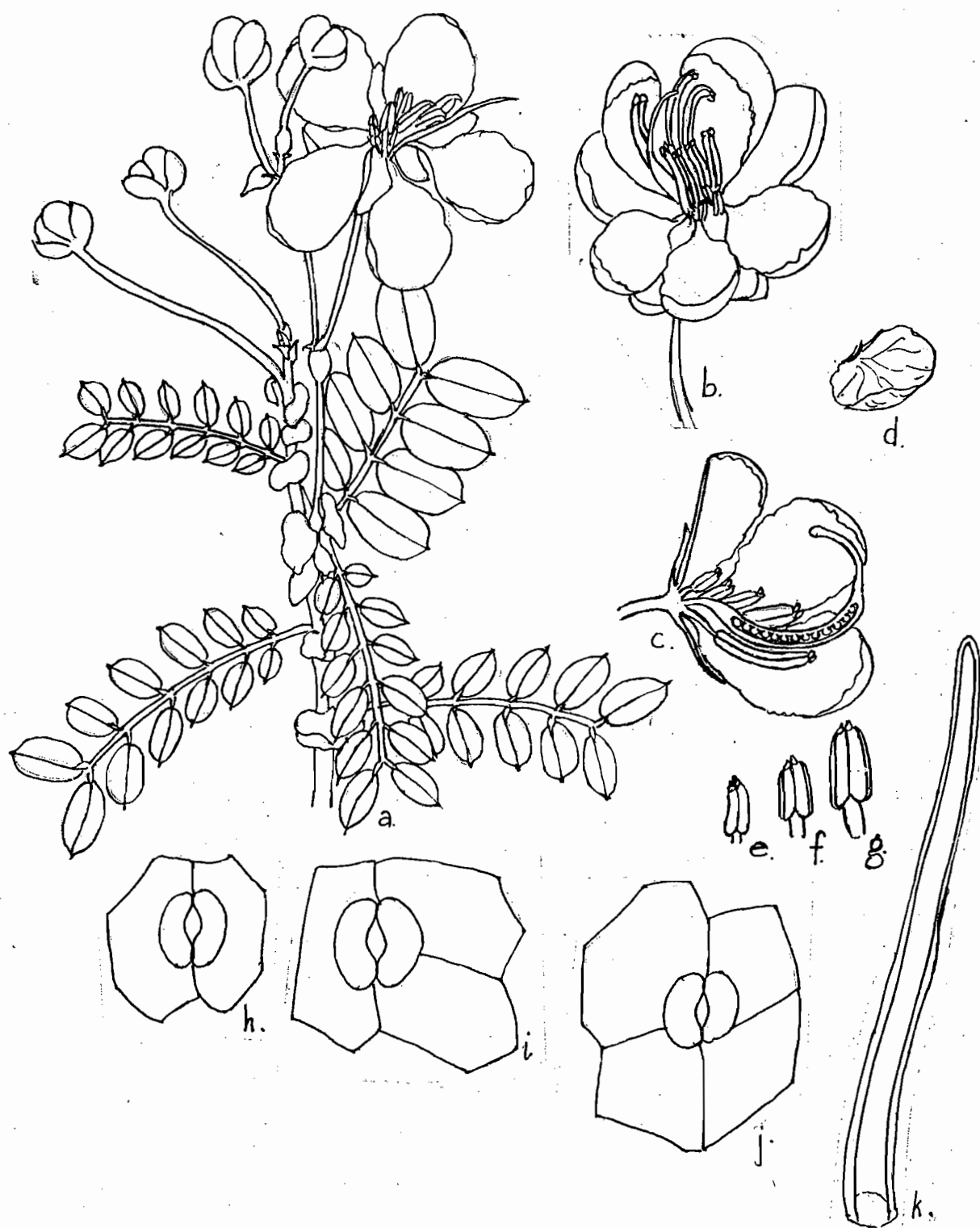


Fig. 168. *Senna auriculata* (L.) Roxb. a. habit, b. flower, c. L.S. of flower, d. petal, e. staminodes, f-g. stamens, h. paracytic stomata, i. anisocytic stomata, j. anomocytic stomata, k. unicellular trichome.

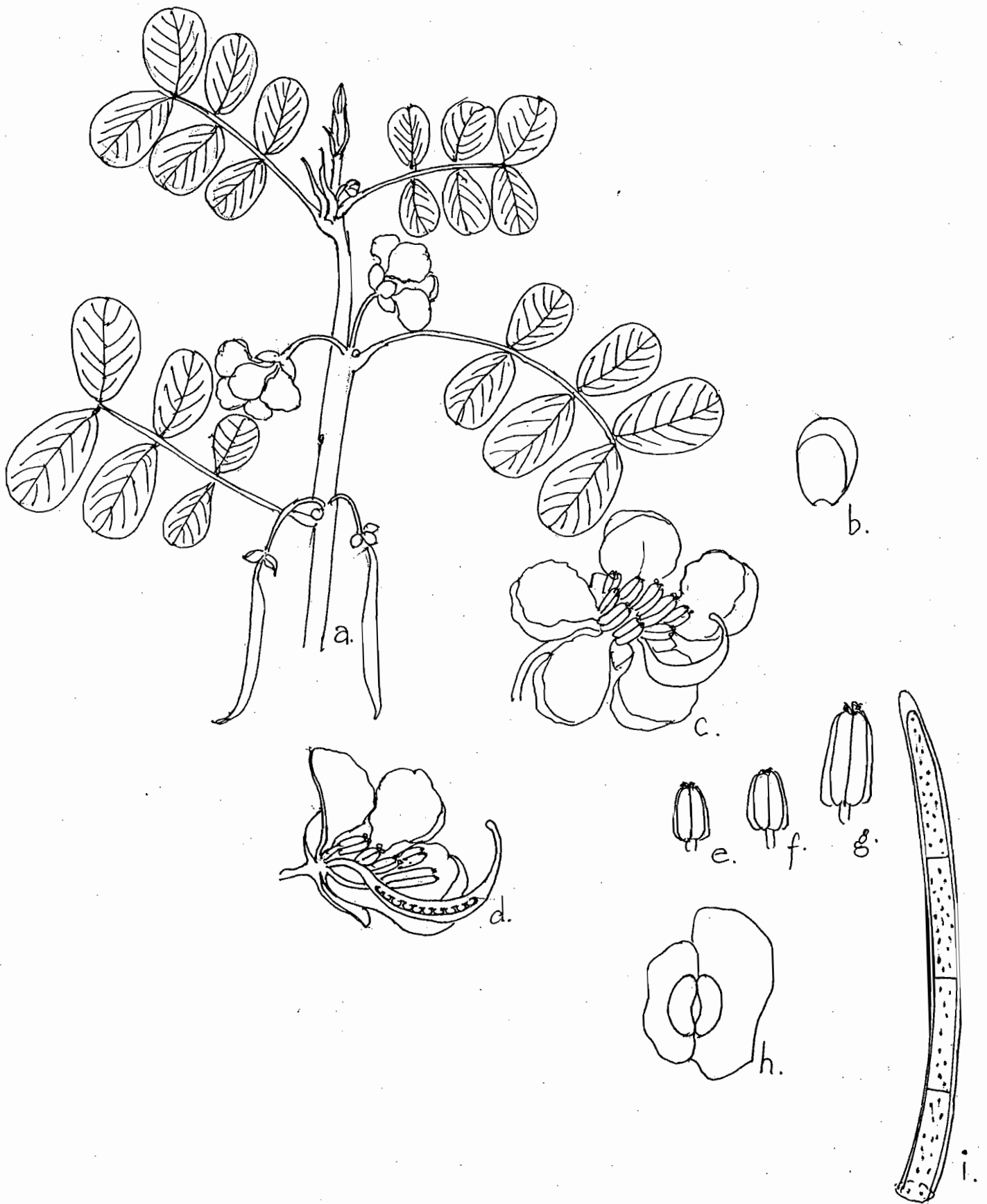


Fig. 169. *Senna obtusifolia* (L.) H. S. Irwin & Barneby, R.C. a. habit, b. sepal, c. flower, d. L.S. of flower, e-g. stamens, h. paracytic stomata, i. multicellular uniseriate trichome with thick wall.



Fig. 170. *Senna occidentalis* Link. a. habit, b. flower, c. L.S. of flower, d. gynoecium, e-g. stamens, h. staminode, i. bract, j. bracteole, k. sepal, l. petal.

Micromorphology (Fig. 171)

Leaf and rhachis showed presence of multicellular, glands differentiated into a multicellular head and a multicellular multiseriate stalk. There were cellular inclusions in some of the glands.

Stomata were paracytic.

D/173

10. *Senna siamea* H. S. Irwin & Barneby, R.C. *Memoirs New York Botanical Garden* 35: 98. 1982

(*Cassia siamea* Lamk.)

An evergreen medium sized tree with dark brown to black wood and pubescent branches. Leaves upto 30 cm long; leaflets 4-16 pairs, ovate-oblong, emarginated, mucronate, 3-7 cm long. Flowers bright yellow in 10 cm long terminal panicles of corymbose racemes; pedicels 2-4 cm long. Sepals elliptic ovate, hairy at margins. Petals upto 2 cms. long, broadly elliptic or orbicular, upper petal clawed. Stamens 10, unequal. Pods reaching upto 30 cm long, strap-shaped. Seeds 20-30. (Fig. 172)

Flowers: September- May.

Micromorphology (Fig. 173)

The trichome present was unicellular, short, pointed with cellular inclusions. tetracytic stomata and anisocytic stomata were seen.

D/370.

11. *Tamarindus indica* Linn. *Sp. Pl.* 34. (1753)

A large evergreen tree with spreading crown and fissured dark grey rough bark. Leaves upto 15 cm long, paripinnate; stipules caducous, linear lanceolate; leaflets 10-20 pairs, opposite, linear-oblong, obtuse. Flowers yellow, in 10-15 flowered lax racemes. Calyx teeth lanceolate, the lowest two connate. Petals 3, yellow, streaked with red, the lower two reduced to scales. Stamens 3, perfect, others reduced to setaceous staminodes. Ovary stipitate. Pods linear, upto 20 cm long, with crustaceous pericarp and pulpy mesocarp; seeds 3-10, brown. (Fig. 174)

Vernacular name: Khati amli.

Fruit pulp sour, used as condiment, also medicinal.

Flowers: August-May.

Micromorphology (Fig. 174)

The unicellular trichome with thick warty wall was observed.

The stomata were of cyclocytic and anisocytic types.

D/367.

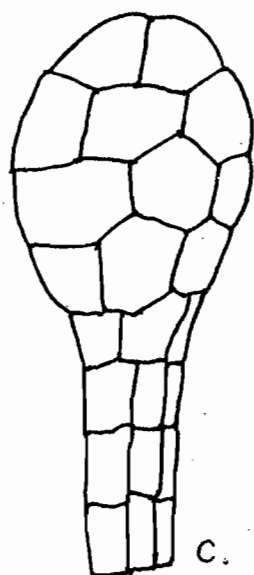
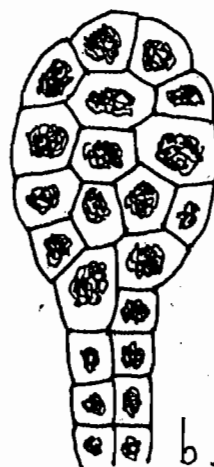
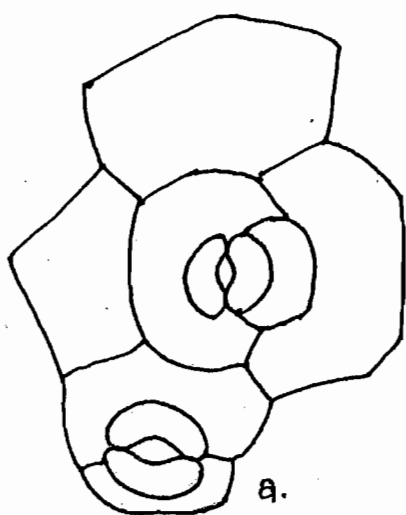


Fig. 171. *Senna occidentalis* Link. a. paracytic stomata, b-c. multicellular gland with a multicellular globular head and a triseriate stalk.

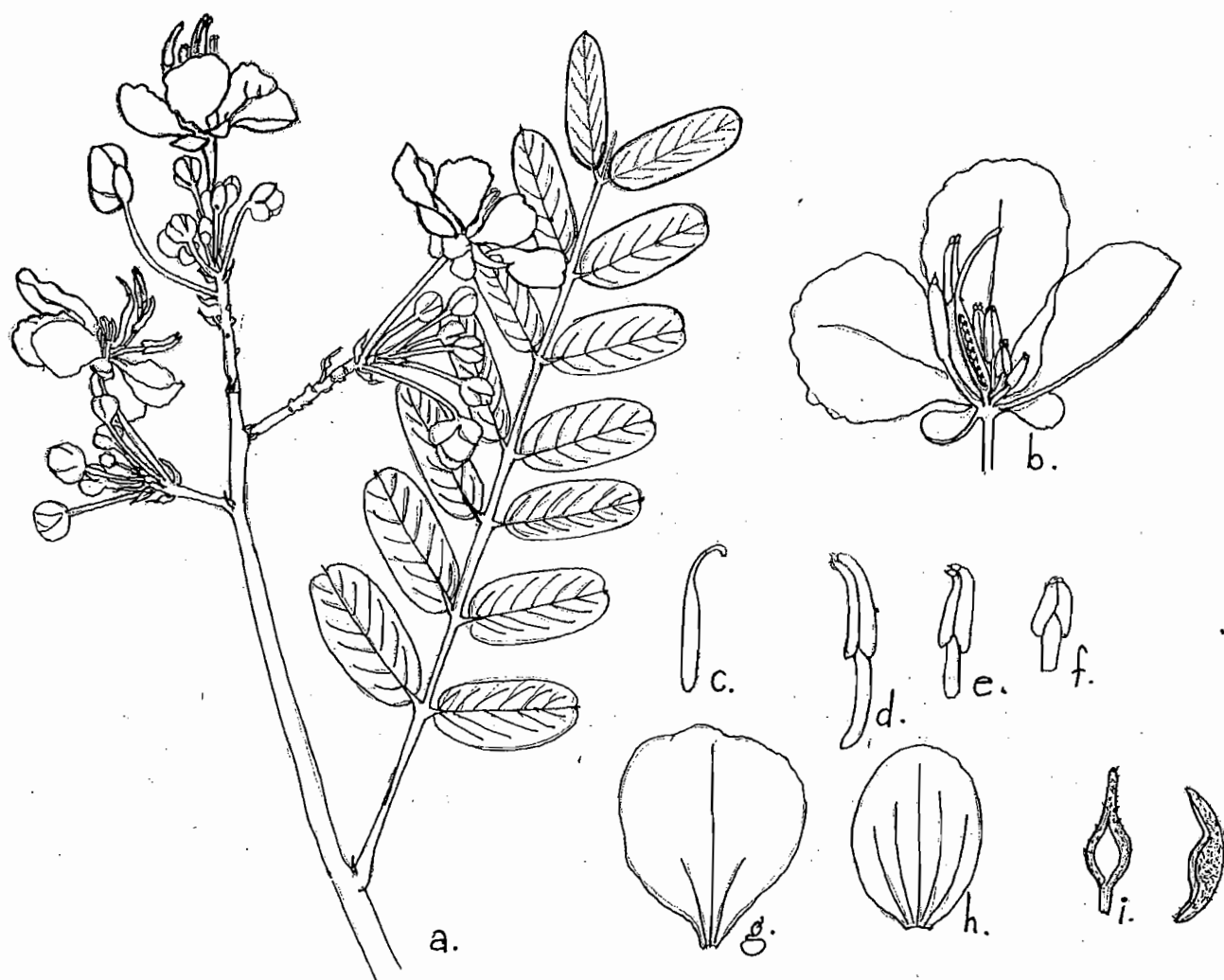


Fig. 172. *Senna siamea* H. S. Irwin & Barneby, R.C., a. habit, b. L.S. of flower, c. gynoecium, d-f. stamens, g. petal, h. sepal, i. bract.

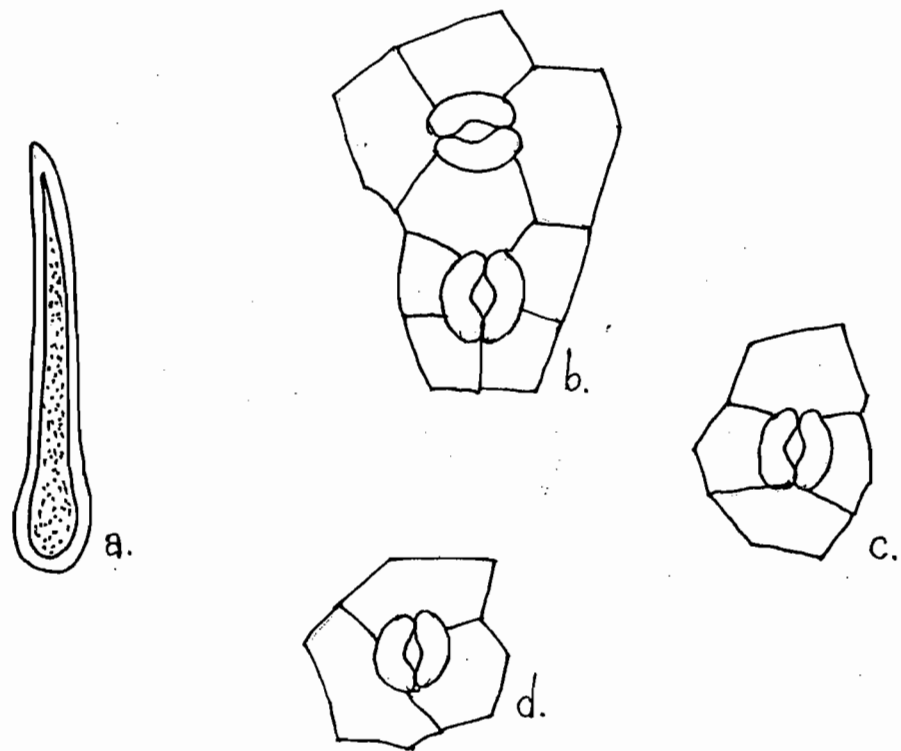


Fig. 173. *Senna siamea* H. S. Irwin & Barneby, R.C., a. unicellular trichome, b-c. tetracytic stomata d. anisocytic stomata.

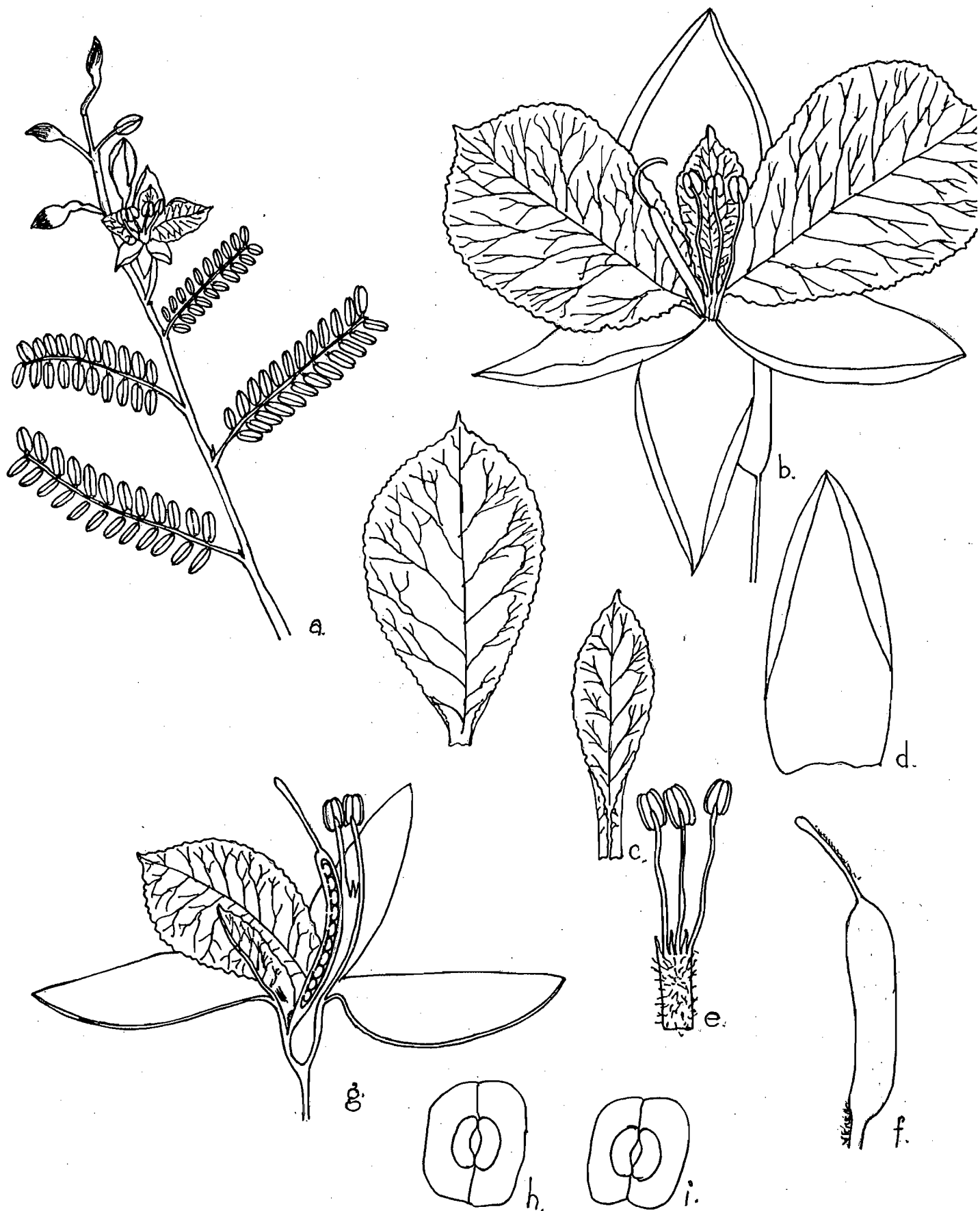


Fig. 174. *Tamarindus indica* L. a. habit, b. flower, c. petals, d. sepal, e. stamens, f. gynoecium, h & i. paracytic stomata.

Mimosaceae

1. *Acacia nilotica* (L.) Willd., *Sp. Pl.* 4: 1083. 1806.

A medium-sized tree with blackish-grey to brown fissured bark. Leaves bipinnate, upto 10 cms. long; pinnae 2-10 pairs, leaflets 7-25 pairs, glabrous. Stipular spines up to 5 cm long; smooth, whitish. Flowers in axillary peduncled globose heads, bright-yellow. Calyx campanulate. Corolla twice the length of the calyx. Stamens indefinite, slightly connate at the base. Pods 15 cm long, persistently grey downy, constricted between the seeds; seeds 8-12. (Fig. 175)

Vernacular name: Deshibaval.

Flowers: December-April.

Micromorphology (Fig. 175)

The trichome present was unicellular filamentous.

The stomata were paracytic.

D/178

2. *Adenanthera pavonina* Linn. *Sp. Pl.* (1753) p. 384.

A small glabrous unarmed tree reaching upto a height of 1 m. Leaves 2-pinnate, upto 30 cms. long, petioles 10 cm long; pinnae 3-6 pairs, opposite. Leaflets alternate, 4-8 pairs, elliptic-oblong, obtuse. Flowers in short-peduncled racemes upto a height of upto 1 cms. long, axillary or paniced at the ends of the branches; pedicels slender. Calyx minute, lobes short, triangular. Corolla pale yellow, segments united at the base only, linear-lanceolate, acute, valvate. Stamens 10, free, hardly exserted; anthers gland-crested. Pods 12 cms., falcately curved. Seeds 8-15, lenticular-globose, with a blunt keel, smooth, shining, usually brilliant scarlet. (Fig. 176)

Vernacular name: Ratanjali.

Flowers: March-May.

Micromorphology (Fig. 176)

The trichome present was unicellular filamentous.

The stomata were paracytic.

D/155

3. *Calliandra haematocephala* Hasskarl, *Retzia.* 1: 216. 1855.

A small tree upto 3 m tall. Branchlets brown, cylindric, rough. Stipules persistent, ovate-lanceolate; petiole 1-2.5 cm; pinnae 1 pair, 8-13 cm; leaflets 7-9 pairs, obliquely lanceolate, sparsely pilose along margin, midvein close to upper margin, base oblique, apex obtuse, mucronate. Heads axillary. Calyx campanulate. Corolla purplish, 5-lobed; lobes reflexed, glabrous. Stamens numerous, scarlet, very brilliant; staminal tube white, mouth inside with a subulate appendix; filaments deep red. Legume dull brown, linear-oblong, valves elastically open from apex to base along sutures when ripe, reflexed. Seeds 5 or 6, brown, oblong. (Fig. 177)

Flowers: Aug-Sep.

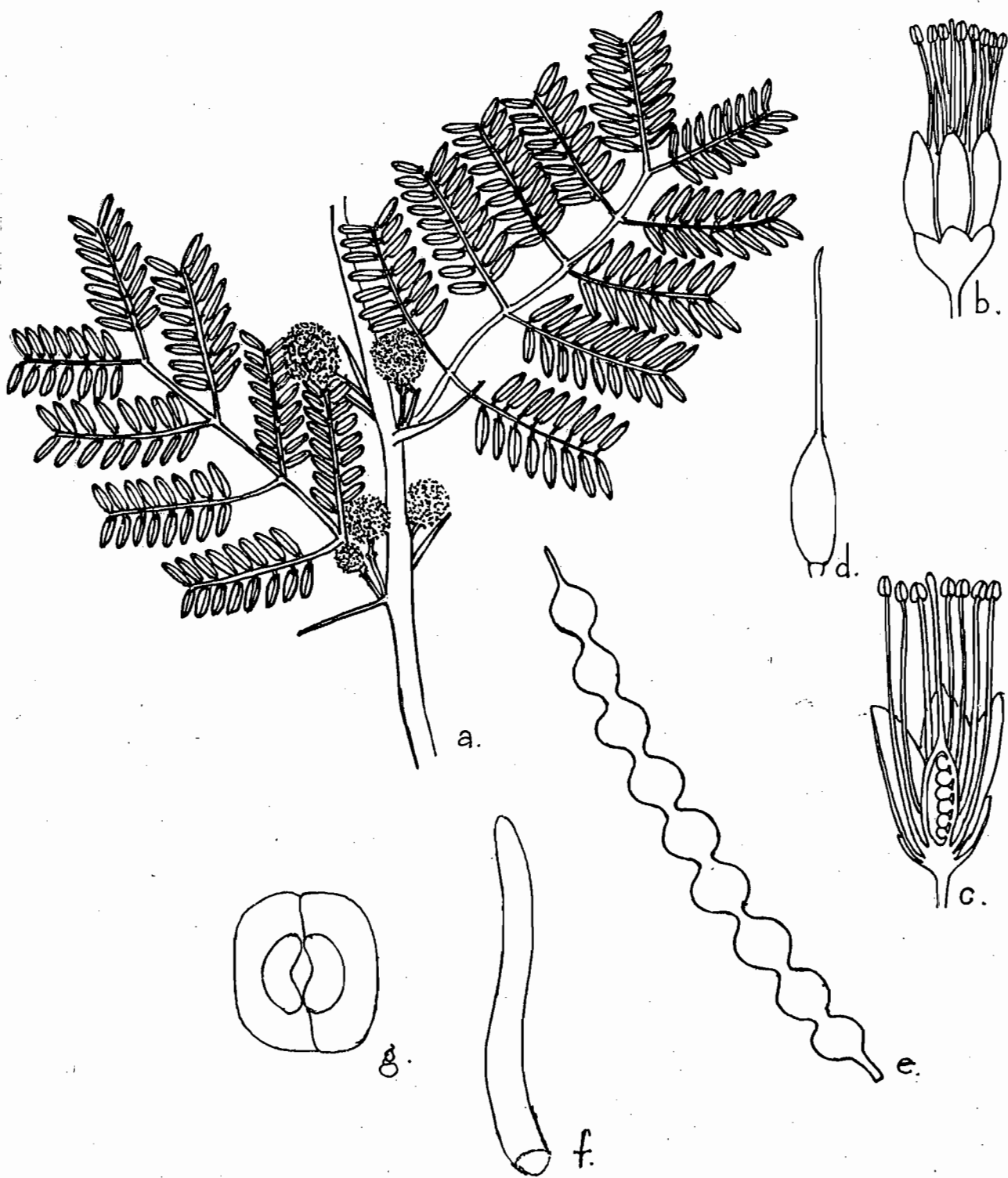


Fig. 175. *Acacia nilotica* (L.) Del. a. habit, b. flower, c. L.S. of flower, d. gynoeceum, e. fruit, f. unicellular trichome, g. paracytic stomata.

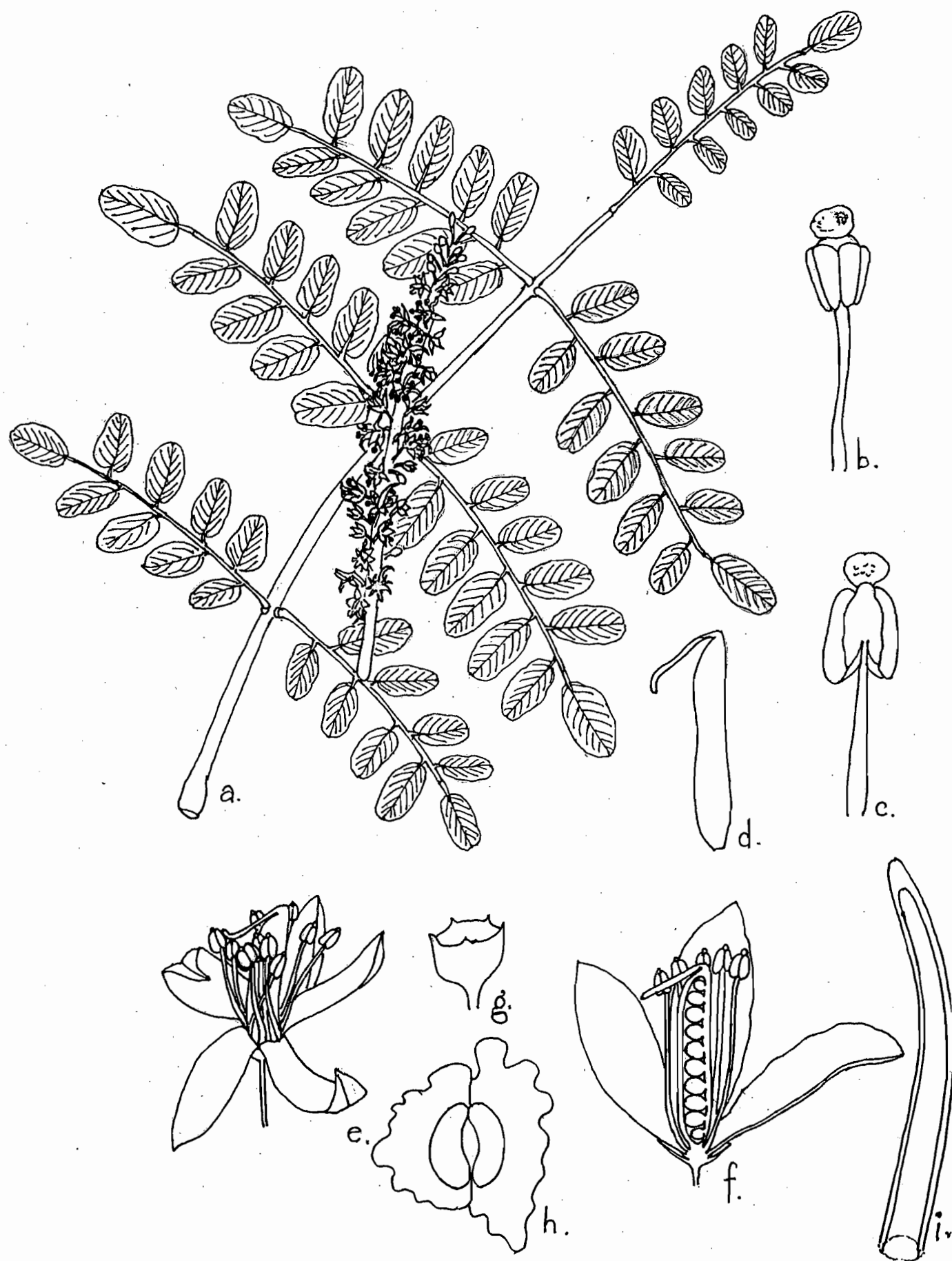


Fig. 176. *Adenanthera pavonina* L. a. habit, b-c. stamens with a gland at tip of the anther, d. gynoecium, e. flower, f. L.S. of flower, g. calyx, h. paracytic stomata, i. unicellular thick

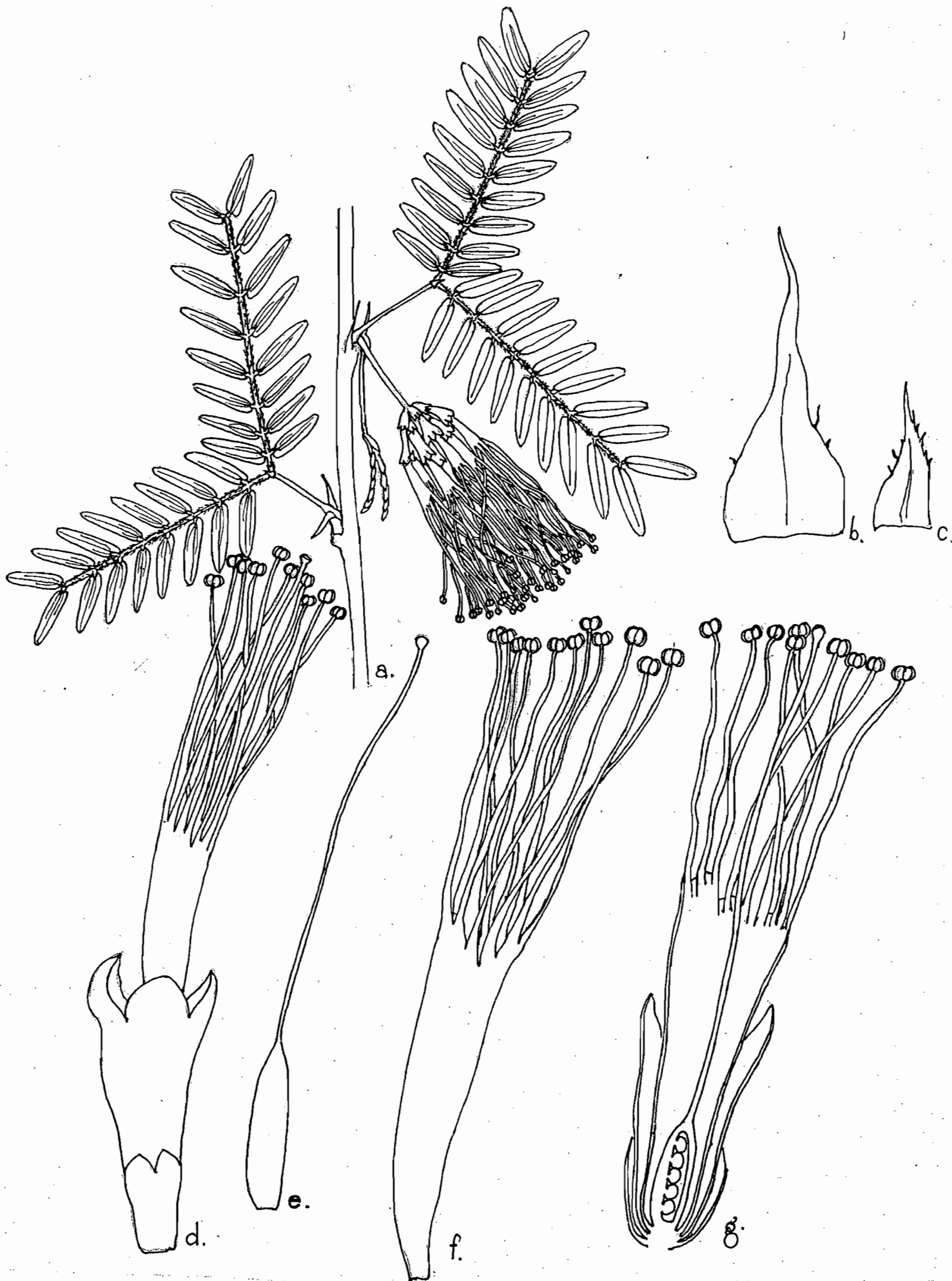


Fig. 177. *Calliandra haematocephala* Hassk. a. habit, b. stipule, c. bract, d. flower, e. gynoecium, f. stamens, g. L.S. of flower.

Micromorphology (Fig. 178)

Multicellular glandular trichome differentiated into biseriate multicellular 4-5 tiered head and multicellular uniseriate stalk.

Stomata were of tetracytic, anomocytic, anisocytic and paracytic types.

D/256

4. *Dichrostachys cinerea* Wight & Arn. Prodr. (1834) p. 271

A much-branched thorny shrub with light colored furrowed bark, and branchlets ending in spines. Leaves 2-pinnate, upto 6 cm long; main rhachis with a small erect gland between each pair of pinnae; stipules long, subulate from a triangular base; pinnae 8-14 pairs, upto 2 cm long, sessile. Leaflets minute, sessile, 12-20 pairs, linear, oblique, subacute. Flowers numerous, crowded in dense axillary or extra-axillary spikes upto 4 cm long, the upper half of the spike yellow, the lower red. Calyx long, campanulate, shortly toothed. Petals cohering below the middle. Stamens of the perfect flowers in the upper half of the spike yellow; stamens in the hermaphrodite flowers 10, free, shortly exserted; anthers gland-crested. Staminodes in the lower half of the spike 1.5 cm long, much longer than the stamens, red. Ovary subsessile; ovules many; style filiform; stigma terminal, truncated. Pods 5-8 cm long, flat, subarticulated, dark brown. Seeds 6-10. (Fig. 179)

Vernacular name: Mor-dhundhiyu

Flowers: September-October.

Micromorphology (Fig. 180)

The plant showed presence of unicellular, non-glandular, elongated thick walled trichome.

Stomata were of paracytic type.

D/835, 836.

4. *Mimosa pudica* Linn. Sp. Pl. (1753) p. 518.

A diffuse undershrub reaching upto 8 cm high with stem and branches sparingly prickly and clothed with long weak bristles from bulbous bases. Leaves sensitive, digitate; petioles upto 5 cm long, bristly; stipules linear-lanceolate, acute; pinnae 1-2 pairs, upto 8 cm long. Leaflets 12-20 pairs, sessile, coriaceous, linear-oblong, acute, base obliquely rounded. Flowers minute, in dense globose heads, polygamous, 4-merous, pink, in globose heads; peduncles upto 3 cm long, prickly, usually in axillary pairs; bracteole solitary, linear, acute. Calyx minute. Corolla pink, lobes 4, ovate-oblong, obtuse. Stamens 4, much exserted. Ovary shortly stalked; ovules many; style filiform; stigma small, terminal. Pods 1-2 cm long, flat, slightly recurved, consisting of 3-5 one-seeded joints which fall away from the persistent sutures which are clothed with spreading yellowish weak bristles. (Fig. 181)

Vernacular name: Lajamani.

Flowers: September-October.

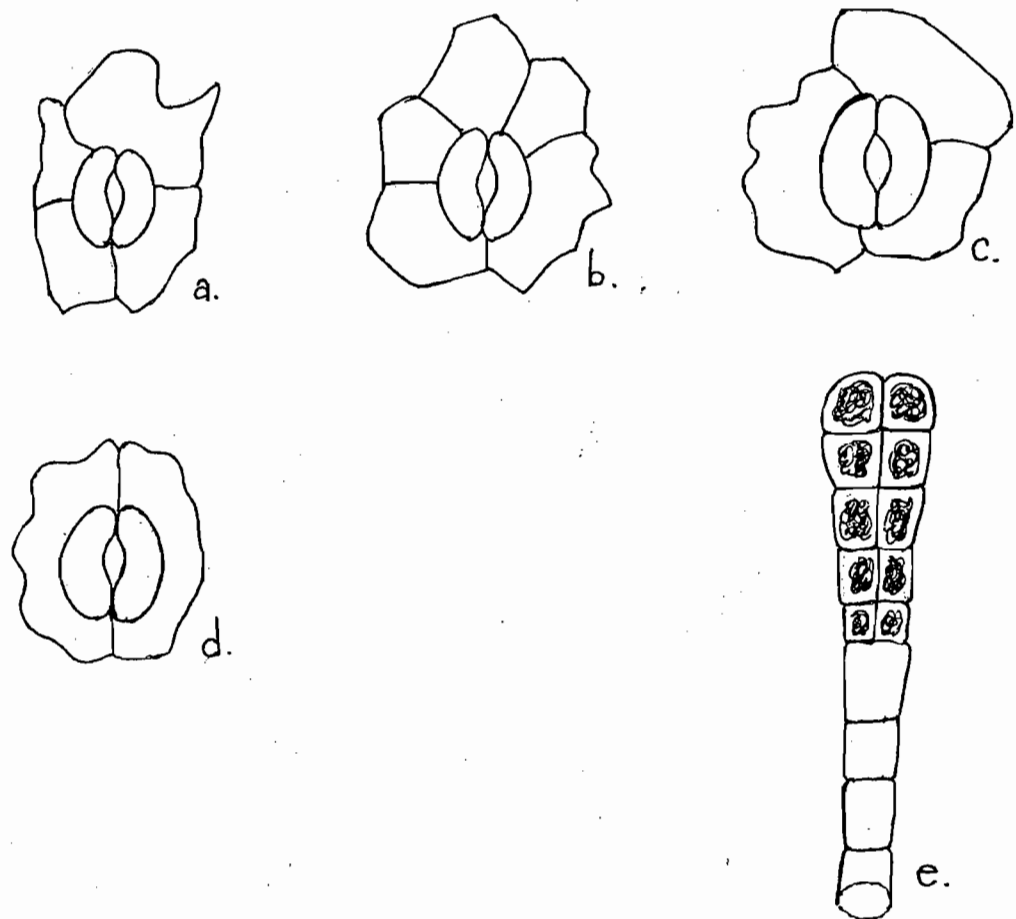


Fig. 178. *Calliandra haematocephala* Hassk. a. tetracytic stomata, b. anomocytic stomata, c. anisocytic stomata, d. paracytic stomata, e. gland with a biseriate 5-tiered head and uniseriate stalk.

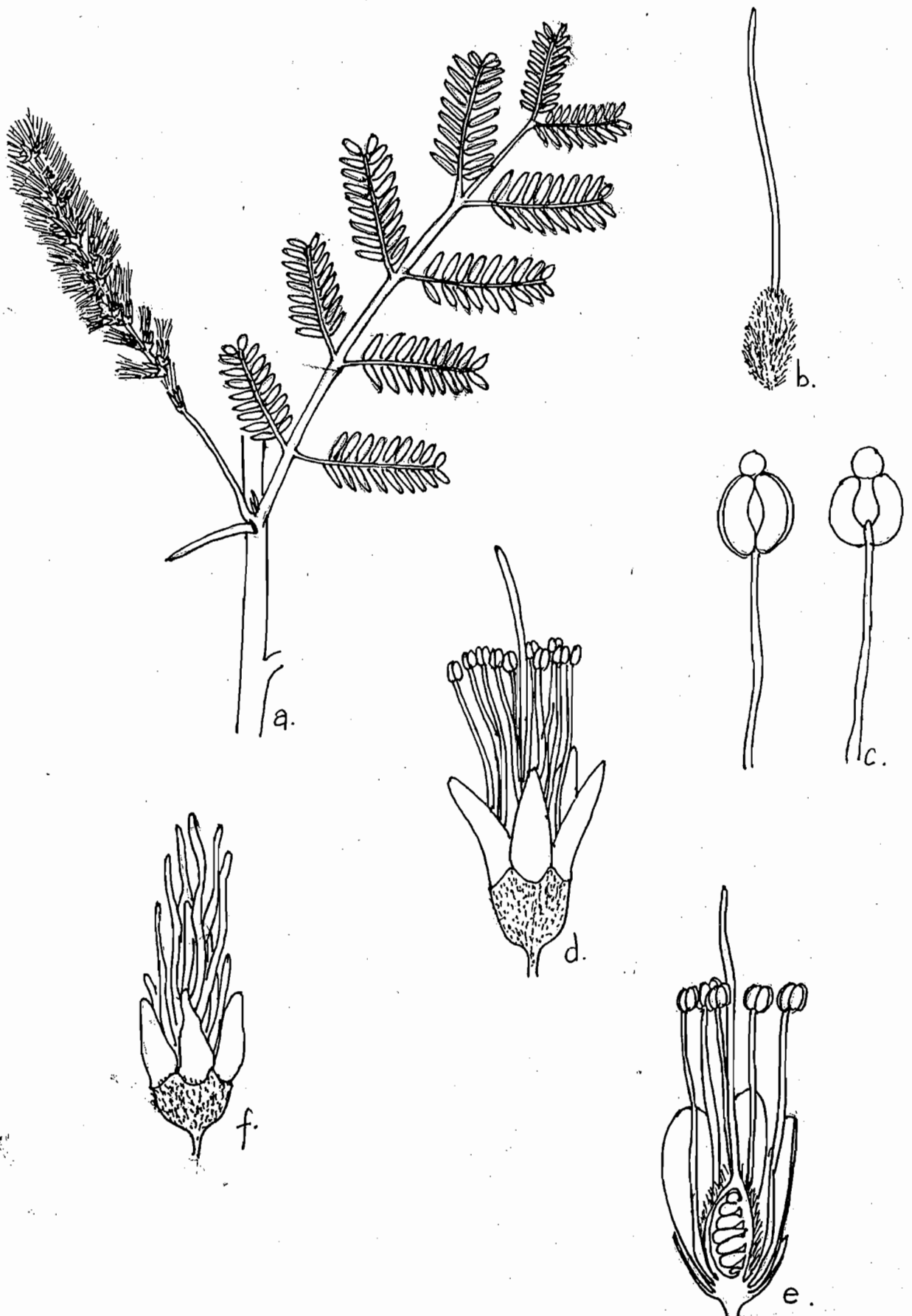


Fig. 179. *Dichrostachys cinerea* (DC.) W. & A. a. habit, b. gynoecium, c. stamens with a

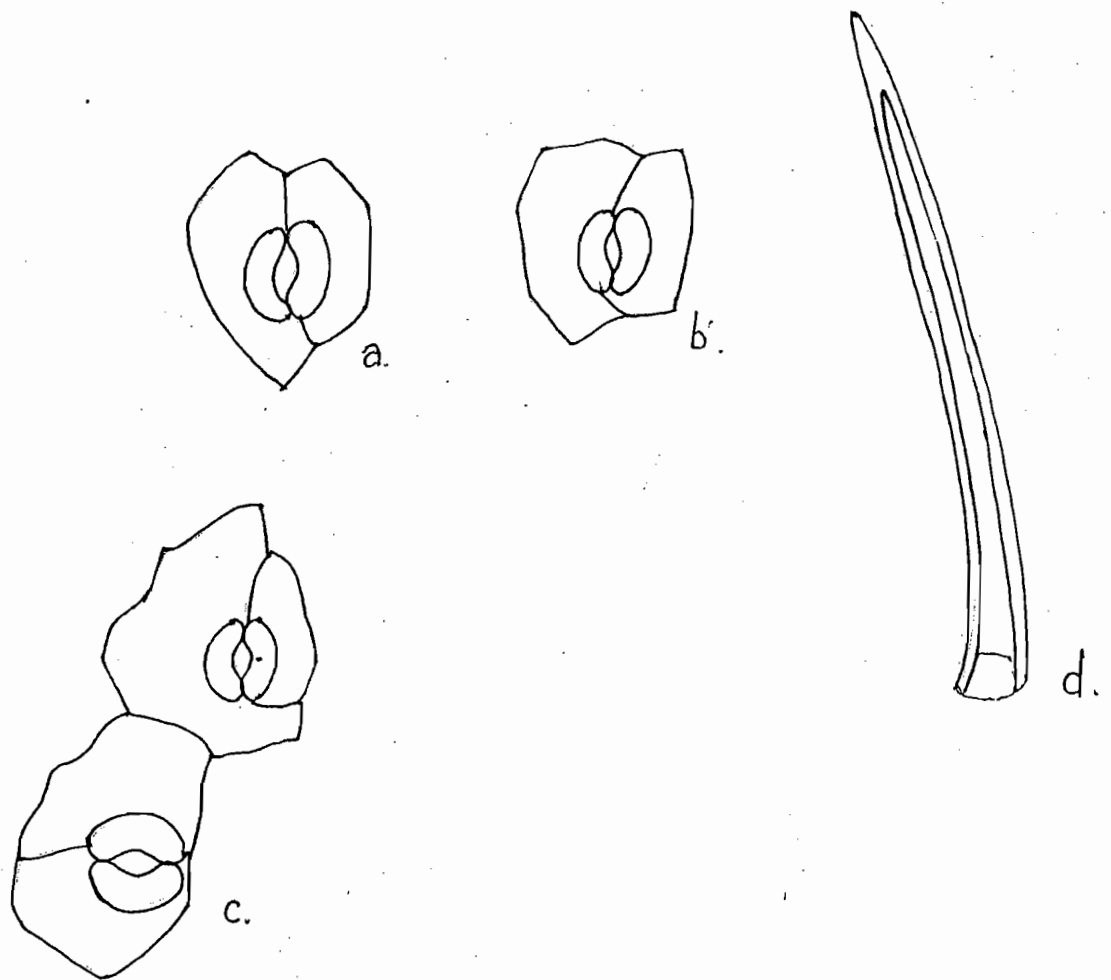


Fig. 180. *Dichrostachys cinerea* (DC.) W. & A. a-c. paracytic stomata, d. unicellular trichome with thick wall.

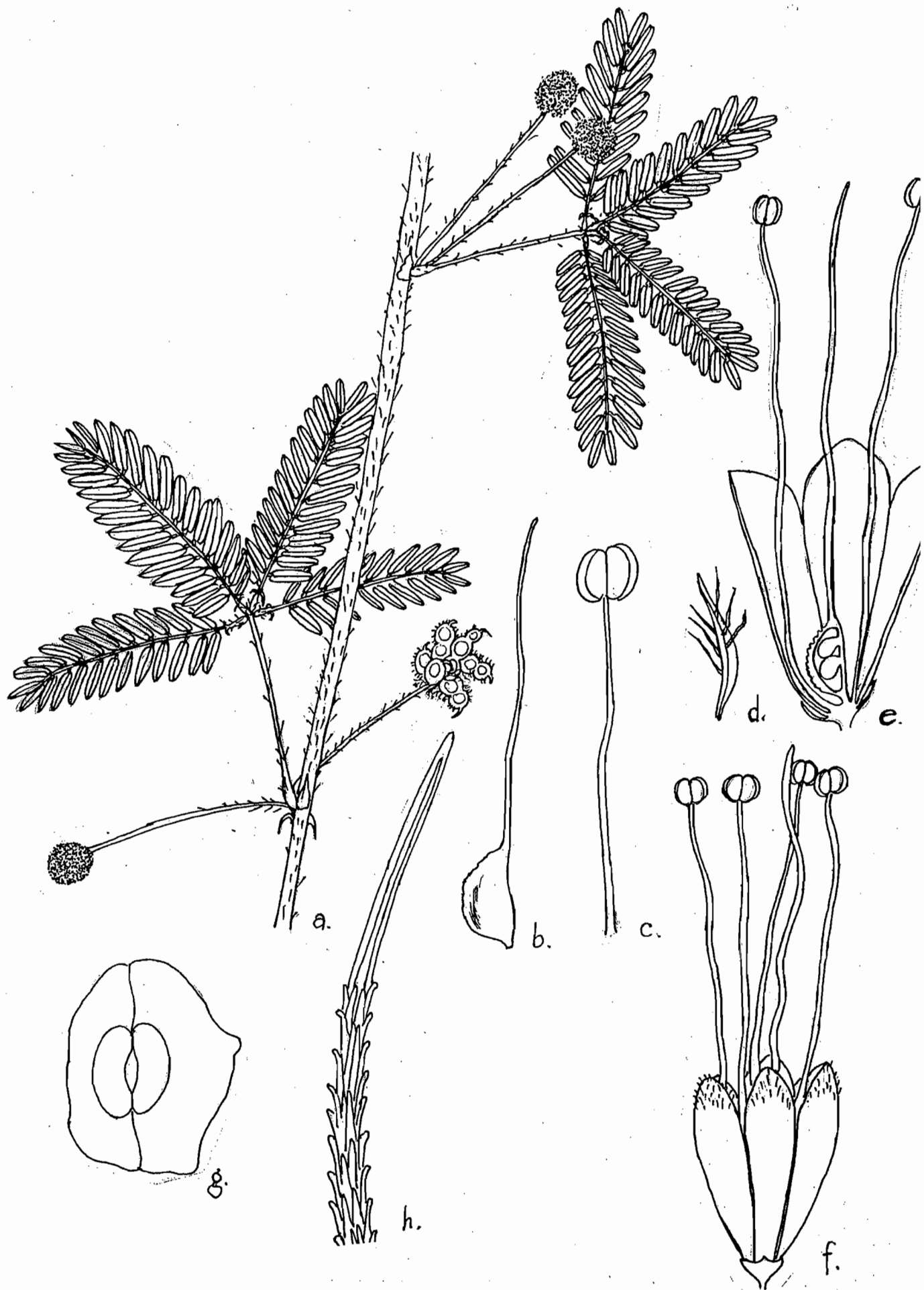


Fig. 181. *Mimosa pudica* L. a. habit, b. gynoecium, c. stamen, d. stipule, e. L.S. of flower, f. flower, g. paracytic stomata, h. multicellular multiseriate barbed trichome.

Miomorphology (Fig. 181)

The plant showed presence of unicellular, non-glandular, elongated trichome with barbed surface.

Stomata were of paracytic types.

D/124.

5. *Mimosa quadrivalvis* L. Sp. Pl. 1: 522. 1753.

A much branched armed shrub with numerous straw-colored curved or straight prickles. Leaves 2-pinnate, upto 5 cm long; main rhachis sometimes prickly; stipules subulate, hairy; pinnae 3-6 pairs, upto 2.5 cm long, shortly stalked. Leaflets 6-10 pairs, ovate-oblong, acute, mucronate, more or less pubescent beneath, base oblique. Flowers 4-merous, in globose heads; peduncles axillary and crowded at the ends of the branchlets, upto 2.5 cm long, slender, downy, often with a few prickles; bracteole solitary, linear-spathulate. Calyx shortly toothed. Corolla pink, divided nearly $\frac{1}{2}$ way down; lobes ovate-oblong, acute. Stamens 8. Ovary stalked. Pods 5-8 cm long, flat, falcate, consisting of 4-8 one-seeded joints which fall away from the persistent sutures which are furnished with hooked or straight hooked or straight prickles. Seeds chestnut-brown. (Fig. 182)

Vernacular name: Kasi.

Flowers: August-November.

Micromorphology (Fig. 183)

Trichomes in the rhachis were unicellular and acicular.

Stomata were of anomocytic types.

D/1234.

6. *Pithecellobium dulce* (Roxb.) Benth. in Hook., Lond. J. Bot. 3: 199. 1844.

A medium-sized evergreen trees with grayish branches. Pinnae 2, rachis upto 2.5 cm long; leaflets two on each pinna, obliquely elliptic, reaching upto 4.5 cm. Stipular spines. Flowers bisexual, pentamerous, greenish-white in paniced globose heads. Calyx funnel-shaped, pilose. Corolla long, petals united below the middle. Stamens indefinite, exserted, monoadelphous. Ovary shortly stalked, many-ovuled; style filiform; stigma capitate. Pods upto 12 cm long, turgid, spirally twisted, velvety pubescent. Seeds 6-8, black, enveloped in white fleshy edible aril. (Fig. 184)

Vernacular name: Goras aml.

Flowers: January-April.

Micromorphology (Fig. 184)

The plant was glabrous.

The plant showed presence of paracytic type only.

7. *Prosopis juliflora* (Swartz) DC. Prodr. 2: 447. 1825.

An evergreen tree reaching up to 5 m high. Leaves bipinnate, 1-3 together; rachis upto 8 cm long, prolonged beyond the last pinnae as a soft bristle; pinnae 10 cm long; leaflets 10-25 pairs, elliptic-oblong, often mucronate. Stipular spines straight, conical, solitary or paired. Flowers greenish-white in axillary pedunculate upto 10 cms. long spikes. Calyx

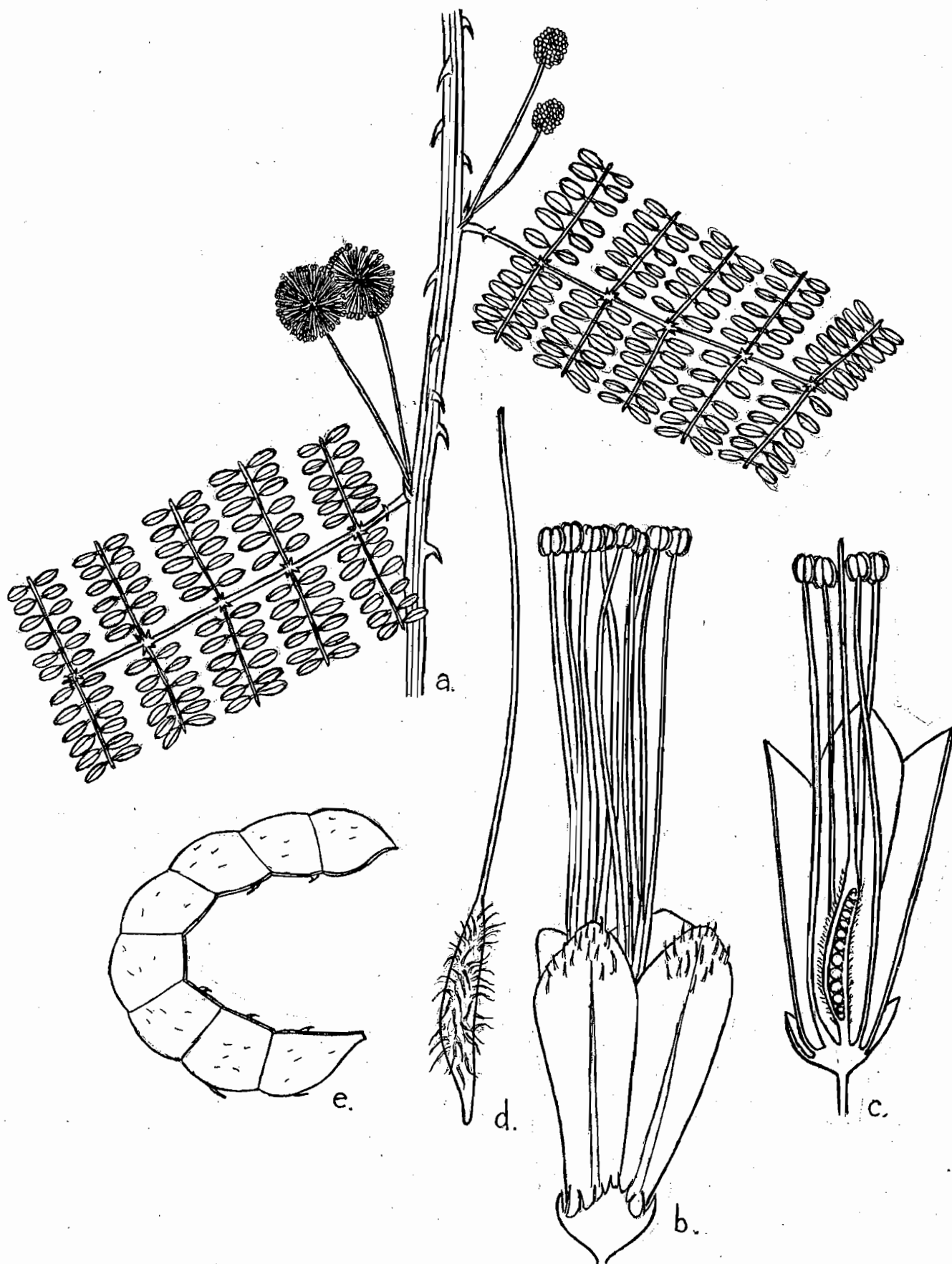


Fig. 182. *Mimosa quadrivalvis* L., a. habit, b. flower, c. L.S. of flower, d. gynoecium, e. fruit.

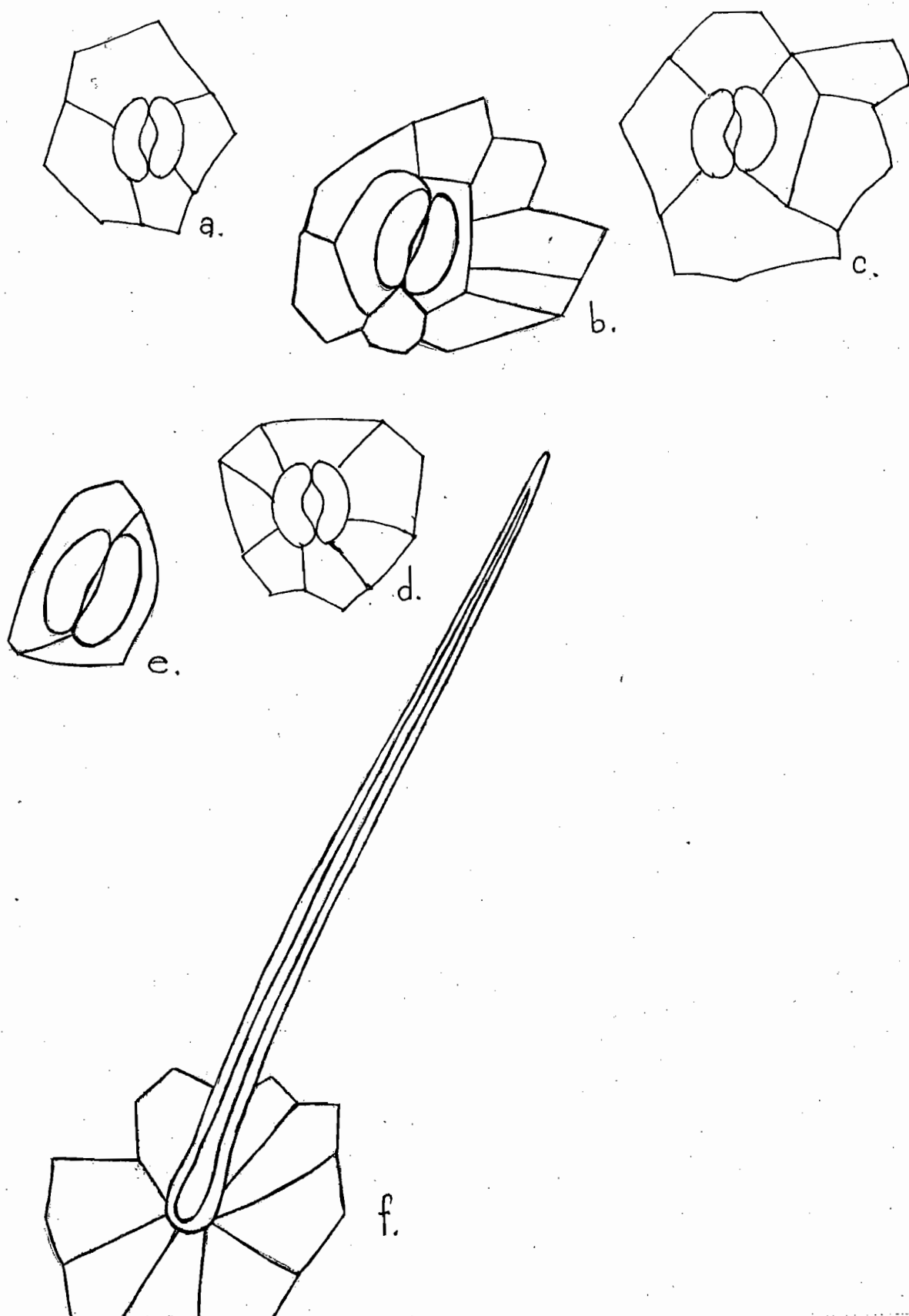


Fig. 183. *Mimosa quadrivalvis* L., a & d. anomocytic stomata, b. anisocytic stomata, c. tetracytic stomata, e. paracytic stomata, f. unicellular trichome with round base and thick wall.

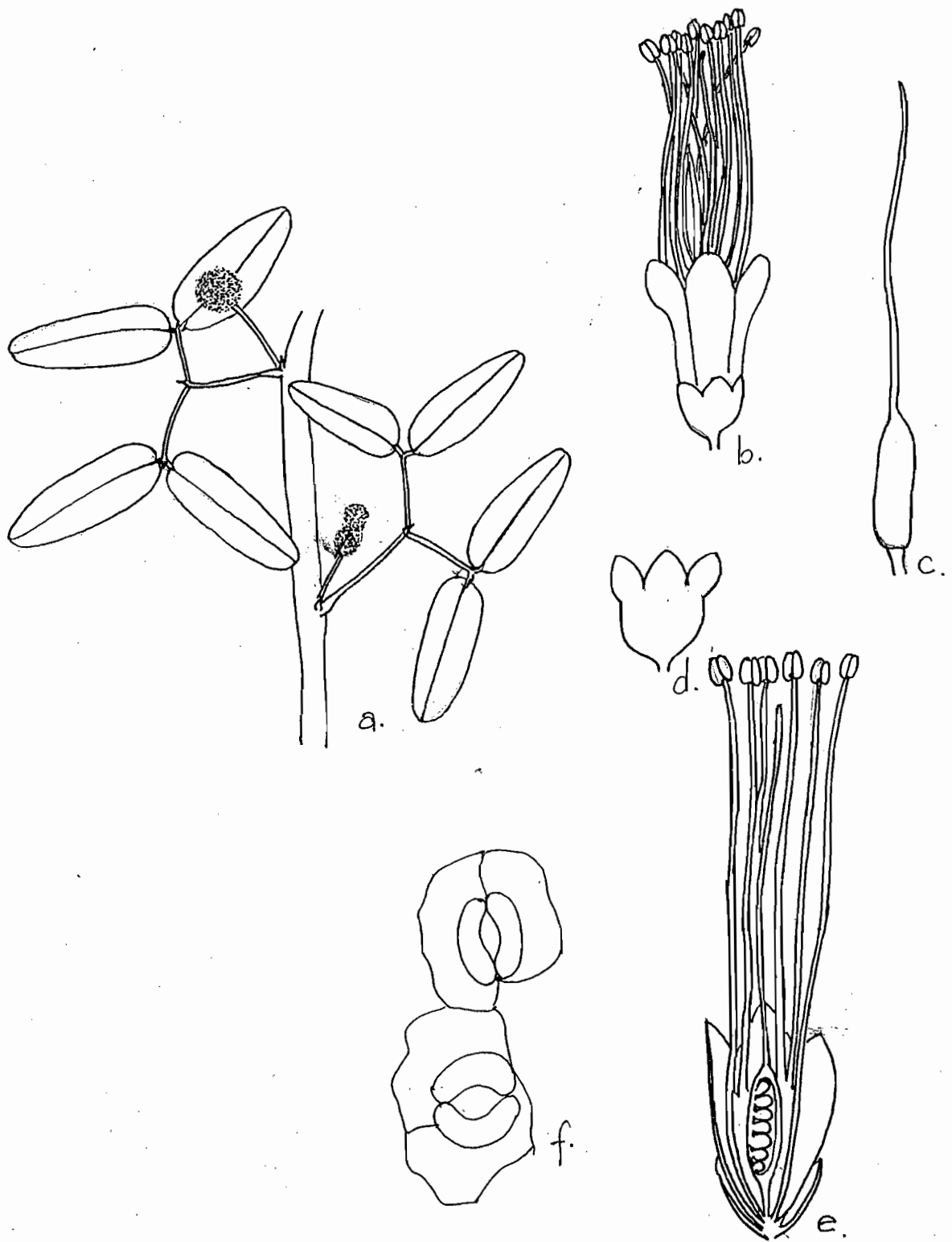


Fig. 184. *Pithecellobium dulce* Bth. a. habit, b. flower, c. gynoecium, d. calyx, e. L.S. of flower, f. paracytic stomata.

campanulate, 5-toothed. Petals 5, free, tomentose on the inner surface. Stamens 10, free, anthers with or without a deciduous gland. Ovary stipitate, many-ovuled. Pods compressed, straight or falcate, upto 20 cm long, light yellow. Seeds 10-18. (Fig. 185)

Flowers: February-October.

Micromorphology (Fig. 185)

The plant was glabrous.

Stomata were of anomocytic and paracytic types.

Combretaceae

1. *Anogeissus sericea* Brandis. in *Indian Forester*. V. 25 (1900) p. 287.

A middle-sized branched tree with branchlets clothed with silky pubescence. Leaves about 4 cms. long, elliptic, obtuse, apiculate, clothed on the lower side and the nerves beneath with silky pubescence; main nerves 4-6 pairs; petioles pubescent. Flowers in globose heads, on long axillary simple peduncles which often bear leafy bracts. Calyx-tube compressed, 2-winged, attenuated and produced above the ovary; limb campanulate, 5-fid, deciduous. Petals 0. Stamens 10, biseriate, exserted; anthers small, cordate. Ovary inferior, 1-celled; ovules 2, pendulous from the top of the cell; style filiform, thickened at the base; stigma simple. Fruit crowned by the pubescent calyx-tube. (Fig. 186)

Vernacular name: Dhav.

Flowers: March-April.

Micromorphology (Fig. 186)

The plant showed presence of unicellular elongated trichome.

Stomata were anisocytic and anomocytic types.

D/480, 481, 482, 1209-1210.

2. *Combretum coccineum* (Sonner.) Lamk., *Encyc. Method.* 1:734. 1784.

An elegant looking climbing glabrous shrub. Leaves dark green, reaching to a length of 13 cm, oblong lanceolate, acute with a distinct central vein, petiole upto 2 cms. long. Racemes terminal and axillary, 5-15 cm long. Flowers red; bract linear lanceolate. Calyx tube 5 angled alternating with calyx teeth. Petals 5, attached on the hypanthium elliptic oblong. Stamens 10, exserted, inserted on the throat of the hypanthium, anthers dorsifixed. Ovary linear oblong. Stigma simple, style subulate, filiform. Fruit oblong-elliptic, with 5 papery wings. (Fig. 187)

Flowers: March-September.

Micromorphology (Fig. 188)

The trichome was unicellular acicular with thick wall and round base.

Stomata were tetracytic, anisocytic and anomocytic types.

D/237.

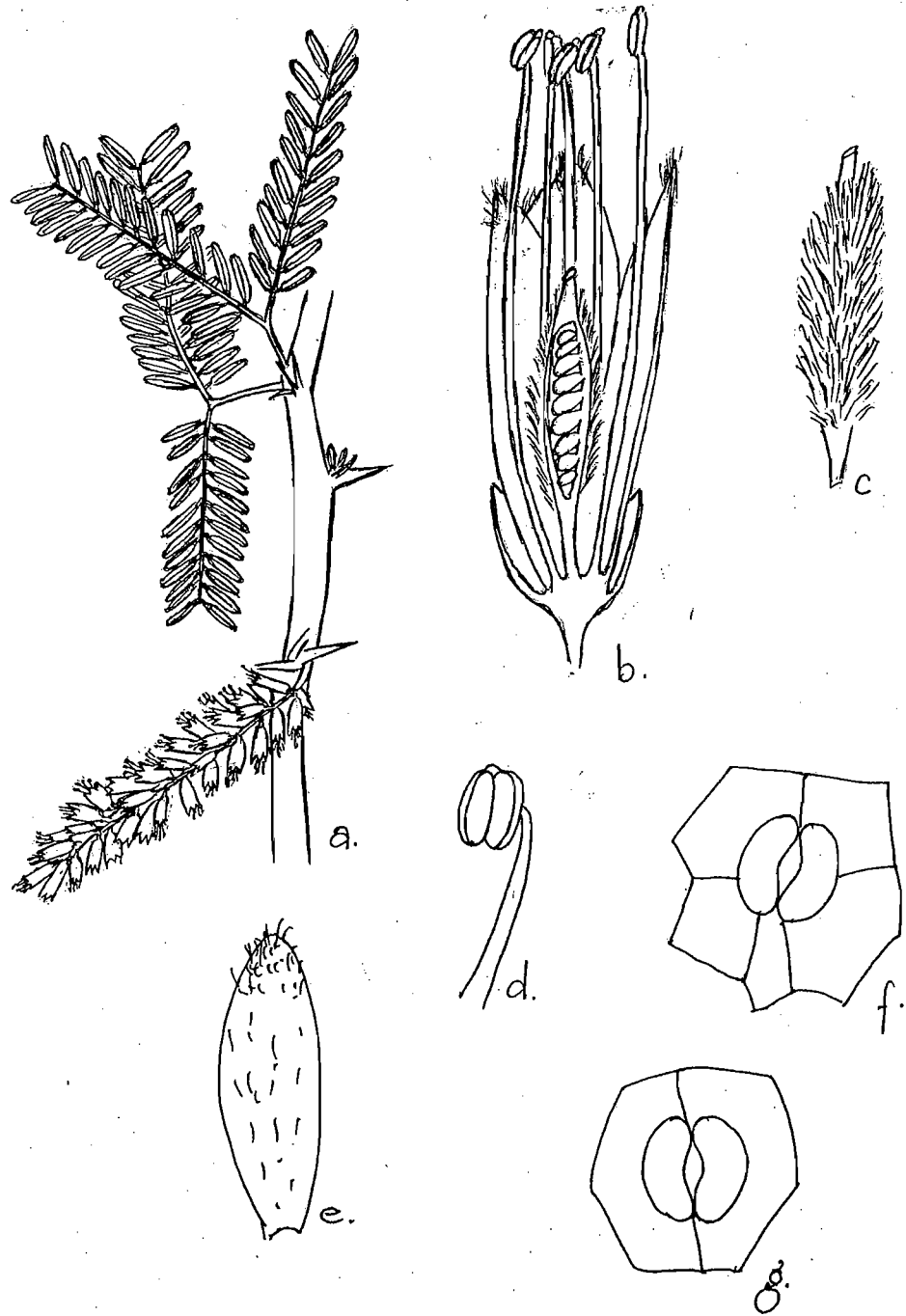


Fig. 185. *Prosopis juliflora* (Sw.) DC. a. habit, b. L.S. of flower, c. gynoecium, d. stamen, e. petal, f. anomocytic stomata, g. paracytic stomata.

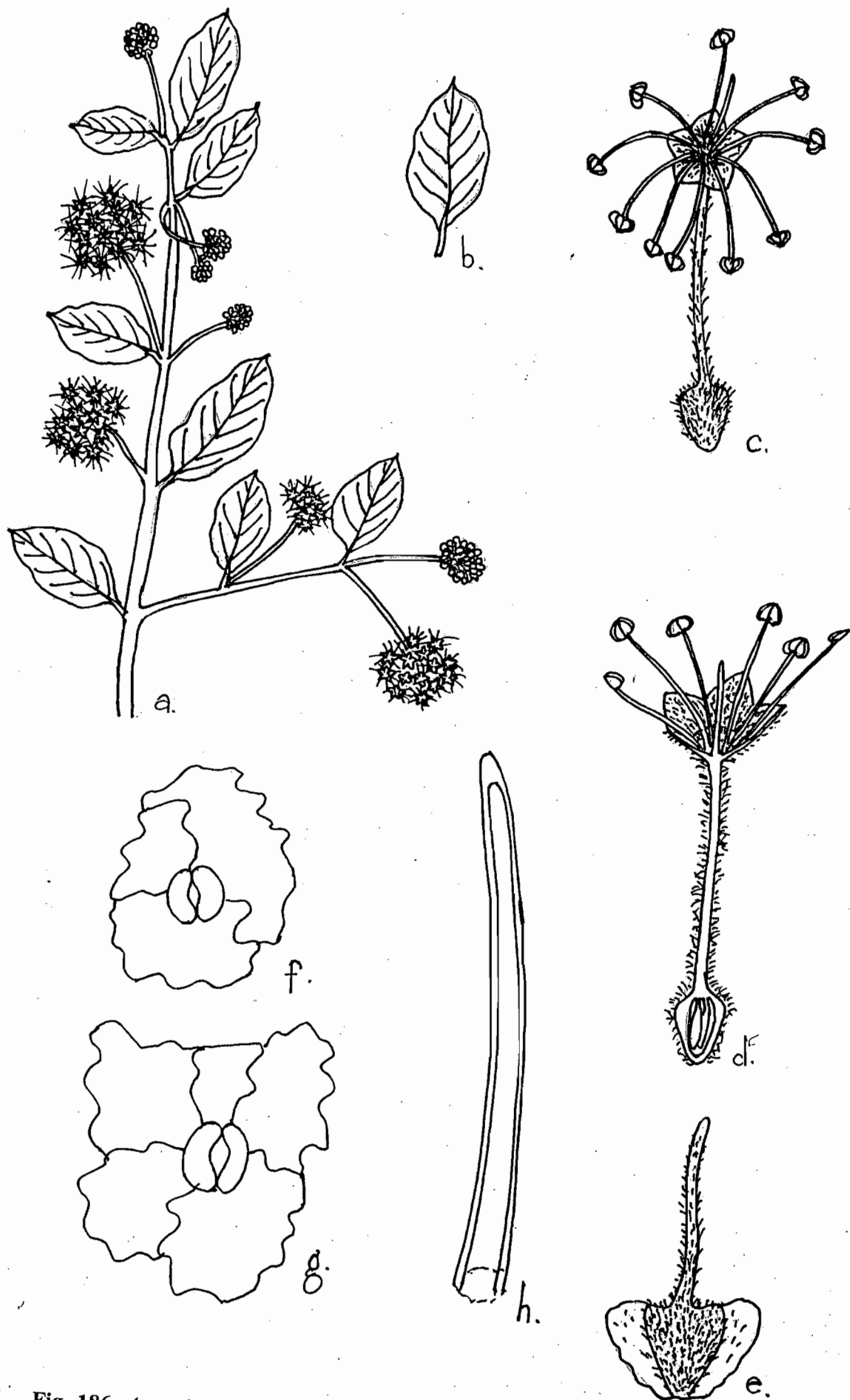


Fig. 186. *Anogeissus serecia* Brandis. a. habit, b. leaf, c. flower, d. L.S. of flower, e. fruit, f. anisocytic stomata, g. anomocytic stomata, h. unicellular trichome.

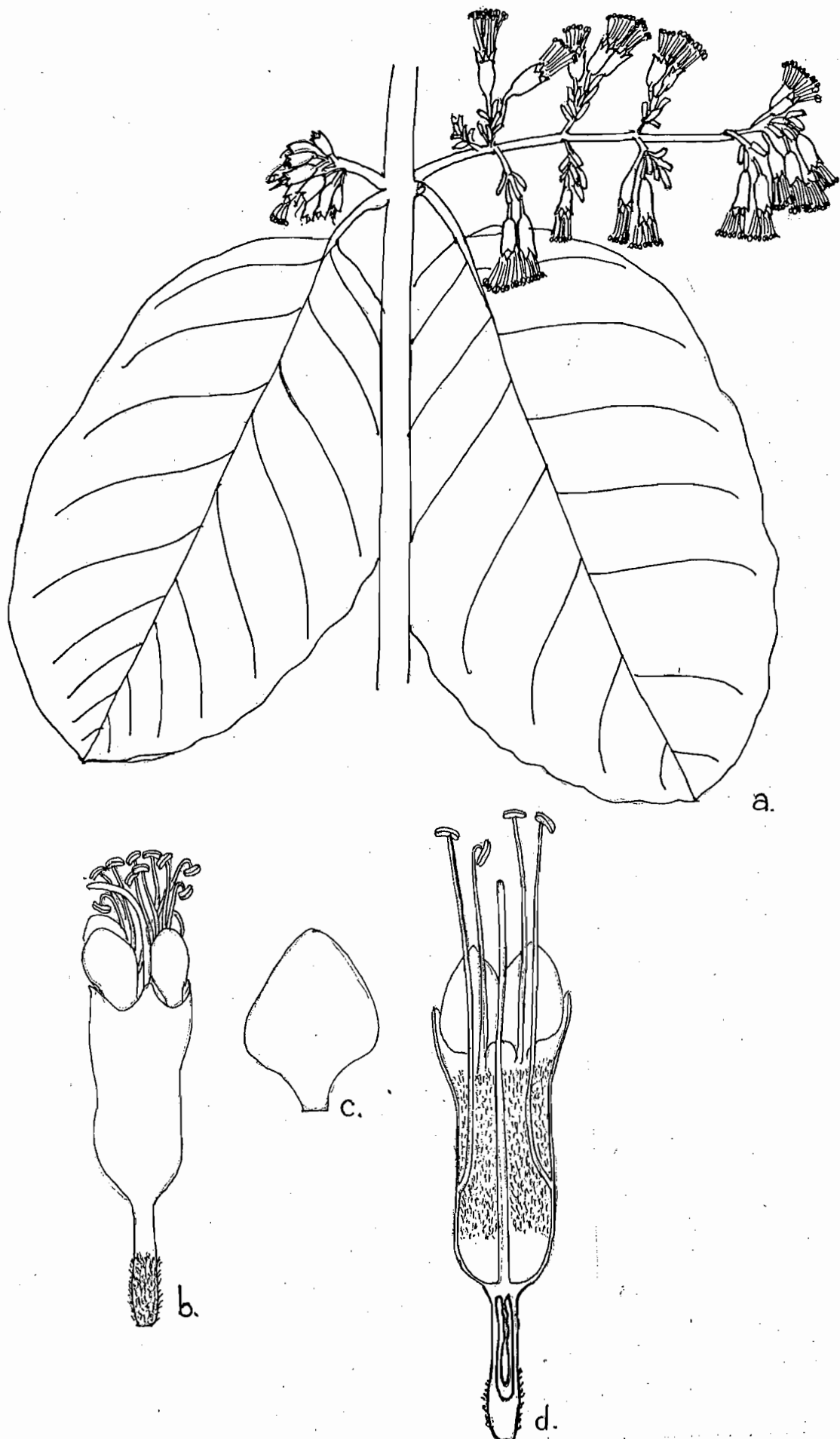


Fig. 187. *Combretum coccineum* Lam. a. habit, b. flower, c. petal, d. L.S. of flower.

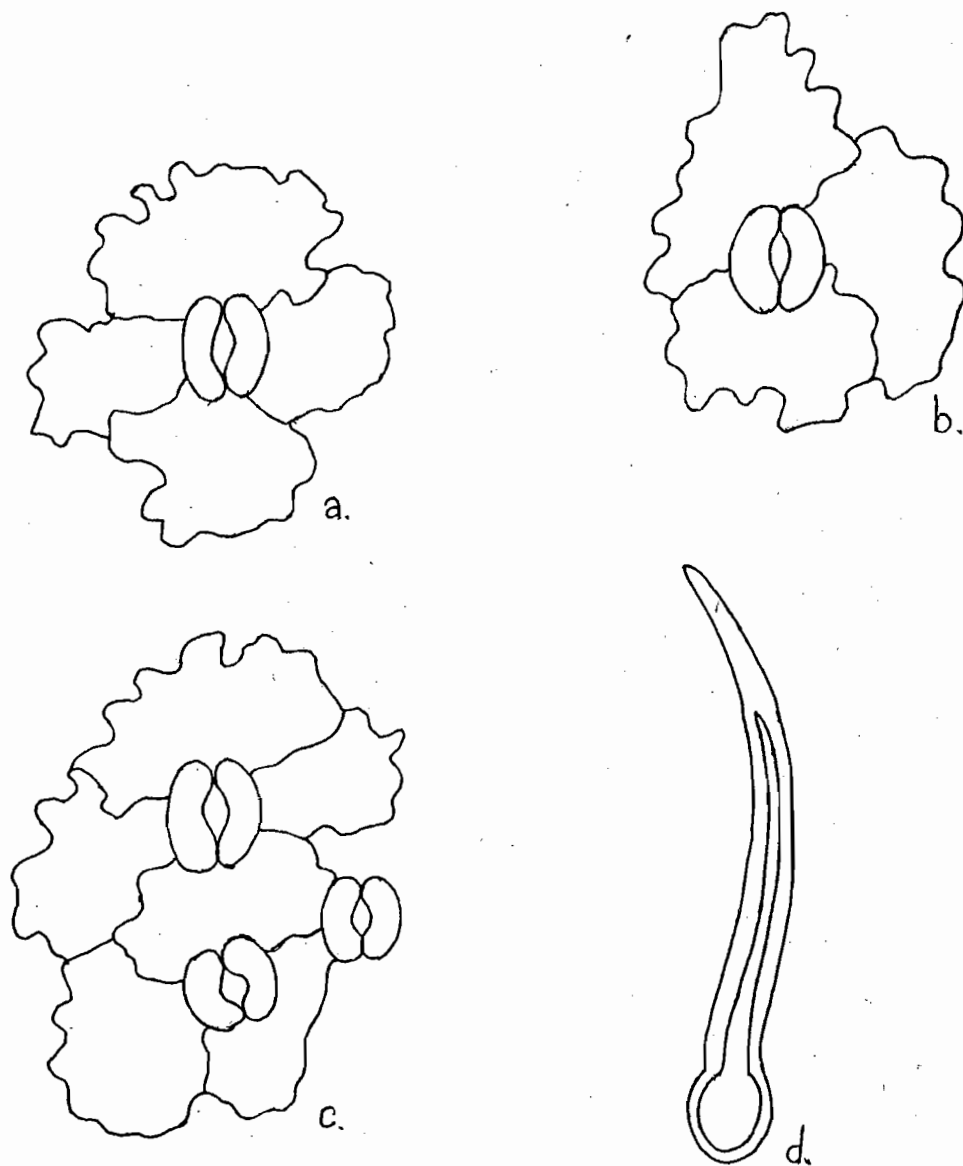


Fig. 188. *Combretum coccineum* Lam. a. tetra-cytic stomata, b. anisocytic stomata, c. anomocytic stomata, d. unicellular trichome with thick wall, broad lumen and round base.

**3. *Combretum latifolium* Blume, *Bijdr.* 641. 1826.
(*Combretum extensum* Roxb.)**

A large scandent nearly glabrous shrub. Leaves opposite, upto 15 cm long, usually broadly elliptic, shortly acuminate; main nerves 4-7 pairs; petioles upto 1 cm long. Flowers sessile, 1 cm long, usually in solitary dense axillary spikes. Calyx contracted above the ovary and then at once expanding into a funnel-shaped limb; lobes 4, triangular, acuminate, reflexed. Petals yellowish white, oblong, truncate or very slightly emarginated at the apex. Stamens 10, biseriate; anthers small, didymous. Ovary inferior, tetragonous, 1-celled; ovules 2-6, pendulous from the apex of the cell; style subulate; stigma simple. Disk hairy. Fruit upto 4 cms. long; wings scarious, horizontally striate. (Fig. 189)

Flowers: October-February.

Micromorphology (Fig. 190)

The trichome was unicellular acicular with thick wall and round base.

Stomata were anisocytic and anomocytic types.

D/169.

4. *Quisqualis indica* Linn. *Sp. Pl. ed.* 2.1:556. (1762).

A deciduous climber with cylindrical branches, covered with soft, brown-golden pubescence. Leaves upto 15 cm long, acuminate, with subcordate base, petiole often converted into curved spines. Spikes upto 10 cm long. Flowers red, upto 9 cm long; bracts lanceolate or elliptic, acuminate. Hypanthium upto 7 cm long, lower portion 5 angled, ellipsoid, sericeous with papillae on the inner surface; upper portion narrowly tubular, slightly constricted above the ovary, expanded at the apex into 5 triangular acute teeth. Style filiform, equal to the length of calyx tube, stigma knob shaped. Fruit narrowly elliptic, five angled, angles scarcely winged. (Fig. 191)

Vernacular name: Madhu-malti.

Flowers: Throughout the year.

Micromorphology (Fig. 192)

The trichome was unicellular acicular with thick wall, with small lumen and round base. Some of them had ergastic inclusions.

Stomata were anomocytic type.

D/234.

5. *Terminalia arjuna* Wight & Arn. *Prodr.* (1834) p. 314

A large branched tree reaching 30 m high with a very thick trunk. Bark thick, smooth, greenish-white, flaking off in large flat pieces. Leaves usually subopposite, upto 15 cm long, elliptic-oblong, subacute; main nerves arcuate, 10-15 pairs; petioles long, with 1 or usually 2 prominent glands at the top immediately below the leaves. Flowers sessile, in short axillary spikes or in terminal panicles; bracteoles linear-lanceolate, shorter than the

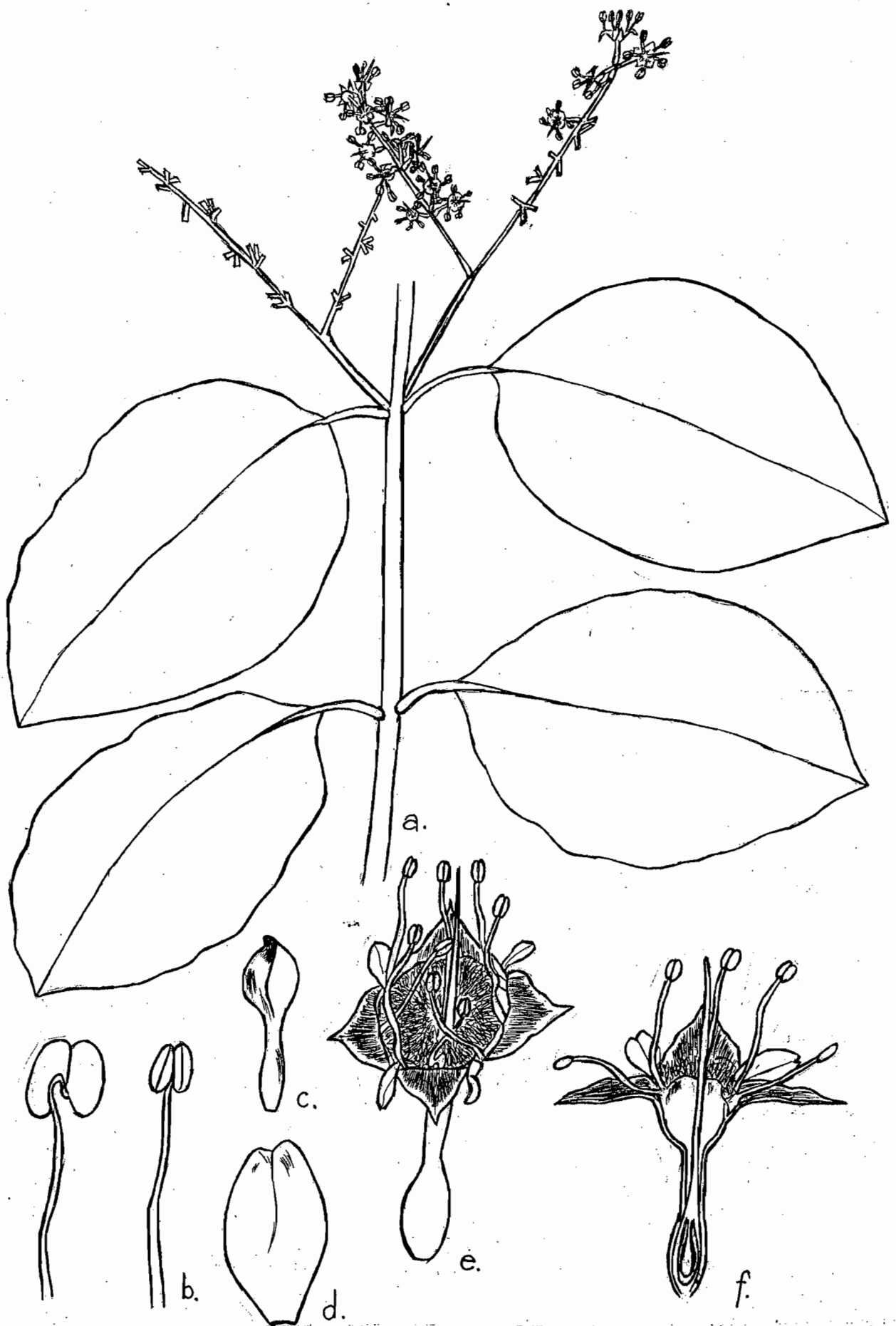


Fig. 189. *Combretum latifolium* Blume., a. habit, b. stamen, c. bud, d. bract, e. flower, f. L.S. of flower

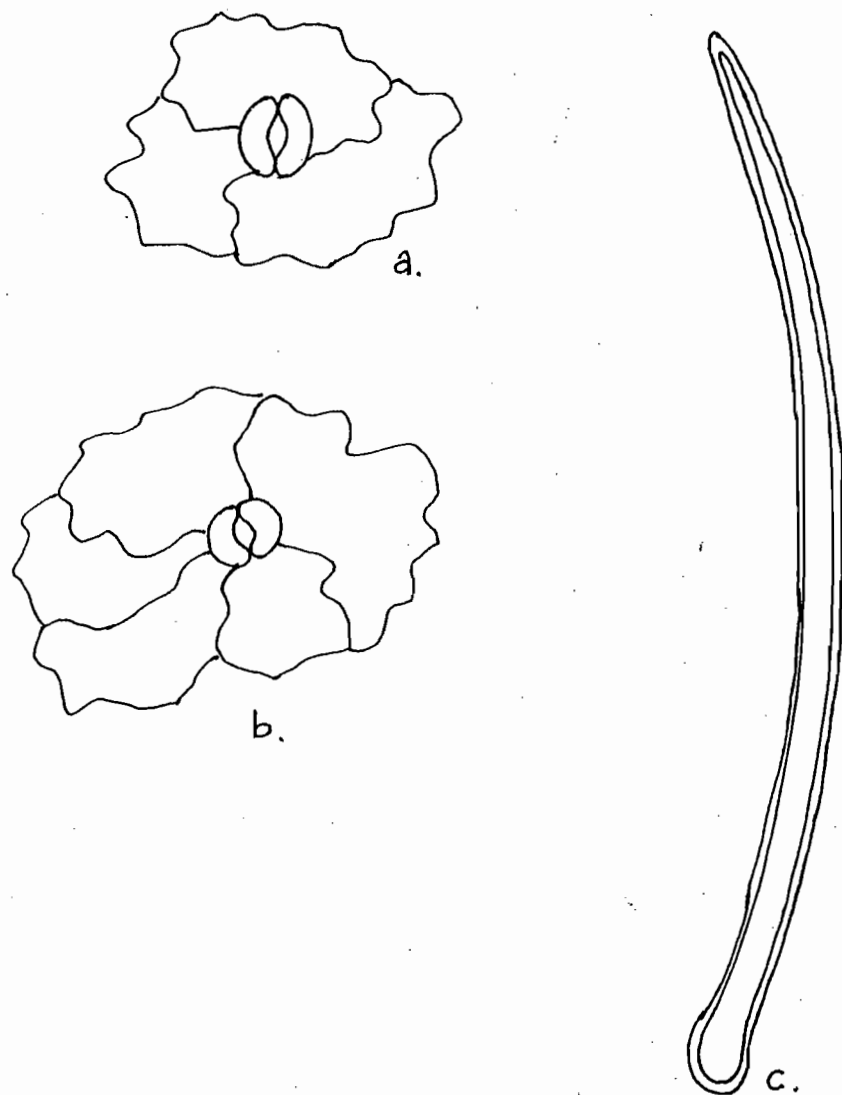


Fig. 190. *Combretum latifolium* Blume., a. anisocytic stomata, b. anomocytic stomata, c. unicellular thick walled trichome with round base.

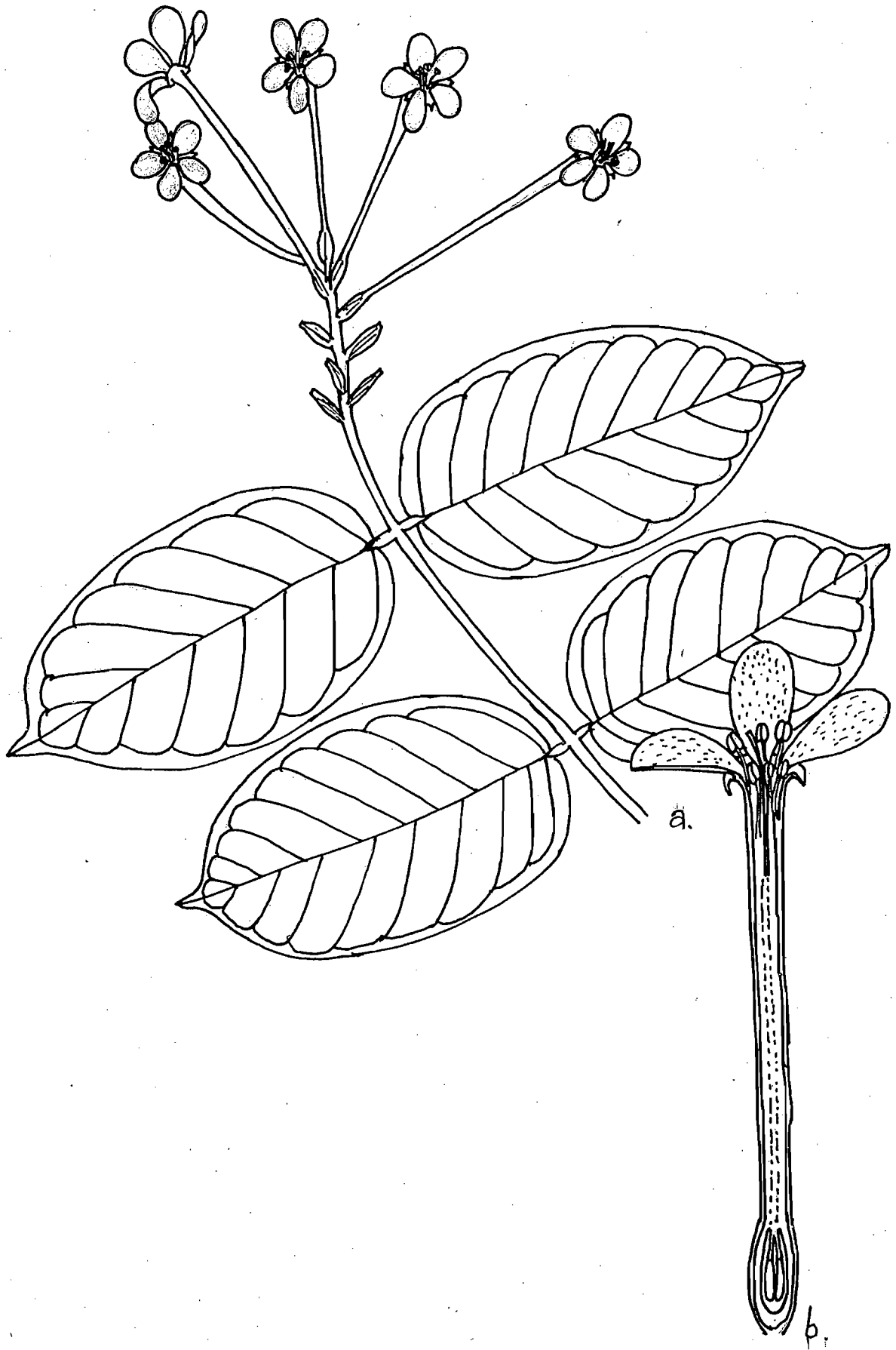


Fig.191. *Quisqualis indica* L. a. habit, b. L.S. of flower.

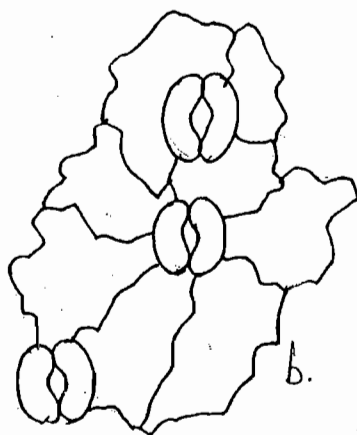
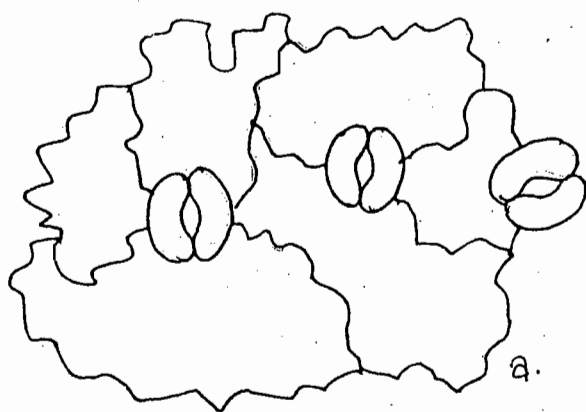


Fig. 192. *Quisqualis indica* L. a and b. anomocytic stomata, c. unicellular trichome w small lumen and ergastic inclusions, d. unicellular trichome with small lumen.

flowers, caducous. Calyx glabrous, long; mouth broadly campanulate; teeth triangular, Ovary quite glabrous. Disk clothed with yellowish or reddish hairs. (Fig. 193)

Vernacular name: Arjun Sadad.

Flowers: April-May.

Micromorphology (Fig. 194)

The trichome was unicellular acicular with thick wall, with small lumen and round base having ergastic inclusions.

Stomata were anisocytic and anomocytic types.

D/98.

6. *Terminalia bellerica* Roxb. Cor. Pl. V. 2 (1798) p. 54, t. 198.

A large branched tree reaching upto 20 m high. Leaves collected about the extremities of the branches, alternate, coriaceous, 10-20 cm long, obovate, shortly acuminate at the apex; main nerves 6-8 pairs; petioles upto 10 cm long, without glands at the apex. Flowers pale greenish-yellow, in axillary slender spikes, those in the upper part of the spike male, very shortly pedicelled, those in the lower part hermaphrodite, sessile. Calyx teeth broadly triangular, acute. Drupe upto 3 cm diameter, suddenly narrowed into a very short stalk, clothed with minute pale tomentum, obscurely angled when dried. (Fig. 195)

Vernacular name: Bahedo.

Flowers: February-May.

Micromorphology (Fig. 195)

The plant was glabrous.

Stomata were anisocytic and tetracytic types.

D/169.

Myrtaceae

**1. *Syzygium calcadensis* (Bedd.) Chandrash. Biol. Membr. Abstr. 2: 57. 1977.
(*Eugenia calcadensis* Bedd.)**

A small branched tree. Leaves upto 6 cm long, subalternate, subobovate, coriaceous, obtuse. Peduncles axillary solitary about equal to the petioles 2-rarely 1-flowered, flowers showy white. Pedicels with a subulate bract at the base. Calyx-lobes rounded lobes 4, rarely 5. Petals 4, rarely 5, oblong. Disk suborbicular, densely woolly, covering the whole of the top of the ovary at the apex of the calyx-tube. Stamens inserted all over the disk, filaments filiform; anthers small, versatile, bursting longitudinally. Ovary 2-celled with numerous ovules; style filiform, stigma small. Berry drupelike, crowned with persistent calyx-limb. Seeds few, globose. (Fig. 196)

Micromorphology (Fig. 196)

The trichome was unicellular flat, with thin wall and broad lumen.

Stomata were paracytic and tetracytic types.

D/300.

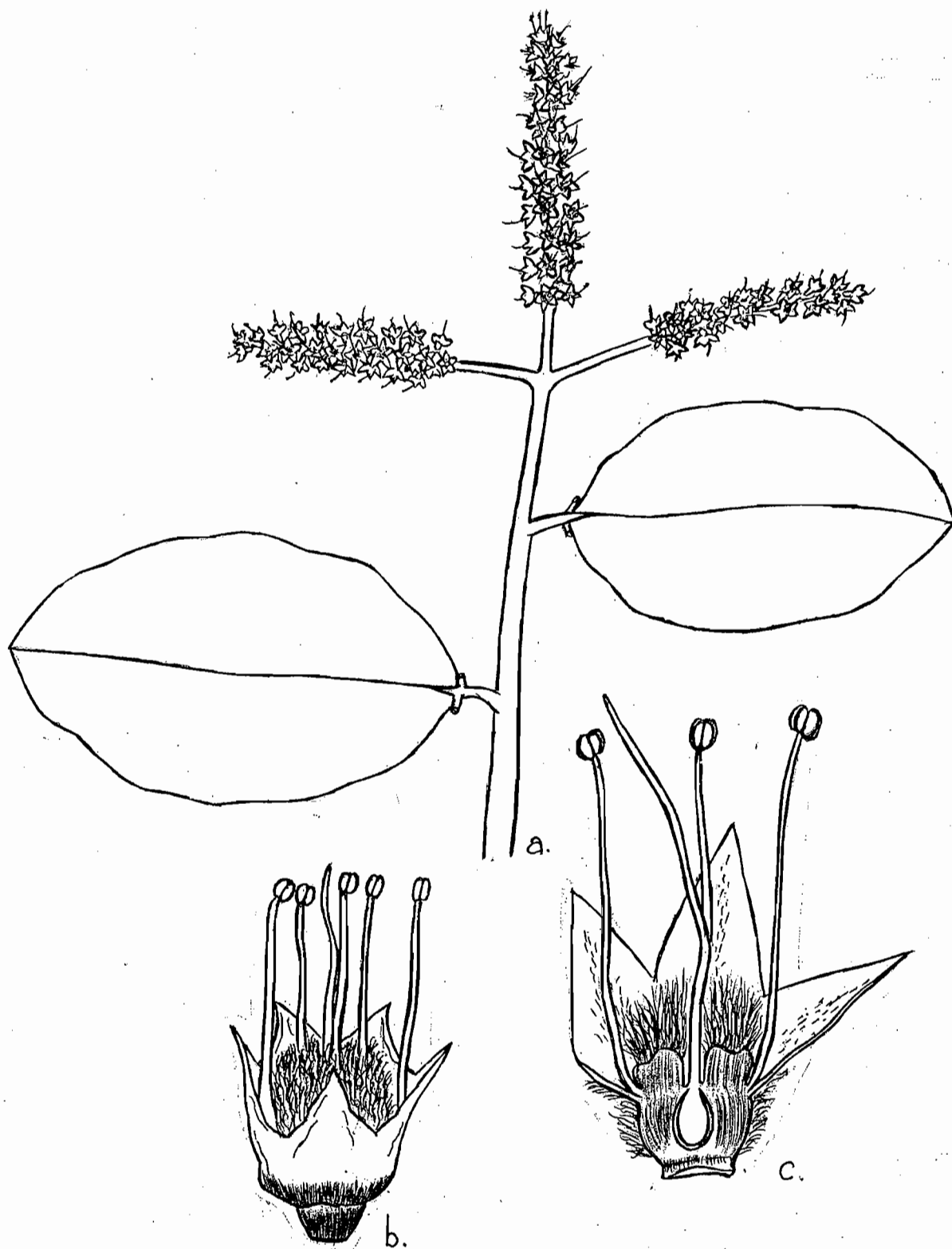


Fig. 193. *Terminalia arjuna* W. & A. a. habit, b. flower, c. L.S. of flower.

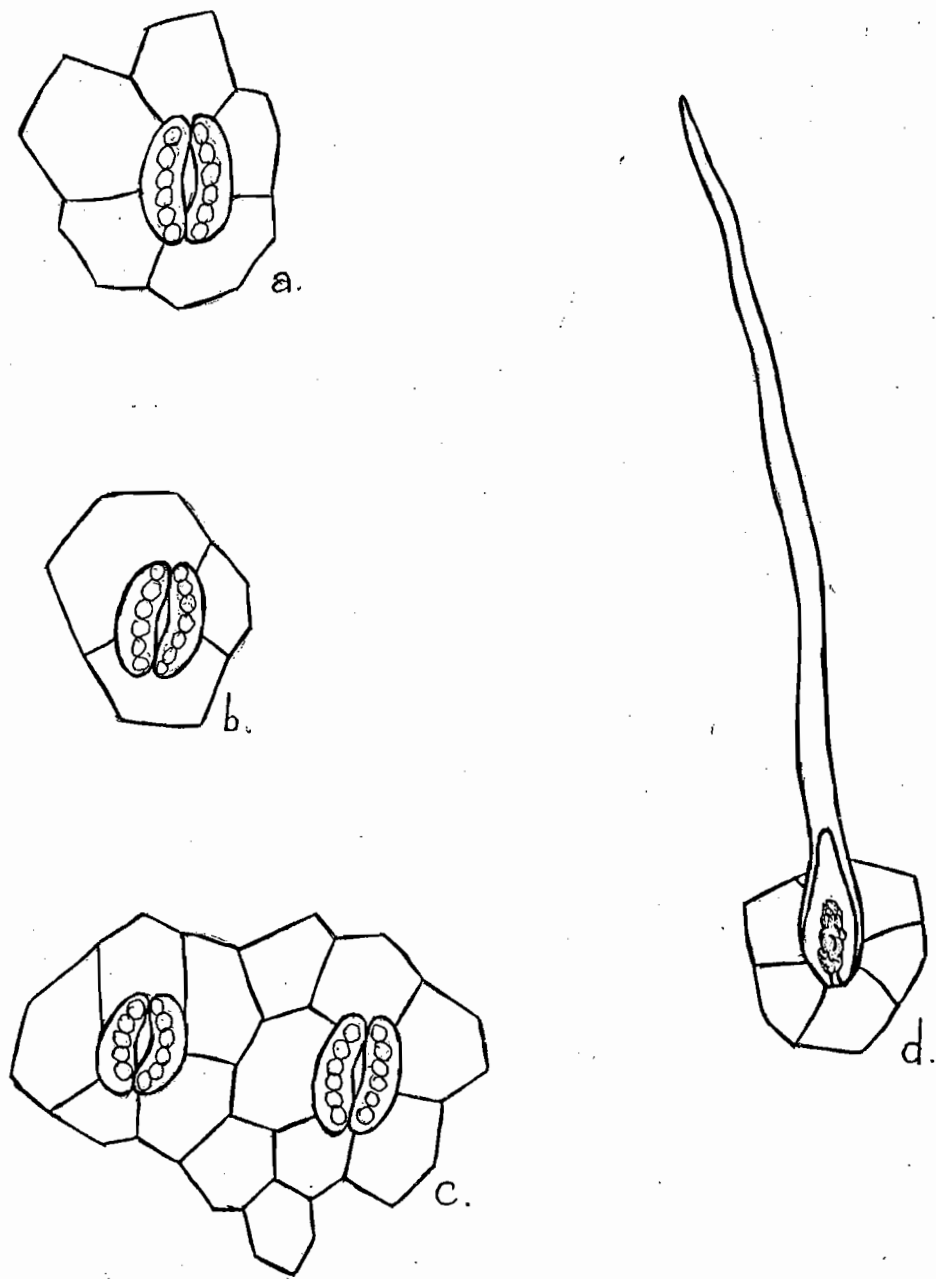


Fig. 194. *Terminalia arjuna* W. & A., a and c. anomocytic stomata, b. anisocytic stomata, d. unicellular trichome with small lumen.

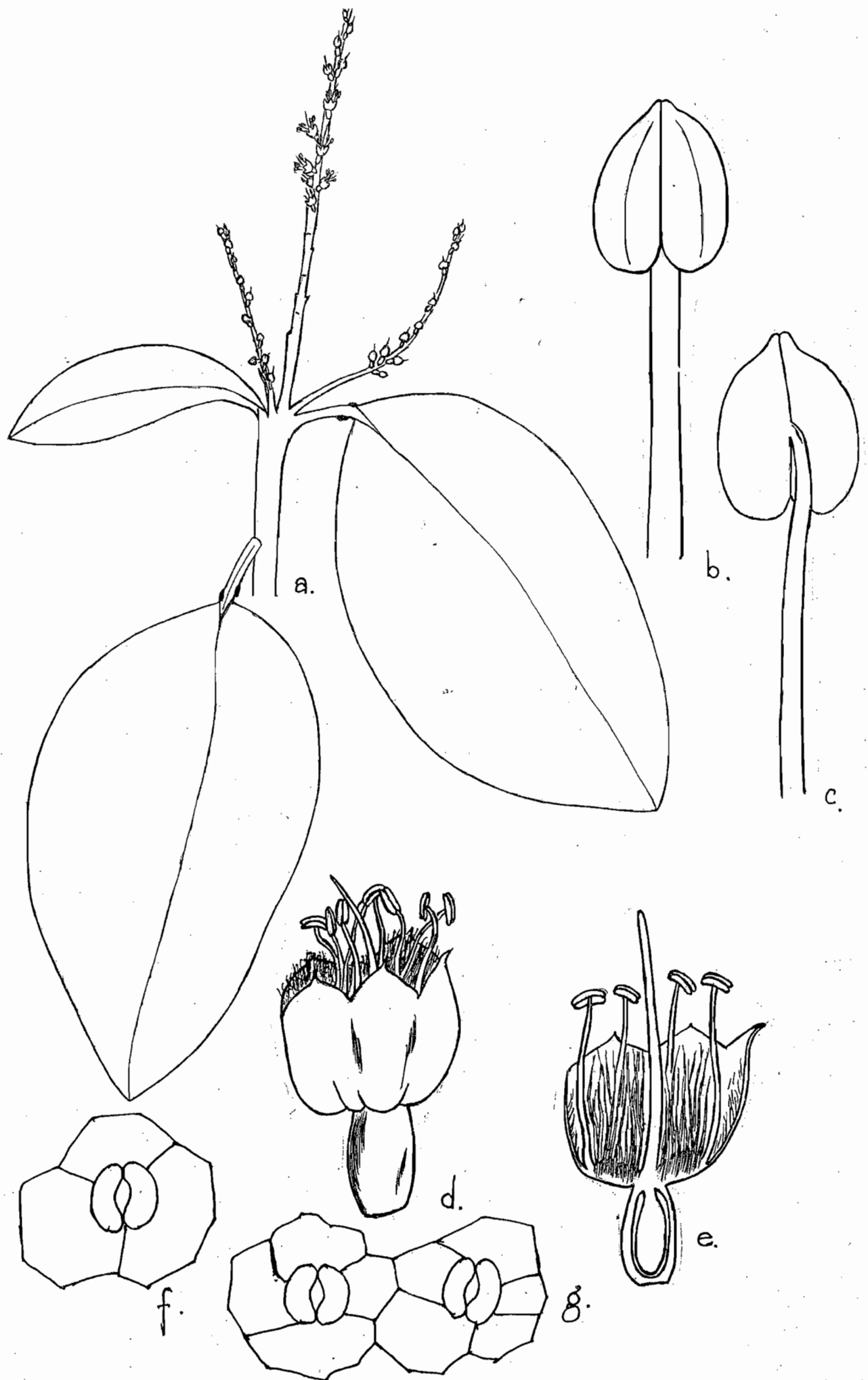


Fig. 195. *Terminalia bellerica* Roxb., a. habit, b and c. stamen. d. flower, e. L.S. of flower.

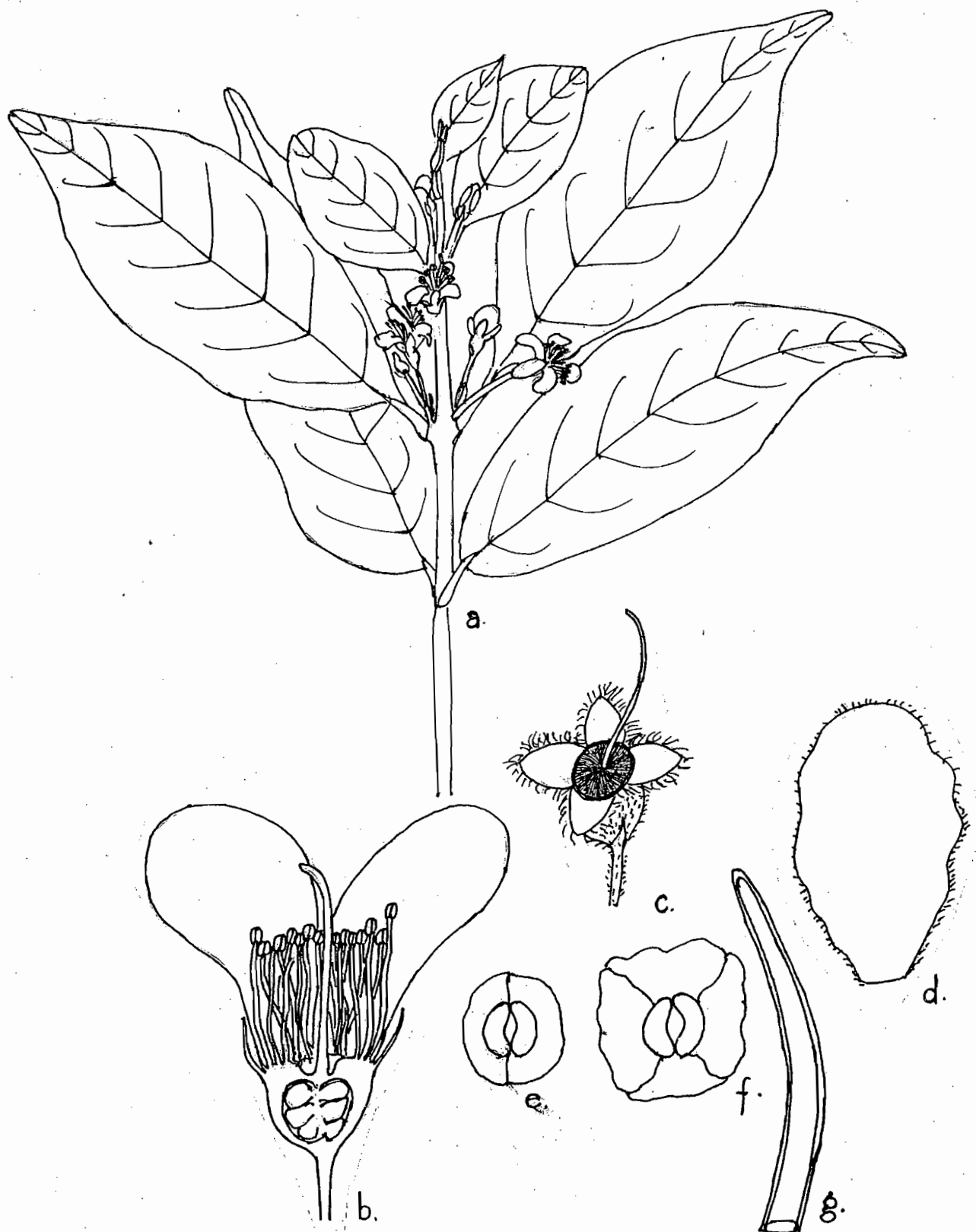


Fig. 196. *Syzygium calcadensis* Chandrash., a. habit, b. L.S. of flower, c. flower, d. petal, e. paracytic stomata, f. tetracytic stomata, g. unicellular trichome with thin wall and broad lumen.

Lecythidaceae

1. *Couroupita guianensis* Aubl. *Hist. Pl. Guiane* 2: 708, pl. 282. 1775.

A tall tree with relatively smooth wall and soft wood. Leaves oblong, obovate, elliptic or broadly lanceolate, entire, upto 16 cm long, acute. Flowers yellow and red tinged, fragrant, 8-15 cm across, arranged in 40-70 cm long racemes. Petals fleshy, about 5 cm long, oblong-ovate. Androphore large, spatulate, cream coloured. Stamens upto 1000. stigmatic disc stellate. Fruit nearly globular, about 20 cm in diameter, reddish-brown, hard outside, pulpy inside. (Fig. 197)

Flowers : Throughout the year.

Micromorphology (Fig. 198)

The whole plant was covered by multicellular trichome which is uniseriate at the upper part, and multiseriate at the lower half.

Stomata were anomocytic type.

D/205.

Lythraceae

1. *Ammania baccifera* Linn. *Sp. Pl.* (1753) p. 120.

A glabrous, annual, branched herb reaching upto 60 cm high with erect tetragonous stem. Leaves opposite, upto 6.6 cm, sessile, linear-oblong or oblong-lanceolate, subacute, much narrowed at the base. Flowers in dense axillary clusters short cymes, forming whorls in the axils; bracts filiform, shorter than the pedicels. Calyx tube hemispheric; teeth 4 (rarely 5), broadly triangular, acute; accessory teeth inconspicuous. Petals 0. Stamens 4, inserted in the middle of the calyx-tube; filaments filiform. Ovary superior, 1 celled; ovules numerous; style filiform, exserted; stigma capitate. Capsule globose, red, irregularly circumscise above the middle. Seeds subhemispheric. (Fig. 199)

Vernacular name: Jal Agio.

Flowers: September-February.

Micromorphology (Fig. 199)

The plant was glabrous.

Stomata were anisocytic and anomocytic types.

D/1010, 1071, 1168.

2. *Ammania octandra* Linn. f. *Suppl.* (1781) p. 127.

An erect annual glabrous branched herb reaching upto 120 cm high with tetragonous stem. Leaves sessile, linear-lanceolate, tapering to an acute apex, subauriculate at the base, upto 6 cm long. Flowers in short-peduncled usually 3-flowered cymes; peduncles scabrous; pedicels short. Calyx campanulate; quadrangular; mouth nearly truncate or with 4 very short teeth; accessory teeth short, horn-like, spreading. Petals 4, broadly obovate, rose-colored. Stamens 8, exserted; filaments dark-red. Ovary inferior; 2-6 celled; ovules

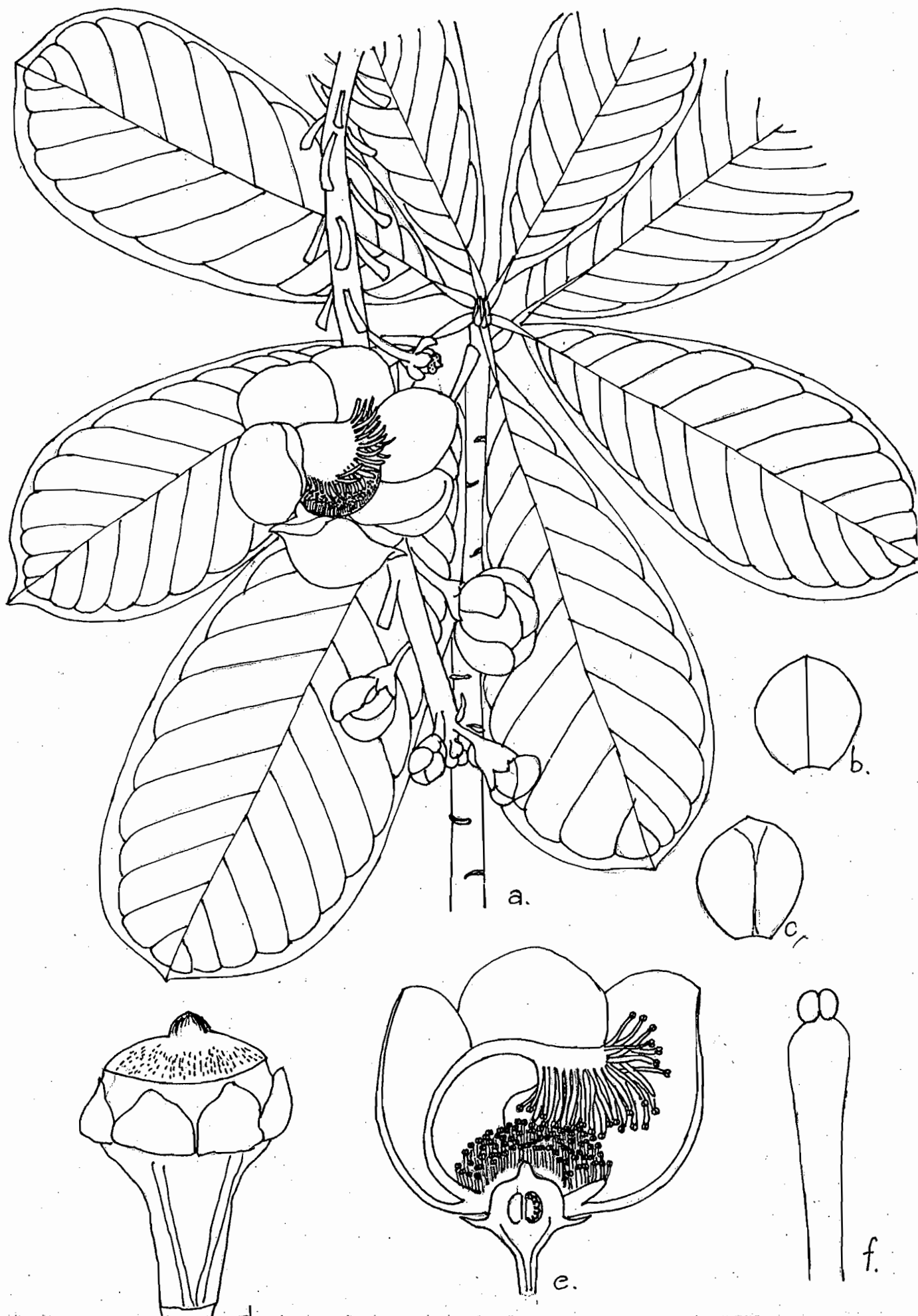


Fig. 197. *Couroupita guianensis* Aubl. a. habit, b. bract, c. sepal, d. gynoecium, e. L.S. of flower, f. stamen.

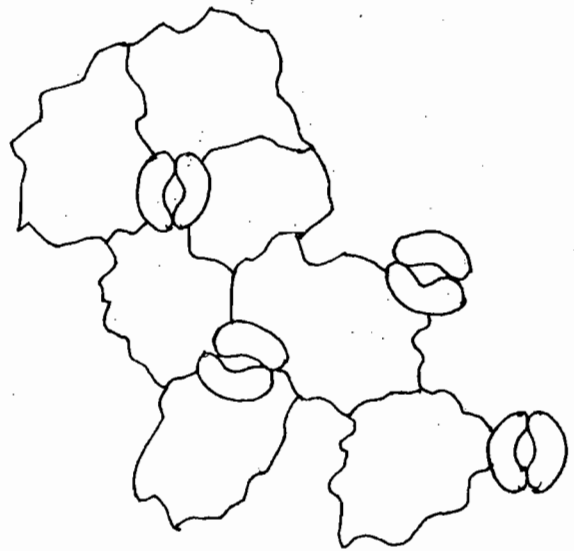
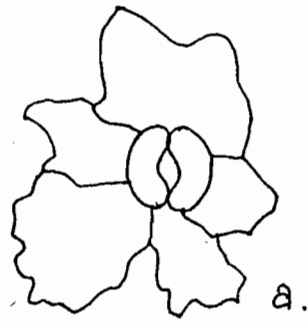


Fig. 198. *Couropita guianensis* Aubl. a. anomocytic stomata, b. multicellular multiseriate trichome.

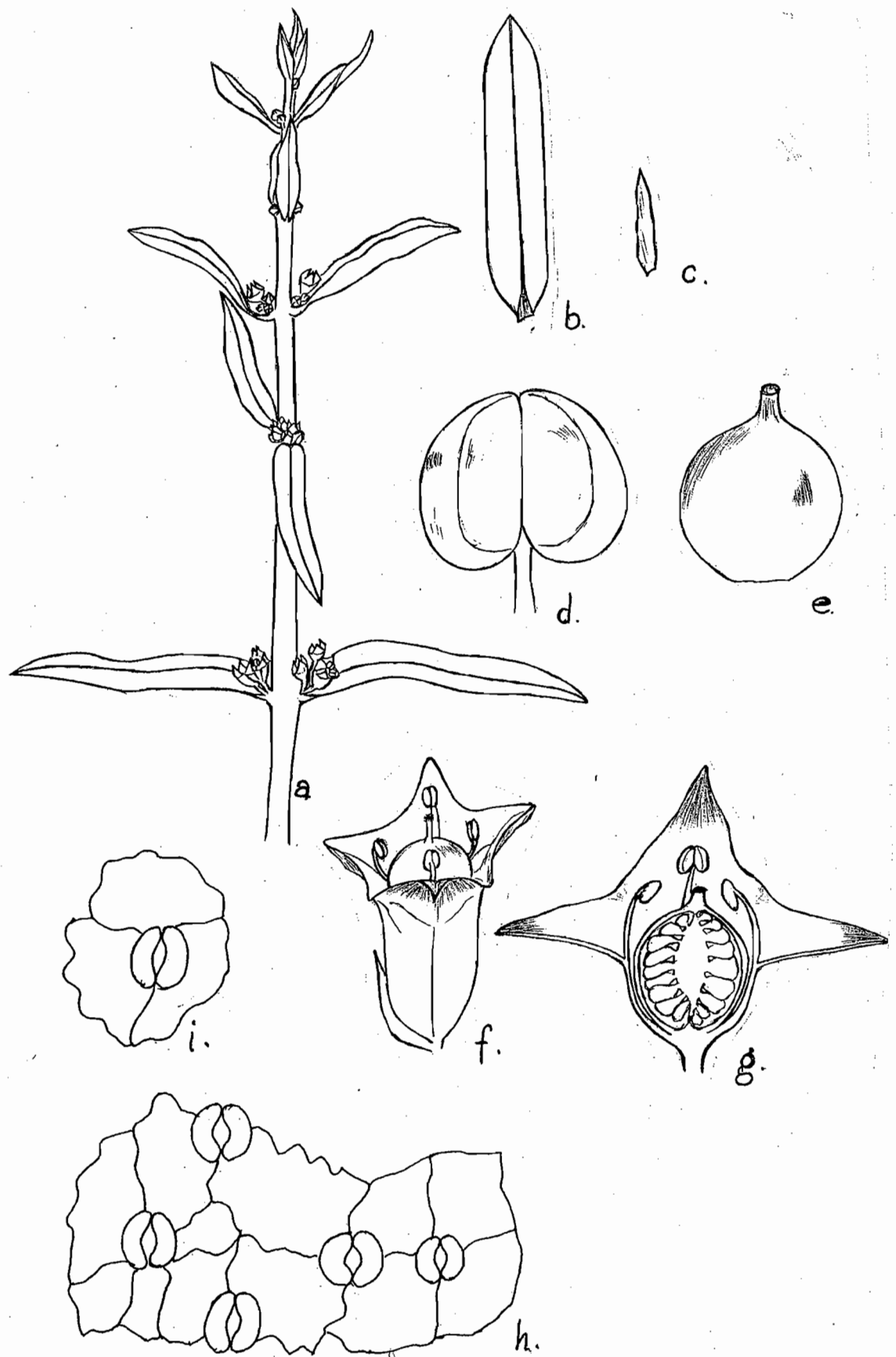


Fig. 199. *Ammania baccifera* L. a. habit, b. leaf, c. bract, d. stamen, e. gynoecium, f. flower, g. L.S. of flower, h. anomocytic stomata, i. anisocytic stomata.

many, placentas axile, style filiform; stigma capitate. Capsules enclosed in the calyx and about equalling it, globose, ellipsoid. Seeds semi-ovoid. (Fig. 200)

Micromorphology (Fig. 200)

The plant was glabrous.

Stomata were paracytic type.

D/177.

3. *Ammania tenuis* C.B. Clarke in Hook. f. *Fl. B. I. V. 2* (1879) p. 567.

An erect annual glabrous branched herb reaching to upto 12 cms. Leaves opposite, subsessile, elliptic, acute; lateral nerves inconspicuous. Stipules 0. Flowers in dense terminal slender racemes short; bracts 1 to each flower, oblong-lanceolate, acute; bracteoles linear-lanceolate, acute, herbaceous. Calyx campanulate, constricted at the top of the tube below the teeth; teeth triangular, acute. Petals obovate, pink. Stamens 4, inserted in the middle of the calyx tube; filaments filiform. Ovary superior, 2-celled, ovules numerous, placentas axile; style filiform, stigma capitate. Capsule ellipsoid. Seeds ellipsoid, pink or yellow. (Fig. 201)

Flowers: October-December.

Micromorphology (Fig. 202)

The plant was glabrous.

Stomata were anisocytic, diacytic and anomocytic types.

D/1243-1245, 1247.

**4. *Lagerstroemia speciosa* (L.) Pers. *Syn. Pl. 2: 72*. 1806.
(*Lagerstroemia flos-reginae* Retz.)**

A large branched tree reaching upto 20 m. high with bark pale, smooth, flaking off in irregular pieces. Leaves opposite, upto 20 cm long, oblong-lanceolate, subacute, glabrous; main nerves 10-13 pairs; petioles upto 1 cm long, stout. Flowers in large panicles sometimes reaching 30 cm long; pedicels thickened upwards and articulated below the middle. Calyx turbinate, covered with white tomentum, ribbed with 12-14 prominent stout ridges, those opposite the calyx-teeth broader; teeth 6-7, triangular, acute. Petals 6-7, purple, upto 4 cm long, suborbicular or rotund-ovate, clawed, much undulate and crumpled, spreading. Stamens numerous, inserted at the summit of the calyx-tube; filaments much exserted all equal. Ovary 3-6-celled; ovules numerous, ascending; placentas axile; style long, bent; stigma capitate. Capsules ellipsoid or subglobose, 3 cm, minutely apiculate. Seeds pale-brown. (Fig. 203)

Vernacular name: Jarul.

Flowers: April-June.

Micromorphology (Fig. 204)

The plant was glabrous.

Stomata were anisocytic, and anomocytic types.

D/196.

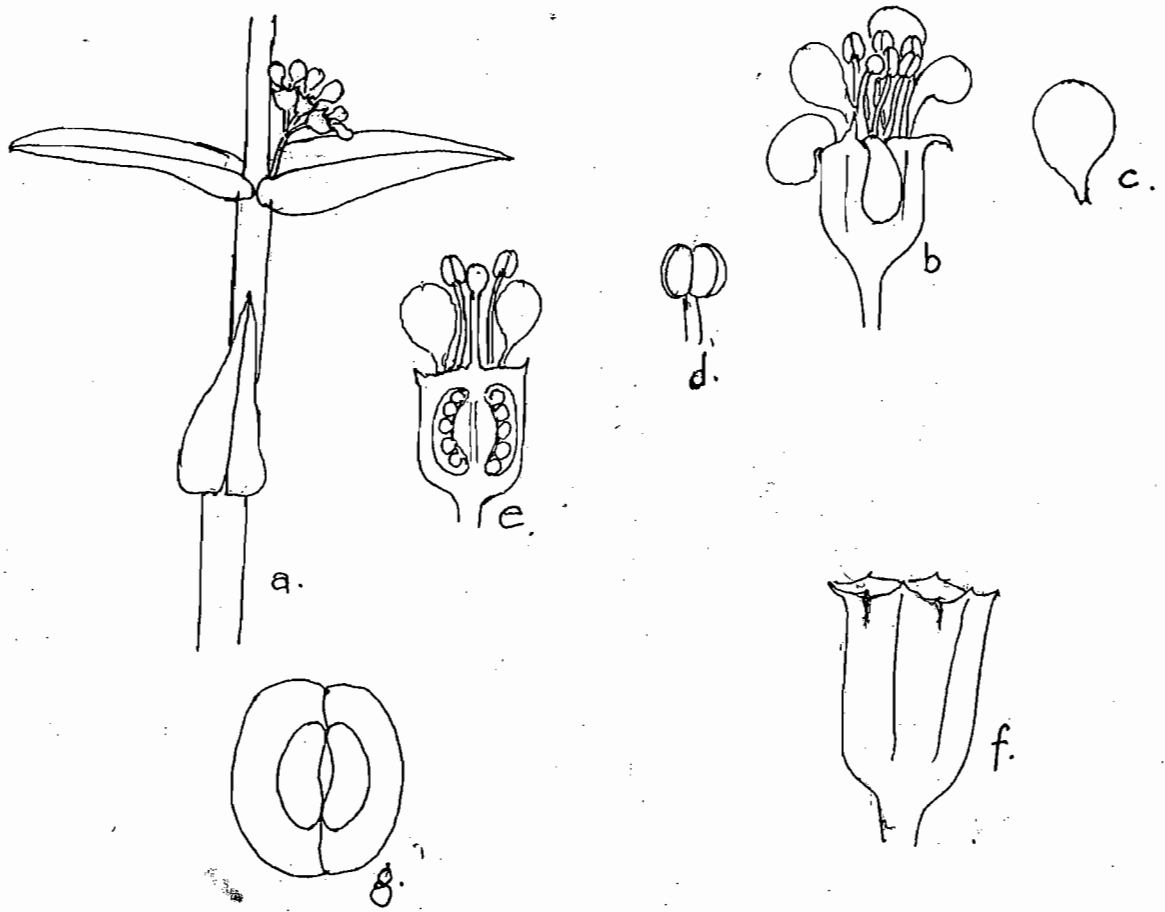


Fig. 200. *Ammania octandra* L. a. habit, b. flower, c. petal, d. stamen, e. L.S. of flower, f. calyx, g. paracytic stomata.

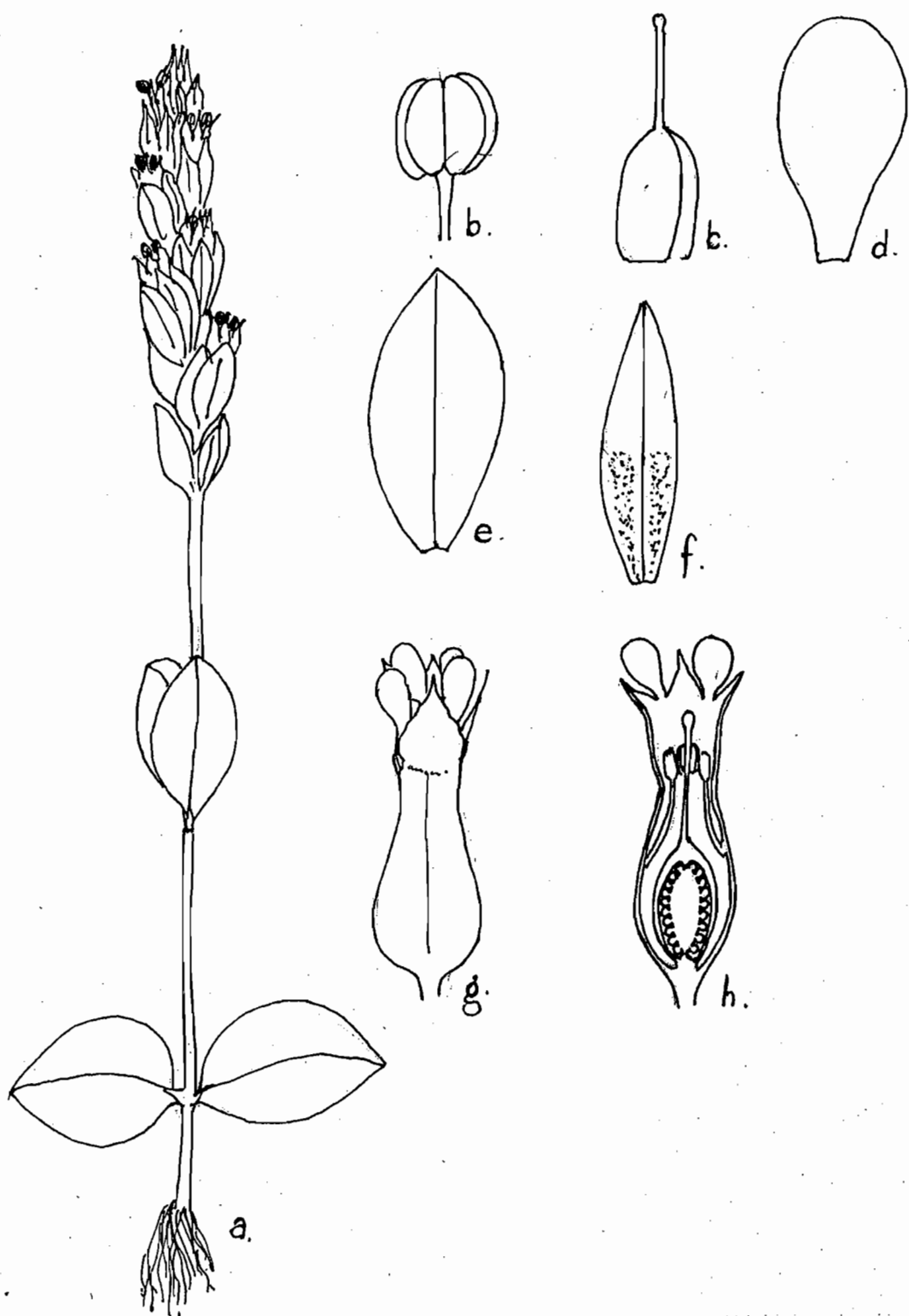


Fig. 201. *Ammania tenuis* Clarke a. habit, b. stamen, c. gynoecium, d. petal, e. bract, f. bracteole, g. flower, h. L.S. of flower.

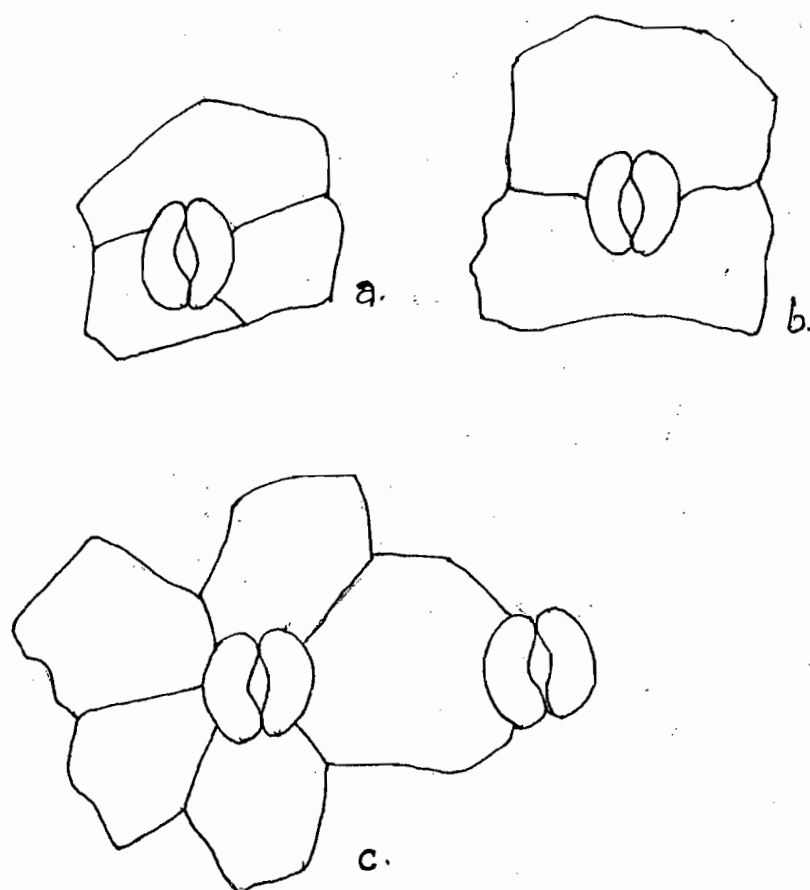


Fig. 202. *Ammania tenuis* Clarke a. anisocytic stomata, b. diacytic stomata, c. anomocytic stomata.

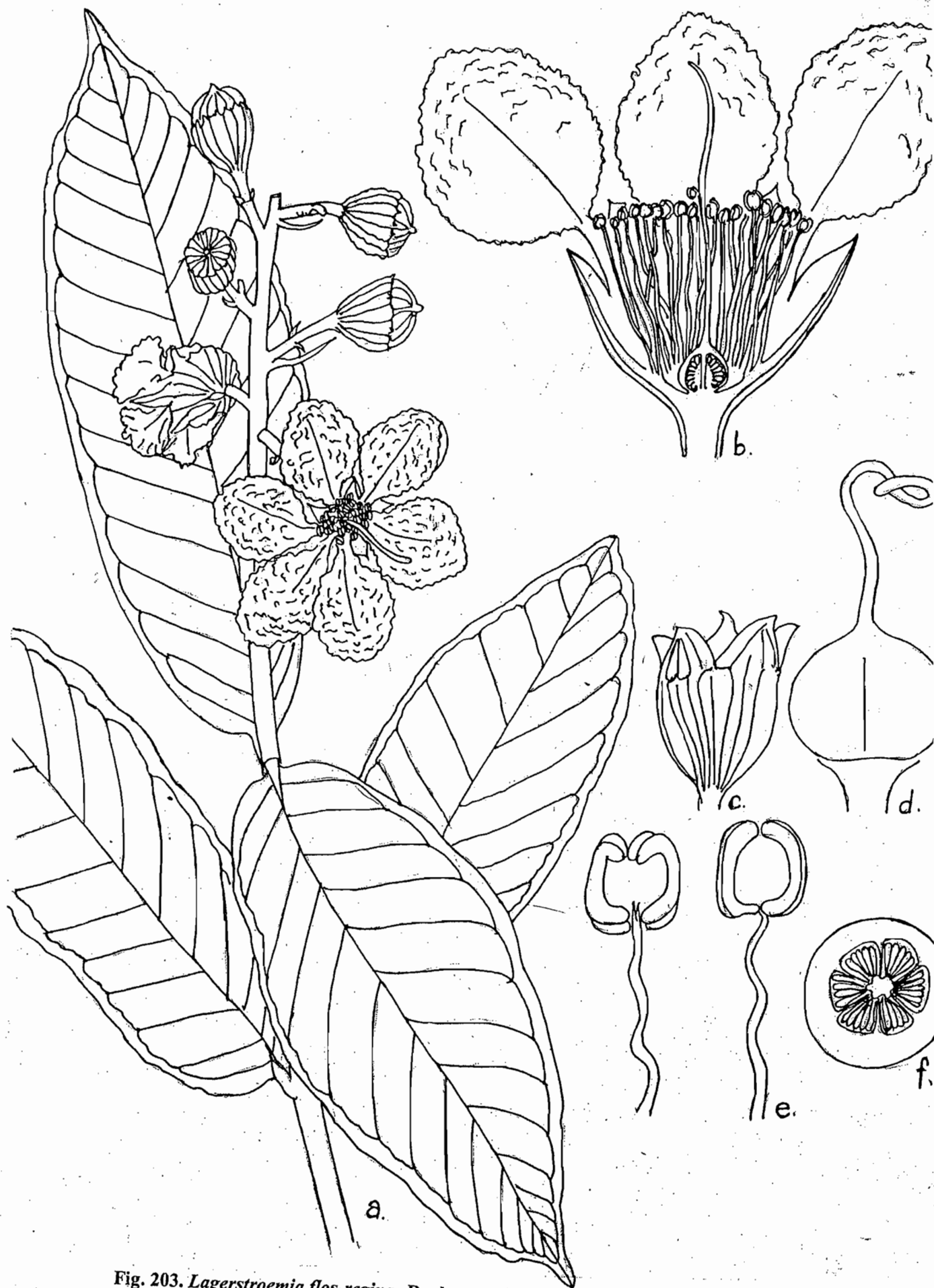


Fig. 203. *Lagerstroemia flos-reginae* Roxb. a. habit, b. L.S. of flower, c. calyx, d. gynoecium, e. stamen, f. T.S. of ovary.

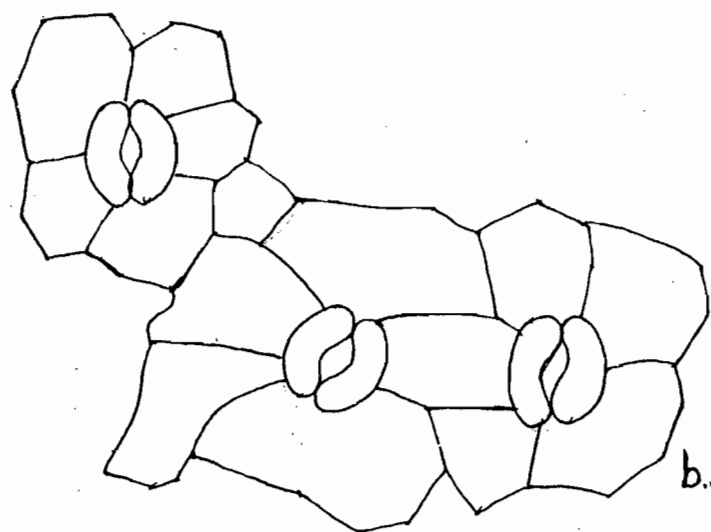
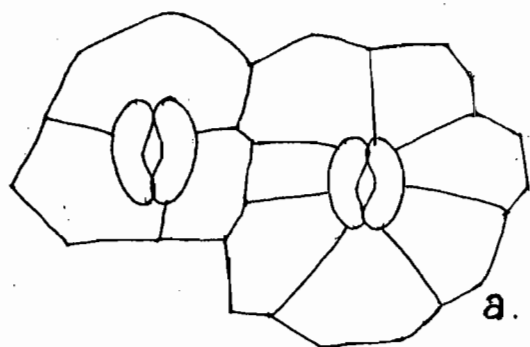


Fig. 204. *Lagerstroemia flos-reginae* Roxb. a. anisocytic and anomocytic stomata, b. anomocytic stomata.

5. *Lawsonia inermis* Linn. *Sp. Pl.* (1753) p. 349.

A glabrous much-branched shrub with lateral tetragonous branches, often ending in a spinous plant. Leaves upto 3.5 cm long, opposite, elliptic, acute, often mucronulate. Flowers numerous, white, in large terminal pyramidal panicle cymes; pedicles short, slender. Calyx-tube short, lobes 4, broadly campanulate; ovate, acute. Petals 4, very shortly clawed, suborbicular, undulate, inserted at the top of the calyx tube. Stamens 8, inserted on the calyx-tube in pairs opposite the calyx-lobes; anthers broadly oblong, the connective thick. Ovary subglobose, 2-4 celled; ovules many, placentas axile; style thick longer than the stamens; stigma capitate. Capsules globose. Seeds trigono-pyramidal. (Fig. 205)

Vernacular name: Mehendi.

Flowers: April-July.

Micromorphology (Fig. 206)

The plant was glabrous.

Stomata were anisocytic, and anomocytic types.

D/309, 617, 680, 654.

6. *Woodfordia floribunda* Salisb. *Parad. Lona* (1806) t. 42.

A straggling branched, pubescent, leafy shrub reaching 4 m high with smooth, cinnamon-brown bark. Leaves 8 cm long, subopposite, sometimes in whorls of 3; main nerves 6-12 pairs, arcuate, prominent beneath, uniting in a distinct intramarginal nerve. Flowers numerous, in short 2-15 flowered cymes from the axils of former; pedicels short, glandular-pubescent. Calyx upto 1 cm striate, covered with glandular dots, with a small campanulate base and a long slightly curved bright-red tube, mouth oblique; Seeds cuneate-obovoid, brown, smooth. (Fig. 207)

Vernacular name: Phul dhawadi

Flowers: December-May.

Micromorphology (Fig. 207)

The plant showed presence of unicellular, non-glandular, elongated trichome with blunt apex.

Stomata were of anomocytic types.

D/110.

Turneraceae

1. *Turnera ulmifolia* Linn. *Sp. Pl.* 271. 1753.

A stiff branched undershrub, upto 1 m tall. Leaves ovate-lanceolate, hairy, dentate-serrate, upto 15 cms. long, 9-10 pairs. Flowers solitary in terminal axils, bright yellow. Calyx densely appressed-pubescent, indistinctly gland-dotted; lobes lanceolate, acuminate. Petals obovate, clawed. Ovary ovoid with small apical tubercles, 3 style. Capsules ovoid, thick-walled, 3-valved. Seeds cylindric-clavate. (Fig. 208)

Flowers: September – December.



Fig. 205. *Lawsonia inermis* L. a. habit, b. gynoecium, c. stamen, d. L.S. of flower.

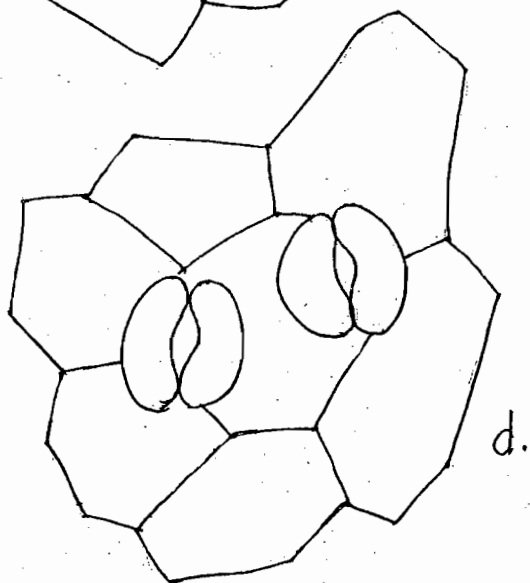
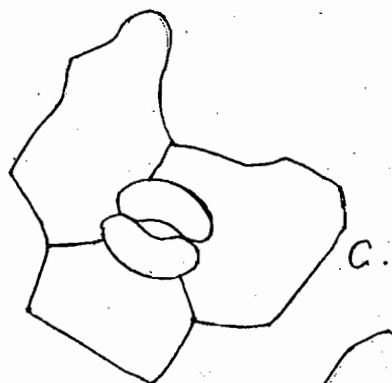
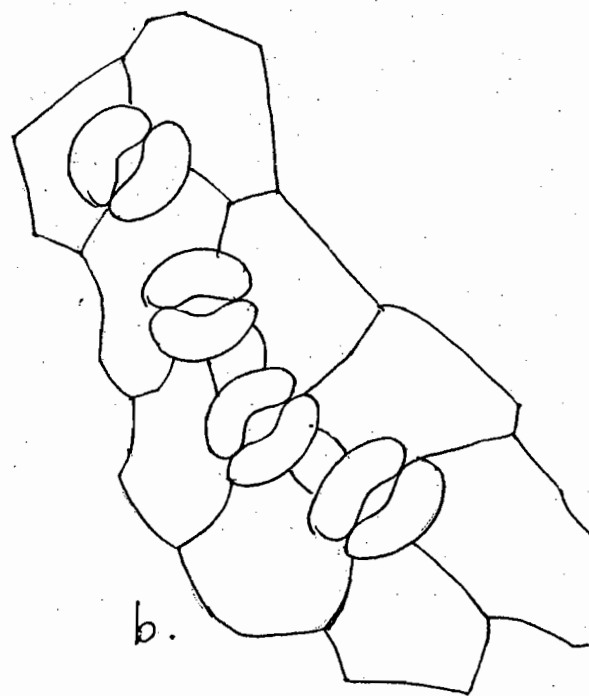
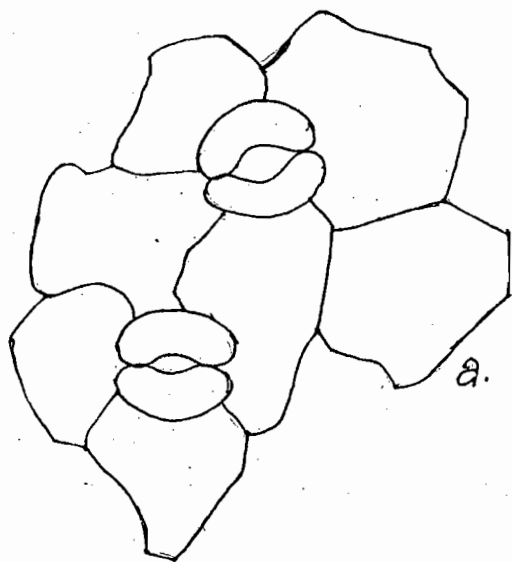


Fig. 206. *Lawsonia inermis* L. a, b and d. anomocytic stomata, c. anisocytic stomata.

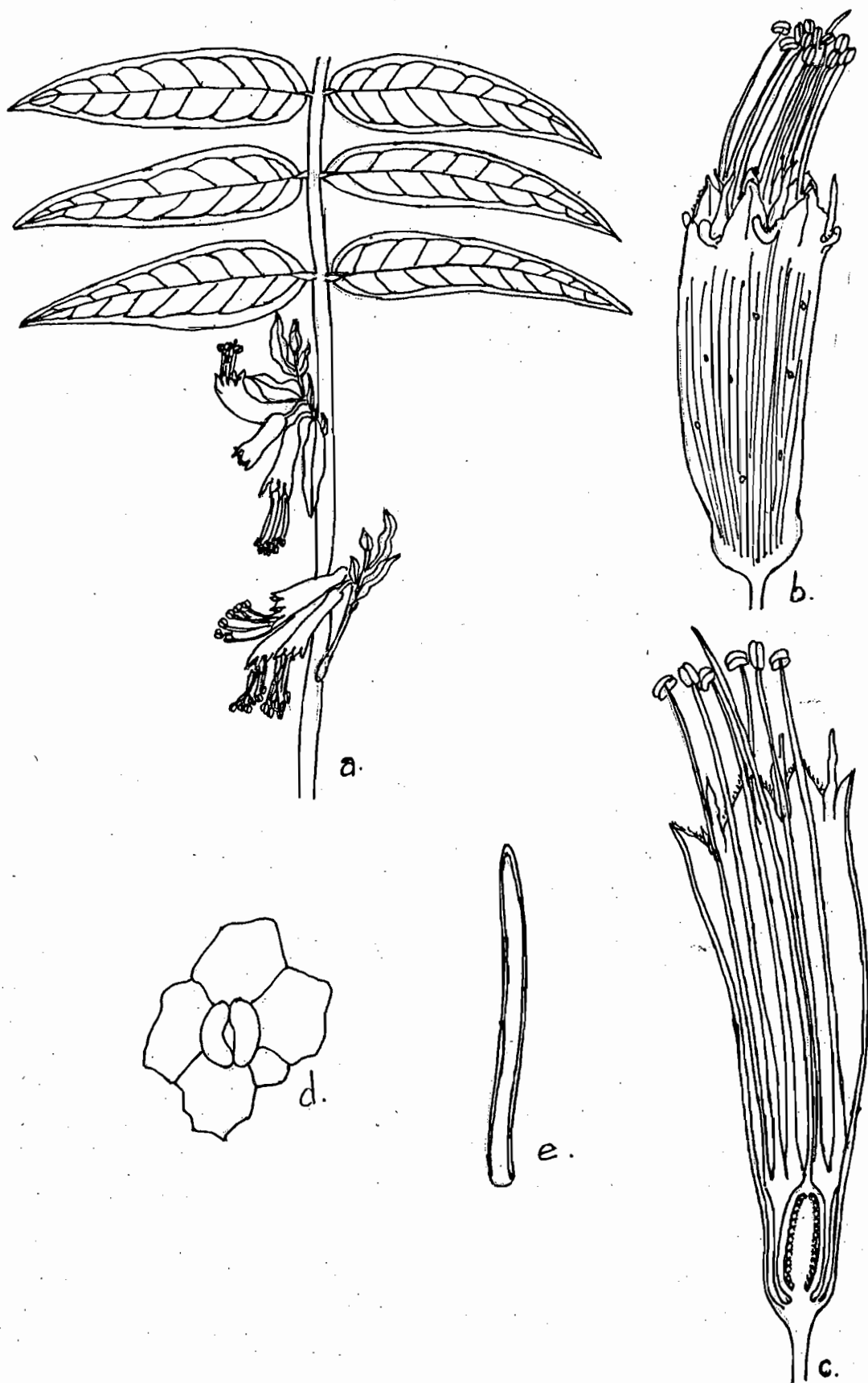


Fig 207. *Woodfordia floribunda* Salisb. a. habit, b. flower, c. L.S. of flower, d. anomocytic stomata, e. unicellular trichome with thin wall and broad lumen.

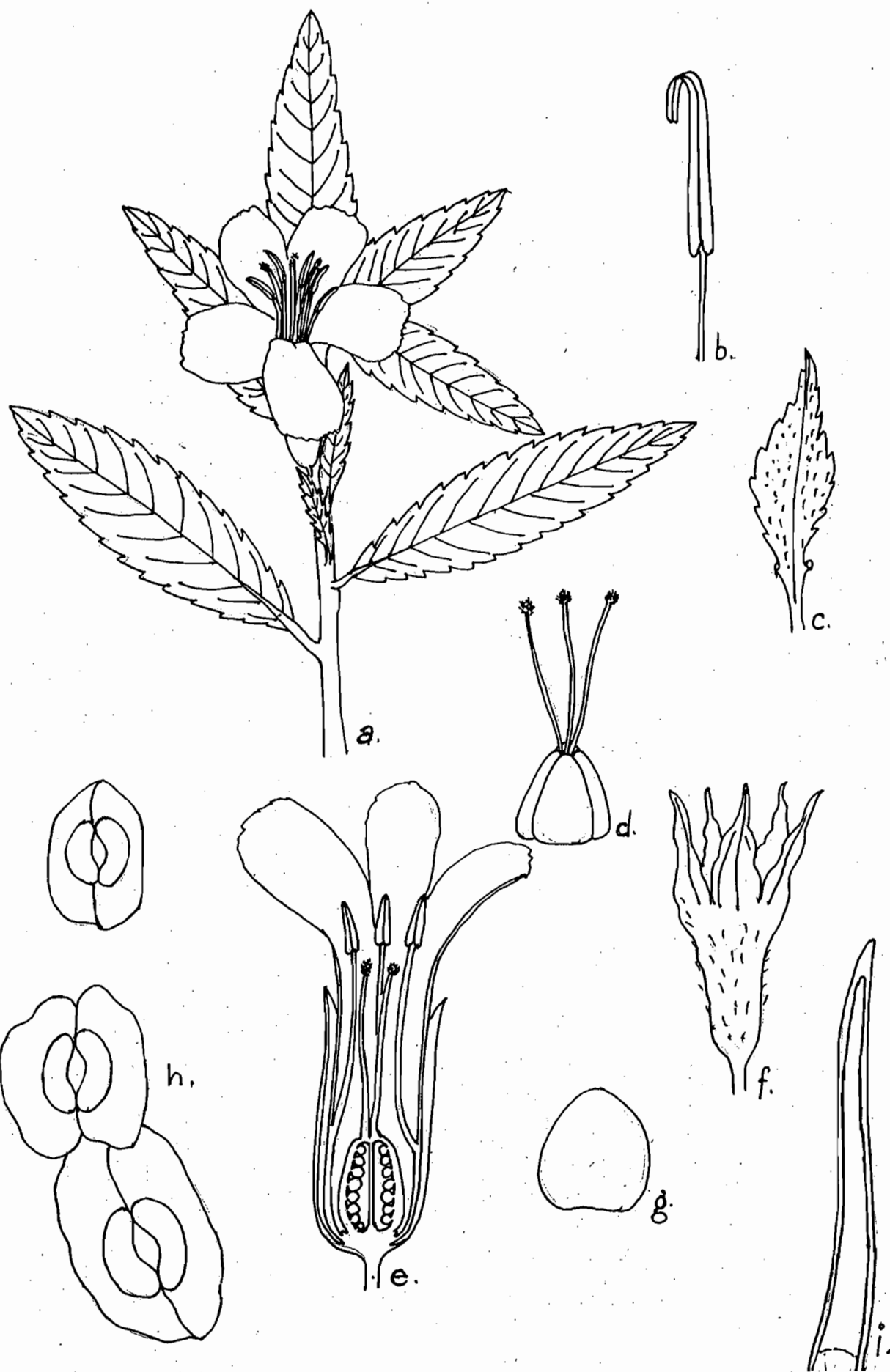


Fig. 208. *Turnera ulmifolia* L. a. habit, b. stamen, c. bract, d. gynoecium, e. L.S. of flower, f. calyx, g. capsule, h. paracytic stomata, i. unicellular trichome with thick wall and broad lumen.

Micromorphology (Fig. 208)

The plant showed presence of unicellular, non-glandular, elongated trichome with blunt apex.

Stomata were of paracytic types.

D/657.

Onagraceae

1. *Jussiaea repens* Linn. *Sp. Pl.* (1753) p. 388.

An aquatic floating, erect herb with stem rooting at the nodes and sustained by means of white spongy bodies which projects in tufts from each side of the base of the petioles and may be modified stipules. Leaves 5 cm, oblanceolate, rounded at the apex, glabrous, much narrowed into the petiole; main nerves 6-10 pairs, slender, nearly straight or slightly curved upwards; petioles very short. Flowers pale-yellow or white. Calyx- tube cylindric; lobes 5, lanceolate. Petals 5, shortly clawed, obovate, obtuse, sometimes retuse. Stamens 10. Capsules upto 4 cm long, cylindric. (Fig. 209)

Flowers: November-December.

Micromorphology (Fig. 210)

The plant showed presence of unicellular, elongated trichome.

Stomata were of anisocytic and anomocytic types.

D/1169-1172.

2. *Ludwigia parviflora* Roxb. *Hort. Beng.* (1814) p. 11.

An erect branched glabrous herb reaching upto 60 cm high with angular stem. Leaves upto 8 cm long, linear-lanceolate; petioles obscure. Flowers small, solitary, axillary; pedicels very short. Calyx-tube subcylindric, lobes 4, ovate, acute. Petals 4, elliptic-oblong. Stamens 4, inserted with petals; filaments short. Ovary 4-celled; ovules numerous, attached in 2 or more vertical rows to the inner angle of each cell, style short, stout. Capsule obsoletely 4-angled, smooth, crowned for a time by the subpersistent calyx-lobes, breaking away from the ribs. Seeds very numerous, minute, ellipsoid, yellowish-brown, polished. (Fig. 211)

Vernacular name: Panlavang.

Flowers: May-November.

Micromorphology (Fig. 212)

The whole plant was glabrous.

Stomata were anomocytic.

D/565, 566.

Passifloraceae

1. *Passiflora foetida* Linn., *Sp.Pl.* 959. (1753).

An annual or perennial climber with stem and branches softly hispid and bears tendril. Leaves with upto 7 cm long, hispid; broad ovate, cordate or subcordate, shallowly 3-

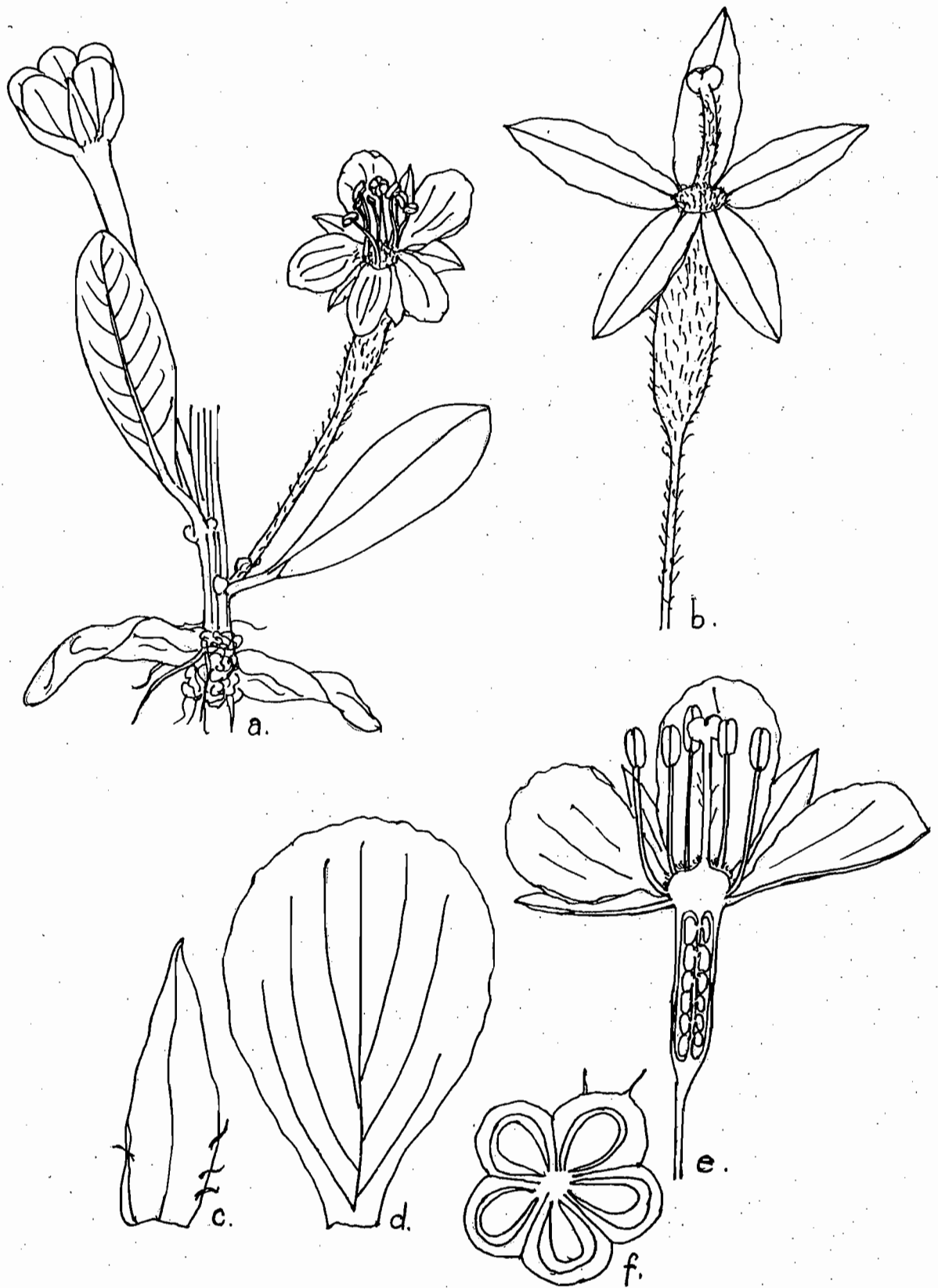


Fig. 209. *Jussiaea repens* L. a. habit, b. flower, c. bract, d. petal, e. L.S. of flower.

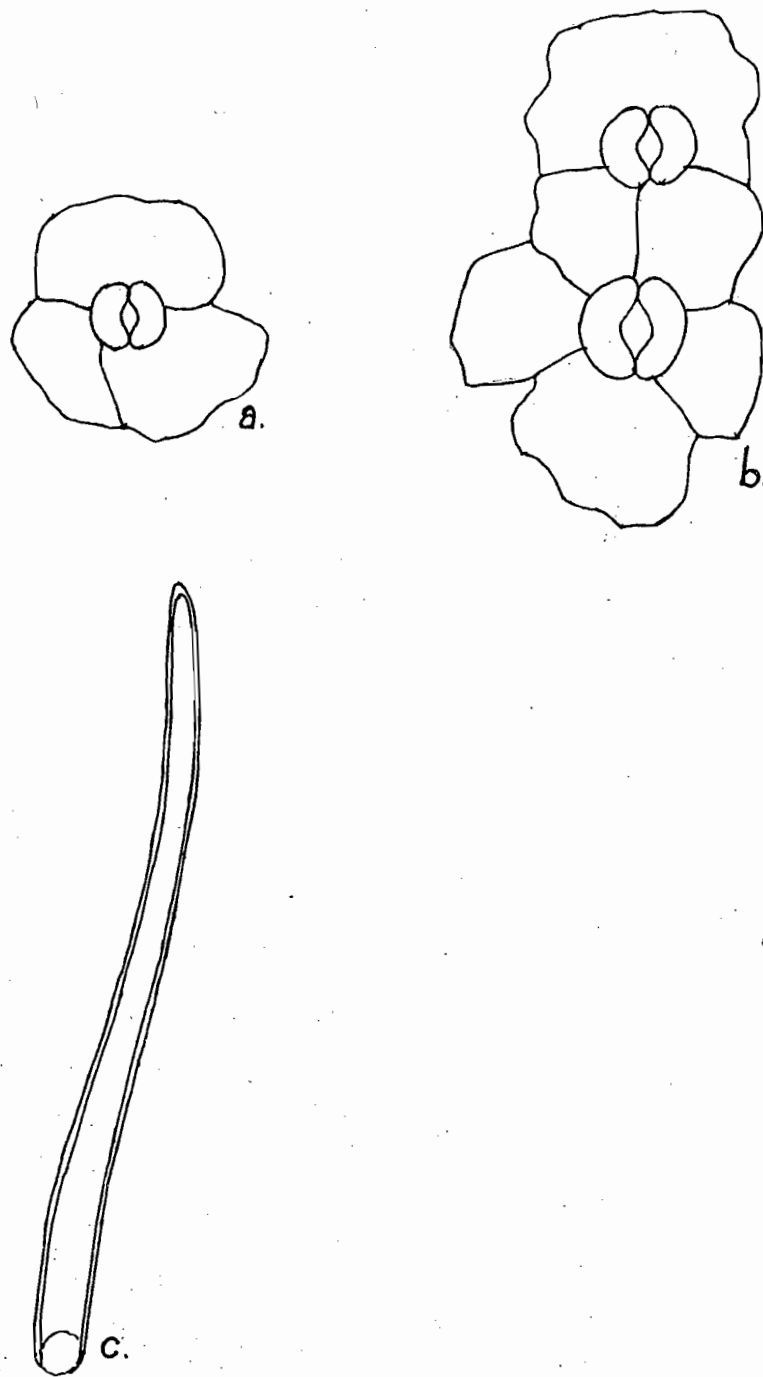


Fig 210. *Jussiaea repens* L. a. anisocytic stomata, b. anomocytic stomata, c. unicellular trichome.

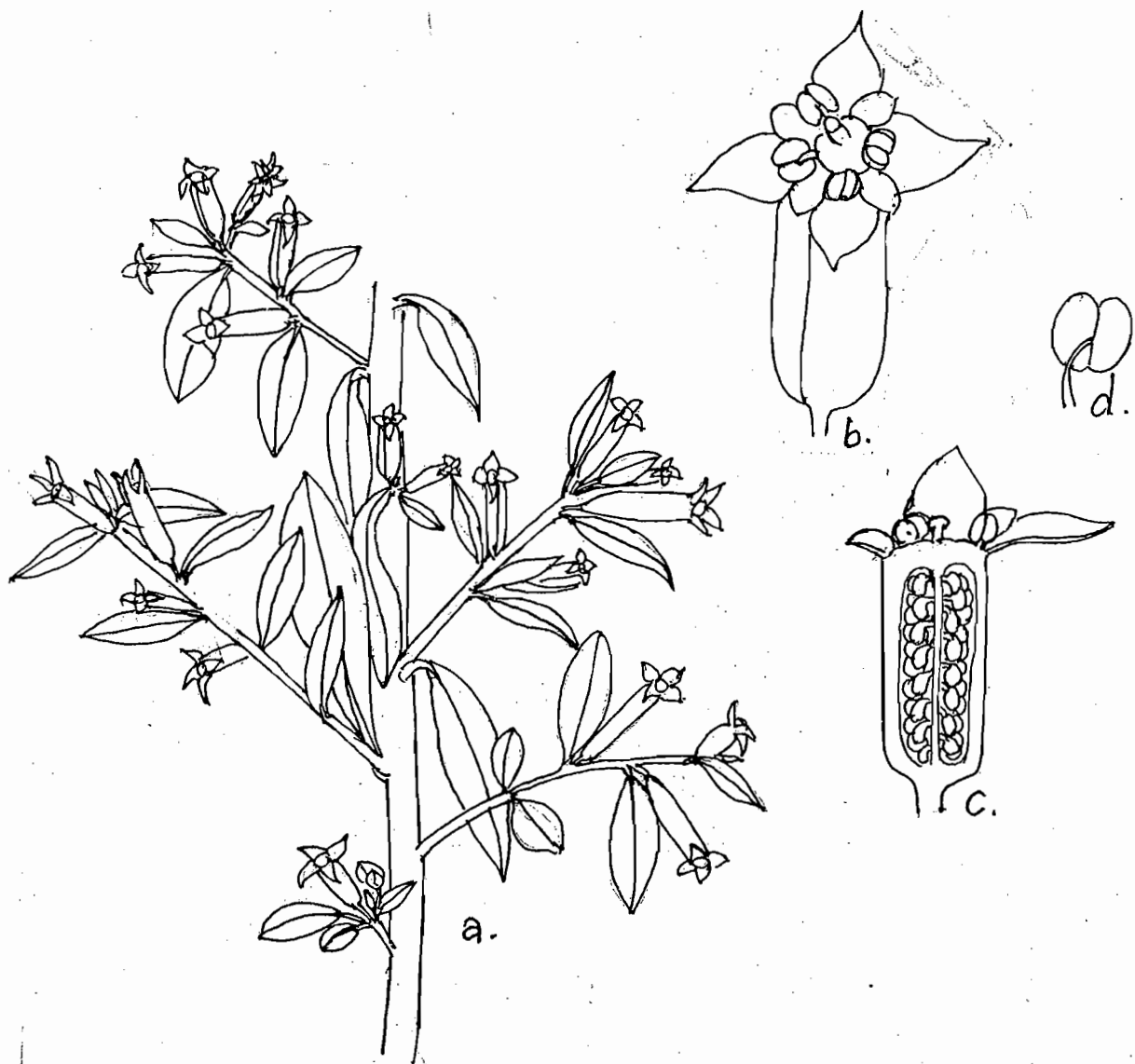


Fig. 211. *Ludwigia parviflora* Roxb. a. habit, b. flower, c. L.S. of flower, d. stamen.

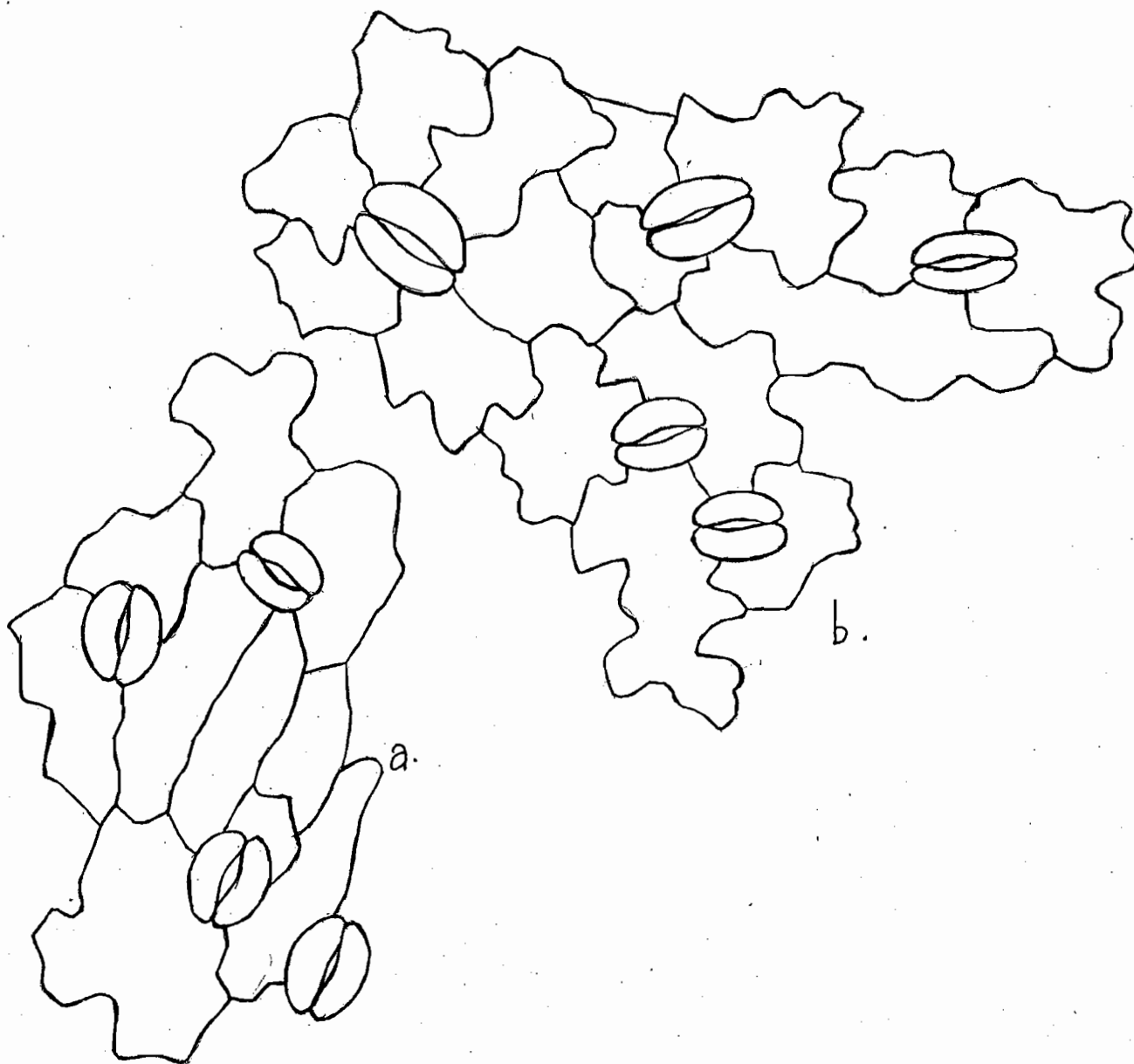


Fig. 212. *Ludwigia parviflora* Roxb. a-b. anomocytic stomata.

lobed, lobes acute, with ciliate margins; stipules falcate, tripinnatisect, with gland tipped segments. Flowers solitary axillary, on up to 4 cm long peduncle; bracts deeply tripinnatisect, segments filiform, gland tipped; hypanthium urceolate. Sepals 5, oblong, 2-2.5 cm long, white within, pale green without. Petals 5, oblong, obtuse, mucronate, white. Corona multiseriate, purple to bluish purple. Stamens 5; anthers greenish yellow. Ovary globose, somewhat pilose; styles clavate. Fruit ovoid-globose, orange yellow, enclosed by enlarged bracts. (Fig. 213)

Vernacular name: Krishnakamal.

Flowers: July-August.

Micromorphology (Fig. 214)

Whole plant was glabrous, but the corona was multicellular, glandular and differentiated into a multicellular distinct head and a multicellular stalk.

Stomata were of anomocytic types.

D/755, 837, 838.

Cucurbitaceae

**1. *Benincasa hispida* (Thunb.) Cogn. in DC. *Monog. Phan.* 3: 513. 1881.
(*Cucurbita hispida* Thunb.)**

A branched, annual climber. Leaves upto 25 cm in diameter, reniform to rounded, deeply cordate, 5-7 lobed, scabrous above, shortly hispid beneath, margin sinuate, dentate; petioles hirsute, upto 20 cms. long; tendrils slender. Male peduncles 15 cm long; female peduncles upto 4 cm long. Calyx-tube densely villose, lobes lanceolate. Petals obtuse, mucronate. Filaments hispid; anthers subtrilobate. Ovary ovoid or cylindric, softly hairy. Fruits fleshy, hairy when young, waxy bloom when mature; seeds compressed, ovoid, yellowish-white. (Fig. 215)

Vernacular name: Karkotika.

Flowers: June-October.

Micromorphology (Fig. 216)

Both glandular and non-glandular trichomes are present in this plant; the glands were multicellular differentiated into multicellular head and uniseriate stalk, the non-glandular trichomes were uniseriate with some of the trichomes having cells arranged at right angles to the previous ones.

Stomata were anomocytic and tetracytic types.

D/964, 965.

2. *Citrullus colocynthis* (Linn.) Schrad. in *Linnaea*. 12:414. 1838.

A perennial trailing herb with stems shortly hairy. Tendrils simple, rarely bifid, slender, glabrous. Leaf elongate-ovate upto 6 cm long, palmately deeply 3-5-lobed; petiolate. Male flowers on long pedicels; calyx campanulate; corolla pale yellow, ovate-acute; female flowers on longer pedicels than male. Ovary subglobose or obovate. Fruit on long stalk, globose, smooth, longitudinally green striped, 5-7 cm in diameter, eipcarp thin, filled with a dry spongy very bitter pulp. Seeds numerous, ovate-oblong, yellowish brown. (Fig. 217)

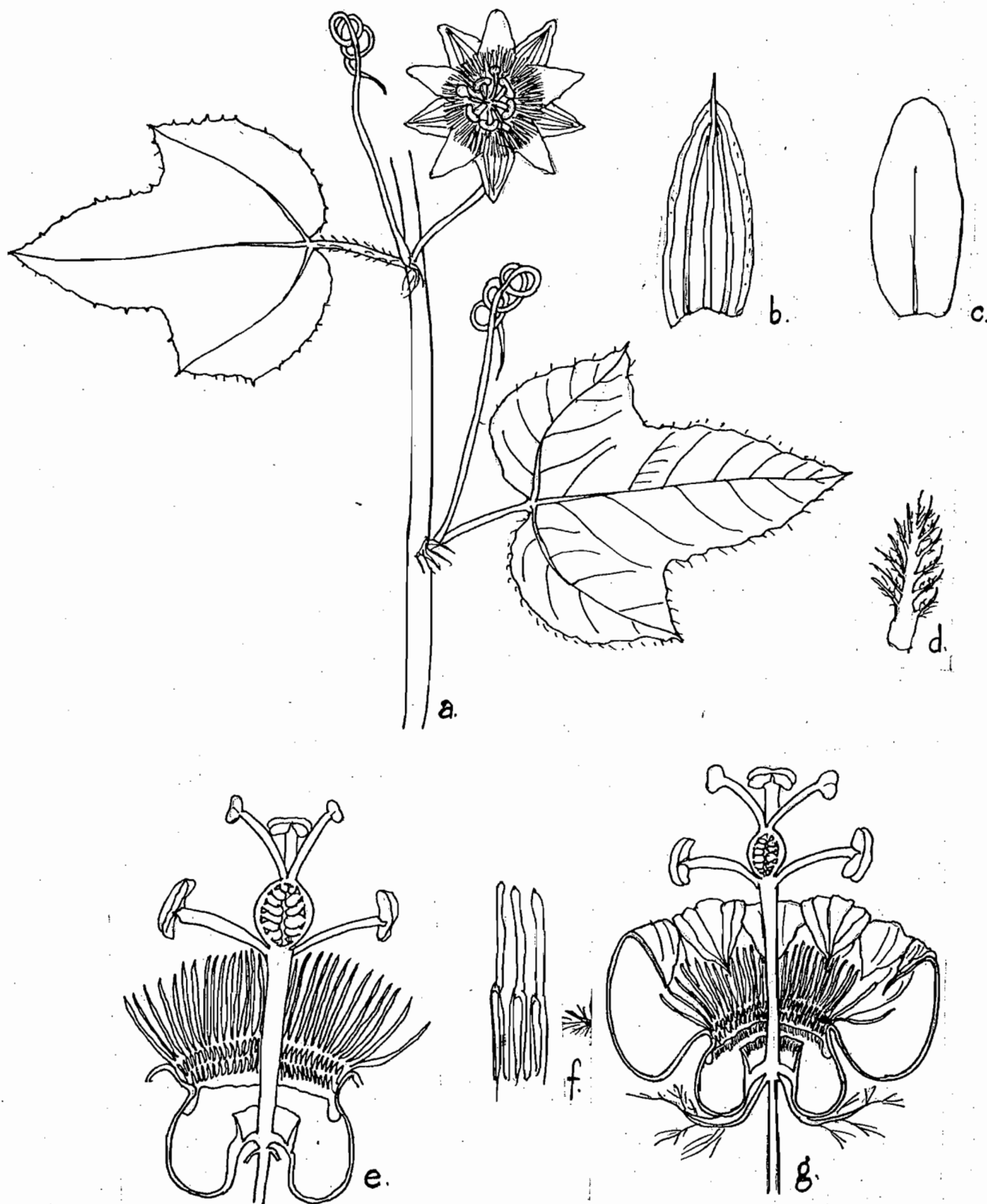


Fig. 213. *Passiflora foetida* L. a. habit, b. sepal, c. petal, d. stipule, e. L.S. of corona with gynoecium, f. enlarged corona, g. L.S. of flower.

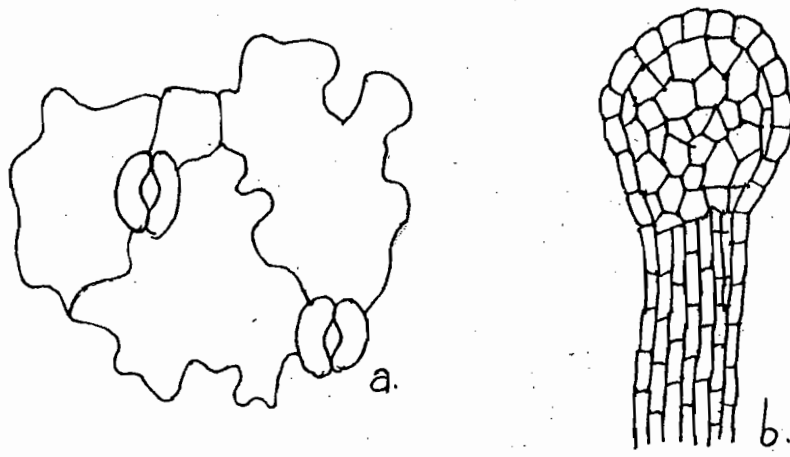


Fig. 214. *Passiflora foetida* L. a. anomocytic stomata, b. Glandular multicellular trichome differentiated into multicellular head and multiseriate stalk.

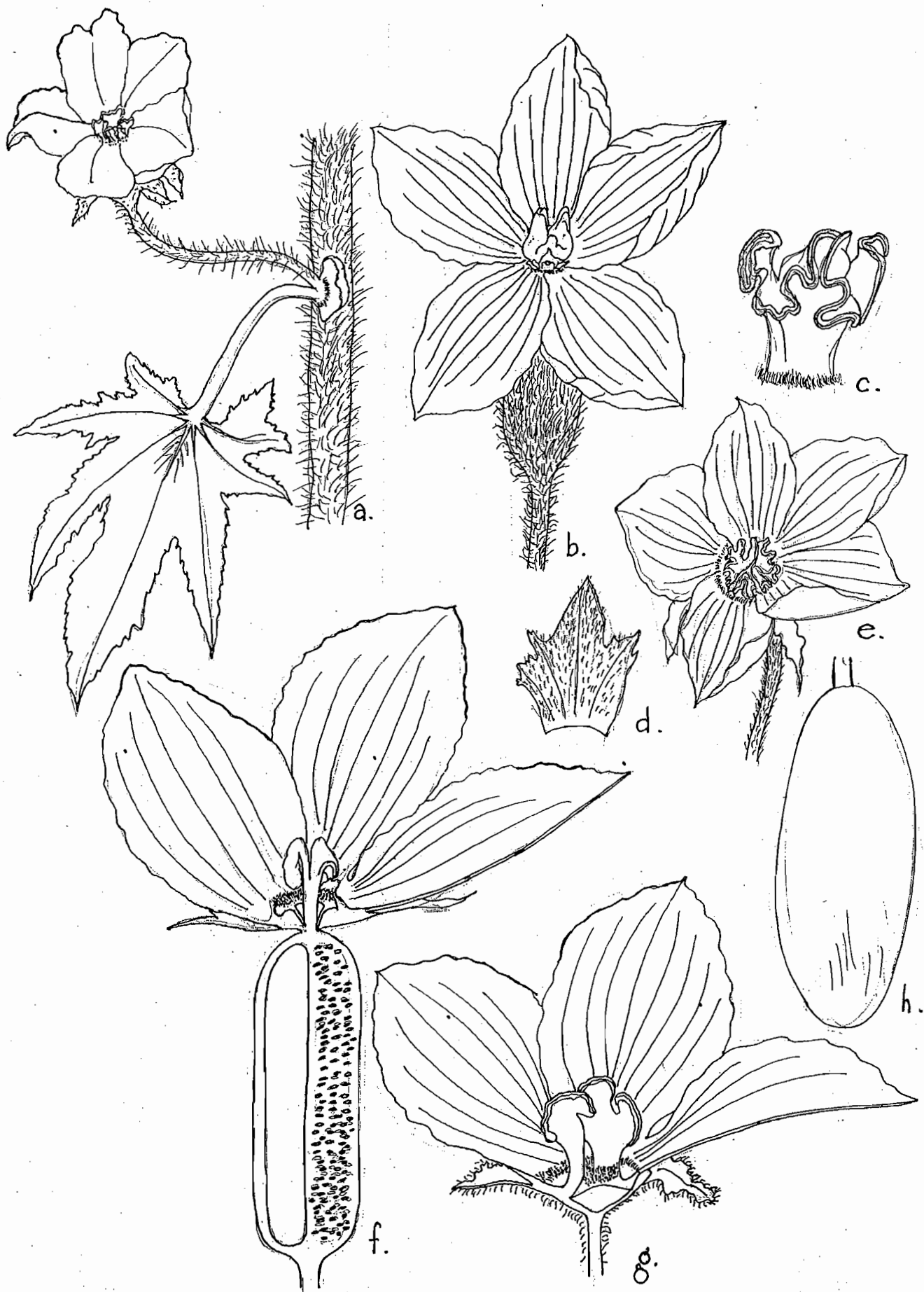


Fig. 215. *Benincasa hispida* Cogn. a. habit, b. female flower, c. synandrous stamen, d. bract, e. male flower, f. L.S. of female flower, g. L.S. of male flower, h. fruit.

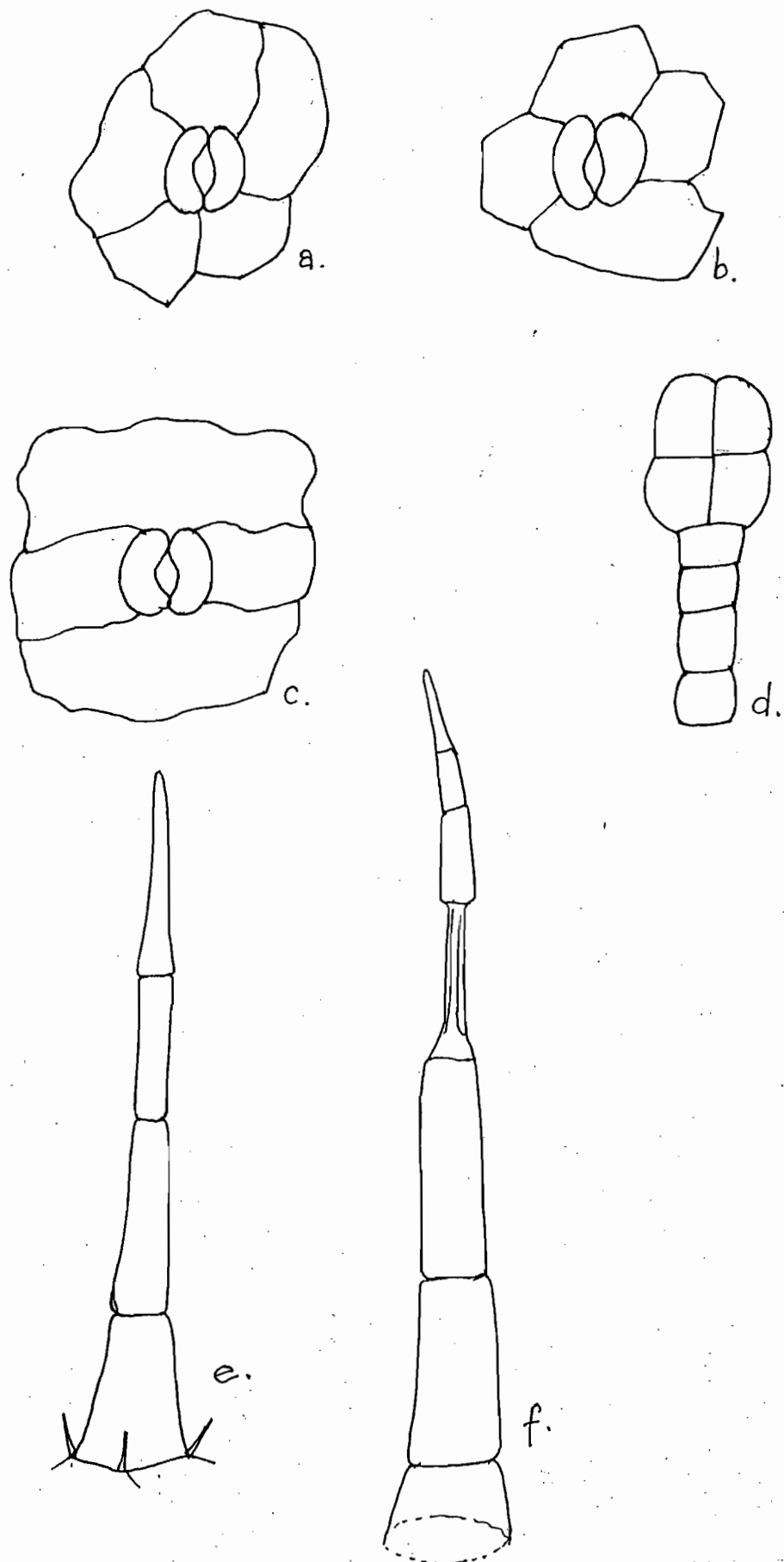


Fig. 216. *Benincasa hispida* Cogn. a. anomocytic stomata, b. anomocytic stomata, c. tetracytic stomata d. glandular multicellular trichome differentiated into multicellular head and multicellular uniseriate stalk e. multicellular uniseriate trichome f. multicellular uniseriate trichome interrupted with cells situated perpendicular to the adjacent cells.

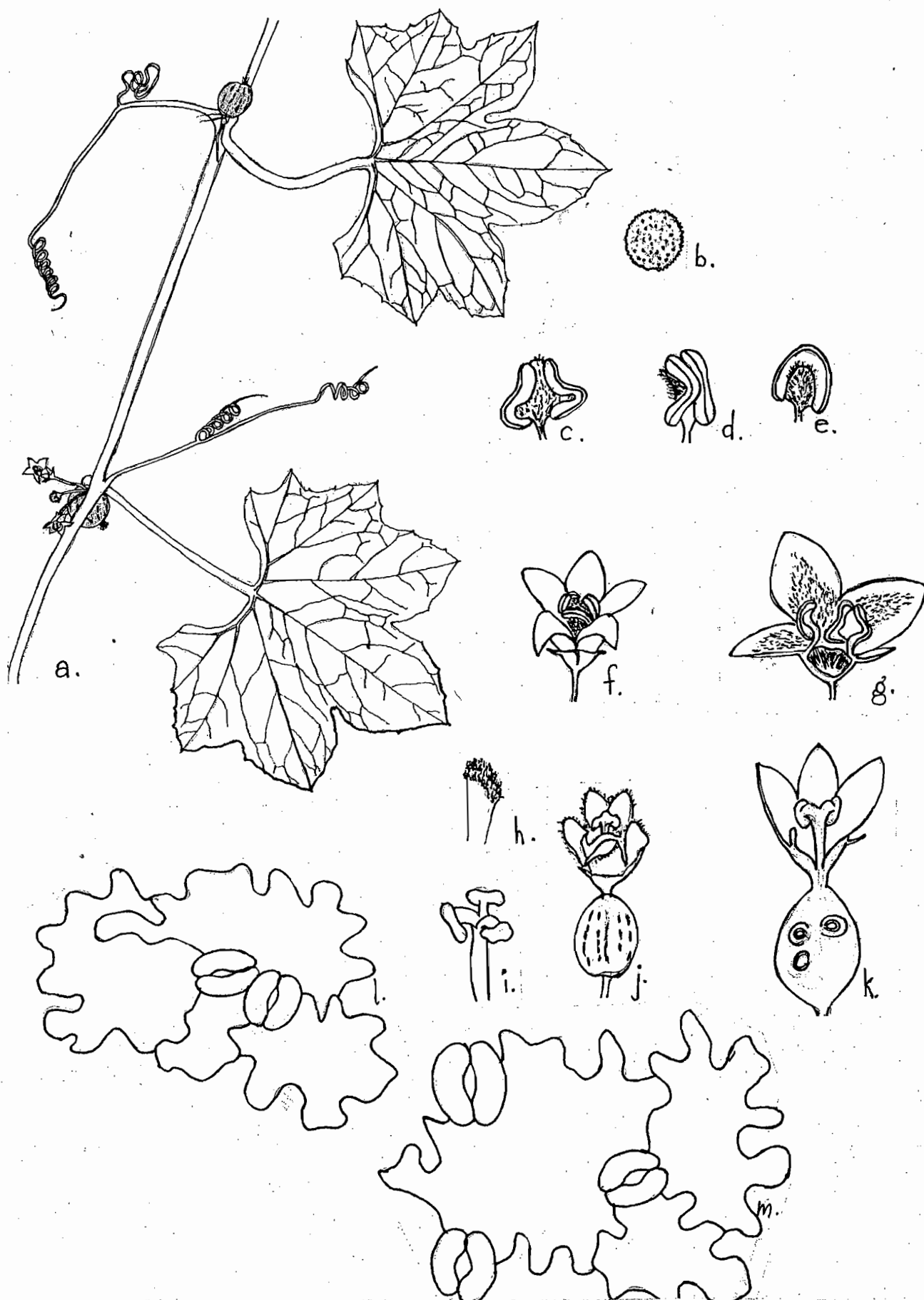


Fig. 217. *Citrullus colocynthis* Schrad. a. habit b. seed c, d, and e. stamen, f. male flower, g. L.S. of flower, h. staminode, i. stigma and style, j. female flower, k. L.S. of female flower, l and m. anomocytic stomata.

Vernacular name: Indravarna.

Flowers: January-April.

Micromorphology (Fig. 217)

Leaves were glabrous.

Stomata were anomocytic.

D/229

3. *Cucumis sativus* Linn. *Sp.Pl.* 1012. 1753.

An annual trailing hispid herb with angled stem angled. Leaves angular or slightly 3-5 lobed, cordate, hispid, lobes triangular, acute or acuminate, dentate. Flowers yellow. Male flowers clustered, hypanthium tubular or campanulate with long white hairs; sepals linear, spreading; filaments short, anthers cohering, connective crested. Female flowers solitary, hypanthium with oblanceolate sepals, hairy. Fruits oblong, cylindric, yellowish-green; seeds numerous, white. (Fig. 218)

Vernacular name: Kakdi.

Flowers: May-September.

Micromorphology (Fig. 219)

There were two types of trichomes; 1) unicellular conical arising from a group of basal cells, 2) uniseriate trichome with a thick warty wall.

Stomata were anomocytic and anisocytic types.

D/121.

4. *Melothria maderaspatana* (L.) Cogn. in DC. *Monogr. Phan.* 3: 623.

A slender scandent monoecious, herb with hispid, furrowed, slightly branched hairy stem. Tendrils simple. Leaves upto 8 cm, broadly ovate, acute, scabrid and coarsely hairy above, soft villous beneath, usually 5-angled or slightly 3-5 lobed, strongly dentate; petioles upto 5 cms. long, densely hairy. Flowers axillary. Male flowers fascicled; peduncles very short. Calyx campanulate; teeth linear-subulate. Corolla segments ovate-oblong. Stamens 3, inserted on the tube of the calyx; filaments free; anthers subsessile, oblong, the connective short, apiculate. Female flowers: peduncles usually solitary. Ovary densely hairy. Fruit globose. Seeds ellipsoid, turgid, smooth on the faces. (Fig. 220)

Vernacular name: Chana chibhadi.

Flowers: July-August.

Micromorphology (Fig. 220)

The trichomes located were all uniseriate with a warty wall, while others had a smooth wall.

Stomata were of anomocytic types.

D/1230, 1148, 1163.

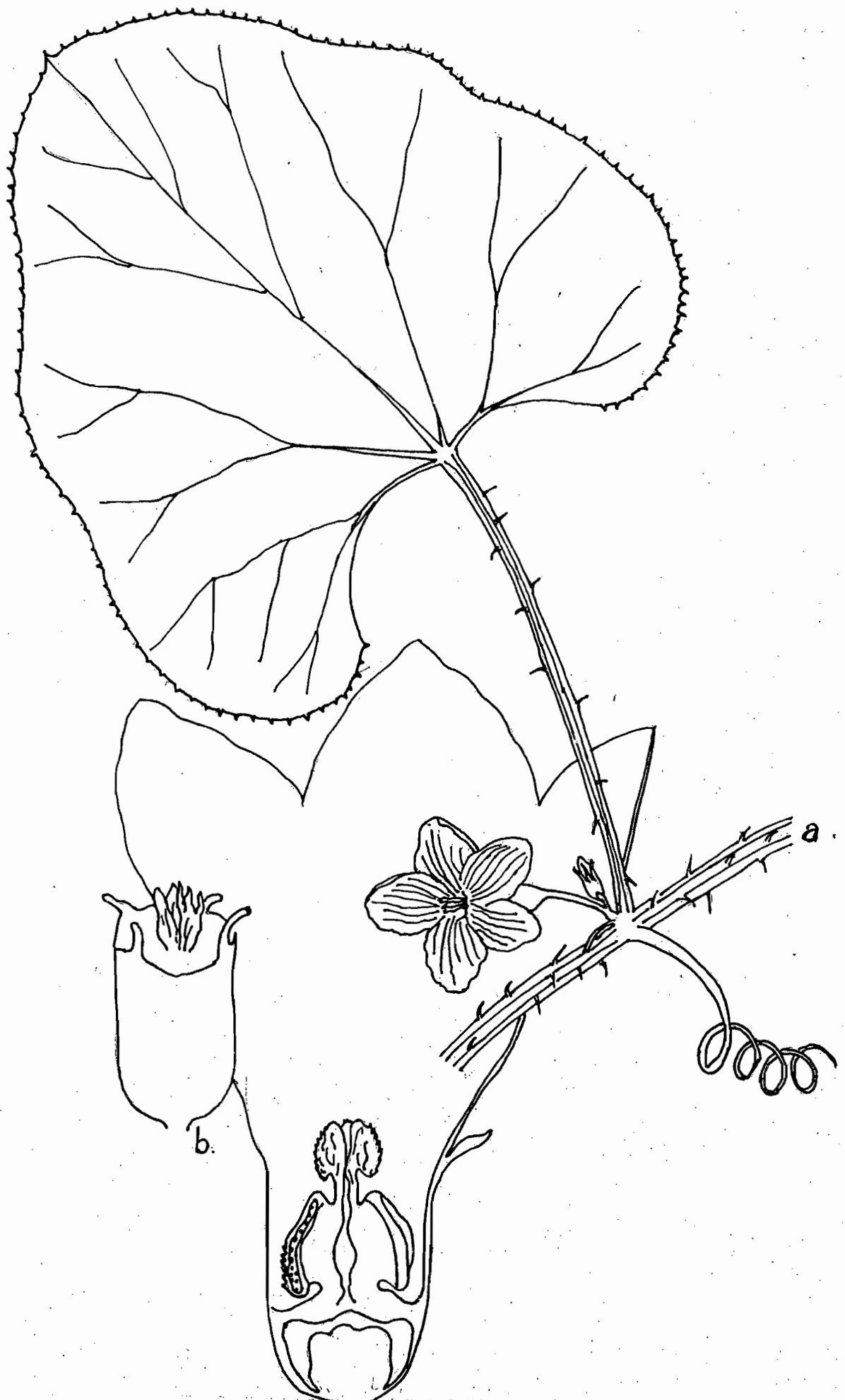


Fig. 218. *Cucumis sativus* L. a. habit, b. calyx, c. L.S. of male flower.

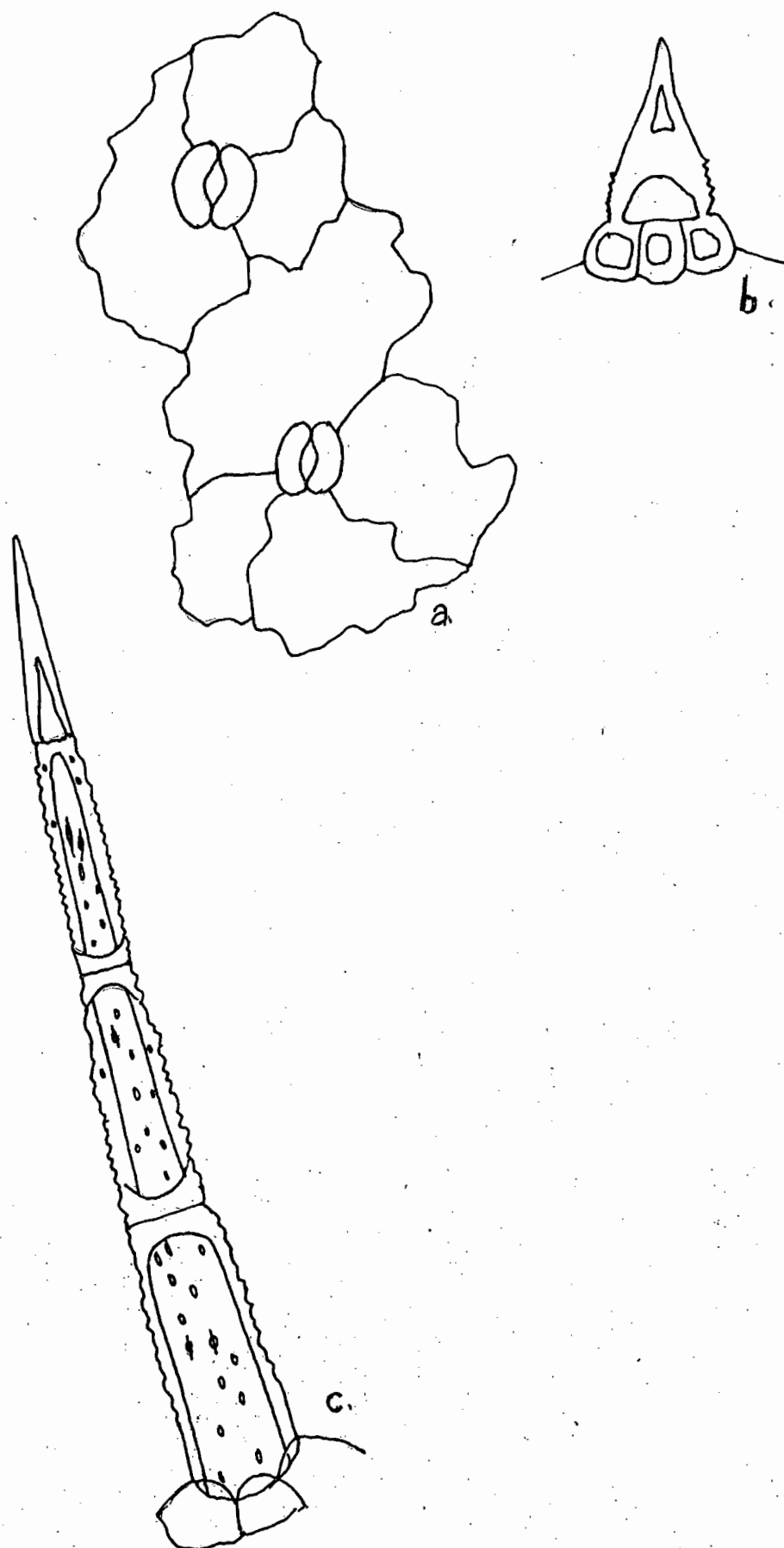


Fig. 219. *Cucumis sativus* L. a. anomocytic stomata and anisocytic stomata, b. unicellular conical trichome with subsidiary cells, c. multicellular uniseriate trichome with warty wall.

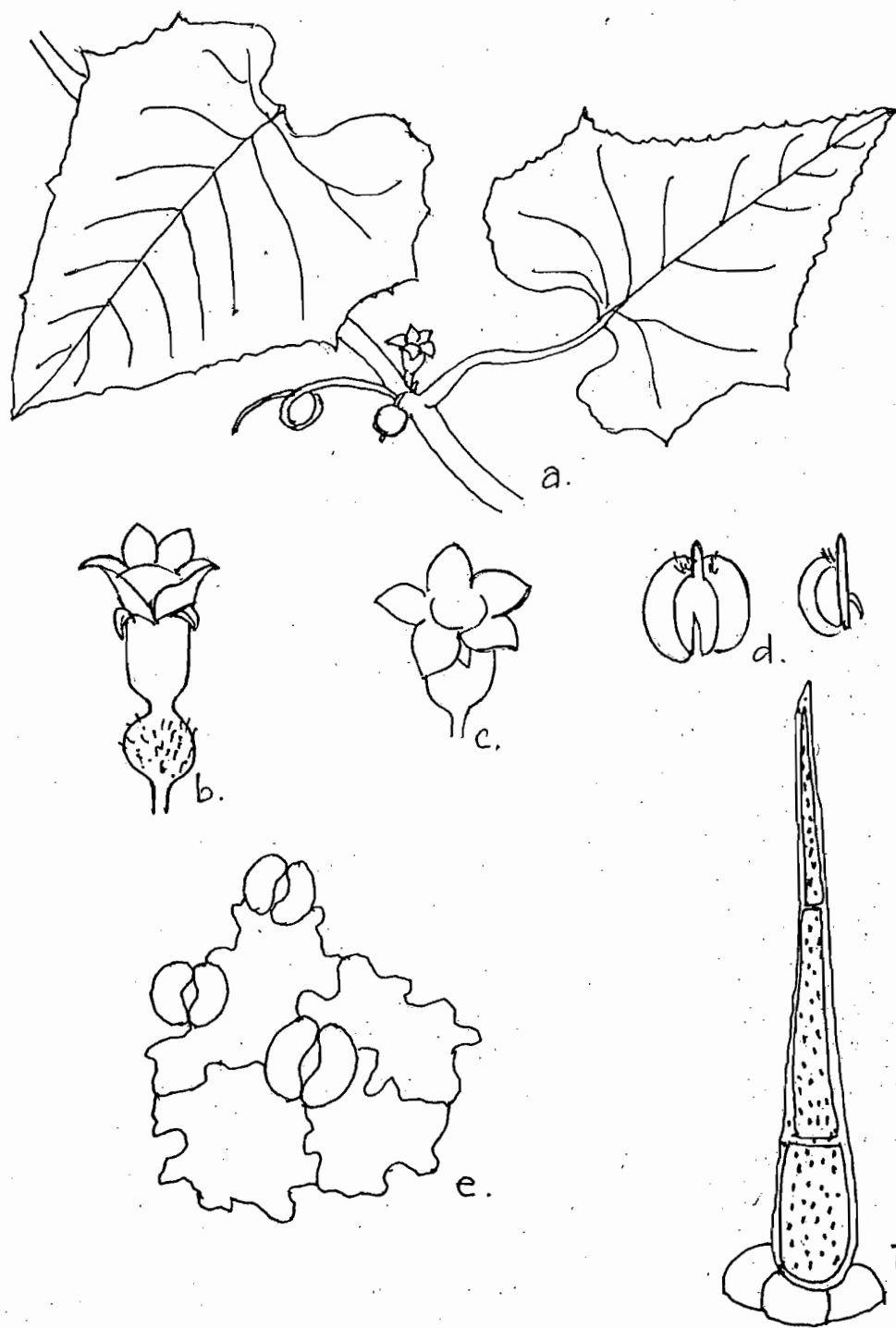


Fig. 220. *Melothria maderaspatana* Cogn. a. habit, b. female flower, c. male flower, d. stamen, e. anomocytic stomata, f. multicellular uniseriate trichome with warty wall.

5. *Momordica charantia* Linn. *Sp. Pl.* (1753) p. 1009.

An much branched annual with stem 2.5 m long with stem grooved, angled and hairy. Tendrils simple, slender, elongate, pubescent. Leaves almost orbicular, upto 14 cm in diameter, pubescent, cordate at the base, deeply divided into 5-7 lobes, lobes apiculate, coarsely spinous-dentate; petioles upto 5 cm long, channeled, pubescent. Flowers monoecious. Male flowers solitary; peduncles furnished with a large reniform or orbicular bract at or below the middle. Calyx lobes elliptic, subacute. Corolla somewhat irregular, lemon-yellow; segments obtuse or emarginated. Stamens 3, inserted on the mouth of the calyx -tube; filaments short, free; anthers at first cohering, at length free, one 1-celled; the others 2-celled, the cells flexuose. Female flowers: Peduncles bracteate. Staminodes 3, glanduliform. Ovary fusiform, muricated; stigmas 3, bifid. Fruit bright orange-colored, upto 15 cm long, pendulous, fusiform, usually pointed or beaked, ribbed, and bearing numerous triangular tubercles. Seeds compressed, corrugate on the margin. (Fig. 221)

Vernacular name: Karela.

Flowers: May-August.

Micromorphology (Fig. 221)

The trichomes located were all uniseriate but some of them had a warty wall, while others had a smooth wall.

Stomata were of anomocytic types.

D/497.

6. *Trichosanthes cucumerina* Linn. *Sp. Pl.* (1753) p. 1008.

An annual branched monoecious climber with stems 4-5 m long, slender, furrowed, slightly hairy, leafy. Tendrils 2-3 (usually 3-) fid. Leaves upto 13 cm long, orbicular-reniform, distantly denticulate, more or less deeply 5-lobed, the lobes broad, acute, more or less pubescent beneath, base deeply cordate. Male flowers in axillary racemes; peduncles of the racemes upto 15 cm long, slender, striate, bearing 8-15 flowers near the apex. Calyx-tube dilated at the apex, teeth short, acutely triangular. Petals white, 1 cm long, lanceolate-oblong. Female flowers axillary, solitary; peduncles of female flowers 1 cm long. Stamens 3, inserted in the calyx-tube; filaments very short; Fruit 3-8 cm long, ovoid-fusiform, scarlet when ripe. Seeds semi-ellipsoid. (Fig. 222)

Vernacular name: Jangli parval.

Flowers: July-October.

Micromorphology (Fig. 223)

Plant showed multicellular, uniseriate, non-glandular, trichome with thick wall. The basal cell was swollen.

Stomata were anomocytic.

D/135.

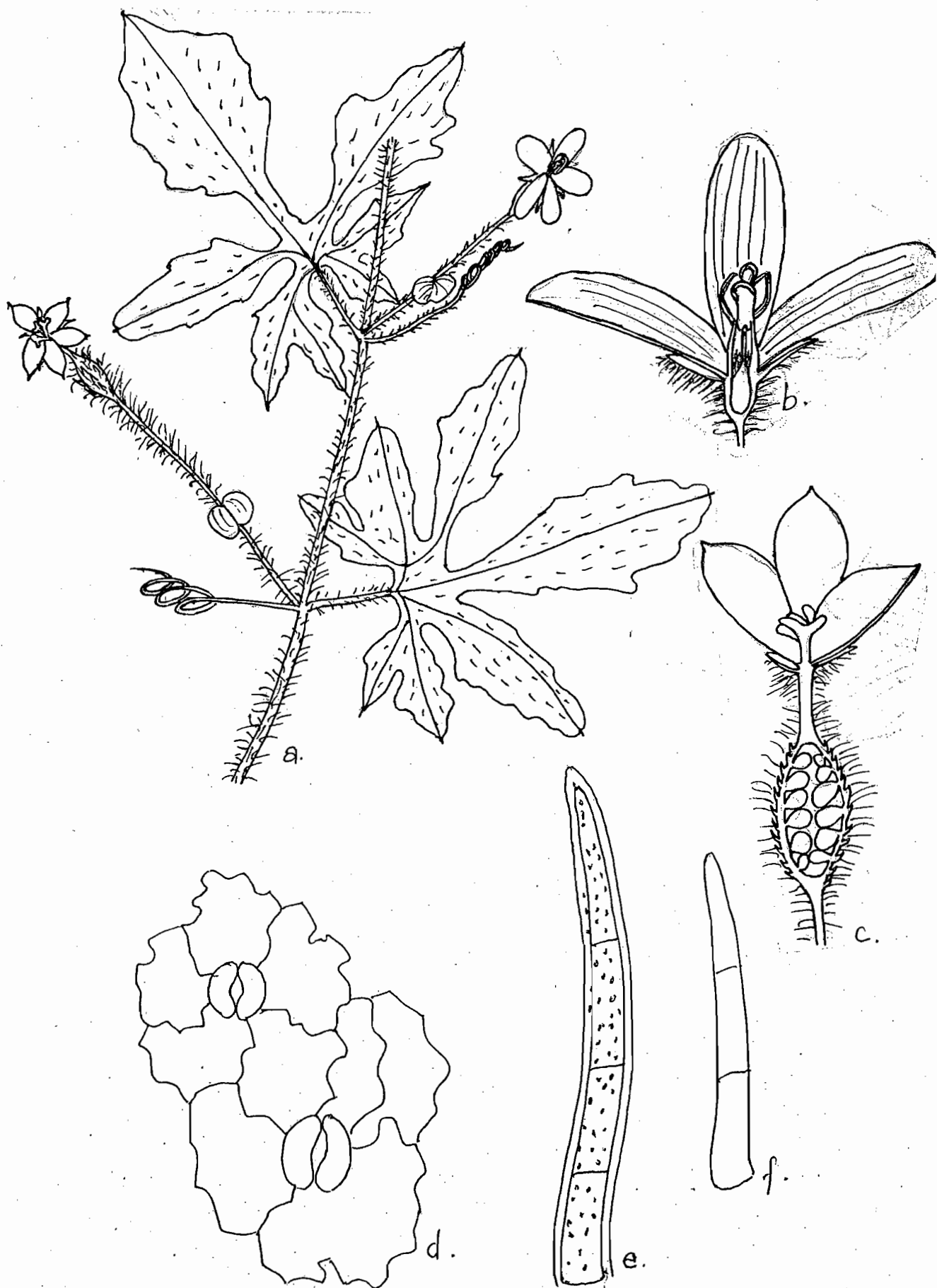


Fig. 221. *Momordica charantia* L. a. habit, b. L.S. of male flower, c. L.S. of female flower, d. anomocytic stomata, e. multicellular uniseriate trichome with warty wall, f. multicellular uniseriate trichome with smooth wall.

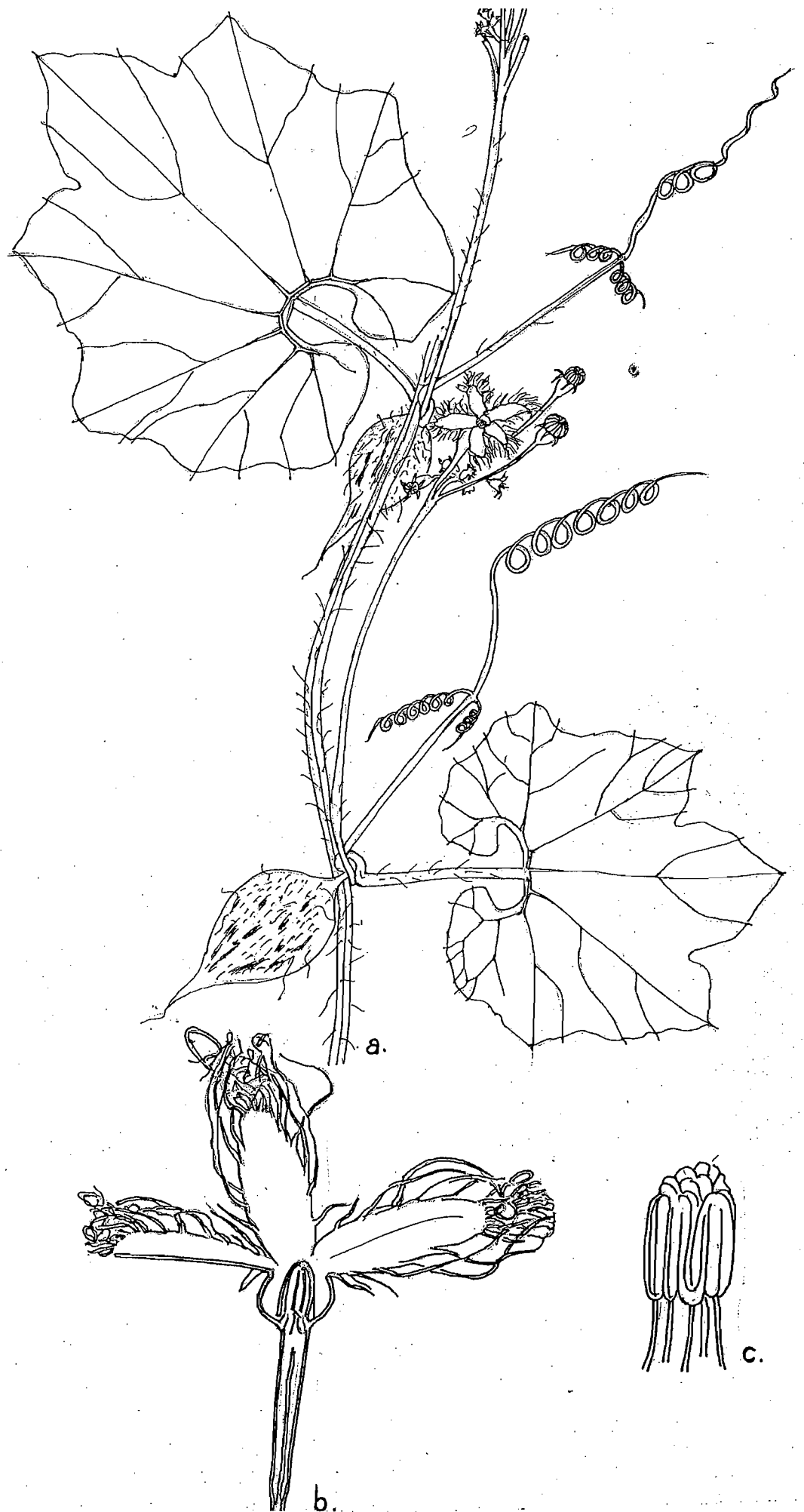


Fig. 222. *Trichosanthes cucumerina* L. a. habit, b. male flower, c. syanandrous stamen.

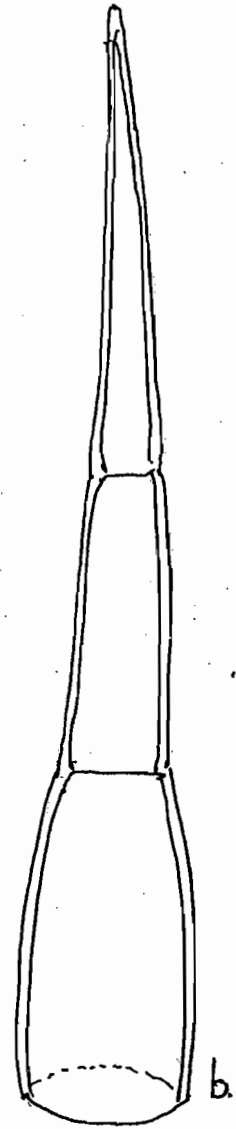
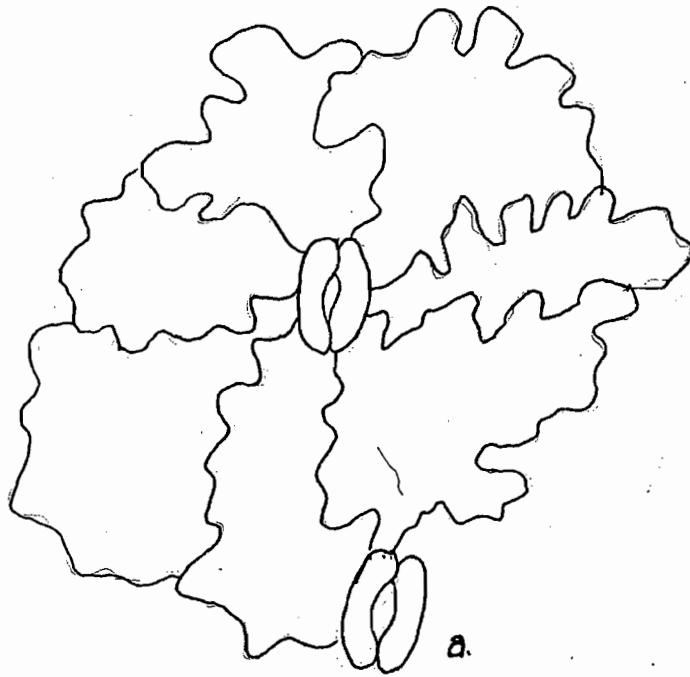


Fig. 223. *Trichosanthes cucumerina* L. a. anomocytic stomata, b. multicellular uniseriate three-celled trichome.

Aizoaceae

1. *Glinus lotoides* L. *Sp. Pl.* 1: 463–464. 1753.

An annual prostrate branched herb spreading upto 45 cms. from a centre, sometimes ascending, leafy and softly villous with stellate hairs. Leaves opposite or several at a node, upto 2 cms. broadly obovat, very obtuse at the apex; petioles upto 1 cm long. Flowers pinkish-white, in axillary fascicles, 1-6 together; calyx stellately hairy outside; sepals elliptic-lanceolate, acute. Stamens usually 10 or more, varying to 5. Ovary ovoid, quite glabrous, 5-lobed, 5-celled; ovules many; styles almost 0 or very short; stigmas usually 5, spreading. Capsules a little shorter than the sepals, ovoid. Seeds numerous, subreniform, with raised tubercular points, black, appendaged with a white scale at the hilum extended into a long filiform process which curves round the seed. (Fig. 224)

Vernacular name: Mitho okharad.

Flowers: February-April.

Micromorphology (Fig. 225)

Whole plant showed the presence of stellate hairs; with 4-5 arms and each arm further bifurcate dichotomously.

Stomata were of anomocytic types.

D/232.

2. *Glinus oppositifolius* (L.) Aug. DC. *Bull. Herb. Boissier, sér. 2, 1: 552, 559. 1901.*

A pubescent diffuse, prostrate or ascending dichotomously branched herb with long internodes on stem. Leaves upto 2.5 cm long, in whorls of 4-5, sessile, unequal, linear-lanceolate, apiculate at the apex. Flowers white, in axillary fascicles of 2 or more; pedicels 1 cm long, filiform. Calyx glabrous outside; sepals 0.4 cm long, oblong, subacute, with membranous margins. Petals 0. Stamens usually 4-5, subhypogynous, usually alternate with the sepals, sometimes intermixed with subulate staminodes. Ovary glabrous; styles 3, very short; stigmas spreading. Capsules ellipsoid, a little shorter than the sepals, 3-celled. Seeds very numerous, subreniform, with raised tubercular points, dark brown, appendaged with a very small white scales at the hilum extended into a bristle which curves round the seed. (Fig. 226)

Variations observed: In flora the stamens are usually 3 but here the number of stamens were found to be 4-5.

Vernacular name: Mitho okharad.

Flowers: September-October.

Micromorphology (Fig. 227)

The plant showed two types of trichomes: 1) unicellular, non-glandular trichome with blunt apex and a broad lumen; 2) multicellular, uniseriate, unbranched, glandular trichome with broad cells having striated walls.

Stomata were of anomocytic and anisocytic type.

D/437, 457, 655, 740.

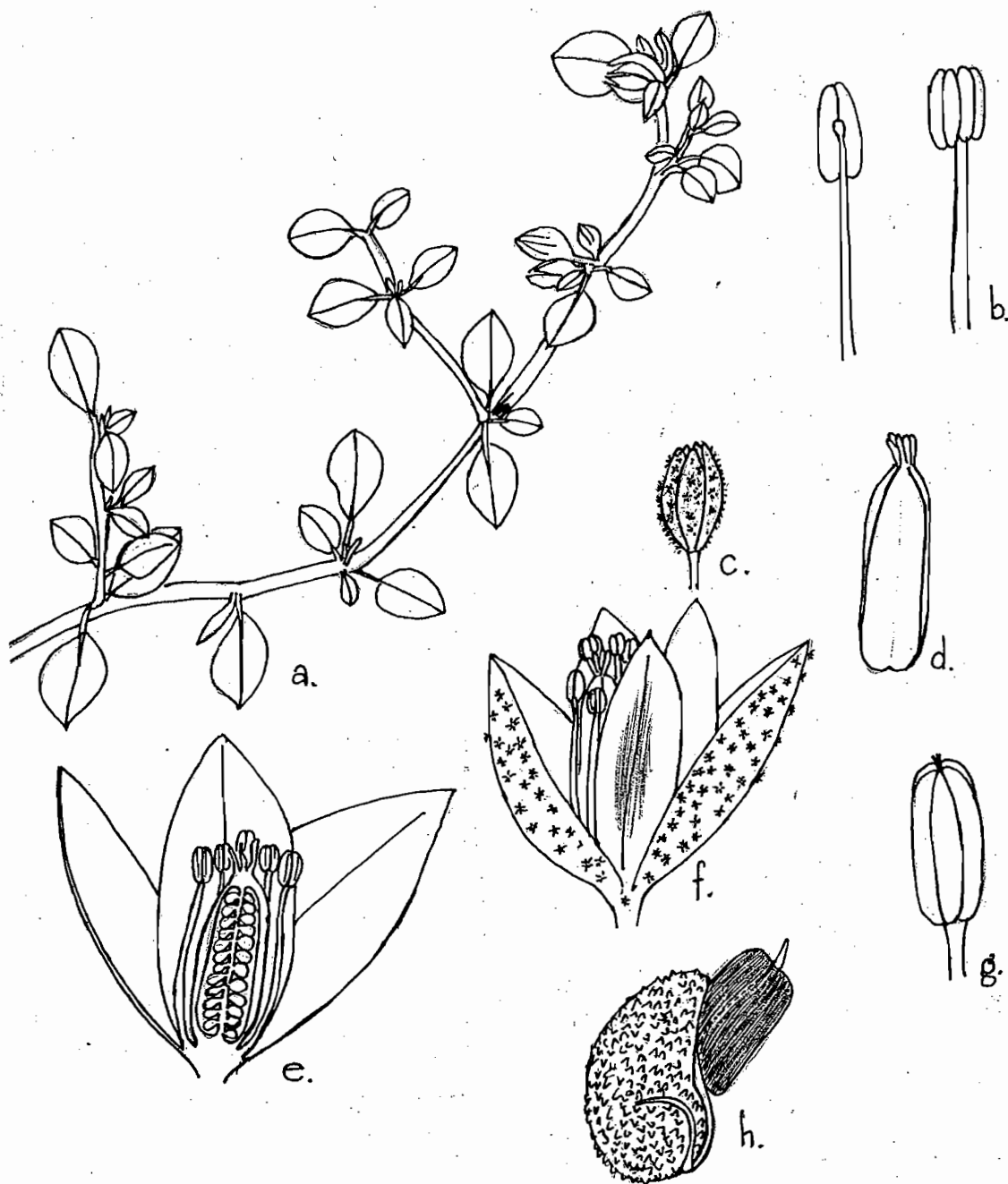


Fig. 224. *Glinus lotoides* L. a. habit, b. stamen, c. flower bud, d. gynoecium, e. L.S. of flower, f. flower, g. capsule, h. Seed.

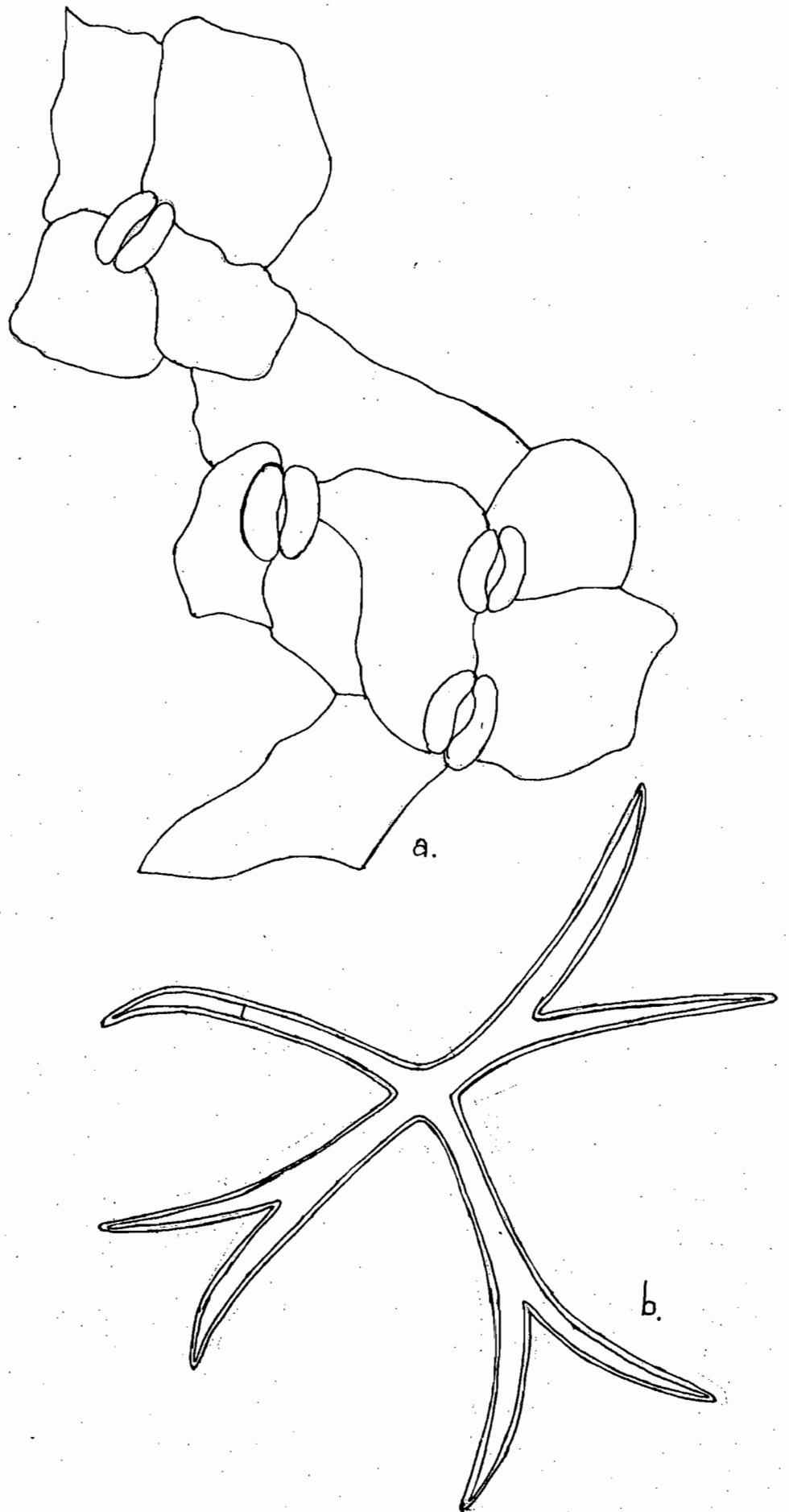


Fig. 225. *Glinus lotoides* L. a. anomocytic stomata, b. unicellular branched and bifurcated trichome.

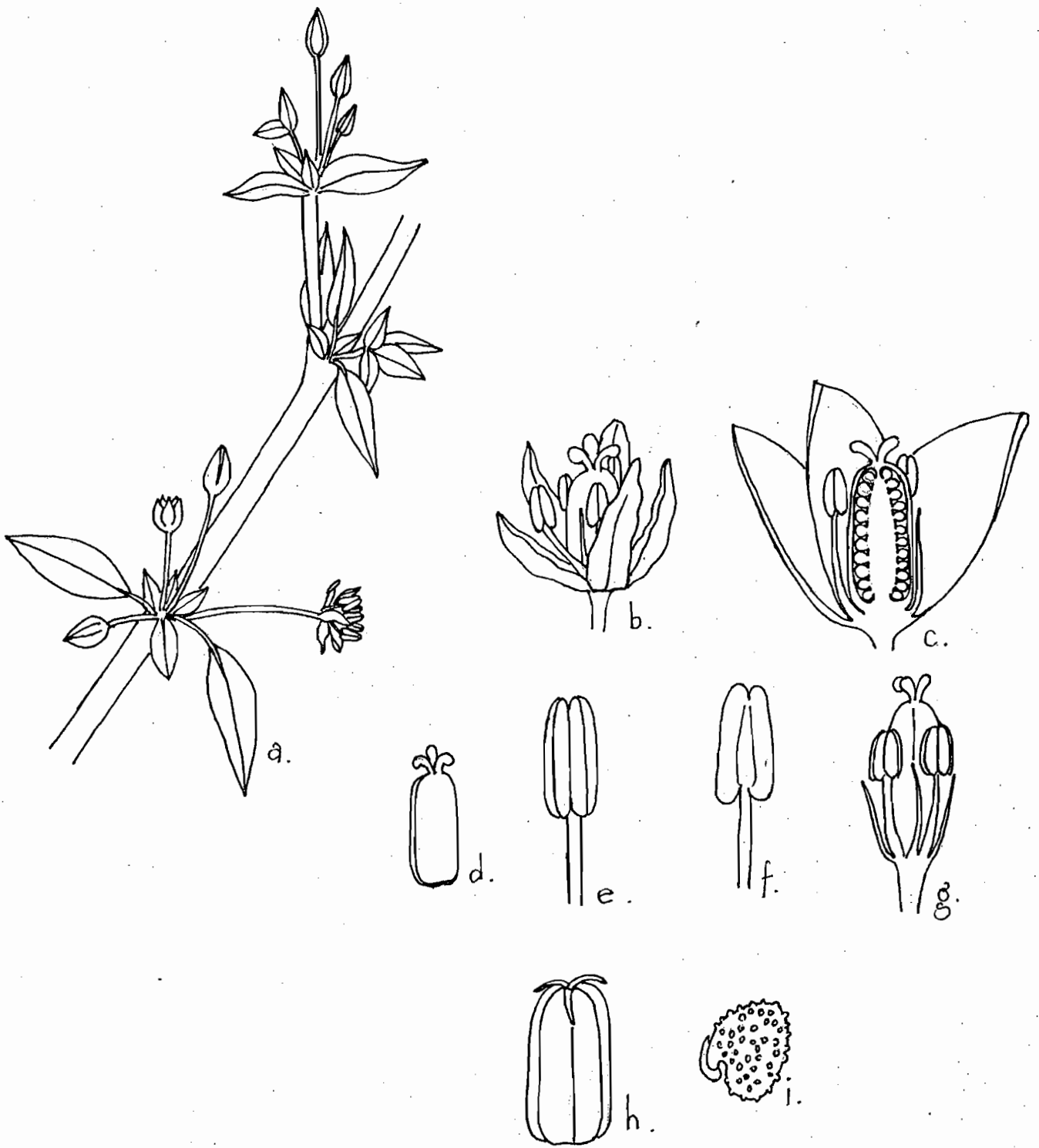


Fig. 226. *Glinus oppositifolia* Aug. a. habit, b. flower, c. L.S. of flower, d. gynoecium, e and f. stamen, g. stamen with gynoecium, h. capsule, i. seed.

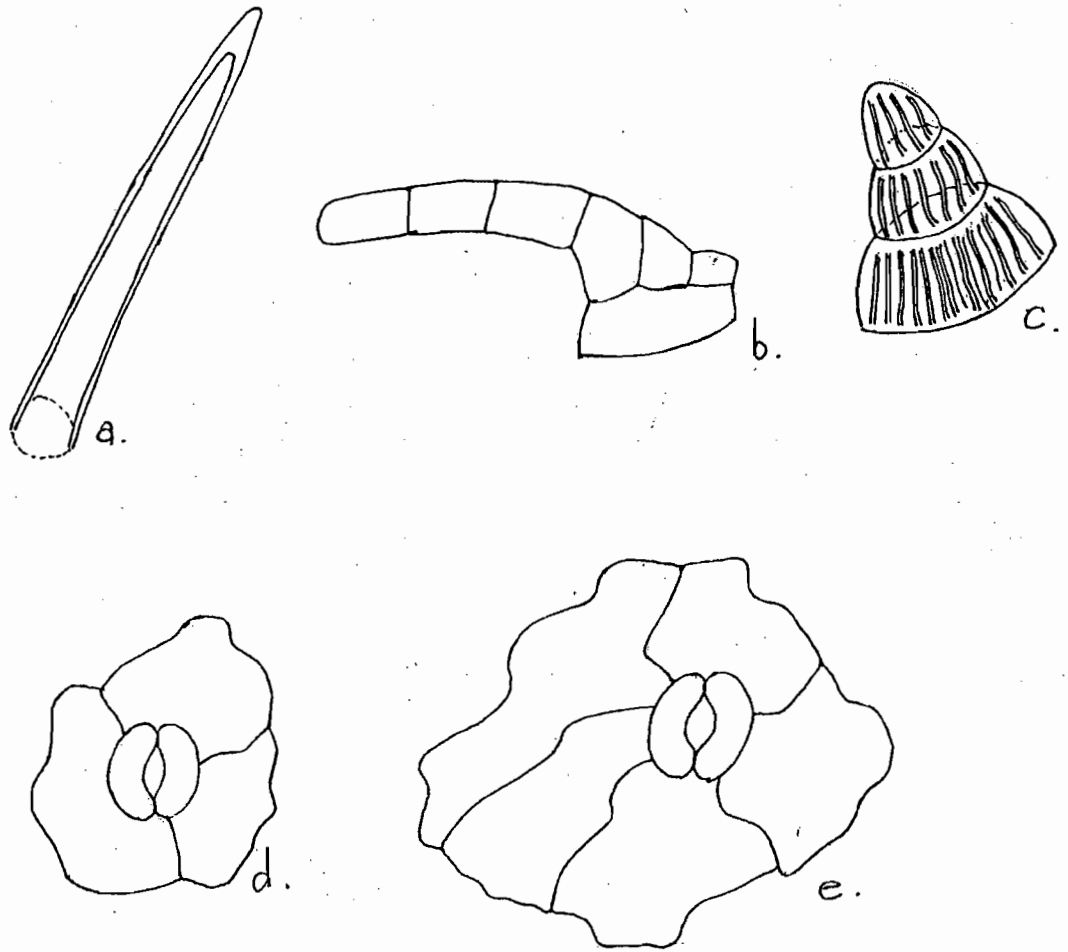


Fig. 227. *Glinus oppositifolia* Aug. a. unicellular trichome with thin wall, b. multicellular uniseriate trichome, c. glandular multicellular uniseriate trichome with bulbous cells, d. anisocytic stomata e. anomocytic stomata.

3. *Mollugo nudicaulis* Lamk. *Encycl.* 234. 1797.

Annual up to 22 cm tall. Leaves basal, 1.5-6.0 cm long, 6-16 mm broad, spatulate to oblanceolate, glabrous, attenuate. Flowers in dichasial cymes; scapes slender, glabrous; involucre bracts ovate-oblong, 1-2 mm long, scarious; pedicels up to 1.4 cm long. Sepals oblong, 2.5-3.0 mm long, mucronate, imbricate persistent. Filaments 1 mm long, persistent, anthers less than 1 mm long, sub-globose. Ovary sub-globose, 1.5 mm long. Stigmas 3, short, curved. Capsule as long as the sepals, sub-globose, dehiscent by 3 valves. Seeds less than 1 mm, muricate, minutely strophiolate, black and shiny. (Fig. 228)

Vernacular name: Parpat ni jat.

Flowers: October-November.

Micromorphology (Fig. 229)

Whole plant was glabrous.

Stomata were of anomocytic and anisocytic types.

D/371, 981-982, 1079-1083.

4. *Trianthema monogyna* Linn. *Mantiss.* (1767) p. 69.

A prostrate somewhat succulent herb; stems more or less angular, glabrous or pubescent, much branched. Leaves subfleshy, obliquely opposite, unequal, the upper one of the pair the larger; upto 4 cm long, the lower 1.5 cm long, broadly obovate, rounded and often apiculate at the apex, cuneate at the base, glabrous; petioles upto 1 cm long, much dilated and membranous at the base, especially those of the smaller leaves in which the membranous enlargement forms a triangular pouch. Flowers solitary, sessile, almost concealed by the pouch of the petiole. Calyx-lobes ovate, acute. Petals 0. Stamens 10-20. Ovary truncate, one-celled, ovules numerous, basal; style 1. Capsules small, almost concealed in the petiolar pouch, lid truncate, slightly concave, with 2 spreading teeth, carrying away at least one seed, the lower part 3-5 seeded. Seeds reniform, muriculate, dull-black. (Fig. 230)

Vernacular name: Satodo.

Flowers: June-August.

Micromorphology (Fig. 231)

Whole plant was glabrous.

Stomata were of anomocytic types.

D/292.

5. *Zaleya pentandra* (Linn.) Jeffrey in *Kew Bull.* 14(2)238. 1960. (*Trianthema pentandra* L.)

Diffuse, much-branched, from a few inches to 45 cm high; stems and branches more or less papillose (sometimes glabrous), angled and grooved. Leaves upto 3 cm long, elliptic-oblong, sometimes slightly obovate, glabrous or more or less papillate, rounded (rarely subacute) at the apex, narrowed at the base; petioles distinct, upto 1.25 cm long, dilated at the base, slightly sheathing. Flowers sessile or subsessile, in few- or many-flowered

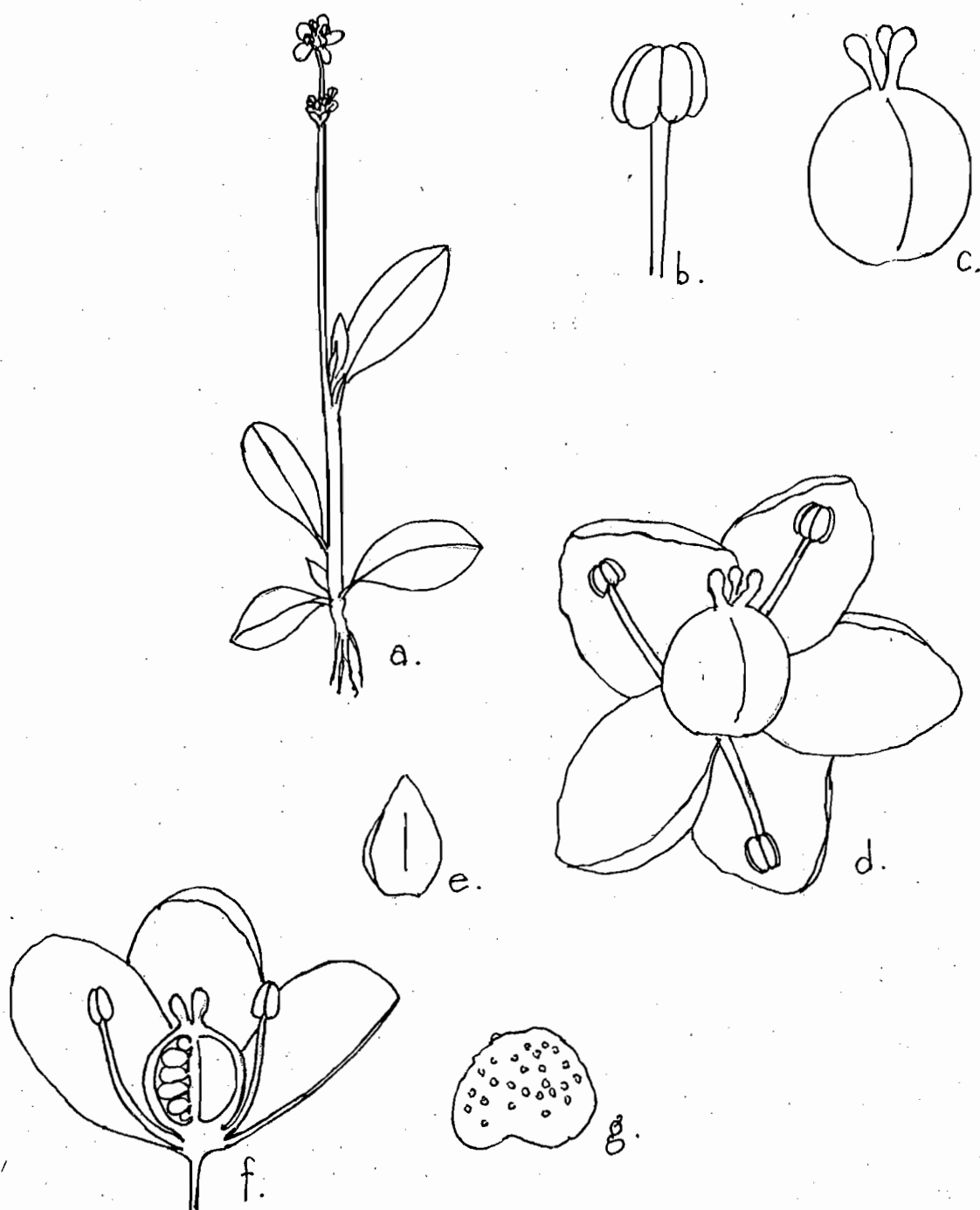


Fig. 228. *Mollugo nudicaulis* Lam. a. habit, b. stamen, c. gynoecium, e. sepal, d. flower, f. L.S. of flower, g. seed.

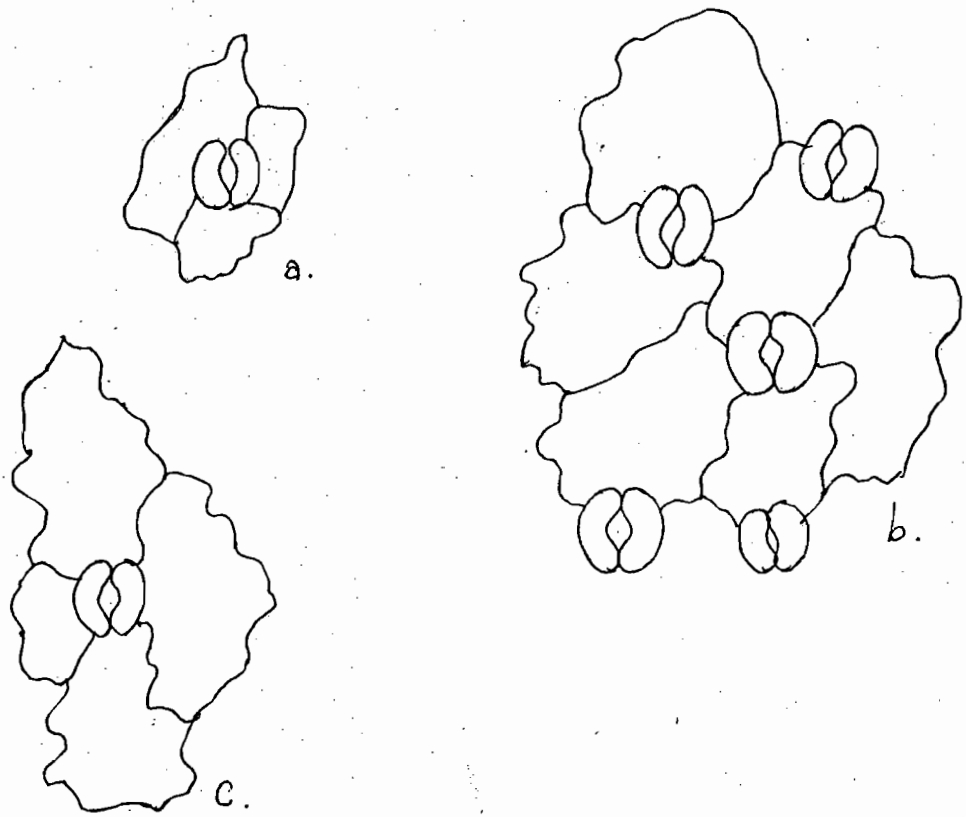


Fig. 229. *Mollugo nudicaulis* Lam. a. anisocytic stomata, b & c. anomocytic stomata.

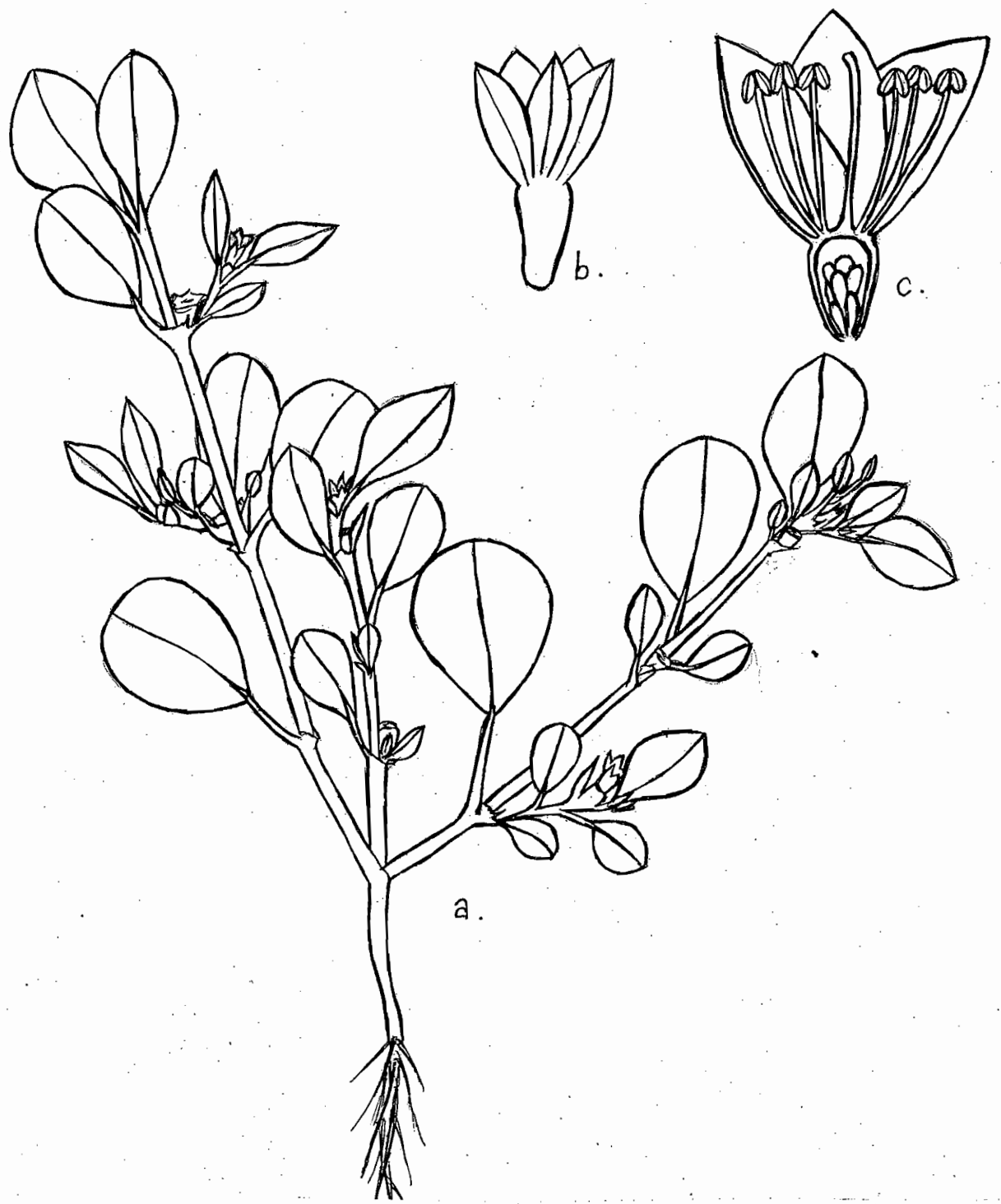


Fig. 230. *Trianthema monogyna* L. a. habit, b. flower, c. L.S. of flower.

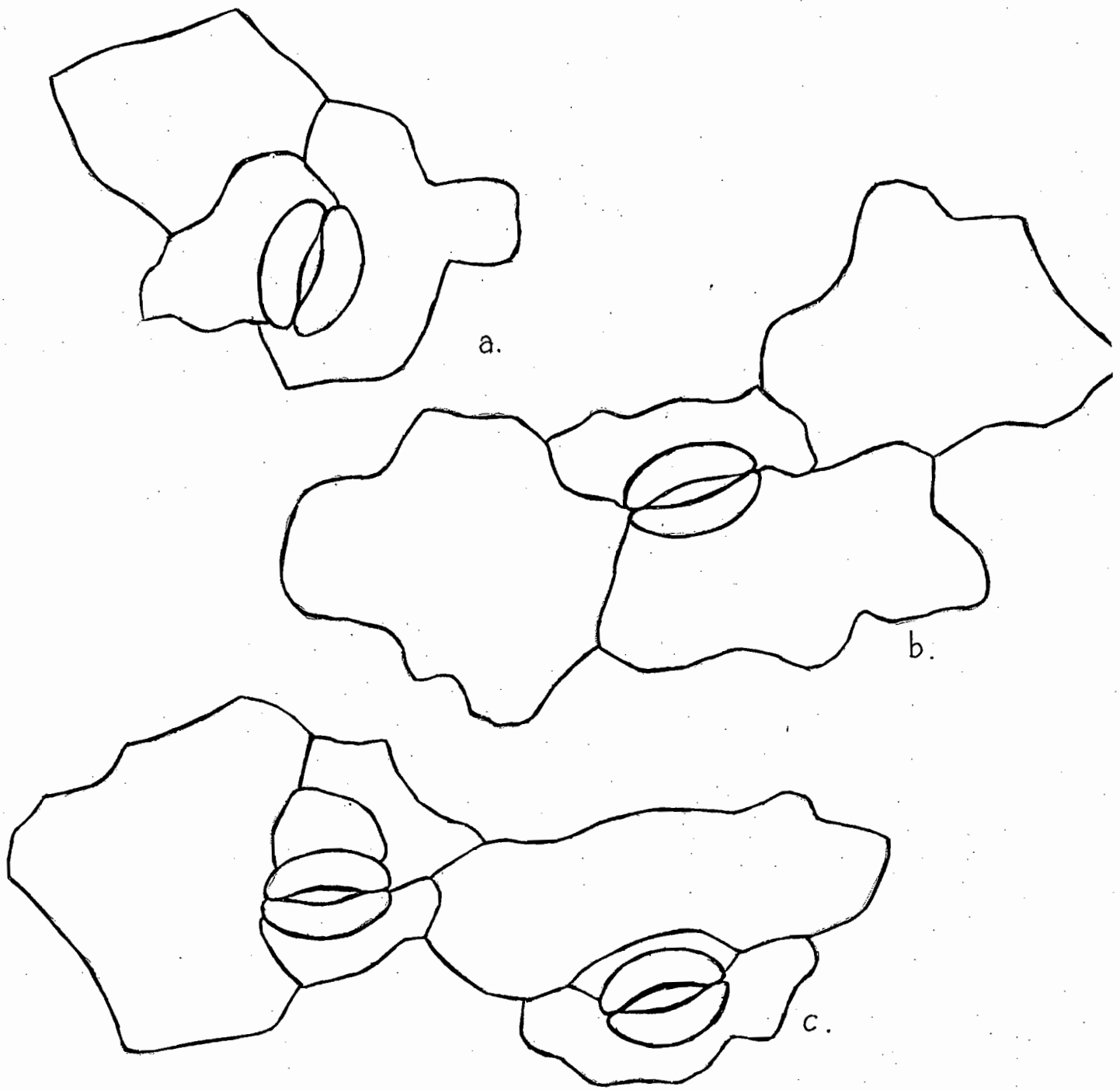


Fig. 231. *Trianthema monogyna* L. a & c. paracytic stomata, b & c. anisocytic and paracytic stomata.

axillary fascicles; bracteoles thinly membranous. Calyx deeply 5-lobed; lobes ovate-oblong, colored within, with a short apiculation at the back below the apex. Stamens 5, styles 2. Capsules 0.5 cm long, exserted, the cap with broad deflexed horns, mitriform, dividing into two 1-seeded portions, the lower half of the capsules containing 2 seeds. Seeds orbicular-reniform, compressed, rugules, dull-black. (Fig. 232)

Flowers: October-November.

Micromorphology (Fig. 233)

The surface of the plant showed presence of papillae, except this the plant was glabrous. Stomata were of anisocytic, tetracytic, obliquely paracytic, and anomocytic types.

D/99.

Apiaceae

1. *Centella asiatica* (L.) Urb. *Fl. Bras.* 11(1): 287. 1879.

A slender herbaceous creeping plant; stems long, prostrate, coming off from the leaf-axils of a vertical rootstock, filiform, often reddish, and with long internodes, rooting at the nodes. Leaves 1-6 cm in diameter, several from the rootstock which often have much elongated petioles, and 1-3 from each node of the stems, orbicular-reniform, rather broader than long, more or less cupped, entire or shallowly crenate, glabrous on base; petioles very variable in length, 8-15 cm long or more, channeled, glabrous or nearly so; stipules short, adnate to the petioles, forming a sheathing base. Flowers in fascicled umbels, each umbel consisting of 3-4 pink, sessile flowers; peduncles pubescent or glabrous, short, pink; bracts ovate, acute, concave, 2 beneath each umbel. Calyx-teeth 0. Petals minute, pink, ovate, acute. Fruit 0.5 cm long, longer than broad, ovoid, hard, with thickened pericarp, reticulato-rugose, often crowned by the persistent petals, the primary and secondary ridges distinct. (Fig. 234)

Vernacular name: Brahmi.

Flowers: May-November.

Micromorphology (Fig. 235)

Leaf was glabrous.

Stomata were of anisocytic, anomocytic, paracytic types.

D/151.

2. *Trachyspermum roxburghianum* (de Candolle) H. Wolff in *Engler, Pflanzenr.* 90(IV. 228): 129. 1927.

(*Carum stictocarpum* C. B. Clarke.)

Annual, upto 1 m high, erect, much branched; root fusiform; stem glabrous. Lower leaves 2-pinnate; leaflets deeply cut into linear-lanceolate apiculate glabrous or minutely pubescent segments, the segments of the upper leaves often linear; petioles with broad sheaths, their margins membranous, ciliolate. Flowers white. Primary umbels 5-10 rayed; bracts 3-6, linear, acute, upto 1 cm long. Partial umbels 6-20 flowered; pedicels 0.5 cm long; bracteoles 4-8, linear-lanceolate, 0.6 cm long, with white scarious ciliate margins.

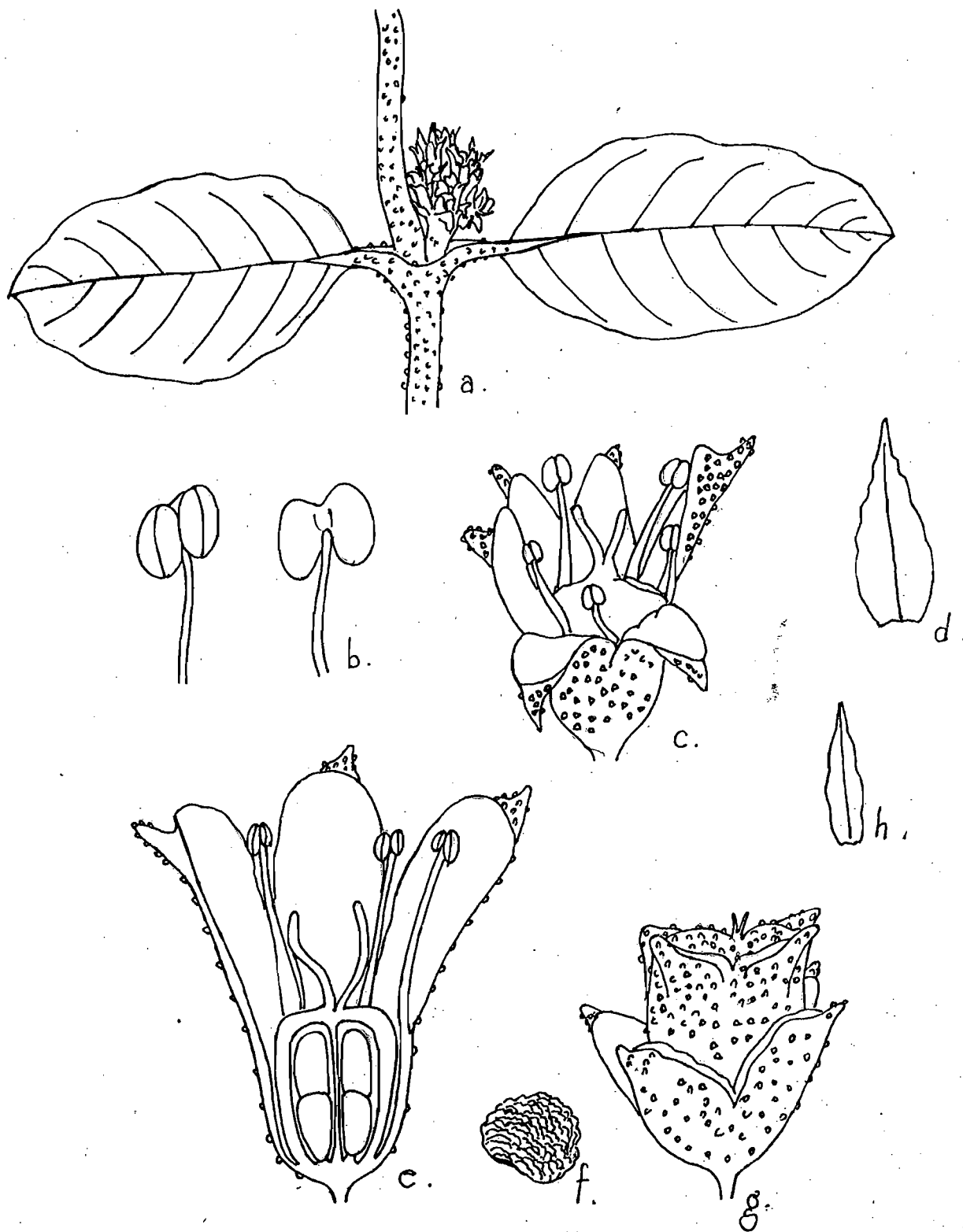


Fig. 232. *Zaleya pentandra* Jeffrey. a. habit, b. stamen, c. flower, d. bract, h. bracteole, e. L. S. of flower, f. seed, g. fruit.

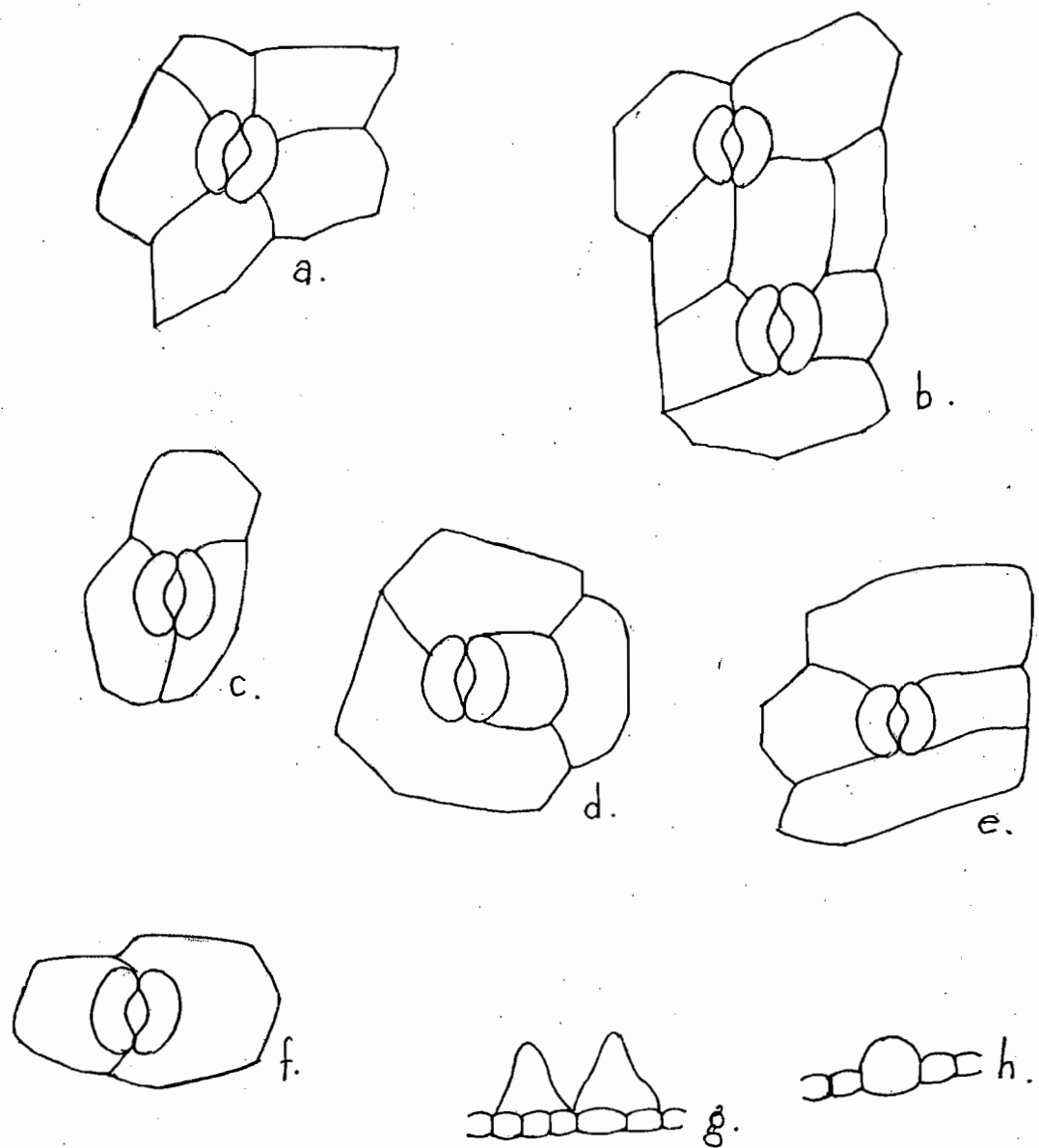


Fig. 233. *Zaleya pentandra* Jeffrey. a & b. anomocytic stomata, c & d. anisocytic stomata, e. tetracytic stomata, f. paracytic stomata, g & h. epidermal papillae.

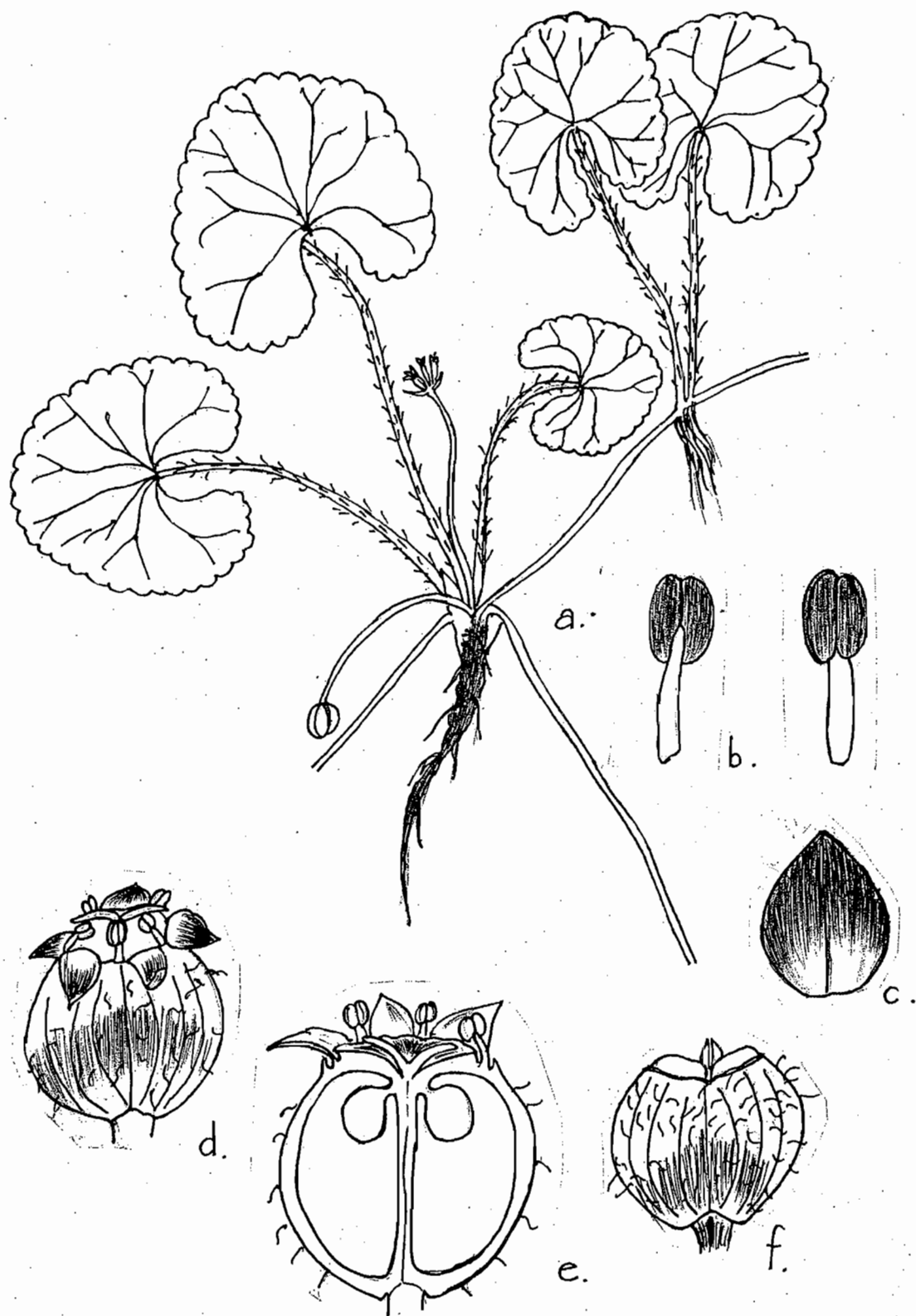


Fig. 234. *Centella asiatica* (L.) Urb. a. habit, b. stamen, c. petal, d. flower, e. L.S. of flower.

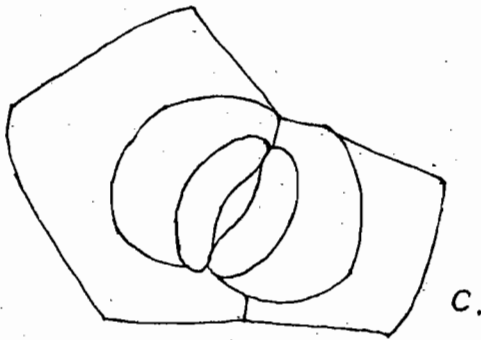
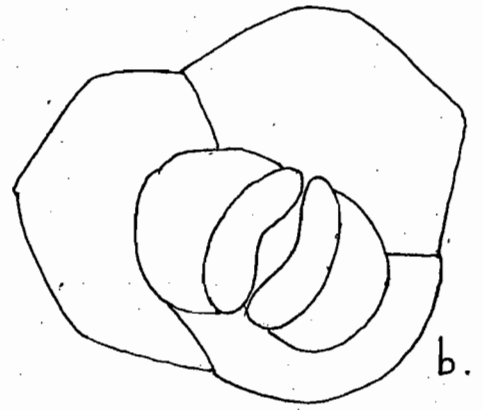
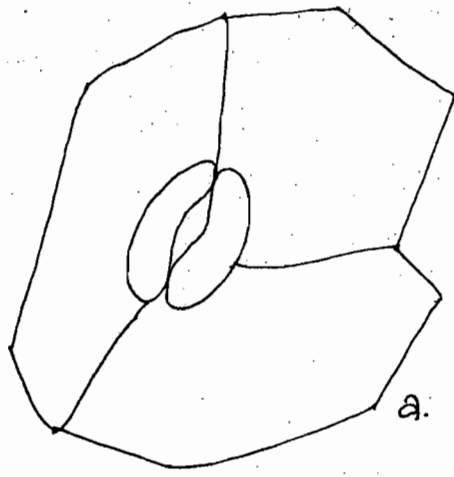


Fig. 235. *Centella asiatica* (L.) Urb. a & c. anisocytic stomata, b. tetracytic stomata.

Calyx-teeth small or 0. petals broad, obtuse, entire, emarginated. Stamens 5, inserted on the mouth of the calyx-tube. Ovary globular, slightly compressed; styles long, recurved on the fruit; stigma capitate. Petals broadly obovate or suborbicular, rounded at the apex. Fruit ovoid, glabrous or puberulous, brown; mericarps scarcely compressed, the ridges slender, faint. (Fig. 236)

Vernacular name: Ajmo.

Flowers: August-October.

Micromorphology (Fig. 237)

Whole plant was glabrous.

Stomata were of anomocytic types.

D/268.

Cornaceae

1. *Alangium salvifolium* (L.f.) Wang. in *Engler Pflanzen*. IV. 220B (Heft 41):9. 1910
(*Alangium lamarckii* Thw.)

A small branched spinescent tree. Leaves alternate, upto 13 cm long, ovate-lanceolate, acuminate, pubescent; petioles upto 1 cm long, densely pubescent. Flowers few, in axillary fascicles; pedicels densely pubescent, jointed at the top. Calyx turbinate, 5-10 toothed; teeth triangular. Petals 5-10, upto 2 cm long, narrowly linear, reflexed. Stamens numerous, nearly as long as the petals; filaments hairy at the base; anthers long. ovary 1-celled; ovule solitary in each cell, pendulous; style narrowly clavate or filiform; stigma clavate. Fruit globular when ripe, upto 2 cm in diameter, crowned by the persistent calyx-limb, finely pubescent. (Fig. 238)

Vernacular name: Ankol.

Flowers: February-April.

Micromorphology (Fig. 238)

The plant was glabrous.

Stomata were anisocytic and tetracytic types.

D/478, 1214.

Rubiaceae

1. *Gardenia lucida* Roxb. *Hort. Beng.* (1814) p. 15.

A large glabrous shrub or small tree reaching upto 8 m high; bark smooth grey; young shoots grayish-green, smooth, resinous. Leaves upto 20 cm long, elliptic-oblong, subacute or shortly acuminate, base narrowed into a petiole; main nerves 20-25 pairs, slender prominent beneath; petioles somewhat obscure; stipules large, broadly ovate, acute, membranous. Flowers axillary, solitary, from the axils of the uppermost leaves near the end of the branches. Calyx teeth upto 1 cm long, erect, lanceolate, subulate. Corolla large at first pure white, soon turning yellow; tube 5 cm long, slender, puberulous outside; lobes 5, obovate, obtuse, 3 cm long, spreading, veined, glabrous. Fruit ellipsoid or globose, 2.5 cm in diameter, smooth, marked with longitudinal lines, crowned by the

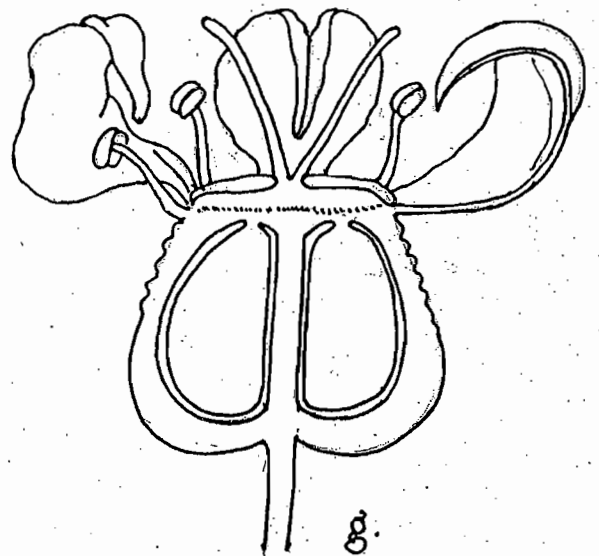
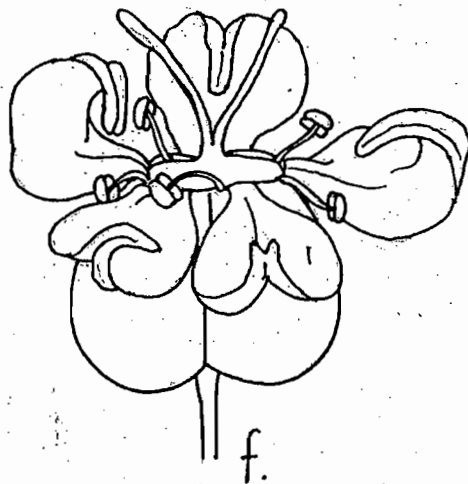
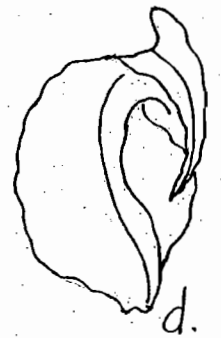
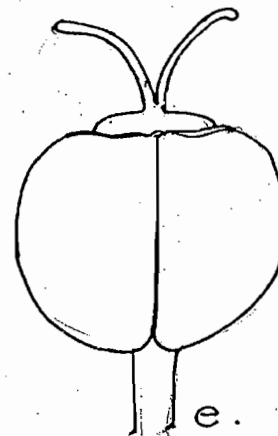
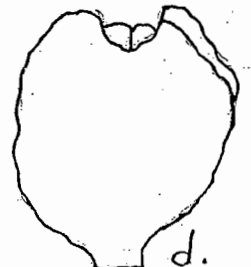
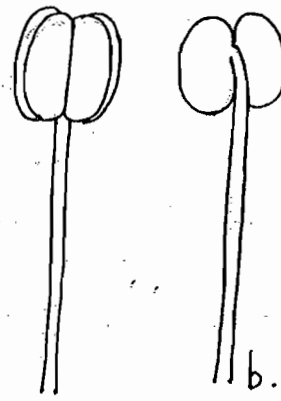


Fig. 236. *Trachyspermum roxburghianum* H. Wolff. a. habit, b. stamen, c. bract, d. petal, e. gynoecium, f. flower, g. L.S. of flower.

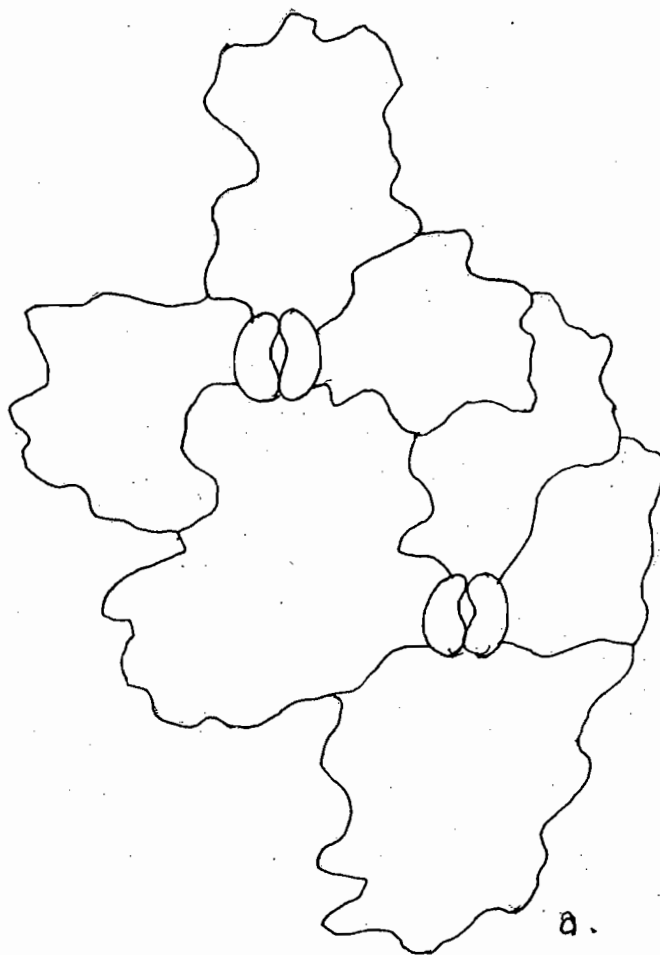


Fig. 237. *Trachyspermum roxburghianum* H. Wolff. a. anomocytic stomata.

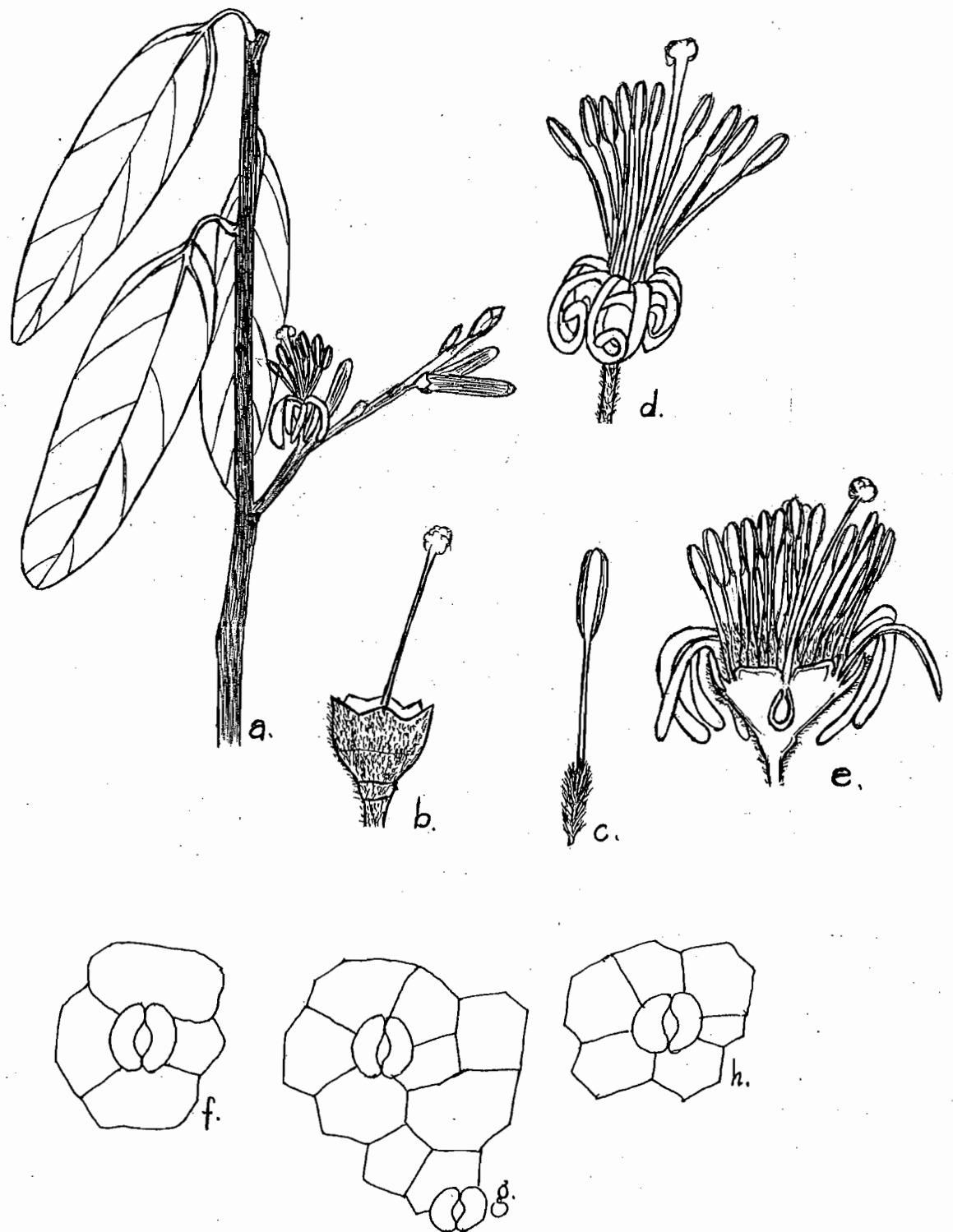


Fig. 238. *Alangium salvifolium* Wang. a. habit, b. calyx with gynoecium, c. stamen, d. flower, e. L.S. of flower, f. tetracytic stomata, g & h. anomocytic stomata.

persistent calyx-limb; pericarp thick, woody; placentas 2. The flower opens in the evening, soon turn from white to yellow and wither. (Fig. 239)

Vernacular name: Jangli champo.

Flowers: March-June.

Micromorphology (Fig. 240)

Leaves were glabrous.

Stomata were of anomocytic and paracytic types.

D/221.

2. *Haldina cordifolia* (Roxb.) Ridsdale, *Blumea* 24: 361. 1978.

(*Adina cordifolia* Benth. & Hook. f.)

A tree with erect trunk and horizontal branches; bark brownish-grey, thick, furrowed; young parts pubescent. Leaves upto 25 cm long and broad as long, orbicular, shortly acuminate, glabrous; main nerves 5-7 pairs; petioles upto 10 cm long, softly pubescent; stipules oblong, obtuse. Flowers numerous, in globose heads; surrounded by paleaceous bracteoles, peduncles stout, axillary, 1-3 together, each bearing 1 heads of yellow flowers. Calyx lobes club-shaped. Corolla tube slender, dilated above, pubescent; segments ovate-oblong, subacute, recurved. Stamens 5, inserted on the mouth of the corolla; filaments short. Disk cup-shaped. Ovary 2-celled; ovules numerous, inserted on a pendulous placenta, imbricate; style-filiform, style much exserted; stigma clavate, rarely capitate. Capsules cuneate, densely downy. Seeds about 6 in each cell. (Fig. 241)

Vernacular name: Haldarvo.

Flowers: June-September.

Micromorphology (Fig. 241)

Leaves were glabrous.

Stomata were anomocytic and paracytic types.

D/398.

3. *Hedyotis corymbosa* (L.) Lamk., *Tabl. Encycl.* 1: 272. 1792.

An annual herb with numerous, slender branches reaching a height of 40 cm. Leaves linear-lanceolate, subsessile, upto 4 cm long, acute, often with recurved and frequently scabrous margins; stipules interpetiolar, membranous, truncate, with a few short bristles. Flowers on filiform pedicels longer than the calyx, usually 2-3 (rarely 1 or very rarely 4) on the top of a very slender axillary solitary peduncle; bracts subulate. Calyx teeth 4, pubescent; narrowly triangular, calyx-tube obovoid or subglobose. Corolla white, lobes 4, acute. Stamens 4, inserted on the throat of the corolla; filaments short; anthers usually exserted. Ovary 2-celled; ovules numerous, on axile placenta. Style filiform; stigmas 2, linear. Capsules globose or sometimes slightly pyriform with a flat top. Seeds pale-brown, angular. (Fig. 242)

Vernacular name: Parapat.

Flowers: September-November.

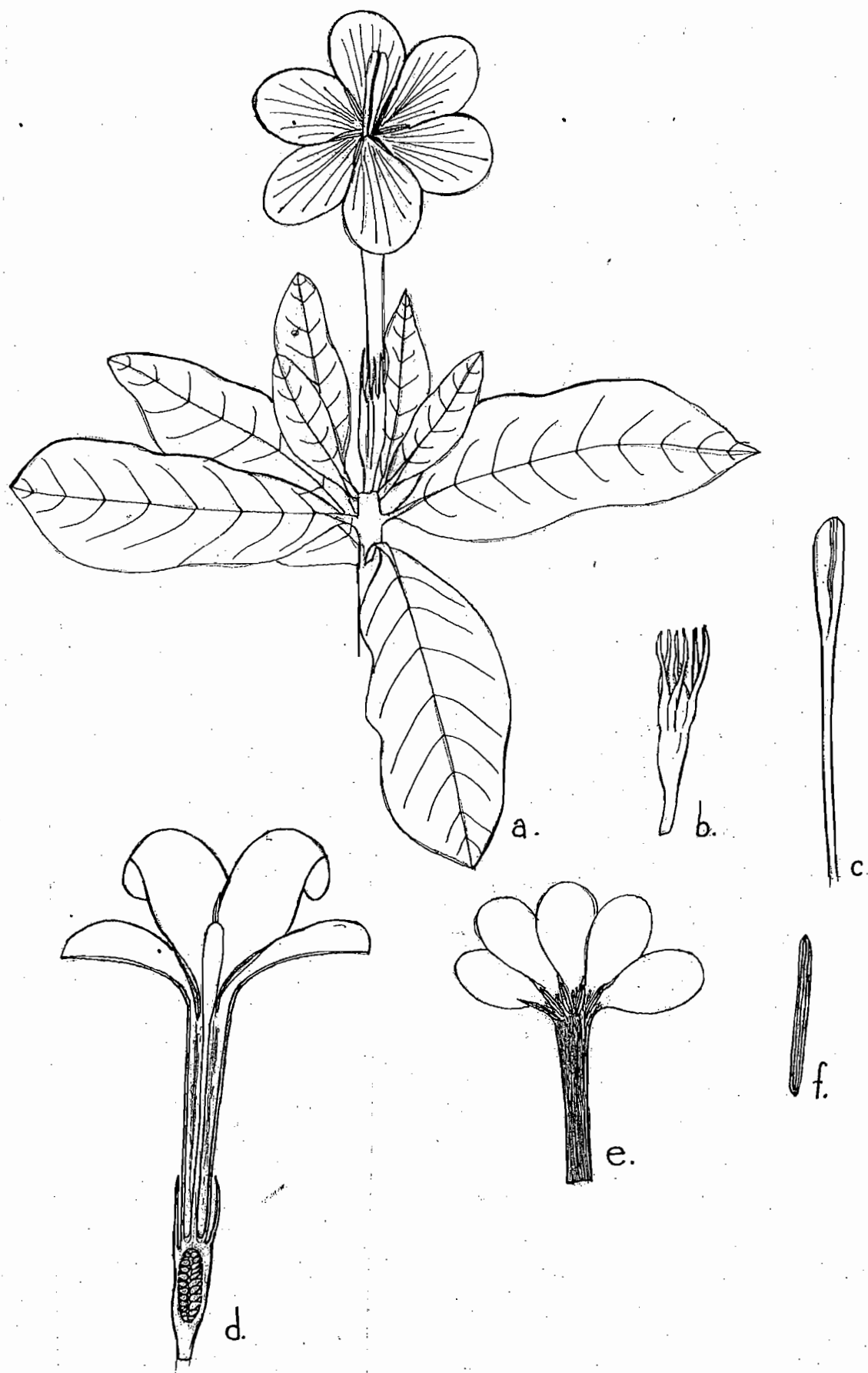


Fig. 239. *Gardenia lucida* Roxb. a. habit, b. calyx, c. stigma and style, d. L.S. of flower, e. corolla cut open f. anther cell quite long.

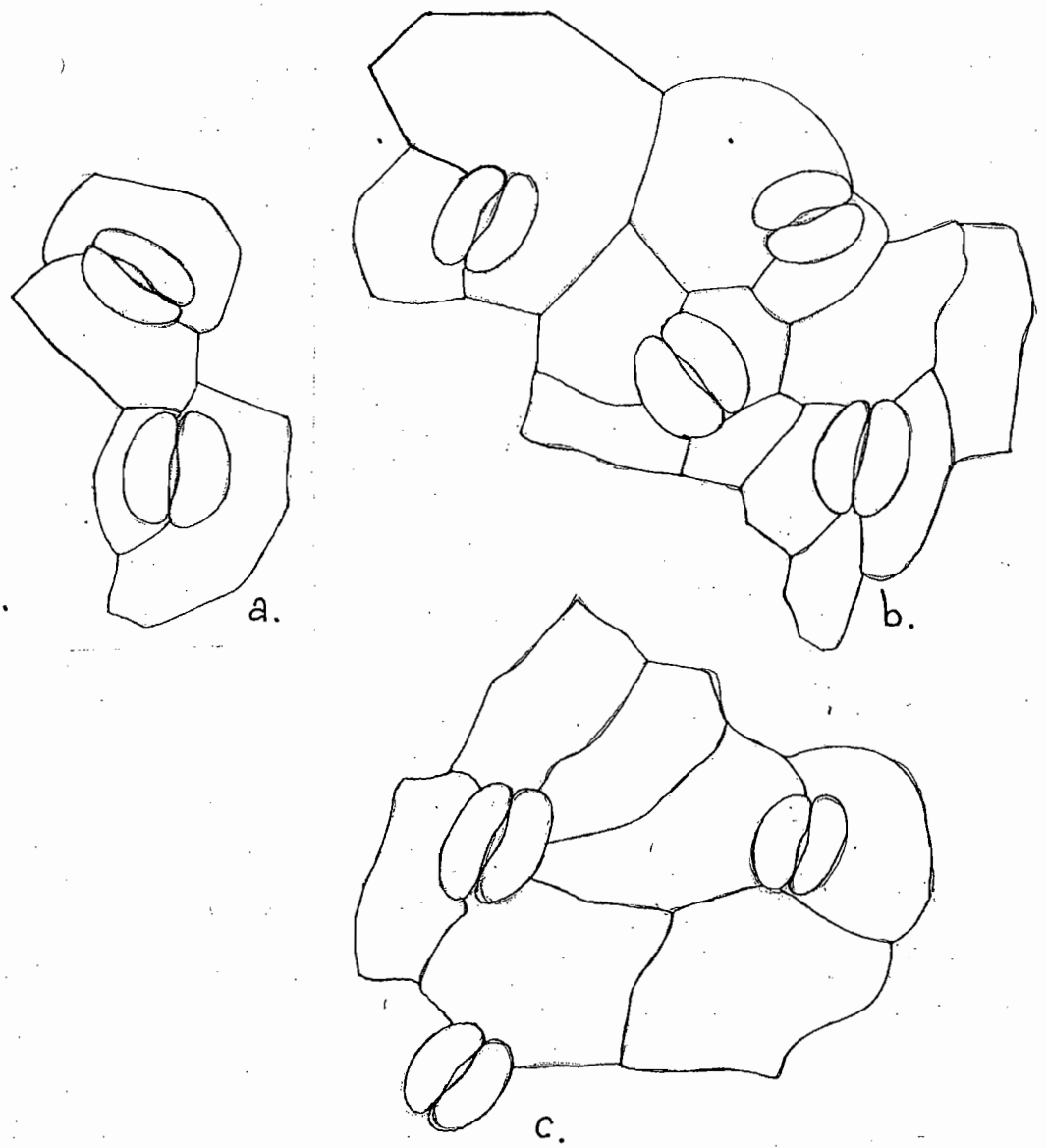


Fig. 240. *Gardenia lucida* Roxb. a-b. paracytic stomata, c. anomocytic and paracytic stomata.

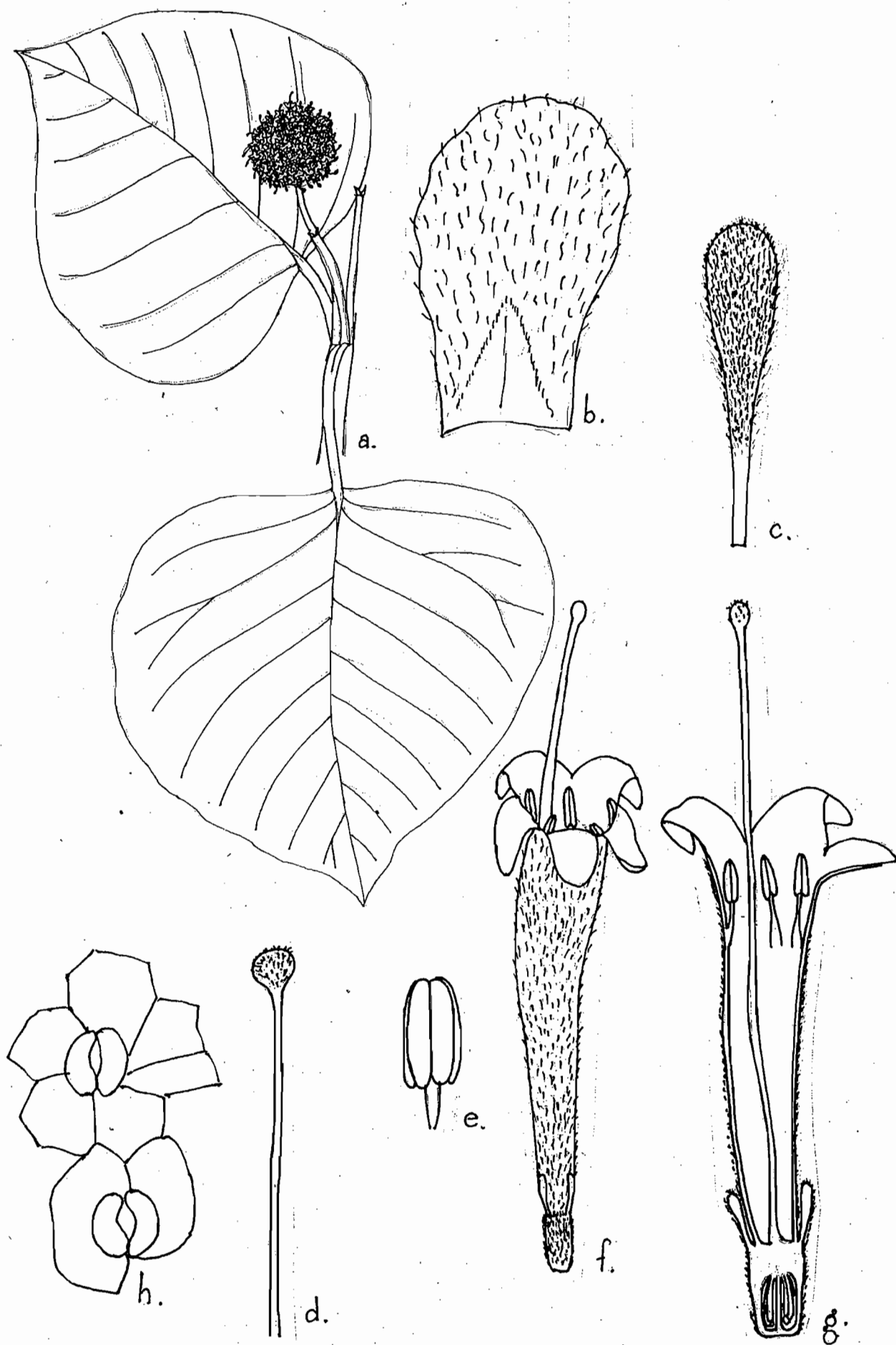


Fig. 241. *Haldina cordifolia* Ridsdale. a. habit, b. stipule, c. bract, d. stigma and style, e. stamen, f. flower, g. L.S. of flower, h. anomocytic and paracytic stomata.

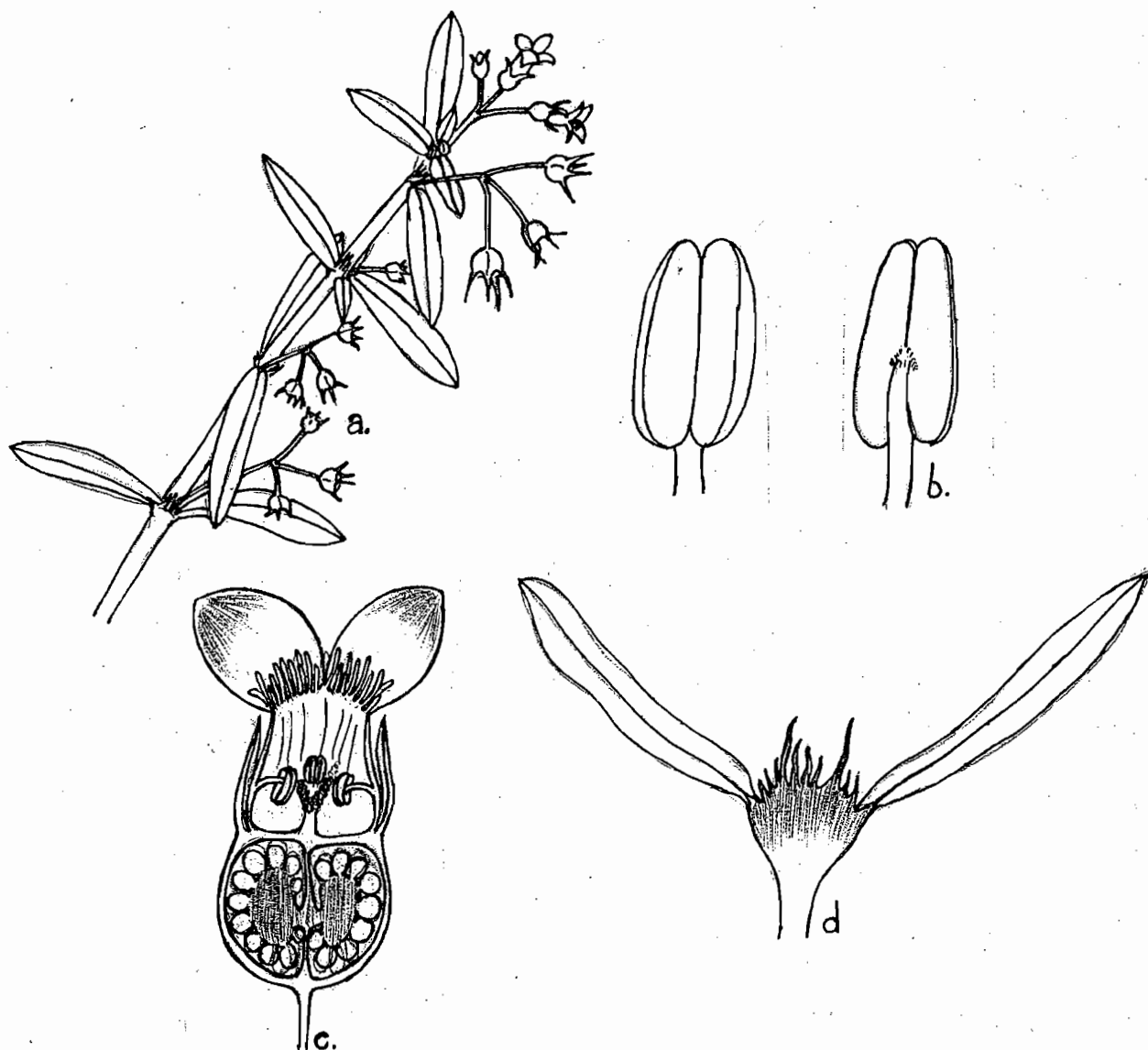


Fig. 242. *Hedyotis corymbosa* Lamk. a. habit, b. stamen, c. L.S. of flower, d. stipule.

Micromorphology (Fig. 243)

Whole plant was glabrous.

Stomata were of paracytic type.

D/573, 574, 1158, 1161, 1193.

4. *Spermadictyon suaveolens* Roxb., *Corom. Pl.* 3: 32. t. 236. 1819.

A small shrub with divaricate more or less herbaceous branches. Leaves opposite, petiolate, elliptic-lanceolate upto 20 cm long; main nerves 10-16 pairs, acruate; stipules triangular, interpetiolar, persistent. Flowers numerous, in subglobose heads in terminal trichotomous pubescent panicles, white or blue; bracteoles beneath the calyx minute, subulate. Calyx tube narrow; teeth 4-5, linear-lanceolate. Corolla up to 1 cm; tube slender, slightly enlarged at the top; lobes 4-5, ovate, acute. Stamens 5, inserted in the throat of the corolla; filaments subulate; anthers included, obovate-oblong. Ovary 5-furrowed, 5-celled; ovules solitary in each cell, erect from the base; style filiform, with 5 linear arms. Capsules ellipsoid. Seeds 3-quetrous, with a loose arillate lace-like covering. (Fig. 244)

Vernacular name: Gida.

Flowers: October-February.

Micromorphology (Fig. 244)

The plant showed presence of non-glandular multicellular uniseriate trichome with warty wall and basal cell spreading.

Stomata were paracytic.

D/123

5. *Spermacoce hispida* Linn. *Sp.Pl.* (1753) p. 102.

A procumbent herb with quadrangular stems having long internodes. Leaves subsessile, upto 5 cm, oblong or elliptic, acute, scabrid, pubescent, or nearly glabrous, with scabrid or ciliate margins; stipules interpetiolar, membranous, hispid, with few bristles which are usually longer than the sheath. Flowers 4-6 in a whorl within the stipular cup. Calyx tube narrowly campanulate; teeth as long as the tube, linear-lanceolate, hairy. Corolla pale-blue or white; lobes oblong, acute, bristly on the back near the tip. Stamens 4, on the throat of the corolla tube. Ovary 2-celled; ovules solitary in each cell. style filiform; stigmas 2, very short. Capsules 0.5 cm long, hairy, ellipsoid, rounded at both ends, crowned with the calyx-teeth, one mericarp only ventrally dehiscent, the other closed by the septum which remains attached to it, finally separating as a membranous plate. Seeds with one end rounded, the other truncate, finely granulate. (Fig. 245)

Vernacular name: Ganthiyu.

Flowers: September-October.

Micromorphology (Fig. 245)

The plant showed presence of unicellular, non-glandular, elongated trichome with thick wall.

Stomata were of paracytic type.

D/367, 368, 595, 737, 1044, 1089.

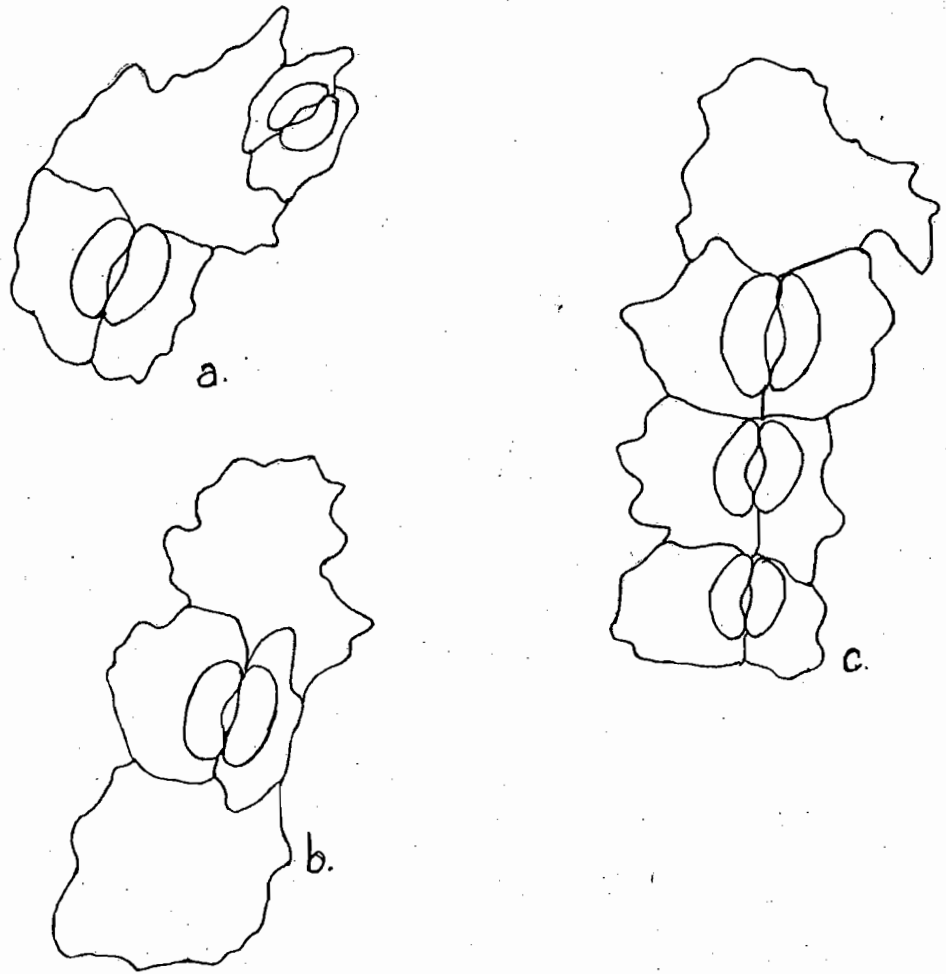


Fig. 243. *Hedyotis corymbosa* Lamk. L. a-c. paracytic stomata.

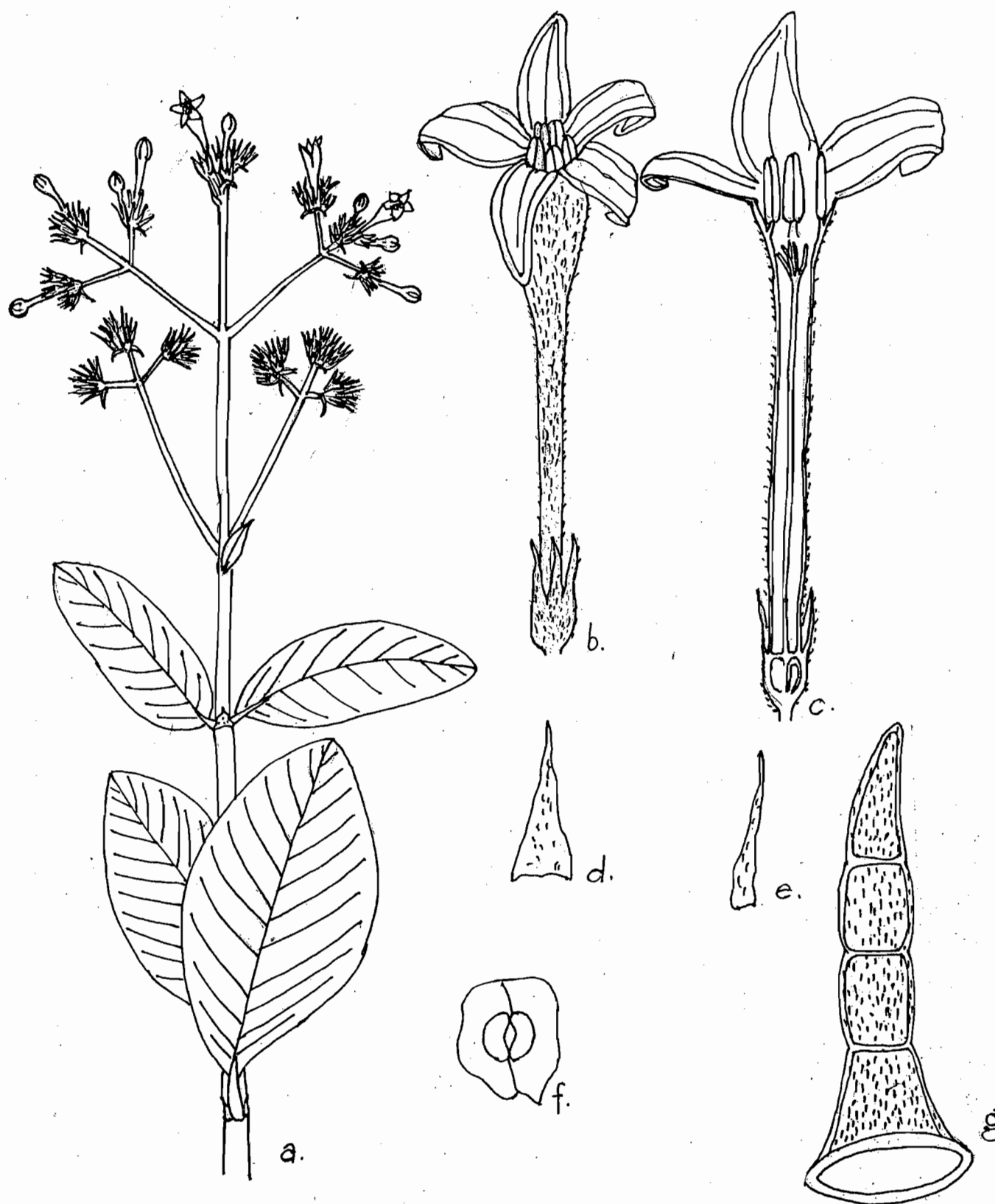


Fig. 244. *Spermadictyon suaveolens* Roxb. a. habit, b. flower, c. L.S. of flower, d. stipule, e. bract, f. uniseriate trichome with warty wall and broad basal cell, g. paracytic stomata.

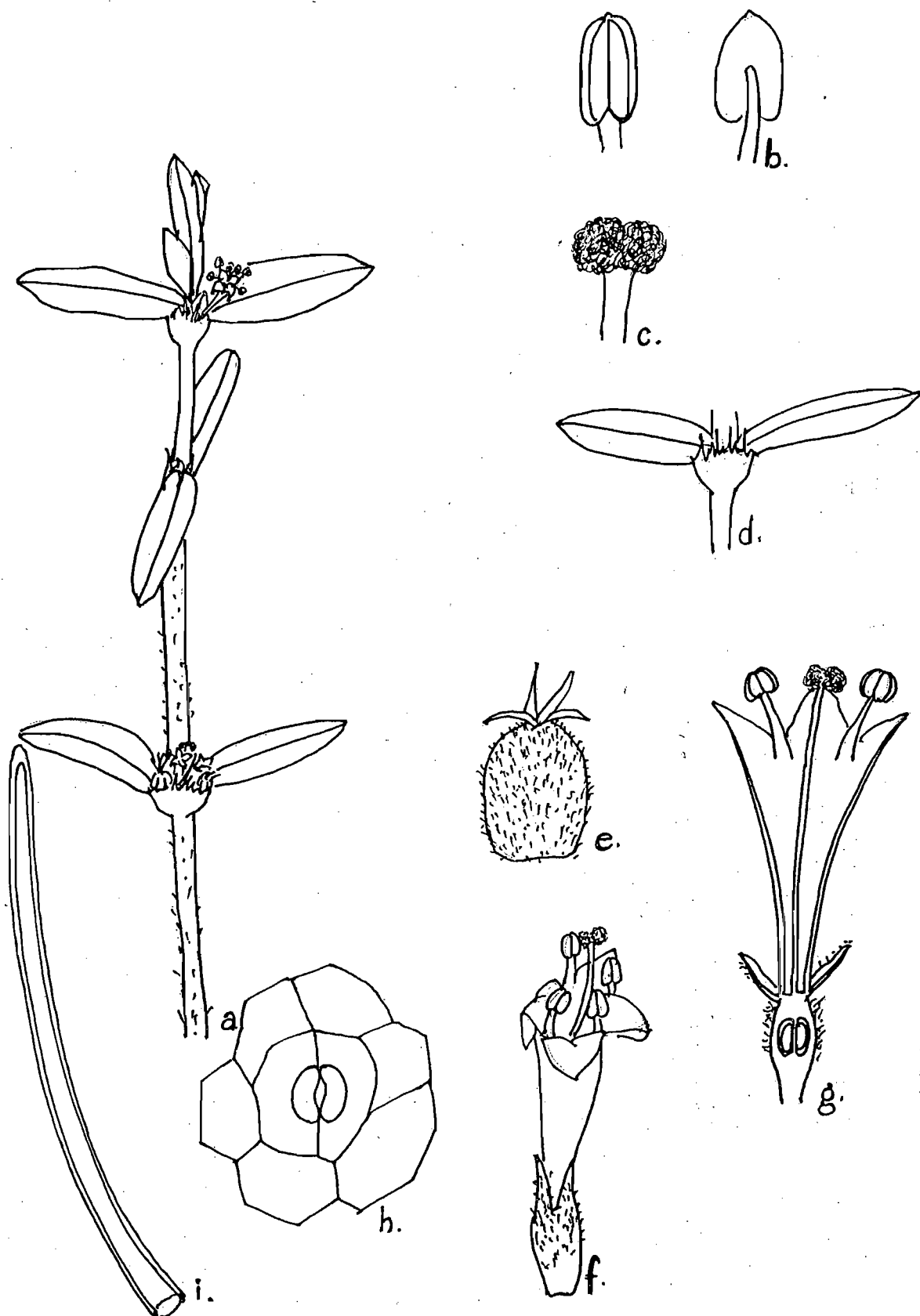


Fig. 245. *Spermacoce hispida* L. a. habit, b. stamen, c. stigma and style, d. stipule, e. gynoeceium, f. flower, g. L.S. of flower, h. paracytic stomata, i. unicellular thick walled trichome with broad lumen.

6. *Stephegyne parvifolia* (Roxb.) Korth., *Verh. Gesch. Nat. Hot.* 161. 1840.

A large deciduous tree, glabrous or pubescent. Leaves variable in size and shape, upto 13 cm long, elliptic, suborbicular, or obovate, bluntly acuminate at the apex, glabrous on both sides; main nerves 6-8 pairs, oblique; stipules upto 1 cm long, oblong-spathulate, obtuse, parallel-nerved, pink. Flowers greenish yellow, fragrant; peduncles solitary, terminal, short, each carrying a globose head of flowers; usually two bracteate; Bracteoles paleaceous. Calyx 5 toothed, funnel shaped; limb truncate. Corolla upto 1 cm long; tube narrowly infundibuliform, glabrous; lobes triangular-ovate, acute, recurved. Stamens 5, on the throat or below the apex of the corolla tube; filaments short, filiform; anthers oblong, apiculate. Disk annular. Ovary 2-celled; ovules numerous, on pendulous placentas, imbricate upwards; style white, much exserted; stigma mitriform. Head of rounded tops and 10 blunt ribs. (Fig. 246)

Vernacular name: Kadamb.

Flowers: May-August.

Micromorphology (Fig. 246)

The plant showed presence of unicellular, non-glandular trichome with thick wall and a broad lumen.

Stomata were anomocytic and paracytic

D/658, 741.

Asteraceae

1. *Acanthospermum hispidum* DC. *Prodr.* 5:522. 1836.

Annual, erect, much-branched hispid-pilose herbs reaching a height of 60 cm. Leaves sessile, obovate, oblique at apex, upto 8cm long, crenate-serrate, pubescent on both surfaces. Heads 4.5 mm in diameter. Involucral bracts 2-seriate; outer bracts longer, elliptic or ovate; inner bracts linear. Ray florets 1.5 mm long, ligulate; disc florets 2 mm long, tubular, 5-lobed. Achenes 1 cm long, compressed, 5-10 together with lateral hooked spinules and 2 large straight spines. Pappus absent. (Fig. 247)

Vernacular name: Kanti.

Flowers: July-November.

Micromorphology (Fig. 248)

Leaf showed presence of multicellular, uniseriate, unbranched, non-glandular trichomes were also present.

Two types of trichomes were present on both calyx and corolla; both of the trichomes were of multicellular, glandular, which were distinctly differentiated into a multicellular head and a multicellular, uniseriate stalk. The only difference between both types of trichomes was that one was with 4-12 celled head and another was with 4-8 celled head.

In addition to above mentioned trichomes multicellular, uniseriate, unbranched, non-glandular trichomes were also present.

Stomata were of anomocytic types.

D/496, 930.

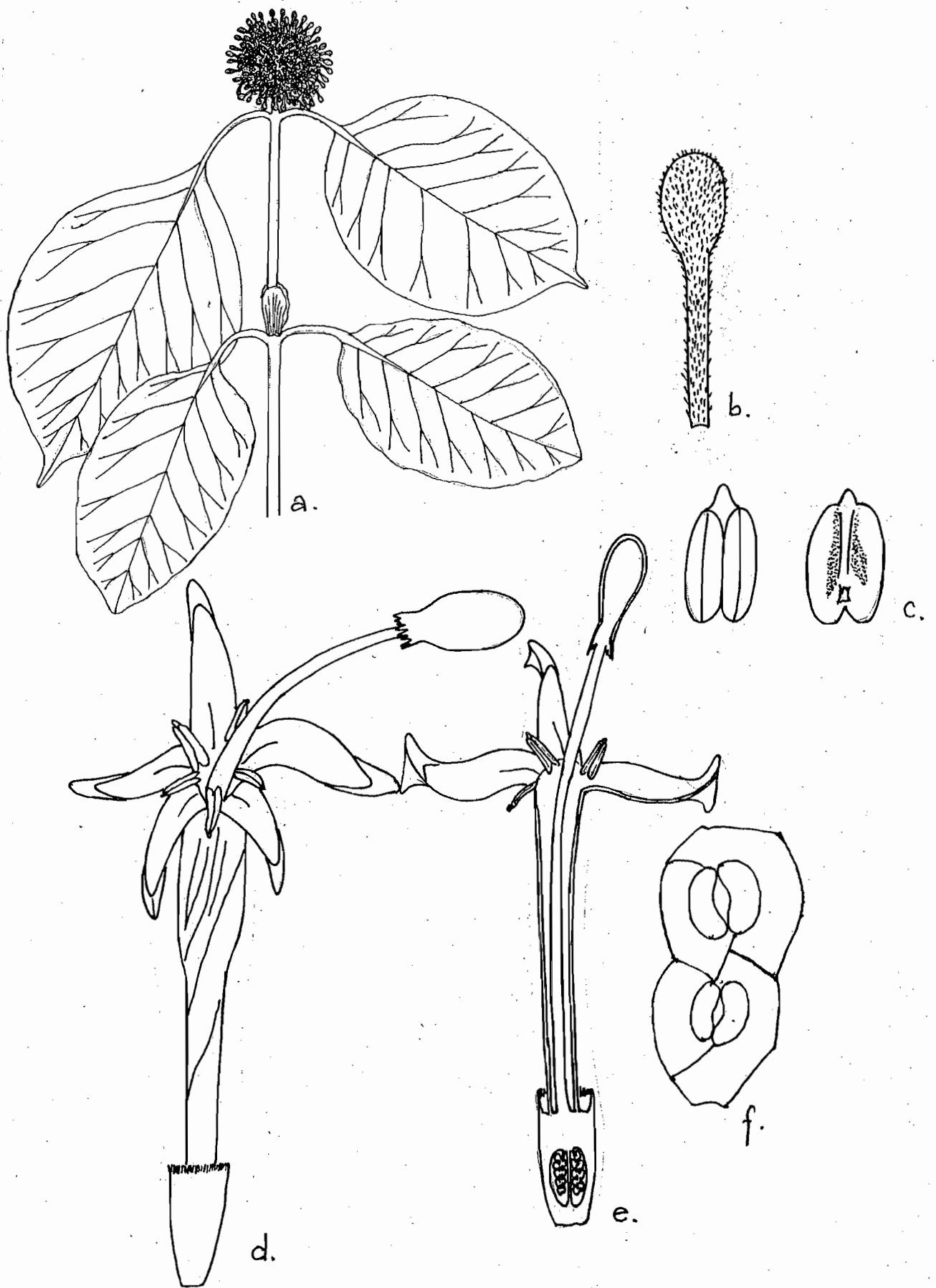


Fig. 246. *Stephegyne parviflora* (Roxb.) Korth. a. habit, b. bract, c. stamen, d. flower, e. L.S. of flower, f. paracytic stomata.

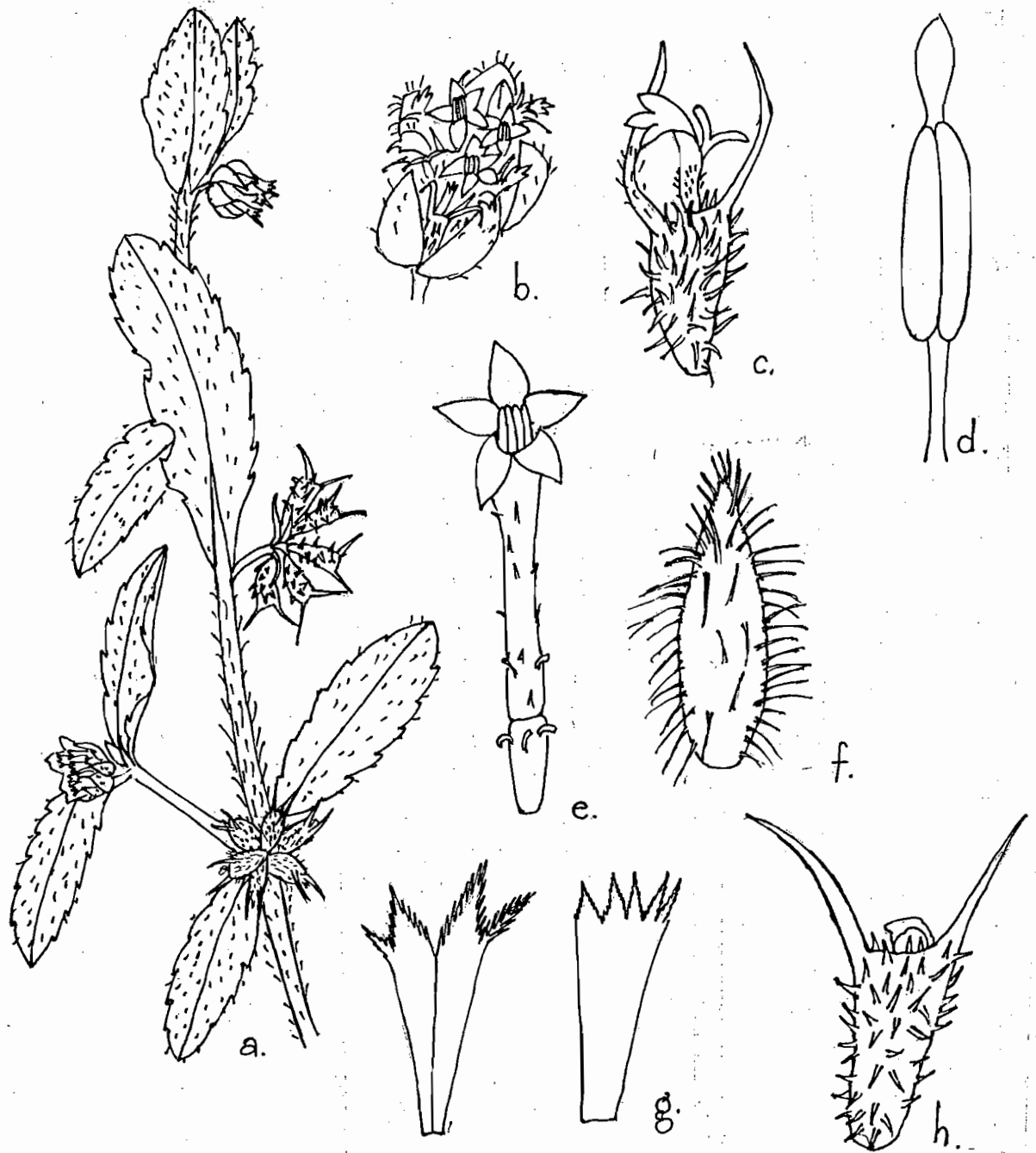


Fig. 247. *Acanthospermum hispidum* DC. a. habit, b. inflorescence, c. ray floret, d. stamen (apiculated), e. disc floret, f-g. bract, h. achene.

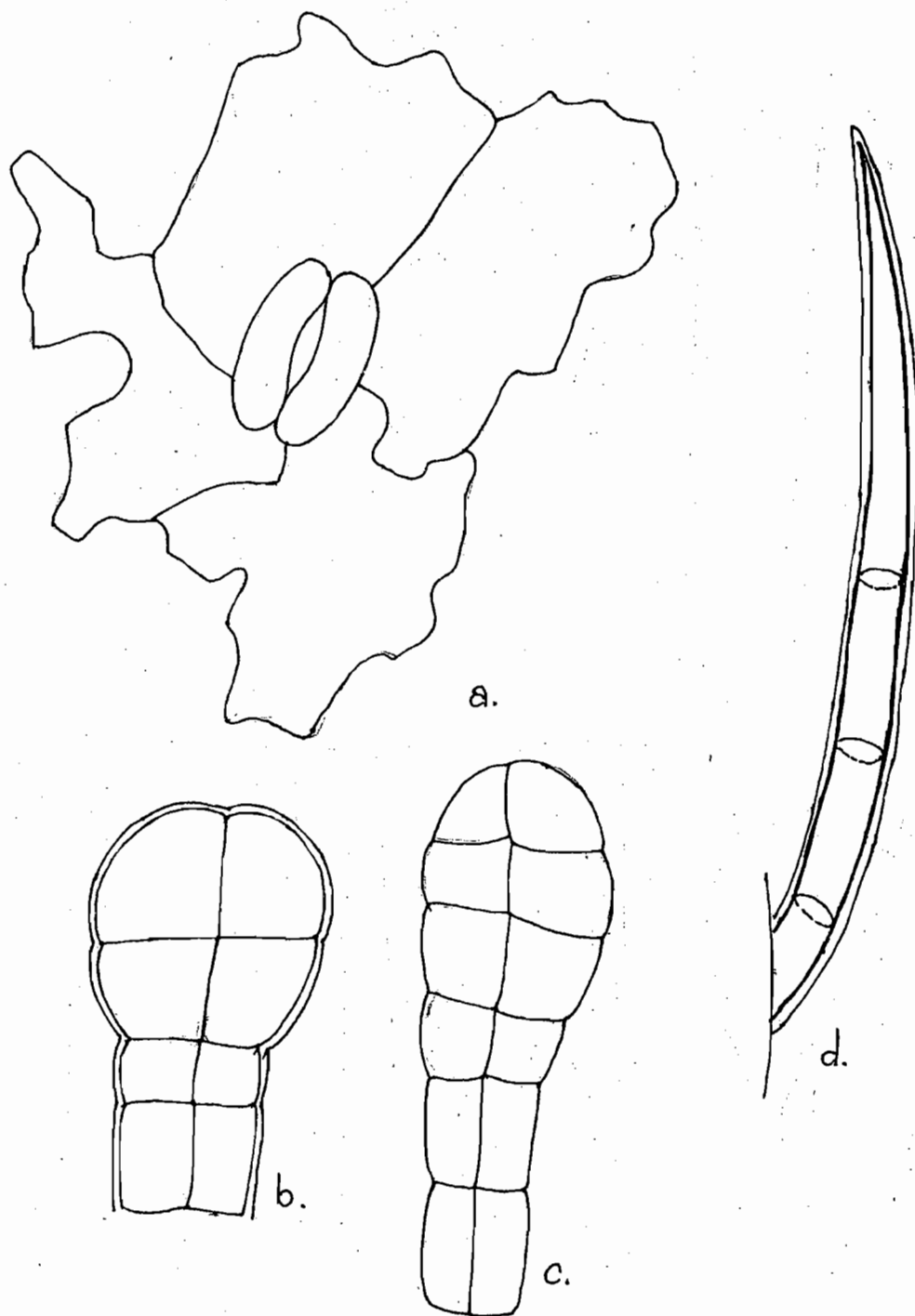


Fig. 248. *Acanthospermum hispidum* DC. a. anomocytic stomata, b&c. Gland differentiated into four to many celled head and a biseriate stalk, d. uniseriate trichome.

2. *Ageratum conyzoides* Linn. Sp. Pl. (1753) p. 839.

An erect, branched foetid annual, upto 1 m high. Leaves opposite, but the upper ones alternate, upto 8 cm long, broadly ovate, subacute, crenate and with ciliate margins, more or less hairy on both sides. Petioles long, hairy. Heads homogamous, small, in dense terminal corymbs; flowers pale-blue or white. Involucral bracts linear, 2-3 seriate, very acute, ribbed on the back, ciliolate and with scarious margins. Receptacle flat. Pappus of 5 aristate scales, dilated at the base, serrulate, about equaling the corolla. Corolla tubular, regular, the tube scarcely distinct from the shortly 5-fid limb. Anthers appendiculate at the apex, obtuse at the base. Style arms elongate, obtuse. Achenes sharply angled, sometimes glandular, attenuated at the base, black. (Fig. 249)

Vernacular name: Mankadamri.

Flowers: November-March.

Micromorphology (Fig. 249)

The plant showed presence of multicellular, sessile, glandular, biseriate trichome having 4- 8 cells.

Stomata were of anomocytic type.

D/233.

3. *Ageratum houstonianum* Mill. Gard. Dict. ed. 8. n. 2. 1768

An erect or decumbent glandular hirsute annual herb reaching a height of 1m. Leaves ovate or broadly ovate, upto 10 cm. long, acute, sharply serrate at margins, whitish hirsute on both surfaces. Heads 5 mm in diameter, in dense corymbs. Involucral bracts 2-seriate; outer bracts 4.5 mm long, linear-lanceolate, acuminate, margins entire, glandular-pubescent; inner bracts 4 mm long, linear-lanceolate. Pappus consists of 5 lanceolate scales. Corolla white, blue or mauve, 5-lobed. Achenes 1.75 mm long, linear-lanceolate, black, scabrous on the ribs. (Fig. 250)

Flowers: November-January.

Micromorphology (Fig. 251)

Stem showed the presence of three types of trichomes: 1) Multicellular, uniseriate, unbranched, non-glandular trichome with small cells arranged end to end. 2) Multicellular, glandular differentiated into a head and a multicellular multiseriate stalk. 3) Multicellular, uniseriate unbranched trichome with big cells.

Leaf showed presence of two types of trichomes: 1) Multicellular, glandular, and differentiated into a multicellular head and a multicellular stalk. The head was 4-8 celled, and the stalk was multicellular, multiseriate. 2) Multicellular, glandular, differentiated into a single celled head and stalk was multicellular, uniseriate.

Corolla showed presence of four types of trichomes: 1) Multicellular, uniseriate, unbranched, non-glandular trichome. 2) Multicellular, uniseriate trichome with apical cell with lot of secretory substances and it was club shaped. 3) two celled, non-glandular trichome. 4) Multicellular, uniseriate, unbranched, non-glandular trichome. 5) two celled non-glandular trichome, cells were arranged side by side and they had presence of pitted walled in between. 6) Multicellular, glandular, and differentiated into a multicellular head

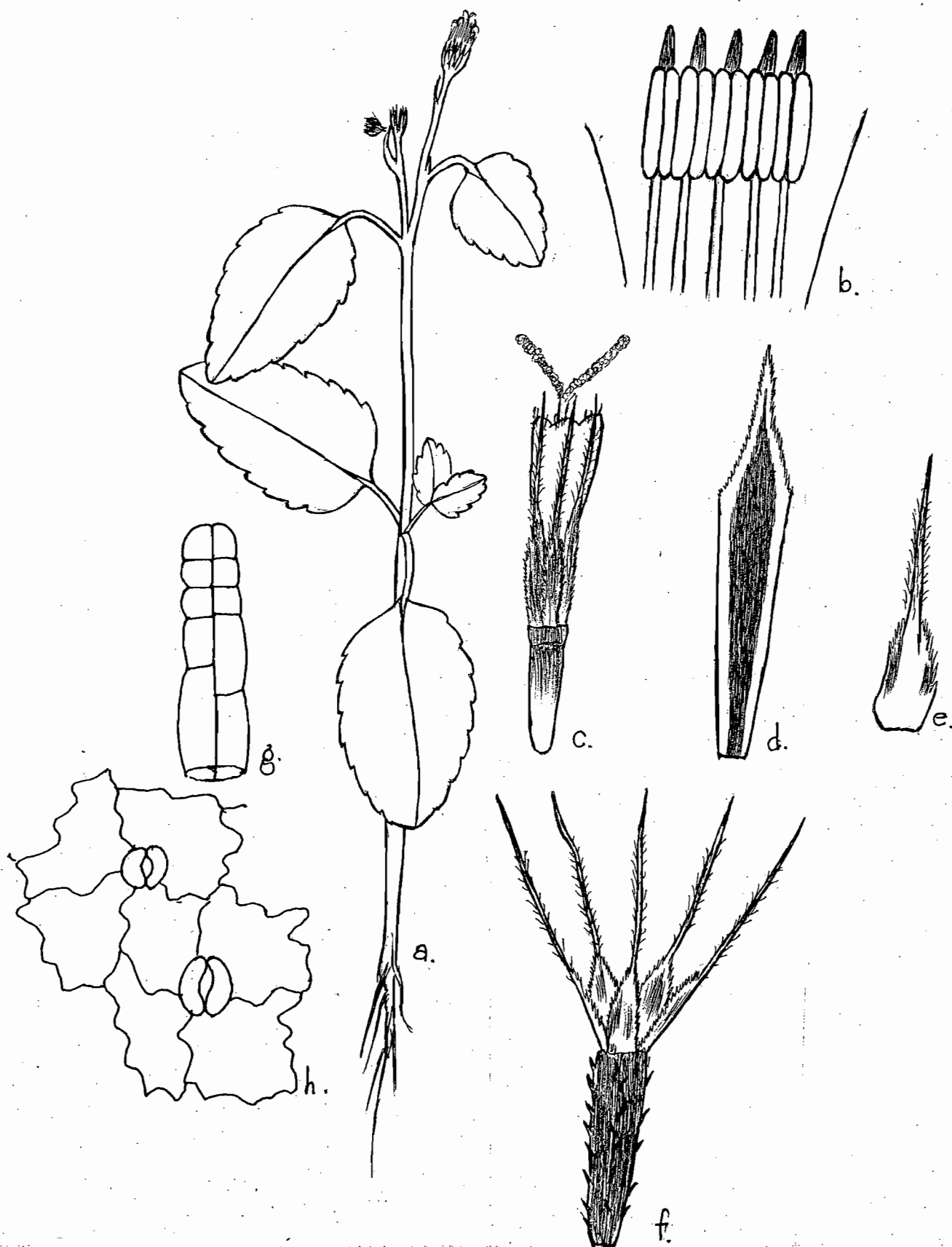


Fig. 249. *Ageratum conyzoides* L., a. habit, b. syngenesious stamens, c. disc floret, d-e. involucre bracts, f. achene, g. gland with multicellular head and biseriate stalk, h. anomocytic stomata

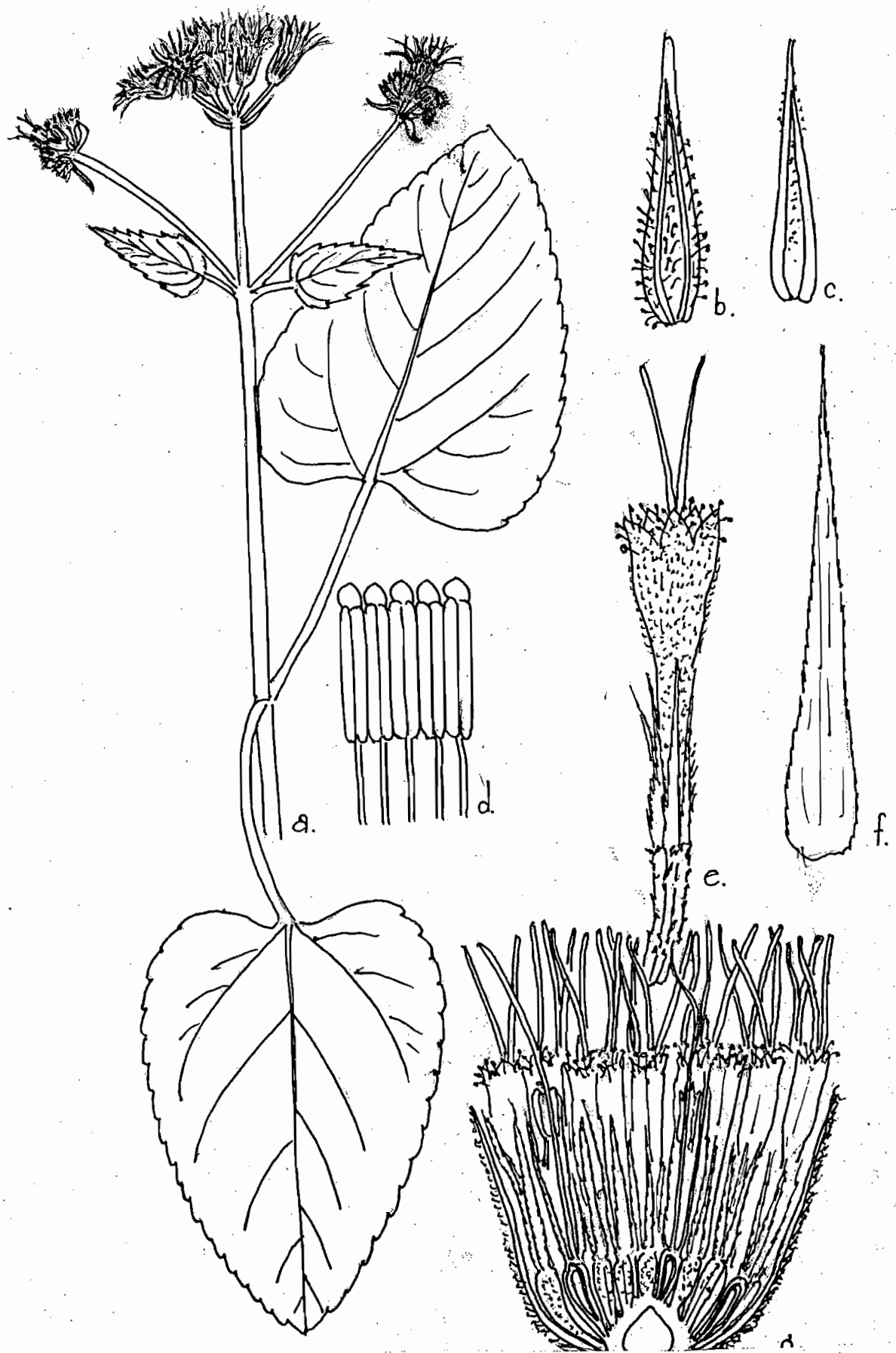


Fig. 250. *Ageratum houstonianum* Mill. a. habit, b & c. involucral bracts, d. stamens (apiculate), e. disc floret, f. pappus, g. L.S. of head.

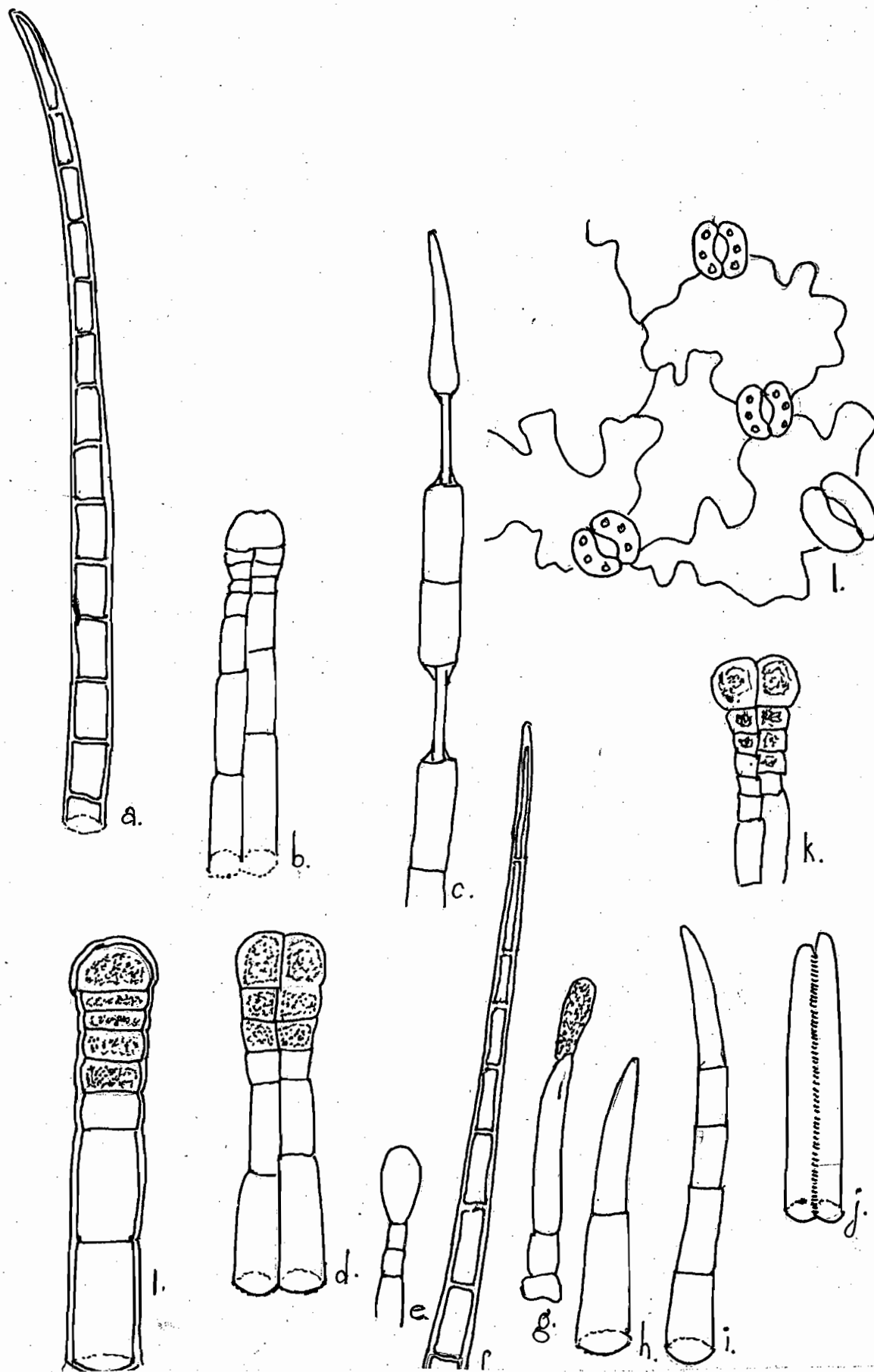


Fig. 251. *Ageratum houstonianum* Mill. a, f and i. multicellular uniseriate trichomes, b. gland with a multicellular head and biseriate stalk, c. uniseriate trichome with certain cells placed at right angles to the adjacent cells, d, k, & l. glands with multicellular head (two - many celled and three-four tiered) and uniseriate or biseriate stalk, e & g. glands with a single celled head and uniseriate stalk, h. two celled trichome j. two celled biseriate trichome.

and a multicellular stalk. The head was 4-8 celled, and the stalk was multicellular, multiseriate.

Stomata were of anomocytic types.

D/150.

4. *Bidens pilosa* Linn. *Sp. Pl.* (1753) p. 832.

An erect annual of 1m. in height quadrangular, grooved stems. Leaves usually consisting of 2 subopposite pairs of leaflets and a deeply 3-lobed terminal leaflet which is larger than the lateral ones, the lowest pair of leaflets sometimes again pinnately divided. Petioles somewhat dilated and sheathing at the base. Heads heterogamous, upto 1.5 cm in diameter, elongating in fruit. Outer Involucral bracts herbaceous, oblong, subacute, shorter than the inner, ciliate and with scarious margins. Receptacle somewhat convex. Ray-flowers ligulate, white or yellow, Pappus of 2-4 rigid retrorsely hispid slightly spreading awns. Corolla narrow, strap shaped. Disk flowers usually yellow, regular, tubular, with a 5-fid cylindric limb. Anther cells entire at the base. Styles arms hairy above. Achenes linear, quadrangular. (Fig. 252)

Vernacular name: Karakokdi.

Flowers nearly all the year.

Micromorphology (Fig. 253)

The plant showed presence of unicellular, elongated trichome with thick warty wall.

Stomata were of anisocytic and anomocytic types.

D/304

5. *Blainvillea acmella* (L.) Philipson *Blumea* 6 350 1950. (*Spilanthes acmella* Murr.)

An erect branched annual with ovate, irregularly serrated leaves. Heads axillary or terminal, heterogamous and rayed or homogamous and disciform; ray flowers female, fertile, 1-seriate; disk flowers, slightly unequal. Receptacle convex, elongate; paleae folded, enclosing the bisexual flowers. Involucral bracts oblong-lanceolate. Corolla of female flowers ligulate, ligules small, white or yellow, entire or 2-3 toothed; corollas of bisexual flowers regular, tubular, the limb enlarged or narrowly campanulate, 4-5 fid. Anther-bases truncate, entire or rarely minutely 2-toothed. Style-arms of bisexual flowers long, truncate. Pappus 0. Achenes oblong or slightly obovoid, truncate, much compressed. (Fig. 254)

Vernacular name: Akkalgaro.

Flowers: August-October.

Micromorphology (Fig. 255)

Both uniseriate and biseriate trichomes were seen. The former were three-many celled and long pointed. Biseriate trichomes were two-four celled.

Stomata were anomocytic.

D/970.

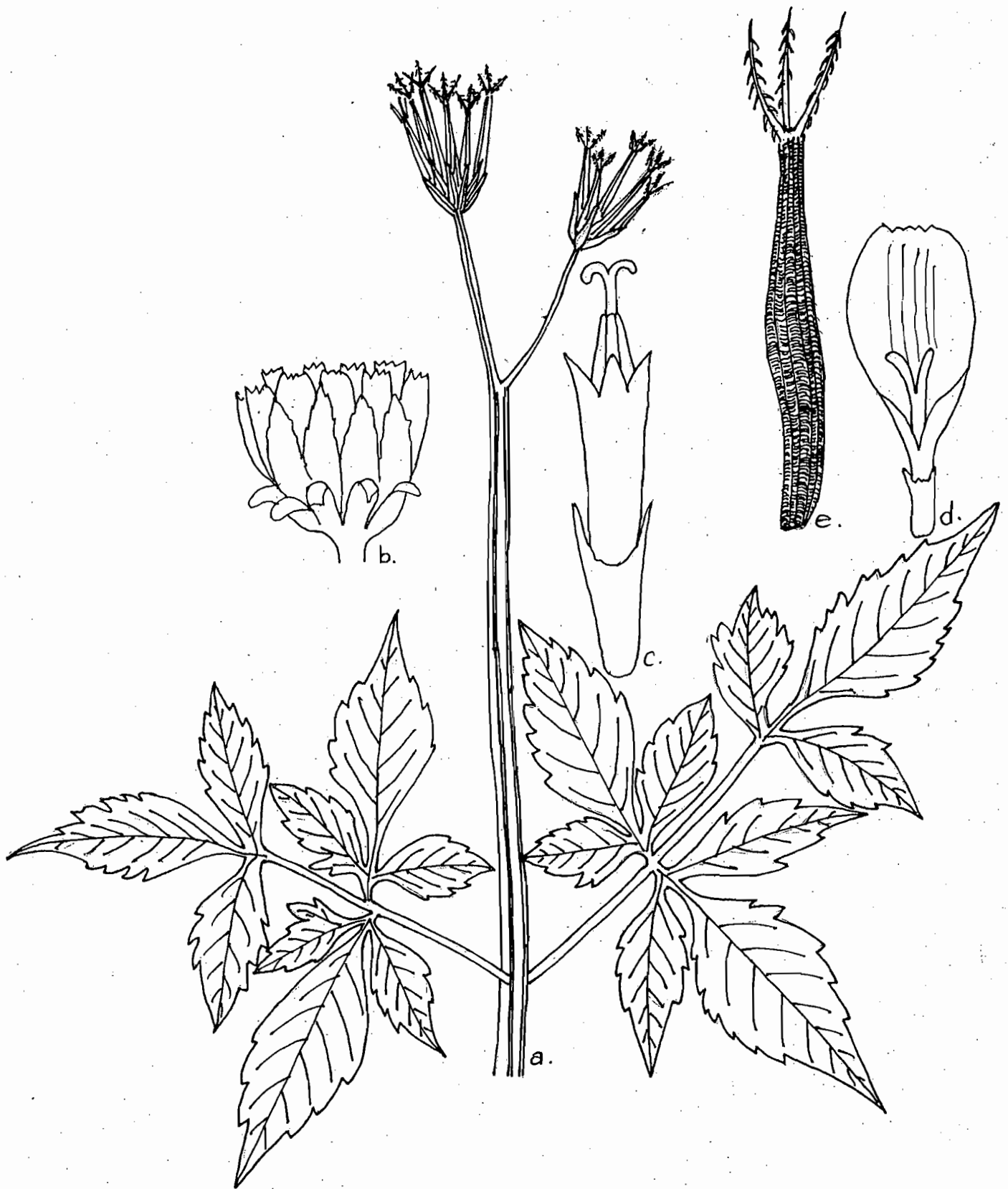


Fig. 252. *Bidens pilosa* Auct. a. habit, b. head, c. disc floret, d. ray floret, e. achene.

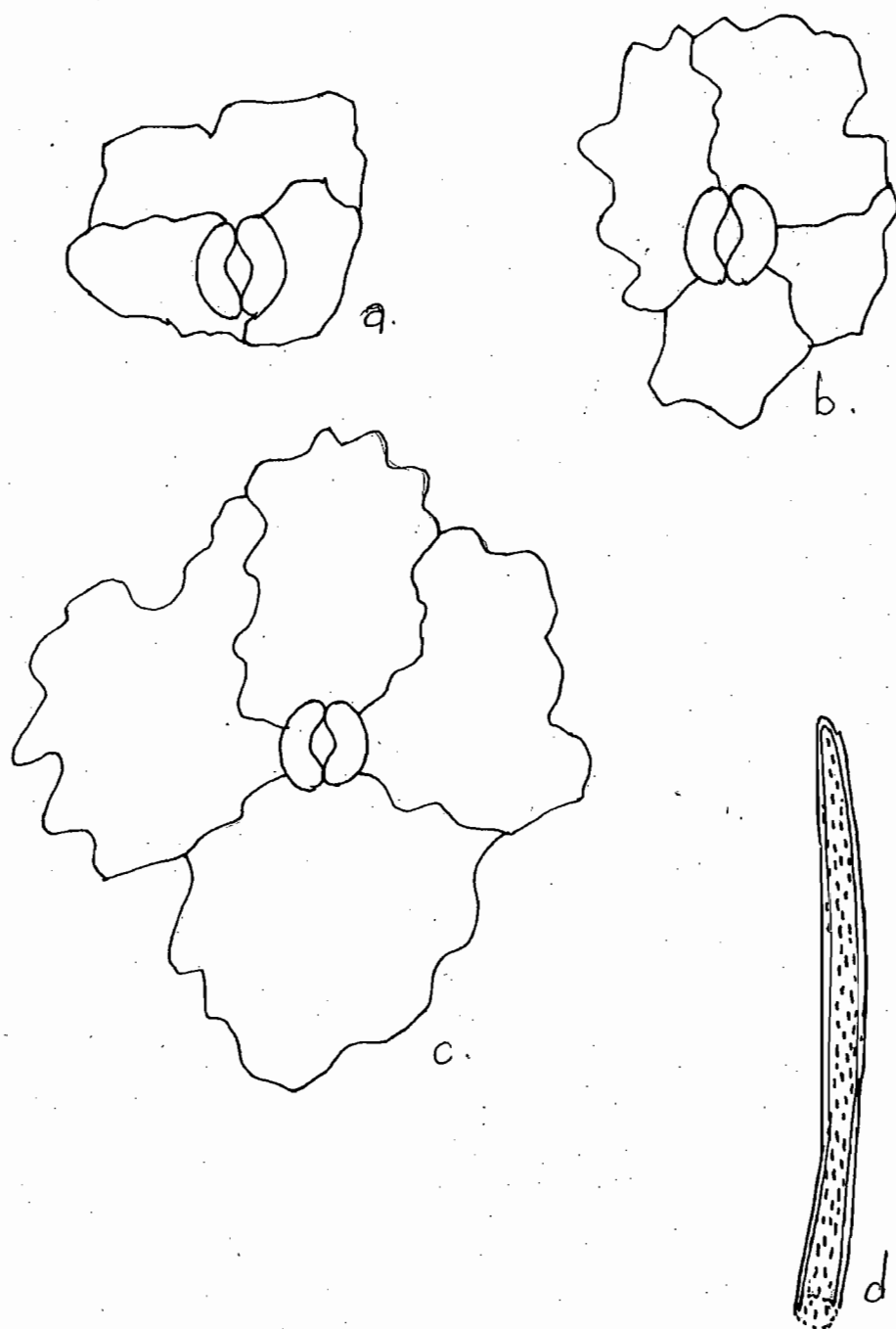


Fig. 253. *Bidens pilosa* Auct. a. anisocytic stomata, b&c. anomocytic stomata, d. unicellular trichome with warty thick wall.

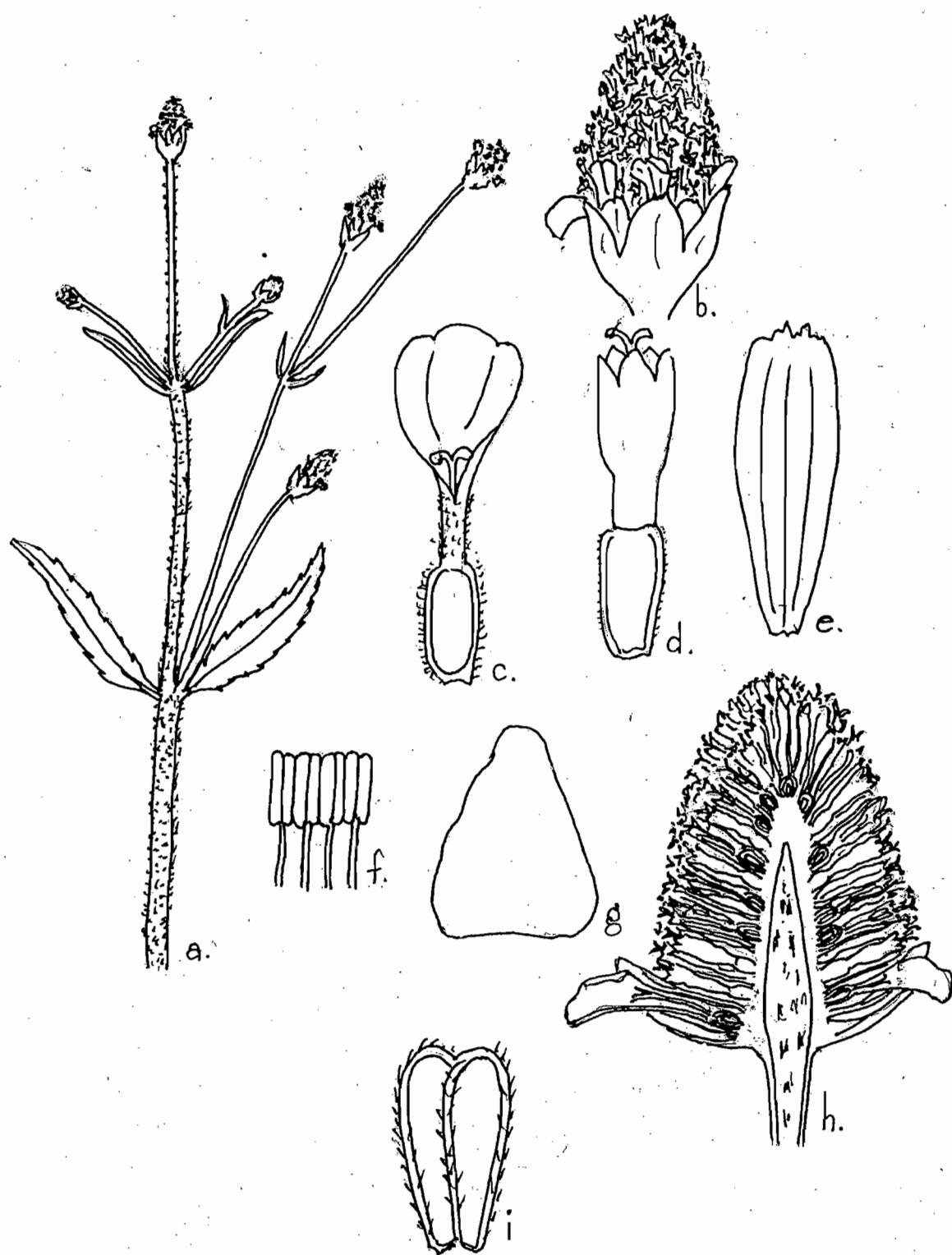


Fig. 254. *Blainvillea acmella* Philipson. Non. Murr., a. habit, b. inflorescence, c. ray floret, d. disc floret, e and g. involucre bract, f. stamen, h. L.S. head, i. achene.

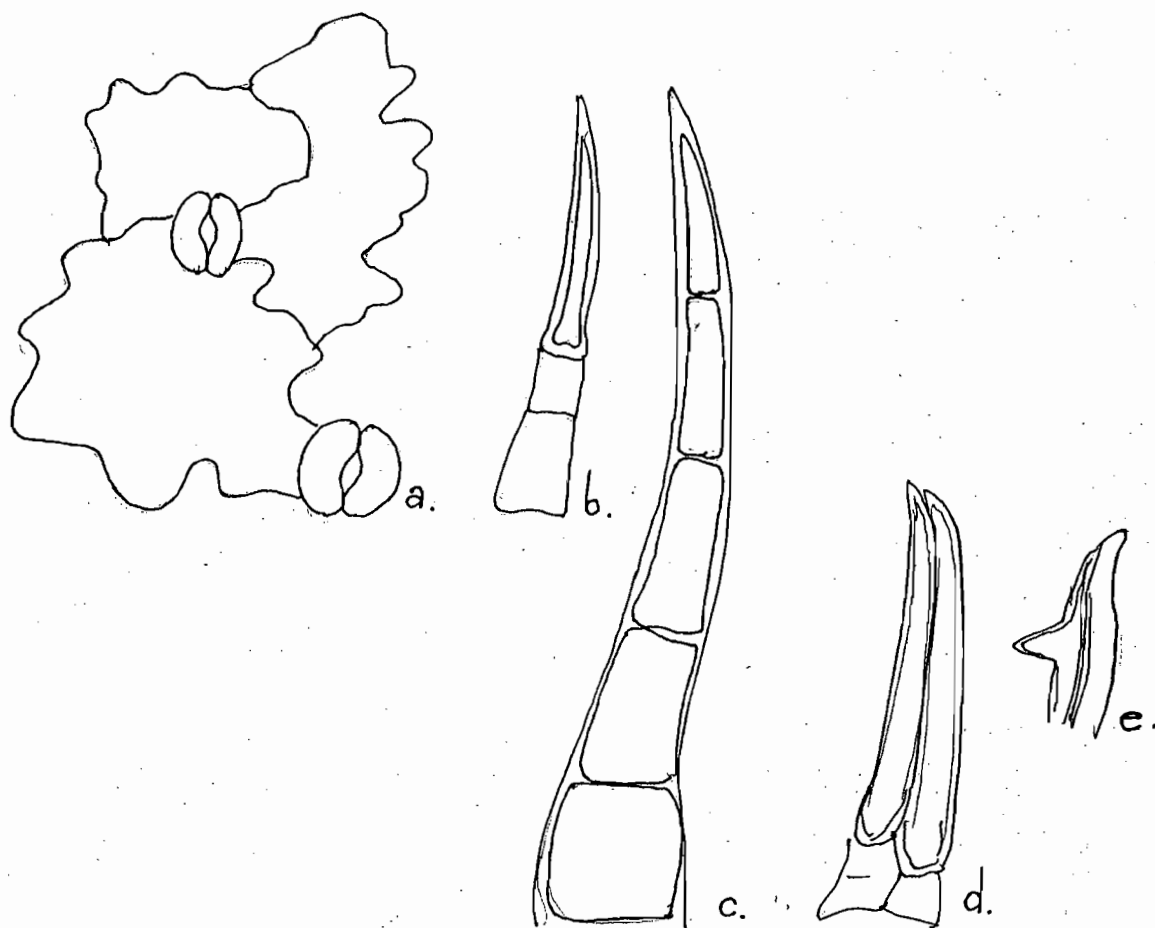


Fig. 255. *Blainvillea acmella* Philipson. Non. Murr., a. anomocytic stomata, b-c. multicellular uniseriate three-many celled trichome, d-e. two-four celled biserial trichome.

6. *Blainvillea dichotoma* (Murray) Stewart, *Proc. Calif. Acad. Sci.*, ser. 4. 2: 149. 1911.

A hispidly hairy annual with striate branched stem reaching upto 60 cm high. Leaves ovate-lanceolate 10 cm long, serrate. Heads heterogamous in erect terminal cymes. Outer involucre bracts green ovate-oblong; inner broadly oblong, striate with green nerves, pubescent, persistent after the fall of the fruit. Receptacle subconvex, furnished with rigidly membranous folded or concave palea. Ray flowers very inconspicuous; ligules yellow or whitish, bifid. Disk flowers tubular, with 5-fid limb. Anthers bases obtuse. Style arms of bisexual flowers with acute or subobtuse appendages. Pappus of a few unequal acute scales. Achenes of the ray triquetrous, slightly curved; achenes of the disk, straight. (Fig. 256)

Flowers: August-September.

Micromorphology (Fig. 257)

The plant contained two types of trichomes; 1) three-celled in which the middle cell is very long with thick warty wall and very narrow lumen, 2) uniseriate many-celled thin walled trichome.

Stomata were anomocytic.

D/159.

7. *Blumea obliqua* (L.) Druce *Rep. Bot. Exch. Club.*: 609. 1917.

An Annual of about 1.5 m height divaricately branched, more or less hairy stem. Leaves elliptic-oblong, upto 5 cm long, semi-amplexicaul, regularly and sharply toothed, the upper teeth the smaller. Heads small heterogamous, upto 1 cm long in diameter, solitary, few, terminal; flowers yellow; peduncles hairy. Involucre bracts linear-subulate, densely pubescent, the inner row tipped with a long white bristle. Receptacle glabrous. Pappus pink. Achenes minute, compressed. (Fig. 258)

Vernacular name: Kapuriyo.

Flowers: September-February.

Micromorphology (Fig. 258)

The plant showed presence of unicellular, non-glandular, elongated trichome with thick wall and broad lumen.

Stomata were of anomocytic and anisocytic types.

D/1211.

8. *Blumea eriantha* DC. in *Wight, Contrib.* (1834) p. 15.

A dichotomously branched herb of about 45 cm high. Leaves, obovate, upto 8 cm long, irregularly apicately toothed, silky-villous. Heads heterogamous 1 cm in diameter, on the long slender silky-hairy peduncles of dichotomous cymes. Corolla-lobes of bisexual flowers hairy. Receptacle glabrous. Involucre bracts linear, clothed with long silky hairs. Anther-bases sagittate; tails usually slender. Style-arms of the bisexual flowers flattened or almost filiform, somewhat acute, papillose on the back, rarely connate so as to form one undivided style. Achenes minute angled, with a few hairs on the angles. (Fig. 259)

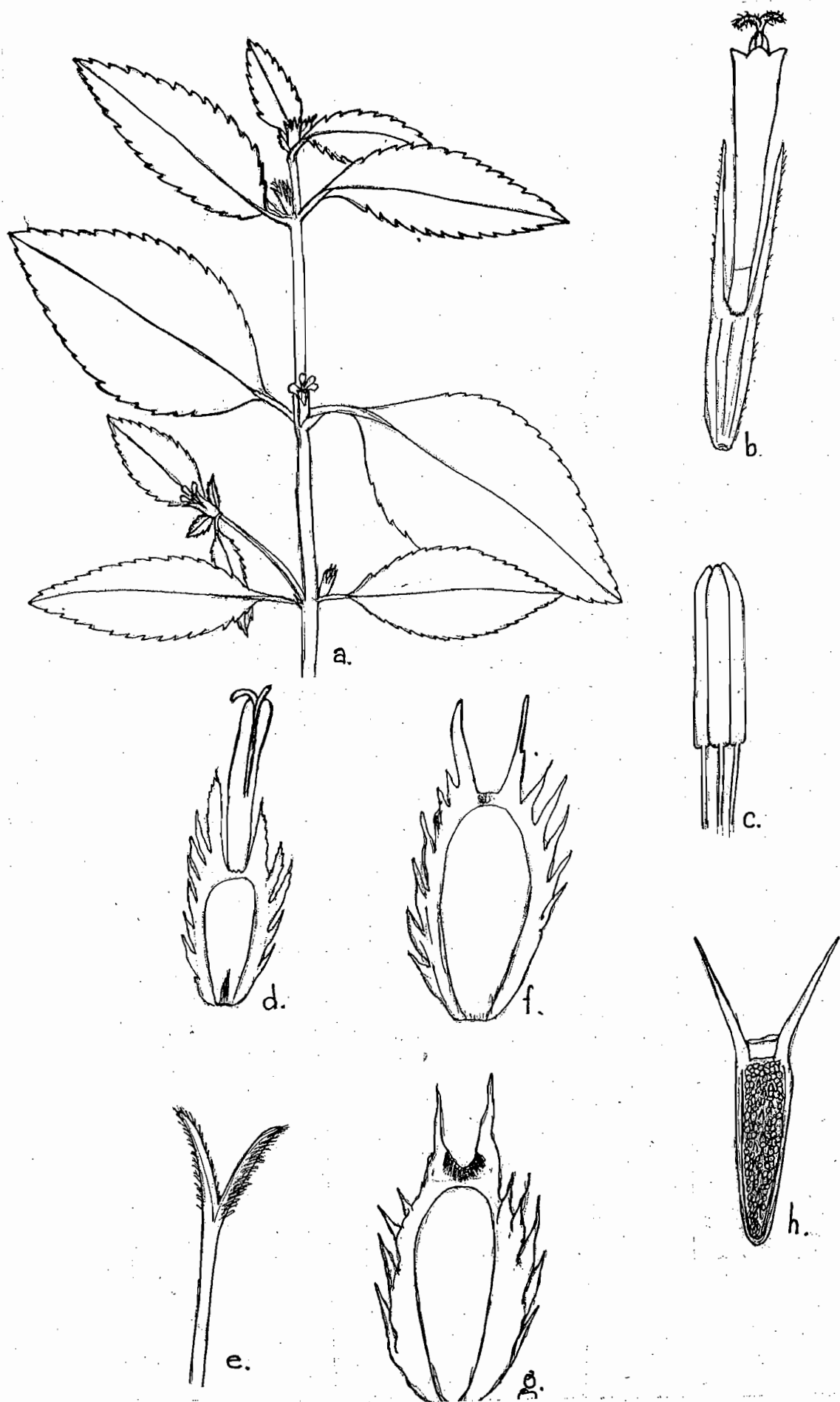


Fig. 256. *Blainvillea dichotoma* Stewart., a. habit, b. disc floret, c. syngenesious stamens, d. ray floret, e. stigma and style, f. & g. achene from ray floret, h. achene from disc floret.

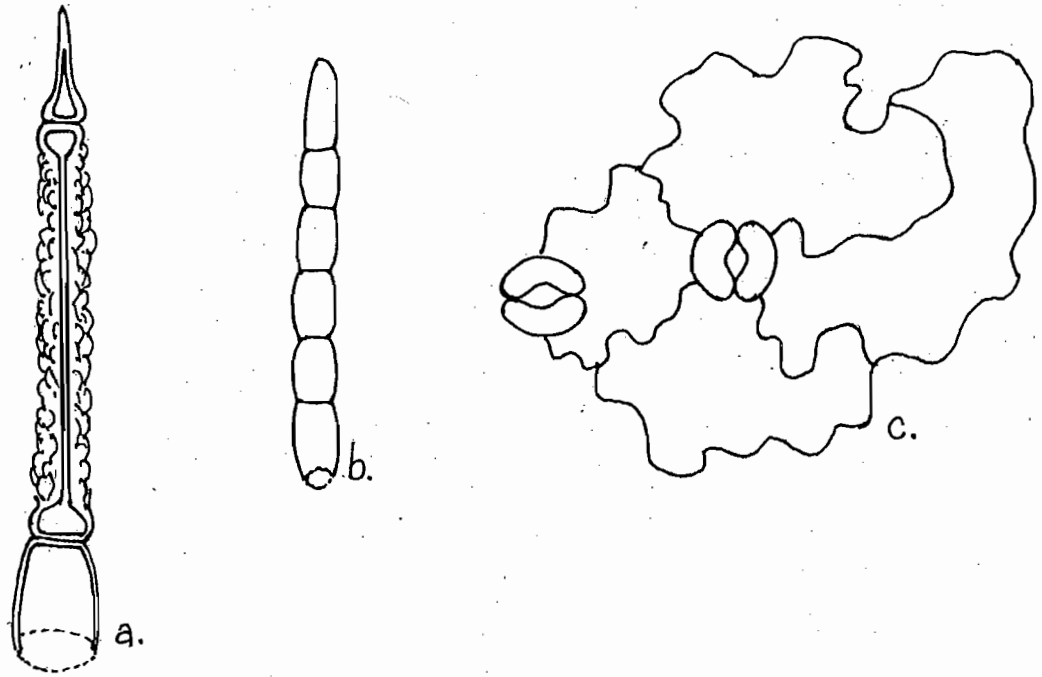


Fig. 257. *Blainvillea dichotoma* Stewart. a. three celled trichome with middle cell long and thick warty walled, b. multicellular uniseriate trichome, c. anomocytic stomata.

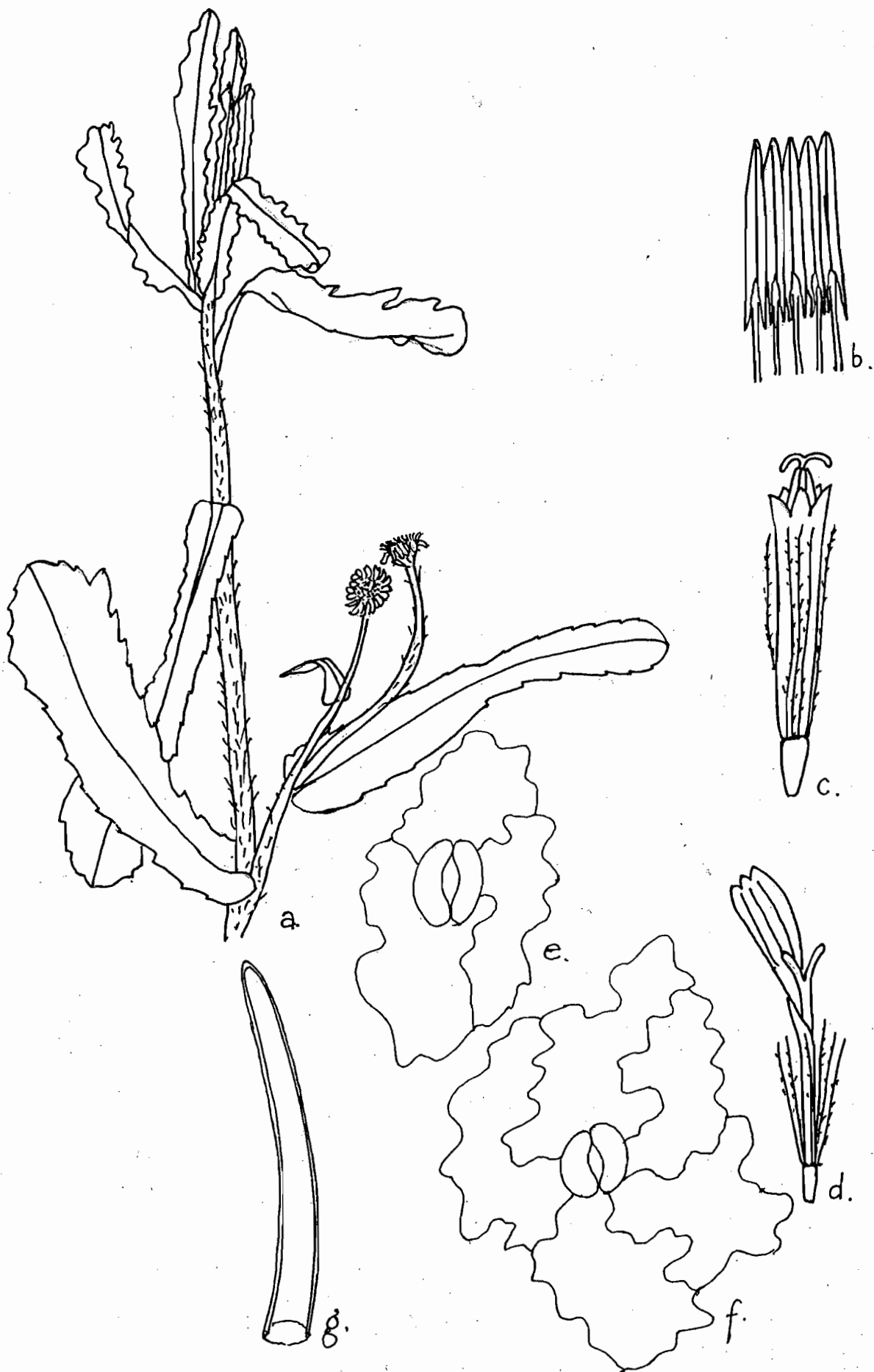


Fig. 258. *Blumea obliqua* Druce. a. habit, b. stamens with tailed anthers, c. disc floret, d. ray floret, e. anisocytic stomata, f. anomocytic stomata, g. unicellular trichome.

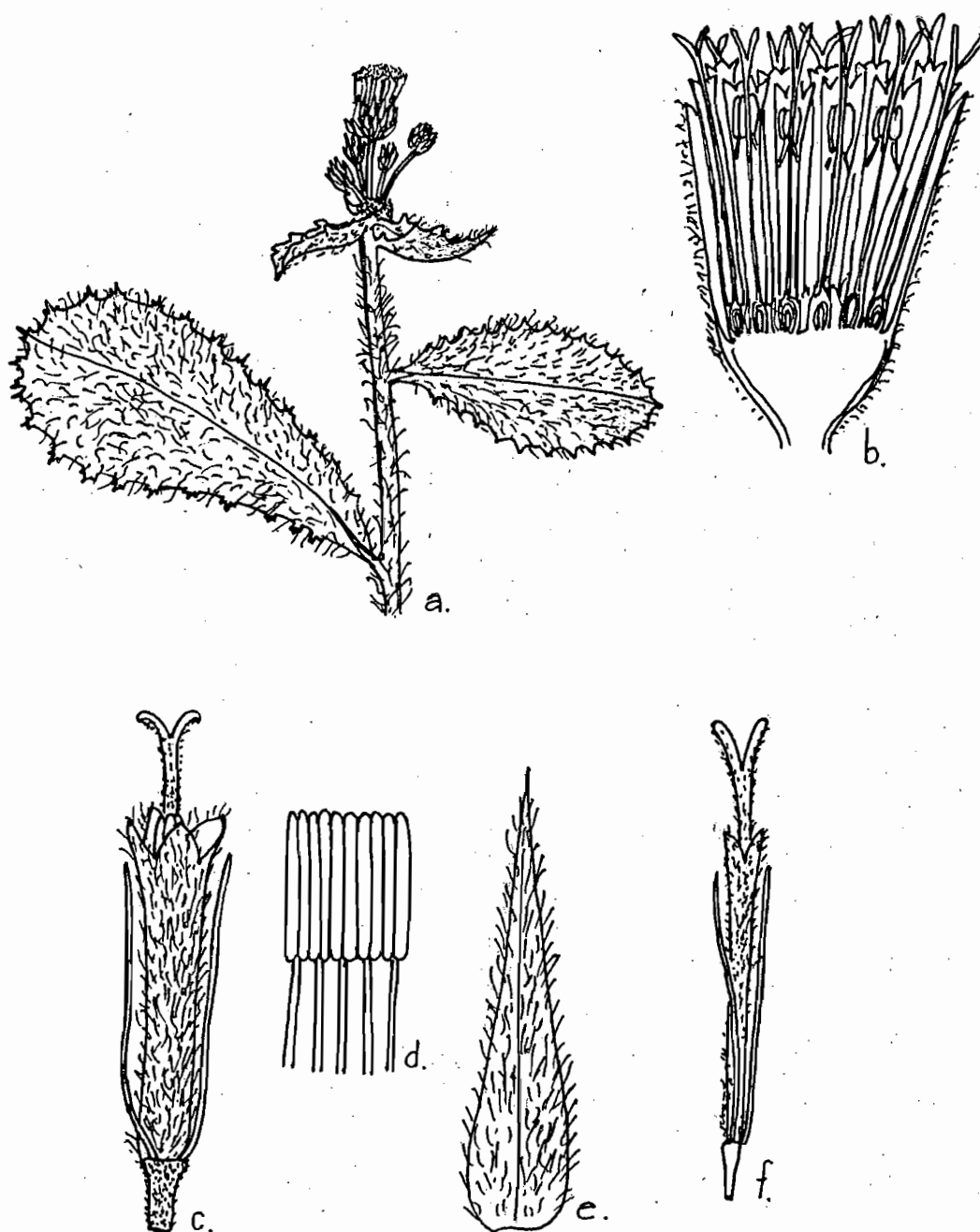


Fig. 259. *Blumea eriantha* DC., a. habit, b. L.S. of head, c. disc floret, d. stamen, e. involucral bract f. female flower.

Vernacular name: Kapuriyo, Kalhar.

Flowers: December-February.

Micromorphology (Fig. 260)

The plant showed presence of two types of trichomes: 1) Multicellular, glandular, and differentiated into a multicellular head and a multicellular, multiseriate stalk. 2) Multicellular, uniseriate, non-glandular, trichome with rectangular or squarish cells.

Stomata were of anomocytic and anisocytic types.

D/1141.

9. *Blumea membranacea* DC. Prodr. V. 5. (1836) p. 440.

A glandular-pubescent annual of about 60 cm high. Leaves obovate, or often lyrate thinly membranous, sometimes reaching 15 cm, coarsely and deeply serrate, base running down like a wing into the petiole. Heads numerous, on glandular-hairy much-branched open panicles. Involucral-bracts glandular-pubescent. Receptacle flat, naked. Corollas of female flowers filiform, minutely 2-3 toothed, those of bisexual flowers regular, tubular, slender, with 5-toothed limb. Anther bases sagittate; tails slender. Style arms of the bisexual flowers flattened, papillose on the back. Pappus white, slender, 1-seriate, caducous. Achenes ribbed. (Fig. 261)

Vernacular name: Mharbir.

Flowers: December-February.

Micromorphology (Fig. 262)

The plant showed presence of multicellular, glandular, trichome differentiated into distinct head and a stalk. The head was 4-12 celled. Stalk was multicellular and multicellular. Another type of trichome was multicellular, uniseriate, non-glandular, with a basal swollen cell.

Stomata were of anomocytic and anisocytic types.

Variety *muralis* Hook. f. Fl. B. I. V. 3, p. 265.

Glandular-hairy. Leaves very tender, elliptic, ovate or lanceolate, the lower often lyrate or pinnatifid, toothed or serrulate, very membranous. Involucral bracts rigid, pink-colored. (Fig. 263)

Micromorphology (Fig. 264)

The leaf showed presence of multicellular, uniseriate, glandular trichome with broad rectangular cells, containing ergastic substances and an apical cell which was pointed. Stem showed presence of multicellular, uniseriate, glandular trichome with swollen broad rectangular shaped cells at the base whereas apical portion of the trichome had elongated cells at the top, some of the cells contained ergastic substances. All the cells of the trichomes were thick walled.

Corolla showed presence of unicellular, non-glandular, elongated trichome was present with a round bottom and sometimes a flat base. The trichome was thick walled.

Stomata were of anomocytic types.

D/137, 493.

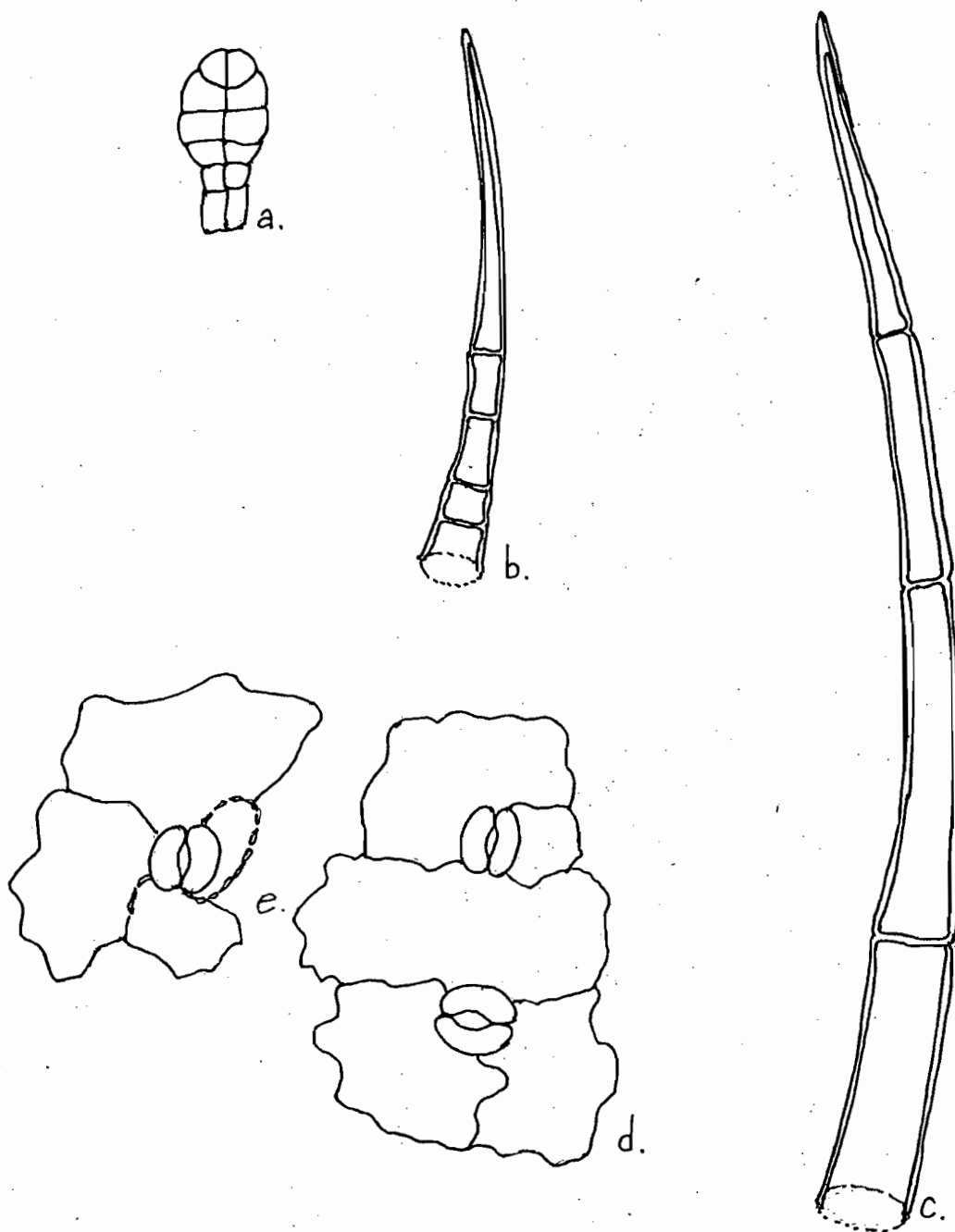


Fig. 260. *Blumea eriantha* DC., a. gland with a multicellular head and biseriate stalk, b. uniseriate trichome with short basal cells, c. uniseriate three-four celled trichome with long cells, d. anisocytic and anomocytic stomata, e. anisocytic stomata with subsidiary cells having pitted wall.

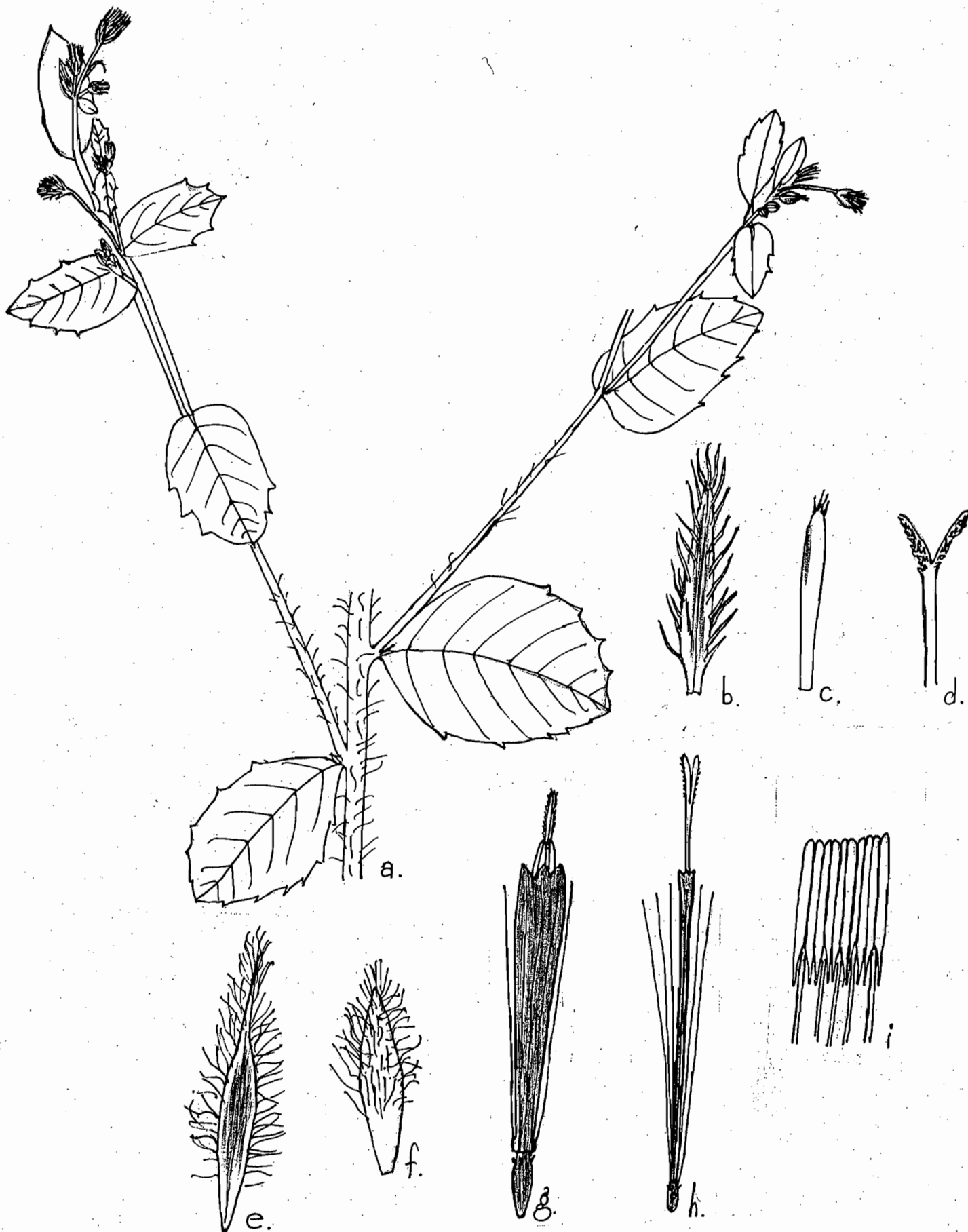


Fig. 261. *Blumea membranacea* DC., a. habit, b-c. involucral bracts, d. stigma and style, e-f. involucral membranous bracts, g. bisexual floret, h. female floret, i. stamens.

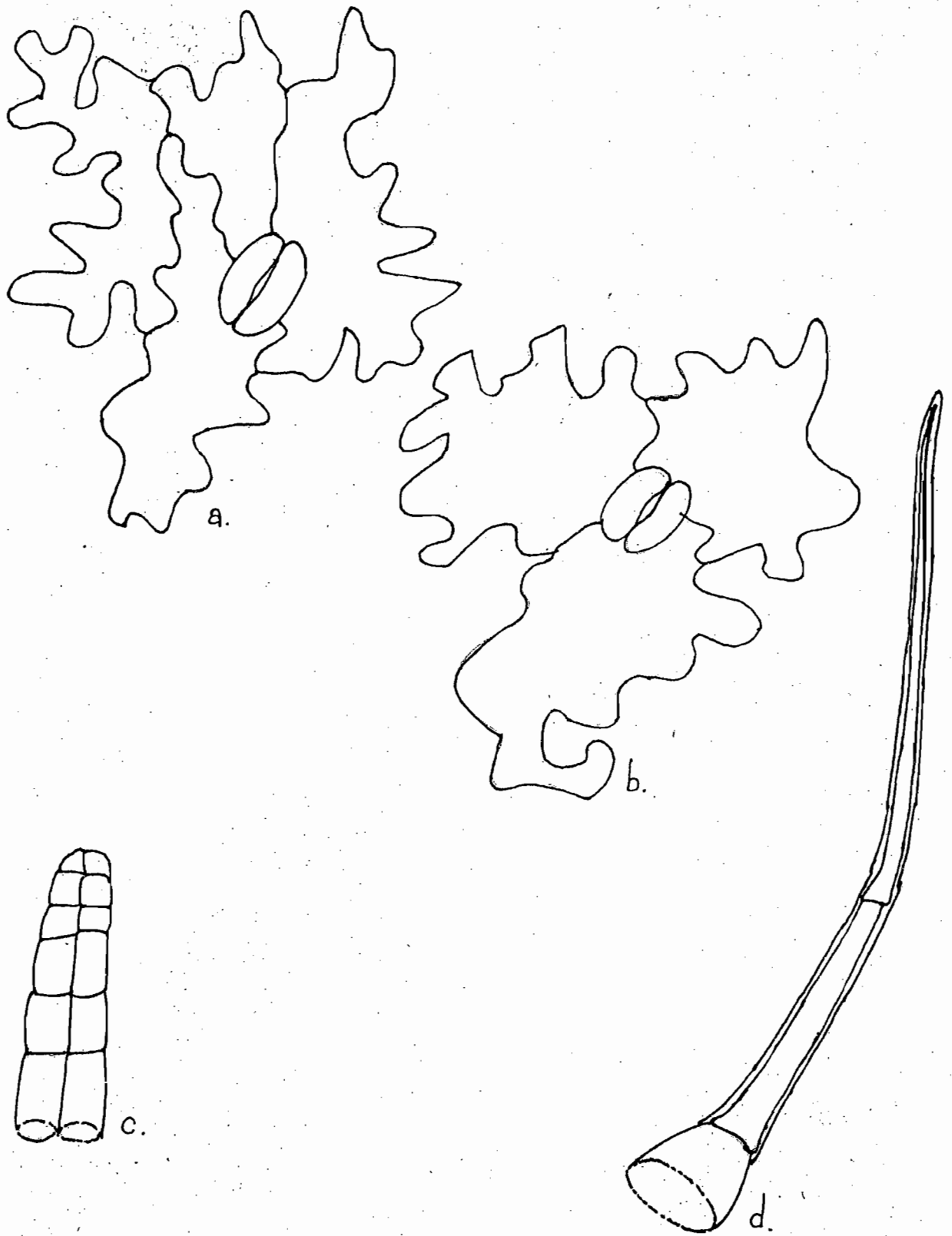


Fig. 262. *Blumea membranacea* DC., a. anomocytic stomata, b. anisocytic stomata, c. gland with a biseriate head and biseriate stalk d. three-celled trichome with broad basal cell.

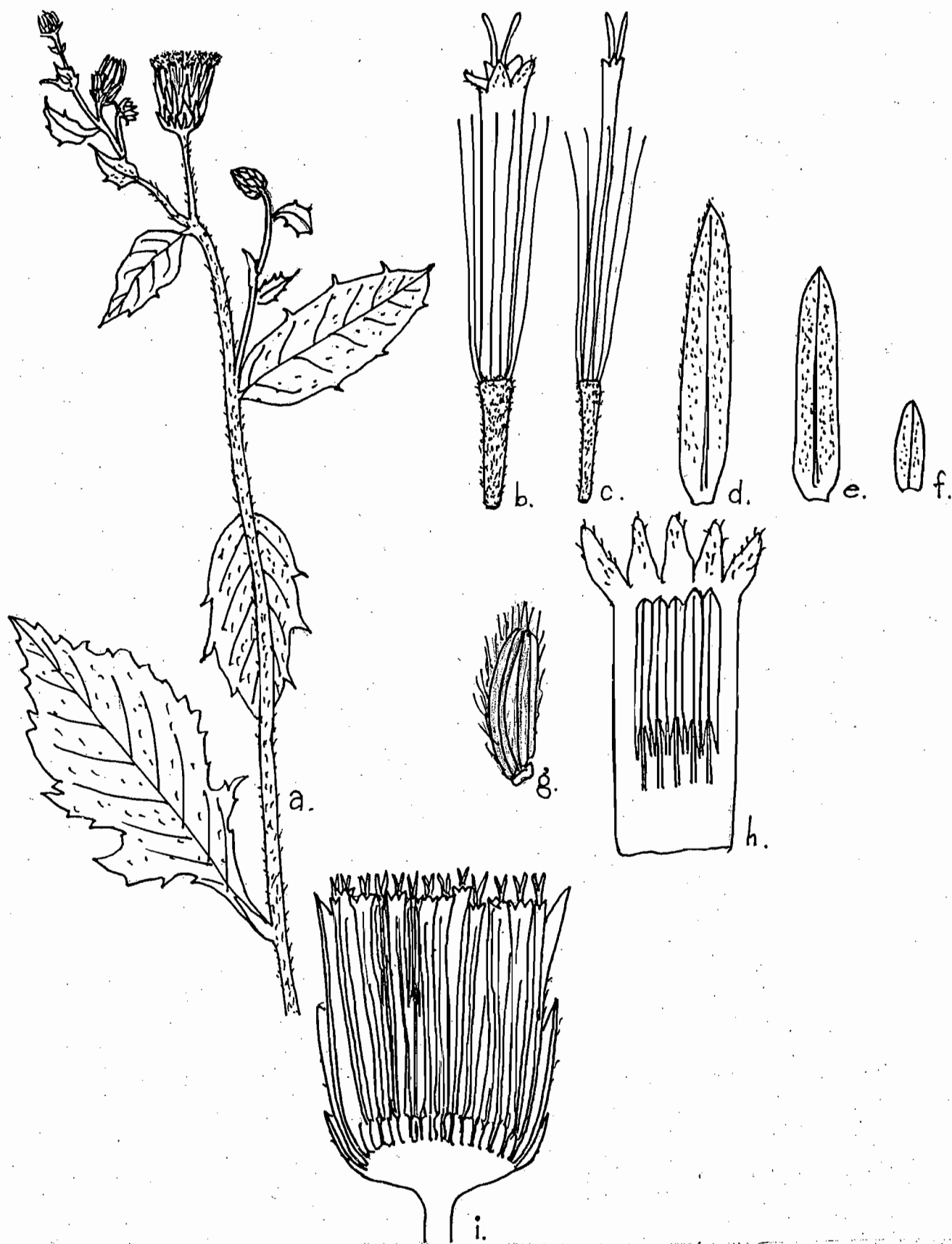


Fig. 263. *Blumea membranacea* var. *muralis* DC., a. habit, b. bisexual floret, c. female floret, d-f. involucral bracts, g. achene, h. epipetalous stamens, i. L.S. of head.

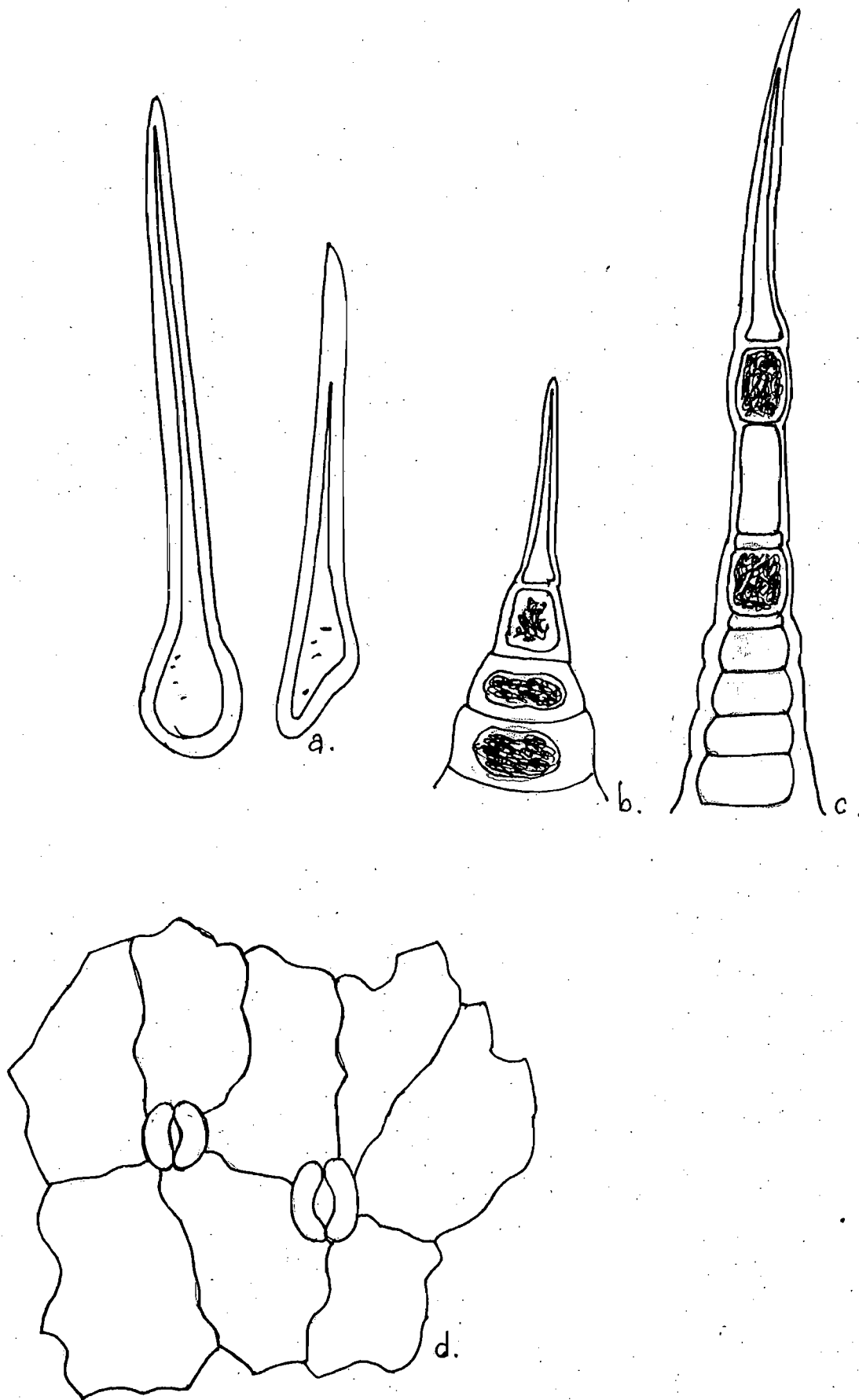


Fig. 264. *Blumea membranacea* var. *muralis* DC., a. unicellular thick walled trichome with round or flat base, b-c. glandular multicellular uniseriate 4-many celled trichome with basal broad cells and thick wall with ergastic substances, d. anomocytic stomata.

11. *Caesulia axillaris* Roxb. Hort. Beng. (1814) p. 62.

A succulent prostrate or suberect herb reaching upto 45 cm high. Leaves lanceolate, sessile, upto 15 cm long. Head heterogamous, axillary and globose with a biseriate involucre; flowers pale-blue or white. The outer most bracts being radiating and glandular while the inner are boat-shaped, enclosing the ray florets. The disc florets are also subtended by bracts, although one or two central bracts do not bear florets. Receptacle glabrous. Bracts 2, orbicular or broadly ovate. Corollas tubular, the limb slightly enlarged with 5 lobes. Anther bases sagittate; tails slender, consisting of a small bundle of fine hairs which cling together. Pappus absent. Achenes broad obovoid, broadly winged on each of the sides. (Fig. 265)

Variation observed: in classical description this plant is said to have two pappus scales, but the specimen I collected were epappose.

Vernacular name: Bangra.

Flowers: September-January.

Micromorphology (Fig. 265)

Whole plant was glabrous.

Stomata were of anomocytic types.

D/380, 829, 830, 831.

12. *Cyathocline purpurea* (Buch.-Ham. ex D.Don) Kuntze Revis. Gen. Pl. 1 333 1891.

A slender delicate erect herb upto 60 cm high with branched, grooved, more or less pubescent stem. Leaves pinnatifid, upto 12 cm long, the segments toothed. Flowers both ray and disk rose-purple; heads arranged in small rounded corymbose panicles. Involucral bracts linear, acute, with scarious and densely ciliate margins. Outer flowers female, fertile and many seriate; inner or disk flowers bisexual, regular, 5-cleft. Receptacle with a contracted base, elevated, top concave. Anther-bases truncate. Style exserted. Corollas of bisexual flowers with 5 short ciliate teeth. Pappus 0. Achenes minute, oblong, smooth. (Fig. 266)

Vernacular name: Okharad.

Flowers: November-March.

Micromorphology (Fig. 266)

Three types of trichomes were observed 1) multicellular, non-glandular, uniseriate trichome, 2) 2 celled trichome which has upper cell conical, elongated and were uniseriate; 3) 2 celled and were distinct into one celled head and one cell stalk.

Stomata were of anomocytic type.

D/1197.

13. *Eclipta erecta* Linn. Mantiss. V. 2 (1771) p. 286.

An erect or prostrate, branched herb. Leaves oblong-lanceolate, 8 cm long, sparsely strigose with appressed hairs on both sides. Heads heterogamous, solitary or 2 together on unequal axillary peduncles; ray-flowers female, sub-2-seriate, fertile or sterile, white or yellow; disk-flowers bisexual, fertile. Involucral bracts about 8, ovate, herbaceous. Disk-flowers tubular, the corollas often 4-toothed. Anther bases obtuse. Style arms

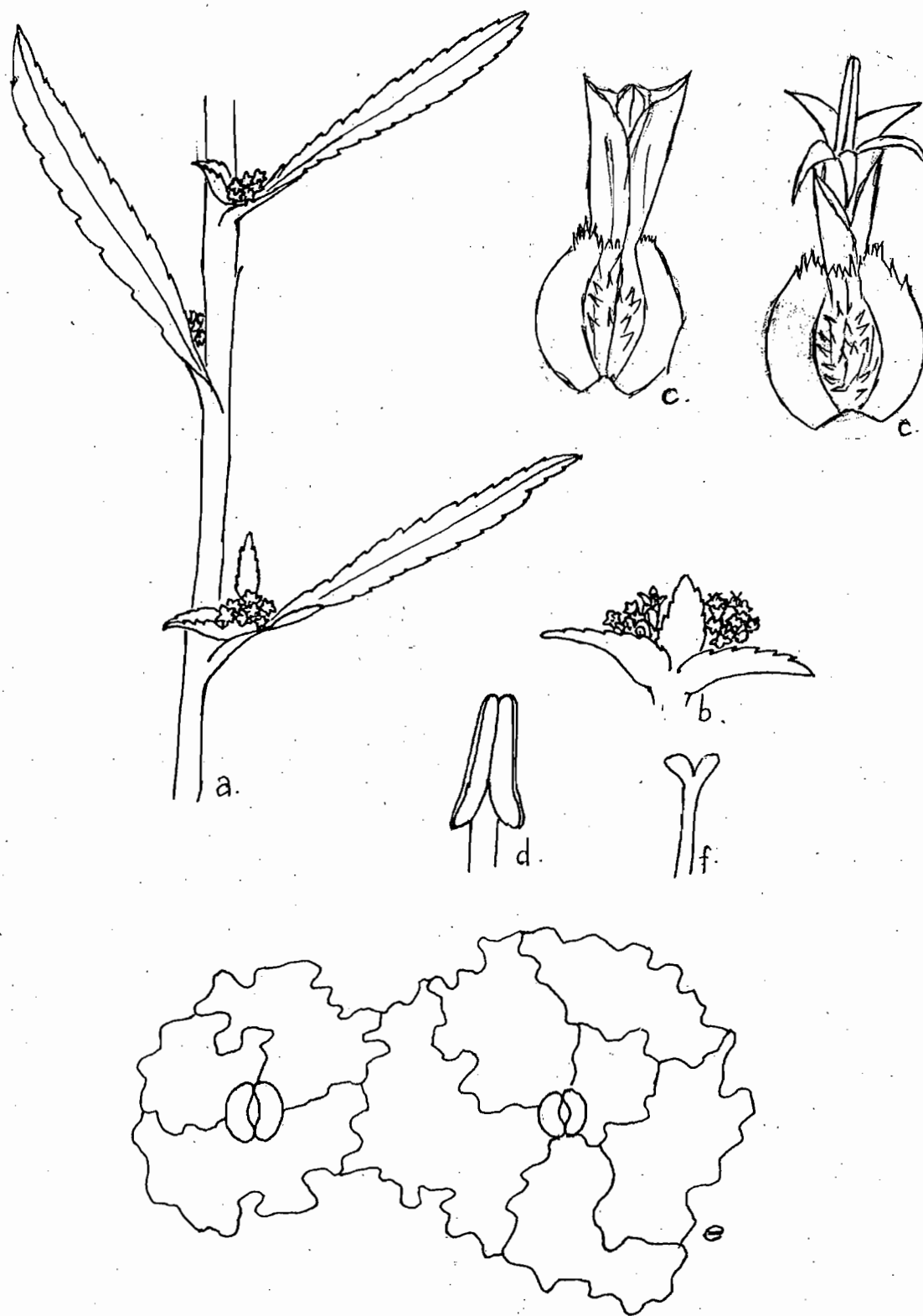


Fig. 265. *Caesulia axillaris* Roxb., a. habit, b. inflorescence, b. involucre bracts, c. bisexual floret with pappus, d. stamen, e. anomocytic and anisocytic stomata, f. style.

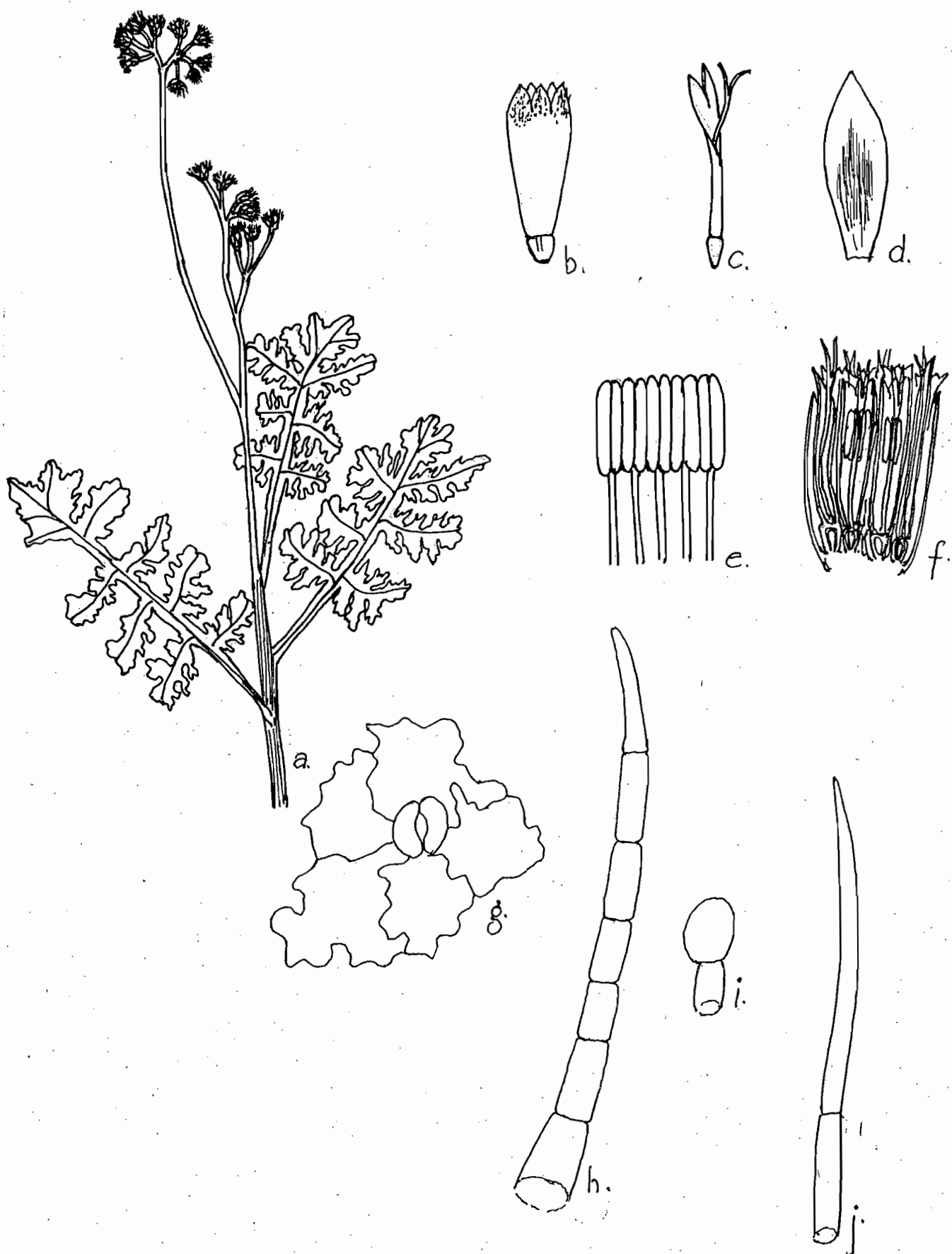


Fig. 266. *Cyathocline purpurea* kuntze., a. habit, b. bisexual floret, c. female floret, d. involucral bract, e. stamen, f. L.S. of head, g. anomocytic stomata, h. multicellular uniseriate trichome, i. gland with a single celled head and a single celled stalk, j. two celled trichome.

terminated by short obtuse appendages. Pappus 0. Achenes cuneate and with a narrow wing. (Fig. 267)

Vernacular name: Bhangro.

Flowers throughout the year.

Micromorphology (Fig. 267)

Whole plant was strigose with appressed hairs.

Stomata were of anomocytic and anisocytic types. Among these anomocytic types of stomata were present in majority.

D/224.

14. *Emilia sonchifolia* DC. in Wight, Contrib. (1934) p. 24.

A glabrous scabrid or puberulous slender herb, reaching a height of 45 cm. Leaves lyrate or obovate, toothed; the cauline more or less amplexicaul and auricled. Heads few, laxly corymbose, without bracteoles beneath the head; flowers purplish, all bisexual, fertile. Involucre cylindric; bracts equaling the corollas, linear-oblong, with scarious margins. Corolla tubular; limb elongate, 5-fid. Anther-bases obtuse. Style-arms semi-cylindric. Pappus copious, white soft, equaling the involucre bracts. Achenes narrowly oblong, 5-ribbed, brown, scabrid on the ribs. (Fig. 268)

Vernacular name: Hiran khuri.

Flowers: September.

Micromorphology (Fig. 269)

The plant showed presence of multicellular, uniseriate, glandular trichome; each cell of the trichome was rectangular in shape and arranged one at right angles to the next one and contained some ergastic substances.

Stomata were of anomocytic and anisocytic type.

D/735; D/1053; D/1090.

**15. *Gnaphalium polycaulon* Pers., Syn. Pl. 2: 421. 1807.
(*Gnaphalium indicum* Linn.)**

A decumbent wooly herb reaching to a length of 45 cm. Leaves spatulate-oblong, upto 6 cm long. Flowers in dense corymbose clusters of yellow glistening heads. Involucral bracts shining, straw-colored, the outer ovate, the innermost linear, acute, all herb; many seriate. Receptacle naked. Corolla of female flowers filiform, minutely dentate or shortly 3-4 fid at the apex, those of the bisexual flowers regular, tubular, slender, the limb slightly enlarged, shortly 5-fid. Pappus shorter than the involucre. Achenes oblong, papillose. (Fig. 270)

Vernacular name: Phulvo.

Flowers: February-March.

Micromorphology (Fig. 270)

The plant showed presence of unicellular, non-glandular, elongated trichome with a thin wall and a narrow lumen.

Stomata were of anomocytic types.

D/698.

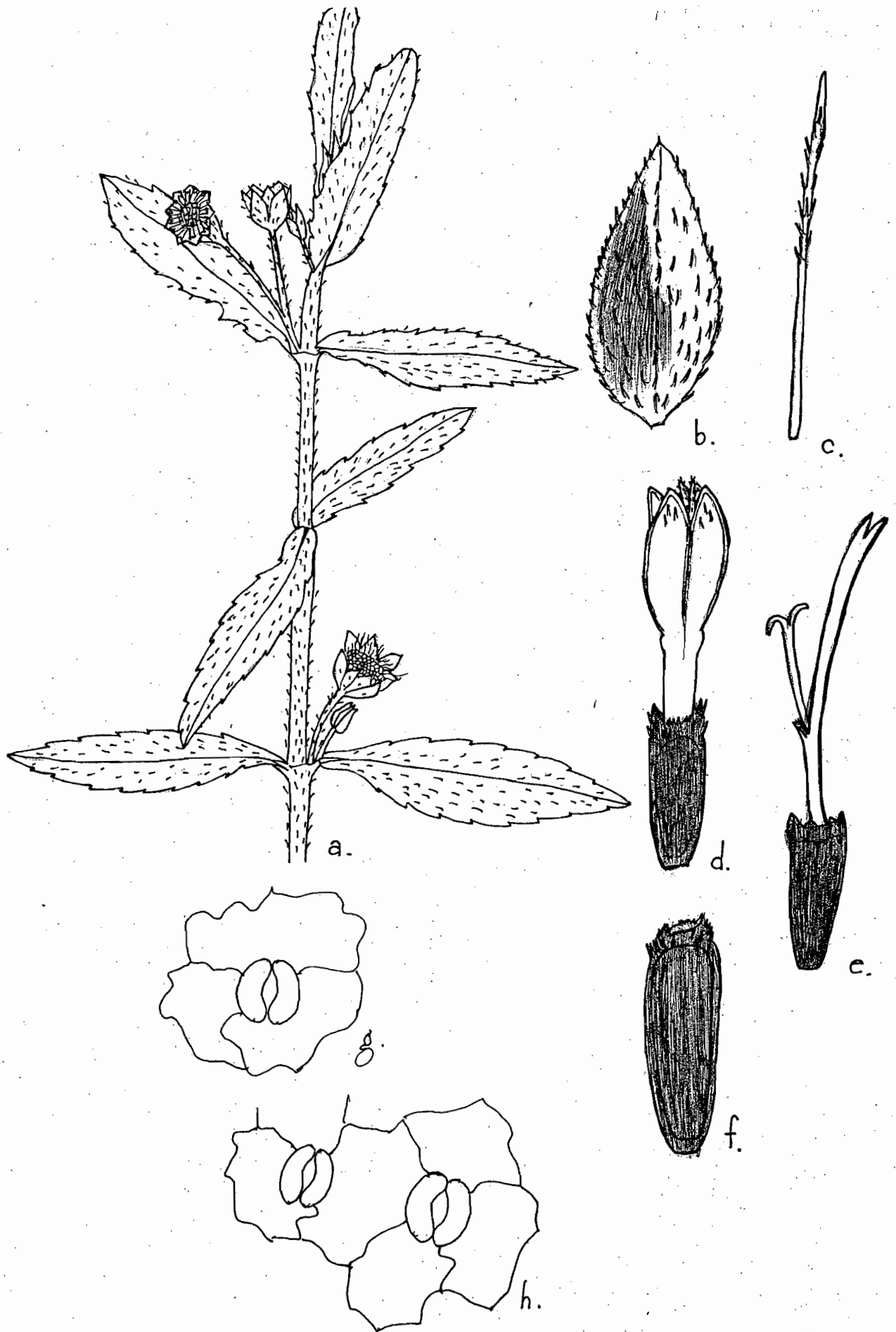


Fig. 267. *Eclipta erecta* L., a. habit, b. involucral bract, c. bristle, d. disc floret, e. ray floret, f. achene, g. anisocytic stomata, h. anomocytic stomata.

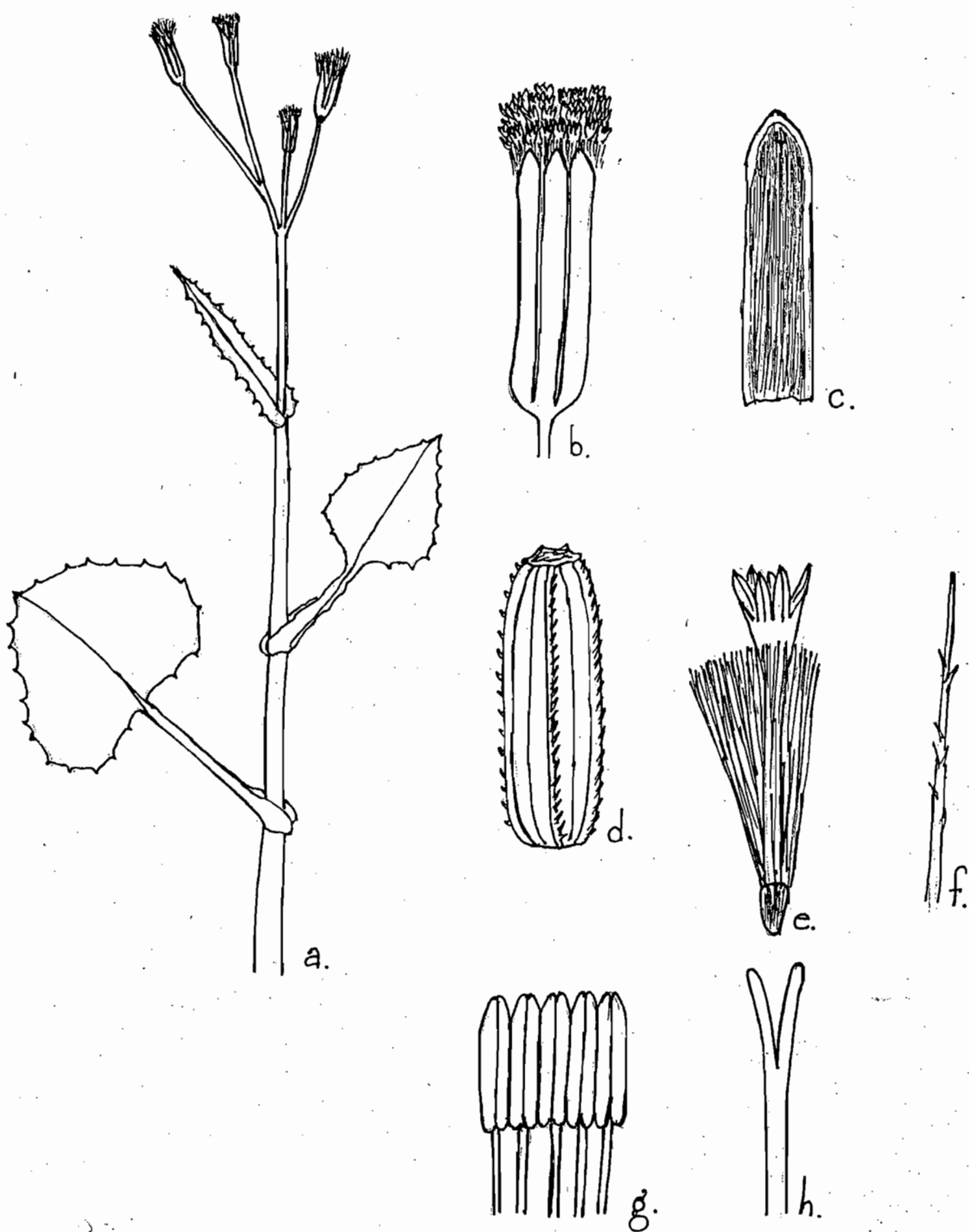


Fig. 268. *Emilia sonchifolia* DC., a. habit, b. inflorescence, c. involucral bract, d. achene, e. disc floret, f. bristle, g. syngenechious stamen, h. stigma and style.

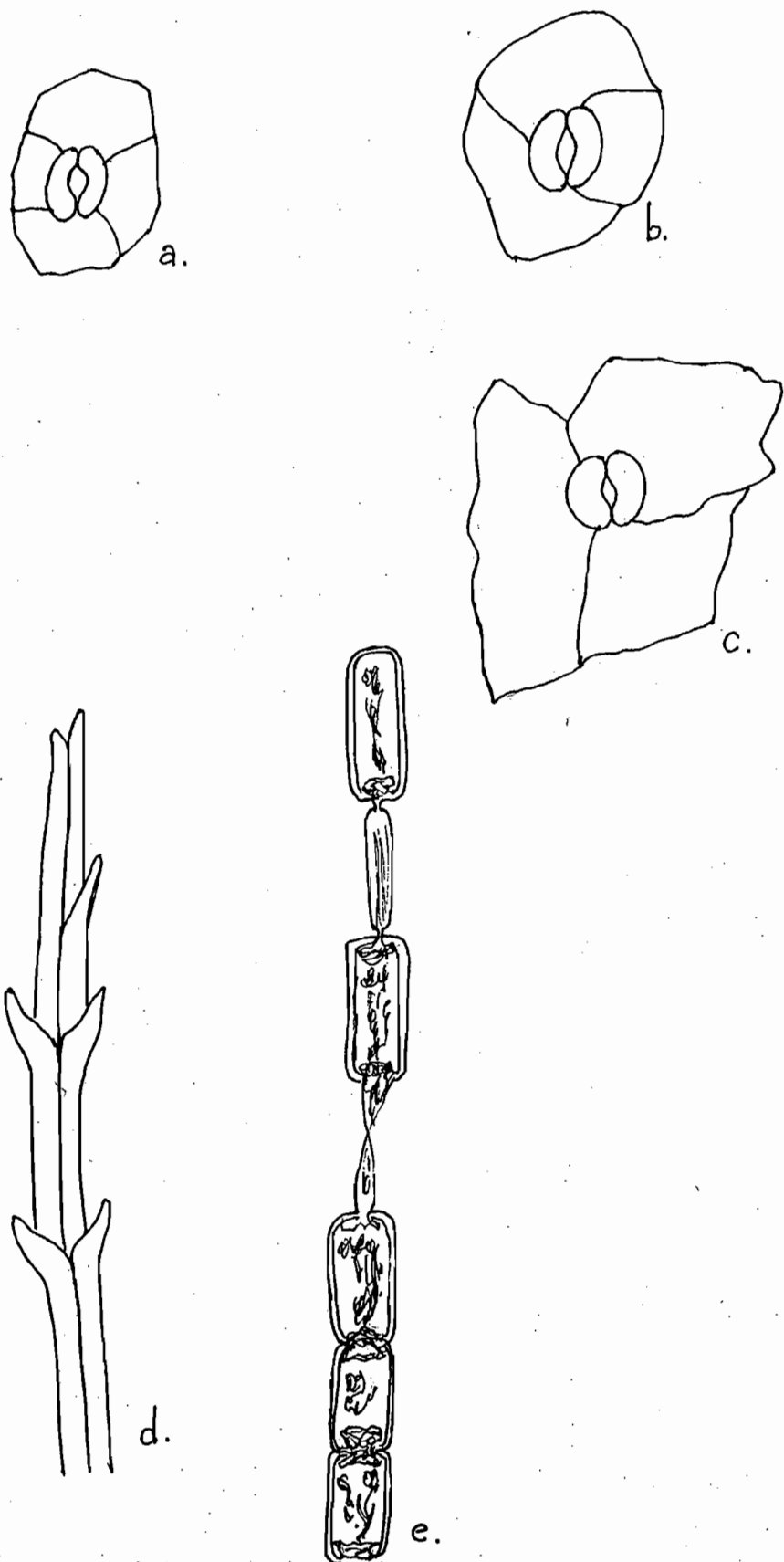


Fig. 269. *Emilia sonchifolia* DC., a. tetracytic stomata, b-c. anisocytic stomata, d. multicellular biseriate barbed trichome, e. glandular multicellular uniseriate trichome with certain cells placed at right angles to the adjacent cells.

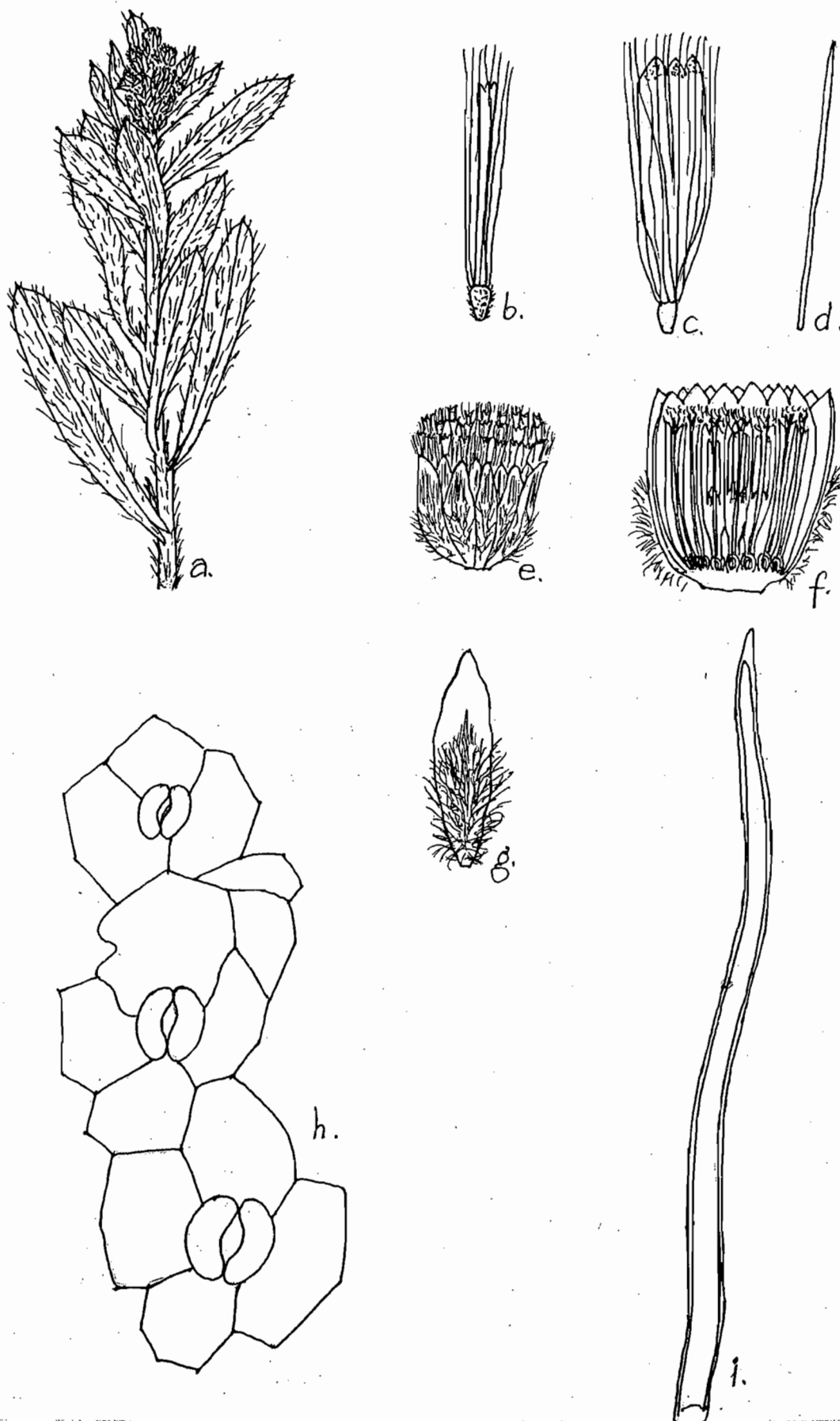


Fig. 270. *Gnaphalium polycaulon* Pers., a. habit, b. female flower, c. bisexual flower, d. bristle, e. inflorescence head, f. L.S. of head, g. involucral bract, h. anomocytic stomata, i. unicellular trichome with thin wall and broad lumen.

16. *Grangea maderaspatana* Poir. *Encyc. Method. Suppl.* V. 2 (1811) p. 825.

An annual branched prostrate with stems upto 30 cm long, hairy. Leaves sinuately pinnatifid, the terminal lobe the largest, all coarsely serrate-dentate, 6 cm long, pubescent on both surfaces. Heads globose, 1 cm in diameter, solitary or 2-nate, on short leaf-opposed peduncles; flower yellow. Involucral bracts elliptic, obtuse, rigid, densely pubescent. Corolla of female flowers filiform, 2-fid at the apex, sometimes 3-4 fid; corollas of bisexual flowers regular, with a slender tube and a campanulate limb 4-5 fid at the apex. Anther-bases obtuse. Style arms of bisexual flowers flattened. Pappus with fimbriate mouth. Achenes glandular. (Fig. 271)

Vernacular name: Nanhi mundi.

Flowers: December-May.

Micromorphology (Fig. 271)

The plant showed two types of glandular trichomes: 1) uniseriate, 3-4 celled with a pointed apical cell and 2) biseriate 10-12 celled sessile trichome.

Stomata were of anomocytic type.

D/319, 702, 703.

17. *Lasiopogon lanatum* Cass. in *Dict. Sc. Nat.* V. 25 (1822) p. 302.

A small bushy plant, looking like a cluster of cottony balls on the ground, the leaves and flowers being hidden by the woolly covering; branches many from the root, prostrate. Leaves linear-oblong or spatulate, woolly. Heads in globose villous clusters. Involucral bracts linear, obtuse, scarious. Receptacle small, naked. Corollas of female flowers filiform, minutely dentate, those of bisexual flowers regular, slender, tubular, the limb slightly enlarged, 3-toothed. Anther bases sagittate, with slender tails. Style arms of bisexual flowers truncate. Pappus-hairs caducous, feathery. Achenes subfusiform. (Fig. 272)

Micromorphology (Fig. 272)

The plant showed presence of two celled, non-glandular, trichome with an elongated pointed apical cell and a basal swollen cell.

Stomata were of anomocytic type.

D/491.

8. *Launaea nudicaulis* Hook. f. *Fl. B.I.* V. 3 (1881) p. 416.

A prostrate glabrous, branched herb reaching to a height of 60 cm. Leaves upto 30 cm, mostly radical, leaves obovate-oblong, pinnatifid, with obtuse segments, spinulose on the margins; cauline leaves distant, few, sessile, narrowly oblong, pinnatifid. Flowering stems decumbent, spreading, branched. Heads upto 2 cm long, cylindric, subracemose, along the branches, subsolitary, or fascicled. Involucral bracts all with broad white membranous margins; outer short, ovate, acute, with a strong midrib, subcordate; the innermost thrice as long as outer, reaching upto 1.5 cms. long, linear, subacute, longer than the pappus, midrib thickend in front, pappus hairs subequal, soft, white, copious, Achenes, polymorphous, inner sometimes as if composed of four thick ribs; outer slightly curved and flattened with a thick ventral and several thick dorsal ribs. (Fig. 273)

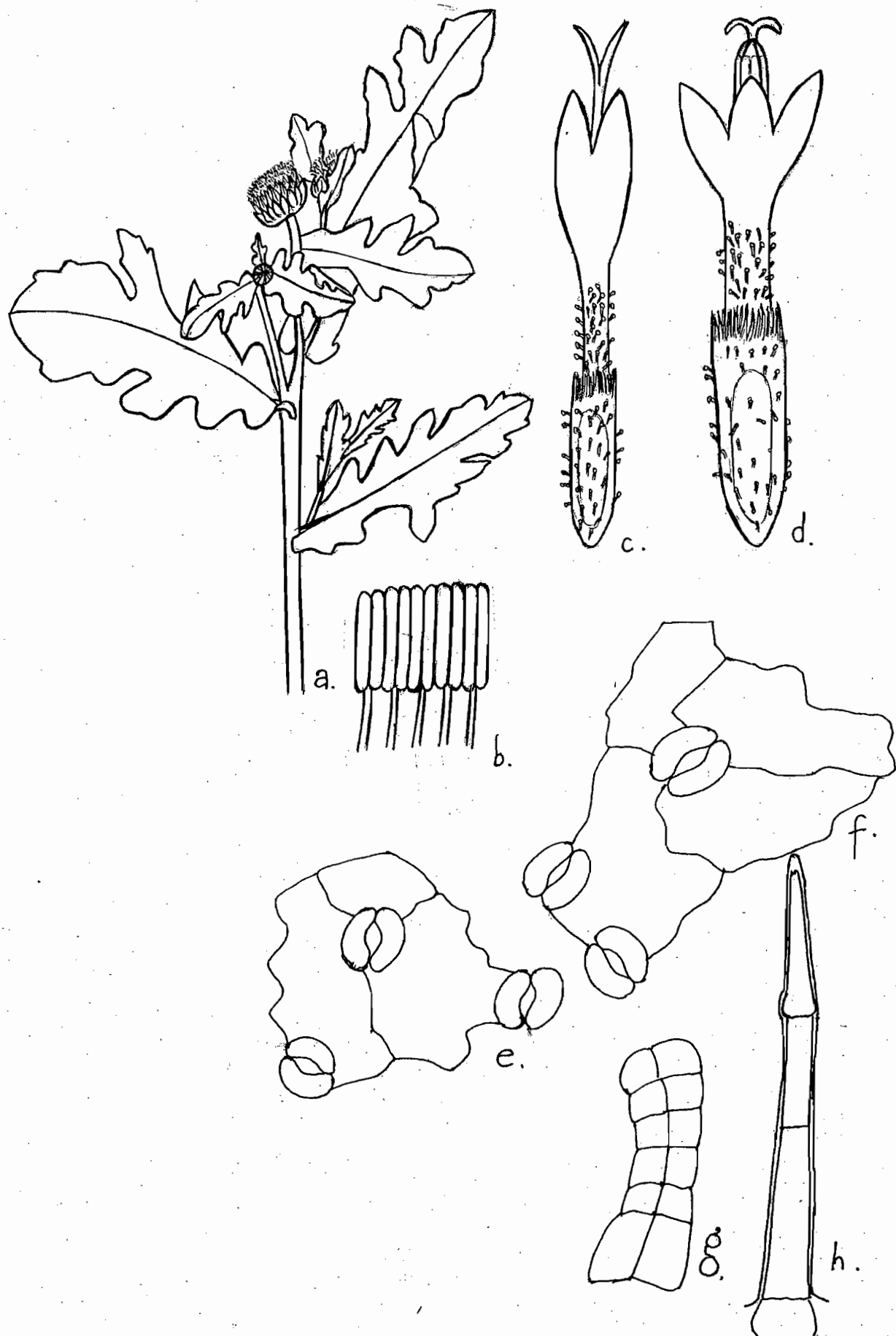


Fig. 271. *Grangea maderaspatana* (L.) Poir., a. habit, b. stamen, c. female flower, d. bisexual flower, e-f. anomocytic stomata, g. gland with multicellular head and biseriate stalk, h. three-celled uniseriate trichome.

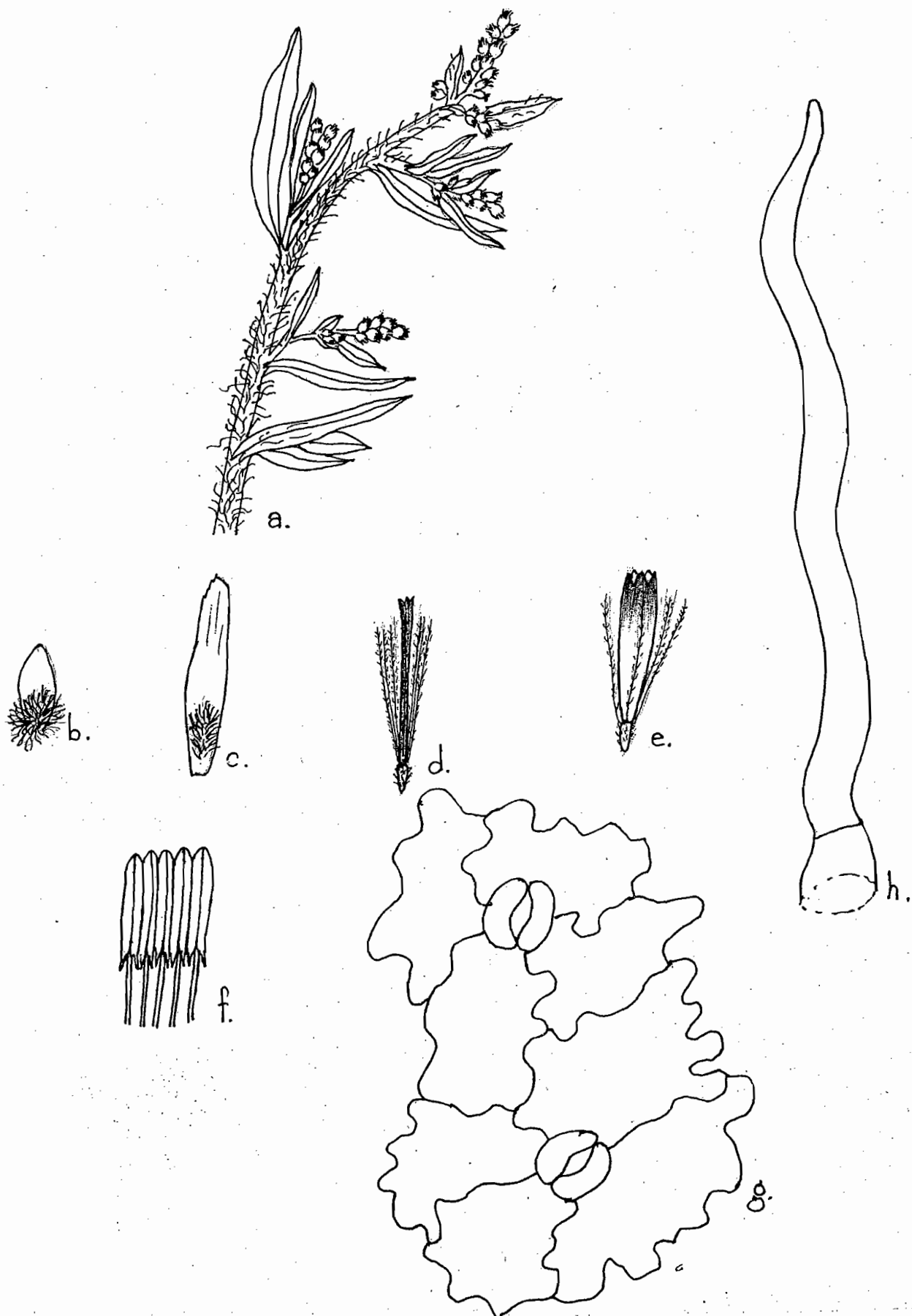


Fig. 272. *Lasiopogon lanatum* Cass., a. habit, b-c. involucral bracts, d. female floret, e. bisexual floret, f. syngenecious stamen, g. anomocytic stomata, h. two celled wavy uniseriate trichome with small basal cell.

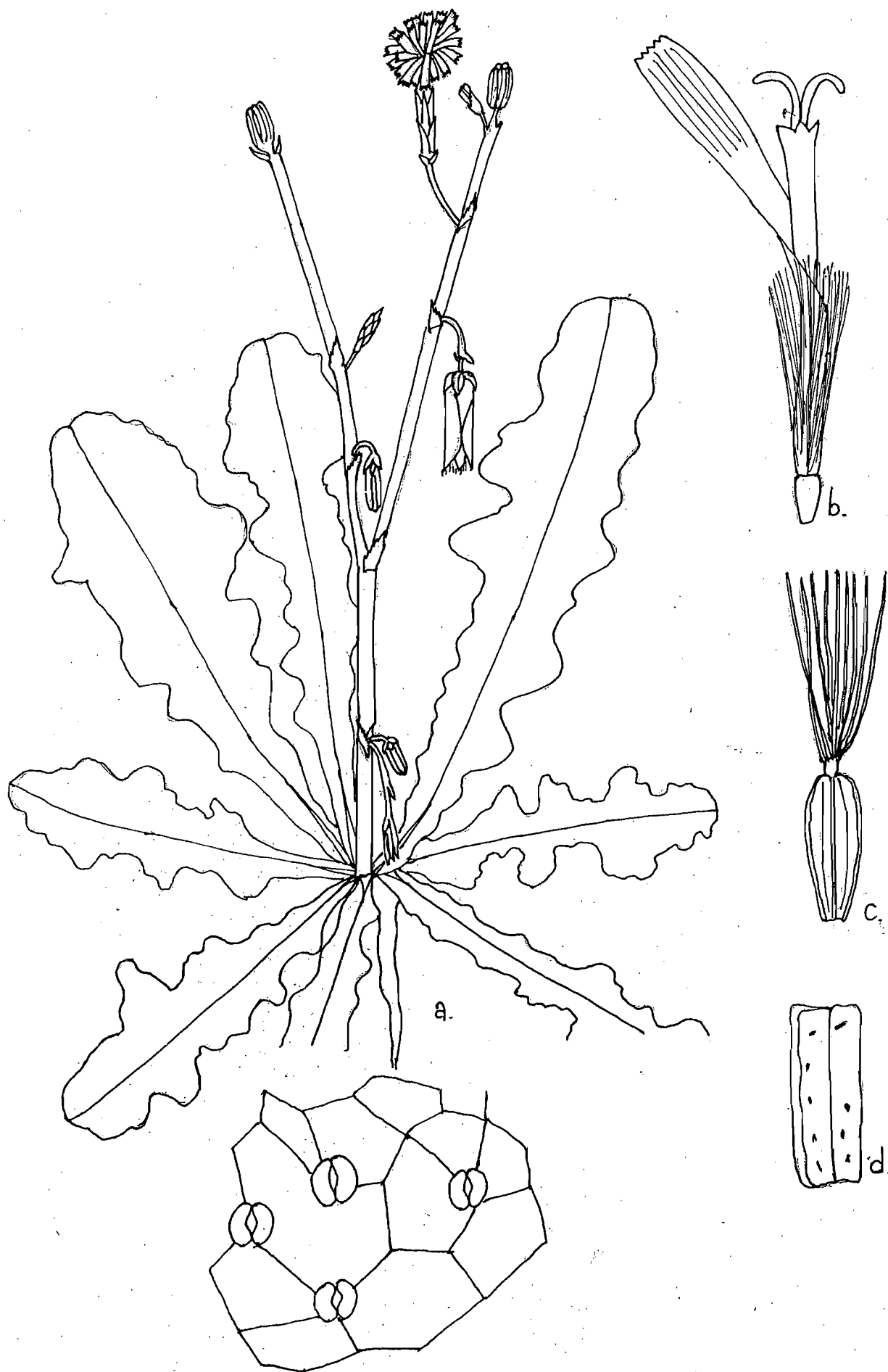


Fig. 273. *Launaea nudicaulis* Hk. f., a. habit, b. ray floret, c & d. achene, e. anomocytic stomata.

Vernacular name: Moti bhonpatri.

Flowers-April-May.

Micromorphology (Fig. 273)

Whole plant is glabrous.

Stomata were anomocytic.

D/104.

19. *Parthenium hysterophorus* Linn. *Sp. Pl.* (1753). 988

An erect diffuse annual herb of about 1m. height with stems longitudinally grooved, covered with white hairs. Leaves deeply 1-2 pinnately dissected, upto 10 cm long. Heads small. Involucral bracts 2-seriate; outer bracts herbaceous; inner bracts thinner. Ray florets urceolate with indistinct lobes, membranous. Pappus present only in ray florets. disc florets smaller infundibuliform, 5-lobed. Achenes obovate, black-crowned with remnant of corolla appendage and style. (Fig. 274)

Variation observed: in floras both ray and disc florets were said to have pappus hairs but I observed pappus only in ray florets.

Vernacular name: Congress grass.

Flowers: September-October.

Micromorphology (Fig. 274)

The plant showed presence of three types of trichomes: 1) 4 celled, glandular, sessile trichome. 2) multicellular, uniseriate trichomes with varying number of cells in the trichome. 3) unicellular, elongated, non-glandular trichome. The cells may be rectangular or squarish.

Stomata were or anomocytic type.

D/295.

20. *Pulicaria wightiana* C. B. Clarke, *Comp. Ind.* (1876) p. 128.

A branched annual reaching to a height of 60 cm. Leaves oblong upto 10 cm long, sessile with serrated margin. Heads solitary. Outer involucral bracts subherbaceous, linear-oblong, inner bracts scarious, linear-lanceolate. Ray flowers ligulate, 1-2 seriate, yellow, 3-toothed at the apex. Disk flowers bisexual, tubular, limb shortly 5-fid. Anther bases sagittate, with minute auricles; tails capillary. Style-arms linear. Pappus a setulose-laciniate cup, inner row of barbellate hairs which are ultimately reddish. Achenes oblong, quadrangular, brown, shining, nearly glabrous. (Fig. 275)

Vernacular name: Son fulaki.

Flowers: September-October.

Micromorphology (Fig. 275)

There were only multicellular uniseriate trichomes.

Stomata were tetracytic.

D/756, 757.

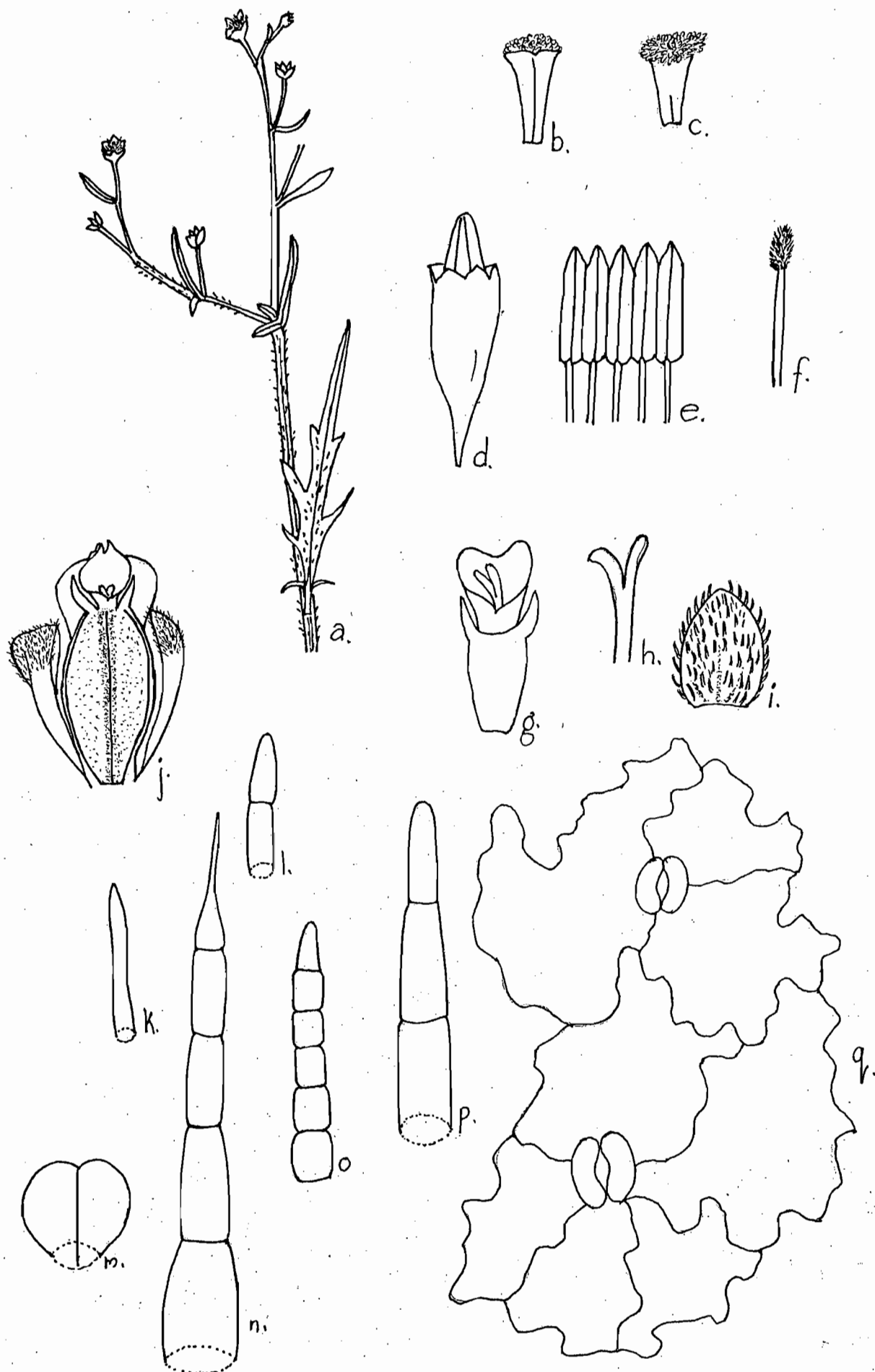


Fig. 274. *Parthenium hysterophorus* L., a. habit, b-c. involucre bracts, d. disc florets, e. syngenesious stamen, f. bristle, g. ray floret, h. stigma and style, i. bract, j. achene, k. unicellular gland, l. two celled gland, m. two celled sessile gland, n. multicellular uniseriate trichome, o. three-celled uniseriate trichome, p. three-celled uniseriate trichome, q. anomocytic stomata.

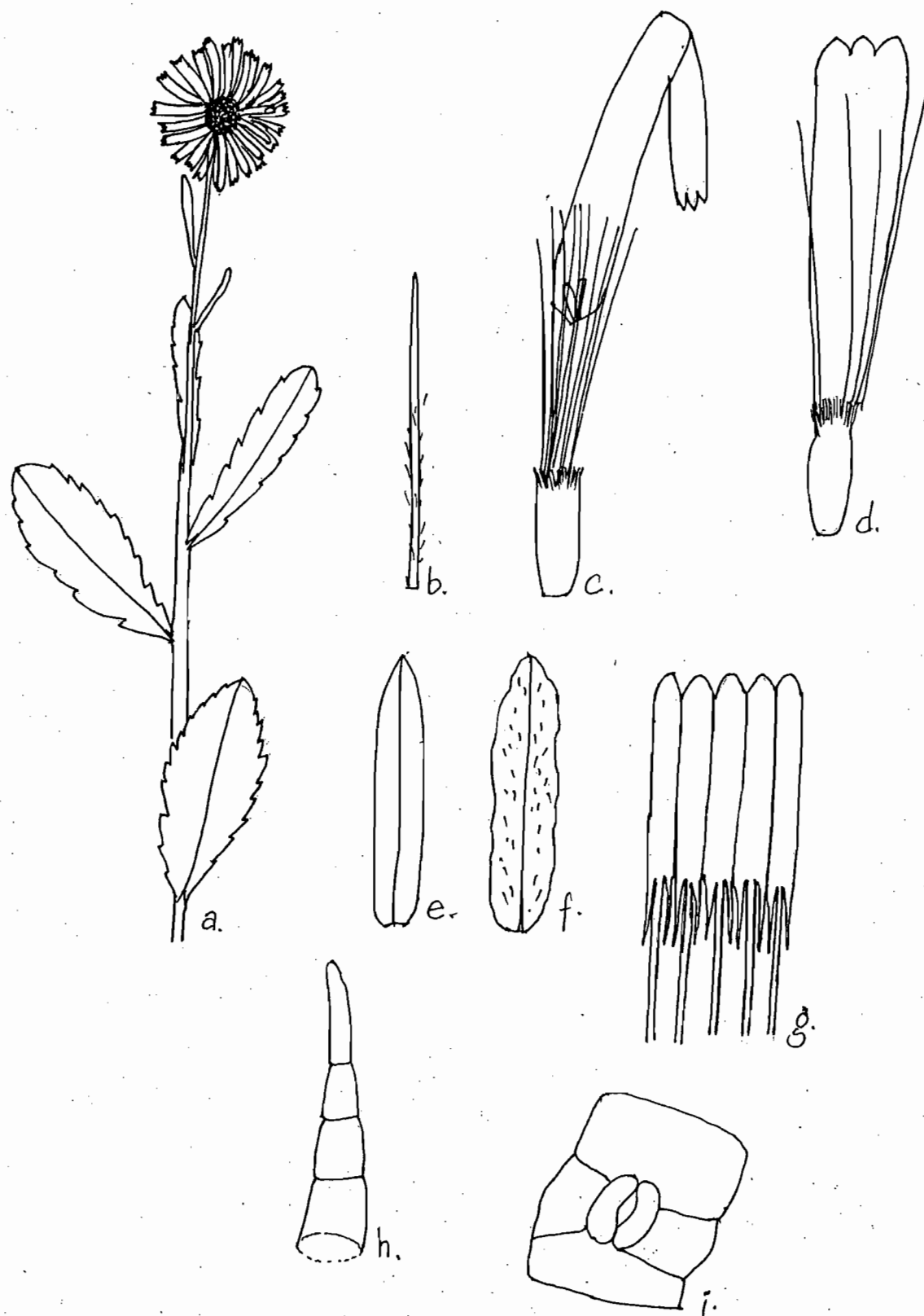


Fig. 275. *Pulicaria wightiana* Cl., a. habit, b. bristle, c. ray floret, d. disc floret, e-f. involucral bract, g. tailed anthers, h. multicellular uniseriate gland, i. tetracytic stomata.

21. *Sonchus oleraceus* Linn. *Sp. Pl.* (1753) p. 794.

A coarse erect annual herb with milky juice reaching upto 1 m high. Cauline leaves sessile, oblong or obovate, pinnatifid, semi-amplexicaul. Heads in umbellate cymes, campanulate, upto 1.5 cm long, many-flowered; flowers yellow. Involucral bracts glabrous; bracts many seriate, imbricate, herbaceous, the outer smaller. Receptacle flat, naked. Corollas all ligulate, truncate and 5-toothed at the apex. Anther bases sagittate, the auricles shortly setaceo-acuminate. Style-branches slender. Pappus pure white. Achenes obovoid, longitudinally ribbed, muriculate, light-brown. (Fig. 276)

Vernacular name: Dudhali Sonki.

Flowers: October-April.

Micromorphology (Fig. 276)

Corolla showed presence of unicellular, non-glandular, trichome with blunt apex.

Stomata were of anomocytic type.

D/378.

21. *Sphaeranthus indicus* Linn. *Sp. Pl.* (1753) p. 927.

A glandular much branched herb about 30 cm high with stems and branches having toothed wings. Leaves obovate-oblong, sessile, upto 5 cm long, glandular-hairy, spinous-serrate. Heads compound, globose-ovoid, ebracteate, on solitary glandular peduncles with toothed wings; flowers purple; outer flowers female, few or many, fertile; disk flowers bisexual, solitary or few, fertile or sterile. Involucral bracts linear, acuminate, pubescent and ciliate near the ends. Receptacle small, naked. Corolla of female flower slender, tubular, minutely 2-3 toothed. Anther bases sagittate; auricles acute or tailed. Style-arms of bisexual flowers filiform or connate. Pappus 0. Achenes glabrous, stalked. (Fig. 277)

Vernacular name: Gorakha mundi.

Flowers: November-April.

Micromorphology (Fig. 278)

The plant showed presence of two types of trichomes: 1) Multicellular, glandular, trichome differentiated into a distinct biseriate head of 5-6 cells high and a broad biseriate stalk. 2) Multicellular, uniseriate, non-glandular trichome with basal cells much swollen and thick walled.

Stomata were of anisocytic types.

D/303, 590, 752, 1030.

22. *Tridax procumbens* Linn. *Sp. Pl.* (1753) p. 900.

A branched hairy straggling herb reaching upto 60 cm high. Leaves ovate-elliptic, about 5 cm. long, inciso-dentate. Heads solitary; peduncles very long, sometimes exceeding 40 cm long, slender. Outer involucral bracts ovate, acuminate; inner bracts membranous, oblong, slightly longer than the outer, pubescent on the back. Ray flowers ligulate, the ligules yellow, deeply 3-partite, the middle lobe the smallest; tube of the corolla hairy. Disk flowers tubular, the limb elongate, slightly enlarged at the apex, shortly 5-fid. Anthers sagittate, with short acute auricles at the base. Style arms of bisexual flowers

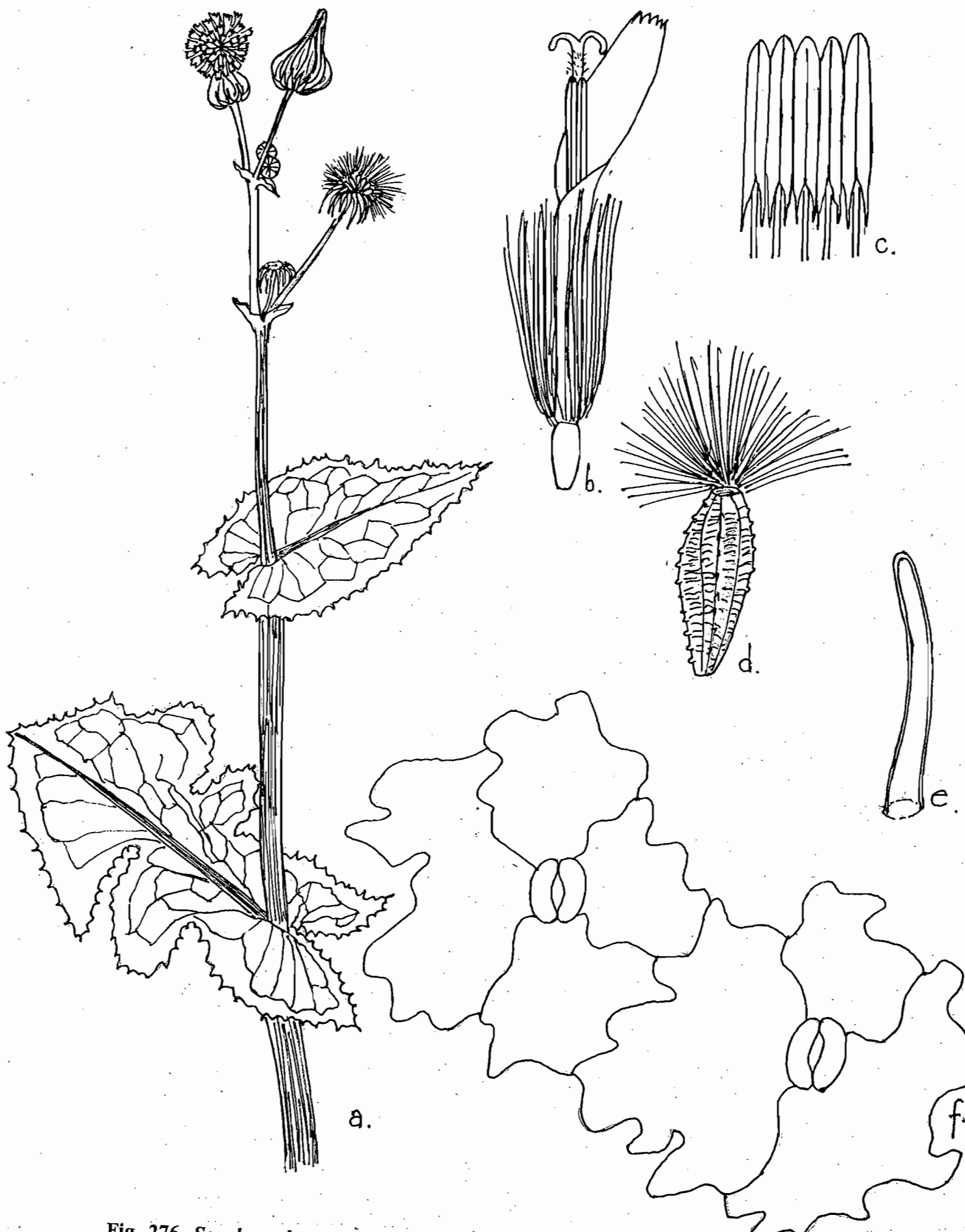


Fig. 276. *Sonchus oleraceus* L., a. habit, b. bisexual ray floret, d. achene, e. unicellular trichome, f. anomocytic stomata.

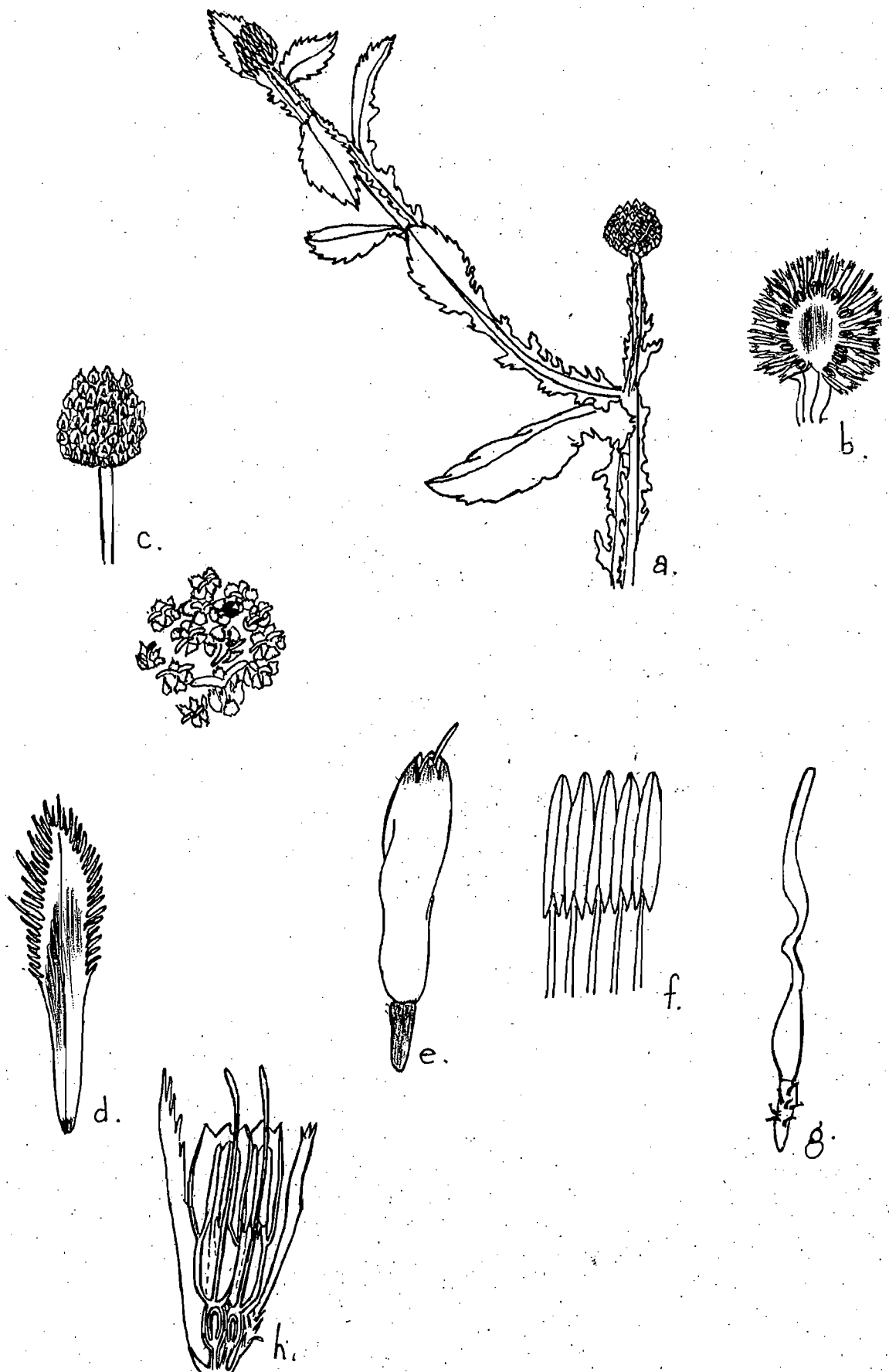


Fig. 277. *Sphaeranthus indicus* L., a. habit, b. L.S. of head, c. inflorescence, d. involucre bract, e. disc floret, f. stamen, g. sterile floret, h. L.S. of florets.

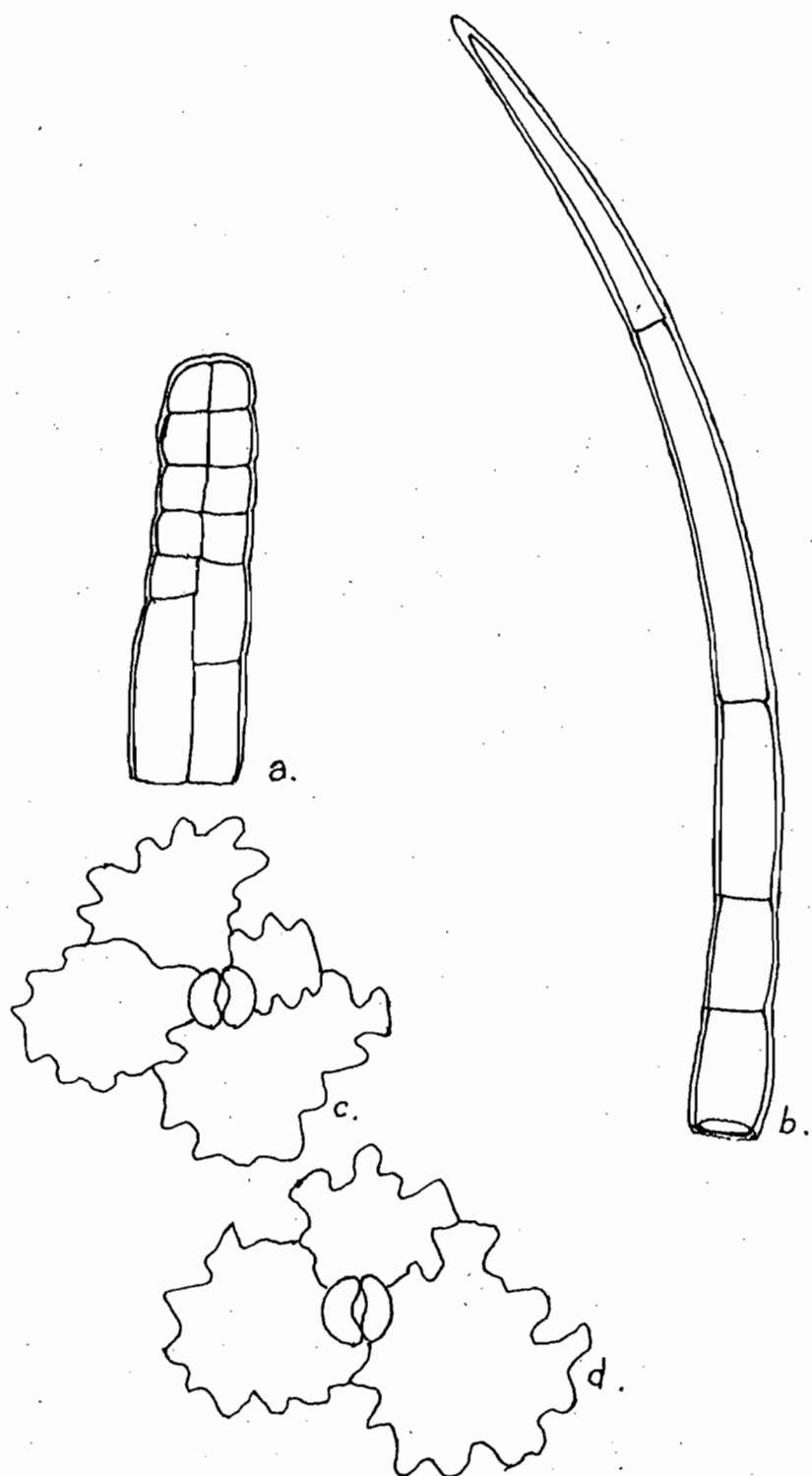


Fig. 278. *Sphaeranthus indicus* L., a. anomocytic stomata, b. anisocytic stomata, c. glandular with multicellular head and biserial stalk, d. uniseriate trichome.

hairy above; tips subulate. Pappus of unequal aristate feathery bristles. Achenes oblong, densely silky-hairy, black. (Fig. 279)

Vernacular name: Pardeshi bhangaro.

Flowers more or less throughout the year.

Micromorphology (Fig. 280)

There were unicellular and multicellular trichomes. The multicellular trichomes were uniseriate, having broader lower cells.

Stomata were anomocytic.

D/203.

23. *Vernonia cinerea* Less. in *Linnaea*, V. 4 (1829) p. 291.

An erect annual with stiff branched stem reaching upto 1m. Leaves broadly-elliptic or lanceolate, upto 7 cm long, shallowly crenate-serrate. Heads small, about 20-flowered, in lax divaricate terminal corymbs, with a minute linear bract beneath each head of flowers and with small bracts in the forks of the peduncles; flowers pinkish-violet. Involucral bracts linear-lanceolate, awned, silky on the back. Corollas all equal, regular, tubular, slender; lobes 5, narrow. Anther bases obtuse. Style arms subulate, hairy. Pappus white, the exterior row short. Achenes oblong, clothed with appressed white hairs. (Fig. 281)

Vernacular name: Sahadevi.

Flowers: June-February.

Micromorphology (Fig. 281)

There were unicellular filamentous trichomes.

Stomata were anomocytic.

D/248

24. *Vicoa indica* (L.) DC. Ling in *Act Phytotax. Sin.* 10:179. 1965.

***Pentanema india* (L.)**

A suffrutescent annual with reddish brown stem reaching upto 60 cm high. Leaves ovate-lanceolate, alternate, sessile, 5 cm, acute, cordate-hastate at base, scabrid on margin, pubescent on both surfaces. Heads heterogamous, usually solitary. Involucral bracts 3-4-seriate, linear-lanceolate, acute, pubescent outside. Ray-florets much longer than the involucres; ligules yellow, 3-dentate; pappus hairs scaly. Disc-florets slender corolla 5-toothed. Anther bases sagittate; tails slender. Achenes small, slender. Pappus hair many. (Fig. 282)

Variations observed: In standard descriptions the ray florets are described as epappose, but the plant I had were having 5 pappose scaly hairs.

Vernacular name: Sonasali.

Flowers: November-February.

Micromorphology (Fig. 282)

There were unicellular trichomes with thick wall and broad lumen.

Stomata were anomocytic types.

D/ 195, 308, 495, 597, 706, 707, 708, 1180 - 1182.

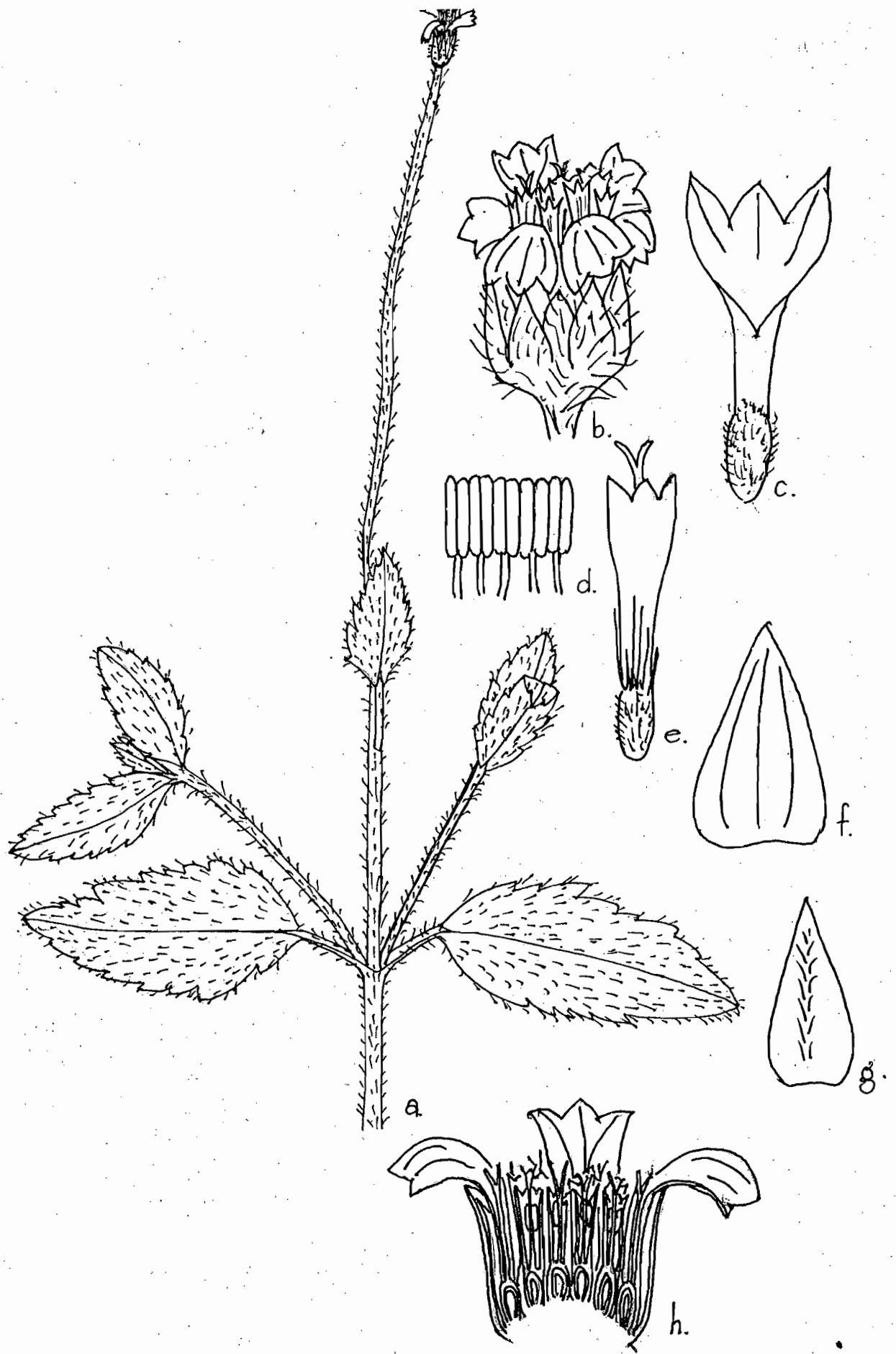


Fig. 279. *Tridax procumbens* L., a. habit, b. head, c. ray floret, d. stamen, e. disc floret, f-g. involucre bracts, h. L.S. head.

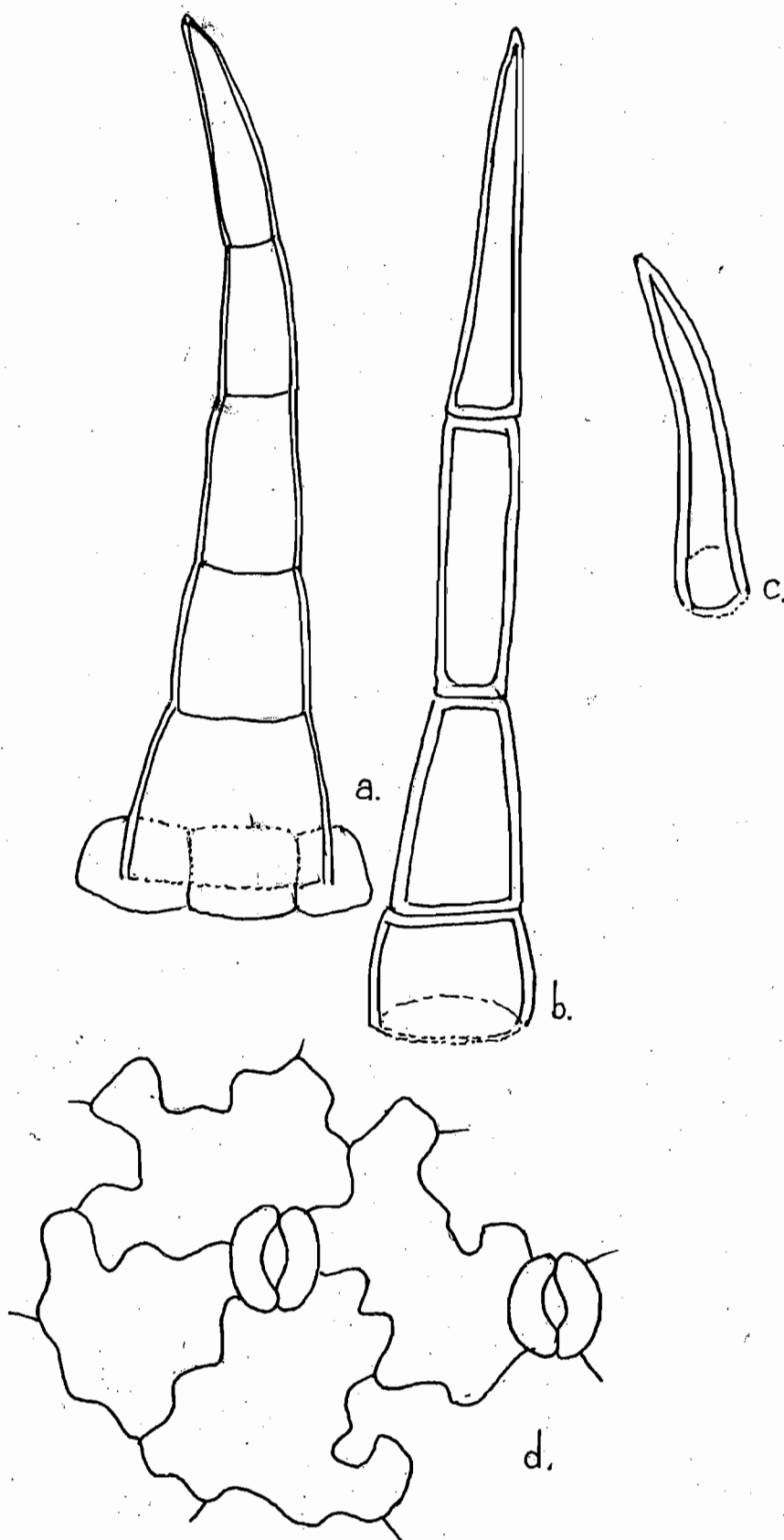


Fig. 280. *Tridax procumbens* L., a-b. multicellular uniseriate trichome, c. unicellular trichome, d. anomocytic stomata.

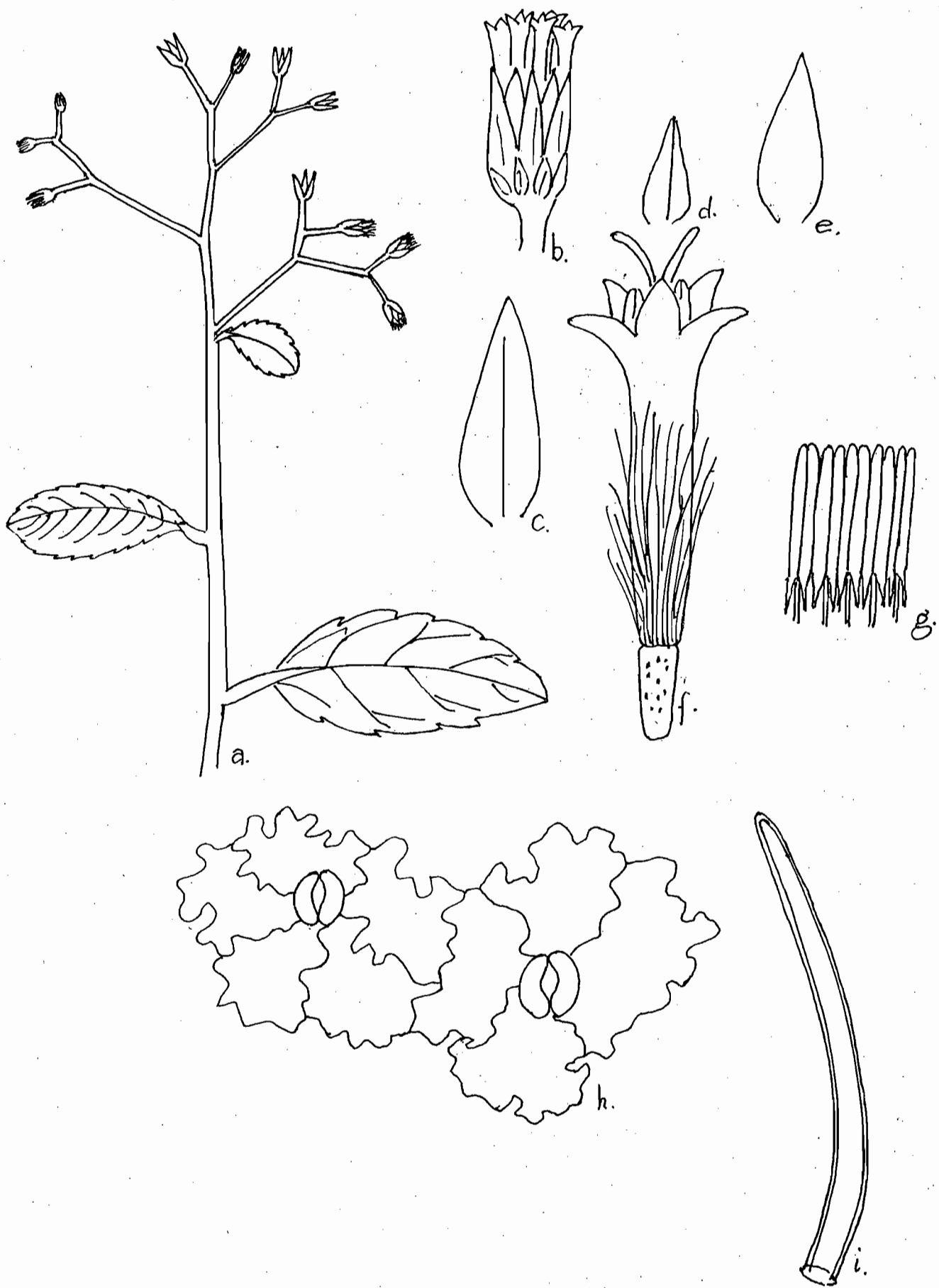


Fig. 281. *Vernonia cinerea* (L.) Less., a. habit, b. head, c-e. involucral bracts, f. bisexual disc floret, g. tailed anther, h. anomocytic stomata, i. unicellular trichome.

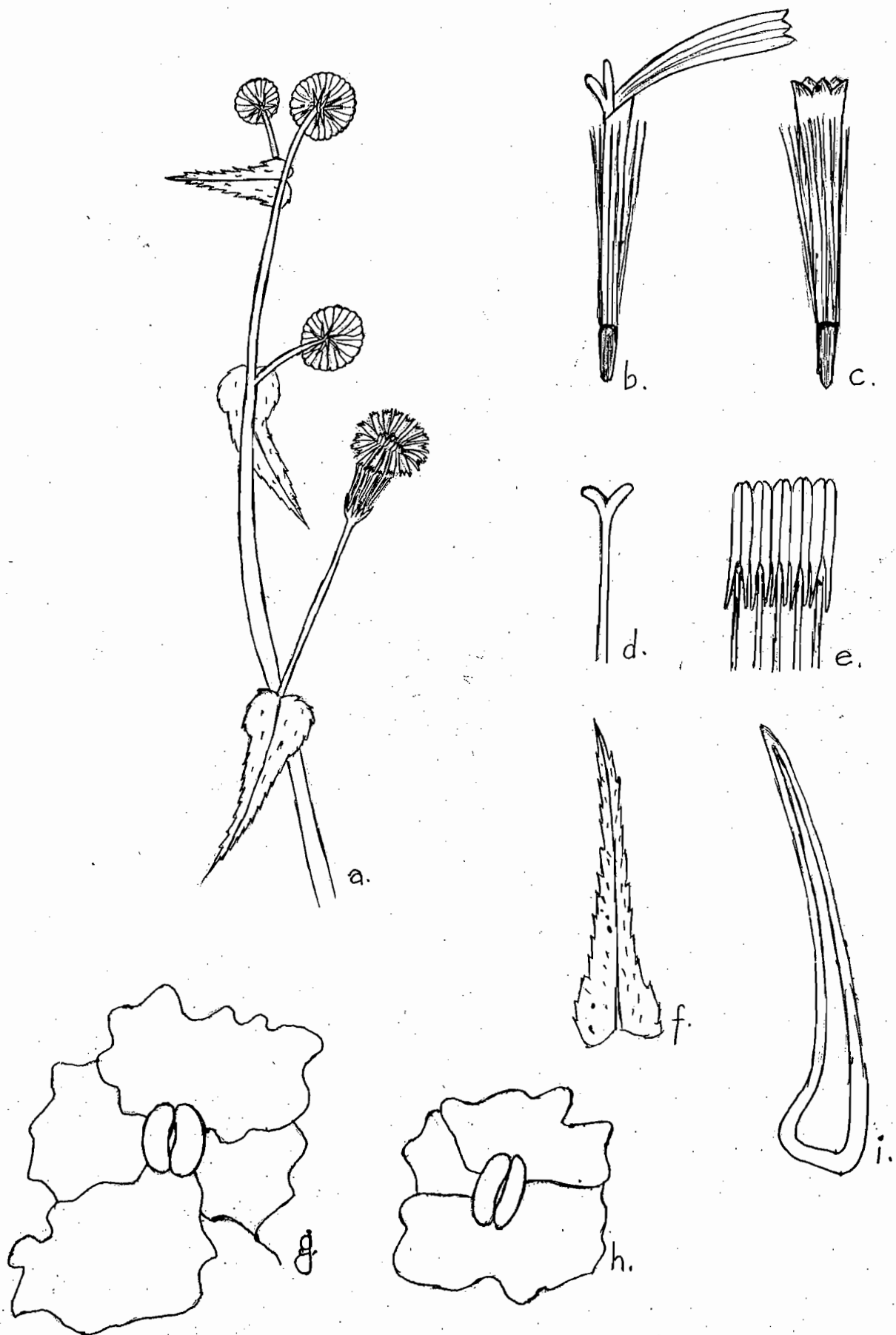


Fig. 282. *Vicoa indica* (L.) DC., a. habit, b. ray floret, c. disc floret, d. stigma and style, e. tailed anther, f. leaf, g. anomocytic stomata, h. anisocytic stomata, i. unicellular trichome.

25. *Volutarella divaricata* Benth. & Hook. f. *Gen. Pl.* V. 2 (1873) p. 476.

A dichotomously branched glabrous herb reaching 60 cm in height. Leaves oblong or obovate, alternate, toothed or pinnatifid with mucronulate lobes. Heads ovoid-oblong, upto 3 cm in diameter; borne on grooved peduncles, with a few small foliaceous bracts. Involucral bracts elliptic-oblong with a long spreading or recurved spinescent awn. Corollas 2 cm long, purple; lobes linear, acute, very tender. Anther-tails connate to the tips, with a membrane between them in front of the minutely pubescent filaments. Style-arms recurved. Paleae of the receptacle short, about equaling or shorter than the achenes. Pappus of many unequal hairs, silvery-brown, the innermost flattened and long. Achenes acutely angled. (Fig. 283)

Flowers: November-February.

Micromorphology (Fig. 284)

Both glandular and non-glandular trichomes were observed; 1) glands were with two celled head and unicellular stalk, 2) trichome was unicellular acicular.

D/190.

26. *Xanthium strumarium* Linn. *Sp. Pl.* (1753) p. 987.

An unarmed annual with short stout stem, rough with short hairs. Leaves broadly triangular-ovate upto 8 cm long and almost as broad as long, often 3-lobed, rough with appressed hairs on both sides, irregularly inciso-serrate. Heads in terminal and axillary racemes, the barren heads rather numerous, crowded at the top of the stem, the fertile heads few, axillary. Involucre of fertile heads with 2 erect mucronate beaks, thickly clothed with usually hooked prickles. Corolla tubular, enlarged into a 5-toothed limb. Anthers distinct, bases obtuse, tips mucronate, inflexed; filaments monadelphous. Style undivided, slender, slightly dilated at the apex. Achenes 1 cm long, oblong, ovoid, compressed, glabrous. (Fig. 285)

Vernacular name: Gadariyun.

Flowers: September-May.

Micromorphology (Fig. 285)

Whole plant was glabrous.

Stomata were of anomocytic, anisocytic and paracytic types.

D/265.

Plumbaginaceae

1. *Plumbago zeylanica* Linn. *Sp. Pl.* (1753) p. 151.

A perennial subscandent herb with somewhat woody, stems reaching upto 2 m. Leaves ovate, upto 8 cm, dilated into stipule-like auricles. Flowers in elongate spikes; rhachis glandular, striate; bracteoles ovate, acuminate. Calyx narrowly tubular, densely covered with stalked glands; teeth small, with membranous margins. Corolla hypocrateriform,

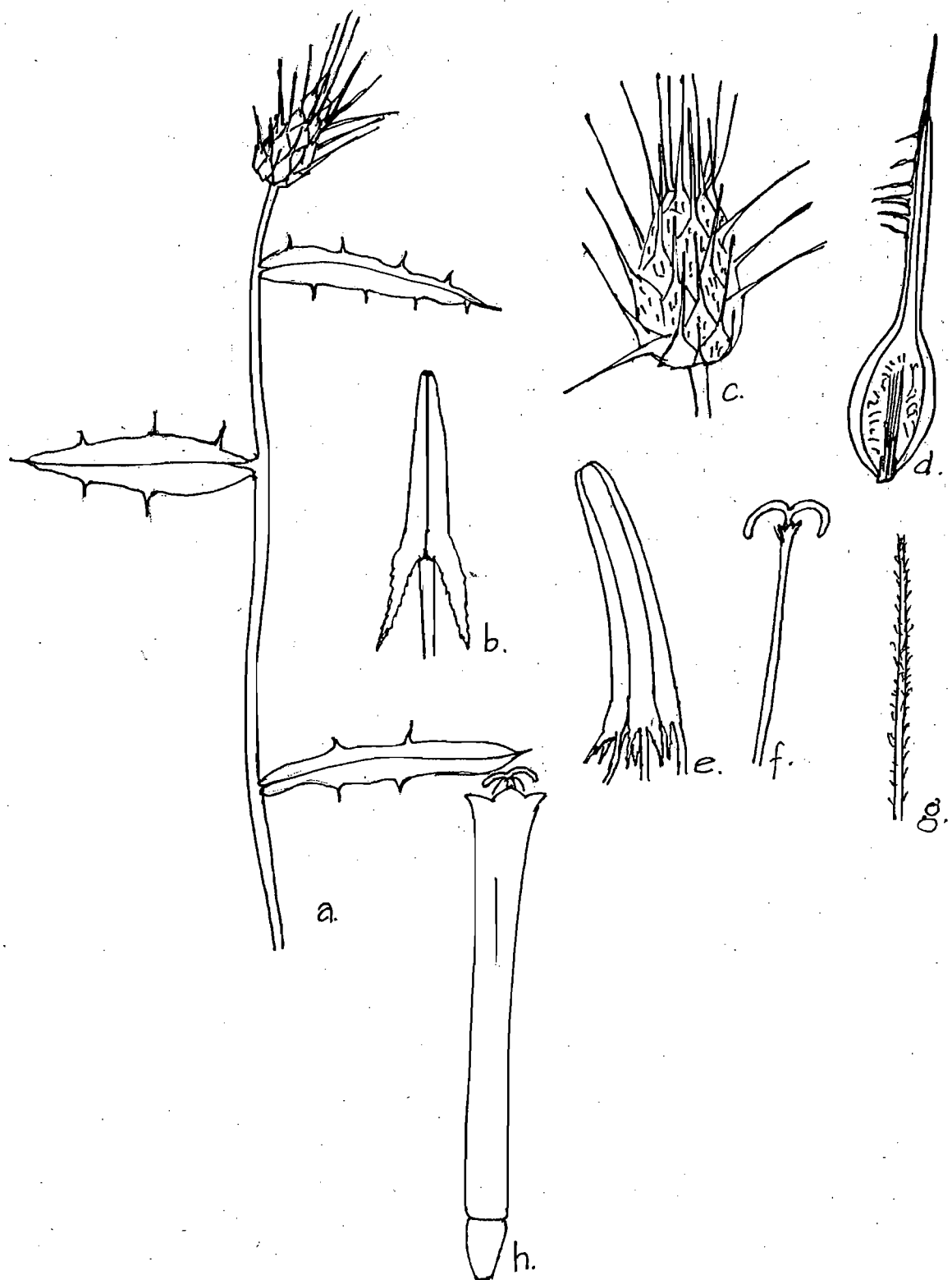


Fig. 283. *Volutarella divaricata* Bth., a. habit, b. tailed anther, c. head, d. involucral bract, e. anthers united with their fimbriated tail free, f. stigma and style, g. bristle, h. disc bisexual floret.

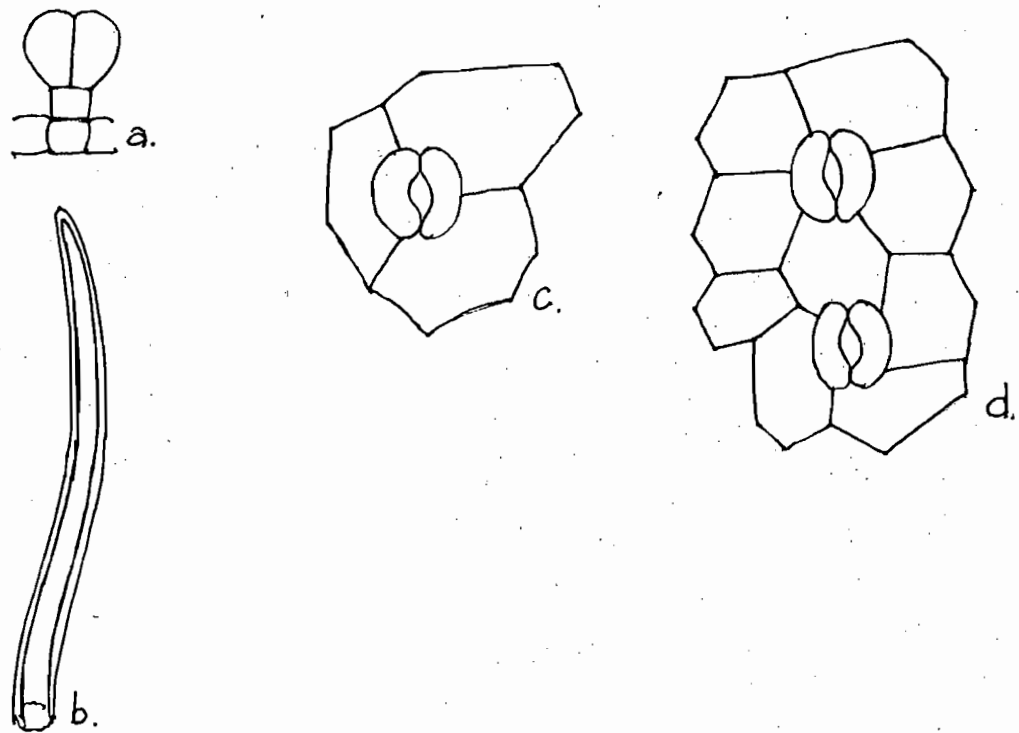


Fig. 284. *Volutarella divaricata* Bth., a. gland with two celled head and a single celled stalk, b. unicellular trichome, c. anisocytic stomata, d. anomocytic stomata.

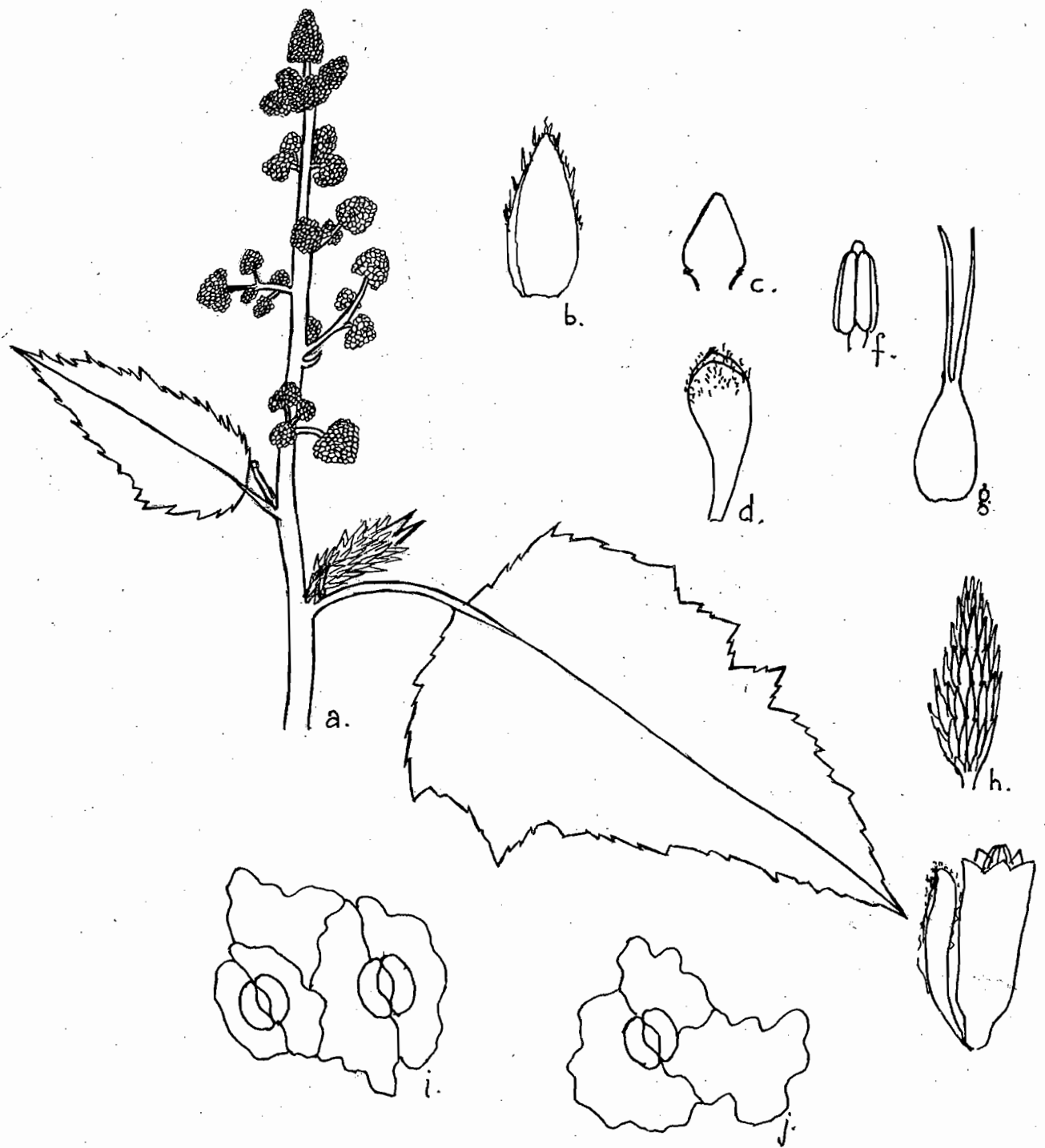


Fig. 285. *Xanthium strumarium* L., a. habit, b. involucral bract, c. receptacle, d. foliaceous bract, e. floral bud, f. stamen, g. female inflorescence, h. ovary, i. paracytic stomata, j. anisocytic stomata.

white, slender; tube long; lobes obovate-oblong. Stamens 5, free from the corolla; filaments as long as the corolla-tube; anthers exerted just beyond the throat. Ovary one celled one ovuled; stigma 5. Capsule oblong, pointed; pericarp thin below, thick and hardened above. (Fig. 286)

Vernacular name: Chitrak.

Flowers: September-March.

Micromorphology (Fig. 286)

Hairs on the calyx were characterized by a heavy multicellular head and a long multiseriate stalk, otherwise the plant was glabrous.

Stomata were of anisocytic and anomocytic types.

D/110, 594, 709, 710.

Primulaceae

1. *Anagallis arvensis* Linn. *Sp. Pl.* (1753) p. 148.

An erect or procumbent annual with 4-gonous stem reaching upto a height of 40 cm. Leaves ovate, sessile, opposite, gland-dotted. Flowers axillary, solitary; peduncles decurved in fruit. Calyx 5-partite, divided nearly to the base; segments narrow, lanceolate, acuminate, slightly shorter than the corolla. Corolla rotate, 5-partite, blue. Stamens 5, inserted at the base of the corolla; anthers oblong, dorsifixed. Ovary globose; ovules many on a free central placenta; style simple, filiform; stigma obtuse. Capsule size of a small pea, operculately dividing about the middle, the style persistent on the operculum. Seeds minute, trigonous, peltate.

(Fig. 287)

Vernacular name: Chanak-chibhadi.

Flowers: September-December.

Micromorphology (Fig. 287)

Whole plant was glabrous except for stamens. Staminal hairs which were on the filaments were glandular, multicellular, differentiated into a single celled head and a uniseriate, 4-5 celled stalk.

Stomata were anomocytic.

D/722, 723, 991.

Myrsinaceae

1. *Jacquinia arborea* Vahl, *Eclog. Amer.* 1: 26. 1797.

A shrubs reaching upto 5 m high, with grayish brown, smooth stems. Leaves usually distinctly pseudovercillate; petiole to sparsely puberulous; blade 3-8 cm, coriaceous, margins slightly revolute, apex rounded or retuse, mucronate or mucro absent. Racemes long, commonly exceeding leaves. Bracts lanceolate. Flowers: sepals slightly erose; petals as long as or slightly shorter than tube; stamens shorter than staminodes; staminodes oblong to ovate, apex rounded or retuse. Berries orange-red or red, pericarp smooth. Seeds light brown. (Fig. 288)

Flowers: December-March.

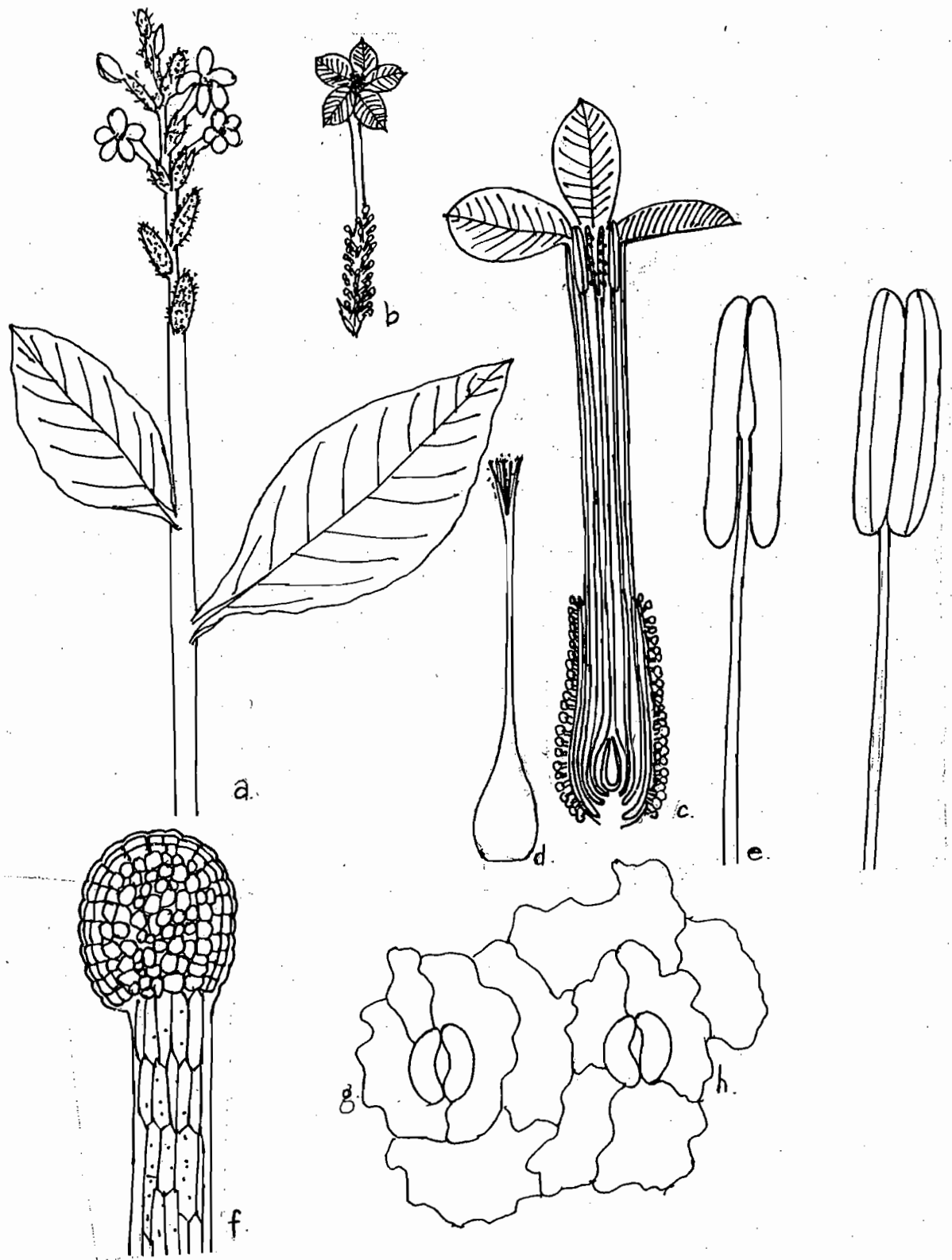


Fig. 286. *Plumbago zeylanica* L., a. habit, b. flower, c. L.S. of flower, d. gynoecium, e. stamen, f. gland with a multicellular head and multiseriate stalk found on the calyx, g. anisocytic, h. anomocytic.

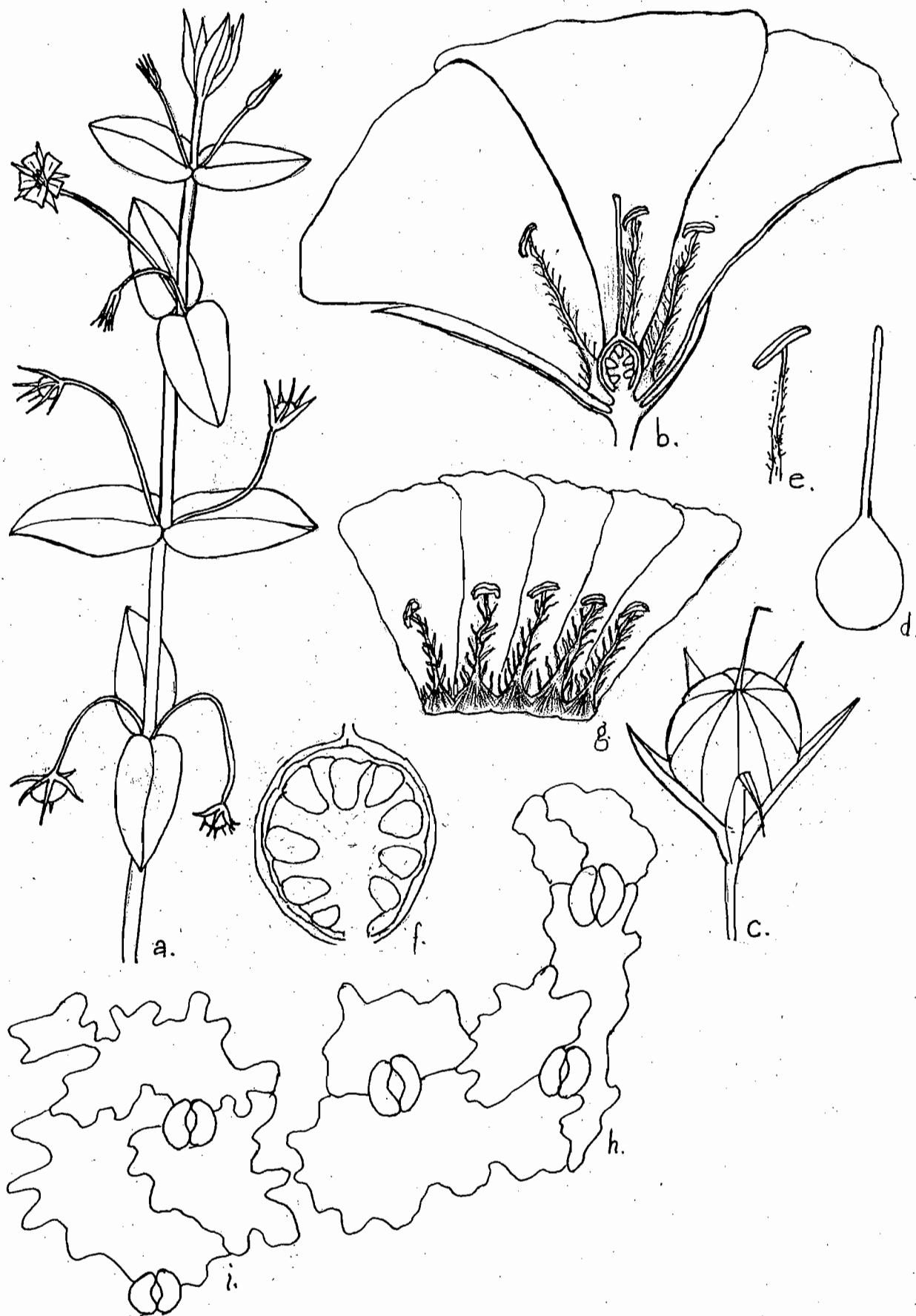


Fig. 287 *Anagallis arvensis* L., a. habit, b. L.S. of flower, c. capsule, d. gynoecium, e. stamen, f. L.S. capsule, g. corolla cut open to expose epipetalous stamen, h-i. anomocytic stomata.

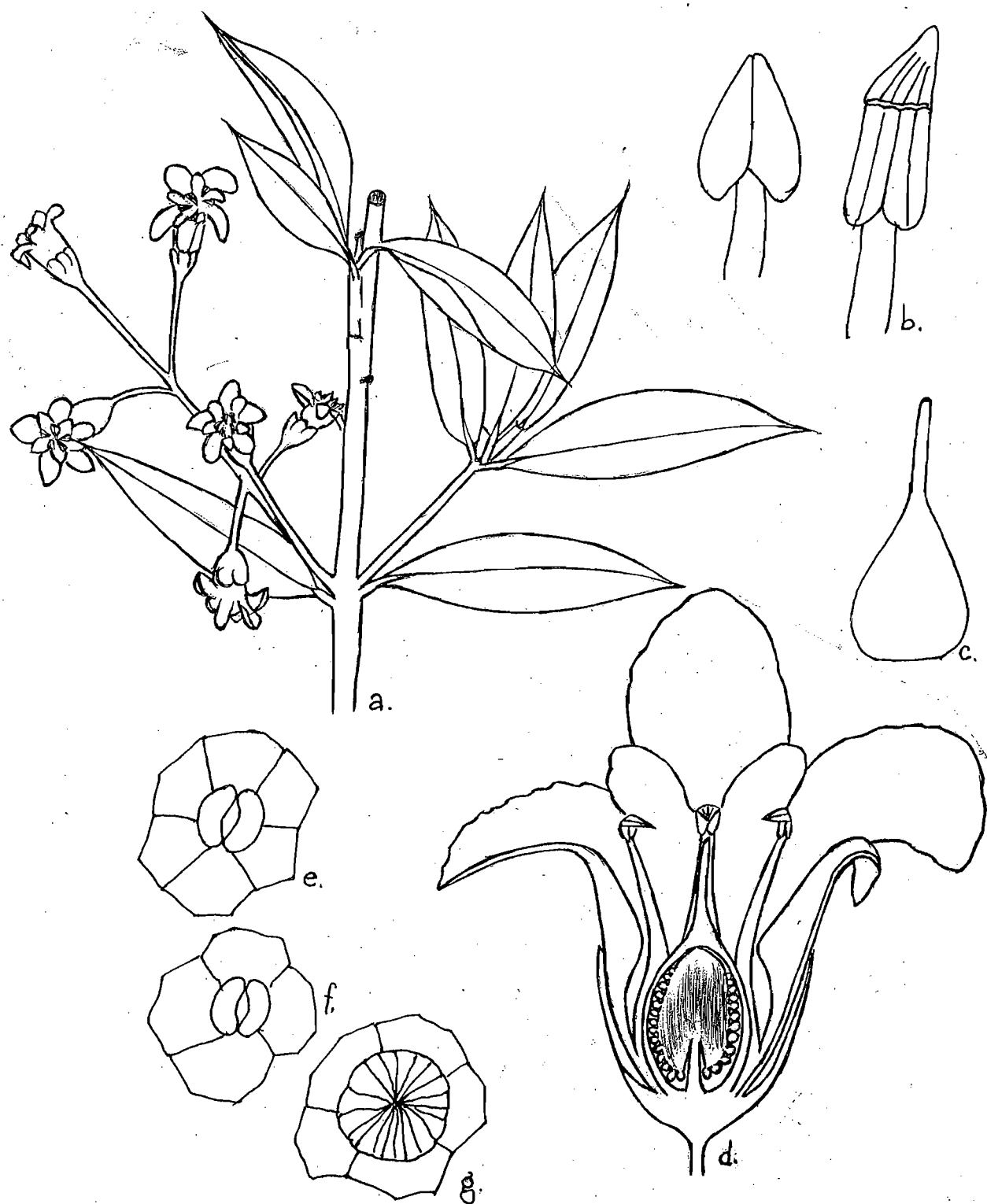


Fig. 288. *Jacquinia arborea* Vahl., a. habit, b. stamen, c. gynoecium, d. L.S. of flower, e. anomocytic stomata, f. tetracytic stomata, g. multicellular sessile gland.

Micromorphology (Fig. 288)

There were multicellular, sessile glands.

Stomata were anomocytic, cyclocytic, and tetracytic types.

Sapotaceae

1. *Manilkara hexandra* (Roxb.) Dub. in *Ann. Mus. Col. Marseille, ser. 3.3:9. 1915.*

A large tree upto 20 m high with deeply furrowed bark. Leaves broadly obovate, upto 12 cm long. Flowers yellowish, axillary, solitary or fascicled. Calyx 6-lobed, pubescent. Corolla 18-lobed, tube short. Stamens 6, with an equal number of staminodes. Ovary 12-celled, hairy. Fruit berry, ovoid, red, 1-seeded. (Fig. 289)

Vernacular name: Rayan.

Flowers: December-February.

Micromorphology (Fig. 289)

The ovary showed presence of unicellular, non-glandular trichome with blunt apex and a thick wall.

Stomata were of paracytic type.

D/301.

2. *Mimusops elengi* Linn. *Sp. Pl.* (1753) p. 349.

A large evergreen tree about 20 m. high. Leaves elliptic, upto 10 cm long. Flowers white, fragrant, nearly 2 cm across, solitary or in fascicles of 2-6, often deflexed. Calyx segments 8, the 4 outer ovate-lanceolate, acute, the 4 inner narrower than the outer. Corolla longer than the calyx; lobes about 24, in 2 series, the inner series of 8 the outer of 16 lobes, linear-oblong, acute. Stamens 8, opposite the inner circle of lobes; anthers slightly twisted, acuminate; staminodes 8, alternate with the stamens, lanceolate, acuminate, densely clothed with white hairs. Ovary appressedly silky-pubescent; style grooved, slightly longer than the corolla. Berry ovoid, yellow when ripe. Seed solitary, ovoid, brown, and shining. (Fig. 290)

Vernacular name: Borsali.

Flowers: January-March.

Micromorphology (Fig. 290)

The leaves were glabrous.

Stomata were anisocytic.

D/162

Oleaceae

1. *Nyctanthes arbor-tristis* Linn. *Sp. Pl.* (1753) p. 6.

A small tree with quadrangular young branches, rough all over with stiff whitish hairs. Leaves ovate, opposite, upto 10 cm long, rough and scabrous above with short bulbous hairs. Flowers fragrant, sessile in pedunculate bracteate fascicles of 3-5, axillary and/or in

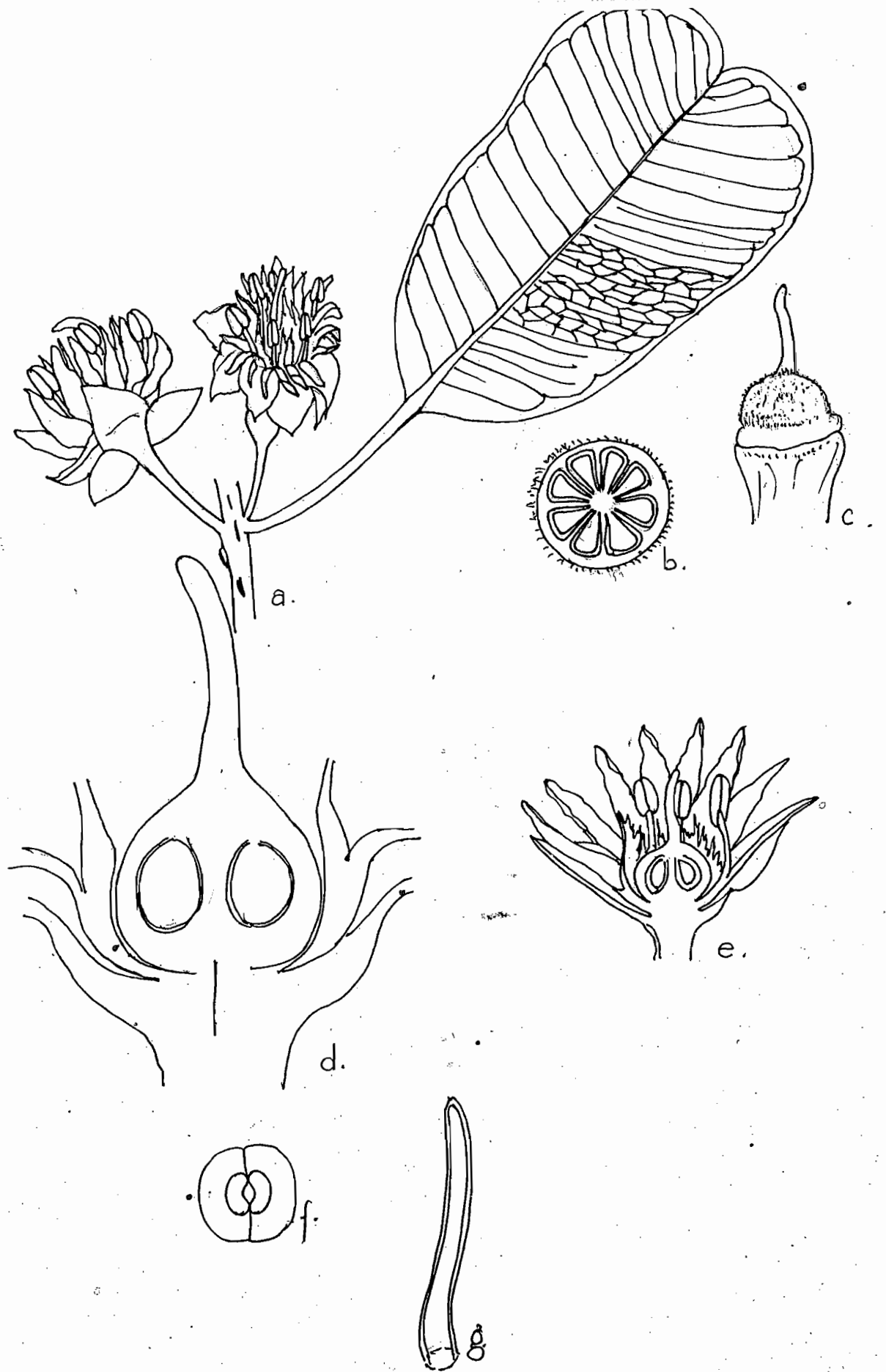


Fig. 289. *Manilkara hexandra* (Roxb.) Dub., a. habit, b. T.S. of ovary, c. gynoecium, d. L.S. of ovary, e. L.S. of flower, f. paracytic stomata, g. unicellular trichome.

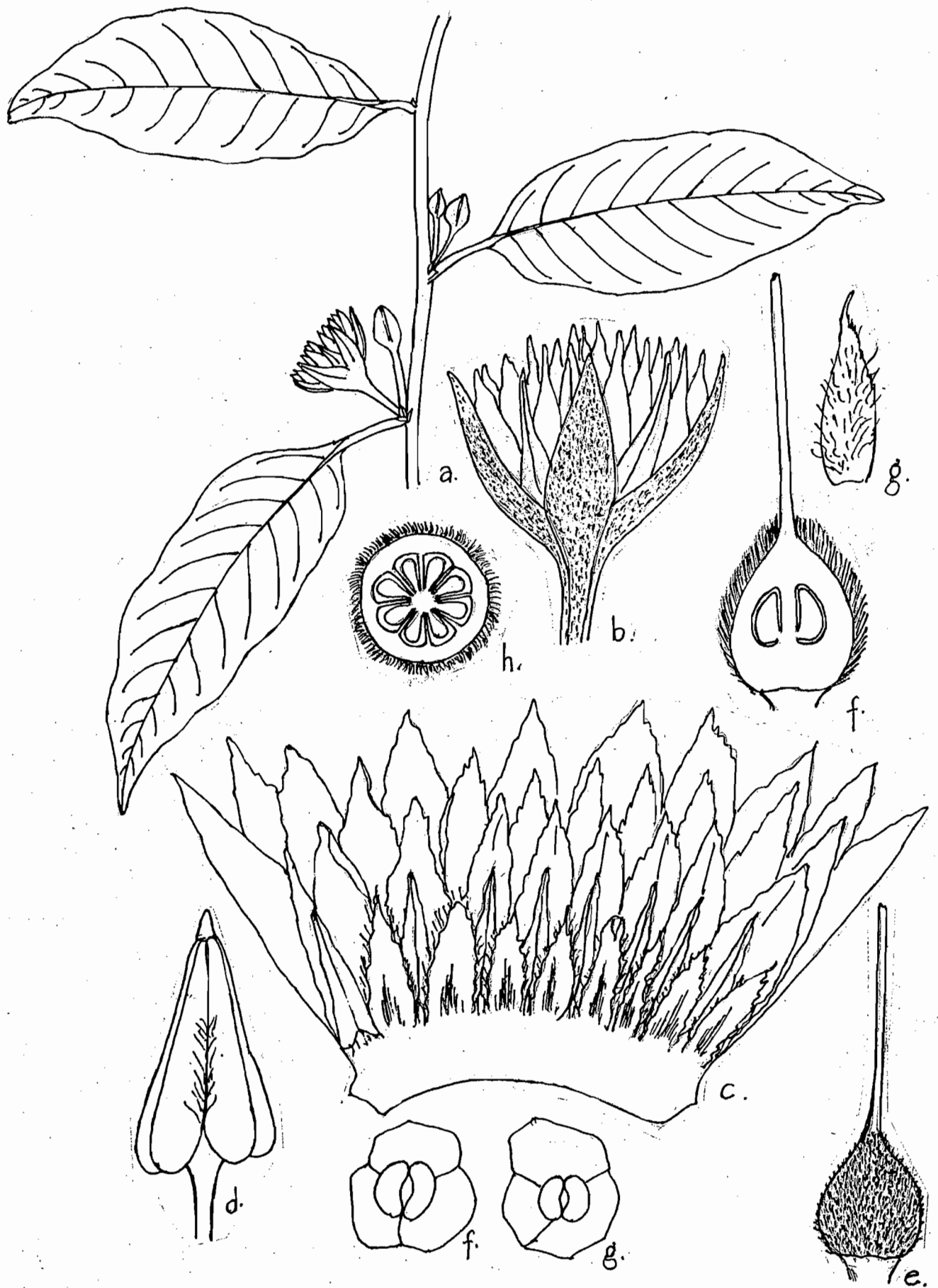


Fig. 290. *Mimusops elengi* L., a. habit, b. flower, c. corolla cut open to show epipetalous stamen, d. stamen, e. gynoecium, f. L.S. of gynoecium, g. bract, f-g. anisocytic stomata.

terminal short trichotomous cymes; bracts broadly ovate or suborbicular, apiculate. Calyx campanulate, obscurely toothed, hairy. Corolla hypocrateriform; orange-colored, about equaling the limb; lobes white, unequally obcordate, cuneate. Anthers 2, subsessile near the top of the corolla-tube. Ovary 2-celled. Capsules nearly orbicular, compressed, 2-celled, separating into 2 flat 1-seeded carpels. (Fig. 291)

Vernacular name: Parijatak.

Flowers: more or less throughout the year.

Micromorphology (Fig. 292)

Stem showed presence of unicellular, non-glandular, trichome, with thick, warty wall and a very short lumen at the round bottom.

Corolla showed presence of unicellular, glandular trichome containing ergastic substance; and a multicellular, glandular trichome differentiated into a four celled head and a one celled stalk.

Stomata were of tetracytic and anomocytic type.

D/ 551, 983.

Salvadoraceae

1. *Salvadora persica* Linn. *Sp. Pl.* (1753) p. 122.

A large much-branched evergreen small tree with drooping white branches, glabrous, terete, finely striate, shining, and almost white. Leaves elliptic-lanceolate, somewhat fleshy, glaucous, upto 7 cm long. Flowers greenish-yellow, in axillary and terminal compound lax panicles upto 13 cm long, numerous in the upper axils; bracts ovate. Calyx cleft half-way down; lobes rounded. Corolla deeply cleft, persistent; lobes oblong, obtuse, much reflexed. Stamens shorter than the corolla, but exserted, owing to the corolla-lobes being reflexed. Drupe globose, smooth, red. (Fig. 293)

Vernacular name: Khari-piludi.

Flowers: November-February.

Micromorphology (Fig. 293)

Whole plant was glabrous.

Stomata were of tetracytic type.

D/ 111, 121.

Apocynaceae

1. *Aganosma caryophyllata* G. Don. *Gen. Syst.* V. 4 (1837) p. 77.

A laticiferous woody liana with ovate-elliptic, opposite leaves. Cymes terminal or axillary, corymblike. Flowers large, showy. Calyx divided halfway, with 5 or more basal glands inside, sepals usually longer than corolla tube. Corolla white, salverform; tube long cylindric, hairy inside, widened at base; lobes overlapping to right. Stamens inserted at lower third of tube; anthers included, sagittate; disc surrounding ovary. Ovaries 2,

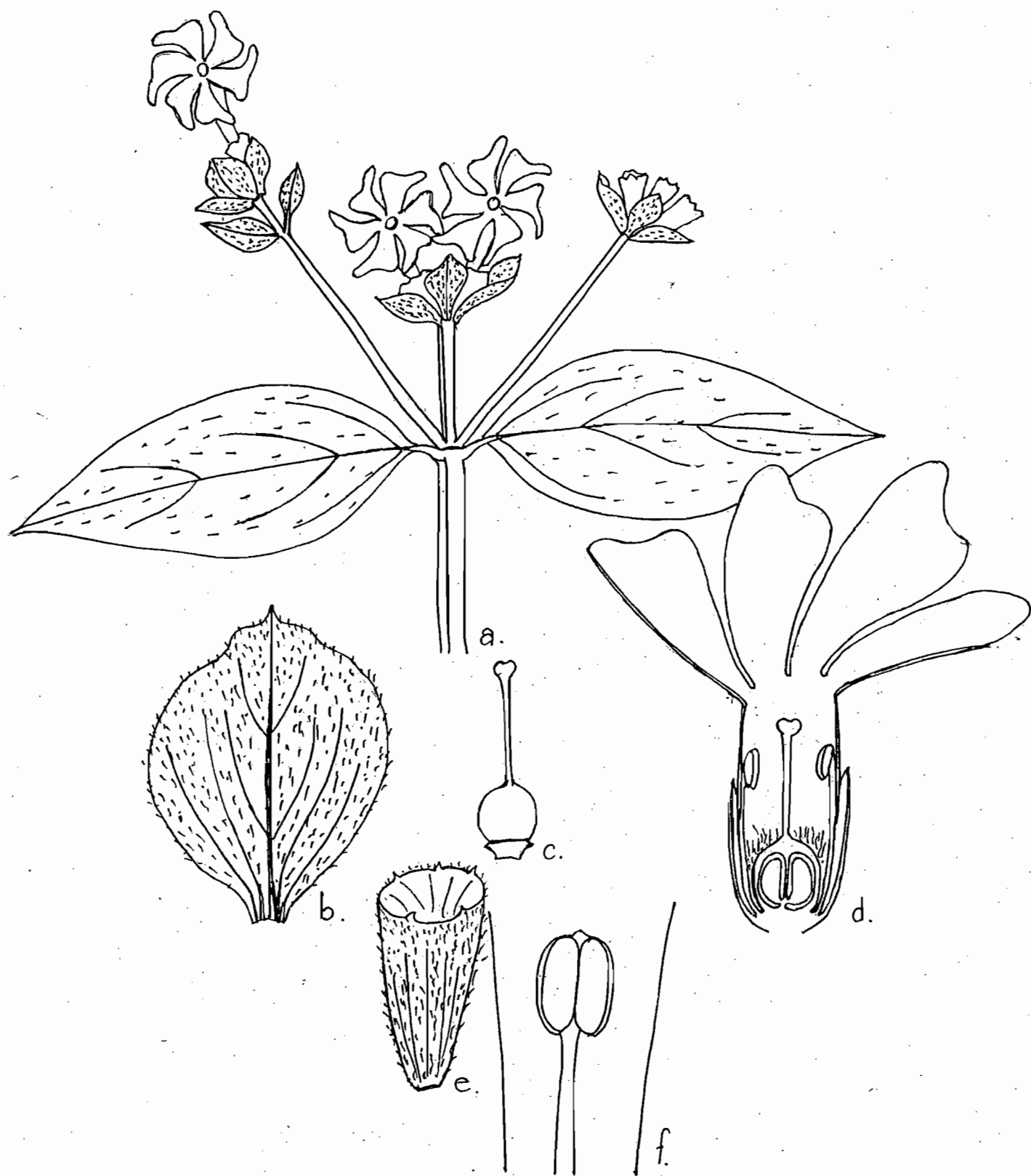


Fig. 29f. *Nyctanthes arobor-tristis* L., a. habit, b. bract, c. gynoecium, d. L.S. of flower, e. calyx, f. epipetalous stamen.

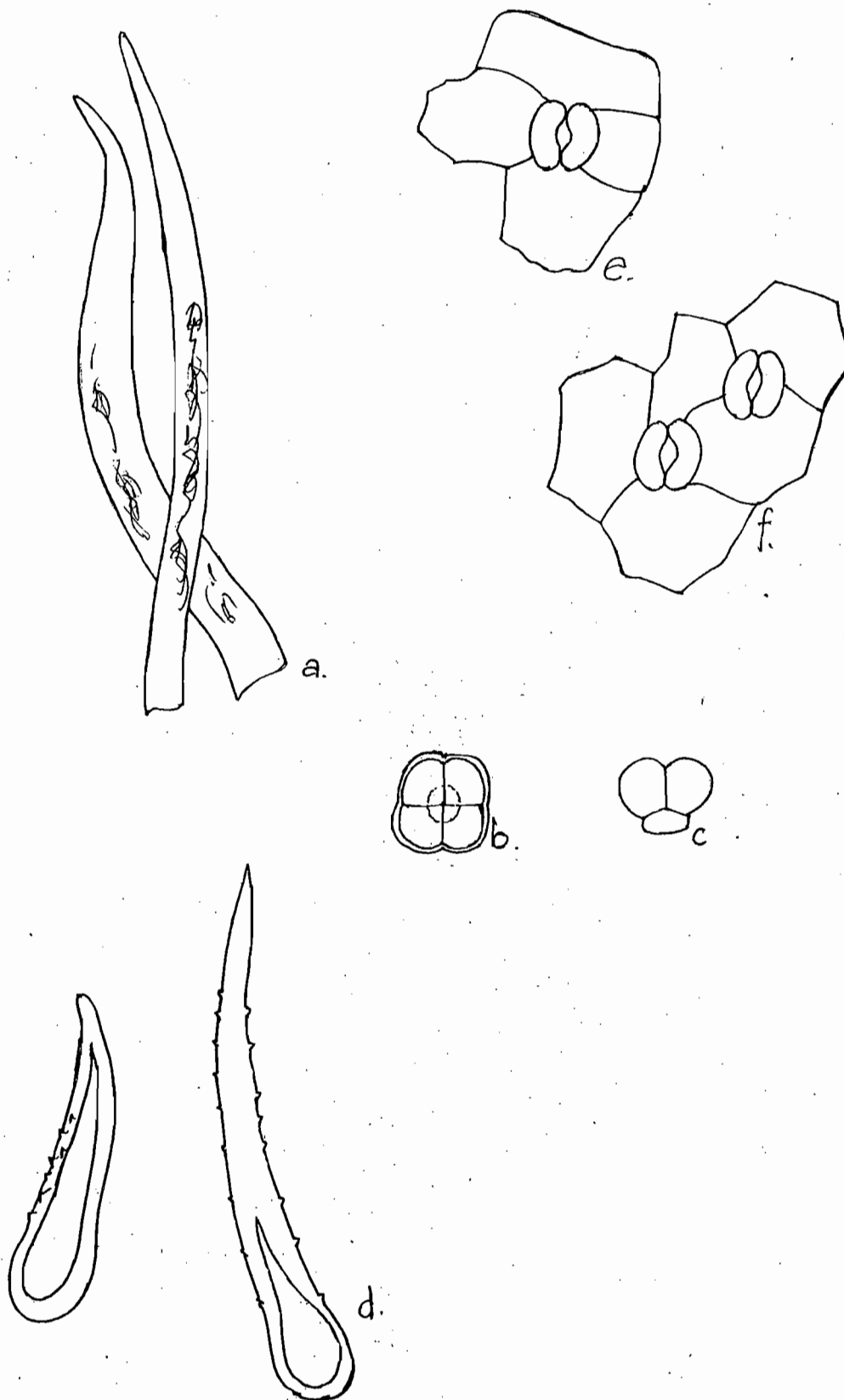


Fig. 292. *Nyctanthes arbor-tristis* L., a. unicellular gland, b. multicellular four celled sessile gland, c. gland with two celled head and a single celled stalk, d. unicellular trichome with small lumen, thick and warty wall, e. tetracytic stomata, f. anomocytic stomata.

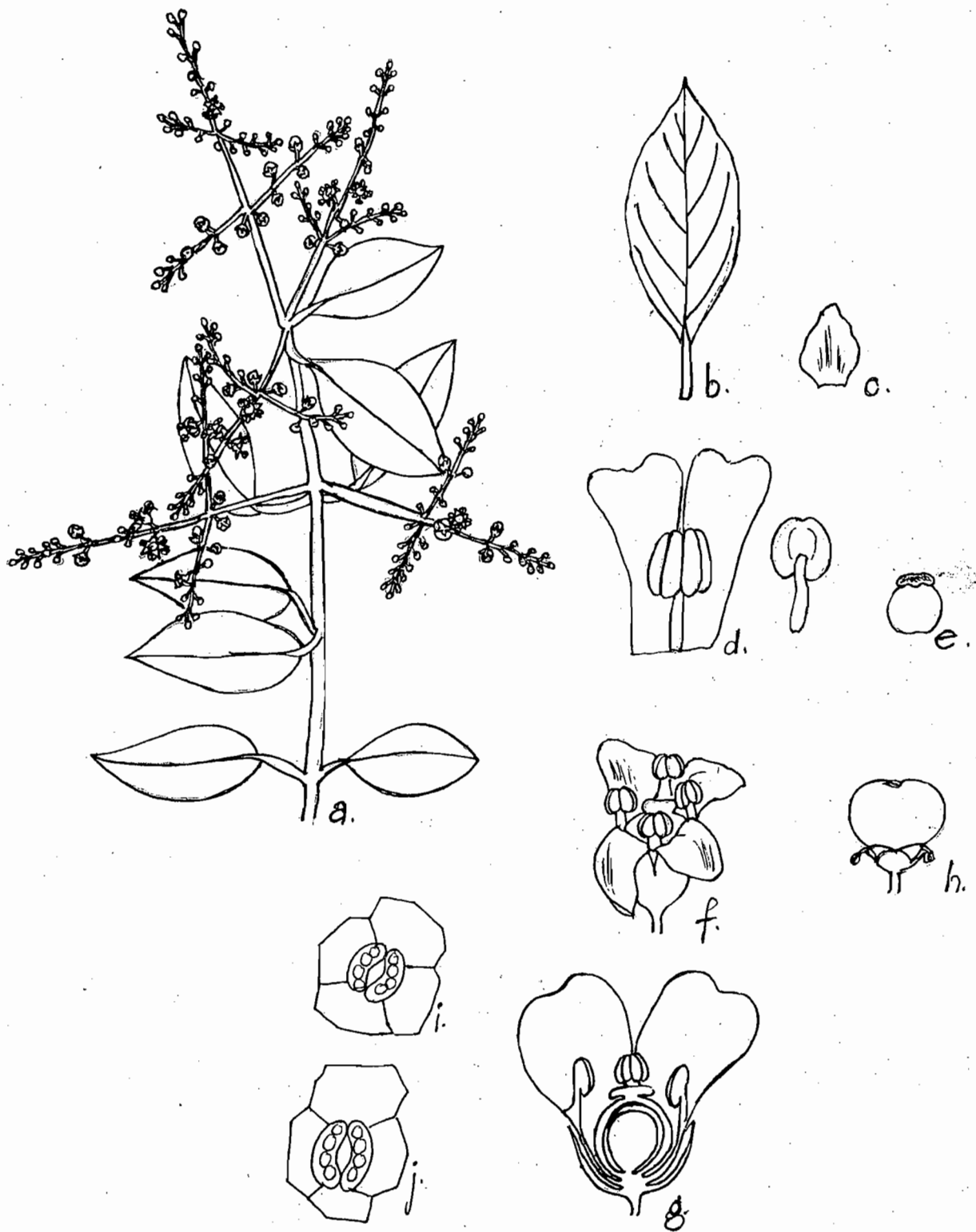


Fig. 293. *Salvadora persica* L., a. habit, b. leaf, c. sepal, d. epipetalous stamen, g. L.S. of flower, h. fruit, i-j. tetracytic stomata.

distinct; ovules numerous. Style short; stigma conical cleft. Follicles linear, terete. Seeds flat, coma deciduous. (Fig. 294)

Flowers: August-February.

Micromorphology (Fig. 294)

The leaves were glabrous.

Stomata were of anomocytic type.

D/204.

2. *Carissa carandas* Linn. *Mantiss.* V. 1 (1767) p. 52.

A large evergreen shrub with twin stout sharp horizontal glabrous spines at the apex of branches. Leaves elliptic or obovate, upto 8 cm long, coriaceous, shortly mucronate. Flowers white, in pubescent terminal corymbose cymes; bracts linear. Calyx 5-partite, cleft rather more than half-way down, lanceolate. Corolla hypocrateriform; corolla-tube about 1.5 cm long; lobes 1 cm oblong-lanceolate. Stamens included within the corolla-tube; anthers linear-oblong. Ovary glabrous; ovules 4 in each cell; stigma slightly penicillate at the apex. Berry ellipsoid, purplish-black when ripe, smooth, 4- or more-seeded. (Fig. 295)

Vernacular name: Karamda.

Flowers: January-April.

Micromorphology (Fig. 296)

Whole plant was glabrous.

Stomata were of anomocytic, tetracytic and cyclocytic types.

D/1073-1074.

3. *Lochnera pusilla* K. Schum. in *Engl. & Prantl. Pflanzenf.* V. 4, Part 2 (1895) p. 145.

An erect annual, with quadrangular branched stem reaching upto 45 cm high. Leaves lanceolate, upto 8 cm, glabrous; axillary glands long, subulate. Flowers white, small, solitary or in pairs, axillary. Calyx segments lanceolate-subulate. Corolla-tube 1 cm long, slightly enlarged near the top, the mouth narrow, hairy, the throat glabrous inside, lobes oblong-obovate, apiculate. Follicles upto 5 cm long, slender, pointed, diverging. Seeds cylindric with many muriculate ribs, black when ripe. (Fig. 297)

Flowers: July-September.

Micromorphology (Fig. 297)

Whole plant was glabrous.

Stomata were of anomocytic types.

D/144.

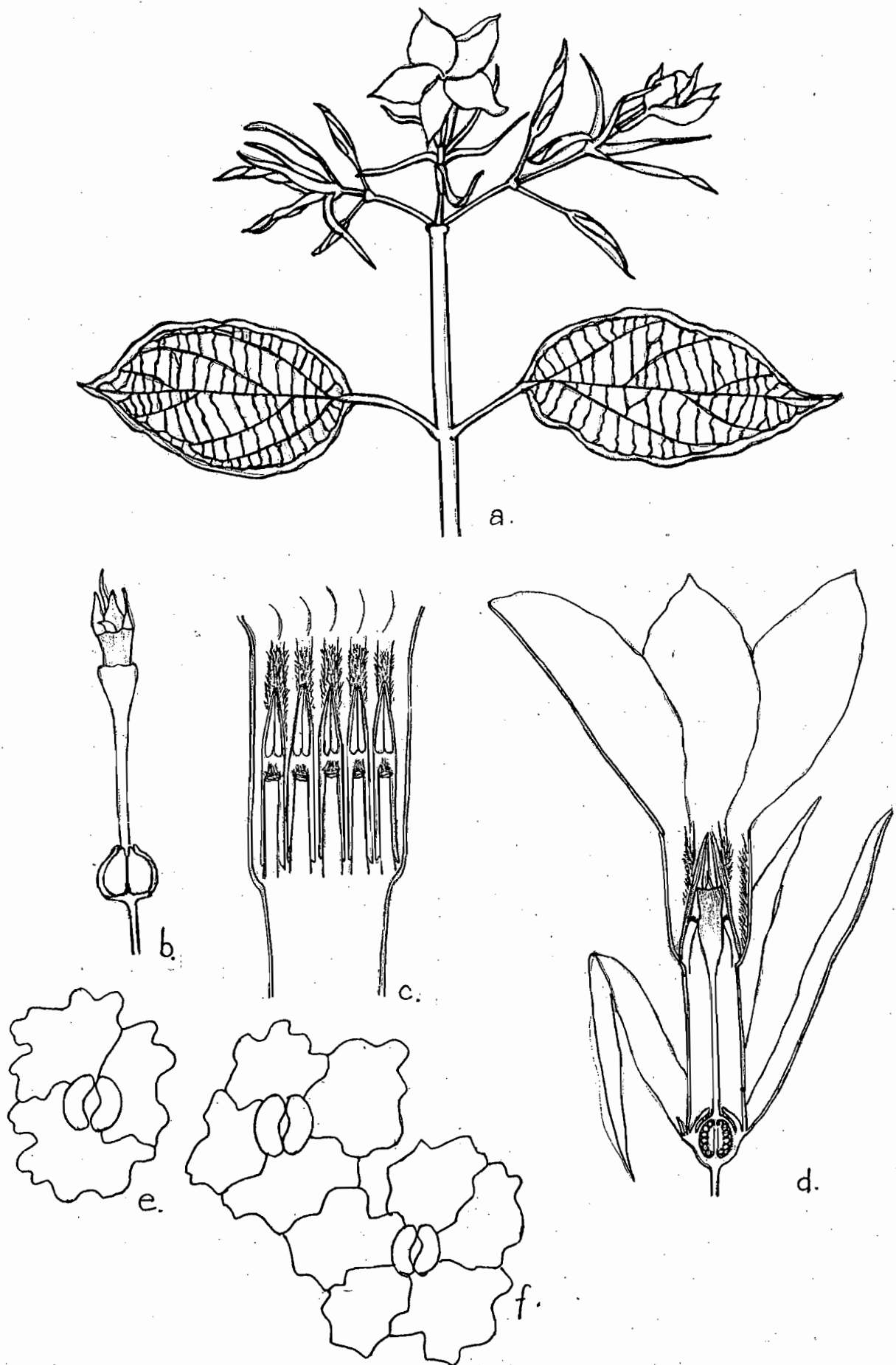


Fig. 294. *Aganosma caryophyllata* G. Don., a. habit, b. gynoecium, c. epipetalous stamen, d. L.S. of flower, e. anisocytic stomata, f. anomocytic stomata.

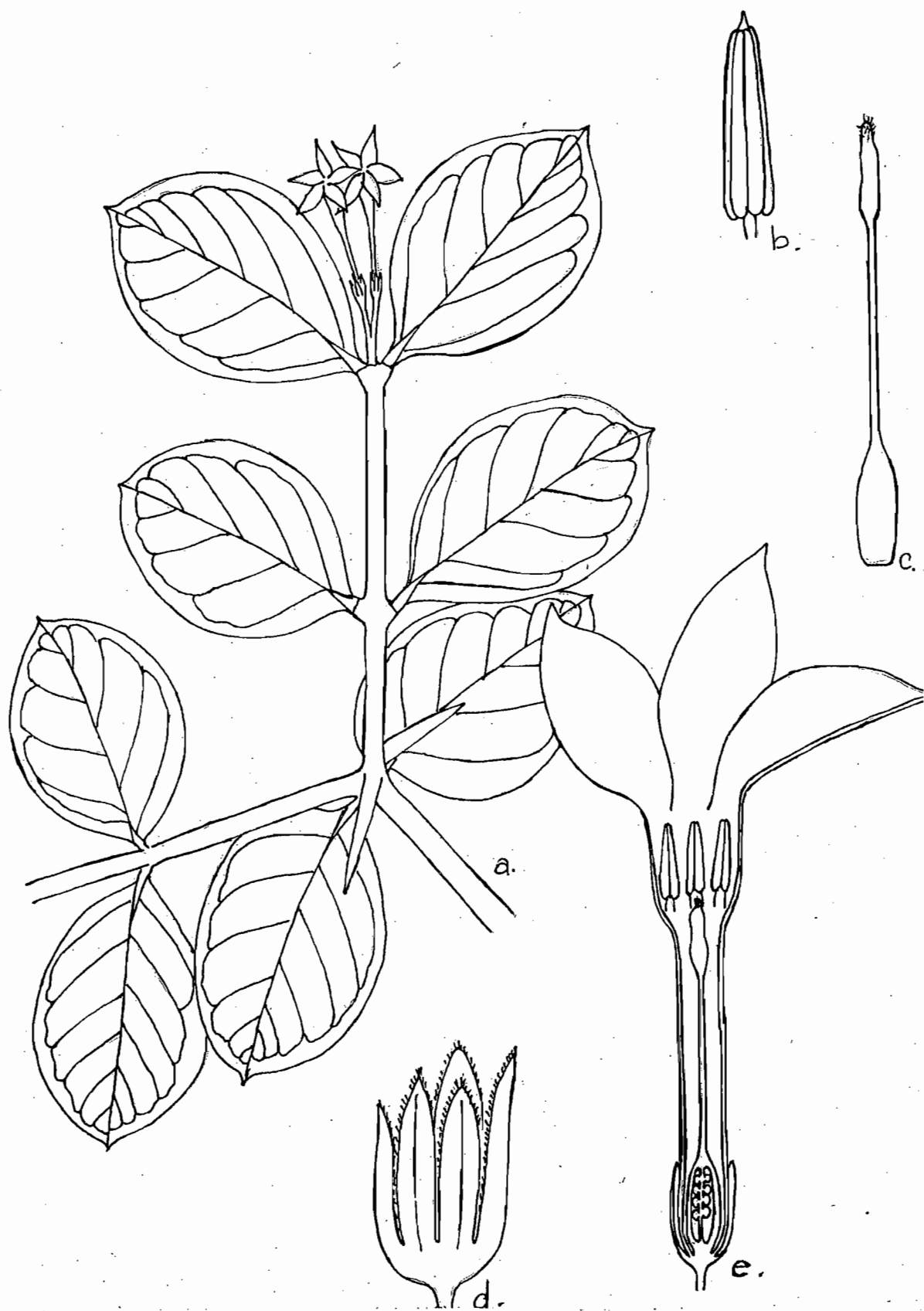


Fig. 295. *Carissa carandas* Auct., a. habit, b. stamen, c. gynoecium, d. calyx, e. L.S. of flower.

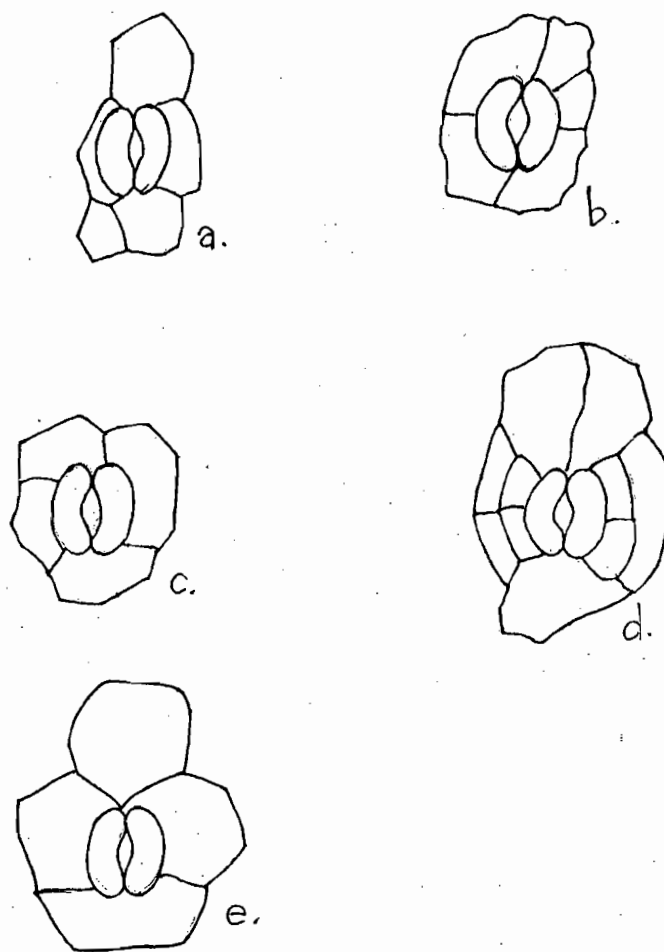


Fig. 296. *Carissa carandas* Auct., a. tetracytic stomata, b-d. cyclocytic stomata, c-e. anomocytic stomata.

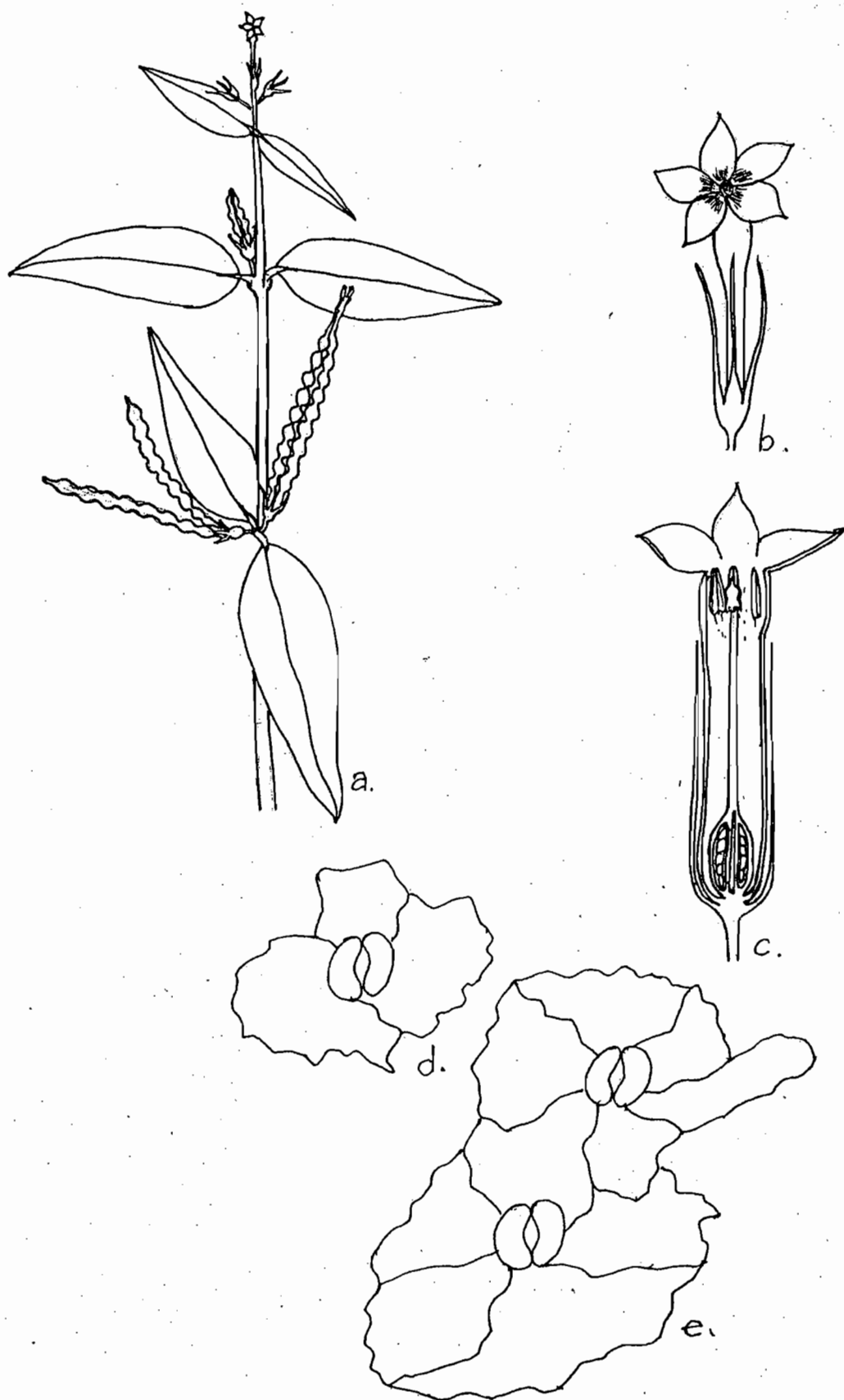


Fig. 297. *Lochnera pusilla* K. Schum., a. habit, b. flower, c. L.S. of flower, d. anisocytic stomata, e. anomocytic stomata.

4. *Plumeria alba* Linn. *Sp. Pl.* (1753) p. 210.

A small branched tree with thick, woody stem and branchlets scarred with the bases of fallen petioles. Leaves oblong to obovate, whorled, upto 30 cm; secondary nerves at right angle to the midrib and joined with intramarginal veins. Flowers in terminal, corymbose or umbelliform cymes. Bract caducous. Corolla hypocrateriform; lobes 3 cm long, twisted to left; tube pubescent inside. Stamens inserted near the base of corolla-tube; anthers oblong or ovate. Ovary glabrous; stigma 2-lobed. Etario of follicle, widely divergent, linear. Seeds with basal wing. (Fig. 298)

Vernacular name: Champo.

Flowers: March-June.

Micromorphology (Fig. 298)

The leaf showed presence of uniseriate, three celled non-glandular, trichome.

Stomata were of anisocytic and anomocytic type.

D/322.

5. *Rauvolfia tetraphylla* Linn., *Sp. Pl.* 1: 208. 1753.

A pubescent bushy shrub reaching upto 2 m height. Leaves ovate, in whorls of 3-5, reaching upto 15 cm, membranous, base broadly cuneate to rounded, apex acute or obtuse; lateral veins 5-12 pairs. Corolla white, tube urceolate, long hairy inside distal half; lobes ovate or suborbicular. Stamens inserted at corolla throat. Ovaries connate. Drupes subglobose. Seeds 2. (Fig. 299)

Vernacular name: Barachandrika.

Flowers: May-August.

Micromorphology (Fig. 300)

Two types of non-glandular trichomes were seen; 1) uniseriate many-celled trichome with thick striated wall and 2) unicellular trichome with thick striated wall.

Stomata were anomocytic, anisocytic and tetracytic types.

D/201.

6. *Walidda antidysenterica* (L.) Pichon *Mém. Mus. Natl. Hist. Nat., B, Bot.* 1: 74 1951. (*Holarrhena antidysenterica* Wall.)

A branched small tree. Leaves broadly ovate to elliptic, upto 20 cm, acuminate. Flowers white, in terminal corymbose cymes; bracts small, lanceolate. Calyx-lobes 5, oblong-lanceolate, ciliate. Corolla hypocrateriform; tube 1 cm long, slightly inflated near the base over the stamens, throat hairy inside; lobes oblong, rounded at the apex. Stamens near the base of the tube, included; anthers lanceolate, free from the style, mucronate, cells rounded at the base. Carpels 2, distinct; ovules many in each carpel; style short, filiform; stigma oblong-fusiform, the tip entire or 2-fid. Follicles upto 40 cm long, cylindric, often dotted with white spots. Seeds linear-oblong, tipped with a spreading deciduous coma of brown hairs. (Fig. 301)

Vernacular name: Kado.

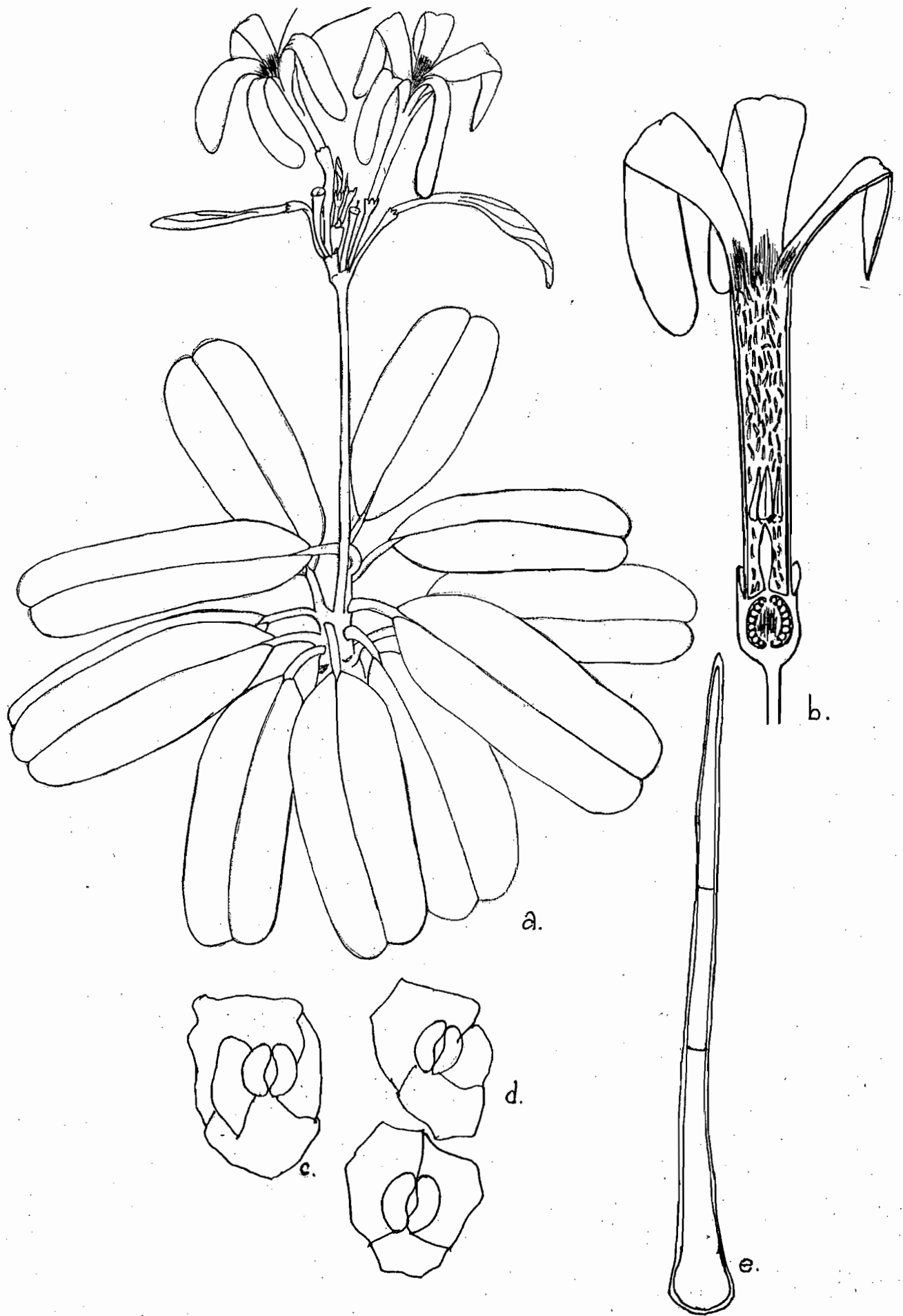


Fig. 298. *Plumeria alba* L., a. habit, b. L.S. of flower, c. tetracytic stomata, d. anisocytic stomata, e. multicellular uniseriate trichome

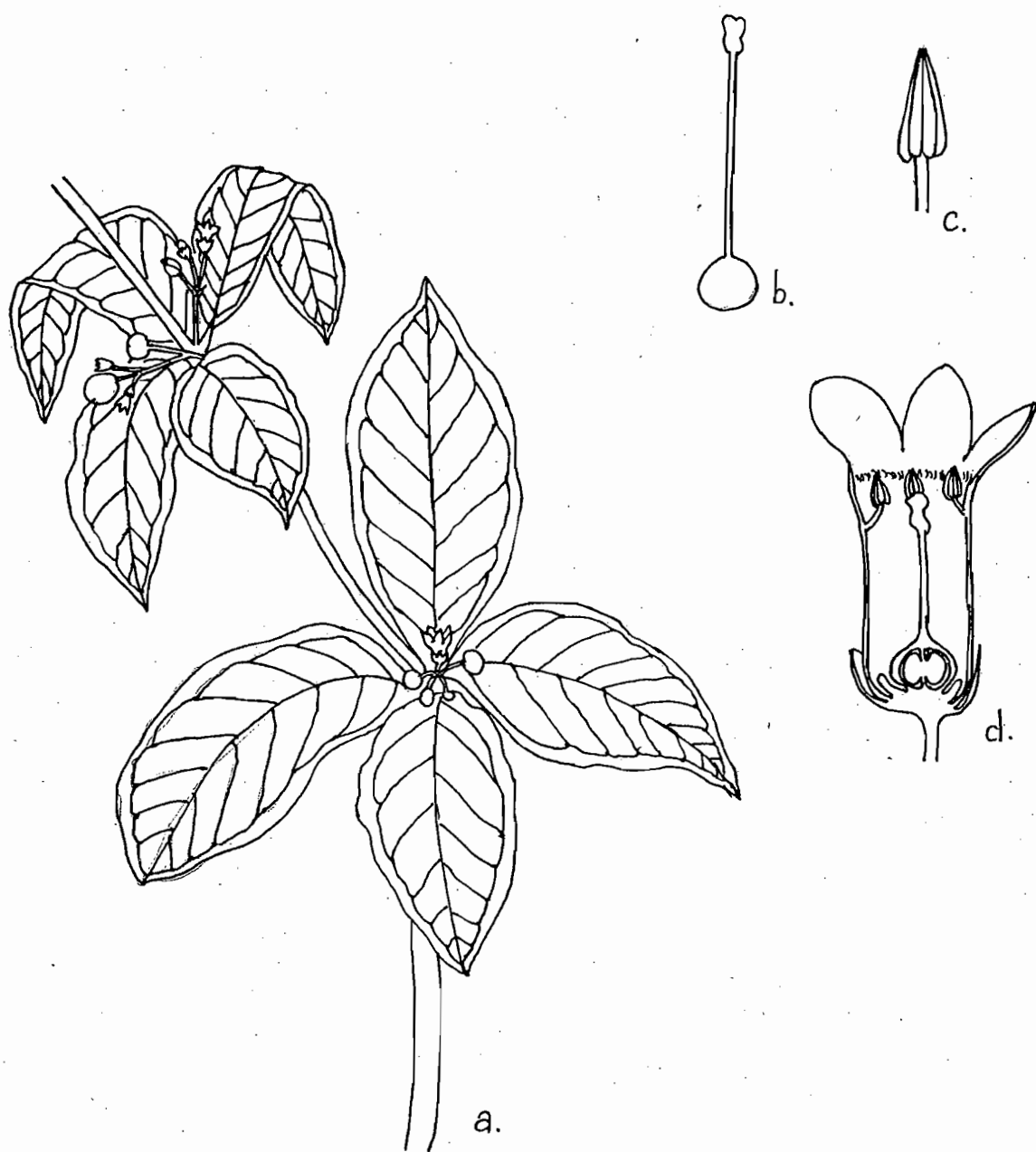


Fig. 299. *Rauwolfia tetraphylla* L., a. habit, b. gynoecium, c. stamen, d. L.S. of flower.

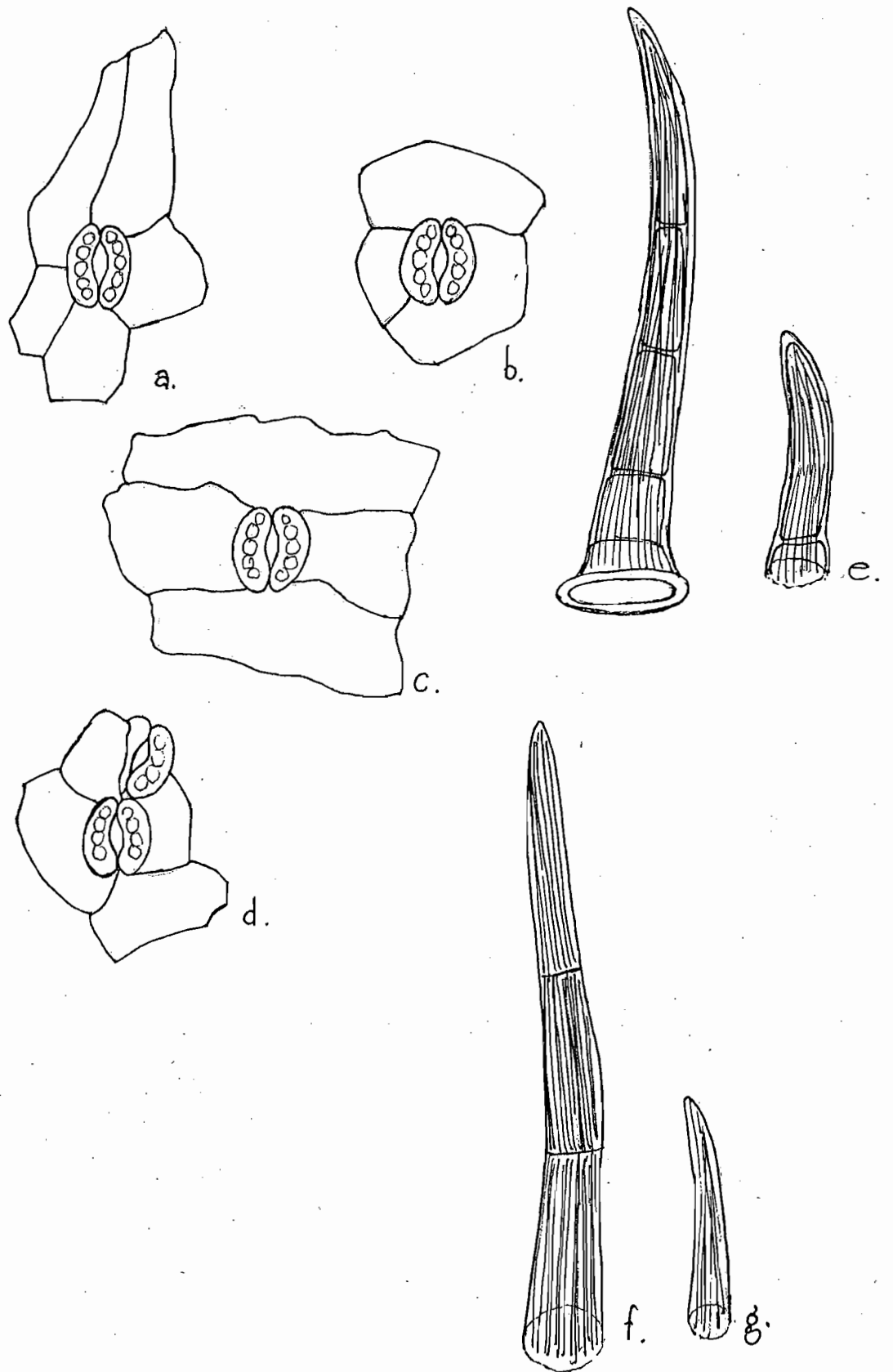


Fig. 300. *Rauwolfia tetraphylla* L., a-d. anomocytic stomata, b. anisocytic stomata, c. tetracytic stomata, e-f. multicellular uniseriate trichome with thick wall and striations on the wall, g. unicellular trichome.

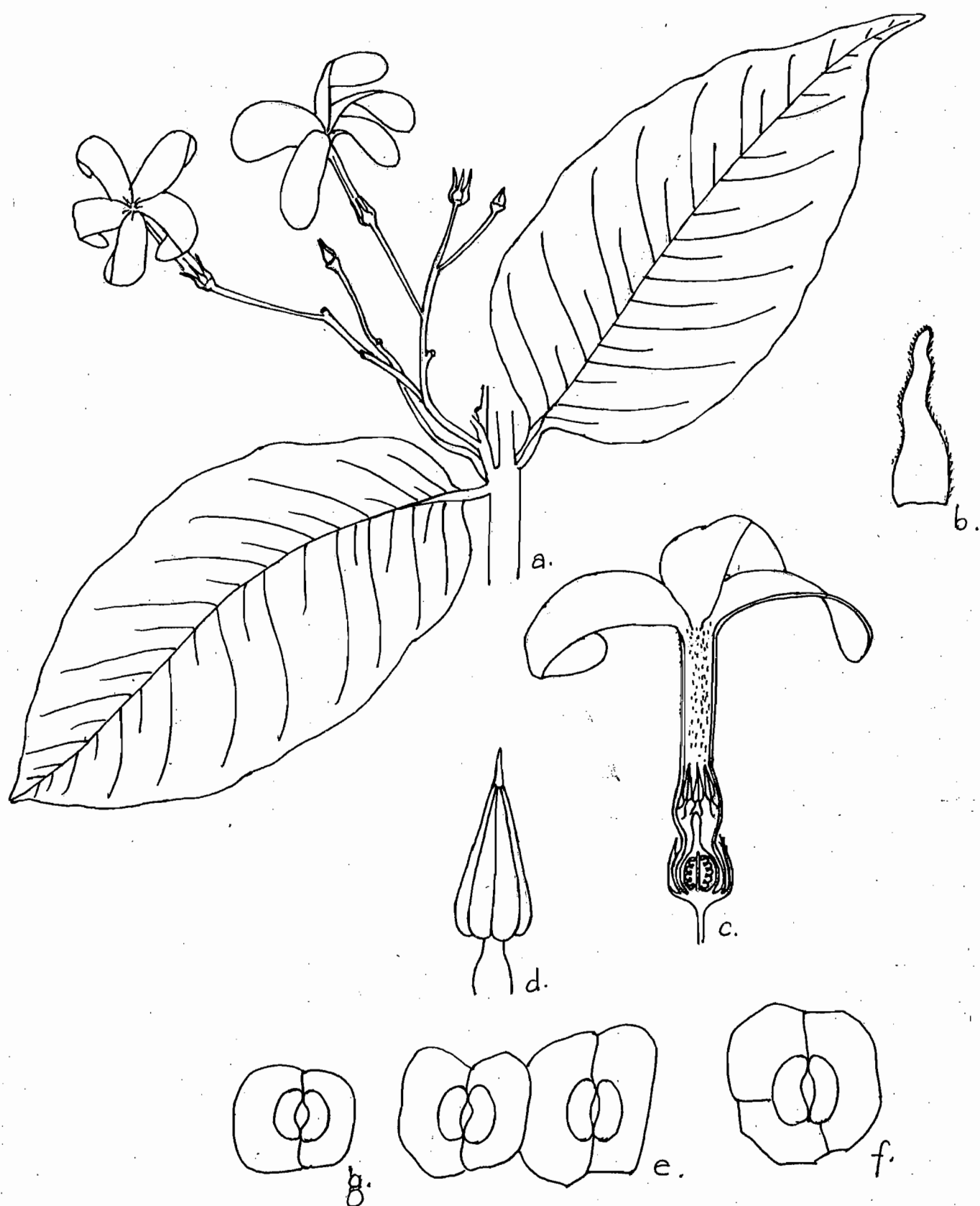


Fig. 301. *Walidda antidysenterica* Pichon., a. habit, b. bract, c. L.S. of flower, d. stamen, e-g. paracytic stomata.

Flowers: February-June.

Micromorphology (Fig. 301)

Whole plant was glabrous.

The stomata were of paracytic and anisocytic type.

D/125.

7. *Wrightia tinctoria* R. Br. in *Mem. Wern. Soc.* V. 1 (1811) p. 74.

A small deciduous tree with scaly bark. Leaves elliptic-lanceolate, upto 15 cm. Flowers white, fragrant, in lax terminal cymes with slender spreading dichotomous branches. Calyx 5-partite, glandular inside; segments oblong. Corolla hypocrateriform, tube cylindric; with a corona of 5 or 10 erect usually fimbriate scales which are distinct into a ring; lobes overlapping to the left. Stamens at the top of the corolla-tube; anthers exserted, sagittate, conniving around and adhering to the stigma, the cells with solid spurs at the base. Carpels of the ovary 2, free or connate; ovules many in each carpel. Fruit of 2 distinct pendulous follicles, upto 50 cm. Seeds 1-2 cm long, pointed at the apex, with a long deciduous coma. (Fig. 302)

Vernacular name: Burai kudi.

Flowers: July-October.

Micromorphology (Fig. 302)

Whole plant was glabrous.

Stomata were of anomocytic and paracytic. Among these anomocytic were in majority.

D/230.

8. *Thevetia neriifolia* Juss. ex. Steud., *Nomencl. Bot.* ed. 2. 2: 680. 1841.

A small laticiferous trees reaching a height of 6 m. Leaves linear upto 15 cm. Flowers in terminal, few-flowered cymes, showy, fragrant. Calyx-lobes 5. Corolla crimson, white, orange or yellow; tube broadly campanulate above, cylindrical at base; lobes overlapping to left. Stamens 5, adnate on the throat; anthers lanceolate, with branched appendages at tip. Carpels 2, syncarpous; ovary 2-locular; ovules 2 in each locule; style filiform; stigma disciform. Drupes green, fleshy, bluntly 4-angled, glabrous. (Fig. 303)

Vernacular name: Pilikaren.

Flowers throughout the year.

Micromorphology (Fig. 303)

Leaves were glabrous.

Stomata were anomocytic, tetracytic and paracytic types.

D/179.

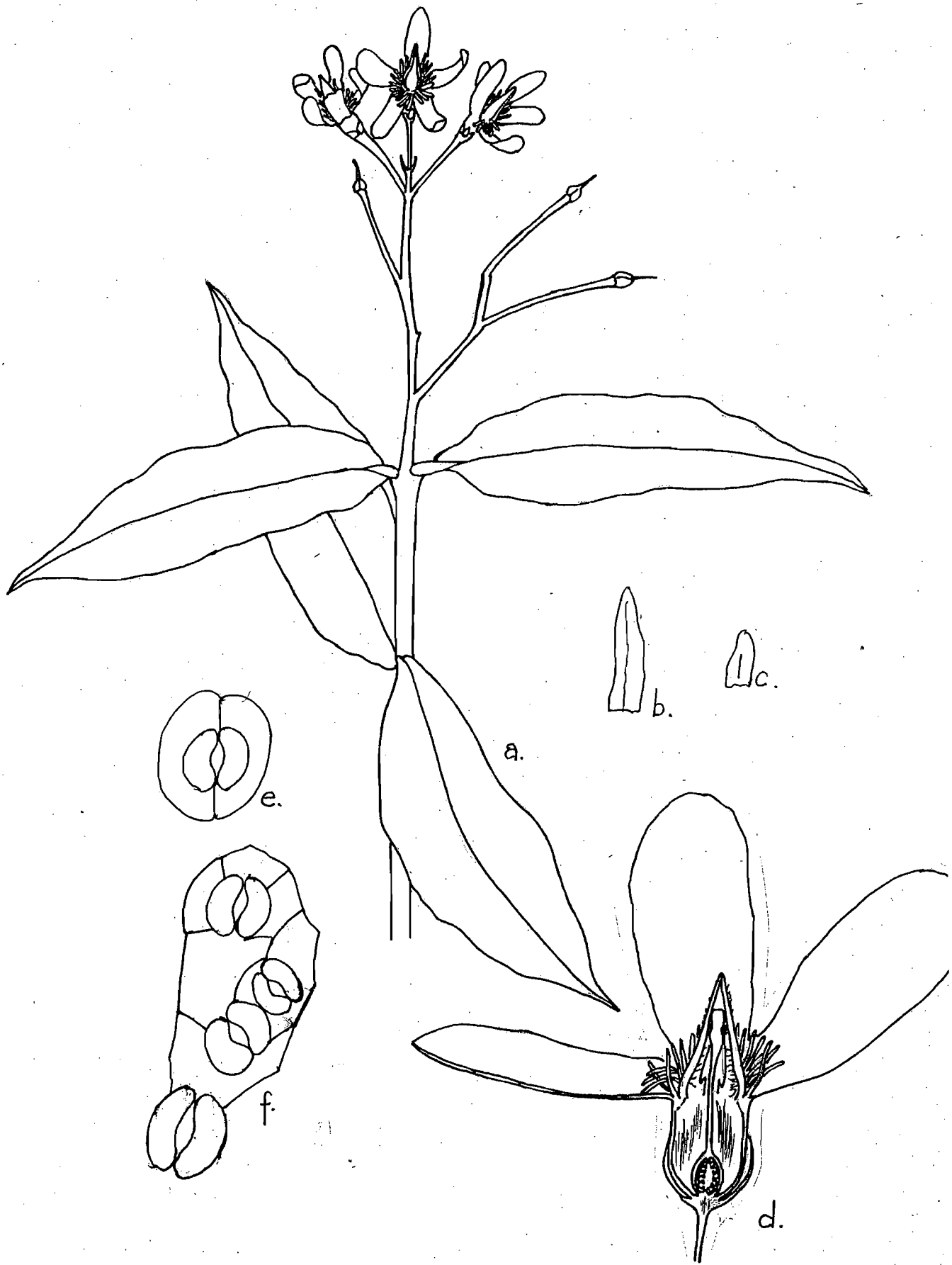


Fig. 302. *Wrightia tinctoria* R. Br., a. habit, b. bract, c. bracteole, d. L.S. of flower, e. paracytic stomata, f. anomocytic and paracytic stomata.

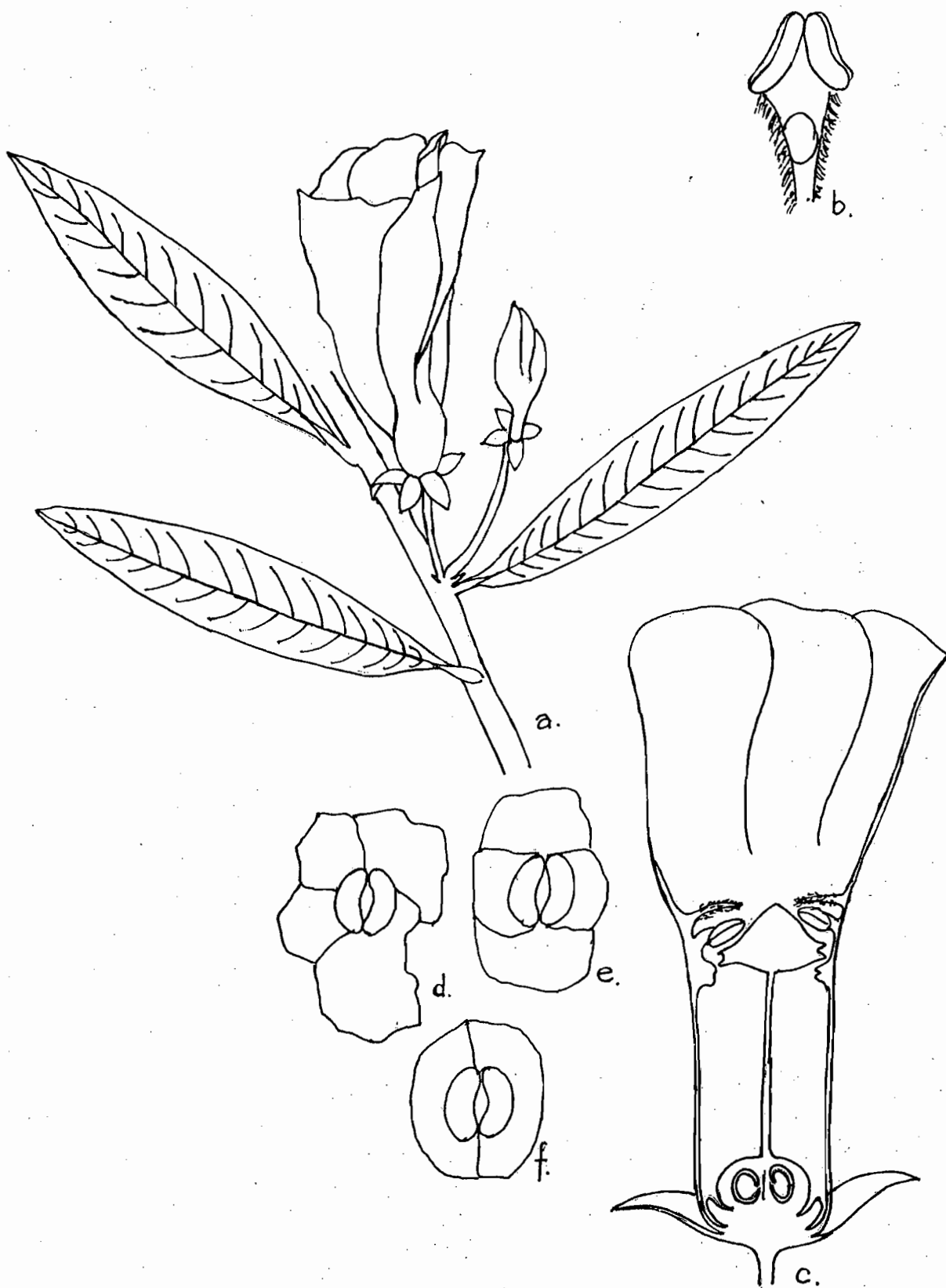


Fig. 303. *Thevetia nerifolia* Juss., a. habit, b. stamen, c. L.S. of flower, d. anomocytic stomata, e. tetracytic stomata, f. paracytic stomata.

*In-Depth Studies on Some of the Floristic Components of
Baroda and Panchmahal Districts with Reference to
Bioprospecting and Speciation.*

Volume - II

**Thesis submitted to
The Maharaja Sayajirao University of Baroda
For The Degree of
Doctor of Philosophy
Botany**

By

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12th June 2012

Certificate

I hereby declare that the thesis entitled "In-Depth Studies on Some of the Floristic Components of Baroda and Panchmahal Districts with Reference to Bioprospecting and Speciation." Submitted to The Maharaja Sayajirao University of Baroda for the award of the Degree of Doctor of Philosophy, is a record of bonafide research carried out by me under the direct supervision of Prof. (Dr.) M. Daniel, Department of Botany, The Maharaja Sayajirao University of Baroda. No part of this thesis has been submitted for the award of any degree or diploma from any other University.

Dipa Gohil
Research Student

I certify that the above statement is correct.

Prof. (Dr.) M. Daniel
Research Supervisor

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Asclepiadaceae

1. *Calotropis gigantea* R. br. in *Ait. Hort. Kew.* ed. 2, V. 2 (1811) p. 78.

A tall laticiferous shrub reaching upto 3 m high with fine appressed cottony pubescence. Leaves obovate-oblong, upto 20 cm, thick, clothed beneath with fine cottony tomentum, base amplexicaul. Flowers purplish or white, in umbellate lateral cymes. Sepals ovate, cottony. Corolla 2 cm long or more; lobes upto 1 cm long, deltoid-ovate, revolute; lobes of the corona 1 cm long, broad in the middle, shorter than the column, the back much curved towards the column above the obtuse spur, the apex rounded with 2 obtuse auricles just below it. Follicles upto 10 cm long, green. Seeds numerous, broadly ovate, flattened, comose. (Fig. 304)

Vernacular name: Moto Ankdo.

Flowers: February-July.

Micromorphology (Fig. 305)

The plant showed presence of multicellular, uniseriate, unbranched, non-glandular trichome.

Stomata were of cyclocytic type, pentacytic, hexacytic and tetracytic types.

D/67

2. *Calotropis procera* R. Br. in *Ait. Hort. Kew.* ed. 2, V. 2 (1811) p. 78.

A plant very similar but smaller than *C. gigantea*, differing in having a shorter staminal column in which the corona remaining equal or higher than the stigma and the bifid apex of the corona lobe without auricles. (Fig. 306)

Vernacular name: Nano Ankdo.

Flowers: September-January.

Micromorphology (Fig. 307)

The plant showed presence of multicellular, uniseriate, non-glandular trichome with rectangular shaped cells.

Stomata were of paracytic and anisocytic type.

D/109

3. *Cryptolepis buchanani* Roem. & Schult. *Syst.* V. 4 (1819) p. 409.

A large twining shrub with terete branches. Leaves elliptic-oblong, upto 12 cm long; main nerves numerous, slender; nearly at right angles to the midrib, uniting in an intramarginal nerve. Flowers greenish-yellow, in short paniculate cymes; bracts ovate. Calyx segments ovate, subacute. Corolla-tube short; lobes linear-lanceolate; corona-scales clavate. Follicles straight, divaricate, gradually tapering to a blunt point. Seeds black; coma more than 2.5 cm long. (Fig. 308)

Vernacular name: Bend vel.

Flowers: June-August.

Micromorphology (Fig. 308)

Stomata were of tetracytic, cyclocytic type.

D/1077-1078.

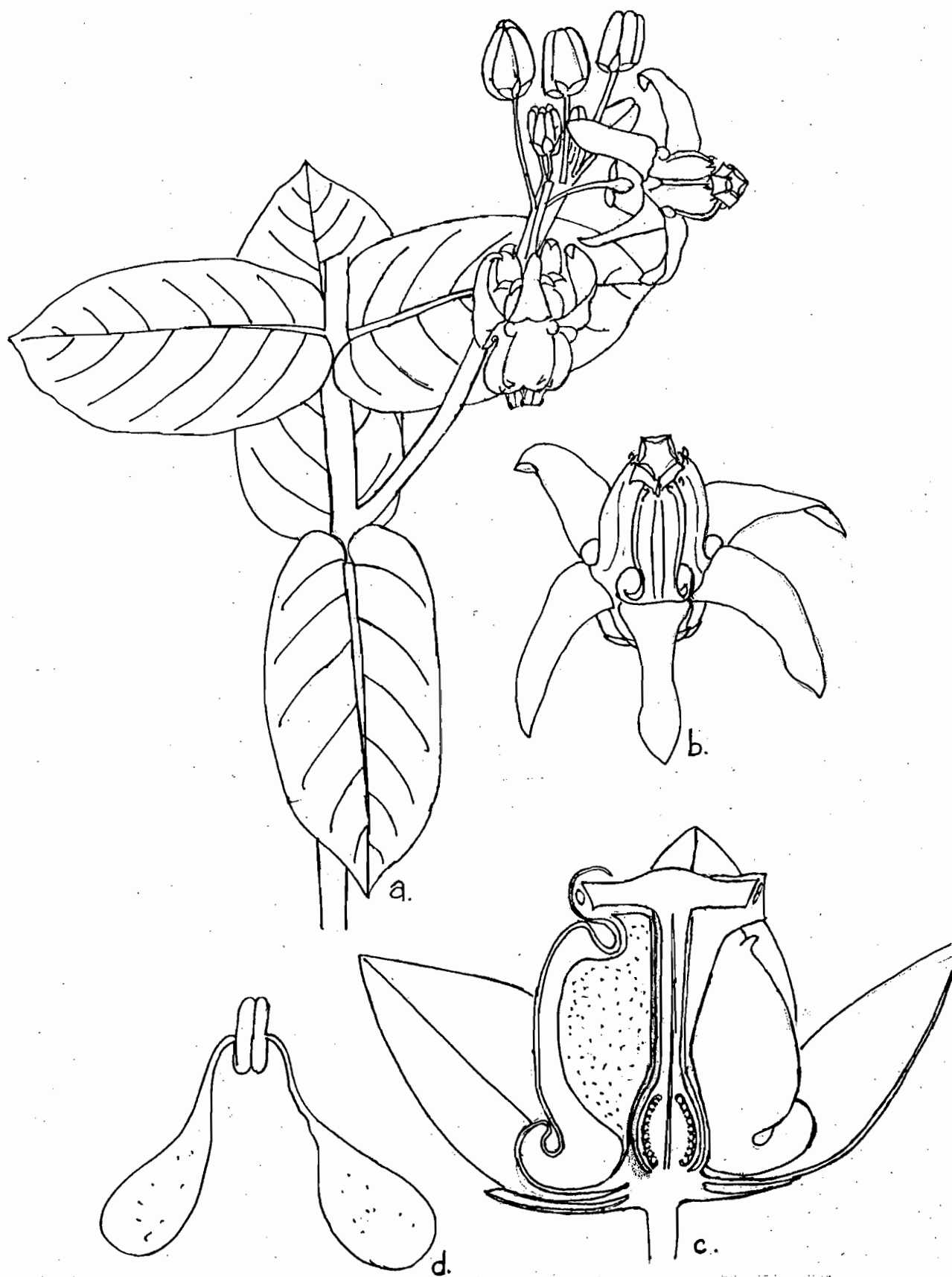


Fig. 304. *Calotropis gigantea* Br., a. habit, b. flower, c. L.S. of flower, d. pollinia.

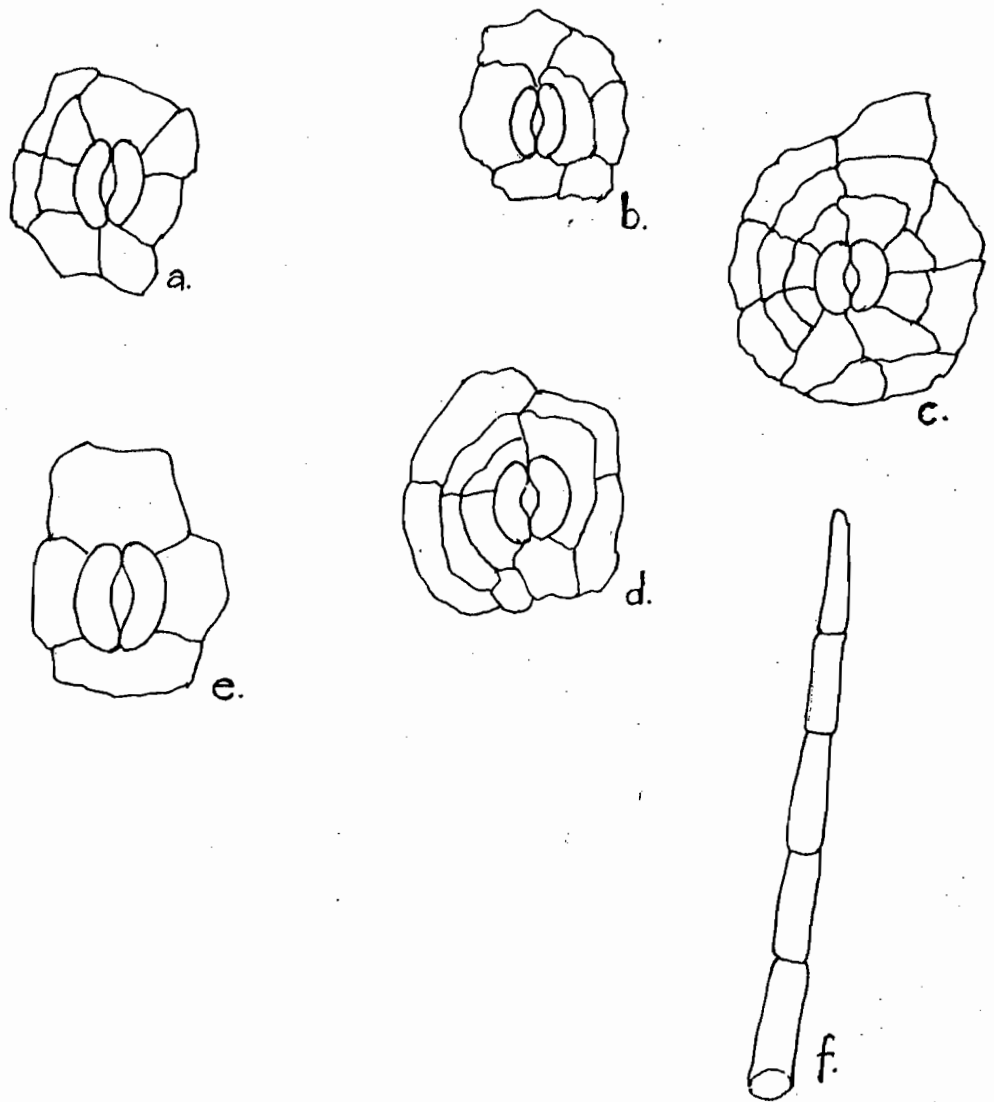


Fig. 305. *Calotropis gigantea* Br., a. anomocytic stomata, b,e. tetracytic stomata, c,d. cyclocytic stomata, f. multicellular uniseriate trichome.

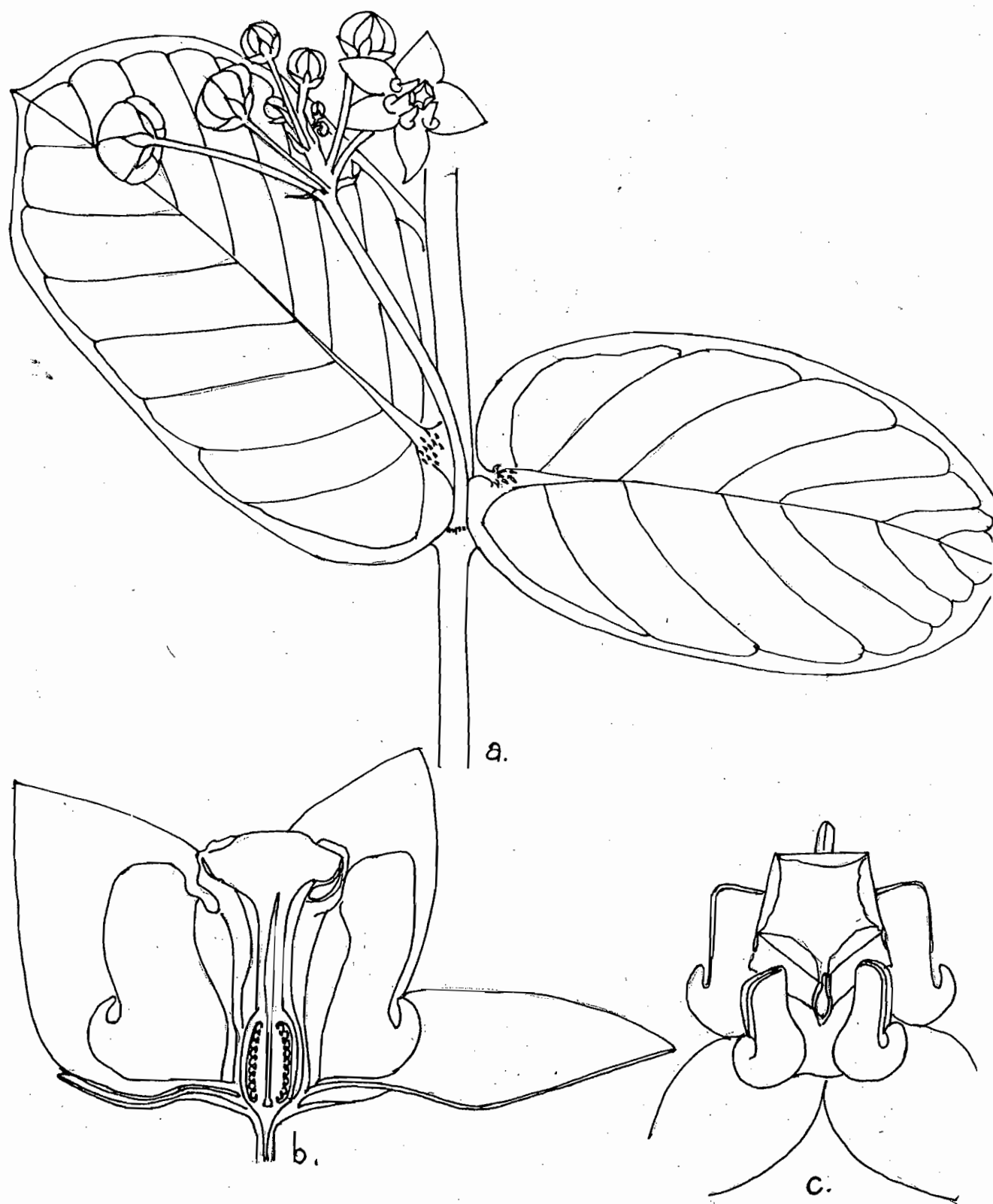


Fig. 306. *Calotropis procera* Br., a. habit, b. L.S. of flower, c. gynostegium.

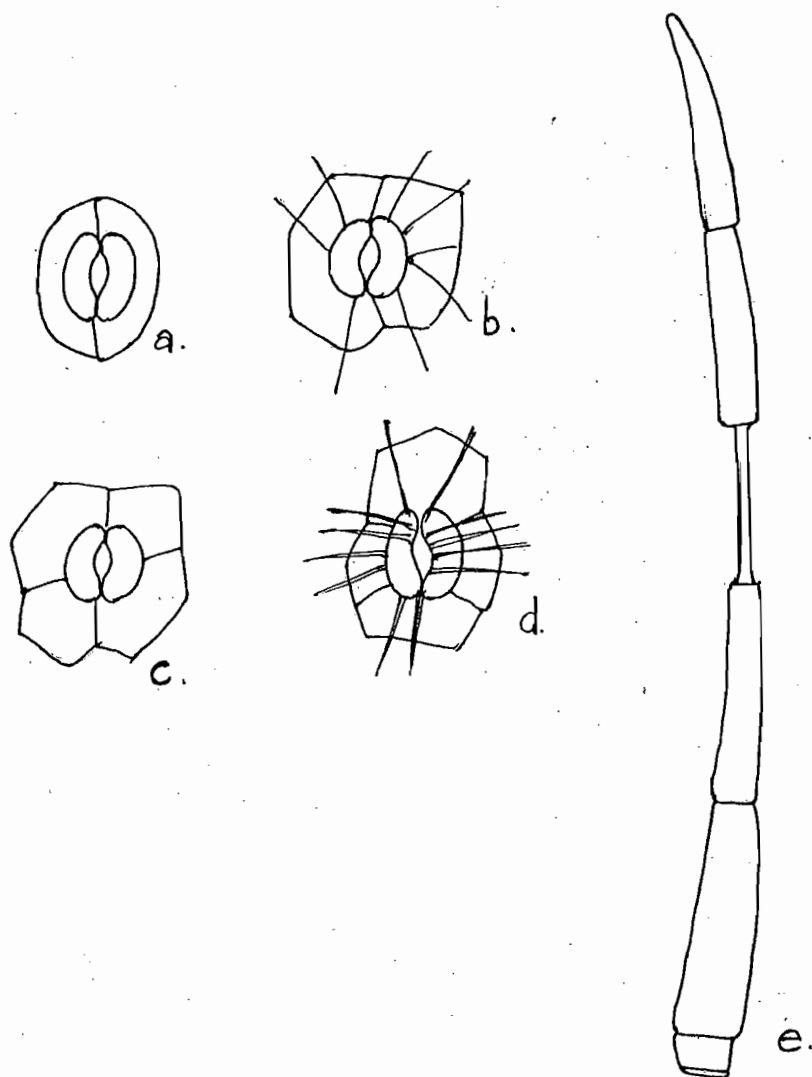


Fig. 307. *Calotropis procera* Br., a & b. paracytic stomata, c & d. tetracytic stomata, e. multicellular uniseriate trichome.

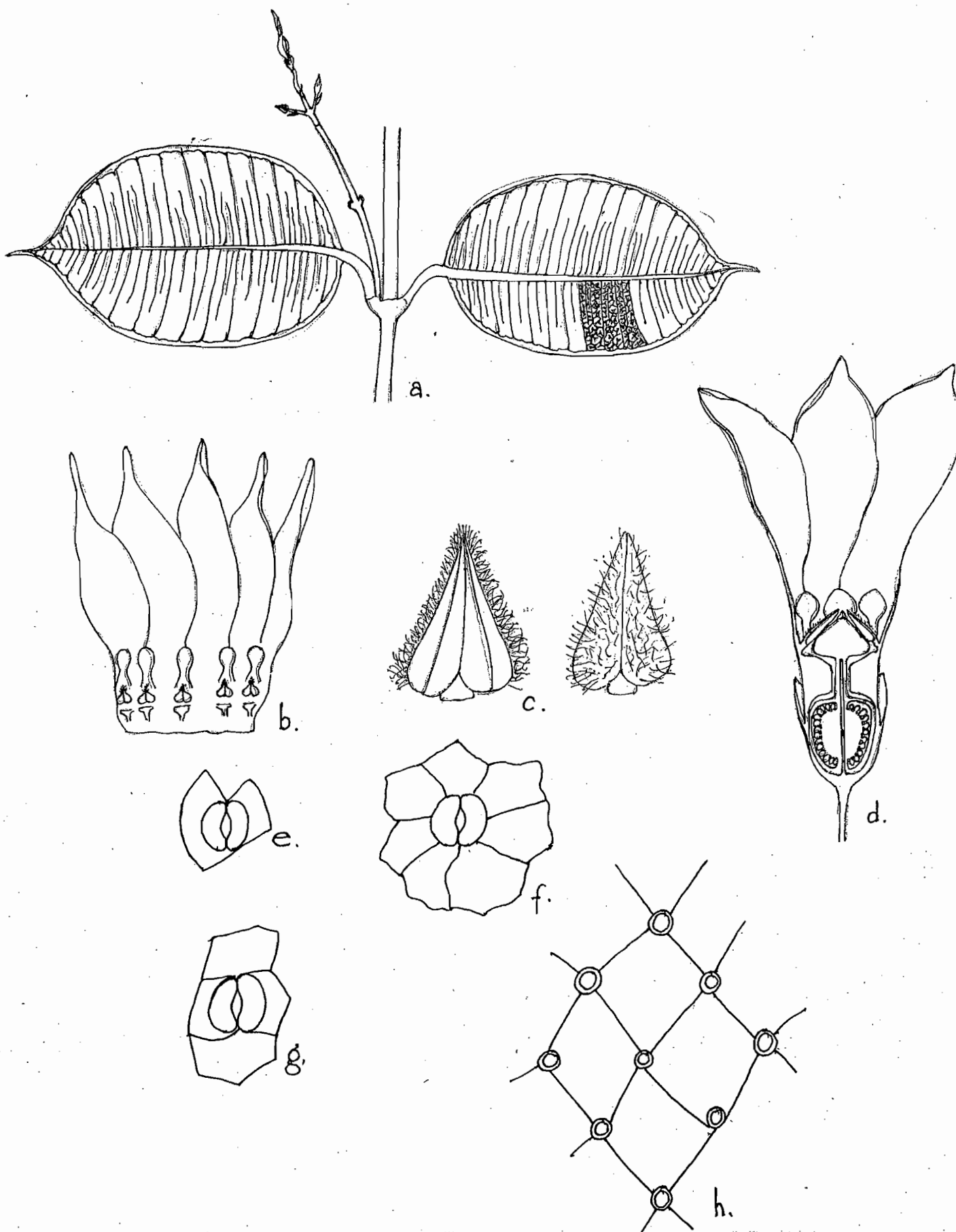


Fig. 308. *Cryptolepis buchanani* (L.) R. & S., a. habit, b. corolla cut open to show epipetalous stamen, c. stamen, d. L.S. of flower, e. paracytic stomata, f. cyclocytic stomata, g. tetracytic stomata, h. cicatrix.

4. *Daemia extensa* R. Br. in *Mem. Wern. Soc.* V. 1 (1811) p. 50.

A perennial laticiferous twiner. Leaves broadly ovate-cordate, upto 10 cm long, usually velvety-pubescent beneath, the margins ciliate. Flowers greenish-yellow or dull white, in lateral cymes; bracts minute, lanceolate. Calyx 5-partite, divided to the base; sepal lobes ovate-lanceolate. Corolla-tube campanulate; lobes ovate-oblong; outer corona membranous-truncate; inner corona-lobes includes the subulate horns which are curved high over the staminal-column, spur acute. Staminal column arising at the mouth of the corolla-tube; anthers erect, with a membranous inflexed appendage. Style apex exserted; pollenia waxy, 1 in each anther-cell, compressed. Follicles reflexed, lanceolate, attenuated into a long beak, echinate with soft spines. Seeds ovate, densely velvety-pubescent on both sides, coma about 3.5 cm long. (Fig. 309)

Vernacular name: Chamar dudheli

Flowers: July-December.

Micromorphology (Fig. 310)

Two types of non-glandular trichomes were found one was multicellular, uniseriate and another acicular unicellular.

Stomata were anomocytic type.

D/690, 689, 1050.

5. *Hemidesmus indicus* R. Br. in *Mem. Wern. Soc.* V. 1 (1811) p. 57.

A perennial prostrate or twiner shrub with a woody rootstock. Leaves elliptic-oblong, upto 10 cm long. Flowers crowded in sub-sessile cymes in the opposite axils; pedicels short, clothed with numerous ovate acute imbricating bracts. Calyx lobes ovate, with membranous margins. Corolla greenish outside, purple inside; tube short; lobes valvate, fleshy, ovate-oblong, acuminate. Follicles upto 15 cm long., cylindric, sometimes slightly curved. Seeds ovate-oblong, coma silvery-white, 2.5 cm long. (Fig. 311)

Vernacular name: Upalsari.

Flowers: throughout the greater part of the year.

Micromorphology (Fig. 312)

The plant showed presence of unicellular, non-glandular, elongated or sometimes curved trichome with thick wall and round bottom.

Stomata were of anomocytic and anisocytic type.

D/99

6. *Leptadenia reticulata* Wight & Arn. in *Wight, Contrib.* (1834) p. 47

A laticiferous twining shrub with corky deeply cracked puberulous stem. Leaves ovate, acute, upto 8 cm long. Flowers greenish-yellow, in lateral or subaxillary many-flowered globose cymes. Calyx segments ovate-oblong, subacute. Corolla tube very short; lobes ovate-oblong with revolute margins; coralline corona of 5 quadrate truncate fleshy lobes at the sinuses; staminal corona annular, close to the staminal-column. Pollinia ovoid, waxy. Follicles upto 8 cm long, tapering into an obtuse shortly curved beak. Seeds ovate-oblong; coma 3 cm long. (Fig. 313)

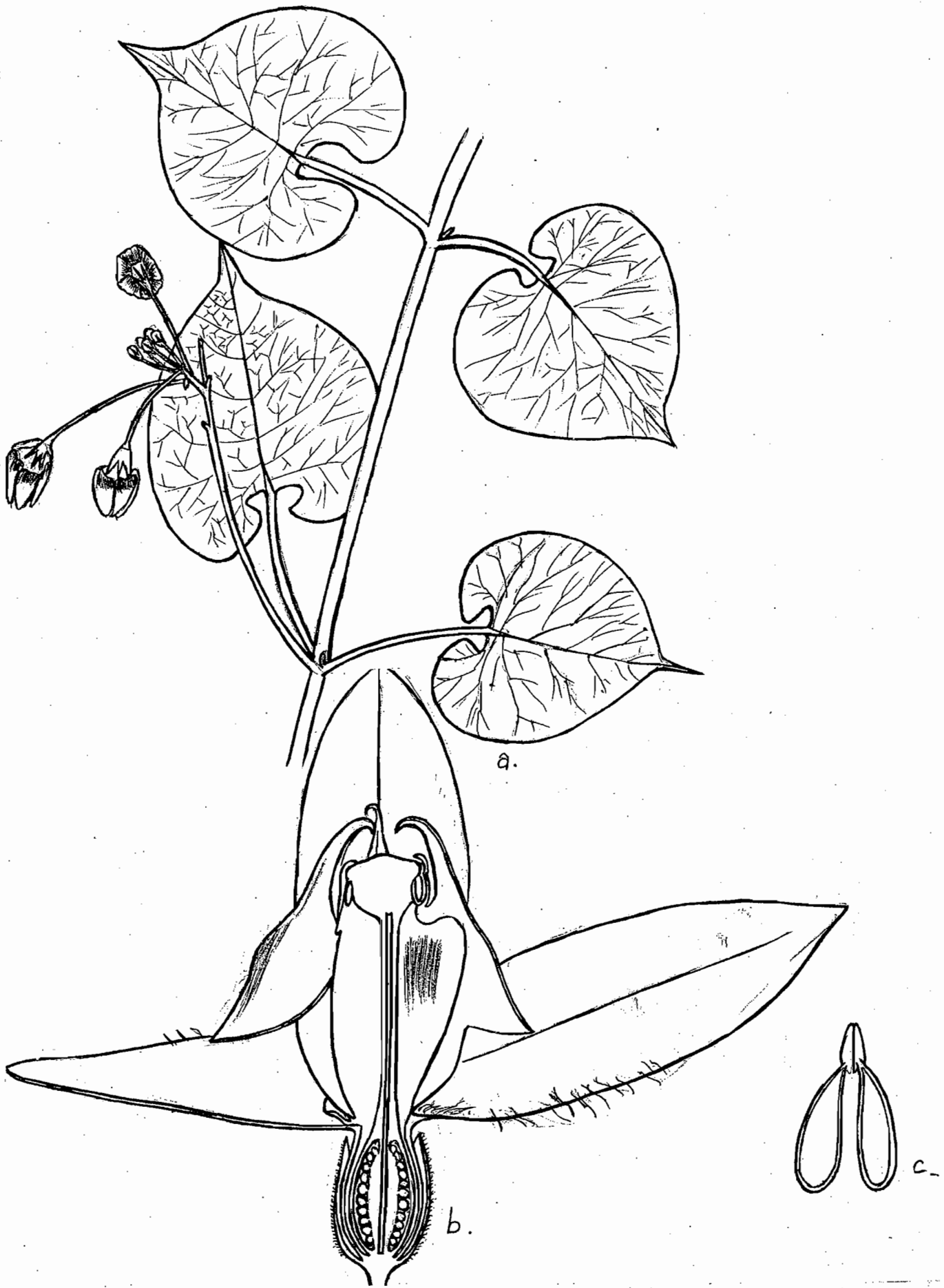


Fig. 309. *Daemia extensa* R. Br., a. habit, b. L.S. of flower, c. pollinia.

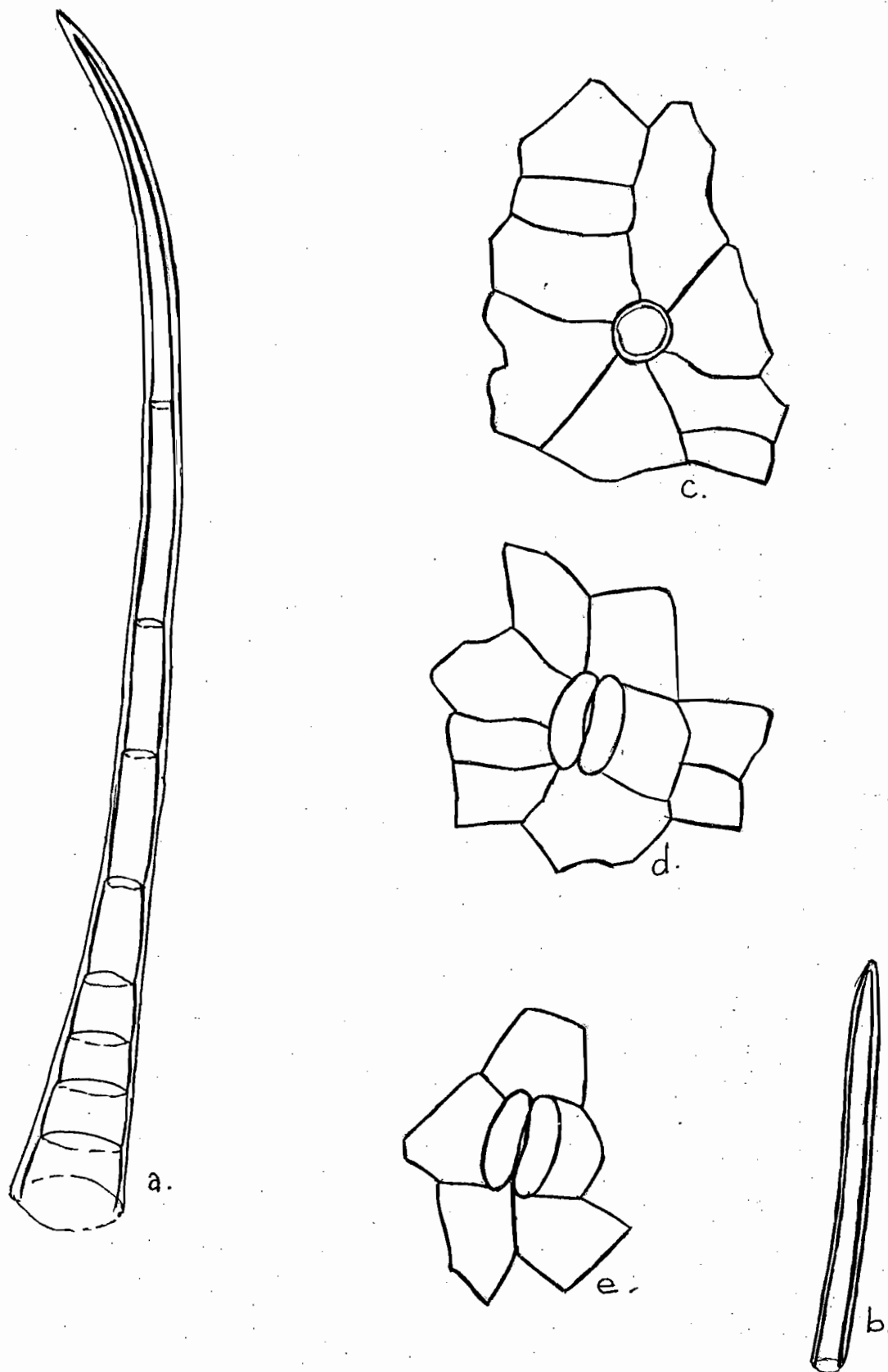


Fig. 310. *Daemia extensa* R. Br., a. multicellular uniseriate trichome with thick wall, b. unicellular trichome, c. cicatrix, d & e. anomocytic stomata.

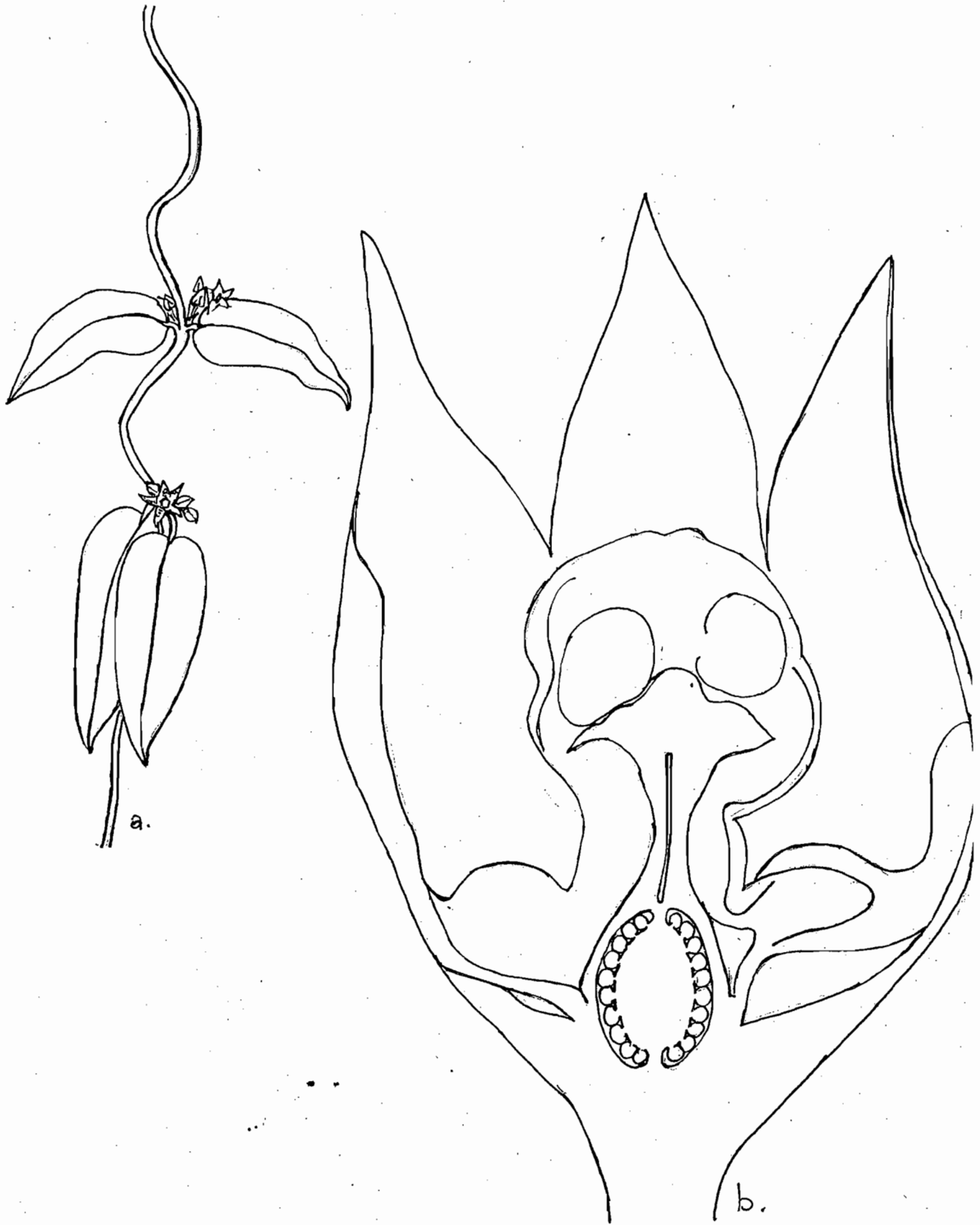


Fig. 311. *Hemidesmus indicus* Br., a. habit, b. L.S. of flower.

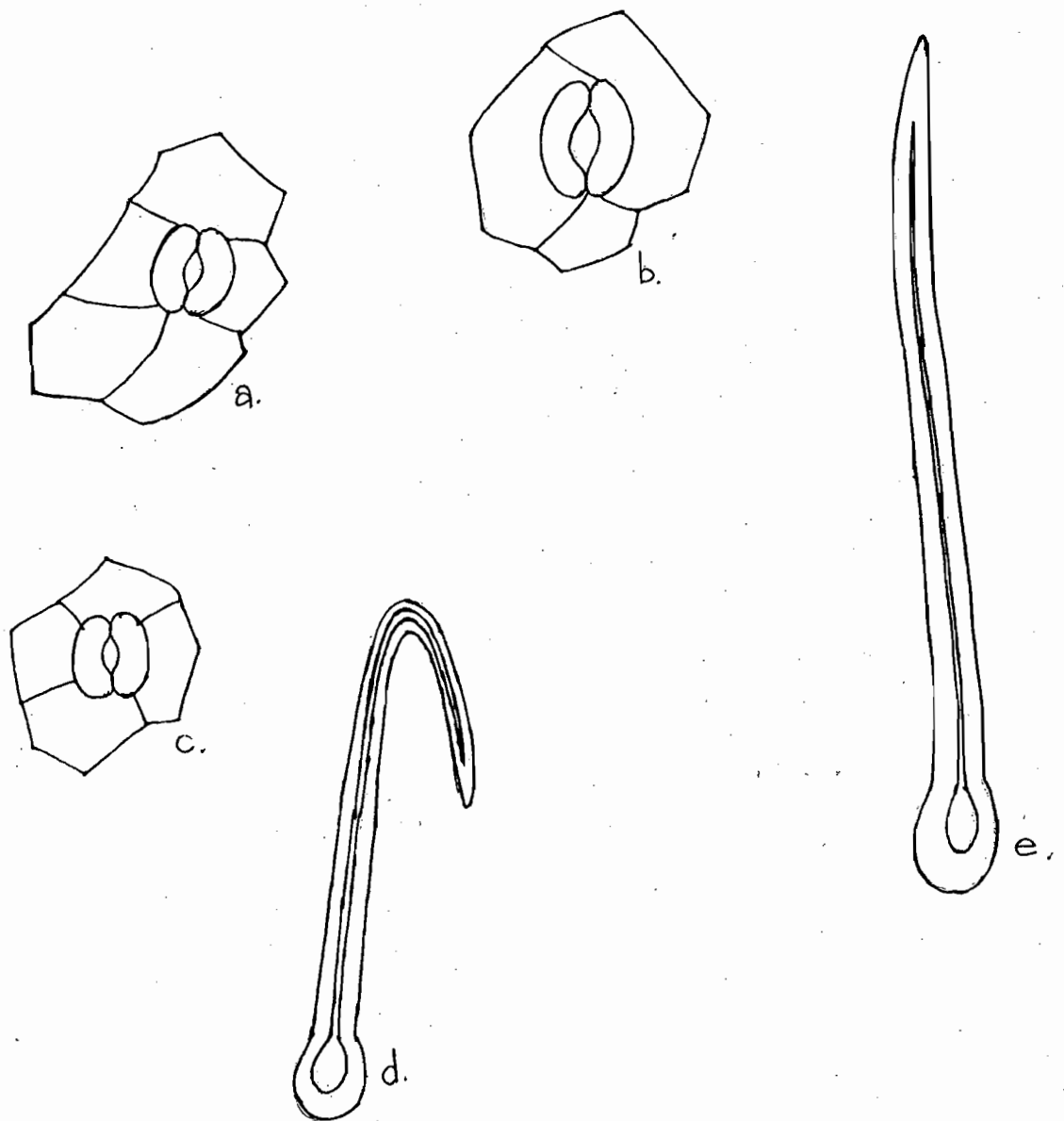


Fig. 312. *Hemidesmus indicus* Br., a & c. anomocytic stomata, b. anisocytic stomata, d & e. unicellular trichome with thick wall and narrow lumen.

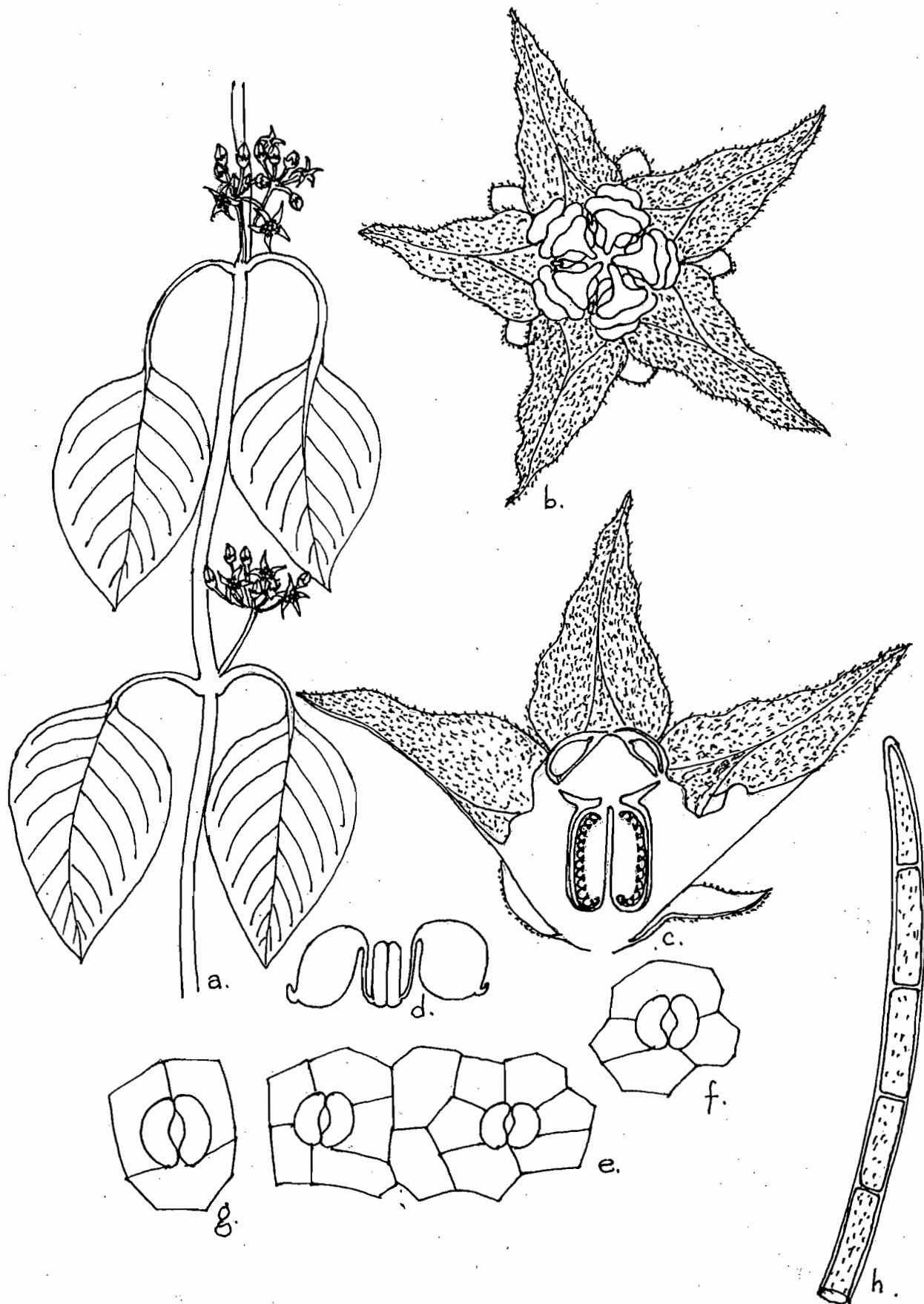


Fig. 313. *Leptadenia reticulata* W. & A., a. habit, b. flower, c. L.S. of flower, d. pollinia, e. anomocytic stomata, f. tetracytic stomata, g. anisocytic stomata, h. multicellular uniseriate trichome.

Vernacular name: Dodi.

Flowers: April-July.

Micromorphology (Fig. 313)

The plant showed presence of multicellular, uniseriate, non-glandular trichome with warty surface.

Stomata were of anisocytic, cyclocytic, and tetracytic type.

D/101

7. *Oxystelma esculentum* R. Br. in *Mem. Wern. Soc.* V. 1 (1811) p. 40.

A perennial laticiferous twiner, rooting at nodes. Leaves linear-lanceolate, upto 10 cm. long; petioles very slender. Flowers large, drooping, in pedunculate lateral subumbellate cymes. Calyx segments 5, oblong-lanceolate. Corolla pale rose-colored or nearly white, upto 2.5 cm. in diameter, saucer-shaped; the mouth with a densely pubescent ring; lobes deltoid, ciliate, veined with purple; corona staminal, the lobes ovate-lanceolate, with incurved entire subulate tips. Pollenia 1 in each cell, pendulous. Style-apex slightly convex. Follicles ovoid-lanceolate, tapering to a point. Seeds ovate, flat, obscurely denticulate near the base, black; comose. (Fig. 314)

Vernacular name: Jal-dudhi.

Flowers: December.

Micromorphology (Fig. 315)

Multicellular, uniseriate non-glandular trichomes with pitted wall were found.

Stomata were tetracytic, anomocytic and anisocytic types.

D/1162.

8. *Tylophora asthamatica* Wight & Arn. in *Wight, Contrib.* (1834) p. 51.

A laticiferous twining perennial. Leaves elliptic-oblong, upto 10 cm long, base usually cordate. Flowers large in sessile umbels. Calyx segments lanceolate. Corolla greenish-yellow or greenish-purple; lobes oblong; corona gibbous below, abruptly narrowed at the apex to a free point which reaches nearly as high as the apex of the style. Pollenia transverse. Follicles upto 10 cm long, tapering to a fine point at the apex, finely striate. Seeds broadly ovate; coma 2.5 cm long. (Fig. 316)

Vernacular name: Dumvel.

Flowers: August-November.

Micromorphology (Fig. 317)

The plant showed presence of multicellular, uniseriate, unbranched, non-glandular trichome.

Stomata were of tetracytic type.

D/1160.

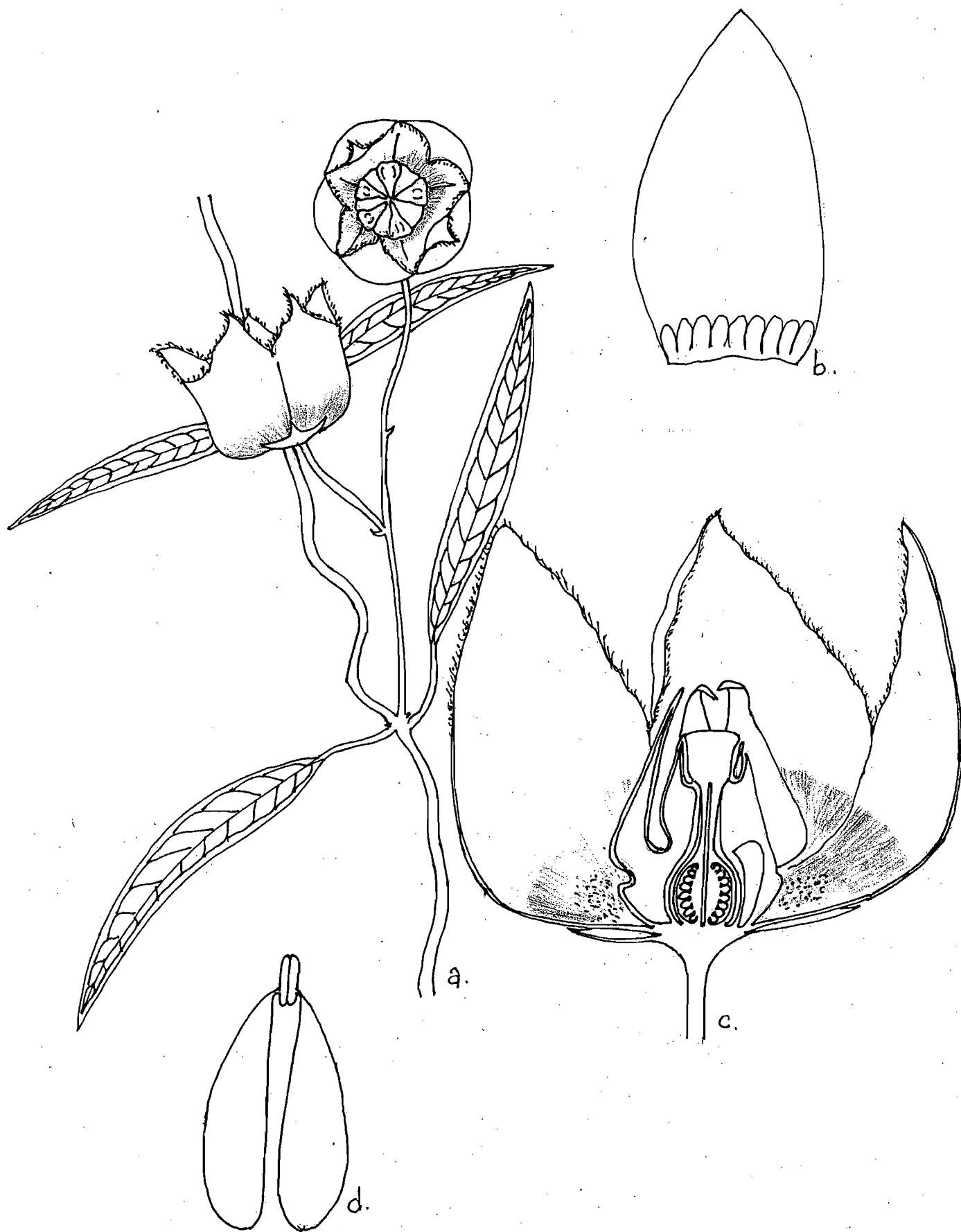


Fig. 314. *Oxystelma esculentum* Br., a. habit, b. sepal, c. L.S. of flower, d. pollinia.

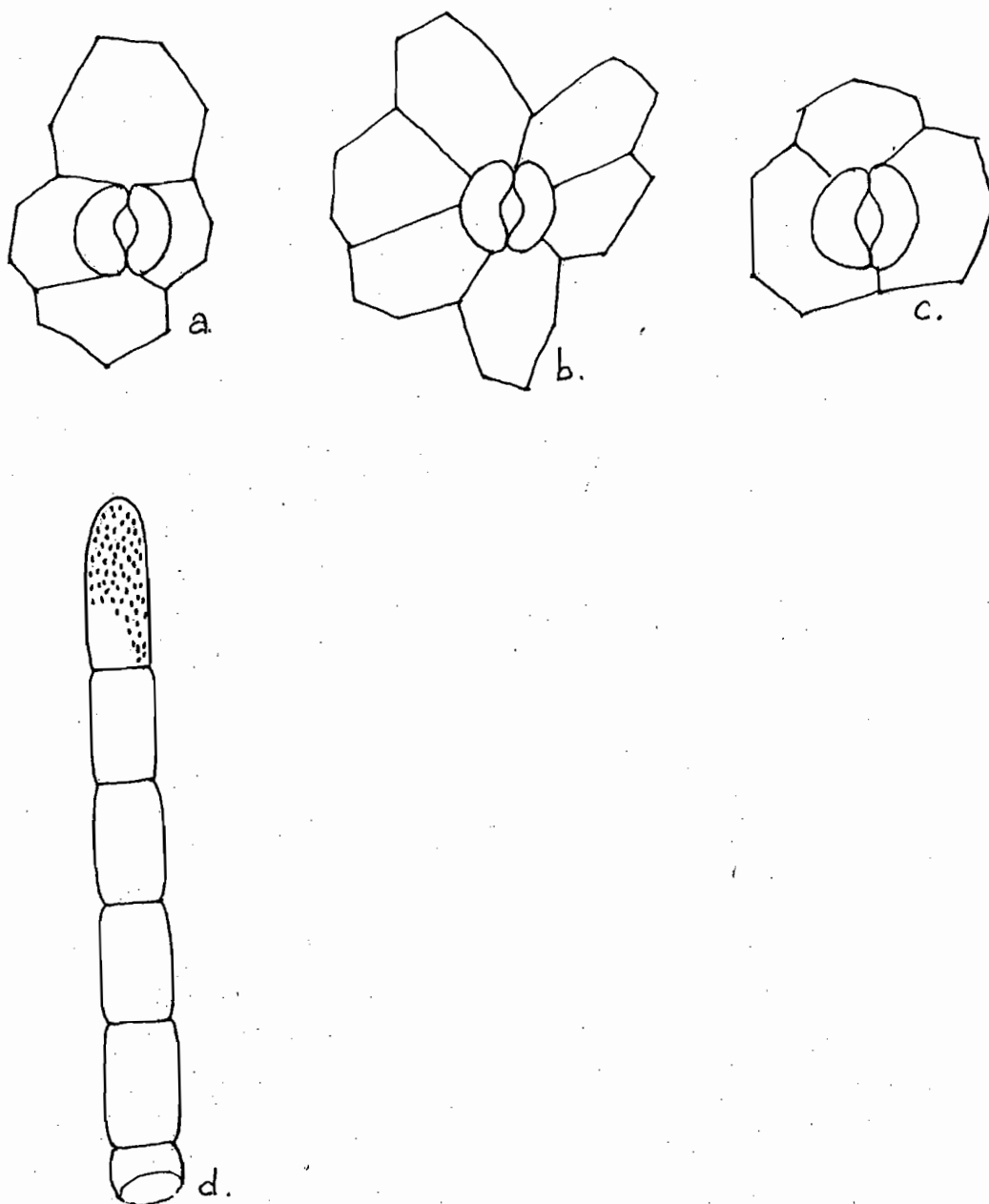


Fig. 315. *Oxystelma esculentum* Br., a. tetracytic stomata, b. anomocytic stomata, c. anisocytic stomata, d. multicellular uniseriate trichome.

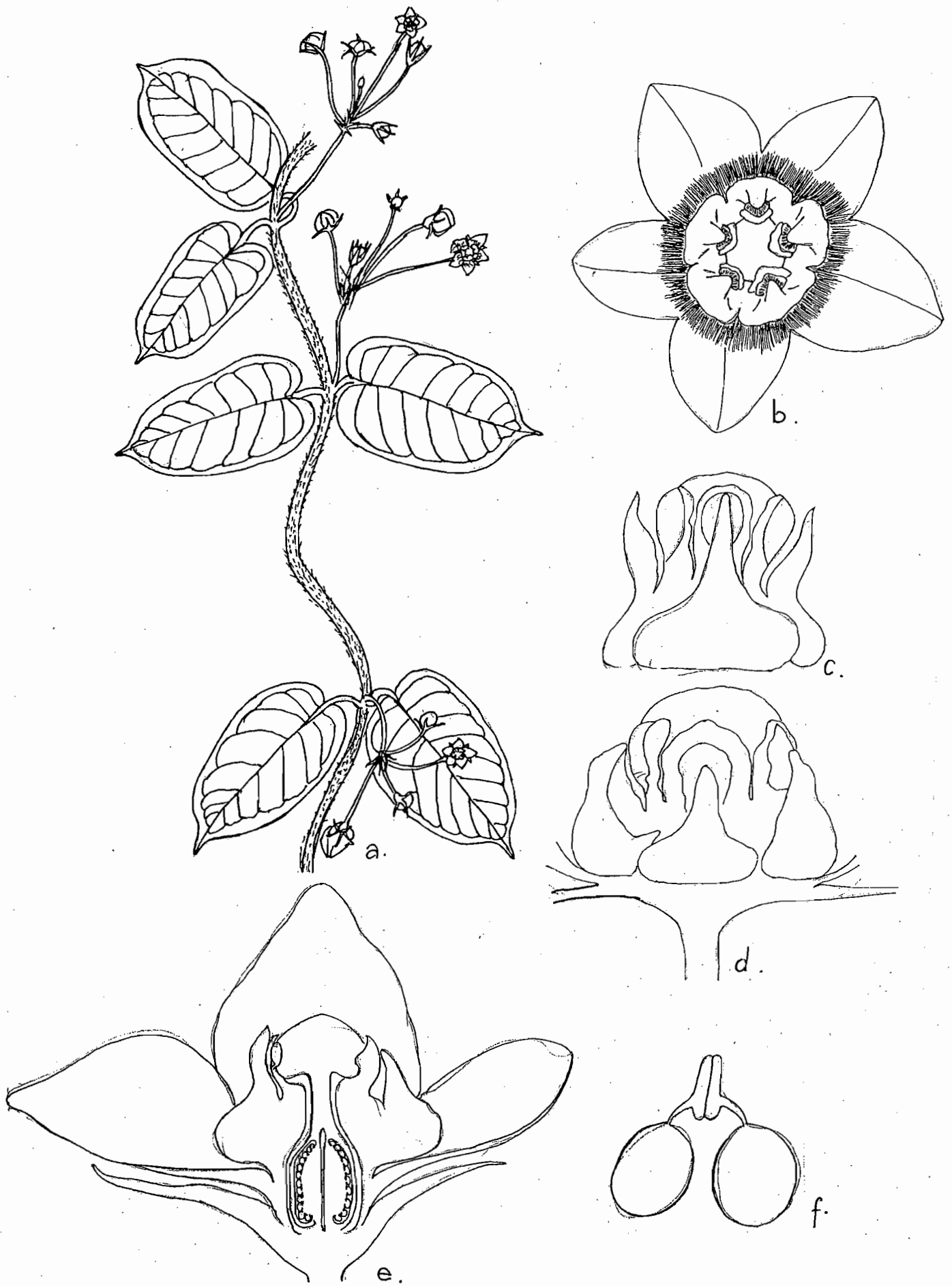


Fig. 316. *Tylophora asthamatica* W. & A., a. habit, b. flower, c & d. gynostegium with staminal column, e. L.S. of flower, f. pollinia.

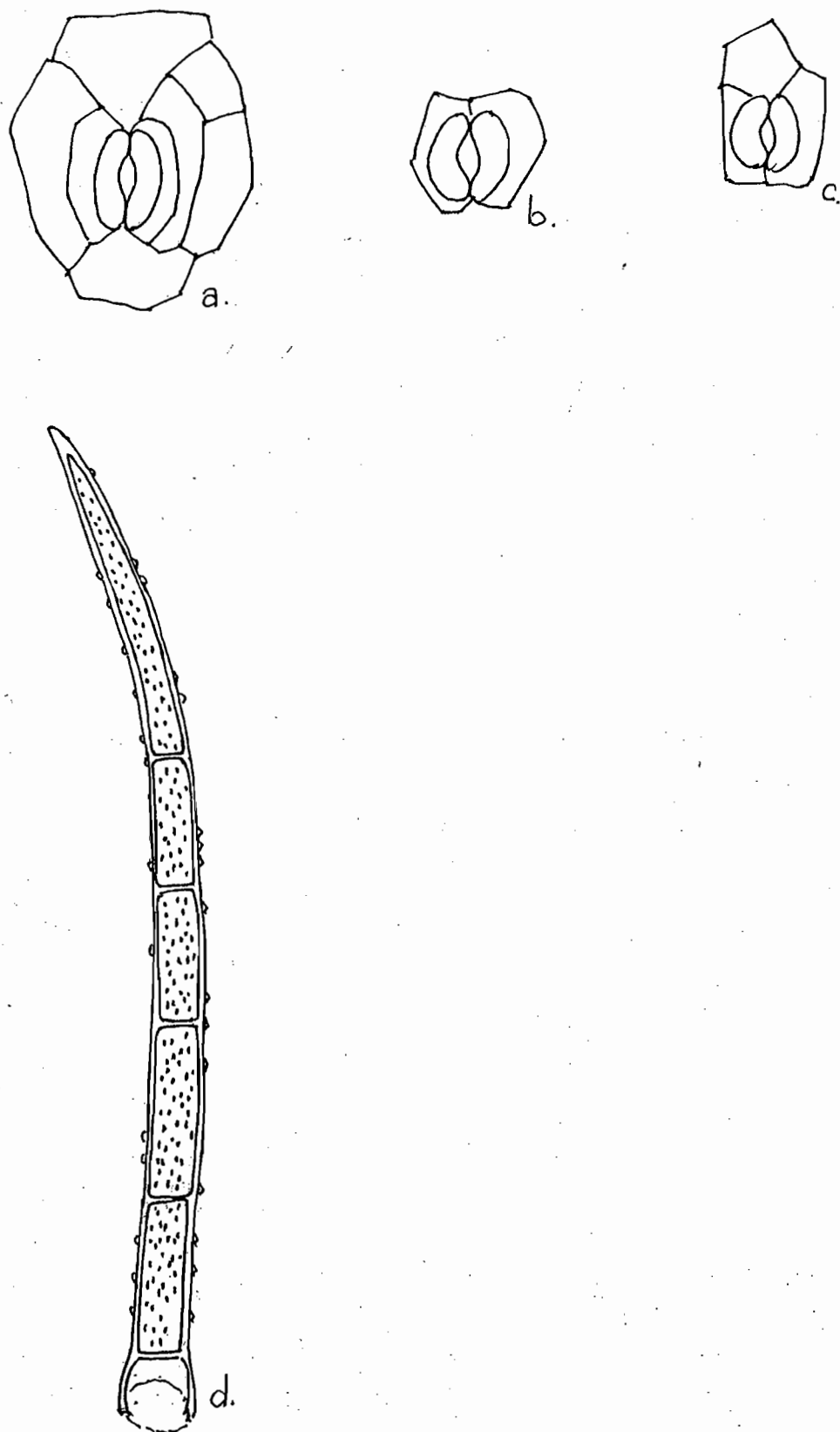


Fig. 317. *Tylophora asthamatica* W. & A., a. cyclocytic stomata, b. paracytic stomata, c. anisocytic stomata, d. multicellular uniseriate trichome with warty wall.

Loganiaceae

1. *Buddleia asiatica* Lour. *Fl. Cochinch.* (1700) p. 72.

A large tomentose evergreen shrub. Leaves lanceolate upto 13 cm long, covered beneath with a white or yellowish more or less mealy tomentum, base usually acute. Flowers white, in bracteate tomentose dense usually continuous terminal and axillary spikes; bracts lanceolate, tomentose. Calyx campanulate, 4-lobed, woolly-tomentose, segments ovate. Corolla campanulate; white, hairy outside and in the throat; lobes obovate. Stamens 4, inserted on the corolla-tube; anthers subsessile. Ovary 2-celled; ovules many in each cell; style capitate at the stigmatose tip. Capsule septicidally 2-valved. Seeds minute, not tailed. (Fig. 318)

Vernacular name: Neemda.

Flowers: January-April.

Micromorphology (Fig. 319)

The plant showed presence of two types of trichomes: 1) Stellate hair with two arms which further bifurcates into two and the trichome was stalked. 2) Two celled glandular trichome and both the cells were of kidney shaped.

Stomata were of anomocytic type.

D/675, 676, 677.

Gentianaceae

1. *Canscora diffusa* R. Br. *Prodr.* (1810) p. 451 in Obs.

A much-branched erect annual upto 60 cm high with quadrangular stem. Leaves broadly ovate, membranous, 3-nerved, upto 4 cm long, sessile. Flowers in lax diffuse paniculate cymes; bracts linear-subulate. Calyx not winged; teeth 4, lanceolate. Corolla zygomorphic, with four unequal lobes. Stamens 4, one longer than the other three, which are equal, the long stamen inserted higher up than the others. Ovary 1-celled, with two intruded parietal placenta. Capsule membranous, narrowly oblong. Seeds reticulate. (Fig. 320)

Vernacular name: Sankhpuspi.

Flowers: October-January.

Micromorphology (Fig. 320)

Stomata were of anisocytic, paracytic, and diacytic type.

D/1184.

2. *Enicostema hyssopifolium* (Willd.) Verd. *Bothalia* 7: 462 1961.

(*Enicostemma littorale* Blume.)

An erect glabrous branched herb with subquadrangular stem upto 50 cm high. Leaves linear-oblong, opposite, sessile, upto 6 cm long, 3-nerved, the midnerve strong. Flowers sessile, in axillary cymes. Calyx lobes ovate-oblong, with narrow membranous margins. Corolla white, upto 1 cm long; lobes lanceolate, acute. Anthers oblong and filaments

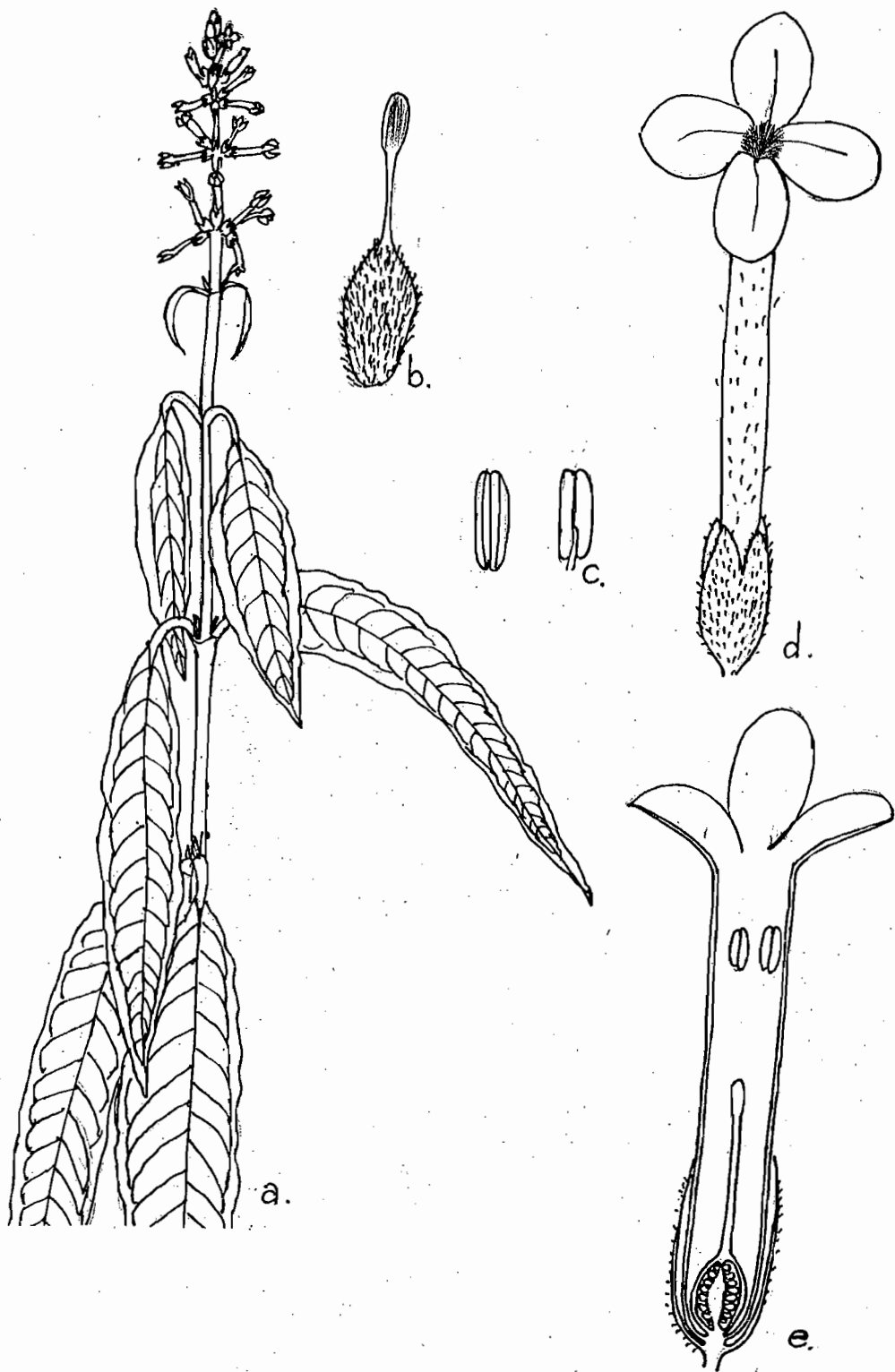


Fig. 318. *Buddleia asiatica* Lour., a. habit, b. gynoecium, c. stamen, d. flower, e. L.S. of flower.

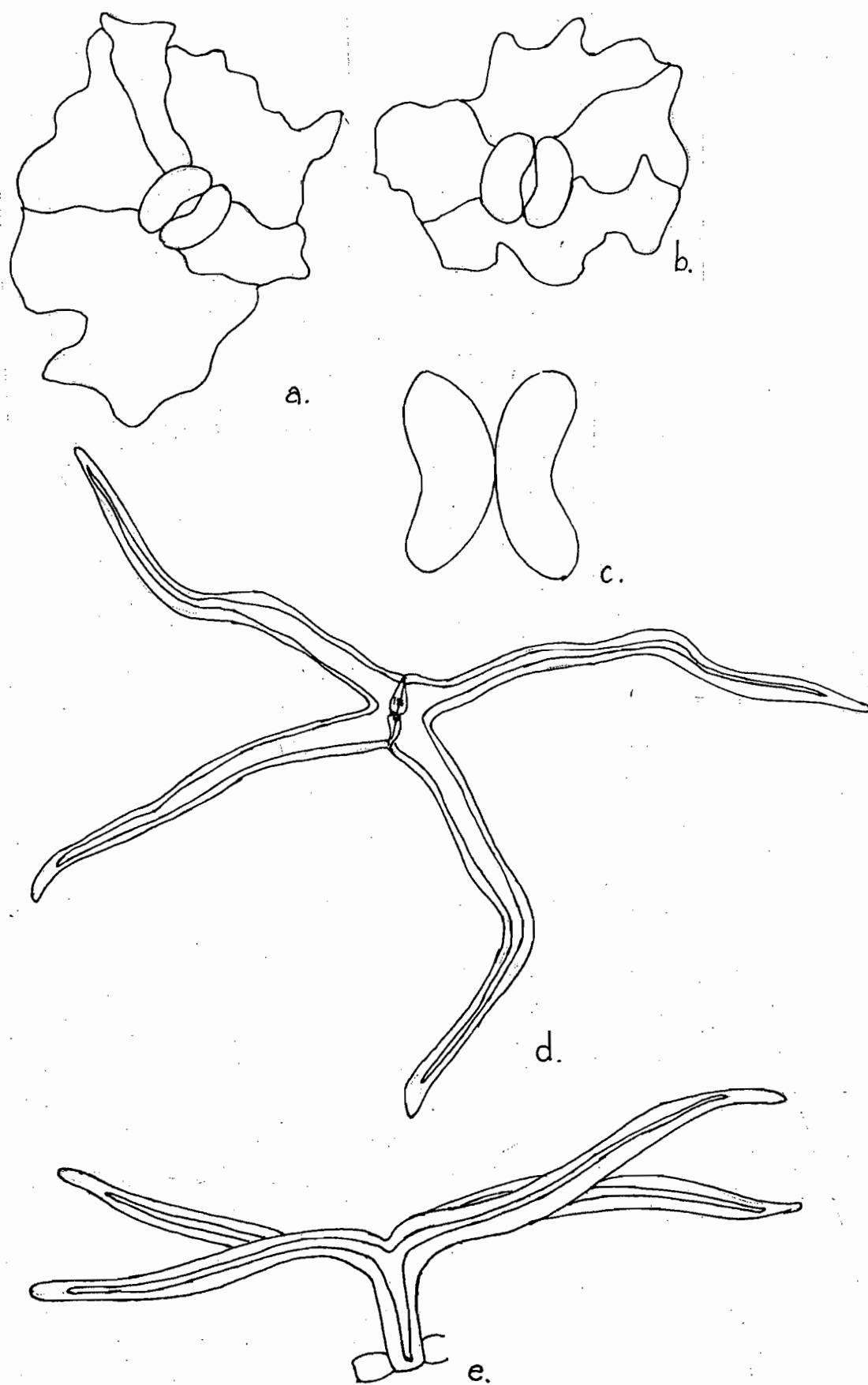


Fig. 319. *Buddleia asiatica* Lour., a & b. anomocytic stomata, c. two celled sessile gland, d & e. two celled trichome with each cell having two arms.

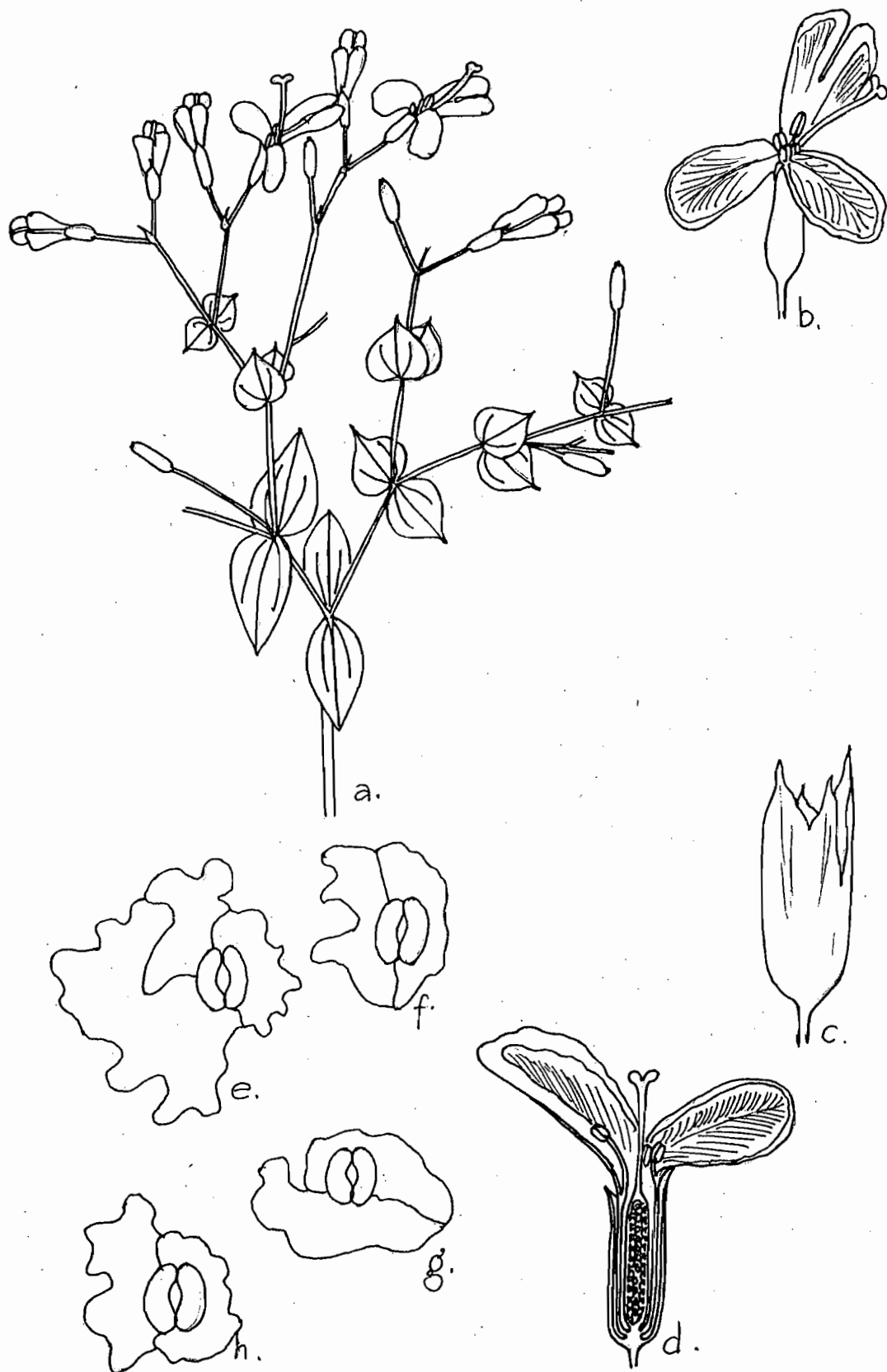


Fig. 320 *Canscora diffusa* Br., a. habit, b. flower, c. capsule, d. L.S. of flower, e. anisocytic stomata, f & h. paracytic stomata, g. diacytic stomata.

were covered by a small pouch like structure at the base. Ovary 1-celled, with two parietal placenta. Capsule ellipsoid, slightly narrowed at the base, rounded at the apex, apiculate with the remains of the style. (Fig. 321)

Vernacular name: Mamejavo.

Flowers: August-November.

Micromorphology (Fig. 321)

Whole plant was glabrous.

Stomata were of anomocytic type.

D/453, 1075-1076.

**3. *Nymphoides cristata* (Roxb.) Kuntze, *Rev. Gen. Pl.* 2:429 1891.
(*Limnanthemum cristatum* Griesb.)**

A rhizomatous aquatic floating herb with several long petiole-like branches which produce a node bearing a tuft of roots, a cluster of flowers, a single floating leaf and another branch. Leaves orbicular, deeply cordate, upto 10 cm in diameter, purplish and with green veins beneath. Flowers numerous, in dense clusters. Calyx 5, segments oblong-lanceolate. Corolla 5, white; lobes obovate, rounded at the apex, with a broad longitudinal crest down the middle of each lobe, the margins not ciliate. Stamens 5, inserted on the corolla-tube; filaments short. Ovary 1-celled; placentas 2, parietal; stigma 2-lobed. Capsule broadly ovoid or subglobose. Seeds 10 or more, strongly muriculate, pale yellowish-brown. (Fig. 322)

Vernacular name: Poyana.

Flowers: August-March.

Micromorphology (Fig. 322)

Non-glandular unicellular trichomes with bifurcated four arms were seen.

Stomata were of anomocytic type.

D/842 - 845.

**4. *Nymphoides indicum* (L.) Kuntze, *Rev. Gen. Pl.* 2:429 1891.
(*Limnanthemum indicum* Thw.)**

This plant is similar and slightly larger than *Nymphoides cristata* but differs in having hairy corolla lobes without a crest in the middle. (Fig. 323)

Vernacular name: Poyana.

Flowers: August-March.

Micromorphology (Fig. 323)

Non-glandular unicellular trichomes with four arms were seen.

Stomata were of anomocytic type.

D/209

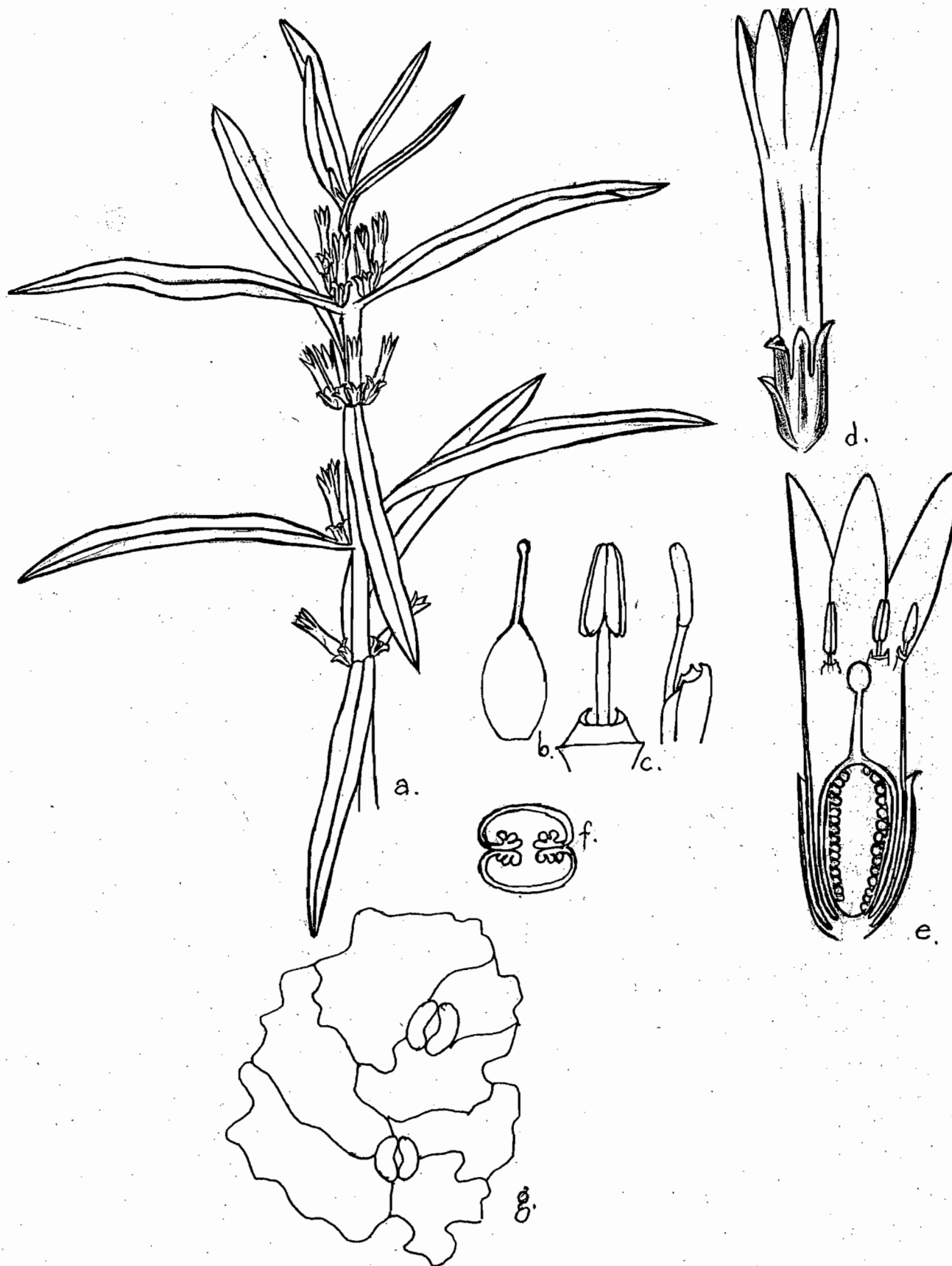


Fig. 321. *Enicostemma hyssopifolium* Verd., a. habit, b. gynoecium, c. stamen, d. flower, e. L.S. of flower, f. T.S. of ovary, g. anomocytic stomata.

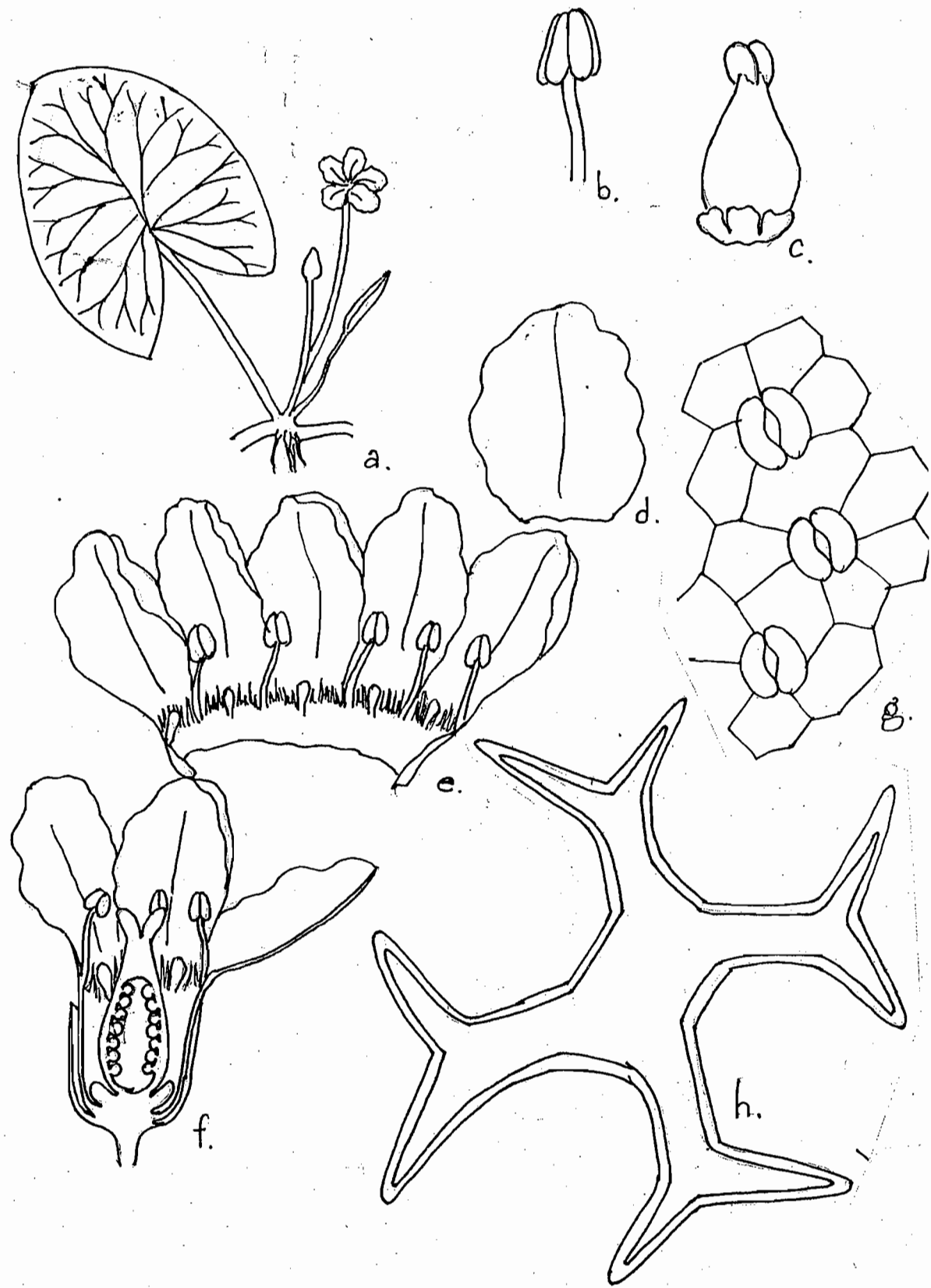


Fig. 322. *Nymphoides cristata* (Roxb.) Kuntze., a. habit, b. stamen, c. gynoecium, d. bract, e. epipetalous stamens, f. L.S. of flower, g. anomocytic stomata, h. unicellular trichome with four arms and each arm bifurcates further.

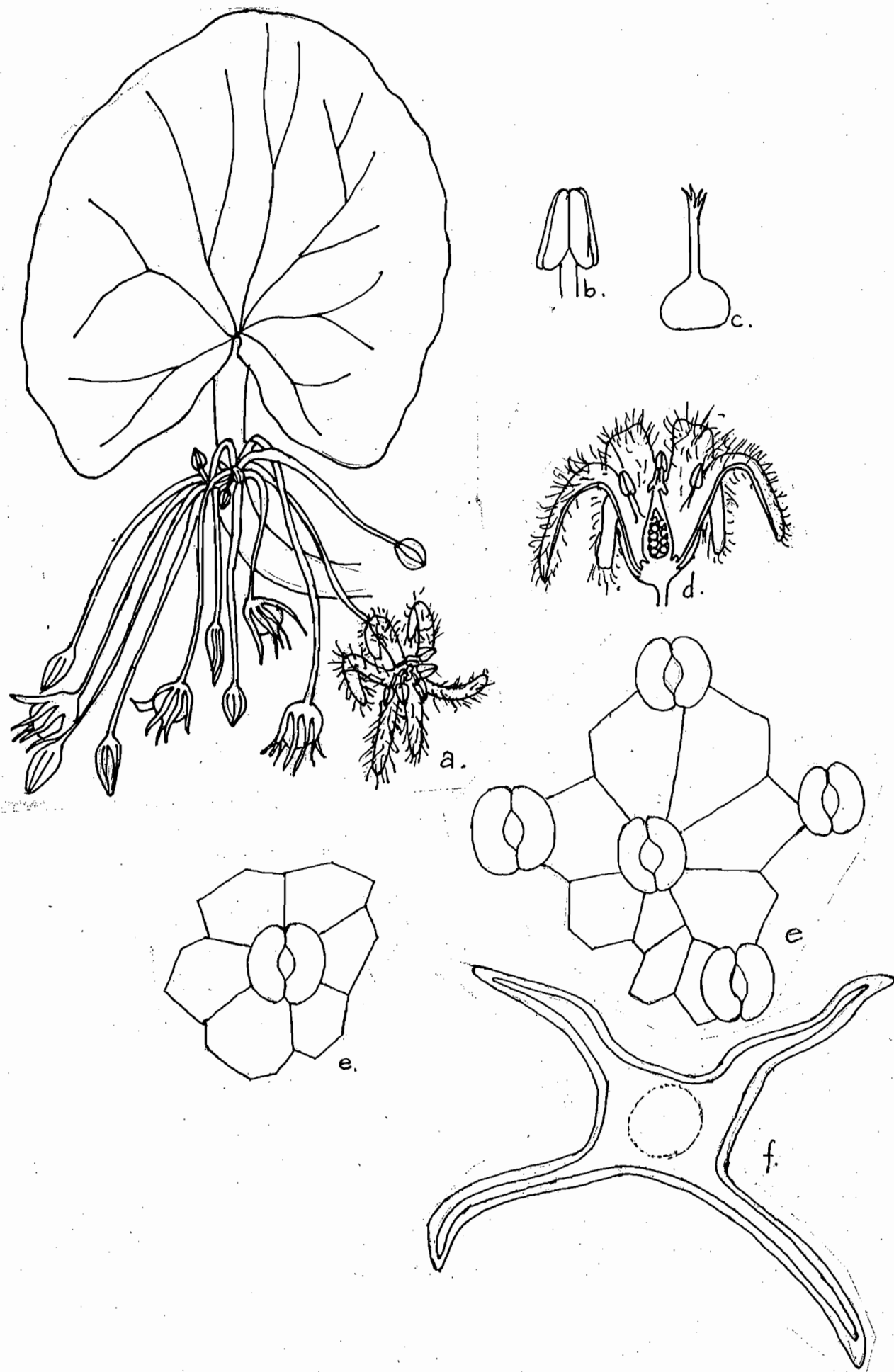


Fig. 323. *Nymphoides indicum* (L.) Kuntze., a. habit, b. stamen, c. gynoecium, d. L.S. of flower, e. anomocytic stomata, f. unicellular trichome with four arms.

Boraginaceae

**1. *Carmona microphylla* (Lamarck) G. Don, *Gen. Hist.* 4: 391. 1837.
(*Ehretia buxifolia* Roxb.)**

A small shrub upto 1.5 m high with divaricate, reddish-brown branches. Leaves obovate, subsessile, upto 3 cm long with a few crenatures at the apex, rough above with short bristly hairs. Flowers white, axillary, solitary or 2 together on slender hairy peduncles. Calyx hairy, lobes lanceolate or spatulate-oblong, acute. Corolla 0.5 cm long, campanulate; lobes broadly ovate, obtuse, spreading or recurved. Stamens exserted. Styles 2, longer than the stamens, undivided. Drupe globose, scarlet; pyrene 1, four-celled. (Fig. 324)

Flowers: March.

Micromorphology (Fig. 325)

The plant showed presence of unicellular, non-glandular, elongated trichome with warty surface.

Stomata were of tetracytic, cyclocytic, anisocytic, and anomocytic type.

D/370.

2. *Coldenia procumbens* Linn. *Sp. Pl.* (1753) p. 125.

A procumbent herb with stems silky with white hairs and reaching 45 cm long. Leaves obovate-oblong, upto 4 cm, coarsely serrate or subpinnatifid, very hairy on both sides. Flowers pale-yellow, solitary, axillary. Calyx segments 4, ovate, ciliate.

Corolla lobes 4, oblong. Stamens 4. Drupe 4-lobed pyramidal in shape containing, one seeded pyrenes. Seeds albuminous. (Fig. 326).

Vernacular name: Basariyo okhrad.

Flowers: September-October.

Micromorphology (Fig. 326)

The plant showed presence of unicellular, elongated, non-glandular trichome with warty surface.

Stomata were of anomocytic type.

D/1059.

3. *Cordia sebestena* Linn. *Sp. Pl.* (1753) p. 190

A small ornamental tree reaching a height of 10m. Leaves ovate, 15 cm long, rough, coarse, scabrous above, pubescent on nerves beneath. Flowers showy, 2-3 borne in large panicle cymes, showy. Calyx tubular, 3-4 lobed; lobes deltoid. Corolla scarlet or orange-red, infundibuliform, 5-6 lobed. Drupes ovoid, 2 cm long, white. Seeds embedded in sticky pulp. (Fig. 327)

Flowers: January-March.

Micromorphology (Fig. 327)

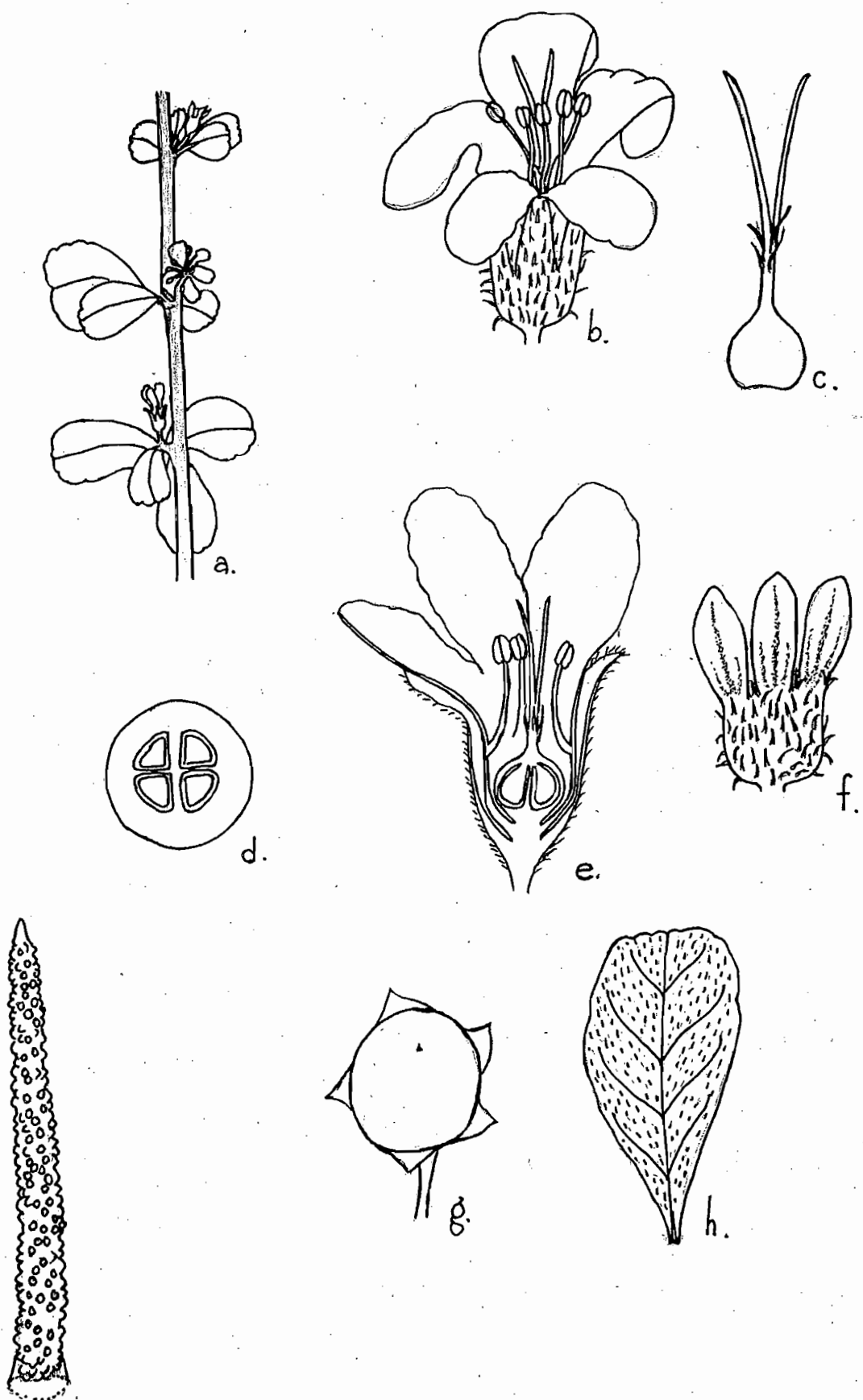


Fig. 324. *Carmona microphylla* (Lamarck) G. Don, a. habit, b. flower, c. gynoecium, d. T.S. of ovary, e. L.S. of ovary, f. calyx, g. capsule, h. leaf, i. unicellular trichome with thick warty wall.

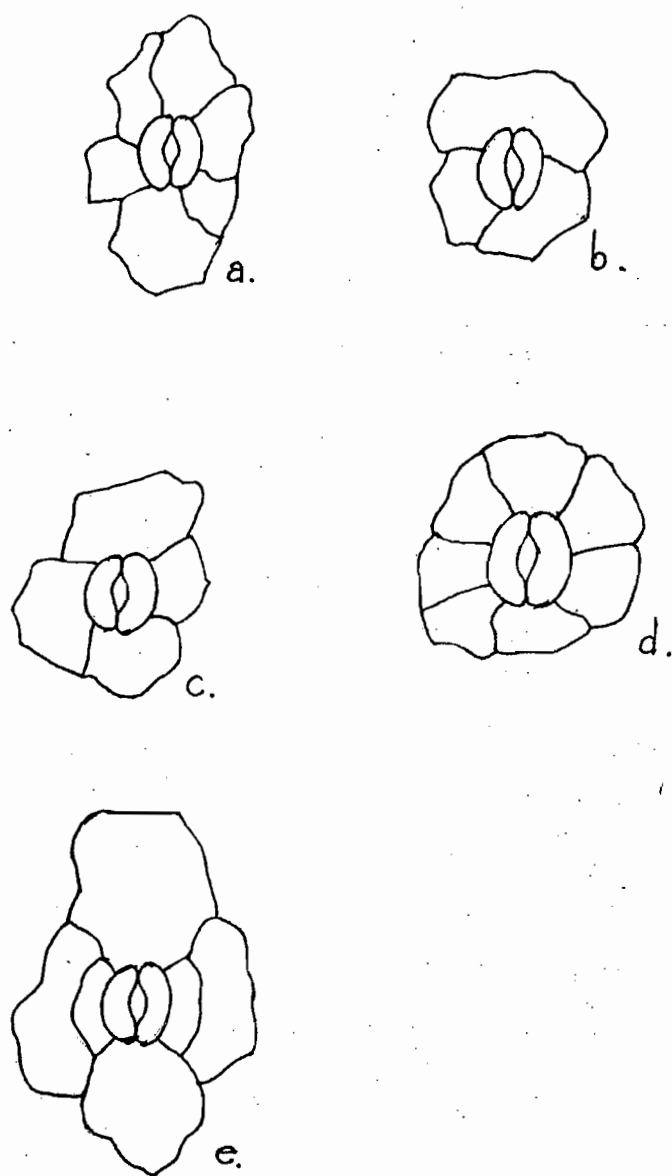


Fig. 325. *Carmona microphylla* (Lamarck) G. Don, a. anomocytic stomata, b. anisocytic stomata, c. tetracytic stomata, d. cyclocytic stomata, e. tetracytic stomata.

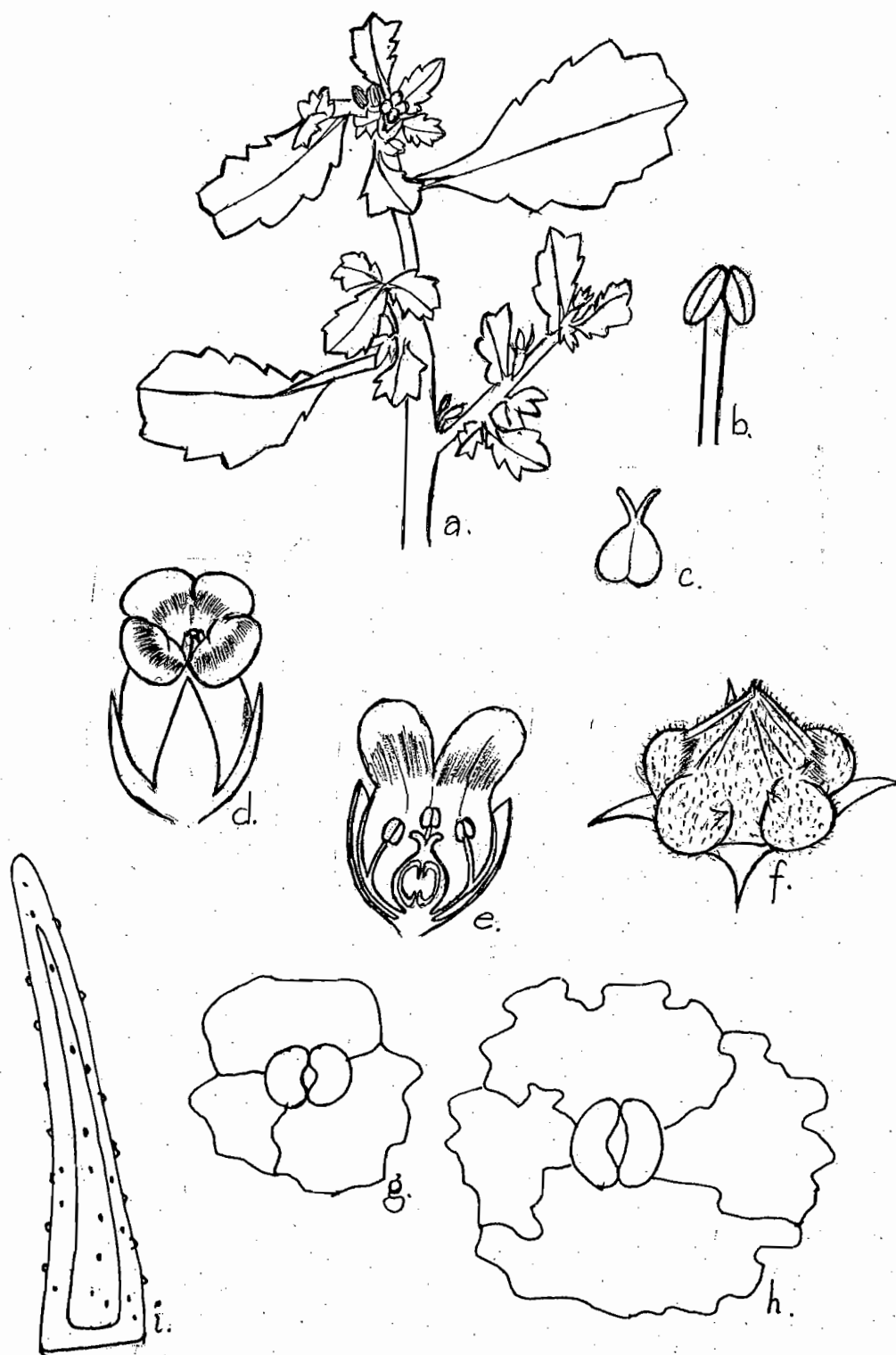


Fig. 326 *Coldenia procumbens* L., a. habit, b. stamen, c. gynoecium, d. flower, e. L.S. of flower, f. capsule, g. anisocytic stomata, h. anomocytic stomata, i. unicellular trichome with thick and warty wall.

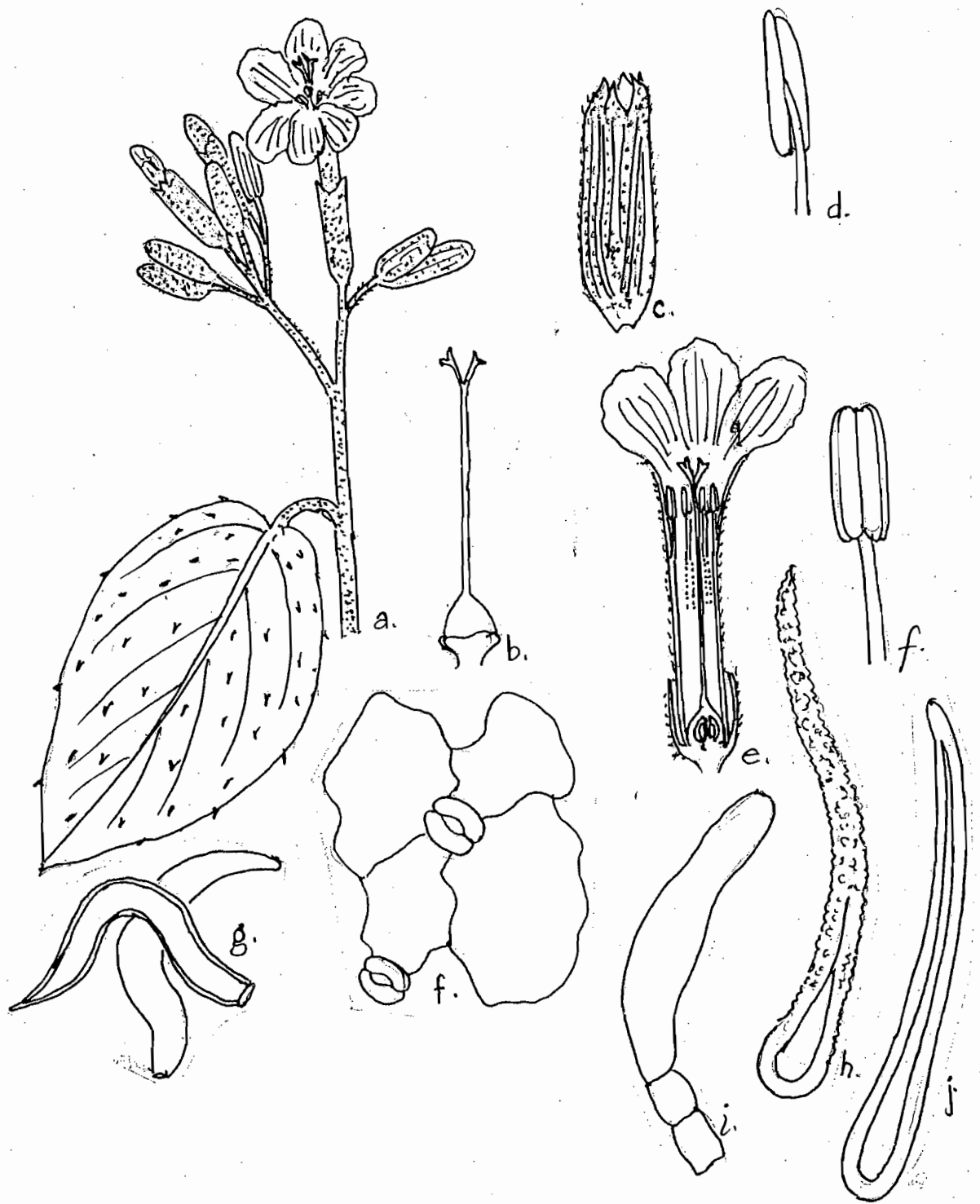


Fig. 327. *Cordia sebestena* L., a. habit, b. gynoecium, c. calyx, d & f. stamen, e. L.S. of flower, f. anomocytic stomata, g. unicellular smooth walled trichome, h. unicellular trichome with small lumen and thick warty wall, i. gland with single celled head and two celled stalk, j. unicellular trichome with narrow lumen and thick wall.

Whole plant is pubescent. Altogether there were 4 different types of trichomes present on different parts of the plant. The trichomes on vegetative parts (leaf and stem) were similar whereas trichomes on reproductive parts were different.

The trichomes on the leaf were unicellular, with thick wall and the surface was warty. The trichomes showed a blunt tip with round bottom.

In case of trichomes on reproductive parts, corolla contained two types of trichomes, one unicellular and non-glandular and another multicellular, non-glandular trichome. The former trichome was unicellular, elongated and with thick wall and the later was glandular multicellular, uniseriate, slightly differentiated into head and stalk. Head was unicellular whereas the stalk comprised of two cells.

The trichome on the leaf was seen on the surface of sepals also. But the sepals, in addition contained another type of non-glandular unicellular curved trichome.

Stomata were anomocytic.

D/306.

4. *Heliotropium indicum* Linn. *Sp. Pl.* (1753) p. 130.

A hirsute succulent annual upto 60 cm high with stout stem. Leaves ovate-oblong upto 10 cm long, base often unequal-sided. Flowers pale-violet, sessile, 2-ranked, in ebracteate scorpioid cymes. Calyx segments linear-lanceolate. Corolla infundibuliform; lobes orbicular-oblong. Stamens inserted below the middle of the corolla-tube. Style short; stigma capitate, with an annular frill 2-lobed; ovary imperfectly four-celled, four ovulate. Drupe beaked containing 4-pyrenes. (Fig. 328)

Vernacular name: Hathi sundha.

Flowers: October-December.

Micromorphology (Fig. 328)

The plant showed presence of two types of unicellular, non-glandular, elongated trichome; of which one was with warty surface whereas another was thick and smooth walled.

Stomata were of anomocytic, anisocytic, anomocytic and tetracytic type.

D/732.

5. *Heliotropium ovalifolium* Forsk. *Fl. Aegypt.-Arab.* (1775) p. 38.

An erect hairy herb reaching upto 45 cm. Leaves elliptic or obovate, upto 2 cm long. Flowers white, 2-ranked, in slender ebracteate, usually once-forked spikes upto 10 cm long. Calyx segments unequal, densely ciliate. Corolla tube cylindric, scarcely swollen over the stamens; lobes ovate-oblong. Stamens inserted; anthers lanceolate, the connective produced. Ovary glabrous; stigma conical, slightly penicillate at the very apex. Nutlets 1-seeded. (Fig. 329)

Vernacular name: Hathi sundha.

Flowers: January-February.

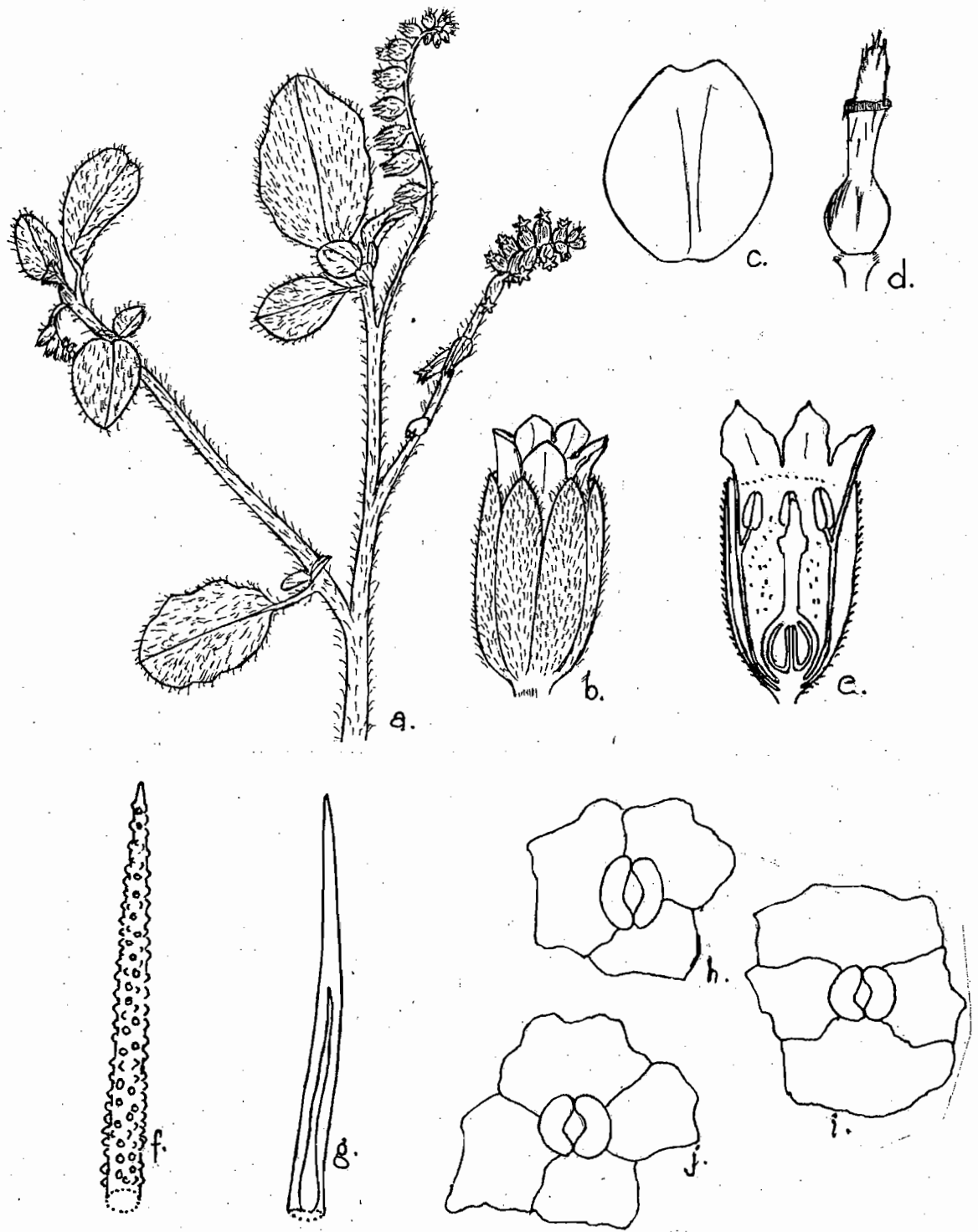


Fig. 328. *Heliotropium indicum* L., a. habit, b. flower, c. bract, d. gynoecium, e. L.S. of flower, f. unicellular trichome with thick warty wall, g. unicellular trichome with smooth wall, h. anisocytic stomata, i. tetracytic stomata, j. anomocytic stomata.

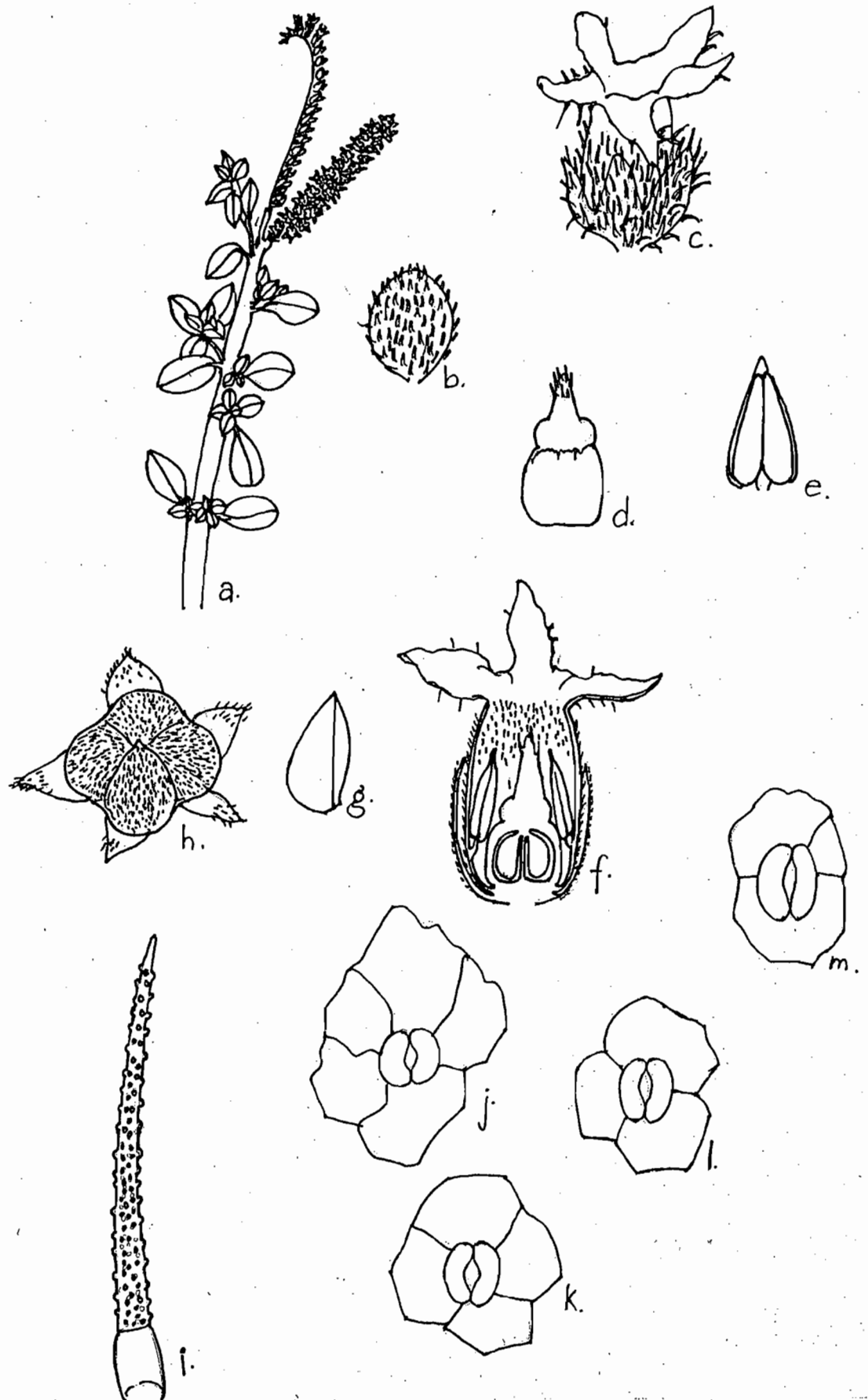


Fig. 329. *Heliotropium ovalifolium* Forsk., a. habit b. bract c. flower d. gynoecium e. stamen f. L.S. of flower g. seed h. capsule, o. two celled trichome with lower cell small and upper cell acicular, warty and thick walled.

Micromorphology (Fig. 329)

The plant showed presence of two celled trichome; the upper cell was elongated and conical with warty surface and the lower cell was swollen and small in size as compared to the upper one.

Stomata were of anisocytic and anomocytic type.

D/968, 969.

6. *Heliotropium marifolium* Retz. Obs. Fasc. 2 (1781) p. 8.

A much-branched decumbent perennial hairy herb with a woody base. Leaves ovate or lanceolate, upto 1.5 cm. Flowers in short axillary and terminal bracteate spikes; bracts foliaceous, lanceolate. Calyx segments unequal, lanceolate, and ciliate. Corolla tube cylindric, hairy outside, glabrous inside; lobes ovate-deltoid, with broad plicate sinuses and minute teeth between the lobes. Stamens inserted; anthers ovate, at first united at the apex by the produced connectives which are fused. Ovary ovoid; stigma subcylindric. Fruit subglobose, separating into 4 nutlets. (Fig. 330)

Vernacular name: Zinku okhard.

Flowers: July-October.

Micromorphology (Fig. 330)

The plant showed presence of two types of trichomes. Both the trichomes were unicellular, elongated, non-glandular, but the only difference was that one trichome was with smooth wall and another was with warty surface.

Stomata were of anomocytic type.

D/308.

7. *Trichodesma indicum* R. Br. Prodr. (1810) p. 496.

An erect branched, hispid annual reaching upto 50 cm high. Leaves lanceolate-oblong, upto 10 cm, clothed above with stiff hairs springing from white circular tubercles, more or less densely villous beneath. Flowers pale violet-blue, solitary and leaf-opposed and in terminal few-flowered cymes. Calyx segments lanceolate, cordate or hastate at the base. Corolla infundibuliform, lobes ovate-deltoid, suddenly acuminate. Cone of anthers large, clothed on the back with dense hairs, finally twisted together. Ovary ovoid. Fruit pyramidal; nutlets ovoid. (Fig. 331)

Vernacular name: Dhadhona.

Flowers: August-October.

Micromorphology (Fig. 331)

Leaf showed presence of unicellular, non-glandular, conical trichome with thick wall and a very broad lumen at the base.

Stamen showed presence of unicellular, non-glandular, elongated trichome with narrow lumen.

Stomata were on anomocytic type.

D/444, 653, 725, 724.

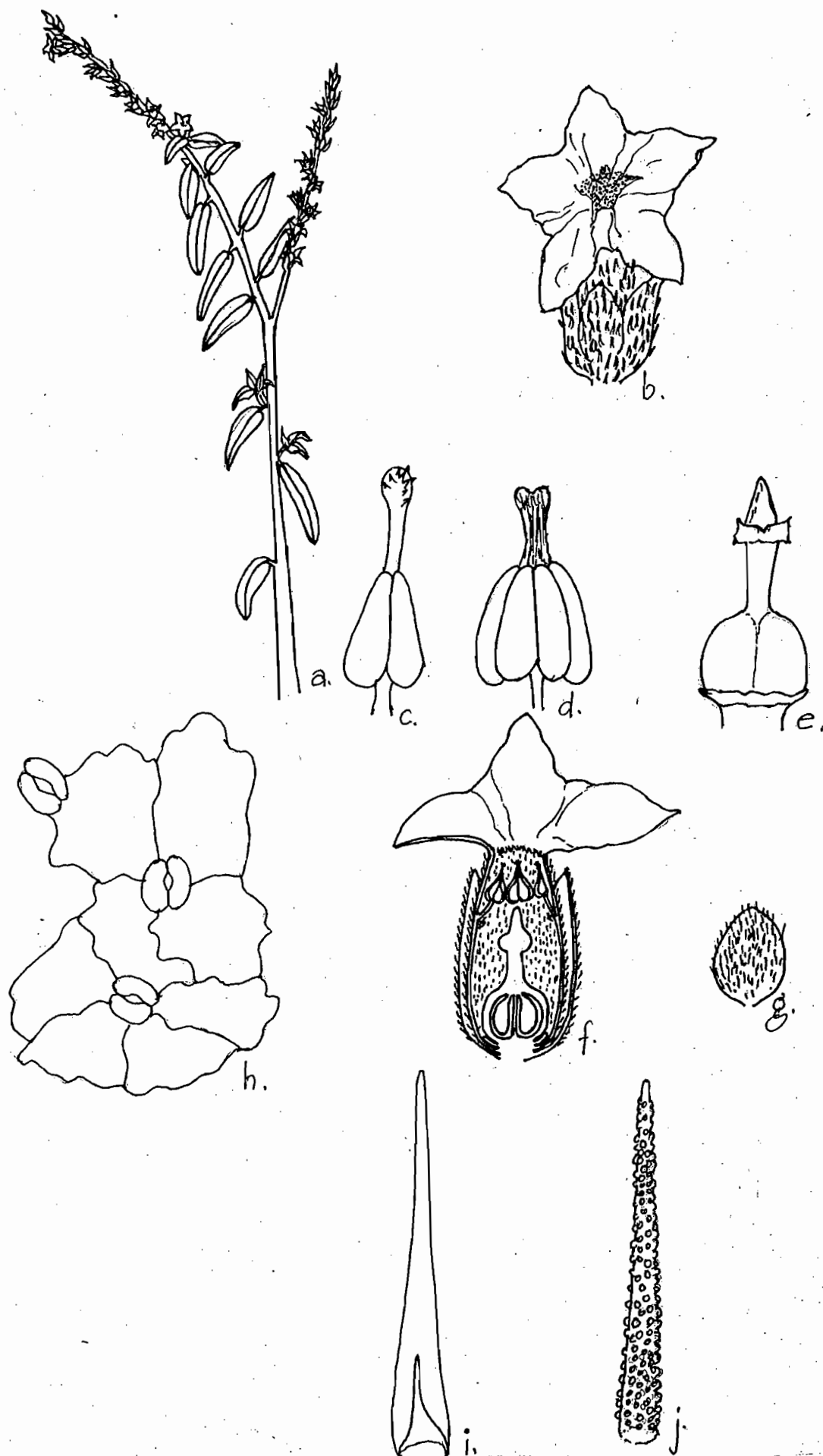


Fig. 330. *Heliotropium marifolium* Retz., a. habit, b. flower, c & d. stamen, e. gynoecium, f. L.S. of flower, g. bract, h. anomocytic stomata, i. unicellular trichome with small lumen

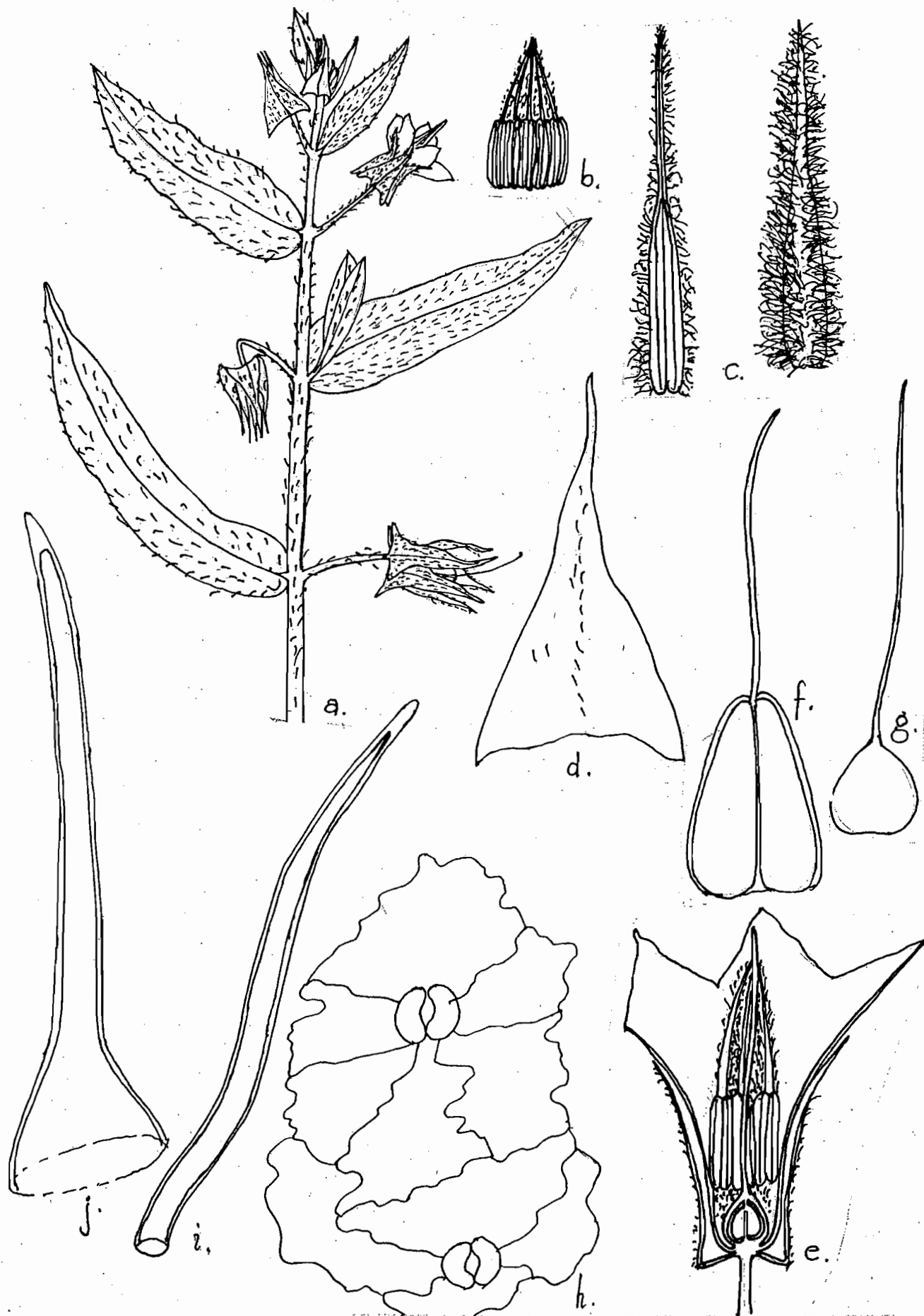


Fig. 331. *Trichodesma indicum* Br., a. habit, b & c. stamen, d. sepal, e. L.S. of flower, f. capsule, g. gynoecium, h. anomocytic stomata, i. unicellular trichome, j. unicellular trichome with broad lumen.

Convolvulaceae

1. *Convolvulus microphyllus* Sieb. ex. Spreng. Syst. V. 1 (1825) p. 611.

A procumbent villous herb with stems suffruticose at the base, upto 50 cm long. Leaves linear-oblong about 2.5 cm long. Flowers axillary, solitary or 2-4 together. Sepals ovate-lanceolate, unequal. Corolla whitish-pink, infundibuliform, with hairy bands outside; limb shallowly 5-lobed, the lobes deltoid, acute, with a tuft of hair at the apex of each. Stamens unequal. Ovary seated on a cup-shaped disk, 4-celled; stigmas filiform. Capsules subglobose, smooth. Seeds 4. (Fig. 332)

Vernacular name: Shankhapuspi.

Flowers: July-September.

Micromorphology (Fig. 332)

Two types of trichomes were present on the plant; one was multicellular, glandular, differentiated into a four celled head and a two celled uniseriate stalk whereas the second was unicellular, non-glandular, elongated trichome with a triangular base.

Stomata were of anisocytic type.

D/365, 696, 697.

2. *Cressa cretica* Linn. Sp. Pl. (1753) p. 223.

An erect dwarf hairy much-branched shrub upto 40 cm high. Leaves ovate, about 0.6 cm long, acute, densely silky-hairy. Flowers white or pink, usually in small clusters in the axils of the upper leaves; bracts 2, linear. Calyx segments 5, elliptic. Corolla infundibuliform; lobes oblong, reflexed. Stamens 5; anthers oblong. Ovary 2-celled; styles 2, distinct from the base, equal; stigmas capitate. Capsules ovoid. Seeds in fully ripe capsules usually solitary. (Fig. 333)

Vernacular name: Rudanti.

Flowers: November-January.

Micromorphology (Fig. 333)

Medifixed hairs with thick smooth wall and narrow lumen were seen along with non-glandular unicellular hairs.

Stomata were anisocytic, tetracytic, and anomocytic types.

D/704-705, 1252.

3. *Cuscuta chinensis* Lamk. Encyc. Method. V. 2 (1786) p. 229.

A leafless parasite with yellow filiform, twining much-branched thin stem. Flowers solitary or in shortly pedunculate cymes; pedicels short; bracts ovate. Calyx lobes-5, deltoid-ovate, with a tubercular keel on the back. Corolla lobes-5, about equaling the tube, ovate-oblong; scales at the base of the filaments fimbriate. Filaments short. Ovary 2-celled; styles 2, distinct. Capsules globose, divided into 2 lobes by a deep furrow on top. (Fig. 334)

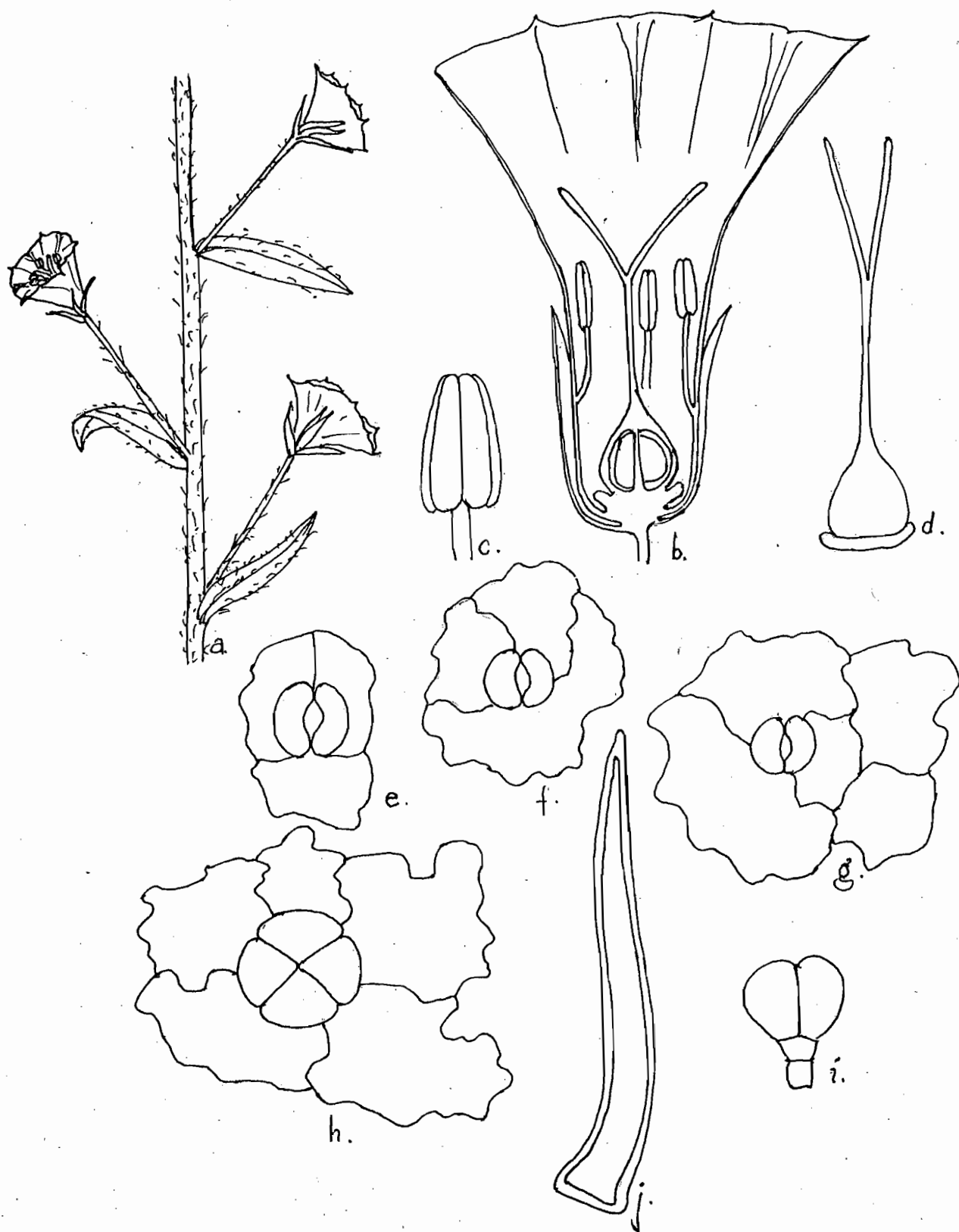


Fig. 332 *Convolvulus microphyllous* L., a. habit, b. L.S. of flower, c. stamen, d. gynoecium, e-g. anisocytic stomata, h. four celled sessile gland, i. gland with two celled head and two celled uniseriate stalk, j. unicellular trichome.

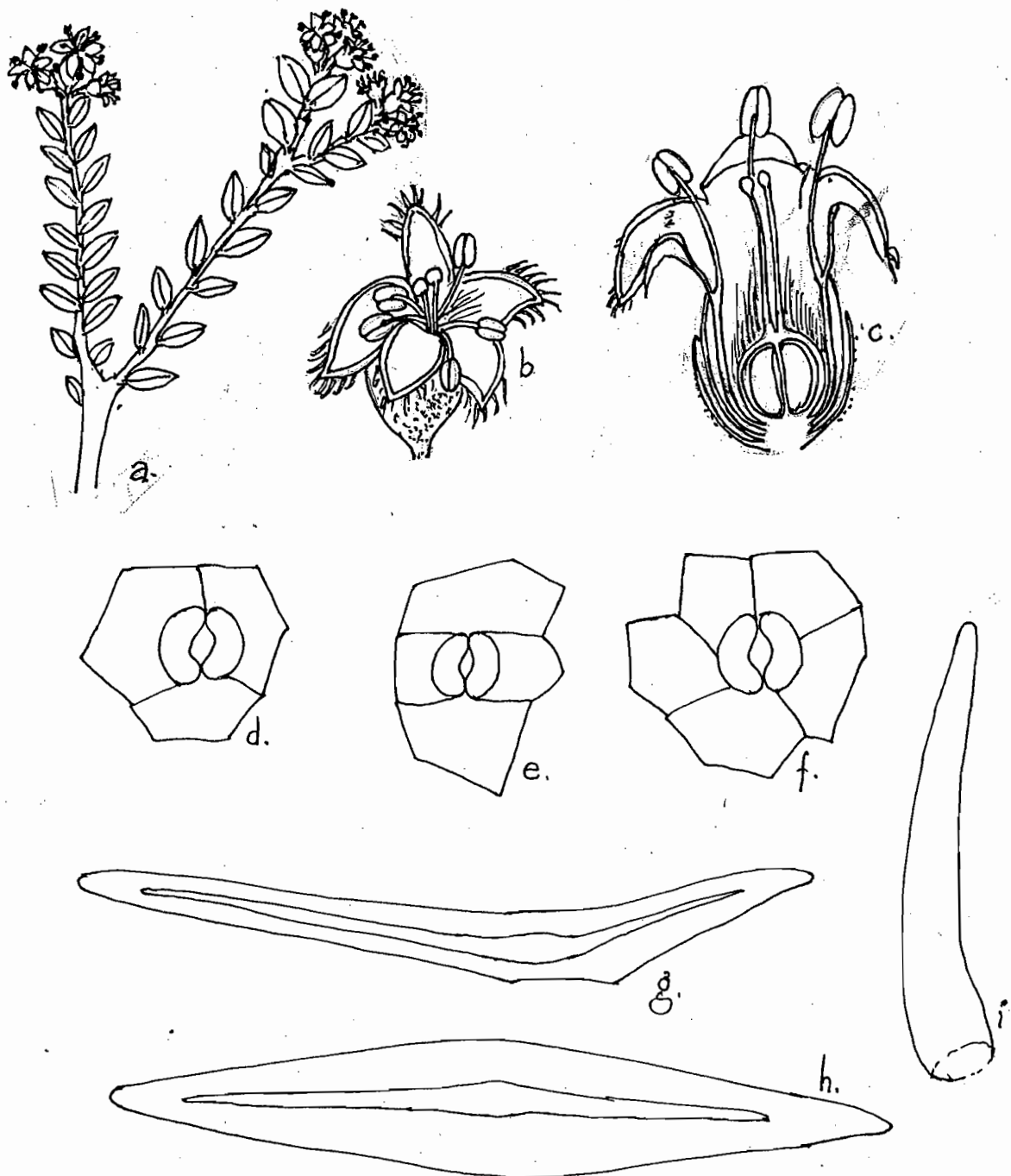


Fig. 333. *Cressa cretica* L., a. habit, b. flower, c. L.S. of flower, d. anisocytic stomata, e. tetracytic stomata, f. anomocytic stomata, g-h. medifixed hair with thick wall and narrow lumen, i. glandular unicellular trichome.

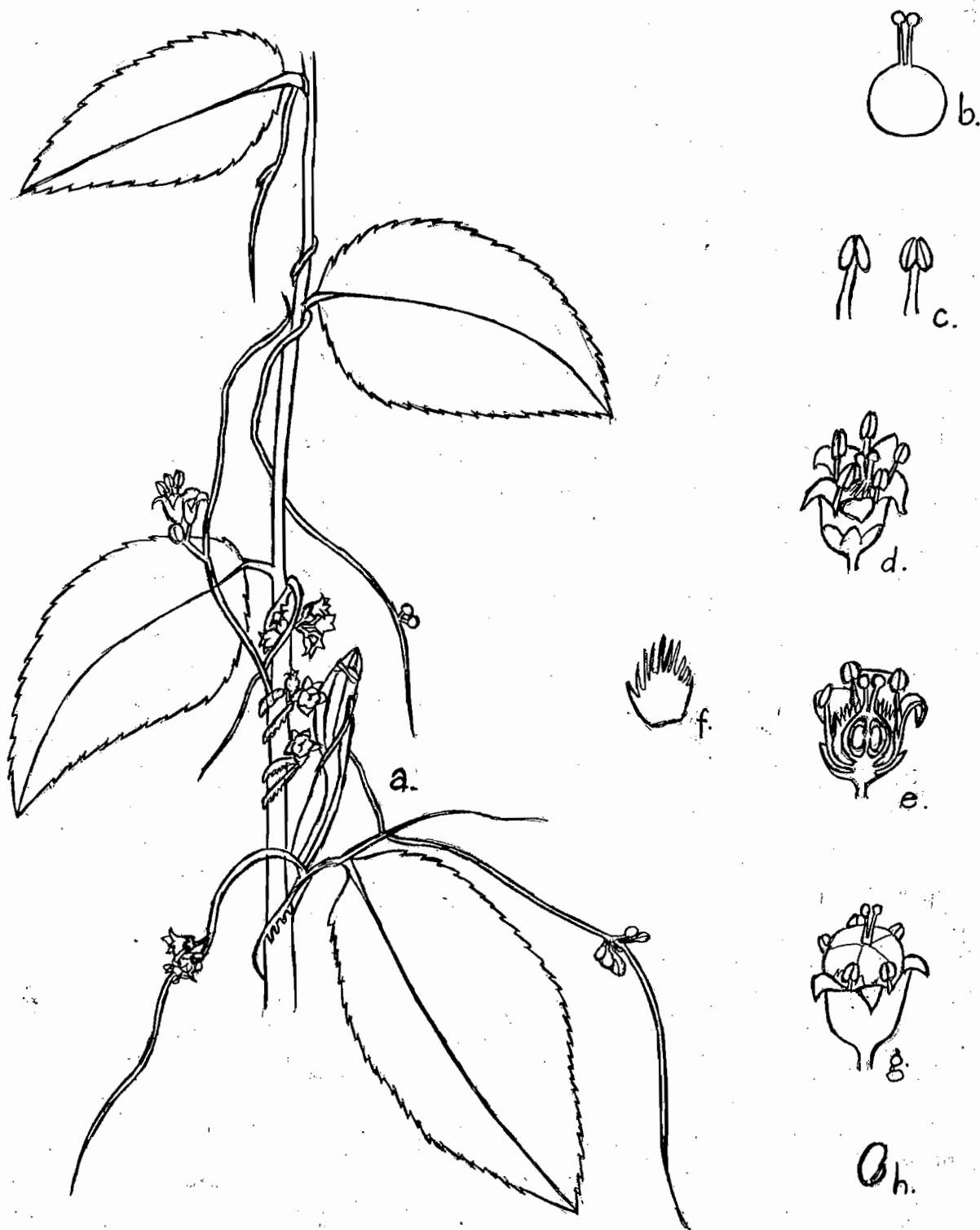


Fig. 334. *Cuscuta chinensis* Lamk., a. habit, b. gynoecium, c. stamen, d. flower, e. L.S. of flower, f. corona, g. capsule, h. seed.

Vernacular name: Amar vel.
 Flowers: June-July.
 D/207.

4. *Cuscuta reflexa* Roxb. *Cor. Pl. V. 2* (1798) p. 3, t. 104.

A leafless parasite with yellow stout, twining much-branched stem. Flowers in umbellate clusters of 2-4. Calyx lobes 5, broadly ovate. Corolla white, lobes deltoid, reflexed. Corolline corona scale like, fimbriate. Stamens in the throat of the corolla-tube; filaments scarcely any; anthers about half-exserted beyond the top of the corolla-tube. Ovary ovoid; style simple; stigmas 2, distinct, large, thick and fleshy, ovoid. Capsules depressed-globose, circumscissile near the base. Seeds 2-4, large, black, glabrous. (Fig. 335)

Vernacular name: Amar vel.
 Flowers: January-February.
 D/651, 681, 932.

5. *Evolvulus alsinoides* Linn. *Sp. Pl. ed. 2* (1762) p. 392.

A prostrate, perennial hairy herb with a stem spreading more than 30 cm long. Leaves elliptic-oblong, upto 2 cm, apiculate, densely clothed with appressed silky hairs. Flowers light-blue, solitary from a pair of lanceolate bracts on the peduncle. Calyx densely silky; sepals-5, lanceolate. Corolla infundibuliform; limb plicate. Stamens 5. Ovary 2-celled; ovules 4; styles 2, distinct from the base, each cleft into 2 linear or subclavate stigmas. Capsules globose, thin 4-valved. Seeds usually 4. (Fig. 336)

Vernacular name: Kali Shankhaval.

Flowers: July-November.

Micromorphology (Fig. 336)

The plant showed presence of medifixed hairs; but sometimes of the two arms one become very short.

Stomata were of anisocytic, tetracytic, paracytic and diacytic type.

D/208.

6. *Evolvulus nummularius* L. *Sp. Pl. ed. 2*. 391. 1762.

A perennial prostrate, glabrous herb rooting at nodes. Leaves broadly ovate(coin-shaped) upto 1.5 cm long, shortly petiolate. Flowers white, solitary or in pairs found in leaf axils. Sepal lobes 5, elliptic-ovate, pubescent. Corolla broadly campanulate, deeply lobed. Stamens 5. Ovary 2-celled, styles 2 branched with 2 branches. Capsules globose one celled. Seeds brown, subglobose. (Fig. 337)

Vernacular name: Musakarni.

Micromorphology (Fig. 337)

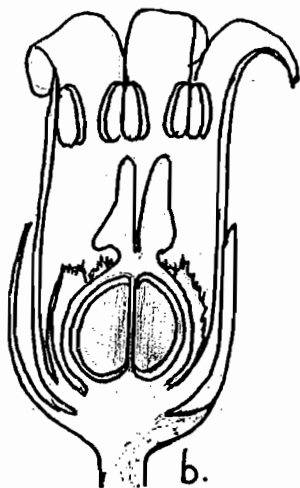
Two types of trichomes were found; one was glandular with two-celled head and singled celled stalk and non-glandular unicellular trichome with thick wall and broad base.

Stomata were anisocytic and paracytic types.

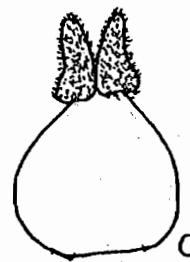
D/685, 813.



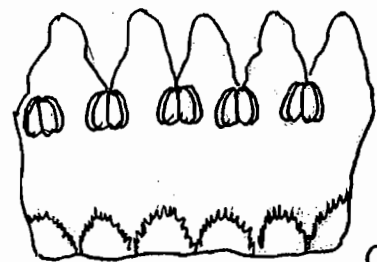
a.



b.



c.



d.

Fig. 335. *Cuscuta reflexa* Roxb., a. habit, b. L.S. of flower, c. gynoecium, d. corona and epipetalous stamen.

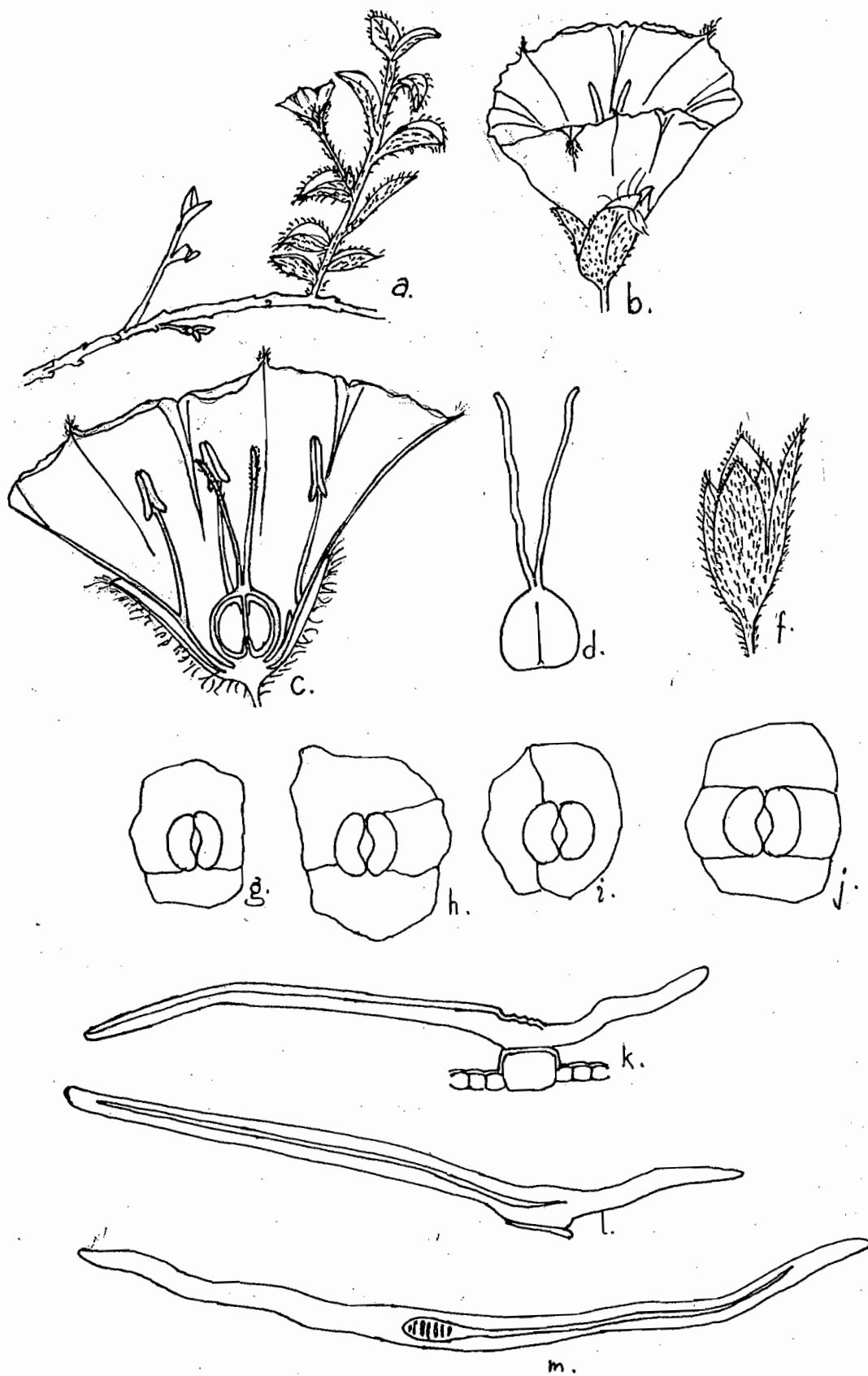


Fig. 336. *Evolvulus alsinoides* L., a. habit, b. flower, c. L.S. of flower, d. gynoecium, f. calyx, g. diacytic stomata, h. anisocytic stomata, i. paracytic stomata, j. tetracytic stomata, k-m. medifixed hair with one arm short in some trichomes.

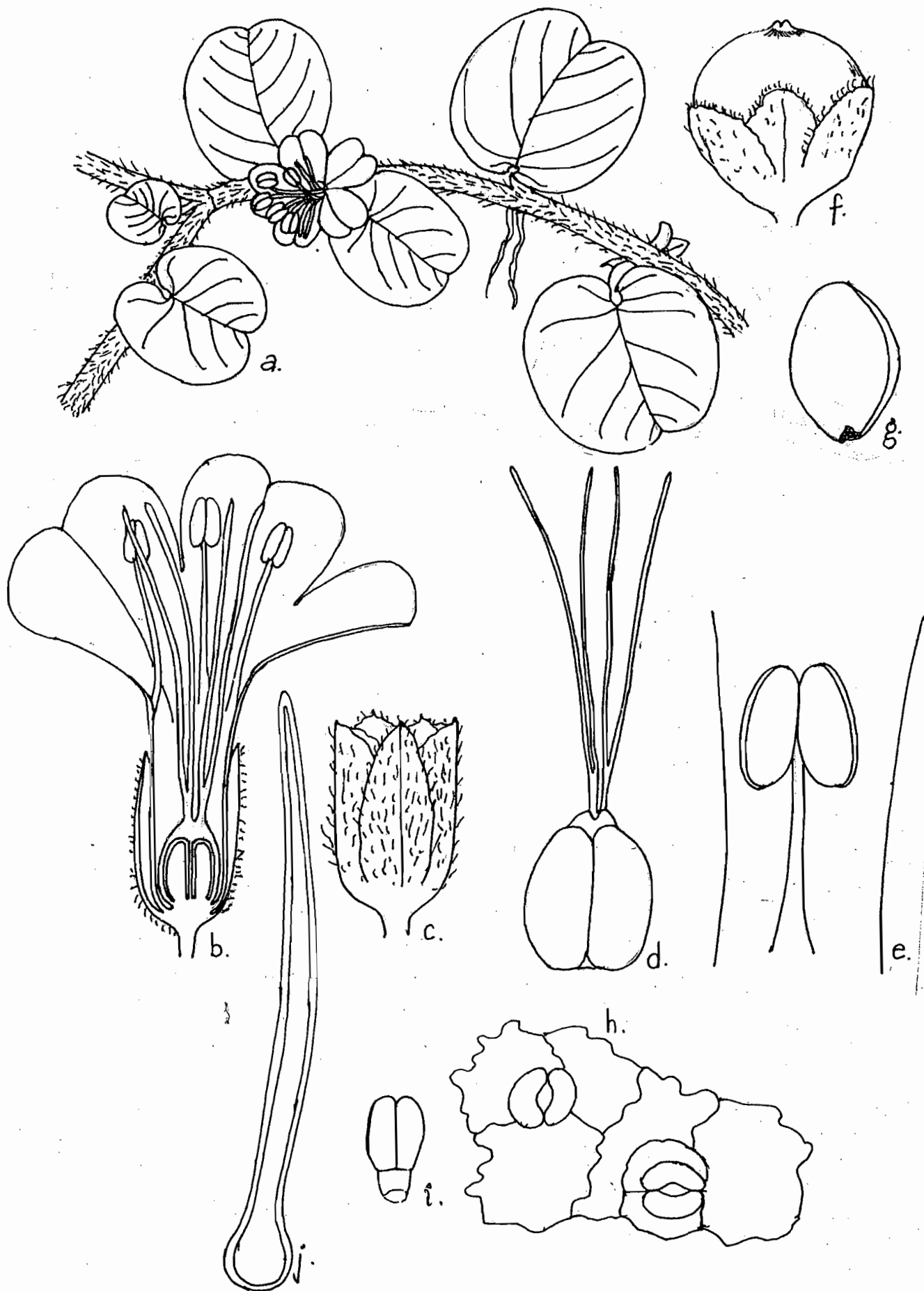


Fig. 337. *Evolvulus nummularius* L., habit, b. L.S. of flower, c. calyx, d. gynoecium, e. epipetalous stamen, f. capsule, g. seed, h. anisocytic stomata, i. gland with two celled head and a single celled stalk, j. trichome with thick wall and broad lumen.

7. *Ipomoea aquatica* Forsk. *Fl. Aegypt.-Arab.* (1775) p. 44.

An annual or biennial twinner trailing on mud or floating on water. Leaves elliptic-oblong, upto 13 cm, base usually dilated, cordate or hastate; petioles upto 12 cm long. Peduncles 10 cm long, usually 1-5 flowered; bracts small, linear-lanceolate. Sepals-5, subequal, oblong-lanceolate. Corolla infundibuliform, upto 5 cm long, purple. Stamens 5; filaments filiform. Ovary 2-celled; ovules 4; style filiform; stigma capitate, 2-3-globose. Seeds 4 or 2, minutely pubescent. (Fig. 338)

Vernacular name: Narivel.

Flowers: November-April.

Micromorphology (Fig. 338)

Leaf showed presence of sessile multicellular, glandular, trichome wherein the cells were radially arranged into a multicellular head.

Staminal hair was glandular, multicellular, differentiated into a single celled oval head with lot of ergastic substance in it and a multicellular, multiseriate stalk; the cells of stalk were thick walled and rectangular in shape.

Stomata were of paracytic type.

D/588, 1036.

8. *Ipomoea batatas* (L.) Lam., *Tabl. Encyc.* 1: 465. 1793.

A perennial climber with tuberous root. Leaves ovate-cordate, 3-5 lobed, upto 9. Flowers solitary or in few-flowered, subumbellate cymes. Sepals oblong, acuminate, cuspidate. Corolla infundibuliform, purple, 2-3 cm long. Ovary 2-celled; ovules 4; style filiform; stigma capitate, 2-3-globose. Capsules ovoid, glabrous. Seeds rotundate, glabrous. (Fig. 339)

Vernacular name: Sakkariyo.

Flowers: October-December.

Micromorphology (Fig. 339)

Three types of glandular trichomes were observed; 1) unicellular, 2) multicellular sessile and 3) multicellular differentiated into single cell head and multiseriate stalk.

The third type of trichome was observed on stamens.

Stomata were paracytic.

D/130

9. *Ipomoea biflora* (L.) Pers. *Syn. Pl.* 1: 183. 1805.

(*Ipomoea calycina* C.B. Clarke.)

The plant is a twinner, sparingly clothed with long spreading hairs. Leaves ovate, upto 8 cm, acuminate, cordate at the base with a wide sinus. Flowers 1-3 in peduncles; bracts small, ovate. Sepals unequal, lanceolate-sagittate with obtuse auricles, the inner linear-lanceolate. Corolla white, tubular, scarcely 3 cm long. Ovary 2-celled; ovules 4; style filiform; stigma capitate, 2-3-globose. Capsules ovoid, pointed. Seeds villous all over, fringed on the margin with soft white hairs. (Fig. 340)

Micromorphology (Fig. 340)

Whole plant was villous. There were 3 types of trichomes on different parts of the plant.

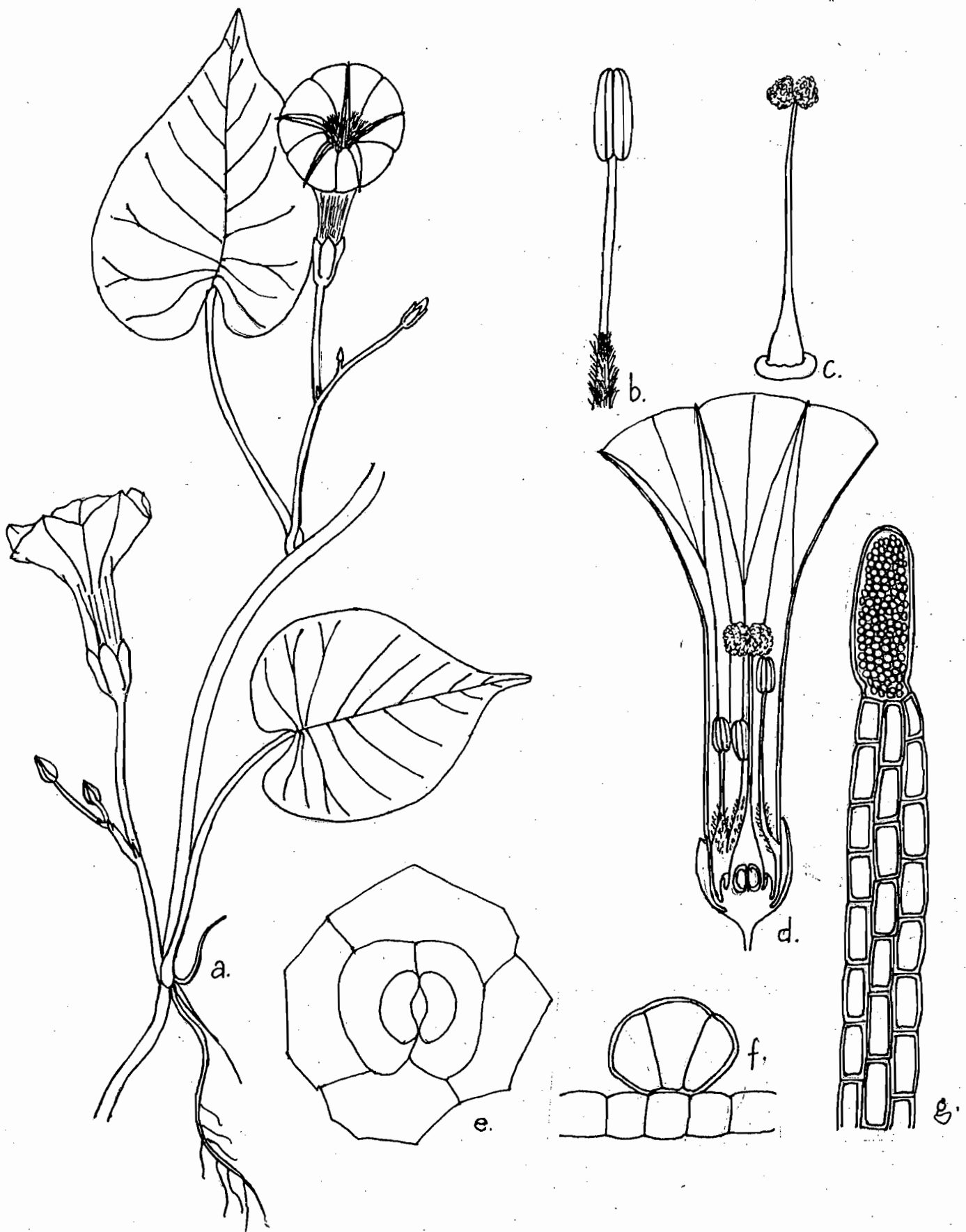


Fig. 338. *Ipomoea aquatica* Forsk., a. habit, b. stamen, c. gynoecium, d. L.S. of flower, e. paracytic stomata, f. sessile multicellular gland, g. gland with a single celled head and multiseriate stalk.

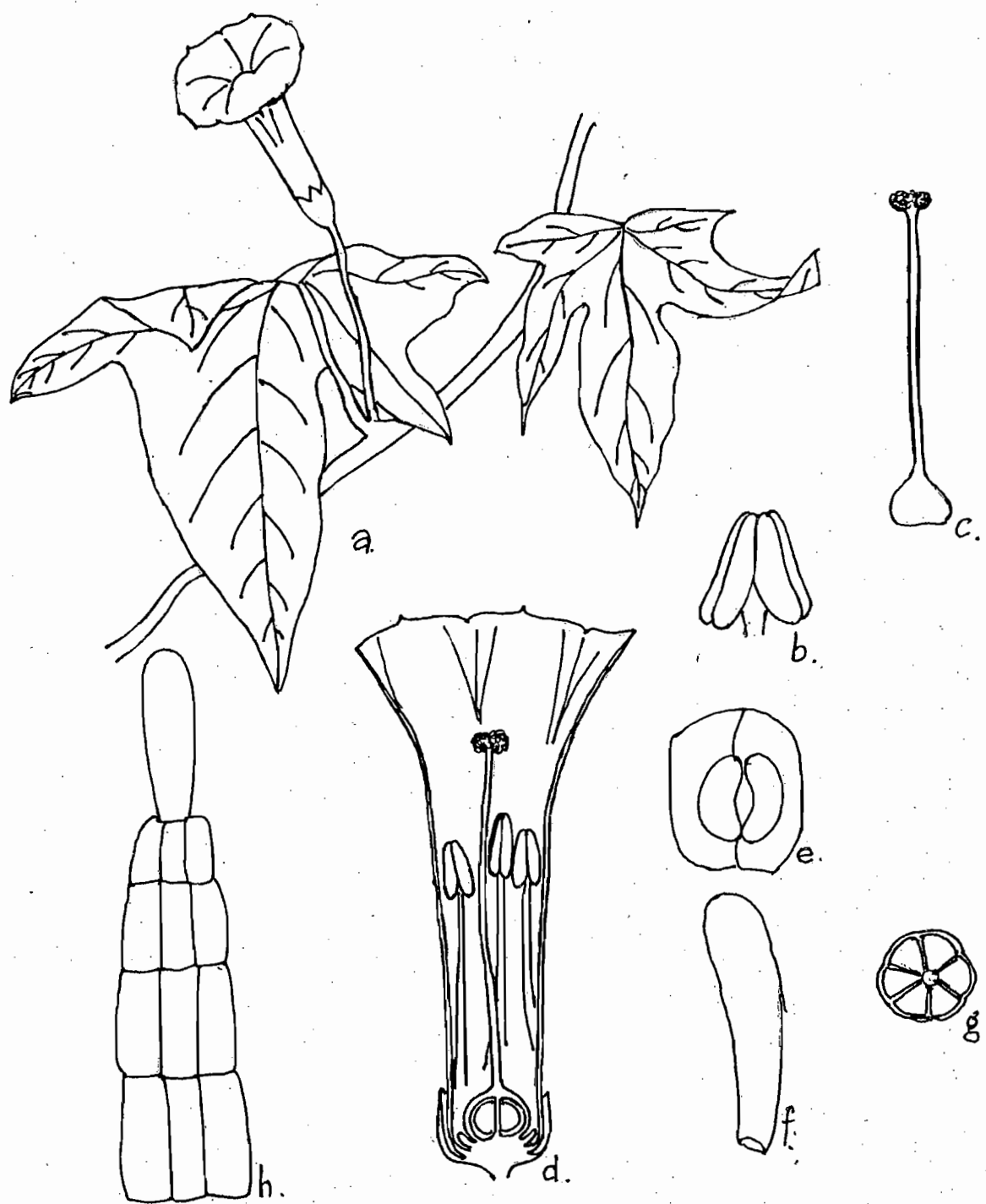


Fig. 389. *Ipomoea batatas* Poir., a. habit, b. stamen, c. gynoecium, d. L.S. of flower, e. paracytic stomata, f. unicellular trichome, g. multicellular sessile gland, h. gland with a single celled head and multiseriate stalk.

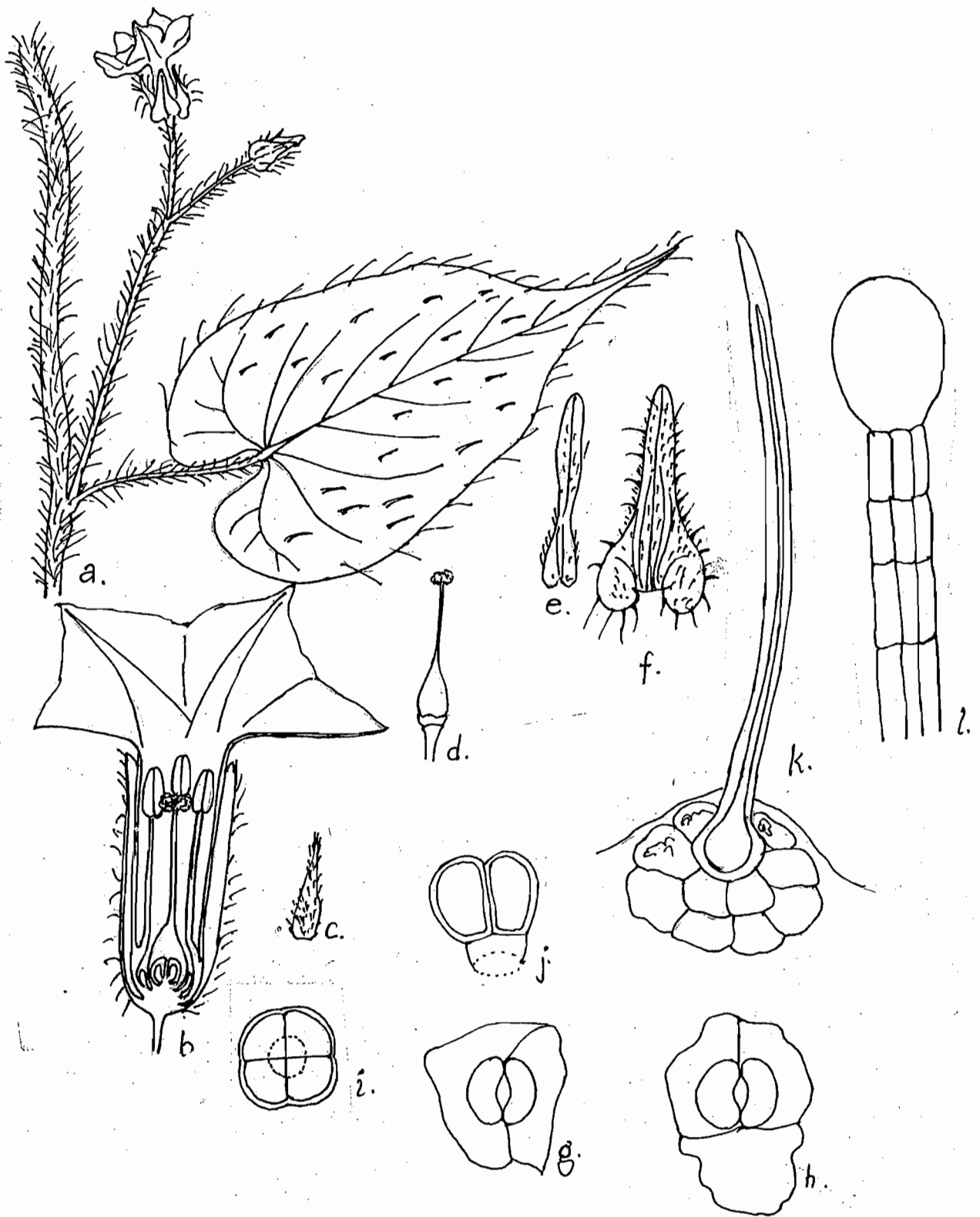


Fig. 340 *Ipomoea biflora* Pers., a. habit, b. L.S. of flower, c. stipule, d. gynoecium, e. bract, f. bracteole, g. paracytic stomata, h. anisocytic stomata, i. multicellular sessile gland, j. gland with two celled head and a single celled stalk, k. unicellular trichome, l. gland with a single celled head and multiserial stalk.

Non-glandular, unicellular trichomes were seen distributed all over the plant. They were thick walled, elongated linear with a pointed tip. The leaves, in addition, contained another type of glandular trichome which was multicellular, and differentiated into 4 celled head and a single celled stalk. In the flower specially on stamens there occurred a glandular trichome with a unicellular large oval head and multicellular multiseriate stalk. Stomata seen were both anisocytic and paracytic.
D/1223.

10. *Ipomoea cairica* (L.) Sweet. Hort. Brit. 287, 1826.
(*Ipomoea palmata* Forsk.)

A perennial twinner woody at the base. Leaves palmatisect with 3-7 (usually 5) oblanceolate lobes, upto 5 cm long. Peduncles 1-3 flowered, curved downwards; bracts minute; pedicels erect and thickened in fruit. Sepals elliptic-oblong, dotted with whitish specks inside and with membranous margins. Corolla upto 5 cm long, dull-violet with a purple tube, widely infundibuliform. Capsules sub-globose, 2-celled. Seeds pubescent with a marginal fringe of long white silky hairs. (Fig. 341)
Flowers: most of the year.

Micromorphology (Fig. 341)

Whole plant was glabrous except the stamens which showed presence of staminal hairs. The staminal hairs were multicellular, glandular, differentiated into a single celled head with lot of ergastic substance and a multicellular, biseriate stalk. Stomata were of anisocytic and paracytic type.
D/ 456, 569.

11. *Ipomoea carnea* Jacq. Enum. Syst. Pl. 1760.

A hollow stemmed shrub. Leaves ovate-lanceolate, truncate to shallowly cordate at base, acuminate. Flowers in paniculate clusters of cymes. Sepals-5, suborbicular. Corolla pink, infundibuliform. Stamens 5, usually included; filaments filiform; Ovary 2 (rarely 3 or 4) -celled; ovules 4 (rarely 6); style filiform; stigma capitate, entire or 2-3-globose. Fruit ovoid to subglobose. Seeds comose. (Fig. 342)
Flowers: July-November.

Micromorphology (Fig. 342)

The leaf showed presence of multicellular, glandular trichome differentiated into a multicellular 4-8 celled head with cells radiating and a one celled stalk. Staminal hairs were multicellular, glandular, differentiated into a one celled head with ergastic substance and multicellular, multiseriate stalk.
D/133.

12. *Ipomoea fistulosa* Mart. ex Choisy in DC. Prodr. 9: 347. 1845.
(*Ipomoea carnea* subsp. *fistulosa* D.F. Austin)

A hollow stemmed shrub upto 1-5 m high, normally grown as a hedge plant. Leaves ovate-lanceolate, upto 25 cm long, acuminate. Sepal lobes 5, suborbicular. Corolla upto 9 cm long, pink. Stamens 5, usually included; filaments filiform, filaments unequal. Ovary 2

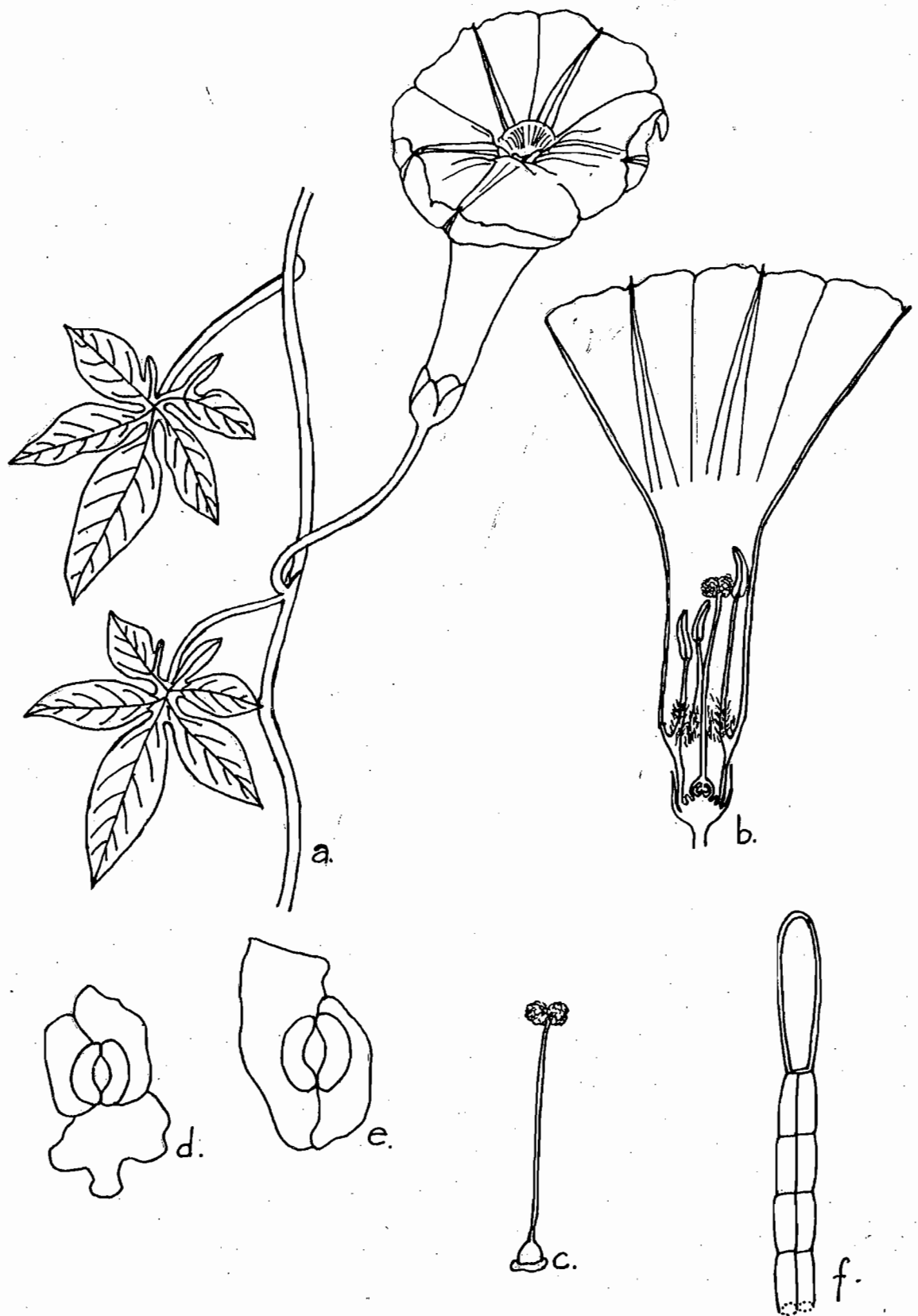


Fig. 341. *Ipomoea cairica* Sweet., a. habit b. L.S. of flower, c. gynoecium, d. anisocytic stomata e. paracytic stomata f. gland with a single celled head and multiseriate stalk.

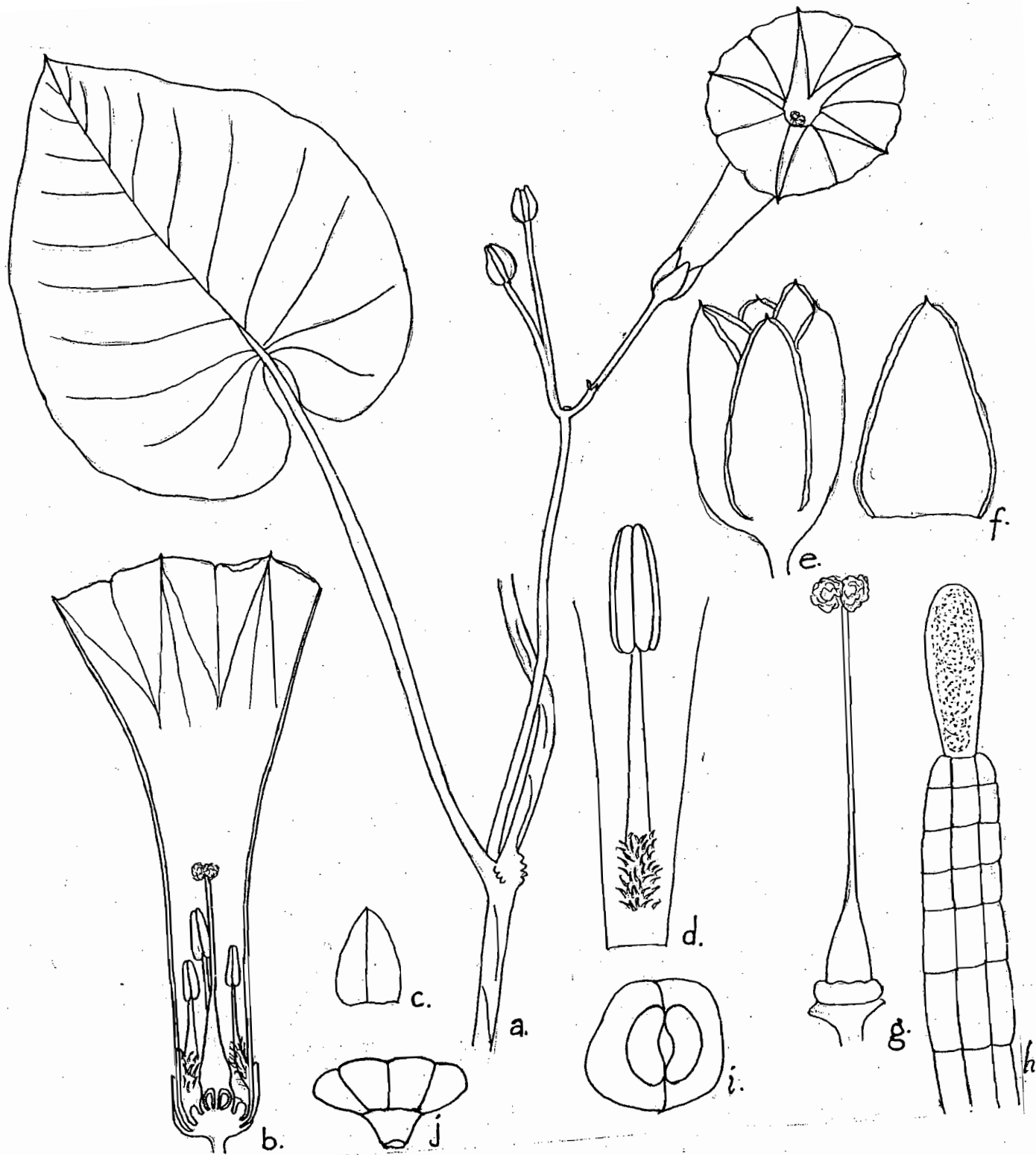


Fig. 342. *Ipomoea carnea* Jacq., a. habit, b. L.S. of flower, c. bract, d. epipetalous stamen, e. calyx, f. sepal, g. gynoecium, h. gland with a single celled head and multiserial stalk, i. paracytic stomata, j. gland with multicellular single tiered head and a single celled stalk.

(rarely 3 or 4) –celled; ovules 4; style filiform; stigma capitate, entire or 2-3-globose. Fruit ovoid to subglobose, the seeds covered with long, woolly hairs. (Fig. 343)

Vernacular name: Besharmi.

Micromorphology (Fig. 344)

Leaf and calyx showed presence of unicellular, non-glandular, conical, trichome with thick wall and blunt apex.

Corolla showed presence of two celled, trichome with upper cell long, pointed and slightly curved, and basal cell was short and swollen.

Staminal hairs were multicellular, glandular, differentiated into a one celled head with ergastic substance and multicellular, multiseriate stalk.

Stomata were of paracytic type.

D/223.

13. *Ipomoea hederifolia* Linn., *Syst. Nat.* ed. 10.925. 1759.

A sparsely pubescent annual climber with ovate to suborbicular trilobate or with 5-7 lobed leaves upto 15 cm long. Flowers red to red-yellow, in few-to several-flowered cymes or solitary. Sepals oblong to elliptic, apically obtuse to truncate, the outer with a subterminal fleshy arista. Corolla salverform upto 4.5 cm long. Fruit capsular, subglobose, 6-8 mm long. Seeds dark brown or black, pyriform. (Fig. 345)

Vernacular name: Krishnabija.

Flowers: November to September, perhaps all the year in some areas.

Micromorphology (Fig. 345)

There were only glandular trichomes having a multicellular, head with radiating cells and a single celled stalk.

Stomata were of paracytic and anisocytic types.

D/989.

**14. *Ipomoea marginata* (Desr.) Verdc. *Kew Bull.* 42(3): 658. 1987.
(*Ipomoea sepiaria* Koenig.)**

A perennial twinner with more or less hairy stem. Leaves ovate, cordate at base upto 8 cm, and with red patches in lamina. Flowers in pedunculate subumbellate cymes; bracts lanceolate. Sepals elliptic, slightly apiculate, with membranous margins, the 2 outer shorter, the 3 inner longer. Corolla tubular-infundibuliform, pale-purple or whitish; tube purple within; lobes of the limb shortly apiculate. Stamens 5. Filaments hairy at the base. Capsules ovoid, 4 – 2 seeded. Seeds grey with silky pubescence. (Fig. 346)

Vernacular name: Rati fuderdi.

Flowers: August-October.

Micromorphology (Fig. 346)

Almost whole plant was glabrous except few hairs on the leaf. The trichome on the leaf was multicellular, glandular, differentiated into 6-8 cells head and uniseriate 2 celled stalk.

Stomata were paracytic.

D/955-956.

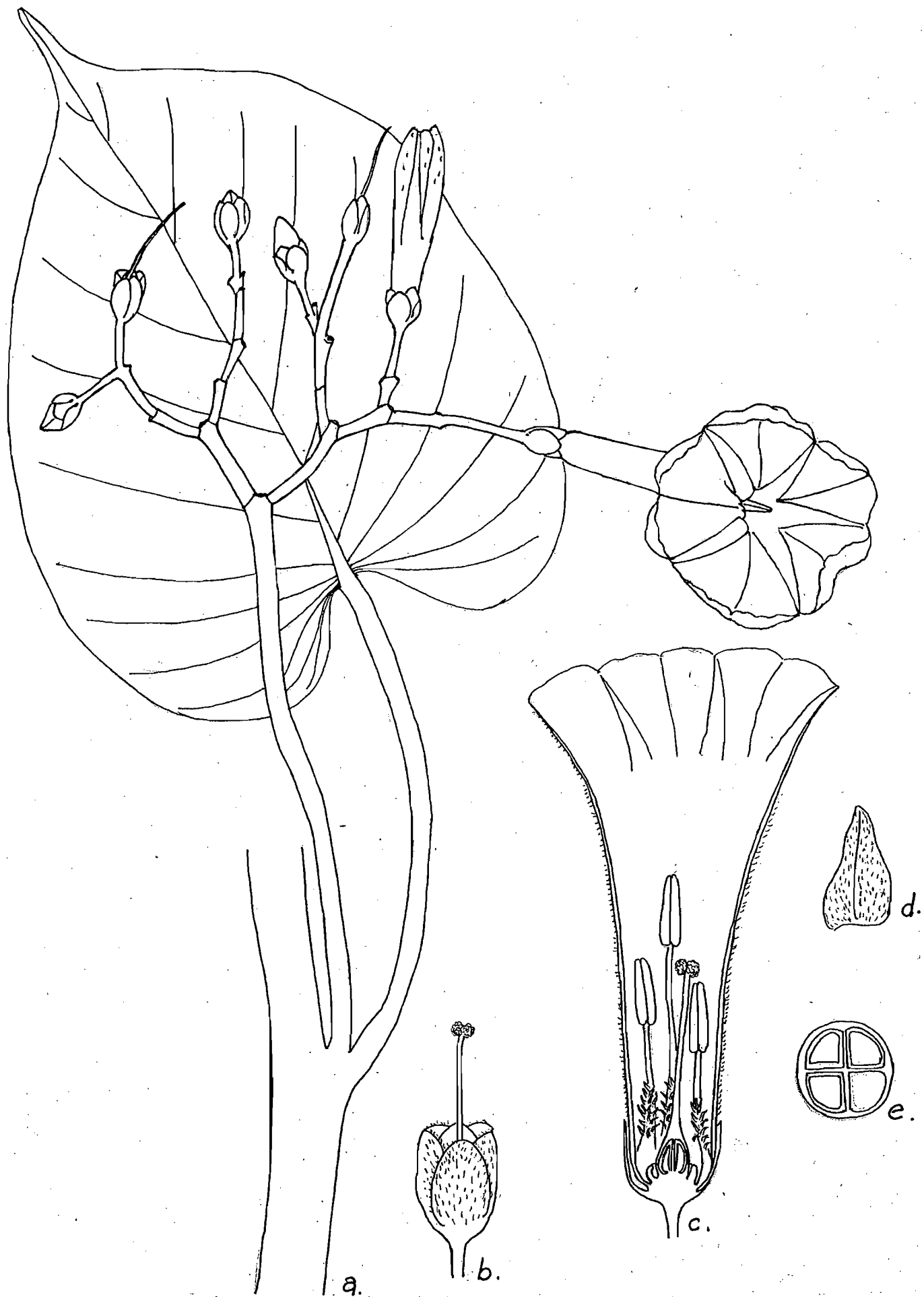


Fig. 343. *Ipomoea fistulosa* Mart. ex Choisy, a. habit, b. Gynoecium with clayx, c. L.S. of flower, d. Bract, e. T.S. of ovary.

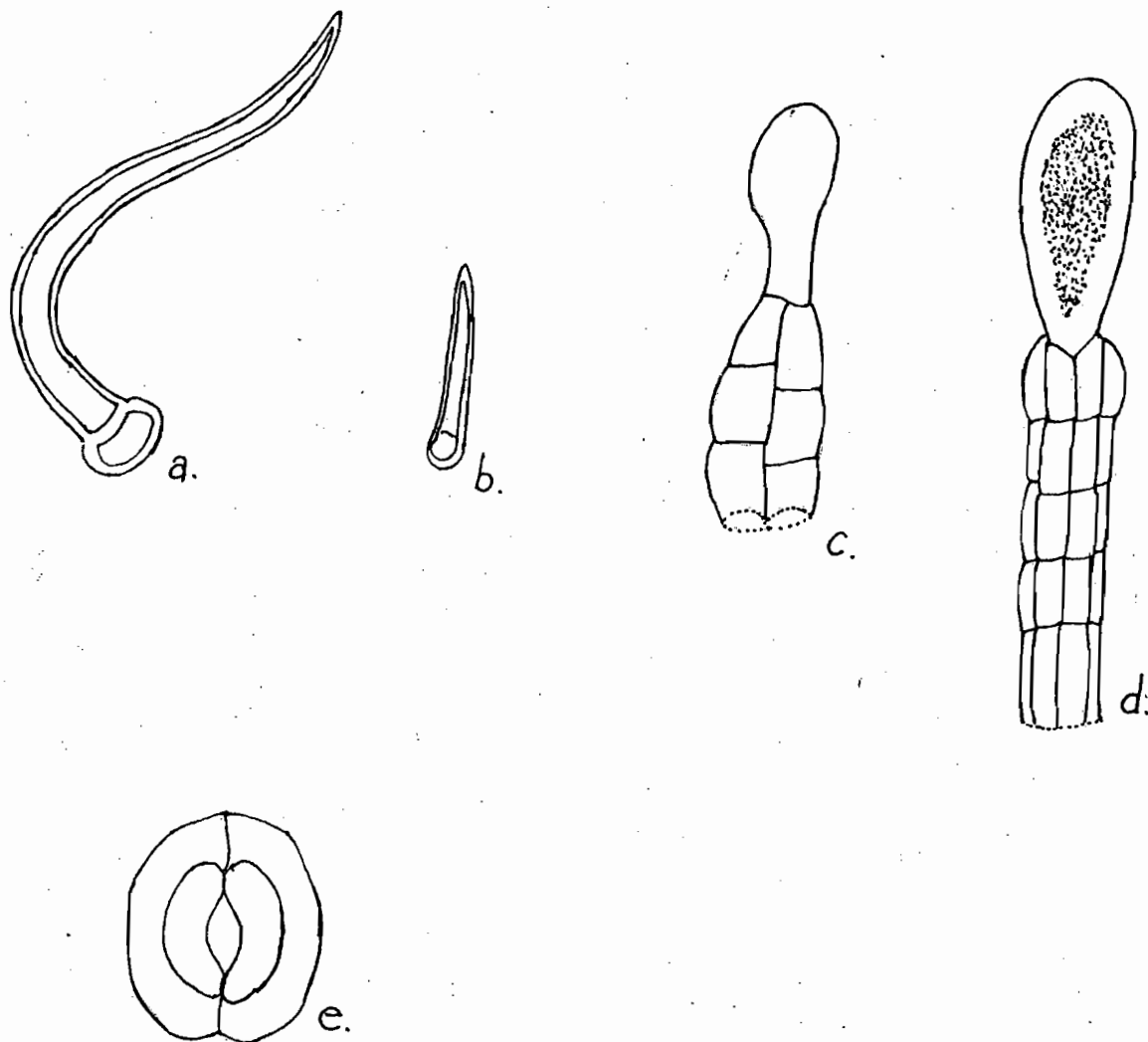


Fig. 344. *Ipomoea fistulosa* Mart. ex Choisy, a. two celled trichome, b. unicellular trichome, c-d. gland with a single celled head and multiseriate stalk, e. Paracytic stomata

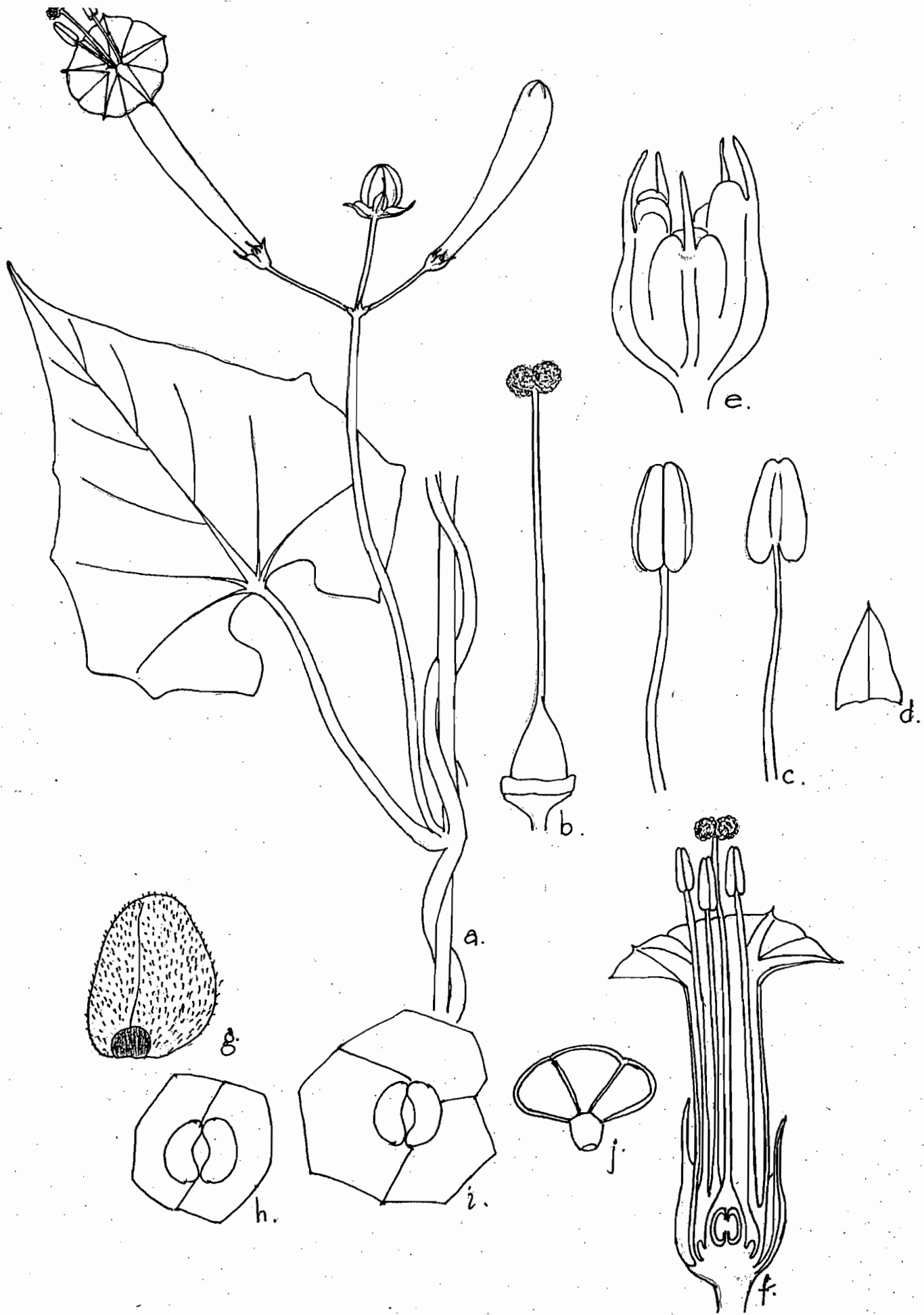


Fig. 345. *Ipomoea hederifolia* L., a. habit, b. gynoecium, c. stamen, d. bract, e. calyx, f. L.S. of calyx, g. seed, h. paracytic stomata, i. anisocytic stomata, j. gland with multicellular head and a single celled head.

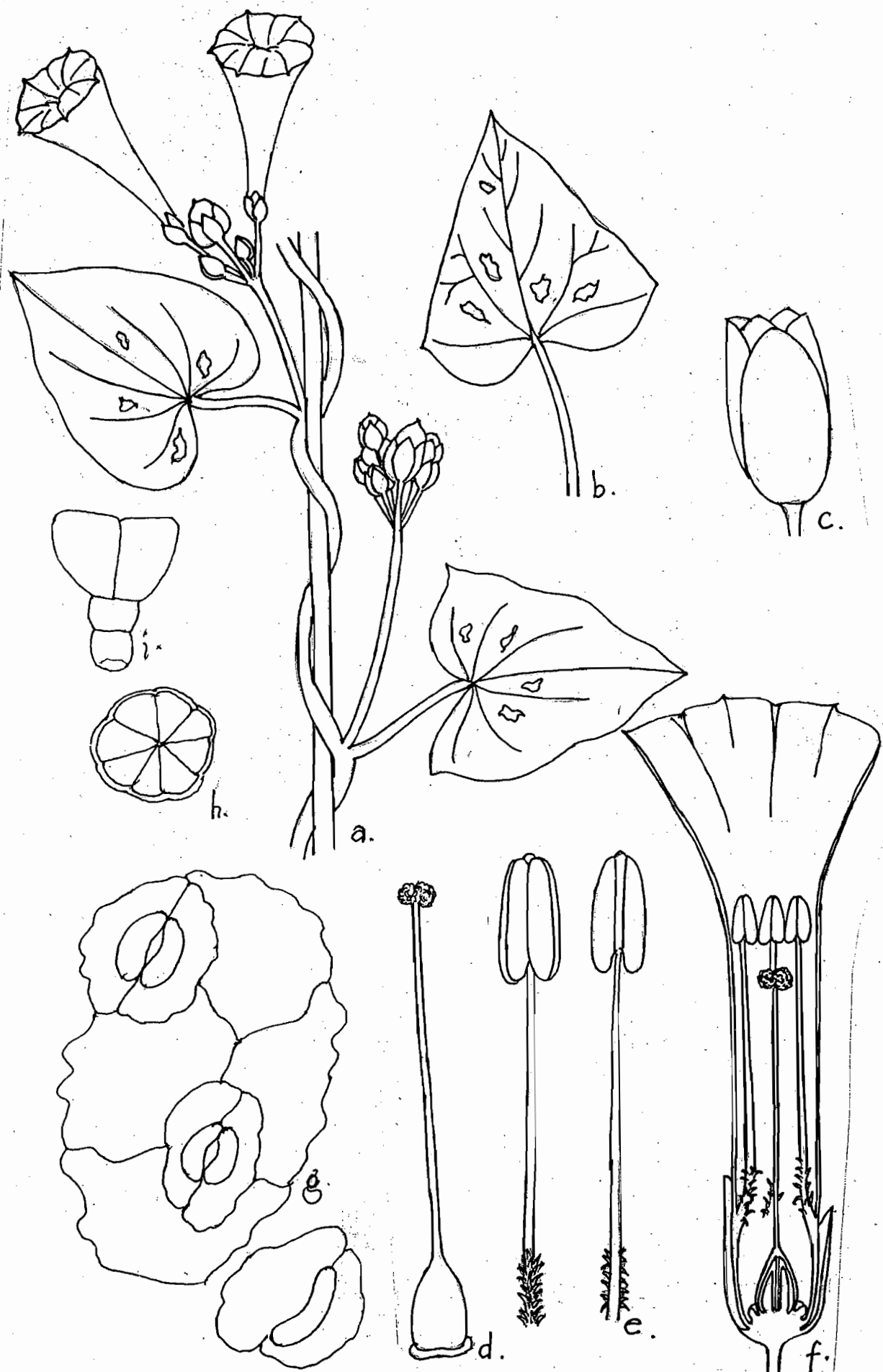


Fig. 346. *Ipomoea marginata* (Desr.) Verdc., a. habit, b. leaf, c. calyx, d. gynoecium, e. stamen, f. L.S. of flower, g. paracytic stomata, h. sessile gland, i. gland with two celled head and two celled uniseriate stalk

15. *Ipomoea nil* (L.) Roth, *Catal. Bot.* 1: 36. 1791

These plants are annual climbers with stems sparsely pubescent or glabrous. Leaves 3-lobed, ovate-suborbicular, upto 14 cm long, acuminate. Flowers mostly in axillary, 1-6 flowered cymes. Sepals lanceolate, with linear-lanceolate apices. Corolla purple or blue, about 5 cm long, infundibuliform. Stamens 5, unequal in length, filaments hairy at the base. Gynoecium bicarpellary, bilocular with single ovule in each locule. Capsules globose. Seeds pyriform. (Fig. 347)

Vernacular name: Kalandana.

Flowers: September-March.

Micromorphology (Fig. 348)

Whole plant was glabrous except few parts of the plants like stem, pedicels, sepals, and stamens. Trichomes were completely absent on the leaf surface whereas the trichomes on the stem, pedicels and sepals were unicellular, non-glandular, very long, acuminate thick walled with a large lumen.

Glands on the stamens were multicellular, differentiated into stalk and head. Head was of oval shaped single cell whereas stalk was multicellular and multiseriate.

Stomata were paracytic in majority but sometimes anomocytic type of stomata were also seen.

D/373.

16. *Ipomoea obscura* Ker-Gawl. in *Bot. Reg.* (1817) t. 239.

An annual twinner with purplish stems and broadly ovate leaves upto 6 cm, acuminate;; petioles upto 8 cm long. Flowers small, 1 or 2 together; bracts minute, lanceolate. Sepals-5, subequal, oblong, shortly apiculate. Corolla infundibuliform, yellow, or white with the plaits yellowish, with a small purple eye; bands usually defined by 2 prominent lines. Stamens 5; filaments filiform. Ovary 2-celled; ovules 4 (rarely 6); style filiform; stigma capitate. Capsules ovoid, subacute, glabrous. Seeds dark-brown. (Fig. 349)

Vernacular name: Vad fudardi.

Flowers: during the greater part of the year.

Micromorphology (Fig. 350)

Leaf showed presence of 3 celled, non-glandular, trichome whose upper cell was elongated pointed and thick walled, the second cell being short and almost rectangular and a similar basal cell with thin walls. A multicellular, glandular, trichome differentiated into a 4 celled head and a single celled stalk was also present.

Stomata were of anisocytic and paracytic type.

D/959, 1232.

17. *Ipomoea pes-tigridis* Linn. *Sp. Pl.* (1753) p. 162.

A hirsute twinner with leaves deeply palmatisect with 5-9 ovate lobes. Flowers sessile, 3 or more in a head on long peduncles. Outer bracts large, both inner and outer bract ovate-oblong. Sepals-5, densely hairy with long stiff hairs, the 2 outer sepals broader than the inner, ovate-lanceolate. Corolla globose. Stamens 5; filaments filiform. Ovary 2-celled; ovules 4 (rarely 6); style filiform; stigma capitate. Seeds grey-pubescent. (Fig. 351)

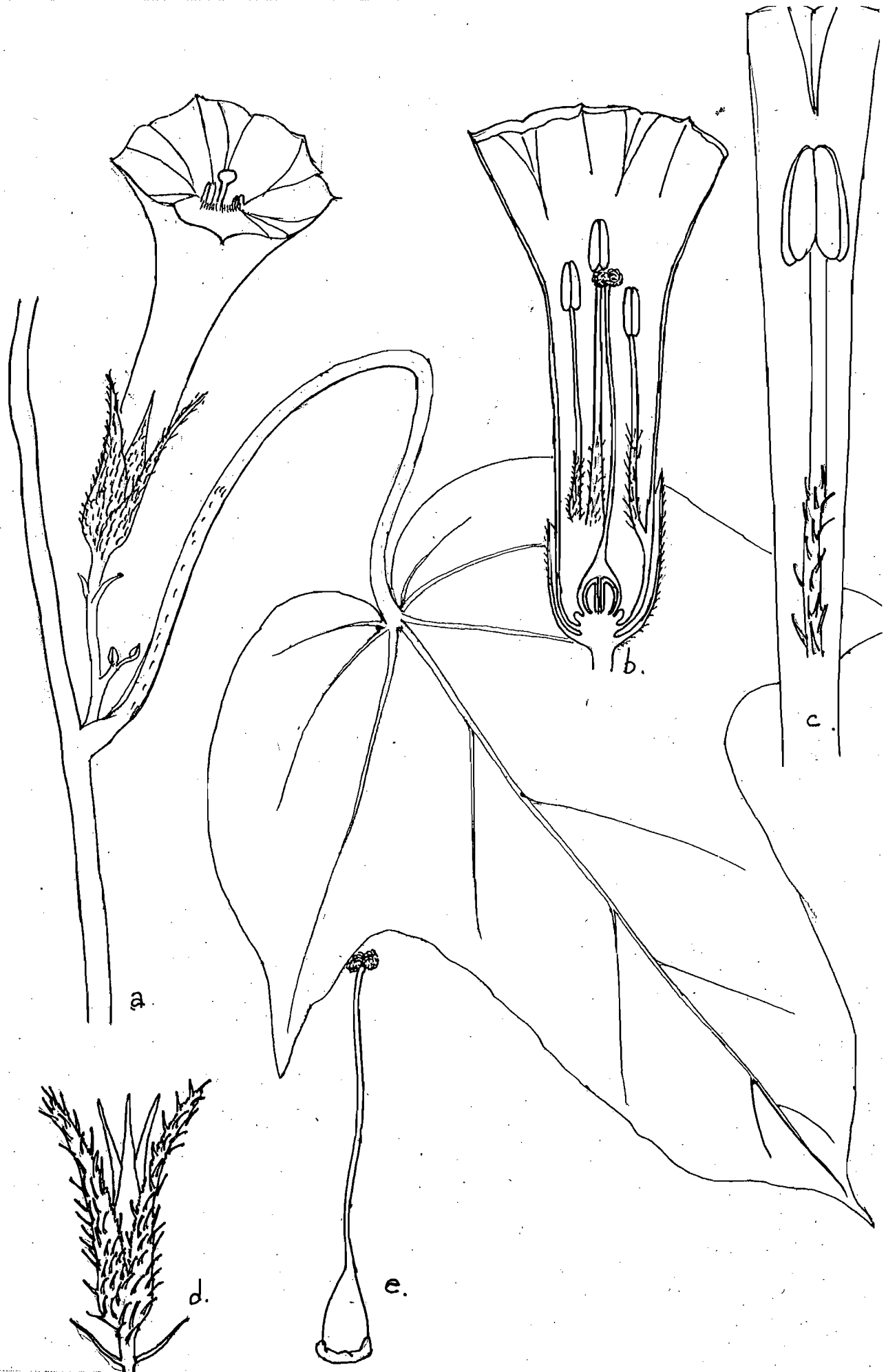


Fig. 347. *Ipomoea nil* (L.) Roth., a. habit, b. L.S. of flower, c. epipetalous stamen, d. calyx, e. gynoecium.

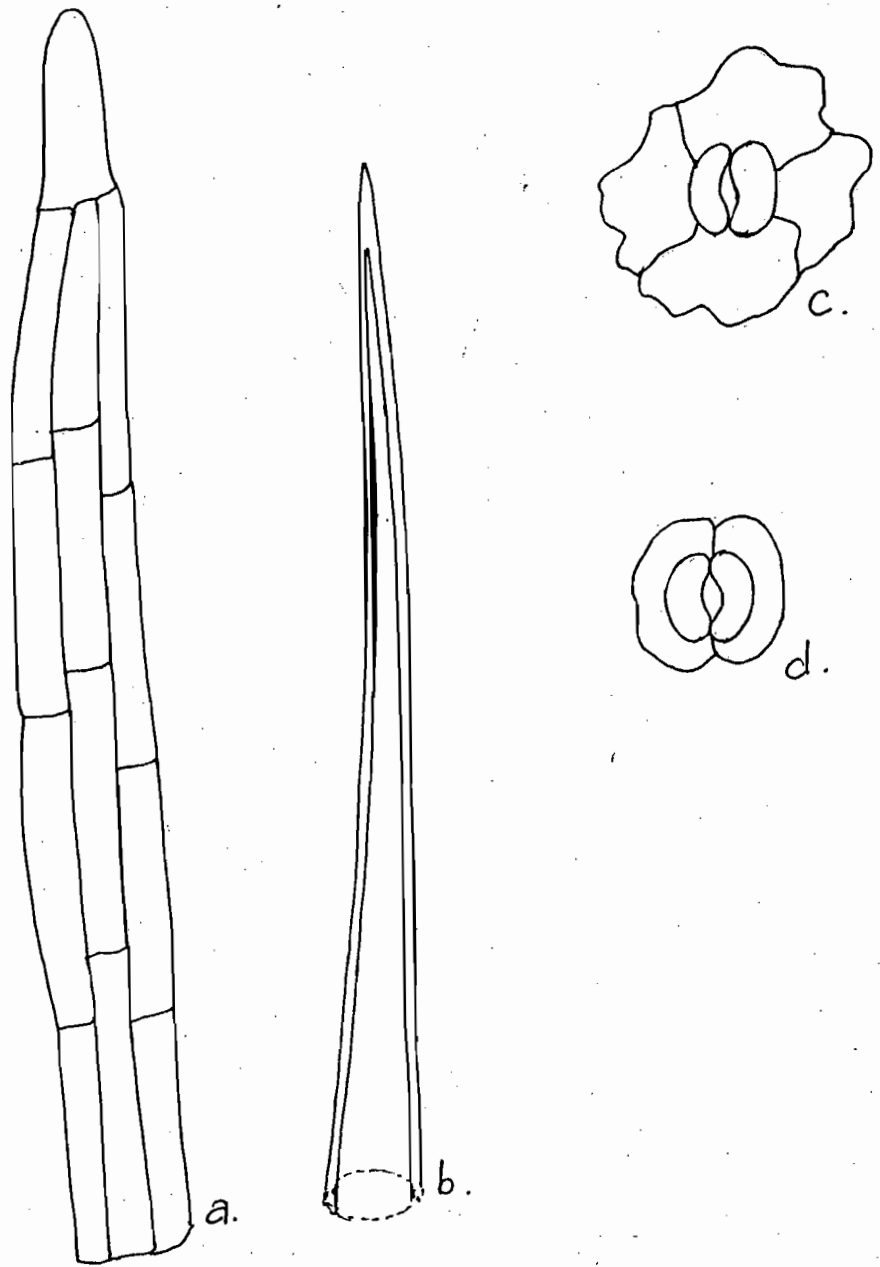


Fig. 348. *Ipomoea nil* (L.) Roth., a. gland with a single celled small head and multiseriate stalk, b. unicellular trichome, c. tetracytic stomata, d. paracytic stomata.

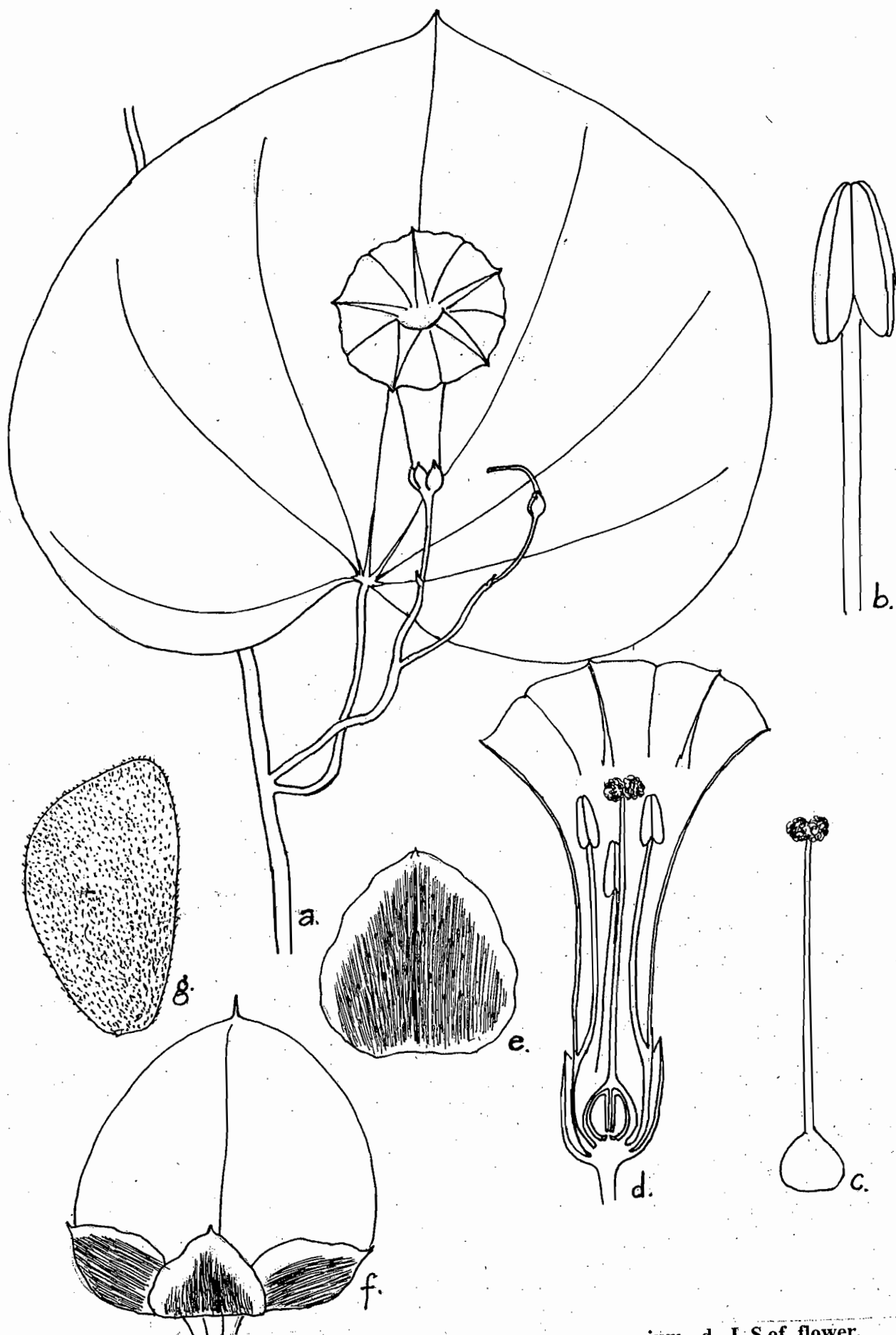


Fig. 349. *Ipomoea obscura* Ker., a. habit, b. stamen, c. gynoecium, d. L.S. of flower, e. sepal, f. capsule, g. seed.

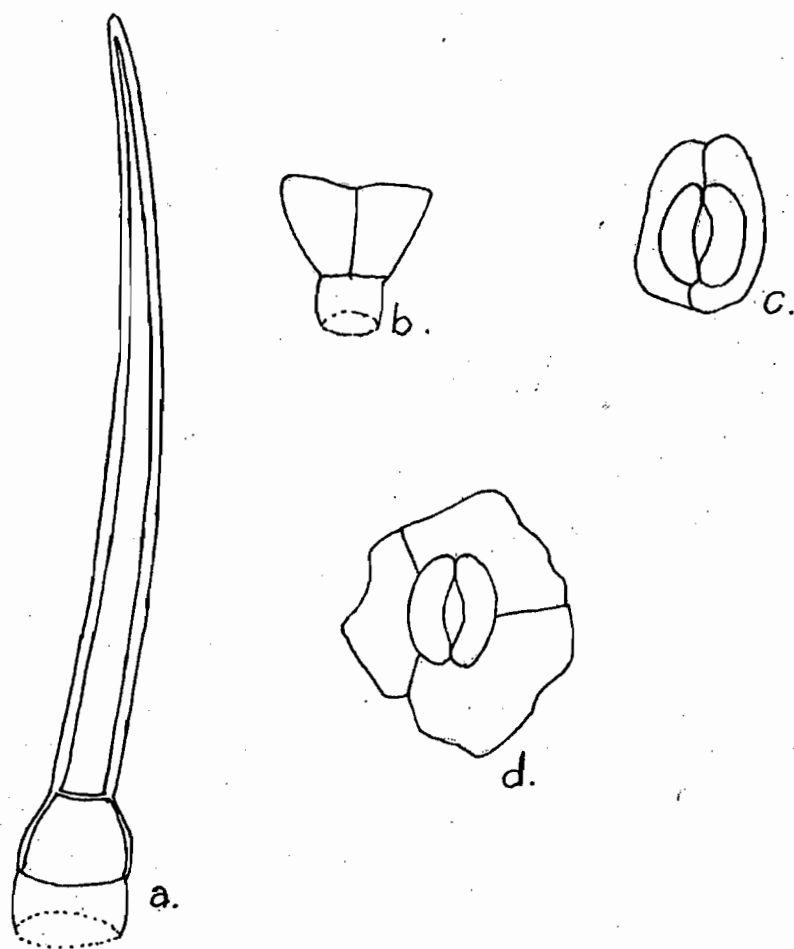


Fig. 350. *Ipomoea obscura* Ker. a. two celled uniseriate trichome with basal cell small, b. gland with two celled head a single celled stalk, c. paracytic stomata, d. anisocytic stomata.

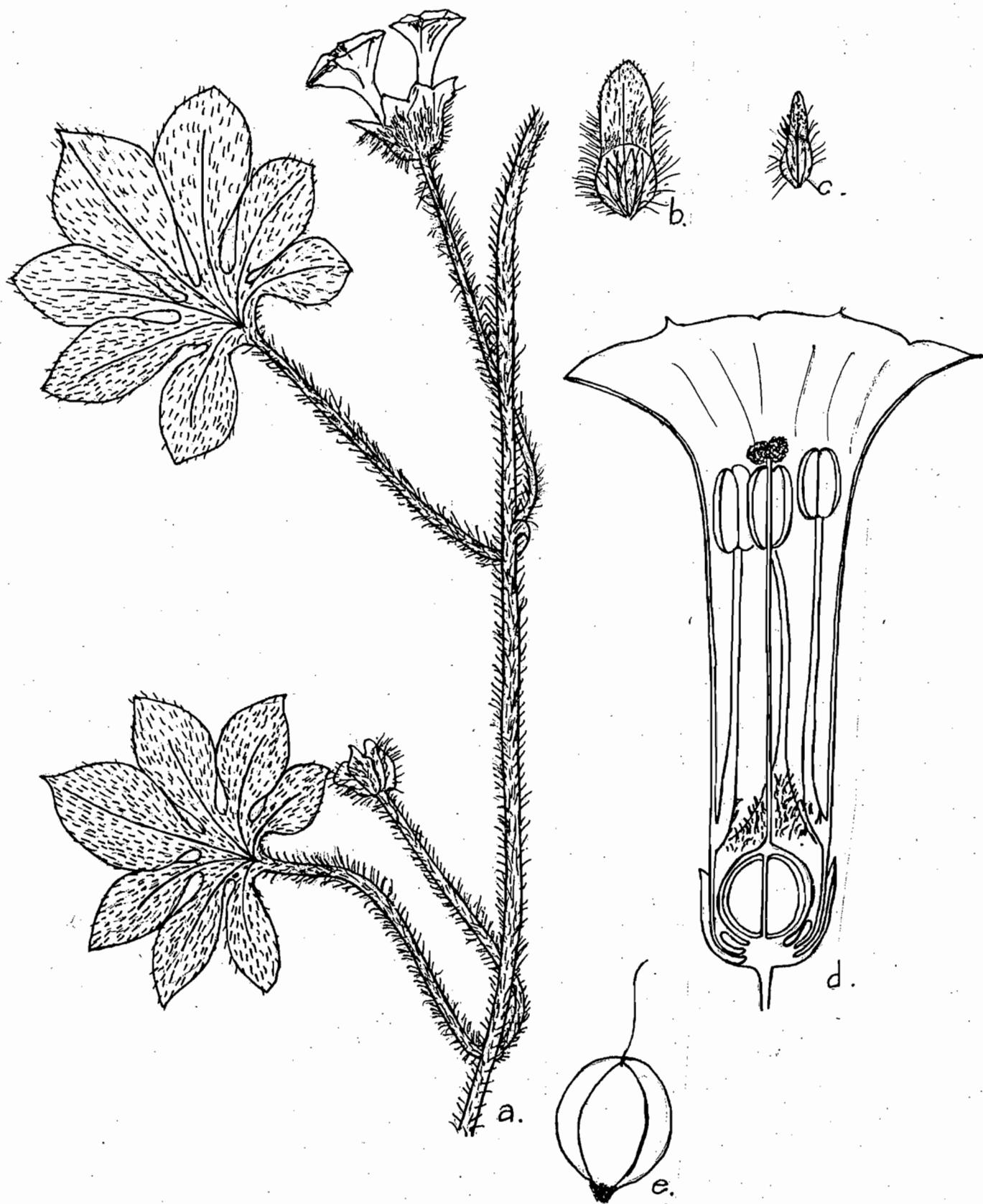


Fig. 351. *Ipomoea pes-tigridis* L., a. habit, b. bract, c. bracteole, d. L.S. of flower, e. capsule.

Vernacular name: Photial wagpadi.

Flowers: September-November.

Micromorphology (Fig. 352)

The plant showed presence of unicellular, non-glandular, elongated trichome with warty surface; along with this a small, unicellular, non-glandular, smooth walled trichome was present.

Staminal hairs were multicellular, glandular, differentiated into a single celled head containing ergastic substances and a multicellular, biseriate stalk.

Stomata were of anisocytic and paracytic type.

D/671, 1034.

18. *Ipomoea quamoclit* Linn. *Sp. Pl.* (1753) p. 160.

A herbaceous twiner upto 3 m long. Leaves ovate, finely dissected, 10cm long. Inflorescence cymose clusters of flowers on long peduncle. Bracts acuminate. Sepals 5 aristate. Corolla salverform, orange red. Stamens 5, exserted. Style 1. Ovary superior, 4-locular, 4-seeded. Placentation axile. Stigma globose tuberculate-papillose. Capsule subglobose. Seeds pyriform, glabrous. (Fig. 353)

Vernacular name: Ganesh vel.

Flowers: September-January

Micromorphology (Fig. 353)

Whole plant was glabrous except inner walls of corolla which showed multicellular, glandular trichome which had an indistinct single celled head and a multicellular, multiseriate stalk.

Stomata were of paracytic type.

D/1249-1251.

19. *Merremia dissecta* (Jacquin) H. Hallier, *Bot. Jahrb. Syst.* 16: 552. 1893.

A semi-woody twiners with woody basally, tuberculate stems. Leaves palmate divided into 5-7 lanceolate lobes. Inflorescences 1- to several flowered; peduncle 5-

10 cm. Pedicel thicker distally, minutely tuberculate, glabrous. Sepals ovate-lanceolate, subequal, 2-2.5 cm, enlarged and leathery in fruit, glabrous, margin narrowly scarious, apex acute, mucronulate. Corolla white, with purple-red throat, funnelform, midpetaline bands distinct. Anthers spirally twisted. Ovary glabrous. Capsule globose, glabrous, 2-loculed. Seeds black, glabrous. (Fig. 354)

Flowers: August-October.

Micromorphology (Fig. 354)

The leaves contained multicellular, sessile gland having radially arranged cells.

Stomata were paracytic.

D/254.

20. *Merremia emarginata* Hallier f. in Engl. *Bot. Jahrb.* V. 16 (1893) p. 552.

A creeping filiform herb rooting at the nodes. Leaves reniform or ovate-cordate, upto 3 cm broad, crenate. Flowers yellow, axillary, solitary or few together on a short peduncle;

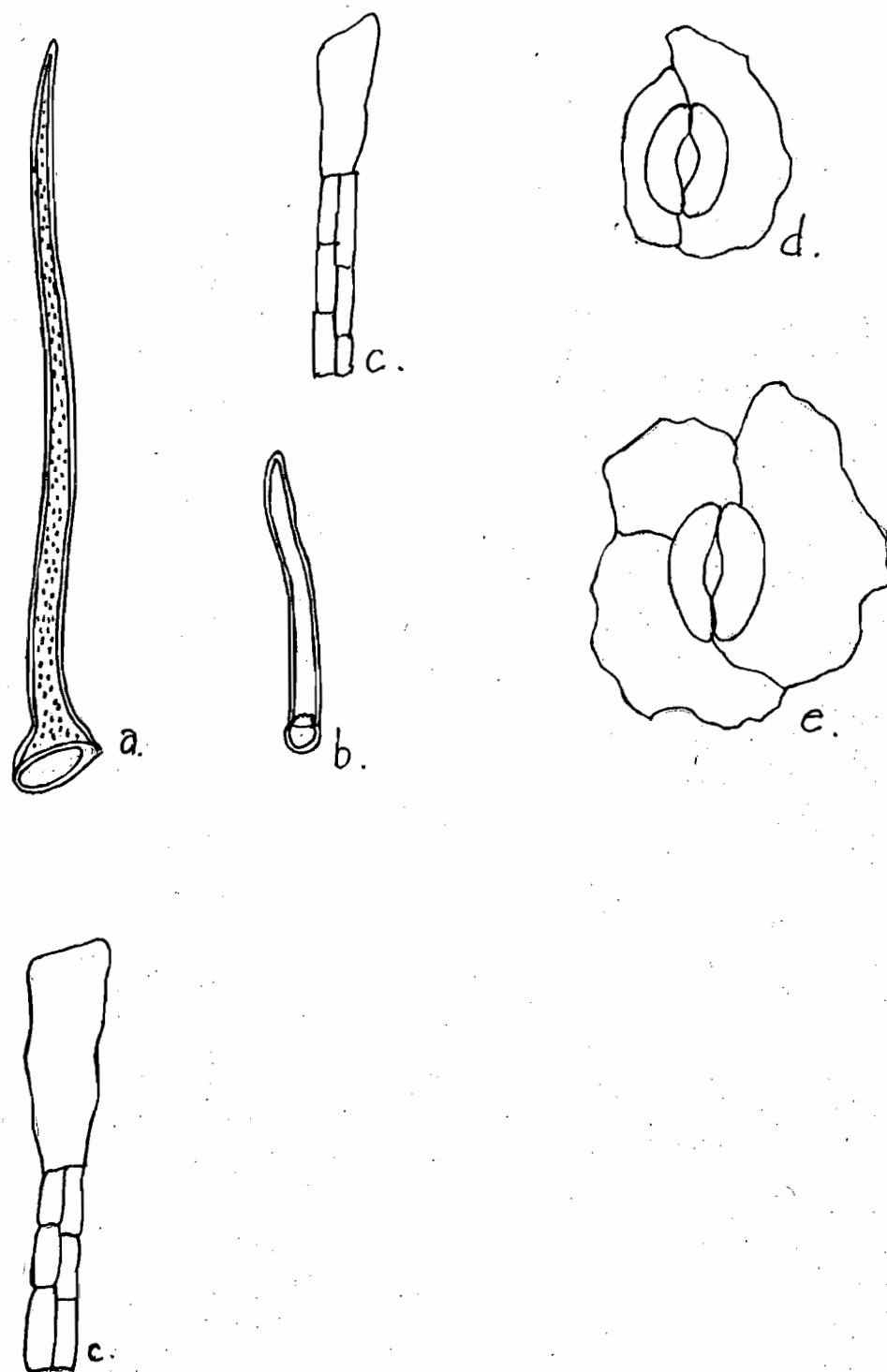


Fig. 352. *Ipomoea pes-tigridis* L., a. unicellular trichomè with thick and warty wall, b. unicellular trichome, c. gland with a single celled head and multiserial stalk, d. paracytic stomata, e. anisocytic stomata.

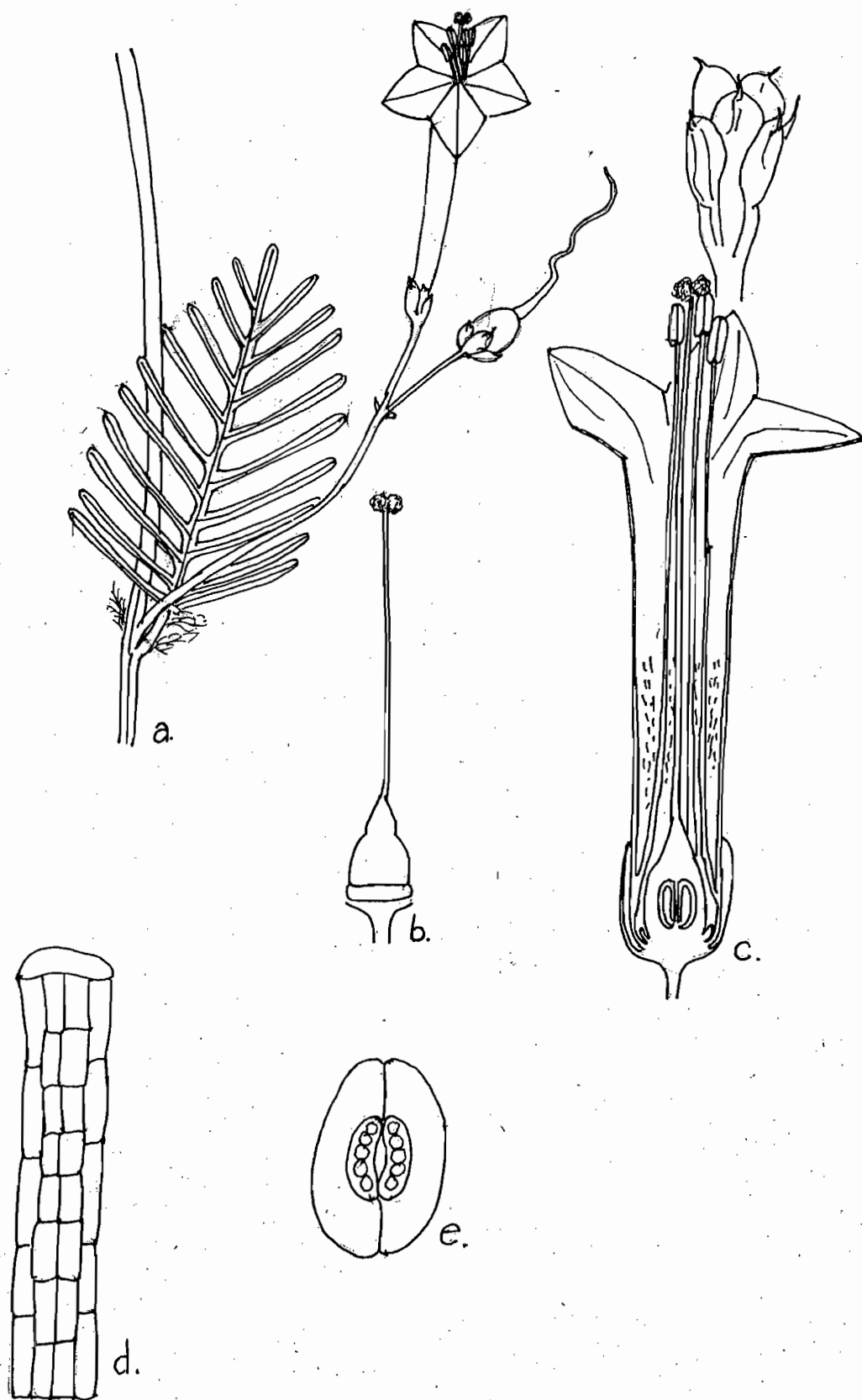


Fig. 353. *Ipomoea quamoclit* L., a. habit, b. gynoecium, c. L.S. of flower, d. gland with a single celled small head and multiseriate stalk, e. paracytic stomata.

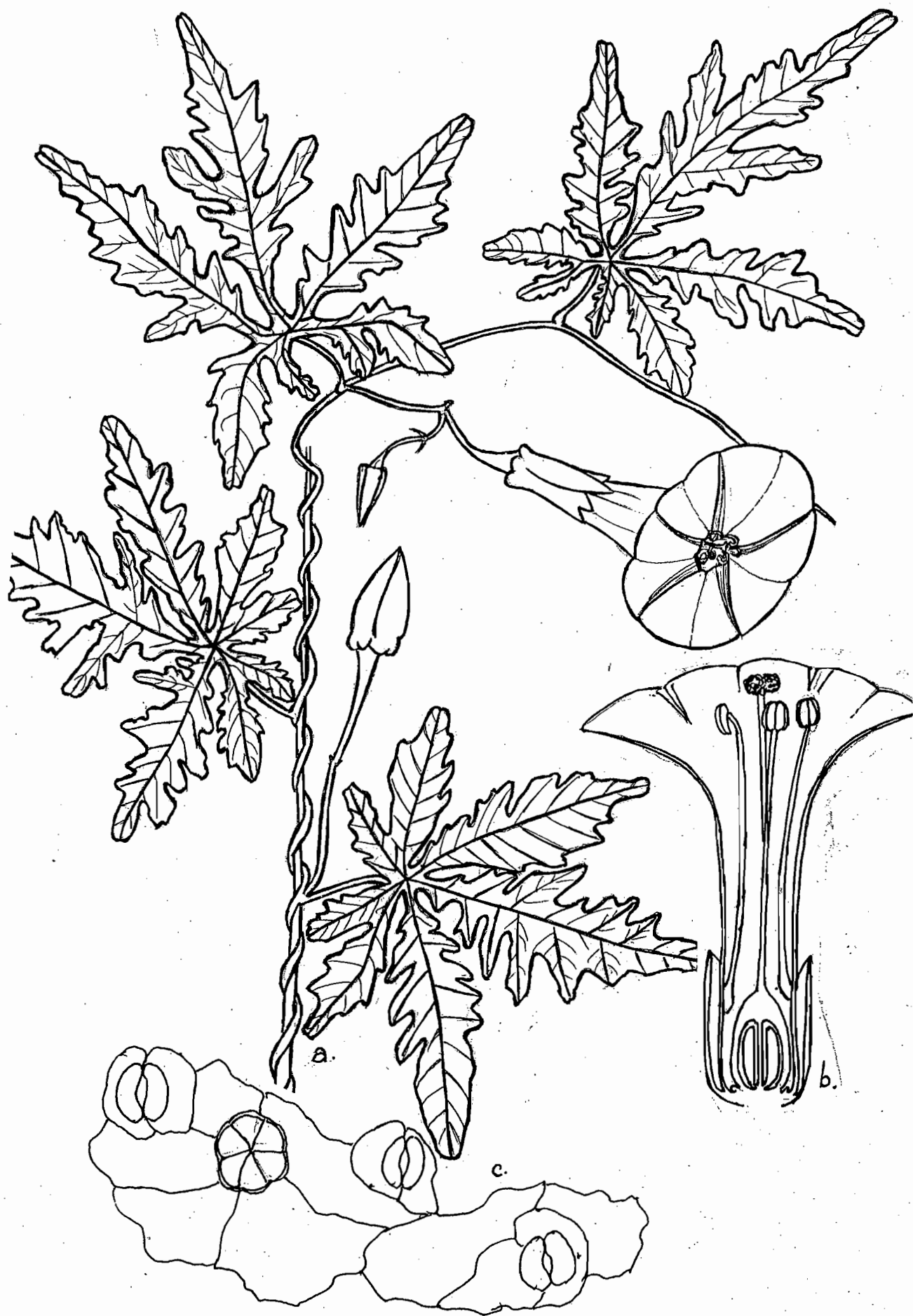


Fig. 354 *Merremia dissecta* Hall., a. habit, b. L.S. of flower, c. paracytic stomata and sessile multicellular gland.

bracts small, ovate. Sepals 5, 2 outer ovate, mucronate, the 3 inner with 2 truncate divaricate lobes. Corolla campanulate lined with 5 dark violet lines. Stamens 5, anthers twisted. Ovary 4 celled; ovules 4; style filiform; stigma 2-globose. Capsules subglobose. Seeds glabrous, dark chestnut-colored. (Fig. 355)

Vernacular name: Undari.

Flowers: September-October.

Micromorphology (Fig. 355)

Unicellular acicular trichomes were present.

Stomata were paracytic.

D/667.

21. *Merremia hederacea* (Burm. f.) Hallier f., *Bot. Jahrb. Syst.* 18(1-2): 118. 1893.

A twinner or prostrate with often tuberculated stem, sometimes rooting at the nodes. Leaves ovate, shallowly to deeply 3-lobed, upto 5 cm long, mucronulate. Flowers solitary or several in lax inflorescences. Sepals obovate to spatulate, dissimilar, notched at the mucronulate apex. Corolla yellow or white, campanulate. Capsule globose or conic, somewhat 4-angled. (Fig. 356)

Flowers: September-October.

Micromorphology (Fig. 356)

Leaf showed presence of two celled, filamentous, non-glandular trichome; the upper cell was conical, elongated with pointed tip and the basal cell was swollen and short. Along with the above mentioned trichome, leaf also showed presence of multicellular, glandular, and differentiated into multicellular head in which the cells are radially arranged and a single celled stalk.

Staminal hairs were multicellular, glandular, distinctly differentiated into a triangular single celled head with lot of ergastic substances, and multicellular, multiseriate stalk.

Stomata were of paracytic type.

D/1128.

22. *Merremia tridentata* Hallier f. in Engl. *Bot. Jahrb.* V. 16 (1893) p. 552.

A perennial herb with a small woody rootstock and elongate, prostrate stems. Leaves linear-hastate, upto 3 cm long, often deeply emarginated and 3-toothed at the apex, dilated at the base into toothed auricles. Flowers axillary, solitary, with lanceolate bracts. Sepals 5, strongly mucronate. Corolla pale-yellow, campanulate. Stamens 5; anthers usually twisted. Ovary 4 celled; ovules 4. Capsules globose. Seeds trigonous. (Fig. 357)

Vernacular name: Bhinigario.

Flowers: August- October.

Micromorphology (Fig. 357)

The leaves contained multicellular, sessile gland having radially arranged cells.

Stomata were paracytic.

D/242.

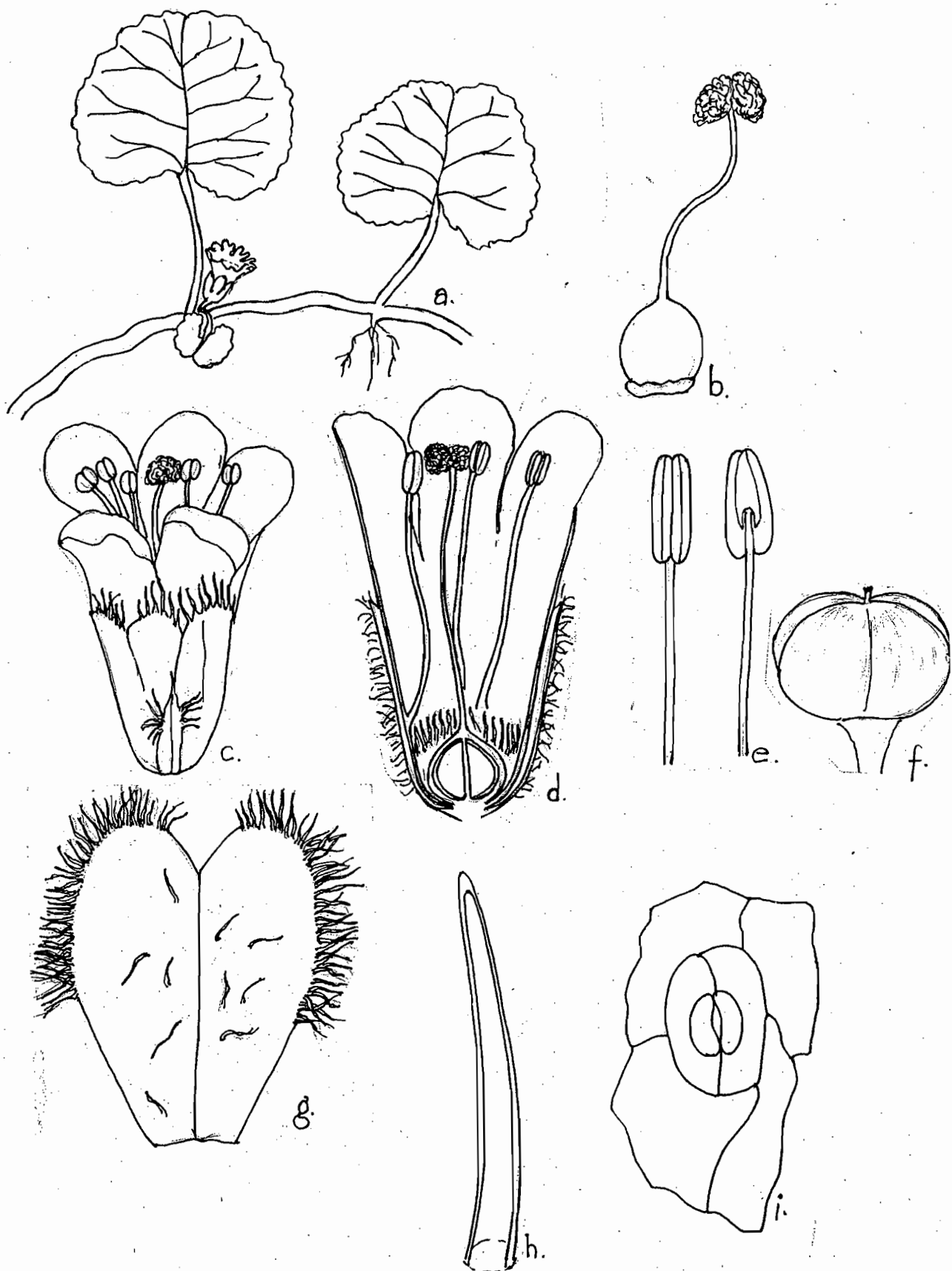


Fig 355 *Merremia emarginata* Hall., a. habit, b. gynoecium, c. flower, d. L.S. of flower, e. stamen, f. capsule, g. sepal, h. unicellular trichome, i. paracytic stomata.

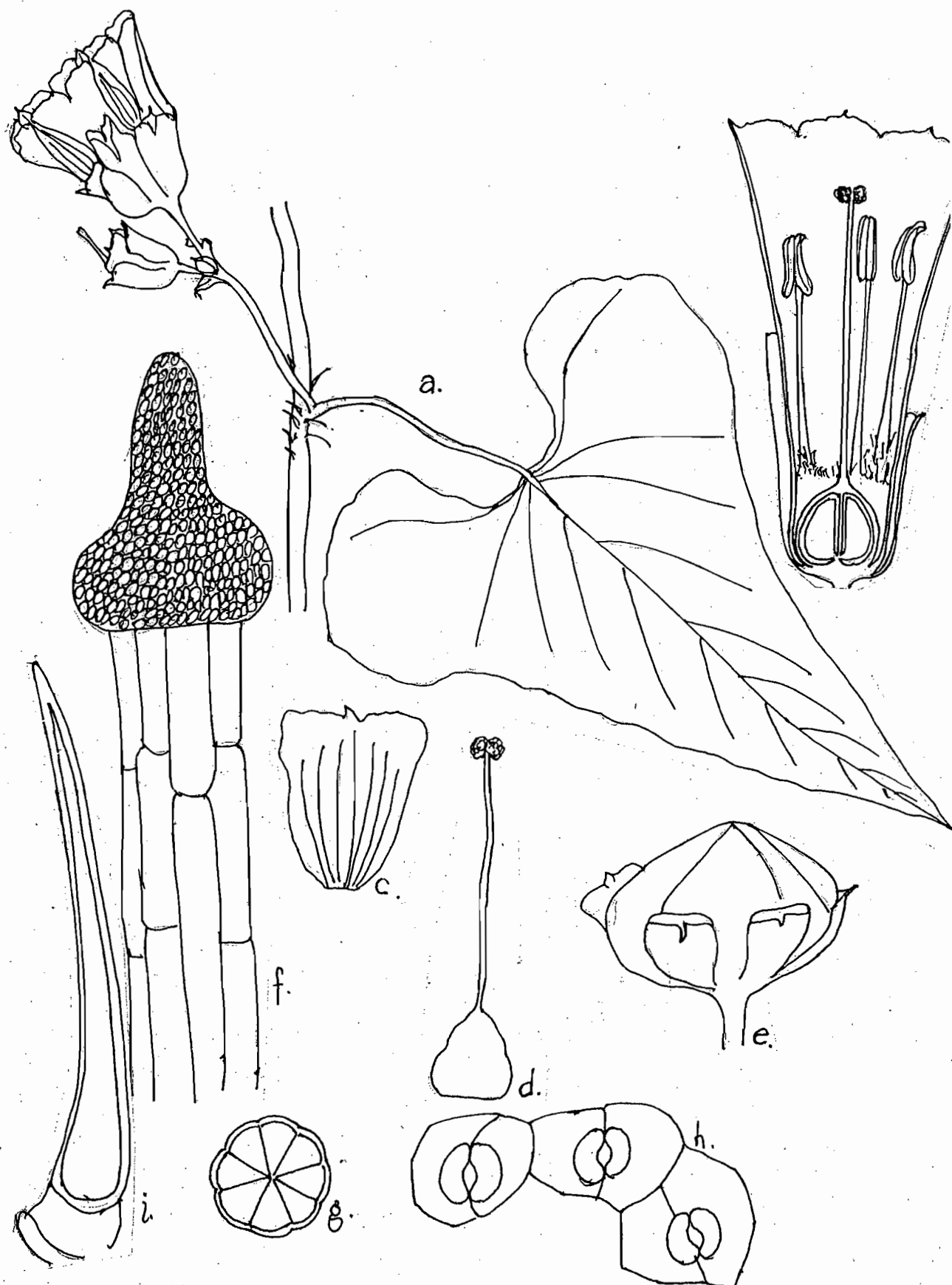


Fig. 356. *Merremia hederacea* (Burm. f.) Hall. f., a. habit, b. L.S. of flower, c. sepal, d. gynoecium, e. capsule, f. gland with a single celled head and multiseriate stalk, g. sessile multicellular gland, h. paracytic stomata, i. two celled trihcome.

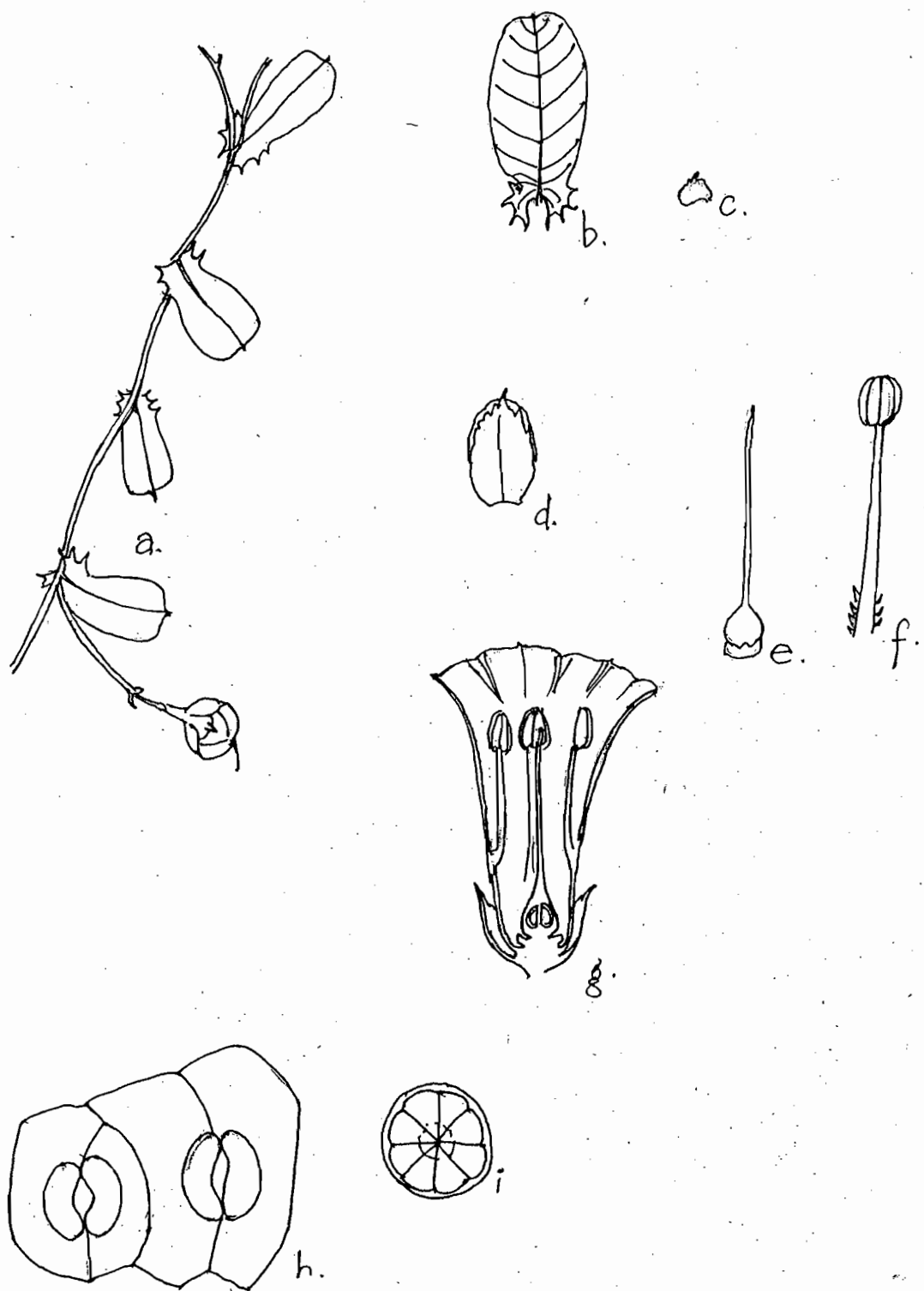


Fig. 357. *Merremia tridentata* Hall. f., a. habit, b. leaf, c. bract, d. sepal, e. gynoecium, f. stamen, g. L.S. of flower, h. paracytic stomata, i. glandular multicellular sessile trichome.

Solanaceae

1. *Datura stramonium* L., *Sp. Pl.* (1753) p. 179.

A shrub of 1 m in height with purplish stems and large broadly ovate leaves reaching upto 17 cm, ovate, sinuately dentate. Flowers in axillary or terminal cymes. Calyx 5.5 cm long, tubular; lobes 5, dentate. Corolla infundibuliform, white or purplish suffused, upto 10 cm long, shallowly 5-lobed. Anthers long, oblong, white. Ovary 2-celled; with many ovules on swollen placenta. Capsule ovoid, spiny and splitting by 4 valves. Seeds reniform, black. (Fig. 358)

Vernacular name: Dhaturo.

Flowers: June-July.

Micromorphology (Fig. 358)

Multicellular uniseriate smooth trichomes were seen on the leaves.

Stomata were of anomocytic and diacytic types.

D/202.

2. *Nicotiana tabacum* L., *Sp. Pl.* 180. 1753.

A branched viscid-pubescent undershrub up to 1 m tall. Leaves cauline, broadly elliptic-ovate, upto 40 cm long. Flowers pink, in axillary and terminal compact corymboid panicles. Calyx oblong; lobes unequal. Corolla tube upto 4.6 cm long; limb up to 15 cm broad, lobes apiculate. Anthers oblong. Ovary 2-celled. Capsule oblong-ovoid. Seeds angled, minutely ruminate, brown. (Fig. 359)

Vernacular name: Tambaku.

Flowers: April-May.

Micromorphology (Fig. 360)

Leaf contained two types of glandular trichomes; 1) two celled 2) many celled having a two celled head and three celled elongated stalk.

Bract and calyx contain glandular trichomes with 3-4 celled stalk and 4-5 celled head containing a lot of ergastic substances.

Corolla contained glandular trichomes having 1 single celled head, and 3-4 celled elongated stalk; and 2-4 celled head with a similar stalk.

Stomata were of anomocytic type.

D/145.

3. *Physalis minima* Linn. *Sp. Pl.* (1753) p. 183.

An annual herb with dichotomous branches and stem reaching to a height of 30 cm. Leaves ovate, upto 6 cm long, shallowly toothed or lobed. Flowers solitary. Calyx teeth triangular. Corolla yellow; lobes of limb short. Filaments glabrous. Anthers oblong, clustered around the stigma. Ovary ovoid, seated on a large disk. Berry ovoid or subglobose, entirely enveloped in the enlarged membranous 5-ribbed calyx. Seeds discoid or subreniform. (Fig. 361)

Variation observed: in flora the filaments are said to be glabrous, but my specimen had hairy filaments.

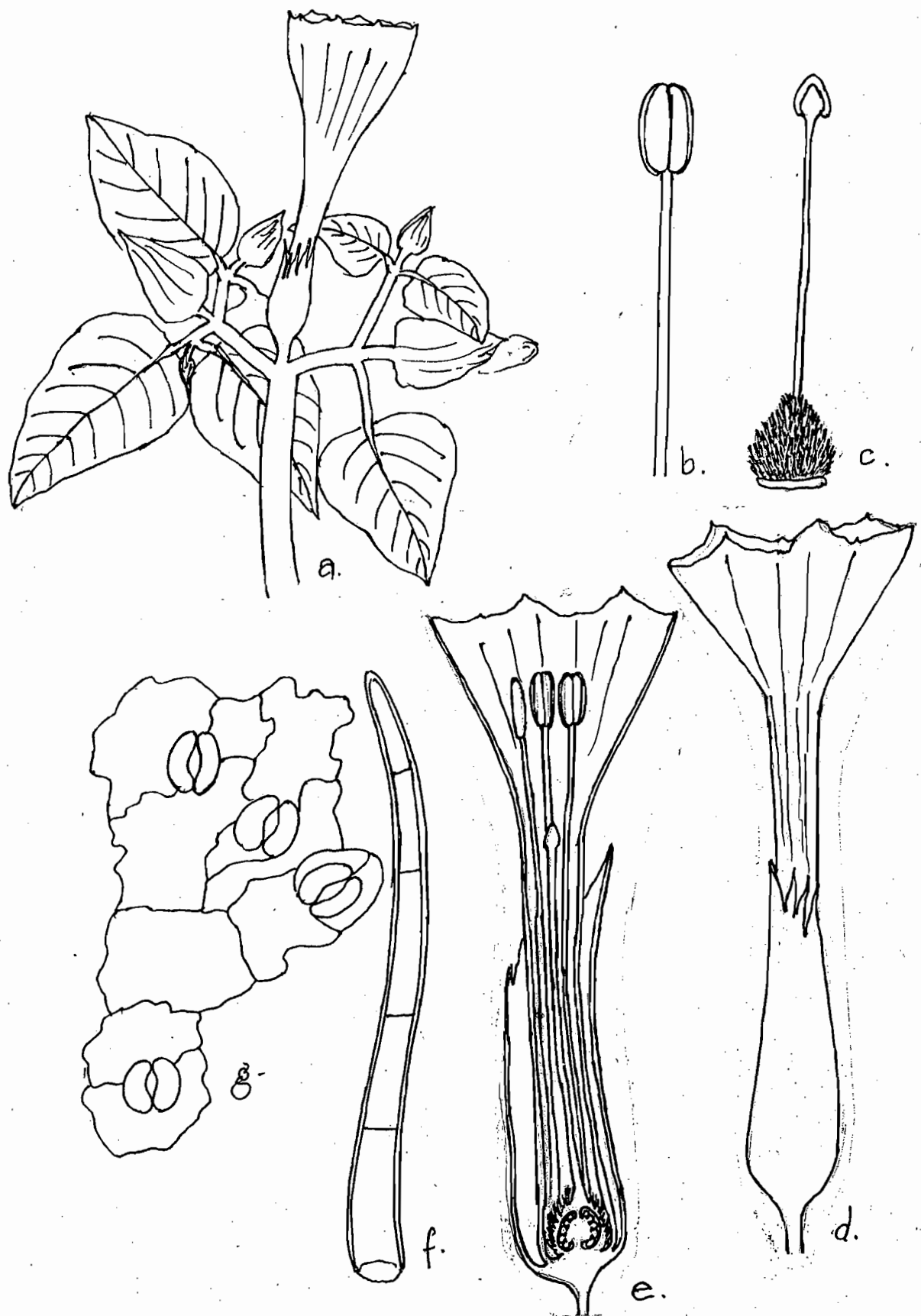


Fig. 358. *Datura stramonium* L., a. habit, b. stamen, c. gynoecium, d. flower, e. L.S. of flower, f. uniseriate trichome, g. anomocytic and diacytic stomata.

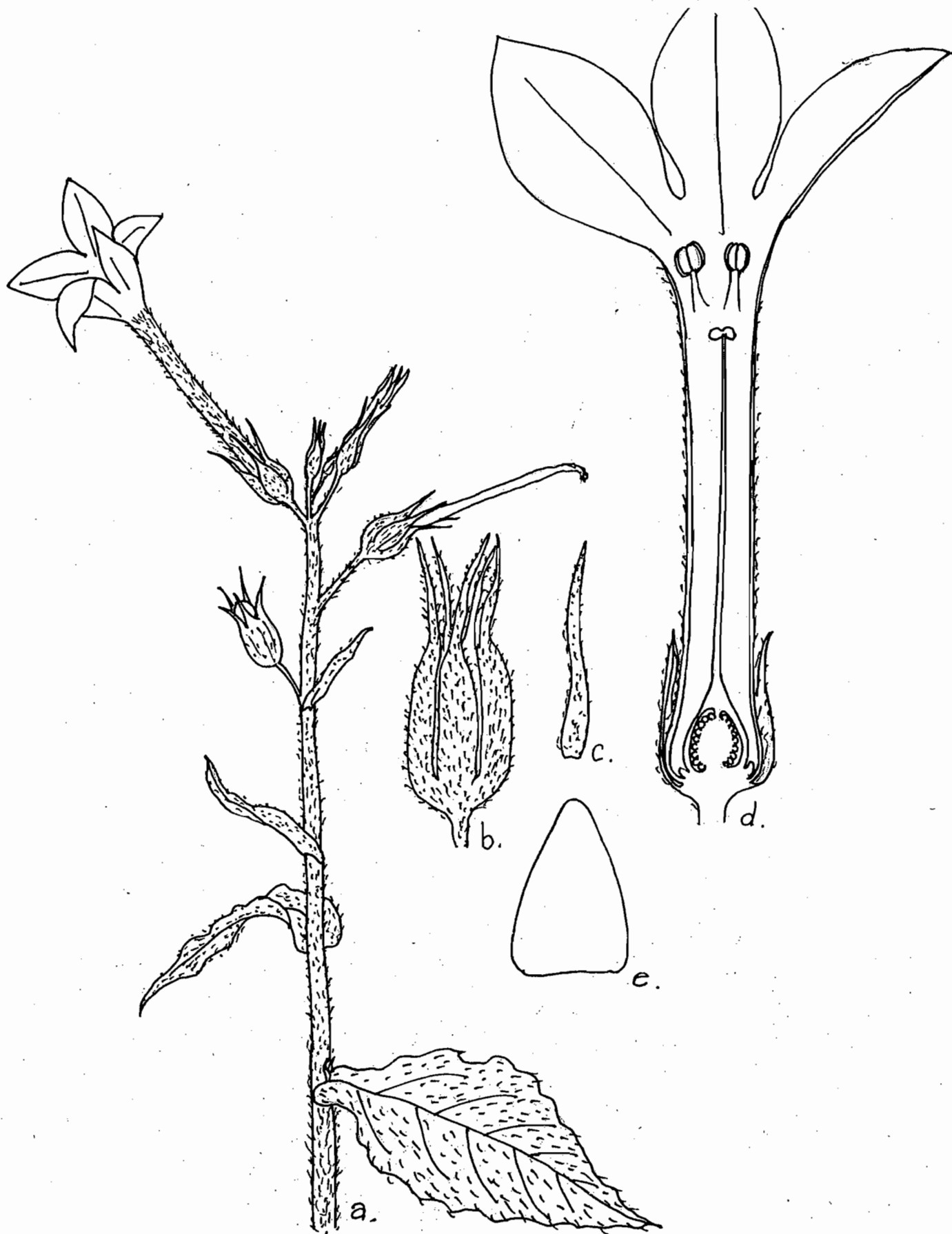


Fig. 359. *Nicotiana tabacum* L., a. habit, b. calyx with capsule, c. bract, d. L.S. of flower, e. capsule.

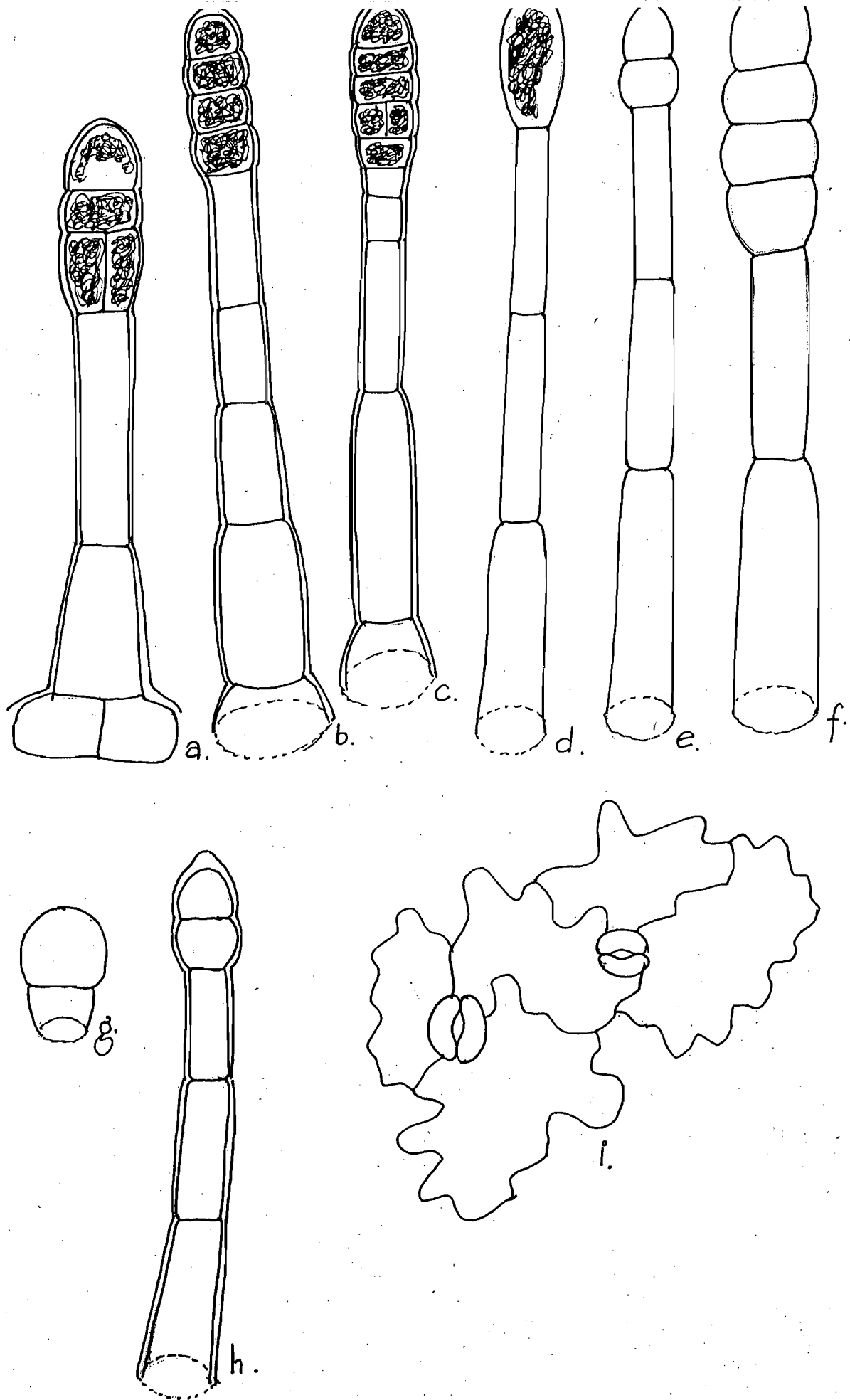


Fig. 360 *Nicotiana tabacum* L., a-h. glands with multicellular head (single celled to many celled head) and multicellular uniseriate as well as single celled stalk in some trichomes. i. anomocytic stomata.

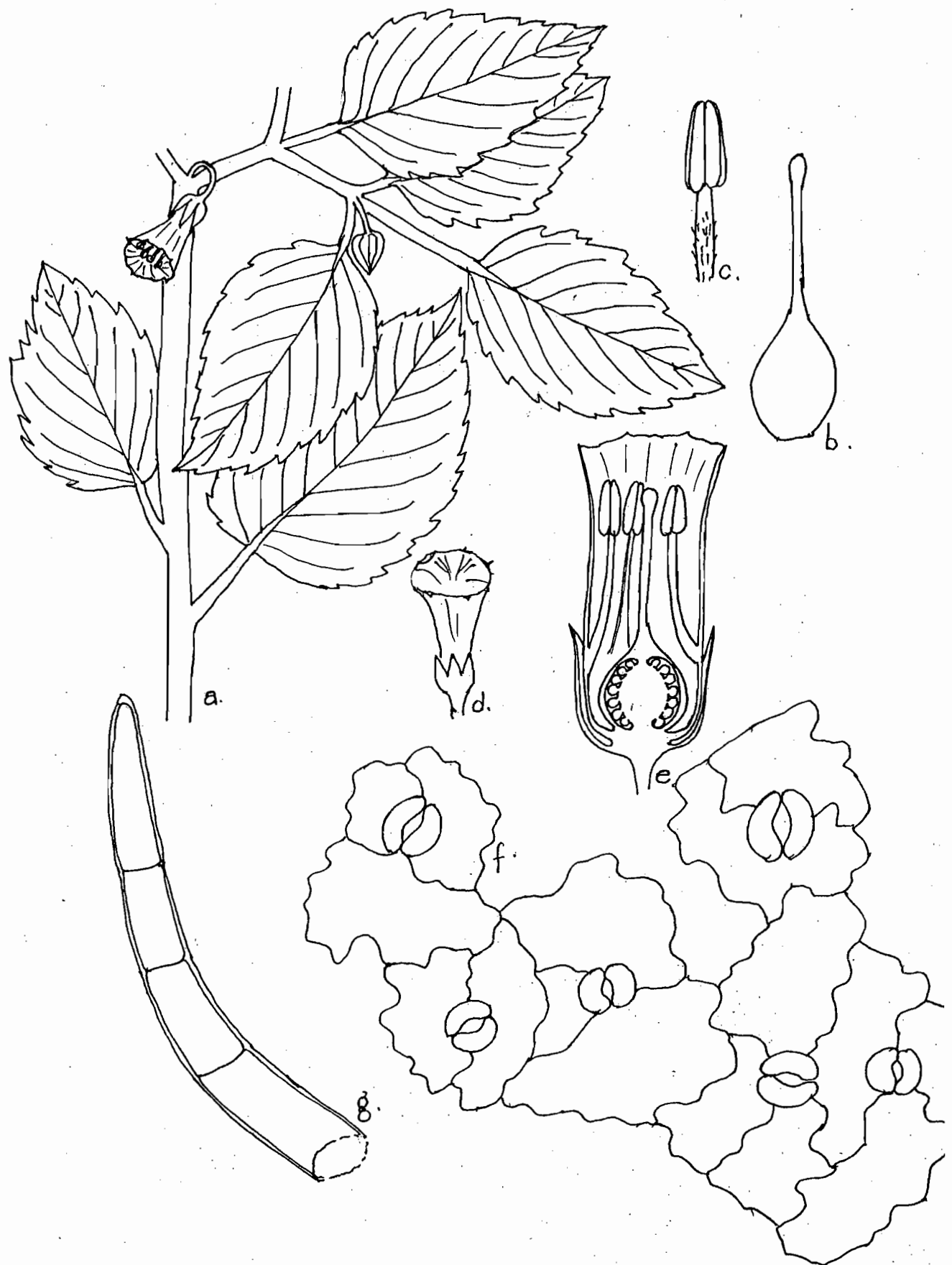


Fig. 361 *Physalis minima* L., a. habit, b. gynoecium, c. stamen, d. flower, e. L.S. of flower, f. anisocytic, diacytic and anomocytic stomata, g. uniseriate trichome.

Vernacular name: Popati.

Flowers: August-October.

Micromorphology (Fig. 361)

The plant showed presence of multicellular, uniseriate, non-glandular trichome. The cells of the trichome were broad at the base and continuously narrowing to the top, and all the cells were thin walled.

Stomata were of anomocytic, anisocytic and diacytic types.

D/311.

4. *Solanum americanum* Miller. Gard. Dict. ed. 8: 5. 1768.

(*Solanum nigrum* L.)

A divaricately branched annual with ovate-lanceolate, sinuate-toothed leaves, upto 9 cm long and tapering into the petiole. 2 cm long, slender; pedicels upto 1 cm long, very slender. Flowers extra axillary in cymes. Calyx 5-lobed, oblong, hairy and enlarged in fruit. Corolla white divided into 5 oblong subacute lobes. Stamens 5 connate into a short cone around the stigma; anthers yellow, oblong, filaments glabrous. Ovary globose, 2-celled. Berry small, purplish-black, but sometimes red or yellow. Seeds discoid. (Fig. 362)

Variations observed: In standard description of this plant, calyx is said to be glabrous and not enlarged in fruit, filaments are hairy but in my specimen calyx was found to be hairy and enlarged in fruit. Filaments were glabrous.

Vernacular name: Kamperu.

Flowers: September-January.

Micromorphology (Fig. 362)

Whole plant was glabrous.

The stomata were of anomocytic type.

D/372.

5. *Solanum virginianum* L. Sp. Pl. 187, 1753

(*Solanum xanthocarpum* Schrad. & Wendl.)

A very prickly diffuse bright-green perennial herb completely covered with long narrow, straight, yellow prickles often exceeding 1.5 cm long. Leaves ovate or elliptic, upto 10 cm, sinuate or subpinnatifid, stellately hairy on both sides, armed on the midrib with long yellow sharp prickles. Flowers in extra-axillary few-flowered cymes. Calyx 5-10 lobed, nearly 1.5 cm long, densely hairy and prickly; tube short; lobes linear-lanceolate, prickly outside. Corolla rotate, purple, 2 cm long; lobes deltoid, acute, hairy outside. Anthers oblong-lanceolate, opening by small pores. Ovary ovoid, 2-celled. Berry upto 2 cm in diameter, yellow, or white with green veins, surrounded by the enlarged calyx. Seeds numerous. (Fig. 363)

Vernacular name: Bhoringi.

Flowers: Throughout the year but less during the monsoon.

Micromorphology (Fig. 363)

The plant showed presence of stellate hairs with 4-5 thick walled arms.

Stomata were anisocytic and diacytic. D/209.

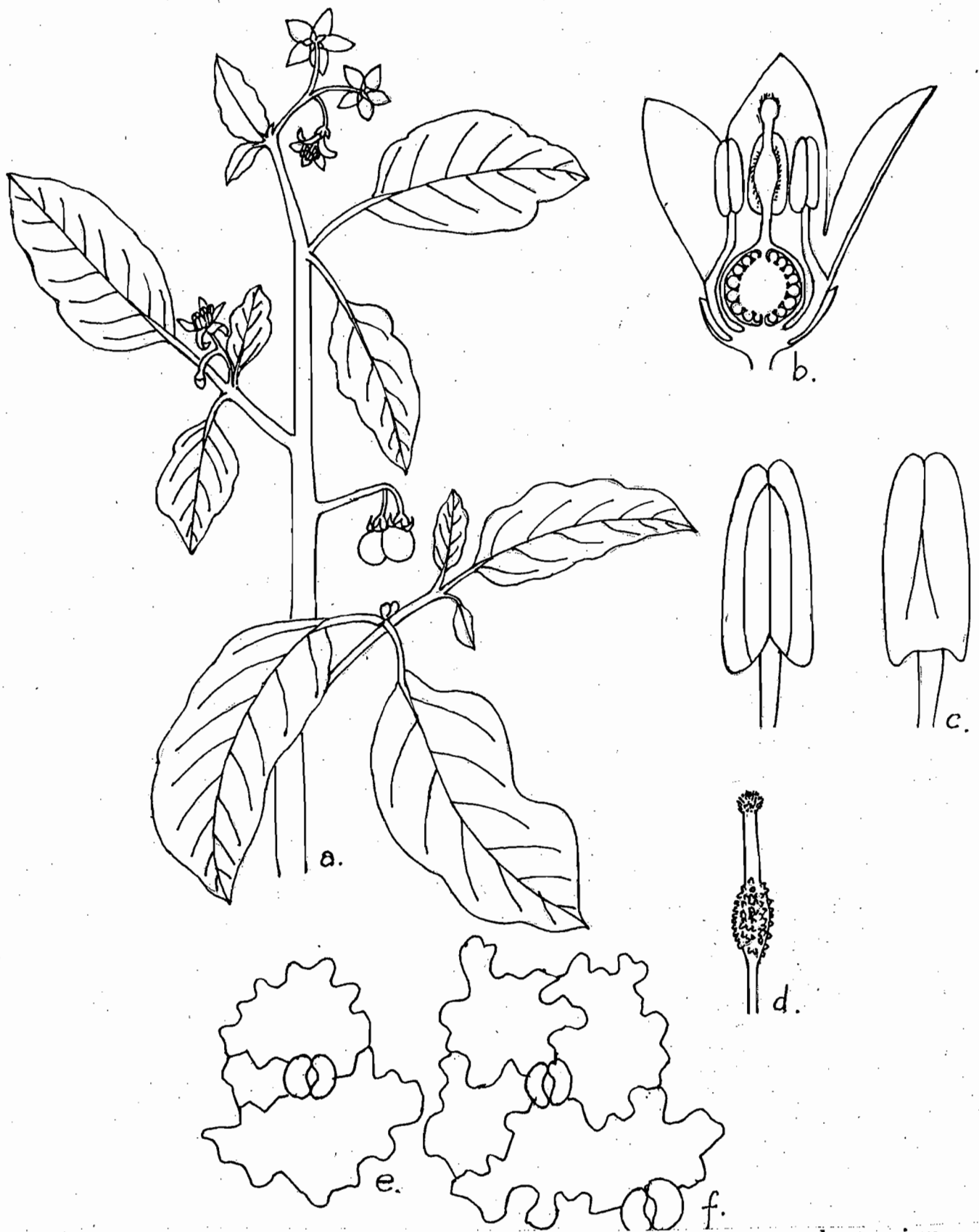


Fig. 362 *Solanum americanum* Miller., a. habit, b. L.S. of flower, c. stamen, d. gynoecium, e. anisocytic stomata, f. anomocytic stomata.

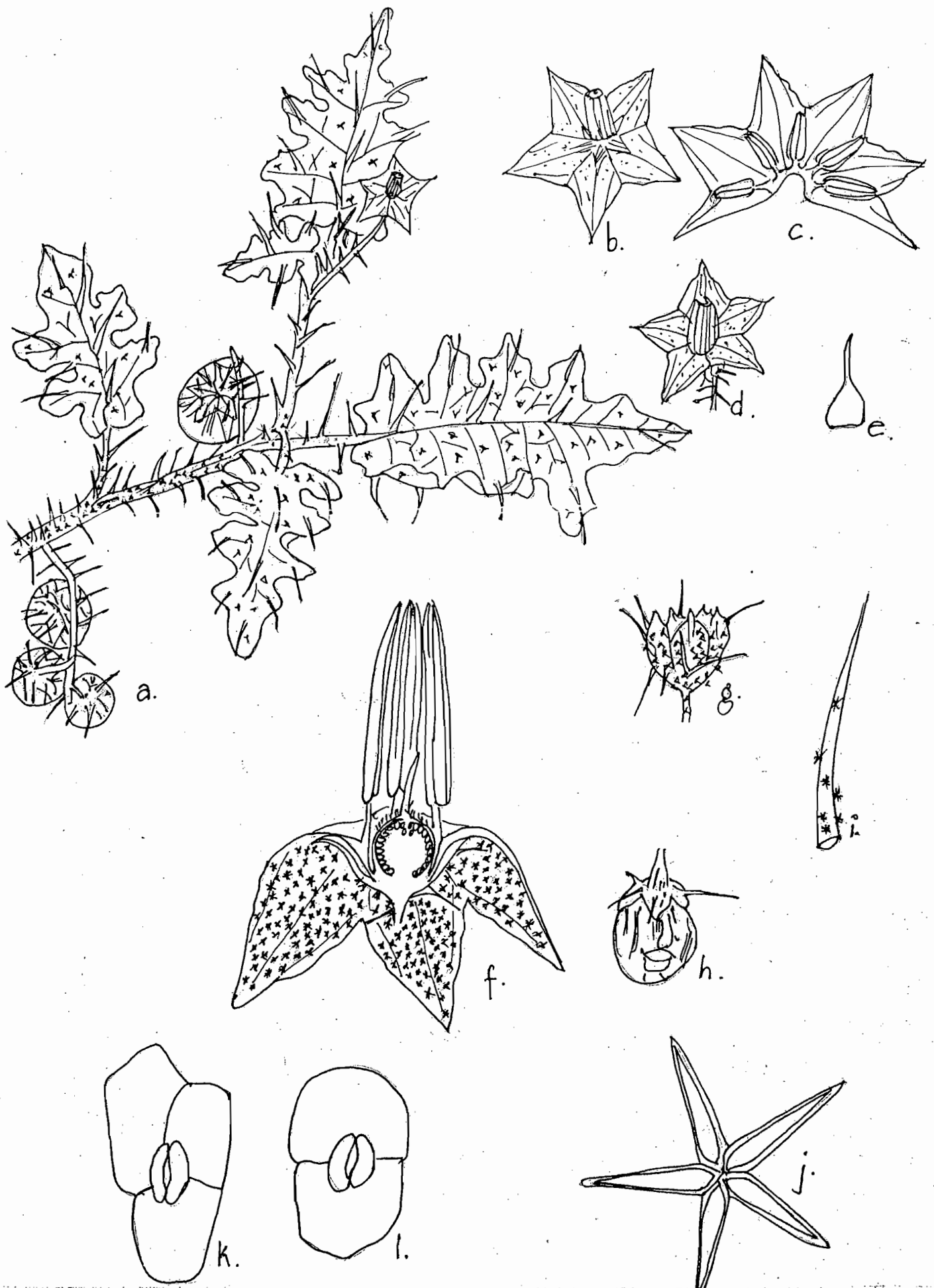


Fig. 363 *Solanum virginianum* L., a. habit, b. flower, c. epipetalous stamen, d. flower, e. gynoecium, f. L.S. of flower, g. calyx, h. fruit, i. spine, j. stellate hair with 5-arms, k. anisocytic stomata, l. diacytic stomata.

6. *Withania somnifera* Dunal. in *DC. Prodr.* V. 13, part 1 (1852) p. 453.

A branched erect undershrub upto 2 m high clothed with mealy stellate hoary tomentum. Leaves ovate, 4 cm long. Flowers small, greenish, about 5 together in sessile umbellate cyme. Calyx teeth long, linear. Corolla lobes lanceolate. Anthers broadly elliptic. Ovary 2-celled. Berry red, slightly 5-angled, pointed with the connivent calyx-teeth and scurfy-pubescent outside. Seeds yellow. (Fig. 364)

Vernacular name: Ashwagandha.

Flowers: Throughout the year.

Micromorphology (Fig. 364)

The plant showed presence of dendritic trichomes.

Stomata were of anomocytic type.

D/1072.

Scrophulariaceae

1. *Bacopa monnieri* (L.) Wettst. *Nat. Pflanzenfam.* 4(3b): 77. 1891.

A glabrous succulent branched creeping herb reaching a length of 30 cm. Leaves spatulate, sessile, upto 2.5 cm long. Flowers axillary, solitary; bracteoles linear. Calyx lobes unequal. Corolla pale-blue; lobes nearly equal, rounded. Stamens didynamous, included; anthers bluish-purple. Ovary 2-celled; ovules many in each cell; style dilated at the top; stigma 2-lobed. Capsules ovoid, acute, pointed with the stylebase. Seeds oblong, striate, pale. (Fig. 365)

Vernacular name: Jal nevri.

Flowers: January-May.

Micromorphology (Fig. 365)

The leaf possessed 6-7 celled glandular trichomes which were sessile and cells were radiating from the head.

Stomata were of anomocytic, anisocytic and diacytic type.

D/302.

2. *Elatinoides ramosissima* (Wall.) Wettst. *Pfam.* 4(3b): 58, 1891.

(*Kickxia ramosissima* (Wall.) Janchan)

A slender, much branched herb hanging down from the walls. Leaves ovate to triangular, hastate. Flowers yellow, solitary, axillary, spurred. Calyx 5-lobed, lobes subequal. Petals 5, 2-lipped, lower lip with a spur. Stamens 4, didynamous, anthers divaricate. Ovary subglobose, stigma minute. Capsules globose, pale brown; seeds echinulate. (Fig. 366)

Occurs in the cracks and crevices of the walls of old dilapidated buildings of Machhi area of Pavagadh, along with its frequent associate, *Lindenbergia indica* Kuntze; not common.

Vernacular name: Bhini ghilodi.

Flowers: November-February.

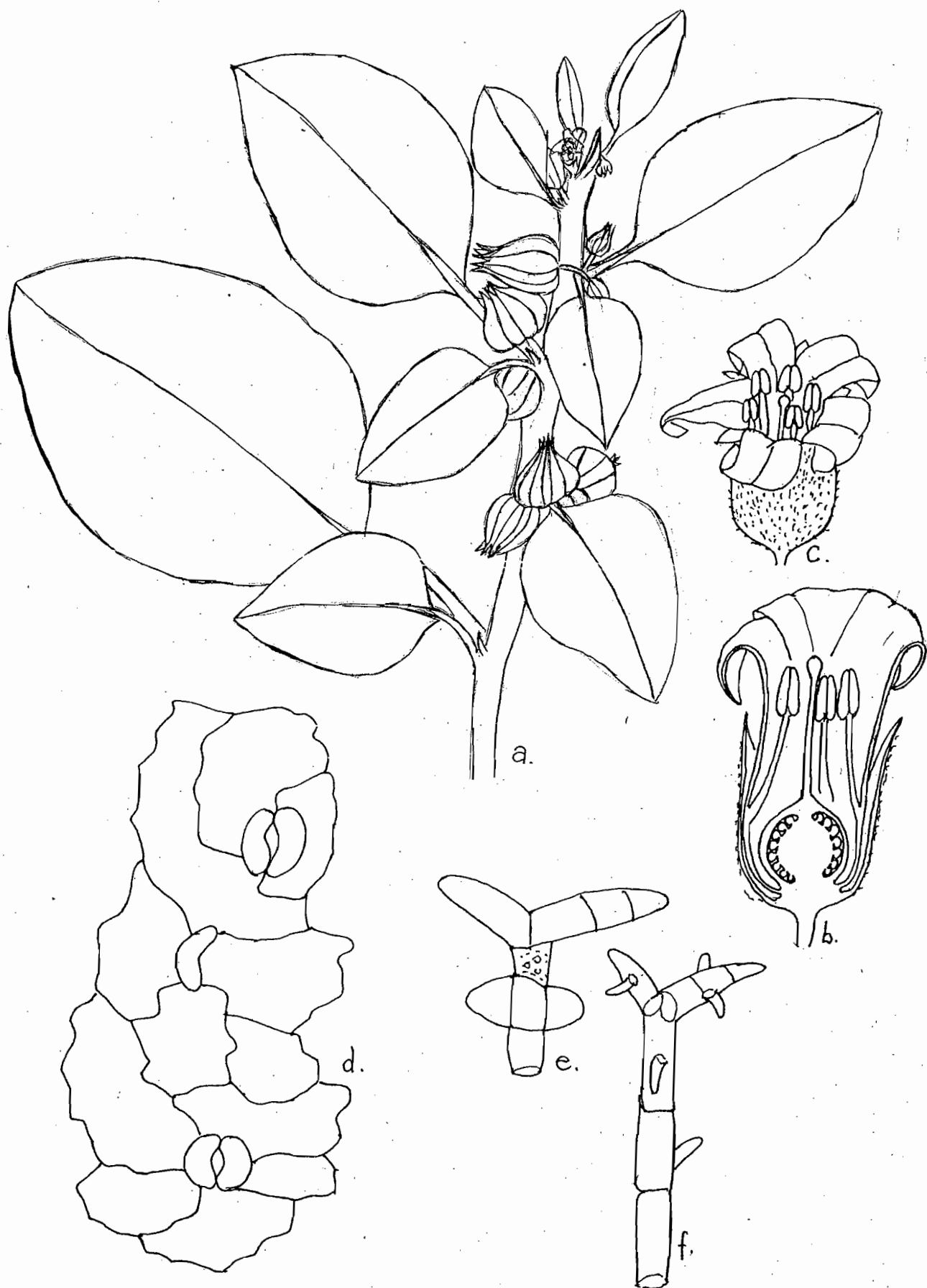


Fig. 364 *Withania somnifera* Dun., a. habit, b. L.S. of flower, c. flower, d. anomocytic stomatam, e-f. dendritic trichome.

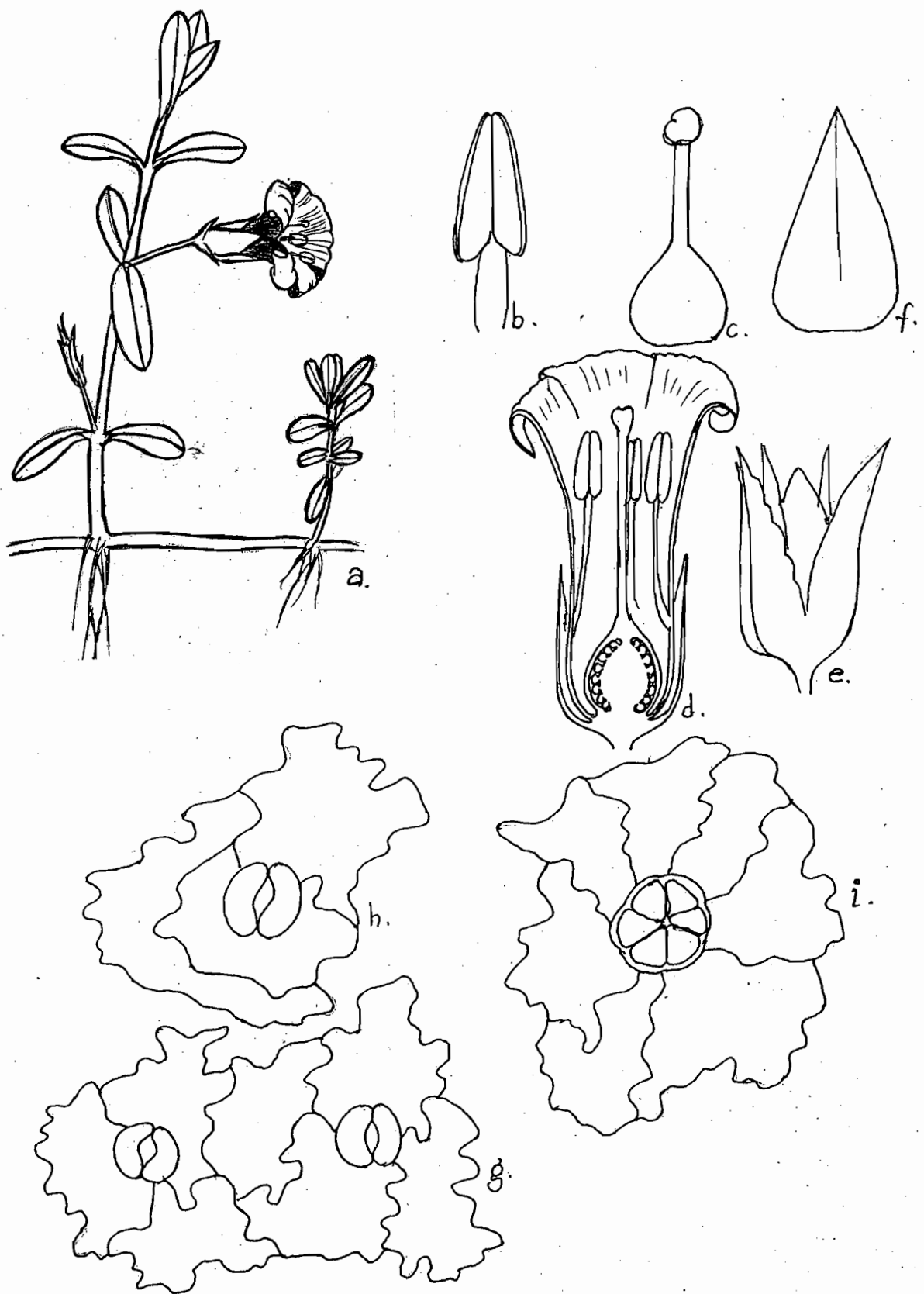


Fig. 365 *Bacopa monnieri* Wettst., a. Habit, b. stamen, c. gynoecium, d. L.S. of flower, e. calyx f. capsule, g. anisocytic and anomocytic stomata, h. diacytic stomata, i. glandular multicellular sessile trichome.

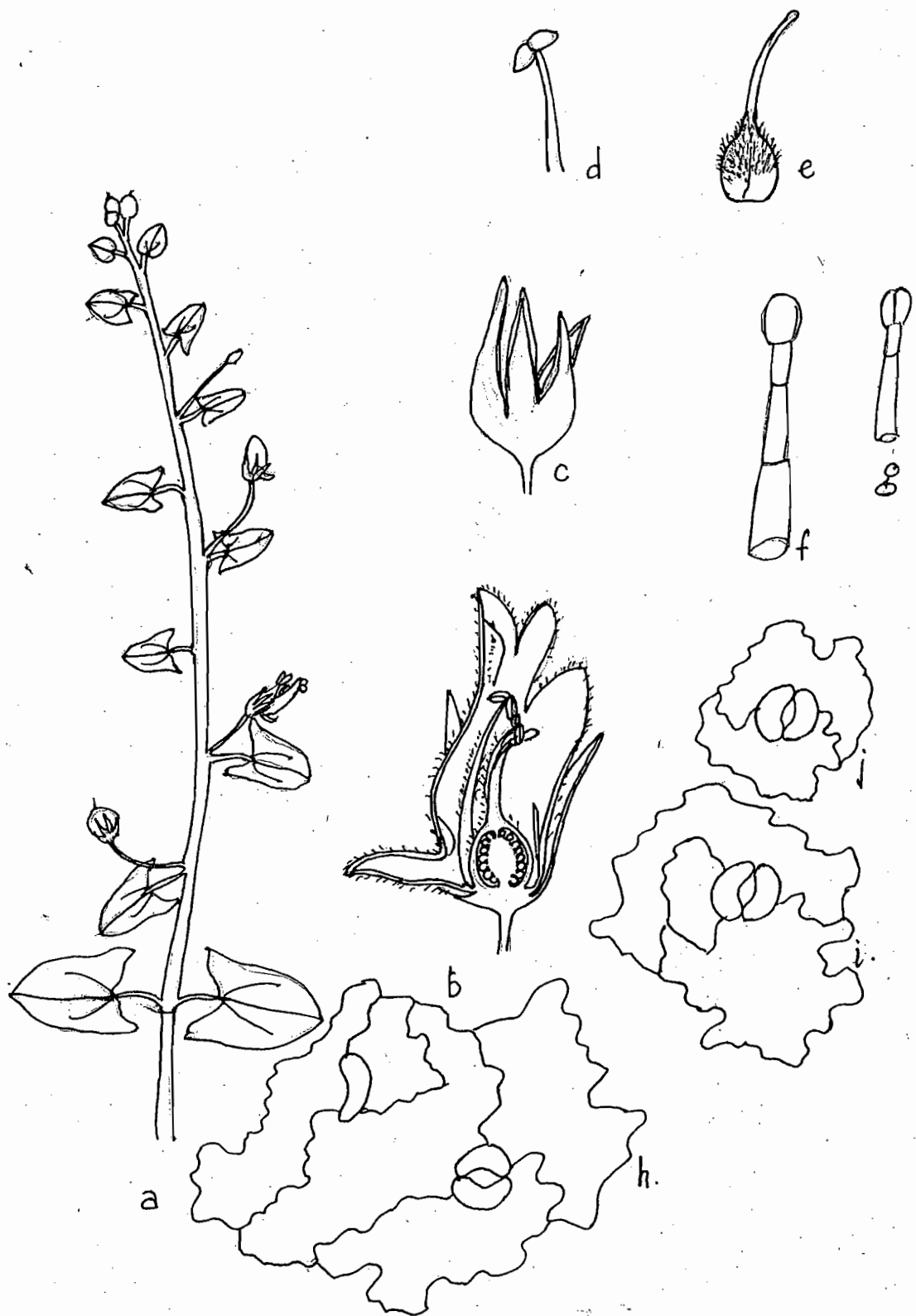


Fig. 366 *Elatinoides ramosissima* (Wall.) Wettat. a. habit, b. L.S. of flower, c. calyx, d. stamen, e. gynoecium, f. gland with single celled head and multicellular uniseriate stalk on corolla, g. gland with two celled trichome with two celled uniseriate stalk, h. anomocytic stomata, i. anisocytic stomata, j. diacytic stomata.

Micromorphology (Fig. 366)

The trichomes were present on stamens, ovary, and petals. Trichomes were multicellular, glandular, differentiated into a unicellular head and a multicellular, uniseriate stalk of 3-4 cells; whereas another trichome showed presence of two celled head.

Stomata were of anomocytic type in majority along with anisocytic and diacytic.

D/180.

3. *Limnophila indica* (L.) Druce Bot. Exch. Club Soc. Brit. Isles 3: 420. 1914.

A submerged aquatic herb with stem reaching a length of 60 cm or more. Leaves dimorphic, upper leaves oblong-lanceolate, sessile, upto 6 cm long, 3-nately whorled, serrate-dentate, glabrous, strongly 3-5 nerved; lower leaves submerged, finely segmented, often deflexed and root-like. Flowers in long erect leafy racemes upto 24 cm long; bracteoles linear-subulate. Calyx membranous; segments deltoid-ovate. Corolla pale-violet, 2-lipped; lobes of the upper lip short, rounded, those of the lower lip ovate, acute. Stamens 4, didynamous; anther-cells separate and stalked. Ovary 2-celled; ovules numerous in each cell; style deflexed; stigma 2-lamellate. Capsules subglobose. Seeds small, truncate at both ends. (Fig. 367)

Vernacular name: Tarati

Flowers: November-January.

Micromorphology (Fig. 367)

Three non-glandular trichomes were observed; two were unicellular and third was uniseriate. Unicellular trichomes were 1) elongated filamentous and 2) triangular with a broad base.

Stomata were paracytic and anomocytic.

D/714-715, 1031.

4. *Lindenbergia urticaefolia* Link & Otto, Icon. Pl. Rar. Hort. Berol. 1828 t. 48.

An annual glandular-villous herb, reaching a height of 50 cm. Leaves ovate, upto 5 cm long, serrate, glandular-villous on both sides. Flowers solitary or 2-nate in the axils of large leaves, sometimes running out into axillary or terminal leafy racemes. Calyx lobes triangular-oblong. Corolla yellow 2-lipped; upper lip shortly 2-lobed; lower lip with 3 rounded veined lobes. Stamens didynamous; anthers with separate stalked cells. Capsules oblong, hairy in the upper part. Seeds minute, ellipsoid-oblong. (Fig. 368)

Vernacular name: Pirasdedi.

Flowers: September-November.

Micromorphology (Fig. 368)

Two types of trichomes were seen one was glandular with two-celled head and uniseriate stalk, second was multicellular uniseriate trichome.

Stomata were anomocytic.

D/1242.

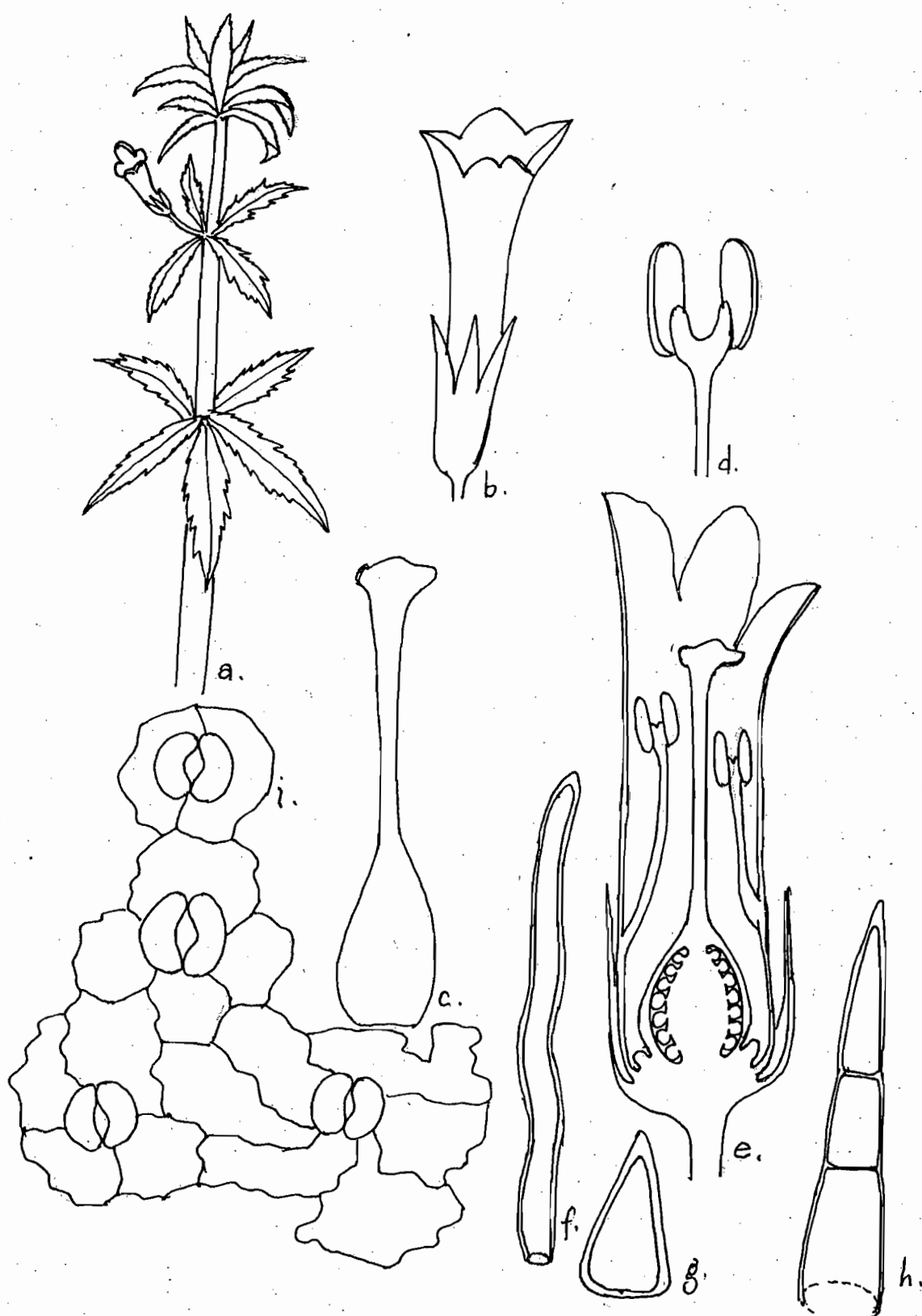


Fig. 367 *Limnophila indica* Druce., a. habit, b. flower, c. gynoecium, d. stamen, e. L.S. of flower, f. unicellular acicular trichome, g. unicellular conical trichome, h. multicellular uniseriate trichome, i. paracytic and anomocytic stomata.

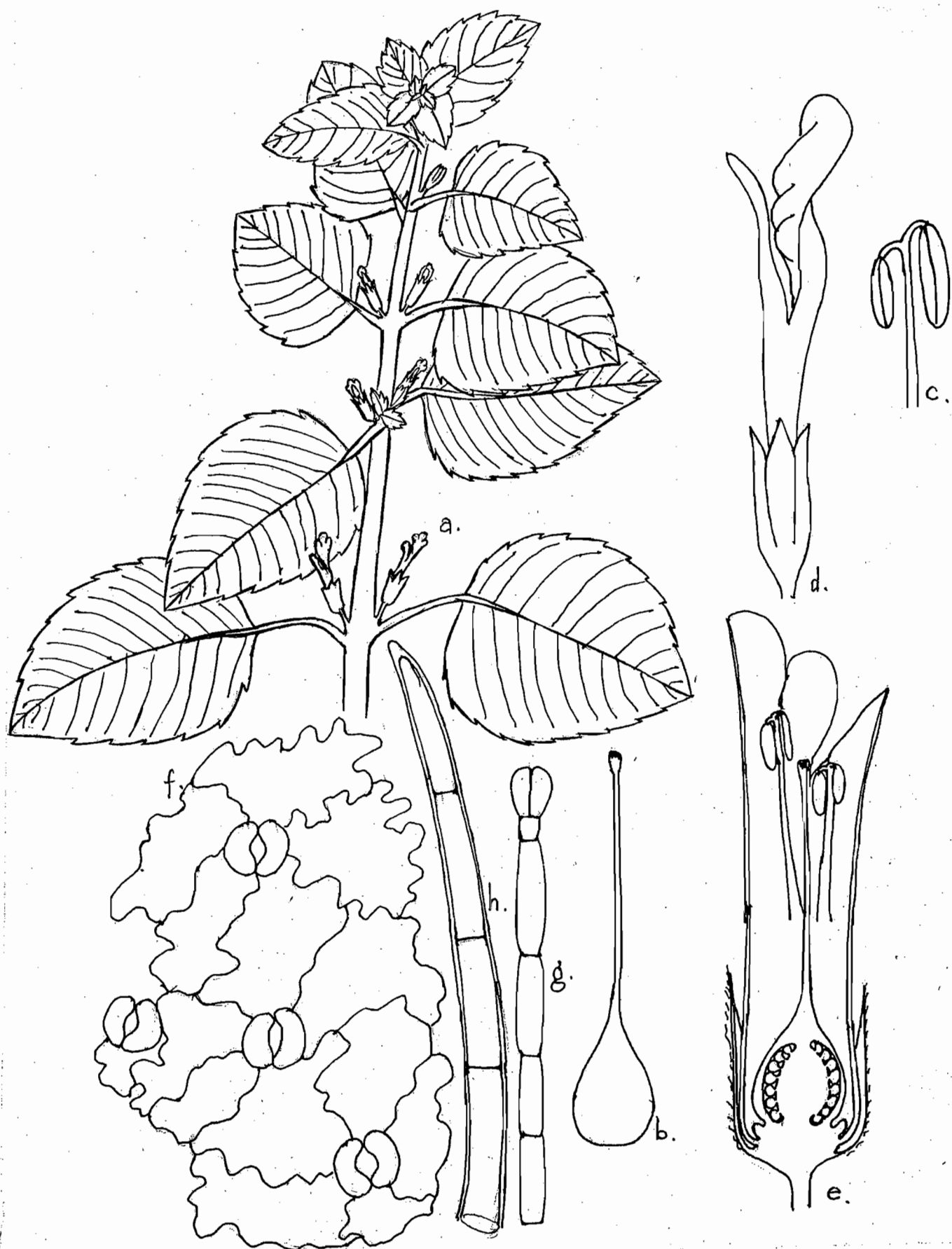


Fig. 368 *Lindenbergia urticaefolia* Link., a. habit, b. gynoecium, c. stamen, d. flower, e. L.S. of flower, f. anomocytic stomata, g. gland with two celled head and uniseriate stalk, h. uniseriate trichome.

5. *Lindernia ciliata* (Colsm.) Pennel, *Brittonia*, 2:182

(*Bonnaya brachiata*)

A glabrous diffusely branched erect annual reaching upto 25 cm high. Leaves oblong, upto 3 cm long, spinous-serrate. Flowers in lax terminal racemes; bracts linear-subulate. Calyx 5-partite; segments linear-subulate, finely aristate. Corolla 2-lipped, pink; upper lip erect, broad, concave or 2-fid; lower lip larger, 3-lobed, spreading. Stamens: the 2 upper perfect; the 2 lower reduced to glabrous staminodes; anther cells divaricate. Ovary 2-celled; ovules many in each cell. Capsules oblong. Seeds small, truncate at both ends. (Fig. 369)

Variation observed: in my specimen the staminodes were glabrous but in the standard description they were said to be pubescent.

Vernacular name: Gadag vel.

Flowers: September-November.

Micromorphology (Fig. 369)

The vegetative part contain one two celled non-glandular and another glandular trichome having a two celled globular head and a 1 celled stalk. Within the corolla there were glandular trichomes with 1-4 celled head and a single cell stalk.

Stomata were of diacytic and anomocytic type.

D/561-562, 1109-1110, 1248.

6. *Lindernia crustacea* (L.) F. Muell. in *Syst. Census. Austral. Pl.* 97, 1882

(*Vandelia crustacea*)

A much-branched, sparsely hairy annual upto 50 cm high, with angular stems. Leaves opposite, ovate, serrate. Flowers axillary and subracemose at the ends of the branches. Calyx-segments 5, teeth triangular, acute. Corolla 2-lipped, purplish; upper lip outermost, concave, notched or 2-fid; lower lip spreading, 3-lobed. Stamens 4, didynamous, filaments with subulate appendages at or towards the base; anthers cohering in pairs under the upper lip, the cells divaricate. Ovary 2-celled; ovules many in each cell. Capsules ellipsoid-oblong, obtuse. Seeds ellipsoid. (Fig. 370)

Flowers: July-December.

Micromorphology (Fig. 370)

The leaves contain both glandular and non-glandular trichomes. The glandular one is 4-celled, disc shaped and sessile. The non-glandular trichome is two celled, long pointed with a warty cells.

Stomata were of anisocytic type.

D/552-553, 1070.

7. *Russelia equisetiformis* Schl. & Cham. in *Linnaea* 6: 377. 1831

(*Russelia juncea* Zucc.)

A handsome bush, upto 120 cm high, with long rush-like ribbed leafless green stems (Phylloclades). The small branches are thin, and on them numerous flowers are produced. Leaves small, seen towards the tip of the stems. Flowers are about 3-cm long, tubular with five-petals. Calyx cupular, sepals 5, acuminate. Corolla mouth subequal; 5-lobed.

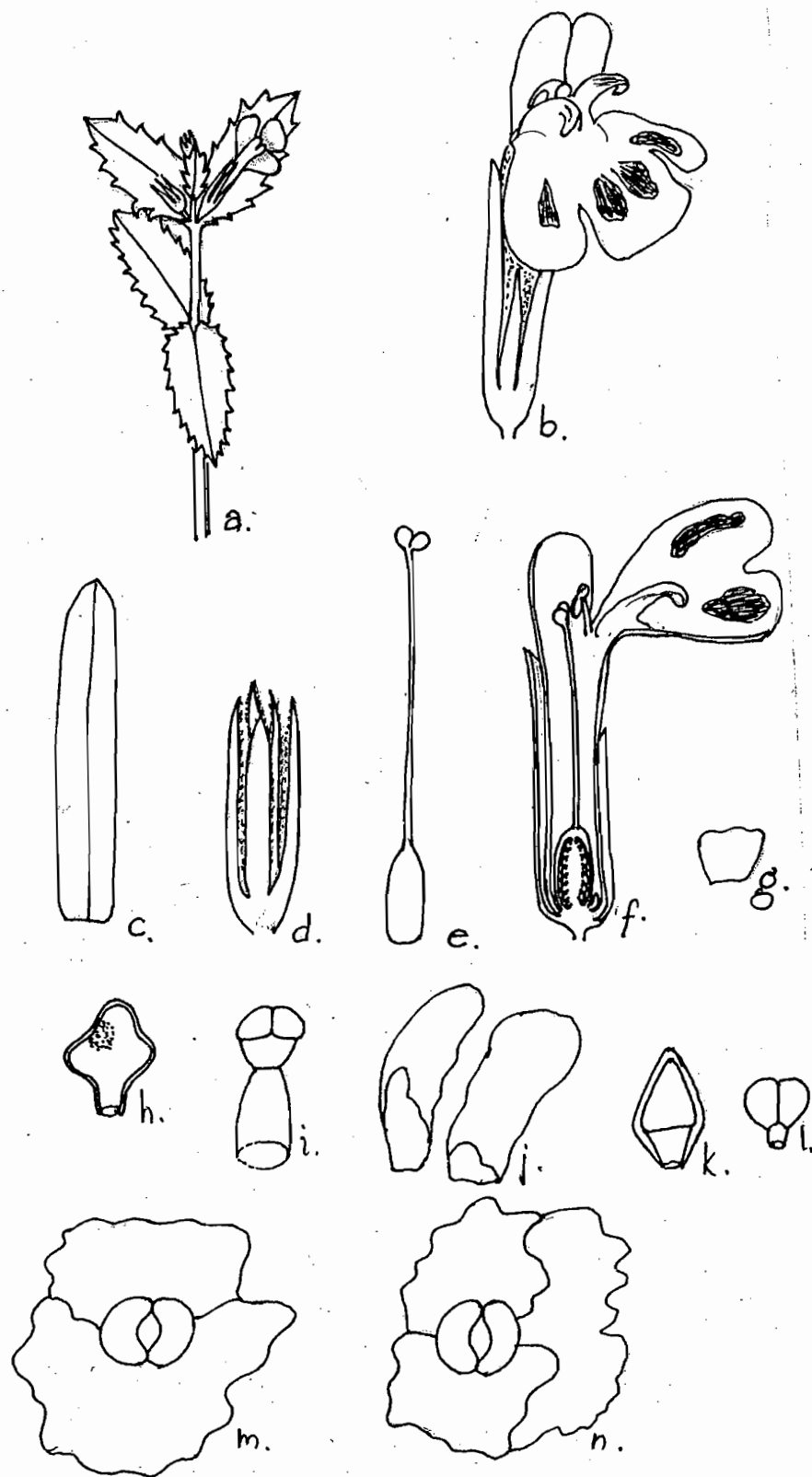


Fig. 369. *Lindernia ciliata* Pennel., a. habit, b. flower, c. sepal, d. calyx, e. gynoecium, f. L.S. of flower, g. Disc, h. unicellular gland, i. gland with three-celled head and a single celled stalk, j. unicellular club shaped gland, k. two celled uniseriate gland, l. gland with two celled head and a single celled stalk, m. diacytic stomata, n. anisocytic stomata.

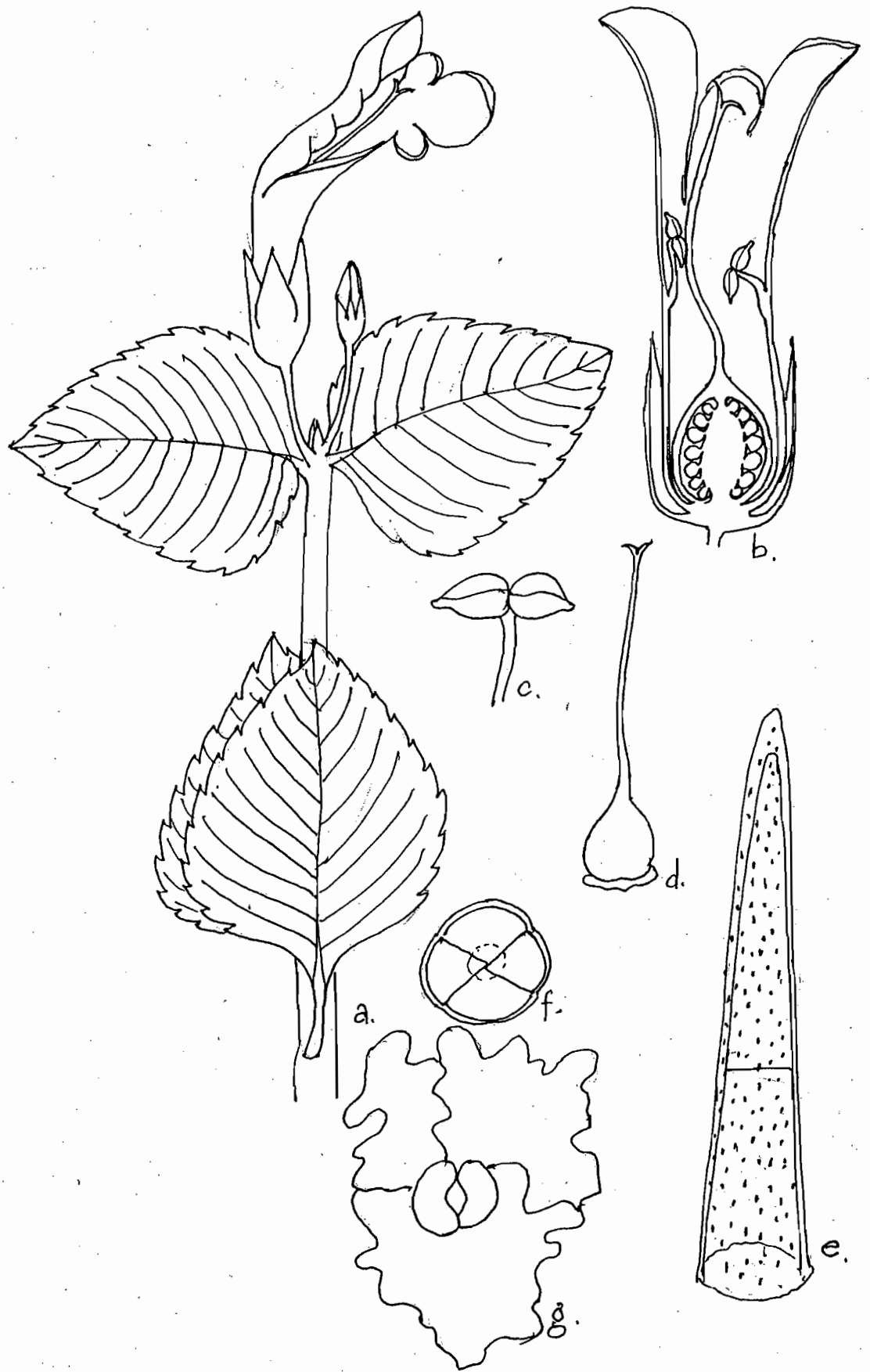


Fig. 370. *Lindernia crustacea* f. Muell., a. habit, b. L.S. of flower, c. stamen, d. gynoecium, e. two-celled uniseriate trichome, f. four-celled sessile gland, g. anisocytic stomata.

Stamens 4; didynamous, anthers divaricate. Ovary ovoid, 2-celled; ovules numerous; style long; stigma minute. (Fig. 371)

Flowers: throughout the year.

Micromorphology (Fig. 372)

Leaf showed presence of multicellular, glandular trichome differentiated into a multicellular, 8-12 celled head and a single celled stalk. Along with it a multicellular cup shaped scale was also present.

Corolla showed presence of two types of trichomes: 1) the same as that of the leaf, a multicellular, 8-12 celled head and a single celled stalk. 2) multicellular, glandular trichome differentiated into a multicellular, 8-12 celled head and multicellular, uniseriate stalk.

Stomata were of anisocytic type.

D/236.

8. *Russelia rotundifolia* Cav. Icon. V. 5. P. 9, t. 415. 1799

This is a leafy bush of about 1 m in height. Stem and branches 6- many angled. The leaves are suborbicular- cordate and sessile. Flowers red, borne in groups of 2-5 from the axils of leaves or in terminal racemes. Corolla tube long upto 2 cm and petal lobes very small, triangular. Stamens 4; didynamous, anthers divaricate. Ovary ovoid, 2-celled; ovules numerous; style long; stigma minute. (Fig. 373)

Flowers: throughout the year.

Micromorphology (Fig. 374)

The plant showed the presence of a number of multicellular glands along with non-glandular trichomes. The glands were with many celled head and single celled stalk. A cup-shaped multicellular gland was also observed. The non-glandular trichomes were unicellular as well as multicellular uniseriate with pitted wall.

Stomata were anisocytic.

D/228.

9. *Scoparia dulcis* Linn. Sp. Pl. (1753) p. 116

An erect branched herb with 4-6 angled stems reaching a height of 1 m. Leaves rhomboid or elliptic, 3.5 cm long, narrowed into a petiole at base, serrate. Flowers 3-6 in axillary whorls. Calyx-segments 4, oblong. Corolla white. Stamens 4, subequal; anthers subsagittate, cells divergent. Style clavate; stigma truncate or notched. Capsules subglobose. Seeds ovoid. (Fig. 375)

Vernacular name: Bhitchati ni jat.

Flowers: Throughout the year.

Micromorphology (Fig. 375)

There were both glandular and non-glandular trichomes. The glands were multicellular disc shaped, as well as with a single celled head and multicellular uniseriate stalk. The non-glandular was unicellular with striated wall.

Stomata were diacytic.

D/119, 791.

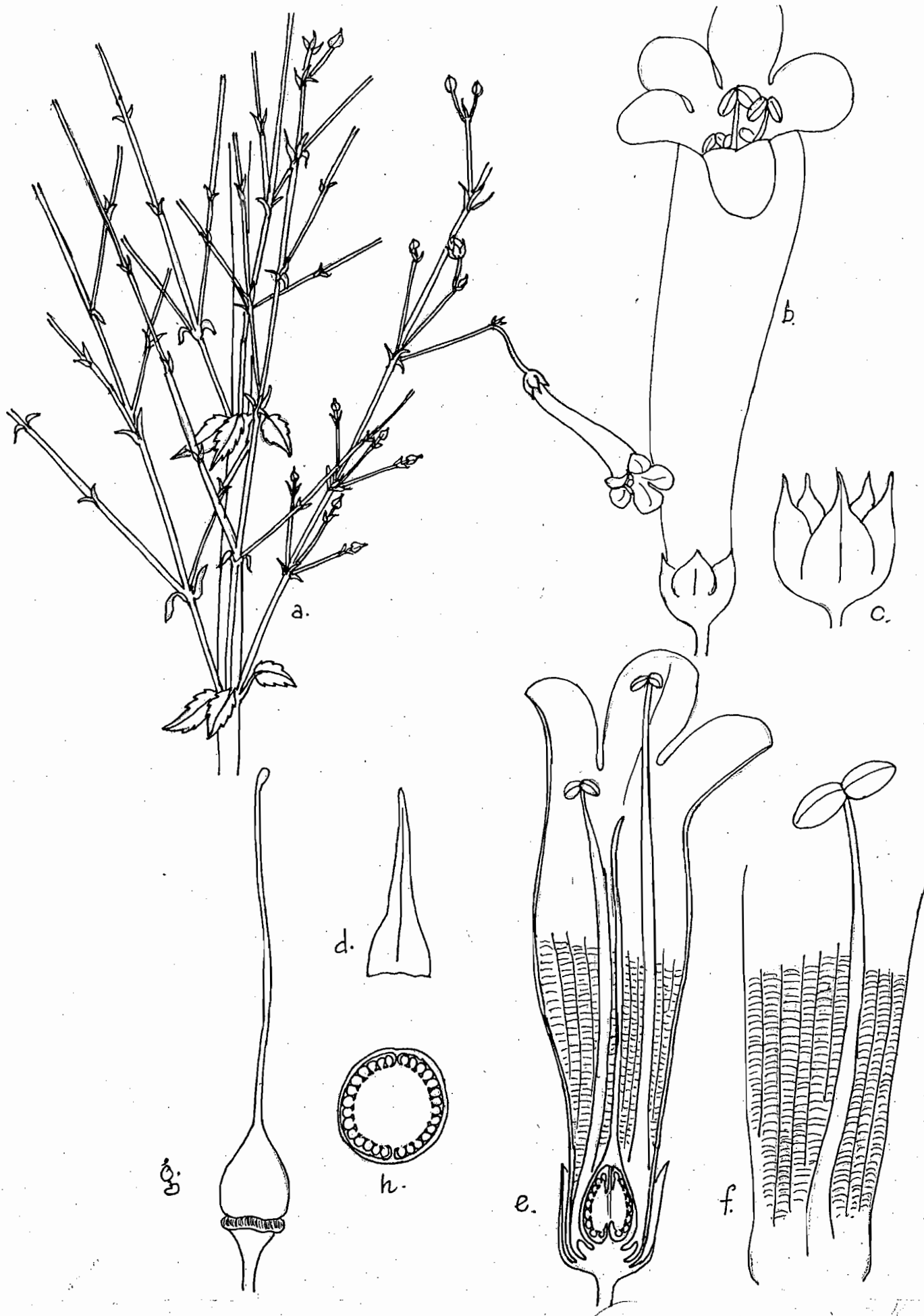


Fig. 371. *Russelia equisetiformis* Schl. & Cham., a. habit, b. flower, c. calyx, d. bract, e. L.S. of flower, f. epipetalous stamen, g. gynoecium, h. T.S. of ovary.

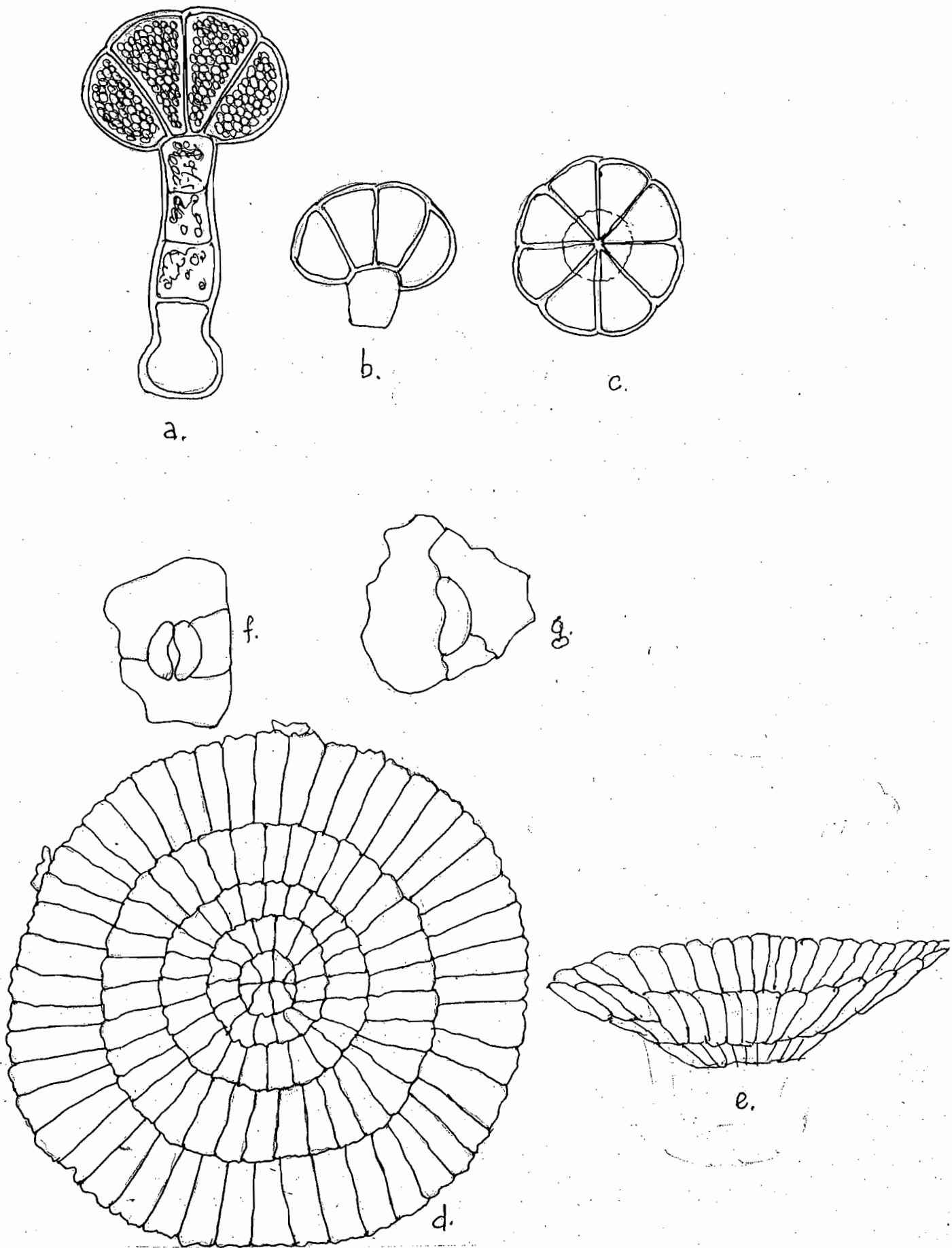


Fig. 372 *Russelia equisetiformis* Schl. & Cham., a. gland with many celled head and multicellular uniseriate stalk, b. gland with many celled head and single celled stalk, c. glandular multicellular sessile trichome, d-e. peltate scale, f. anisocytic stomata, g. anisocytic stomata with single guard cell.

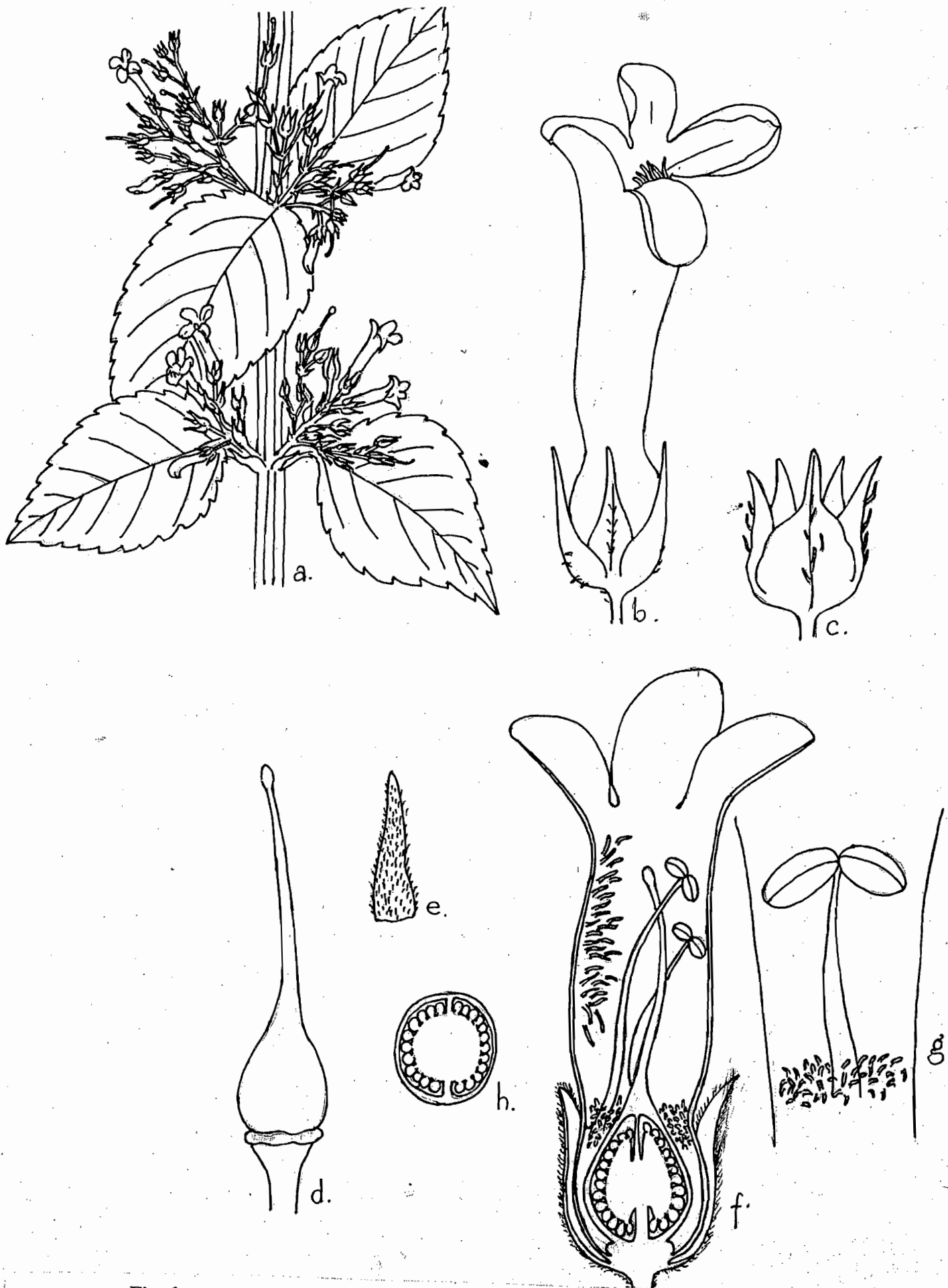


Fig. 373. *Russelia rotundifolia* Cav., a. habit, b. flower, c. calyx, d. gynoecium, e. bract, f. L.S. of flower, g. epipetalous stamen.

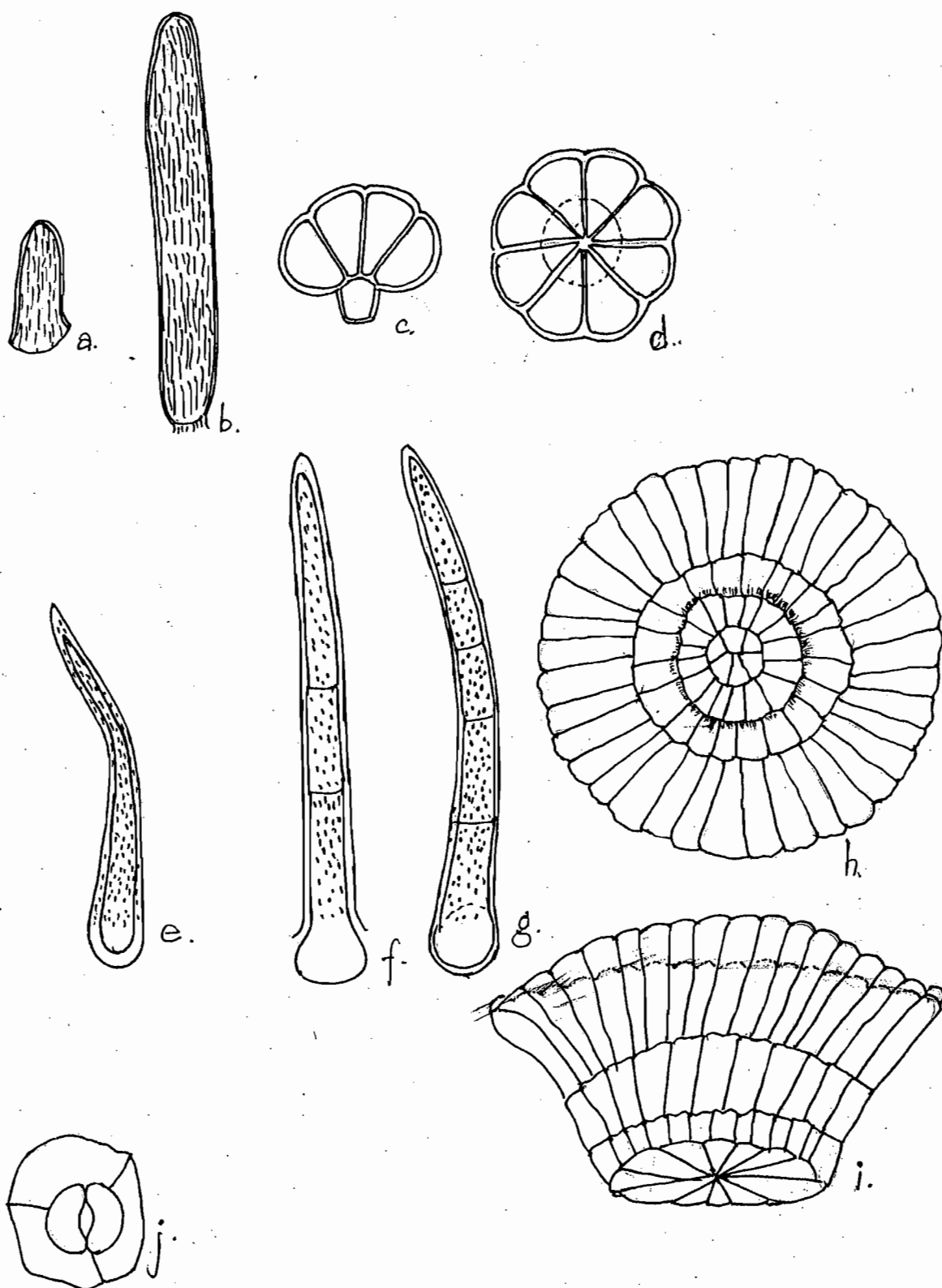


Fig. 374. *Russelia rotundifolia* Cav.. a-b. glandular unicellular trichome with thick wall and striations on the wall, c & d. glandular multicellular trichome with many celled head and single celled stalk, e. unicellular trichome, f-g. uniseriate trichome, h-i. peltate scale, j. anisocytic stomata.

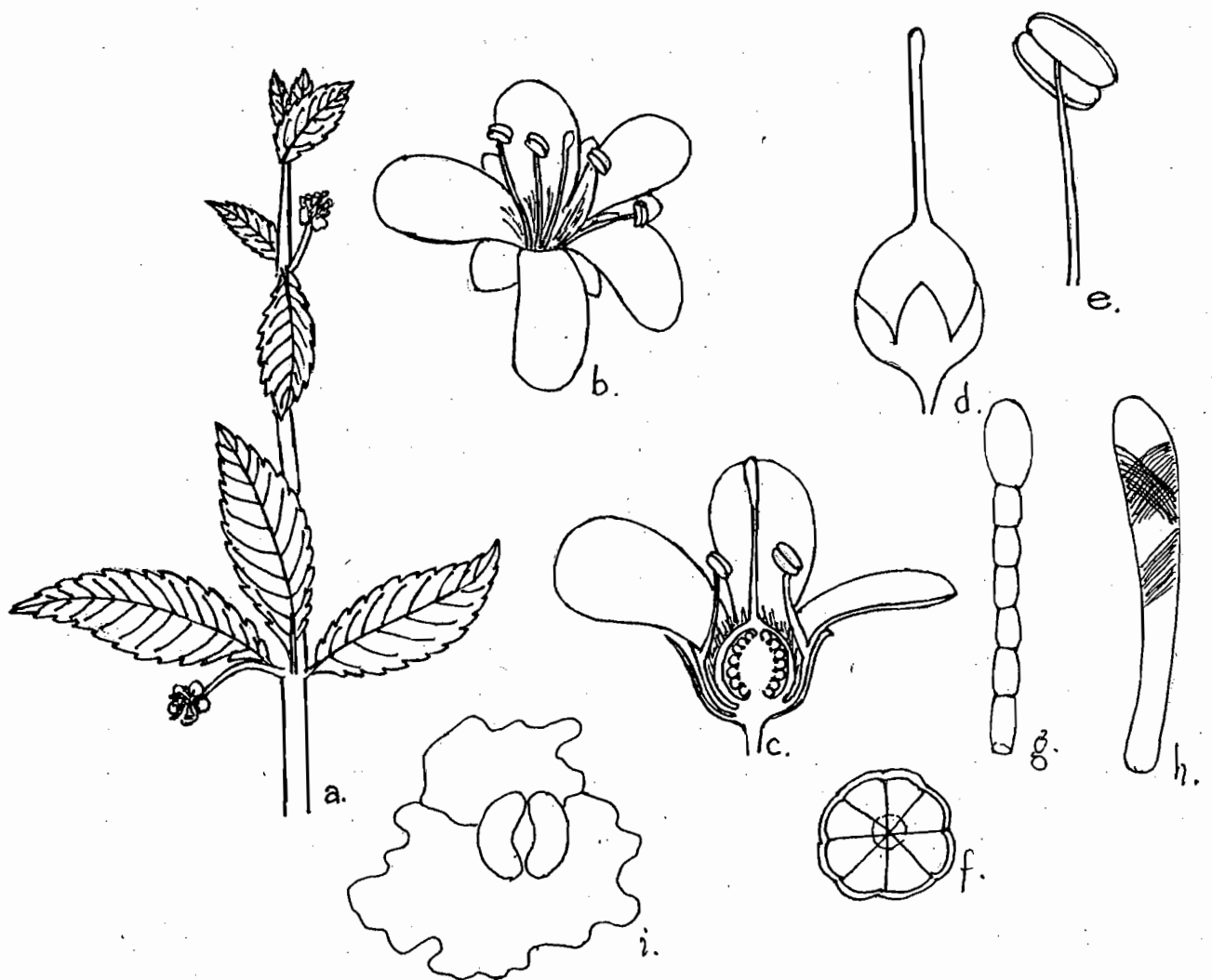


Fig. 375. *Scoparia dulcis* L., a. habit, b. flower, c. L.S. of flower, d. capsule, e. stamen, f. glandular multicellular sessile trichome, g. gland with a single celled head and multicellular uniseriate stalk, h. glandular unicellular thick walled trichome, i. diacytic stomata.

10. *Stemodia viscosa* Roxb. *Cor. Pl. V. 2* (1798) p. 33, t. 163.

An erect, aromatic, viscidly pubescent herb with quadrangular stem reaching upto 60 cm high. Leaves upto 4 cm, sessile, oblong, and amplexicaul. Flowers axillary, solitary or in terminal racemes; bracteoles 2, linear-subulate. Calyx 5-partite; sepals lanceolate. Corolla violet; upper lip broad 2-lobed; lower lip with 3 rounded or emarginated. Anther cells suborbicular, with one cell aborted. Capsules ovoid-oblong, 4-valved. Seeds oblong-ellipsoid. (Fig. 376)

Variation observed: here in this material, one of the anther cells was aborted, whereas, in standard descriptions, both the cells of the stamens were said to be fertile.

Vernacular name: Nukchani.

Flowers: November-December.

Micromorphology (Fig. 376)

Both glandular and non-glandular trichomes were seen in the plant. glandular trichomes were multicellular with 2-3 celled stalk and 1-2 celled heads. The non-glandular trichomes were multicellular, uniseriate with long rectangular cells. In some the terminal cell was swollen at the tip.

Stomata were of anomocytic and anisocytic type.

D/814-816.

11. *Stemodia serrata* Benth. in *DC. Prodr. V. 10* (1846) p. 381.

A robust leafy erect viscidly-pubescent annual with 4-angled stem. Leaves obovate-oblong, upto 3 cm, serrulate above the middle, amplexicaul. Flowers subsessile, axillary, solitary; bracteoles 2 beneath the calyx, linear-subulate. Calyx 5-partite, segments linear-lanceolate. Corolla 2-lipped; upper lip bifid; lower lip with 3 subequal, oblong-obtuse lobes. Stamens 4, didynamous; anther-cells stalked. Ovary 2-celled; ovules numerous in each cell; stigma 2-lobed. Capsules linear-oblong. Seeds minute, oblong-ellipsoid. (Fig. 377)

Flowers: December-February.

Micromorphology (Fig. 377)

The plant contained glands with single to many celled head and multicellular uniseriate stalk.

Stomata were anisocytic and anomocytic.

D/117.

12. *Striga euphrasioides* Benth. in *Comp. Bot. Mag. V. 1* (1835) p. 364.

A partial parasite growing on the roots of grasses. It has a very variable habit, ranging from 15 cm high, with filiform simple stem to a much-branched stout herb reaching 60 cm high. Leaves linear, upto 5 cm long, 1 or 2 toothed on margins, sessile, scabrous. Flowers sessile or shortly pedicellate, in long, often interrupted, lax erect spikes. Calyx 1 cm long, tube campanulate, ribbed, calyx-teeth nearly equaling the tube, linear-subulate.. Corolla white; tube exserted, upper lip much shorter than the lower. Capsules oblong-ellipsoid, the top of the valves reflexed after dehiscence. Seeds cuneate-oblong, usually truncate at one end. (Fig. 378)

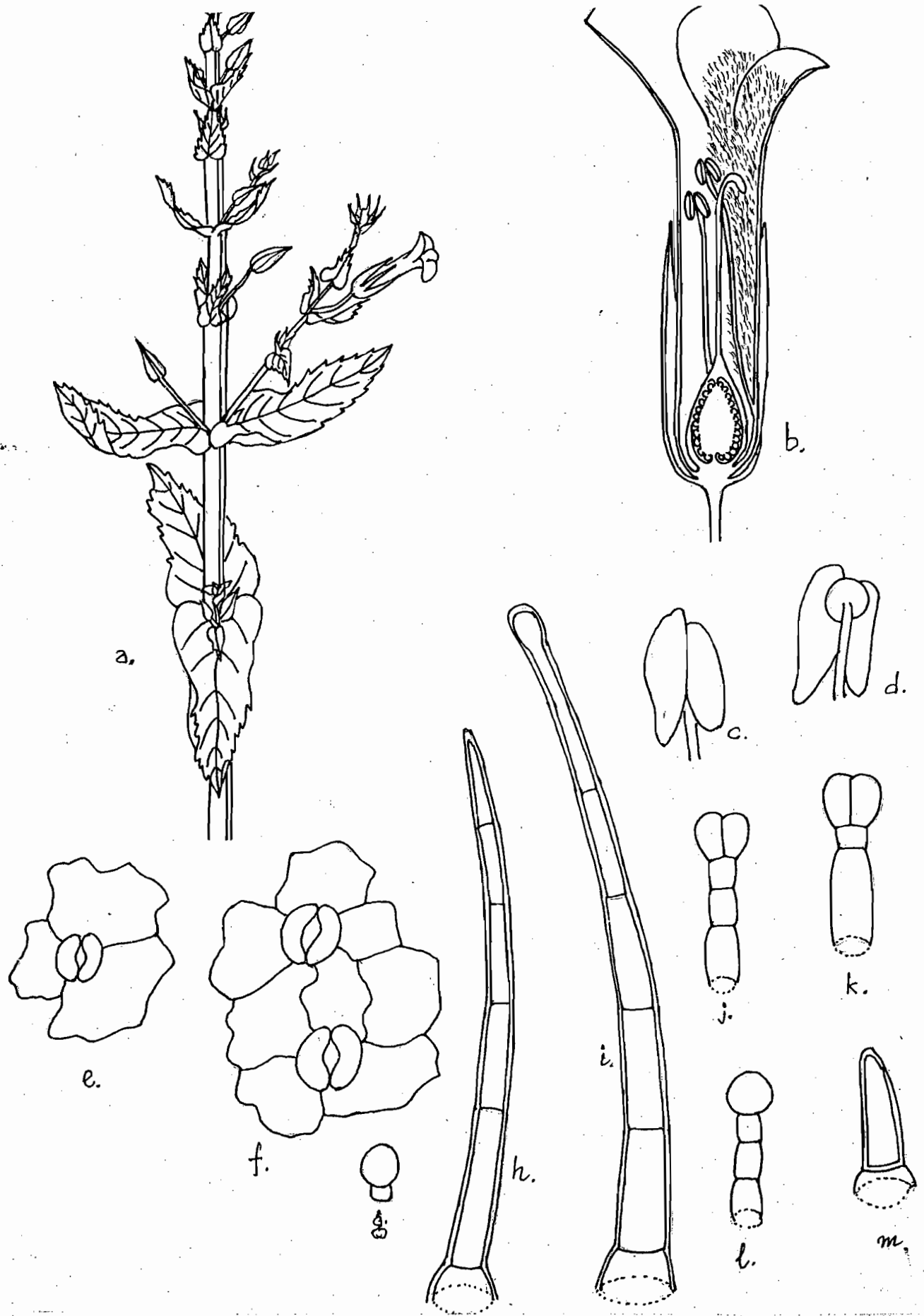


Fig. 376 *Stemodia viscosa* Roxb., a. habit, b. L.S. of flower, c-d. stamen, e. anisocytic stomata, f. anomocytic stomata, g. glandular trichome with a single celled head and a single celled stalk, h-i. uniseriate trichome, j-l. gland with single to many celled head and uniseriate two-three celled stalk. m. two celled uniseriate trichome.

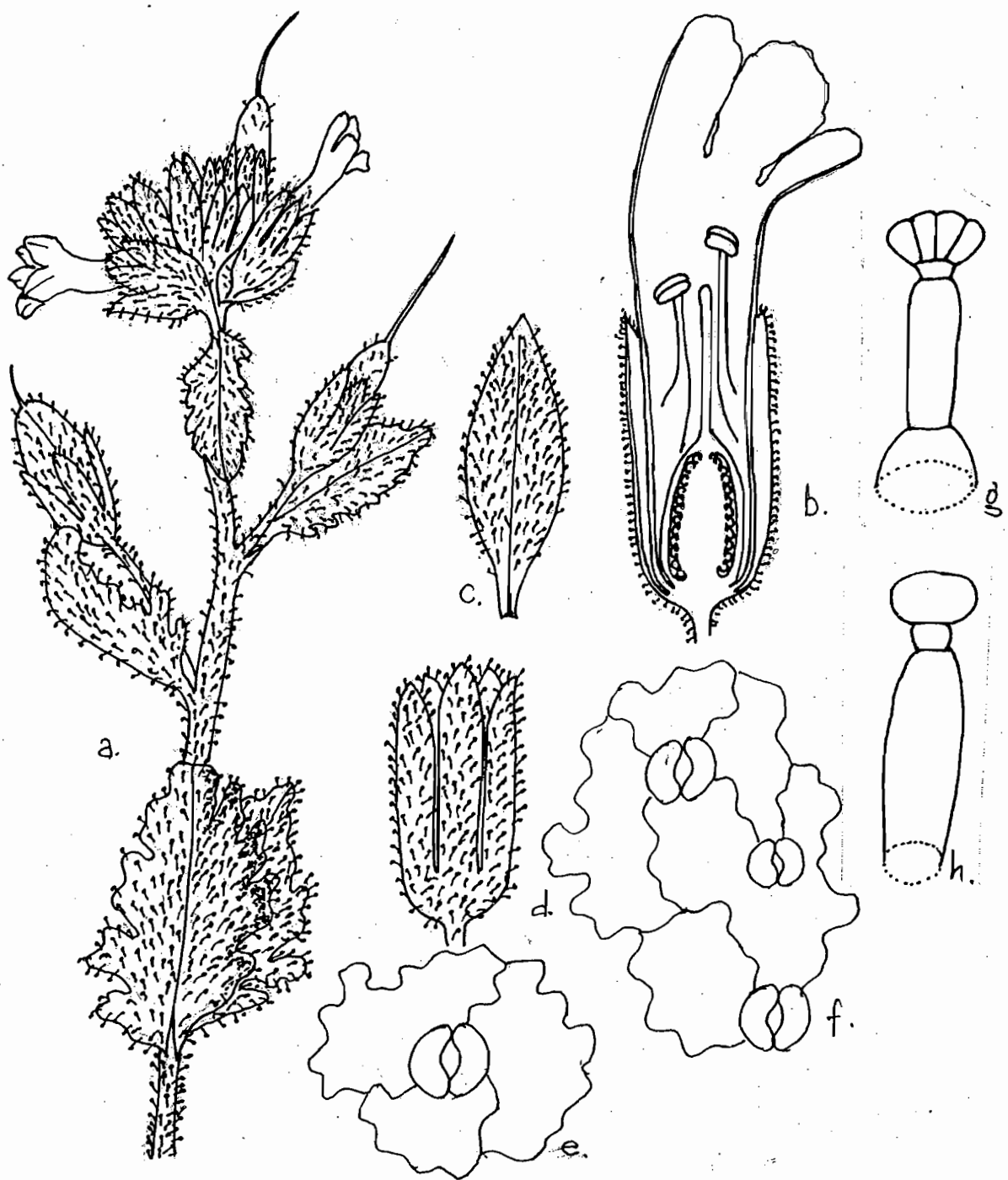


Fig. 377. *Stemodia serrata* Bth., a. habit, b. L.S. of flower, c. bract, d. calyx, e. anisocytic stomata, f. anomocytic stomata, g-h. gland with single to many celled head and multicellular uniseriate stalk.

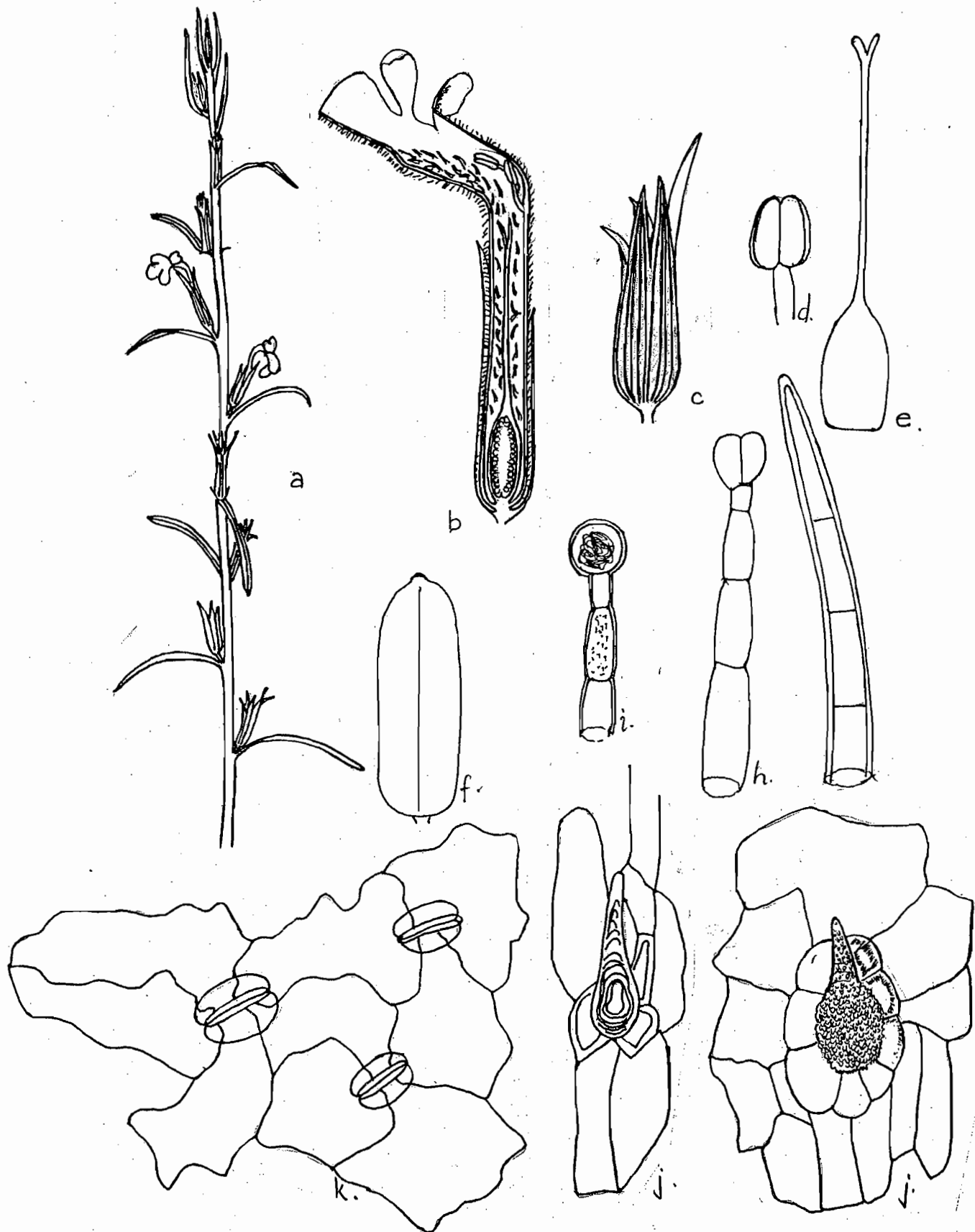


Fig. 378. *Striga euphrasioides* Bth., a. habit, b. L.S. of flower, c. calyx, d. stamen, e. gynoecium, f. capsule, g. gland with single celled head and multicellular uniseriate three celled stalk, h. multicellular gland differentiated into two celled head and multicellular uniseriate many celled stalk, i. multicellular uniseriate trichome, j. unicellular trichome, k. anomocytic stomata

Vernacular name: Dholo agio.

Flowers: August-December.

Micromorphology (Fig. 378)

The leaf showed presence of unicellular, non-glandular trichome which was pointed upward and appressed and had a swollen base with a warty wall.

The corolla showed presence of three types of trichomes: 1) multicellular, uniseriate, unbranched, non-glandular trichome with thick and warty walls. 2) multicellular, glandular trichome differentiated into a two celled head and a multicellular, uniseriate stalk. 3) multicellular, glandular trichome differentiated into a single celled head filled with lot of substances and a multicellular, uniseriate stalk.

Stomata were of anomocytic type and sunken.

D/637, 761.

13. *Verbascum chinense* (L.) Santapau, Fl. Purandhar 90. 1958.

(*Celsia coromandeliana* Vahl.)

A branched hairy annual herb reaching a height of 1 m. Radical leaves lyrate upto 10 cm; cauline leaves are smaller gradually becoming smaller and sessile at the top, passing into bracts. Flowers yellow in simple or branched terminal racemes upto 60 cm long. Calyx glandular-pubescent; lobes linear-oblong. Corolla rotate; lobes 5, rounded. Filaments densely bearded with purple hairs. Ovary globose. Capsules subglobose. Seeds oblong, truncate, warted. (Fig. 379)

Vernacular name: Kalhar.

Flowers: Throughout the year.

Micromorphology (Fig. 379)

There were two types of trichomes; one glandular and another non-glandular. The glandular trichome had a two celled spherical head and a stalk of two cells of which lower cell was elongated rectangular and the upper cell was short and square. The non-glandular trichome was upto 4-cells in length, uniseriate and joints were broad.

Stomata were of diacytic and anomocytic type.

D/1195.

Lentibulariaceae

1. *Utricularia stellaris* Linn. f. Suppl. (1781) p. 86.

An aquatic herb, the peduncles suspended in water by means of a whorl of oblong, vesicles about their middle; stolons submerged, slender, branched. Leaves all submerged, often in whorls of 4, pinnately cut into numerous capillary slender pectinate segments, each pinna usually provided near the base with a small globular-ovoid bladder with a truncate mouth. Flowers in slender erect few flowered racemes with floats in whorls of 4-8 attached below the lowest flower. Pedicels thickened, usually deflexed in fruit. Calyx 2-partite, sepals subequal, enlarged in fruit. Corolla yellow, 2-lipped, tube with a spur. Stamens 2. Ovary 1-celled, ovules many on free-central placentation. Capsules globose. (Fig. 380)

Vernacular name: Arkzver.

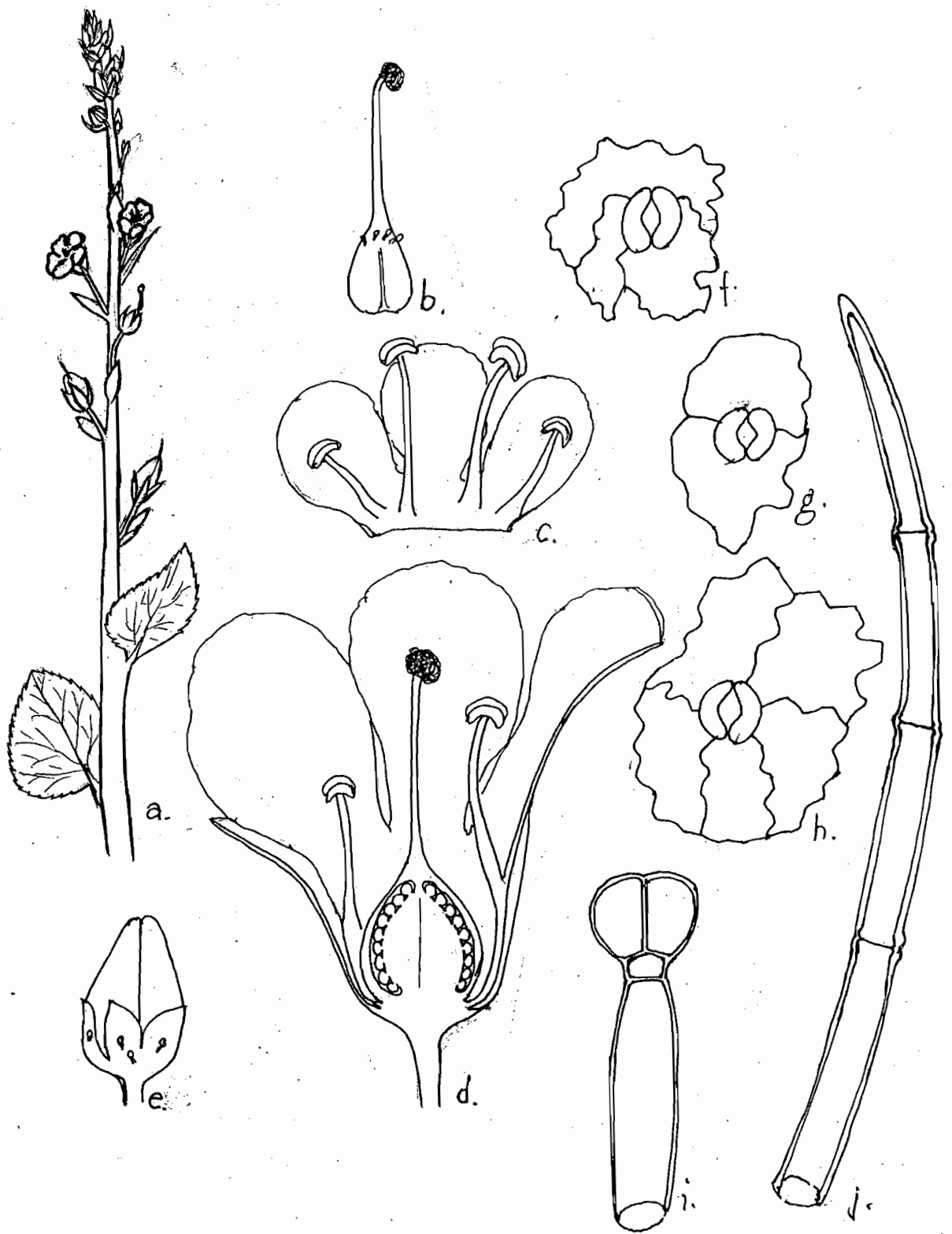


Fig. 379. *Verbascum chinense* (L.) Santapau, a. habit, b. gynoecium, c. epipetalous stamen, d. L.S. of flower, e. capsule, f. anisocytic stomata, g. diacytic stomata, h. anomocytic stomata, i. gland with two celled head and two celled uniseriate stalk, j. uniseriate trichome.

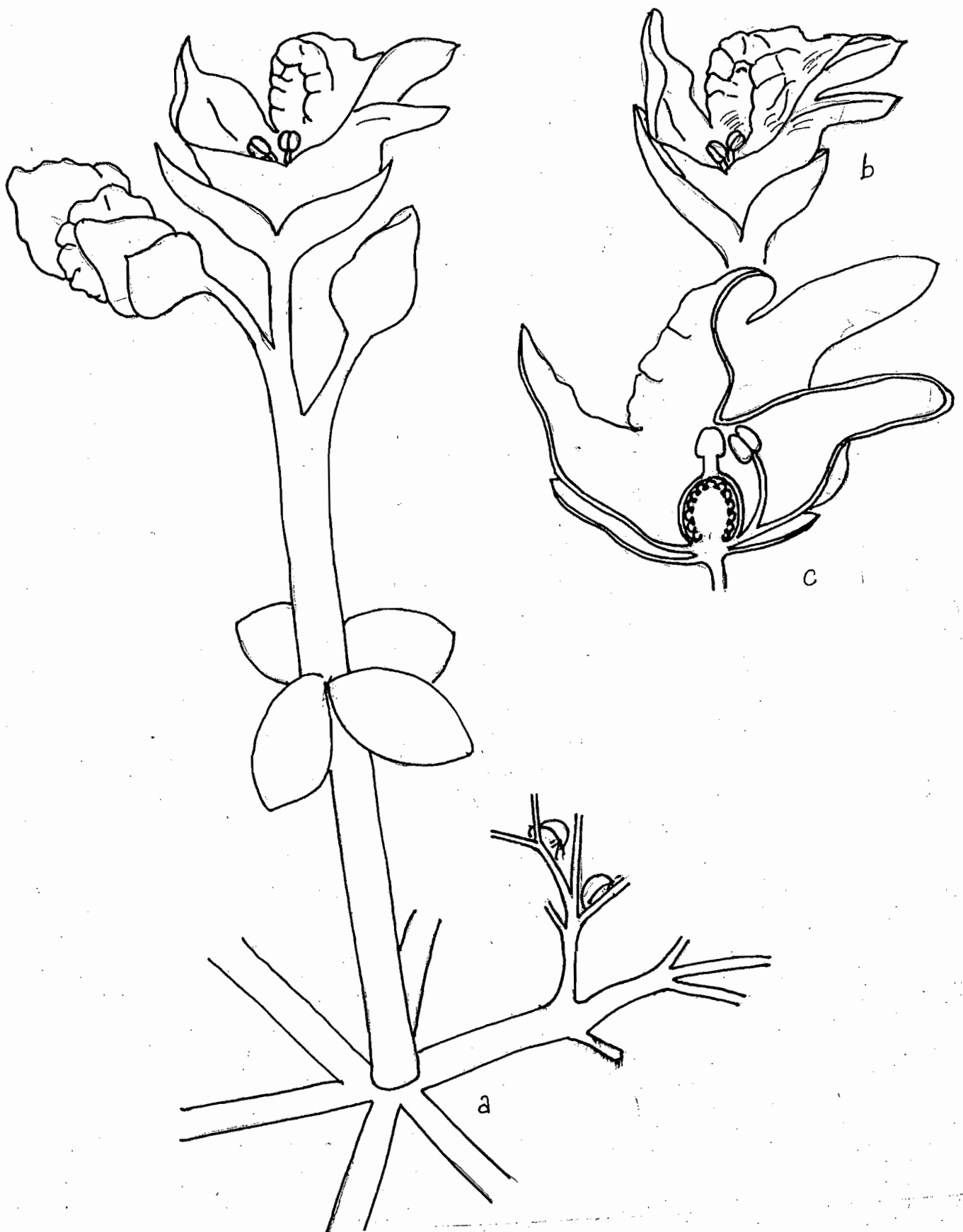


Fig. 380. *Utricularia stellaris* L., a. habit, b. flower, c. L.S. of flower.

Flowers: August-December.
D/277.

Gesneriaceae

1. *Didymocarpous pygmaea* Clarke. in A. DC., *Monogr. Phan.* 5: 82. 1883.

A very small herbs with a slender, curved stem bearing one leaf at the apex. Leaf ovate-elliptic, upto 3 cm long. Flowers 3-5 fascicled in axils. Sepals lobes 5, linear, enlarged in fruit. Corolla, tubular, mouth oblique; lobes 5, rounded. Stamens 2 confluent at apex. Staminodes 2. Ovary unilocular with twoparietal placentae. Style long; stigma small, subcapitate, scarcely 2-lobed. Capsule nearly straight, linear; 2-valved. Seeds ellipsoid, small, smooth, minutely reticulate. (Fig. 381)

Flowers: July-November.

Micromorphology (Fig. 381)

The plant showed presence of two celled, uniseriate, unbranched and glandular trichome with a broad lower cell containing a lot of ergastic substance in it and an apical long pointed cell.

Stomata were of anomocytic and paracytic type.

D/729, 730, 1205.

Bignoniaceae

1. *Crescentia cujete* Linn. *Sp. Pl.* (1753) p. 626.

A small tree of 4 m with arching branches and simple oblanceolate leaves fascicled at nodes. Flowers cauliflorous, foetid, borne singly or in pairs on the trunk and older branches in the evening time. Calyx large, bilabiate. Corolla usually with transverse folds in throat; lobes acuminate. Stamens 4, exserted. Ovary 1-locular; ovules multiseriate on 4 parietal placentae. Fruit a large globose berry with a hard woody shell. Seeds small, flat, embedded in pulp. (Fig. 382)

Vernacular name: Bilayati bel.

Flowers: March-July.

Micromorphology (Fig. 382)

The plant showed presence of unicellular trichome.

Stomata were anomocytic.

D/305.

2. *Heterophragma roxburghii* DC. *Prodr.* V. 9 (1845) p. 210.

A tall tree with dark-brown bark exfoliating in scales. Leaves large, imparipinnate, upto 60 cm long with 3-5 pairs and an odd elliptic-oblong tomentose unequal-sided leaflets. Flowers fragrant, pale-rose colored in large, terminal, many-flowered tomentose panicles. Calyx lobes 5, densely tomentose outside, clothed inside with long silky hairs, 2-lipped. Corolla reaching 5 cm long, lobes 5, often with a pink and crisped margins. Stamens 4,

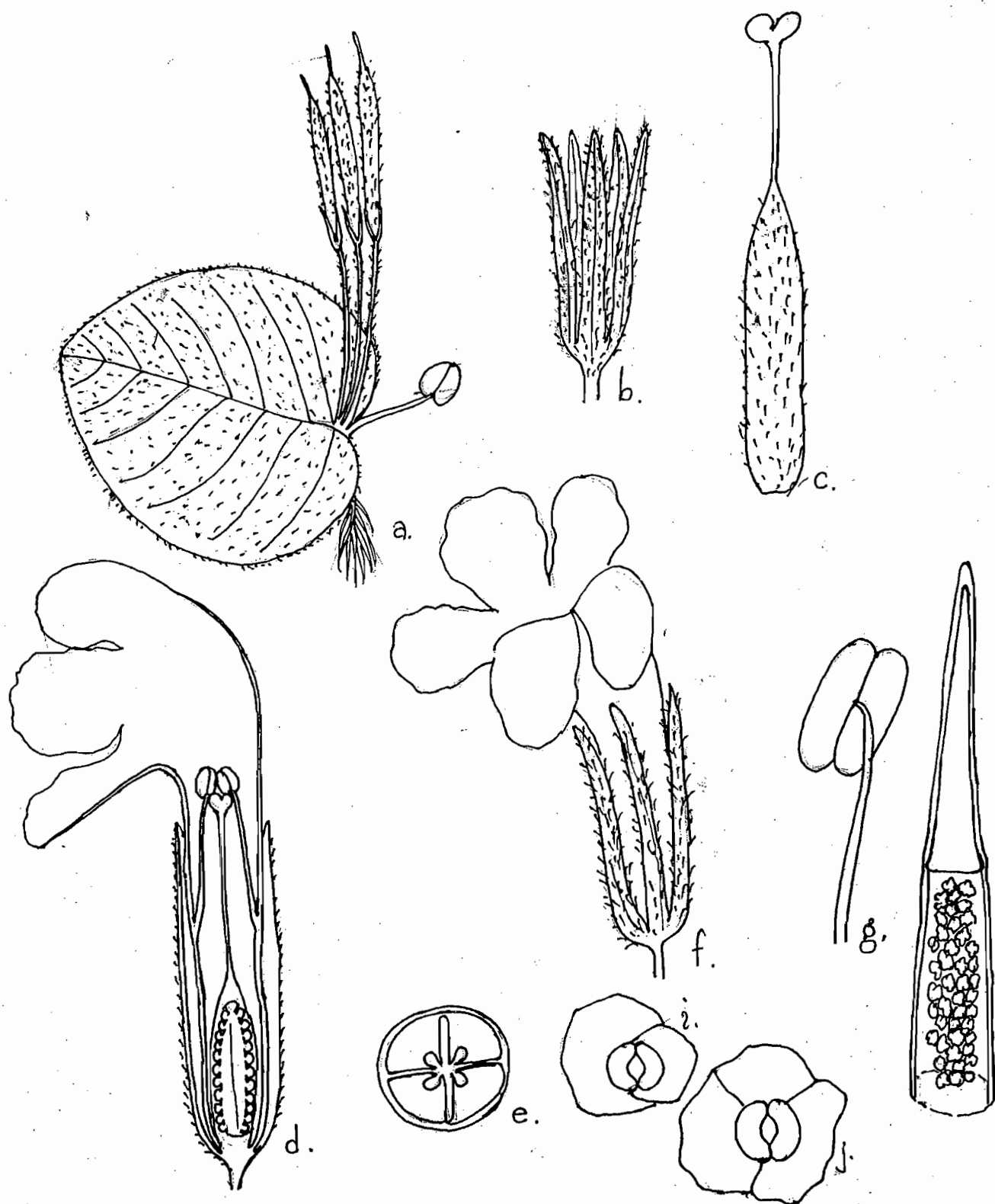


Fig. 381 *Didymocarpus pgymaea* Cl. a. habit, b. calyx, c. gynoecium, d. L.S. of flower, e. T.S. of ovary, f. flower, g. stamen, h. two-celled uniseriate trichome with inclusions in lower cell, i. paracytic stomata, j. anisocytic stomata.

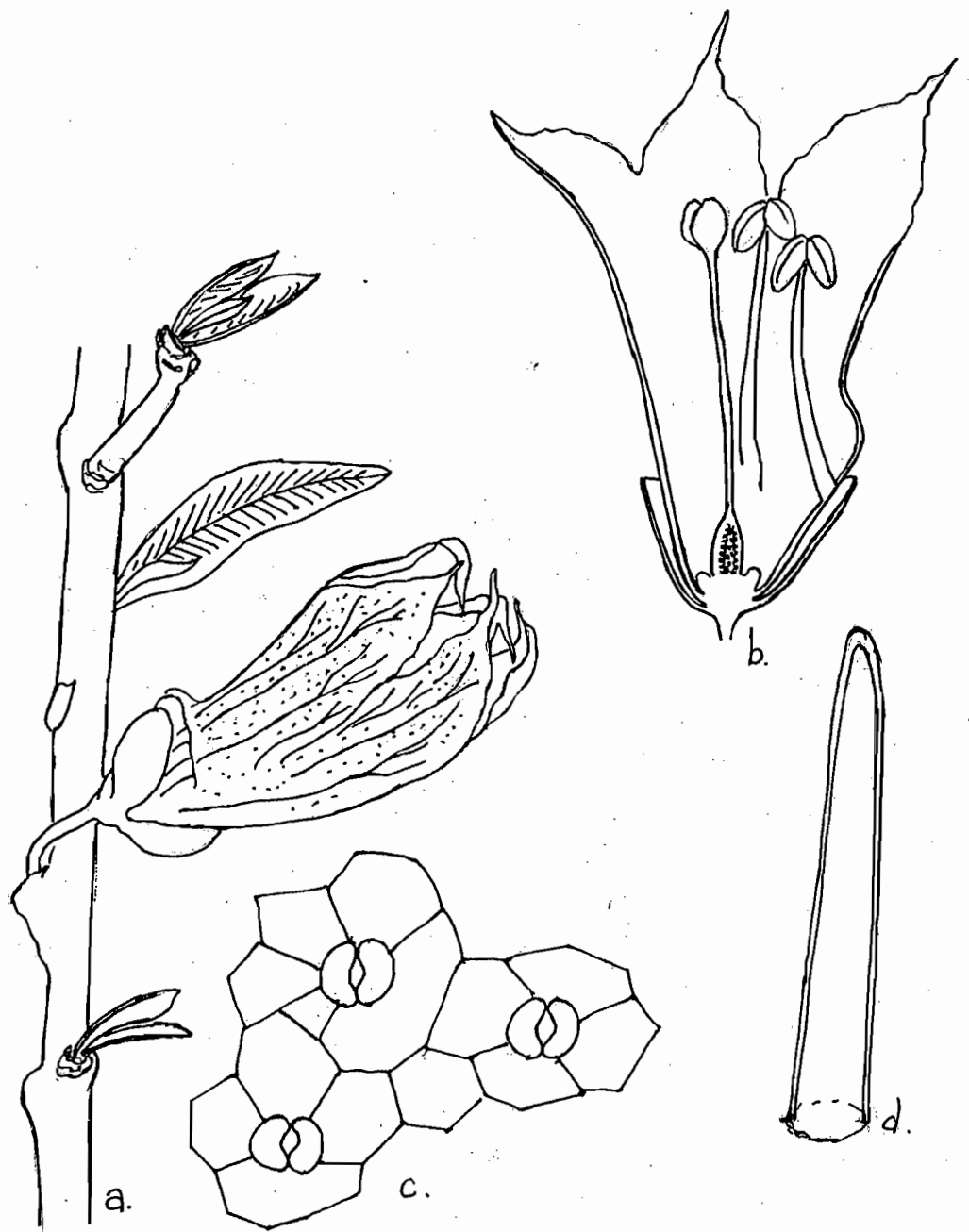


Fig. 382 *Crescentia cujete* L., a. habit, b. L.S. of flower, c. anomocytic stomata, d. unicellular trichome.

didynamous. Ovary 2-celled with numerous ovules. Capsules 30 cm long 4-celled. Seeds winged. (Fig. 383)

Vernacular name: Waras.

Flowers: February-Apr.

Micromorphology (Fig. 383)

The plant contained unicellular acicular trichomes with a bulbous base.

Stomata were anomocytic, and anisocytic.

D/322.

3. *Kigelia pinnata* Jacq. *Rev. Bign. (Bibi. Univ. Geneve)*. 24. 1838.

A tree up to 10 m tall. Leaves 9-20 cm long, rachis ribbed, tomentose or sparsely so; leaflets 5-9, ovate-oblong to elliptic-ovate upto 11 cm, coriaceous, scabrid, entire, acute or retuse, mucronate, base often oblique, midrib and veins prominent on undersurface, strigose. Panicles lax, pendulous. Flowers 6-7 cm broad. Calyx campanulate, glabrous.

Corolla throat wide. (Fig. 384)

Vernacular name: Topgolo.

Flowers: May-August.

Micromorphology (Fig. 384)

Only multicellular sessile glands were present.

Stomata were diacytic and anisocytic.

D/230.

4. *Millingtonia hortensis* L. f. *Suppl. Pl.* 291. 1782

An evergreen tree with corky bark reaching upto a height of 10 m. Leaves upto 50 cm long; imperfectly 2-3 pinnate, leaflets ovate-elliptic, upto 7 cm, acuminate sinuate-dentate. Flowers in terminal, many-flowered panicles opening in night. Flower buds doooping. Calyx 5-lobed. Corolla nicely fragrant, hypocrateriform, white, tube long, 5-lobed, 2-lipped. Stamens 4, didynamous, exserted; anthers with one fertile cell, other rudimentary. Disk cupular, crenate. Ovary linear-oblong; stigma 2-lobed. Fruit a capsule, 2-celled, seeds winged. (Fig. 385)

Vernacular name: Deshi Buch.

Flowers: December-May.

Micromorphology (Fig. 385)

Whole plant was glabrous.

Stomata were of anomocytic type.

D/289.

5. *Spathodea campanulata* P. Beauv. *Oware* 1: 47. t. 27-28. 1805.

An ornamental tree of 25 m high with a crown of odd-pinnate leaves of a length of about 45 cm long. Leaflets 9-13, elliptic-oblong. Flowers in erect racemes, borne on stout peduncles. Calyx golden-brown, spathaceous. Corolla bright red or reddish orange, campanulate; lobes 5, deltoid. Stamens 4, subequal, unequally inserted near the base of swollen portion of tube; anthers large, 2-celled. Ovary 2-locular. Capsules fingerlike containing about 500 tissue papery seeds. (Fig. 386)

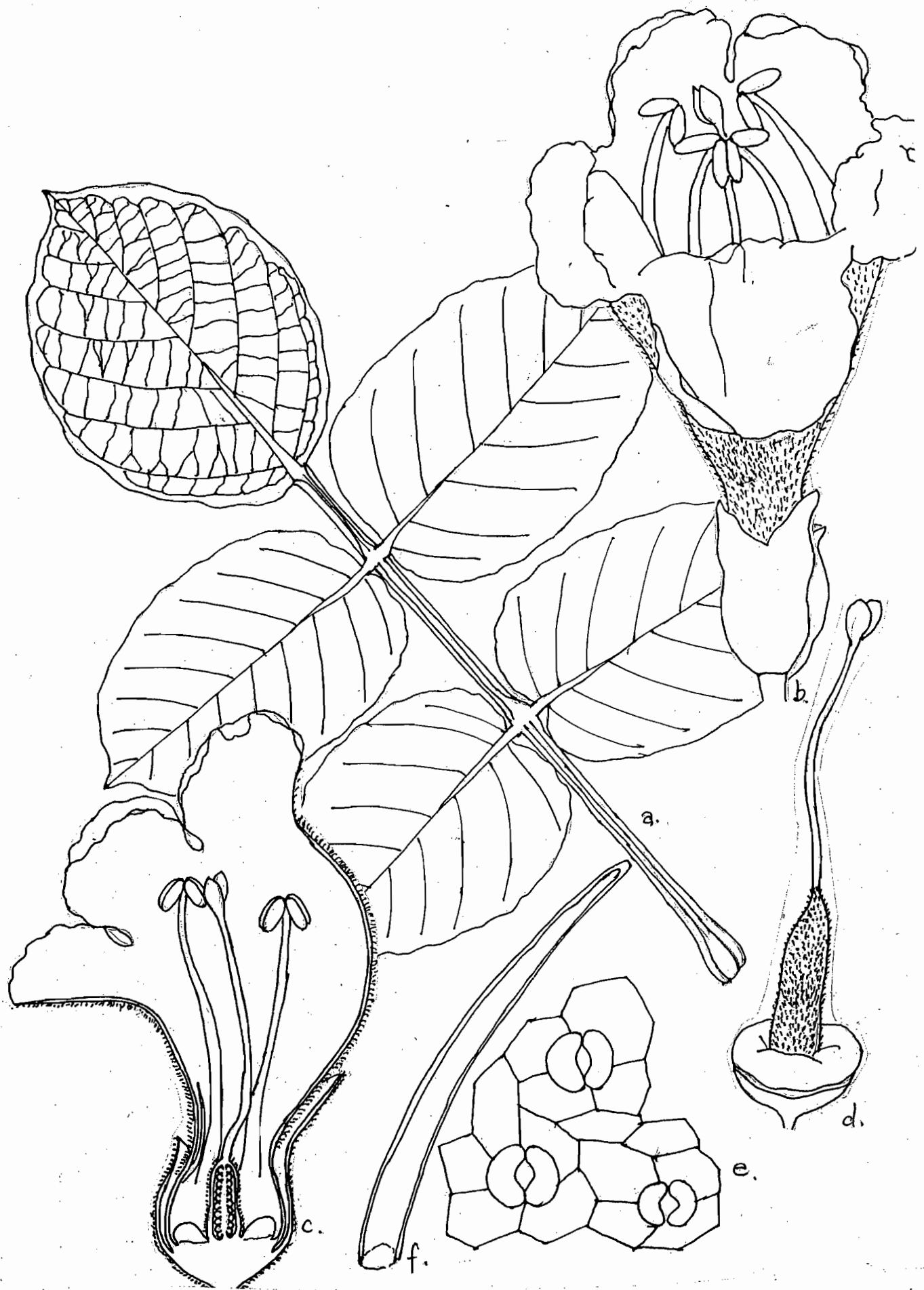


Fig. 383 *Heterophragma roxburghii* DC., a. habit, b. flower, c. L.S. of flower, d. gynoecium, e. anomocytic stomata, f. unicellular trichome.



Fig 384. *Kigelia pinnata* Jacq. a. habit, b. Stamen, c. gynoecium, d. L.S. of flower, e. diacytic stomata, f. anisocytic sotmata, g. multicellular sessile gland.

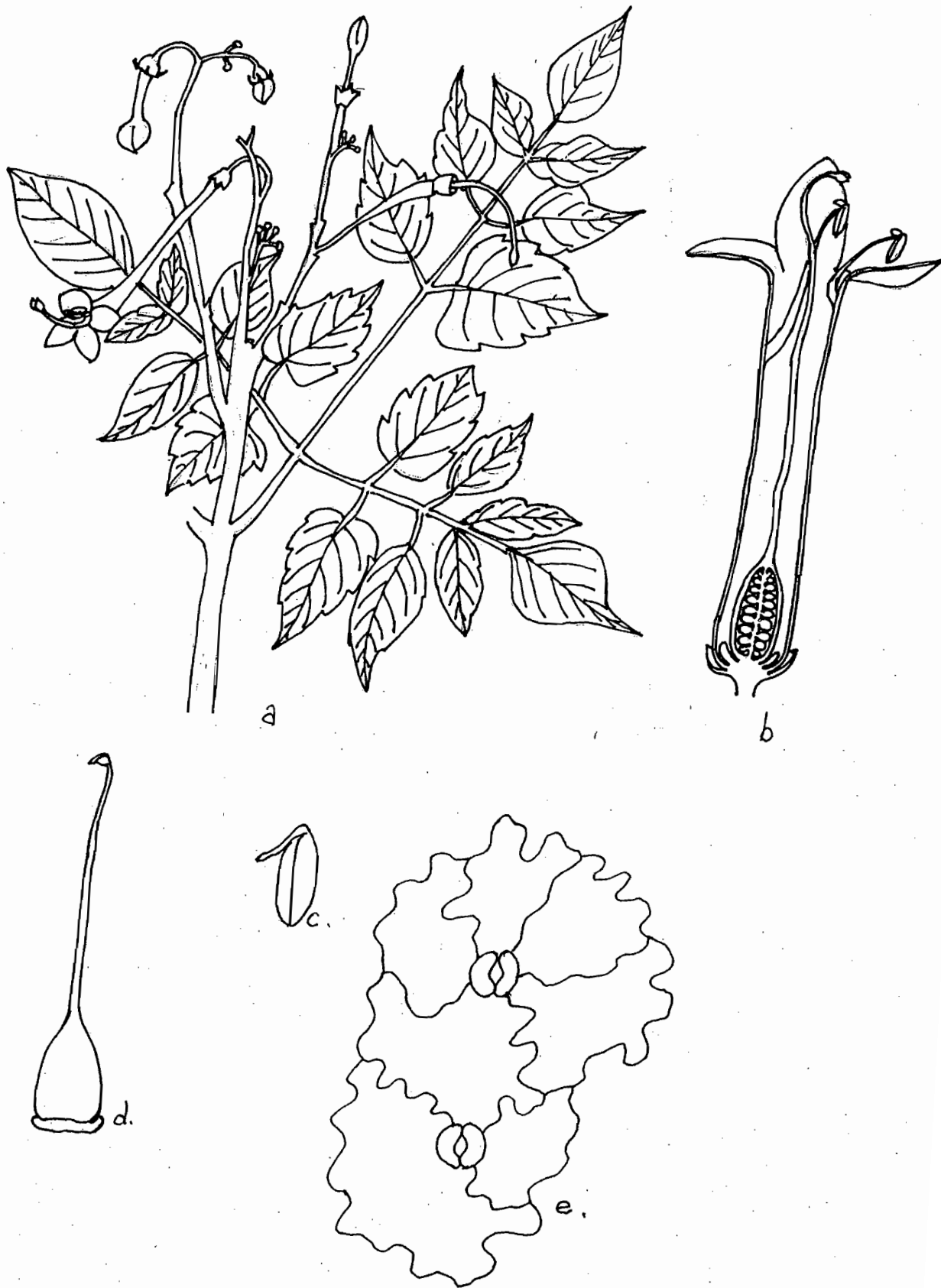


Fig. 385. *Millingtonia hortensis* L. f., a. habit, b. L.S. of flower, c. anther cell, d. gynoecium, e. anomocytic stomata.

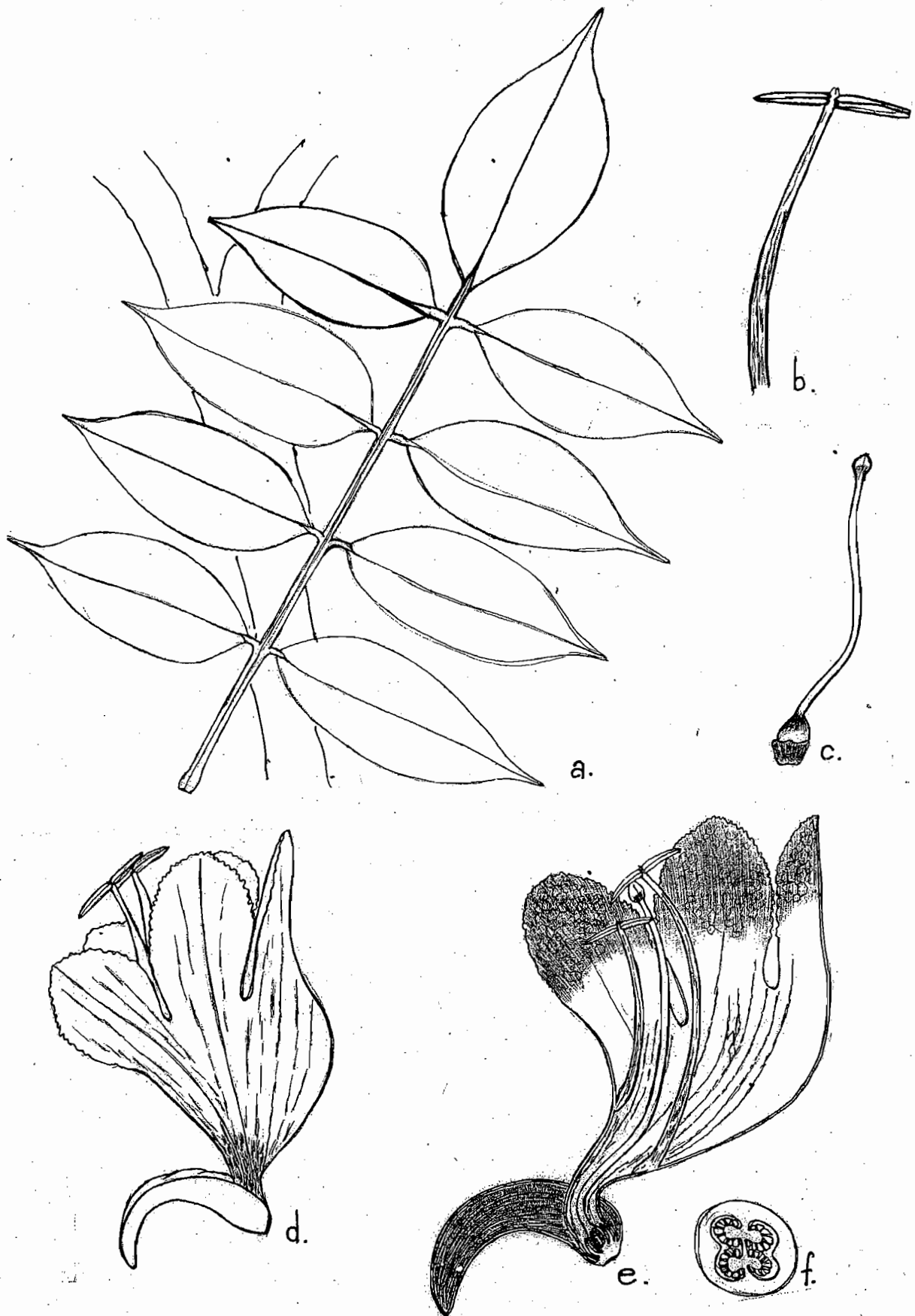


Fig. 386. *Spathodea campanulata* Beauv., a. habit, b. stamen, c. gynoecium, d. flower, e. L.S. of flower, f. T.S. of ovary.

Vernacular name: Rugtoora.

Flowers: July-Dec.

Micromorphology (Fig. 387)

The plant showed presence of multicellular, uniseriate, unbranched trichome with broad lumen and a thick wall.

Stomata were of anomocytic, diacytic, and anisocytic type.

D/265.

6. *Tabebuia rosea* (Bertol) DC., *Prodr.* 9:215. 1845.

A tall tree of about 10 m with palmately penta-foliolate leaves. Leaflets elliptic oblong, varying in length. Terminal leaflets upto 15 cm long. Flowers yellow or rosy-pink borne in terminal panicles. Calyx bilabiate. Corolla infundibuliform having yellow throat, upto 8 cm long. Fruit a linear dehiscent capsule containing many winged seeds. (Fig. 388)

Micromorphology (Fig. 388)

The plant contained three types of glands: 1) three-celled uniseriate gland, 2) gland with multicellular head and two-celled uniseriate stalk, 3) multicellular sessile gland.

Stomata were tetracytic and anomocytic.

D/237.

Pedaliaceae

1. *Pedaliium murex* Linn. *Syst. Nat.* ed. 10 (1759) p. 1123.

A branched herb with stem reaching upto 40 cm high. Leaves ovate-oblong, coarsely sublobate, fleshy, upto 5 cm, the lower side usually covered with minute scales. Flowers axillary, solitary. Calyx minutely scaly outside, divided rather more than ½-way down; lobes 5, linear-triangular, acute. Corolla yellow; lobes rounded. Filaments glandular-hairy at the base. Fruit pyramidal bluntly 4-angled, with stout sharp conical horizontal spines from the angles. (Fig. 389)

Vernacular name: Ubhu gokharu.

Flowers: July-January.

Micromorphology (Fig. 389)

The plant showed presence of multicellular, glandular trichome differentiated into a 2-4 celled head and a single celled stalk.

Stomata were of anomocytic and anisocytic type.

D/323.

**2. *Sesamum orientale* L. *Sp. Pl.* 2: 634. 1753.
(*Sesamum indicum* L.)**

An erect branched, annual upto 65 cm tall. Leaves ovate-oblong, lobed or 3-partite, upto 18 cm long, petiole upto 12 cm long. Flowers with strong unpleasant odour, bracteate; pedicel with 2 glands on either side at the base. Calyx lobes linear to narrowly lanceolate. Petals mauve colored, obtuse. Stamens didynamous. Ovary 2-celled, oblong. Fruit oblong, loculicidal, capsule. Seeds black, brown or white, smooth. (Fig. 390)

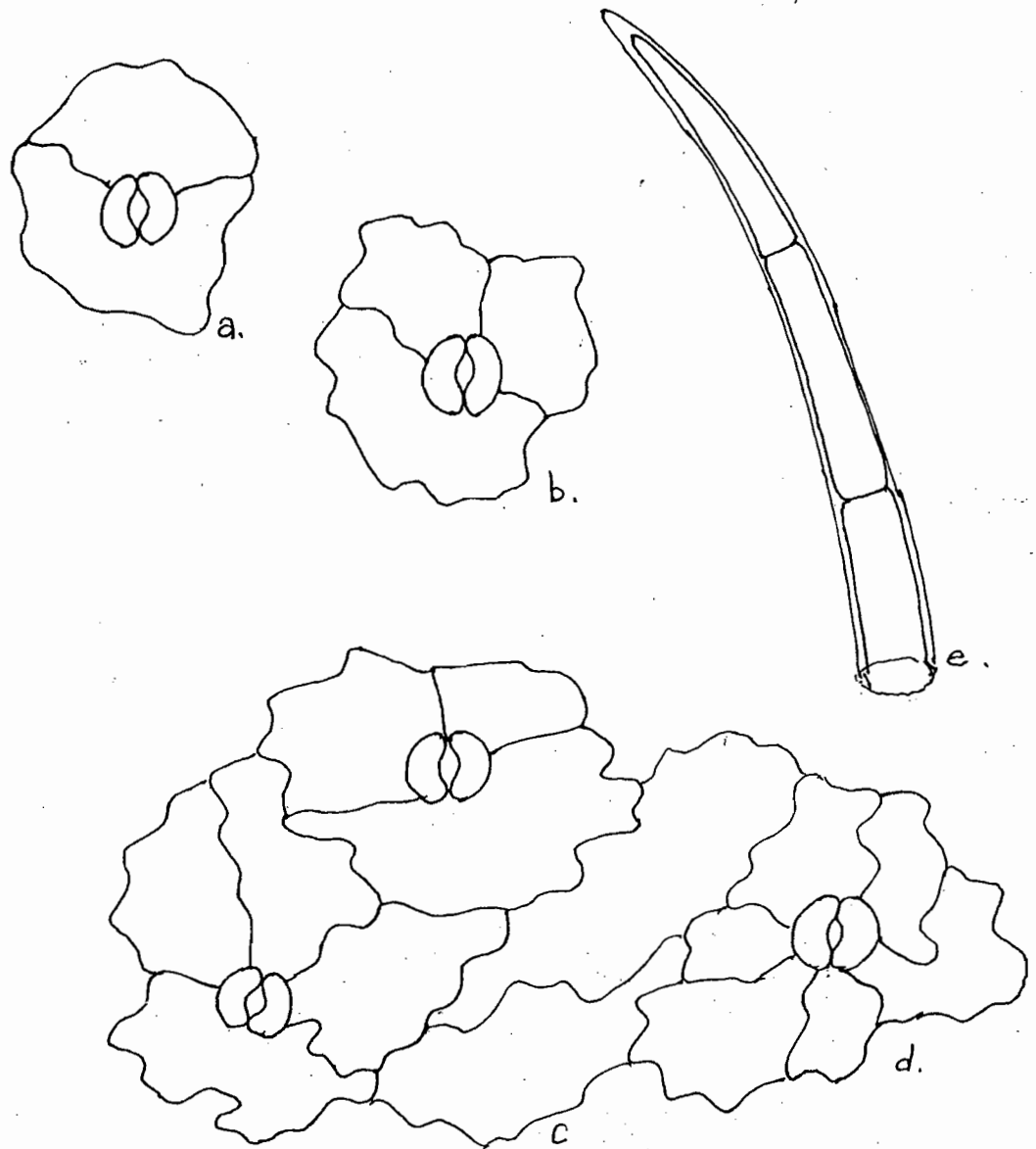


Fig. 387. *Spathodea campanulata* Beauv., a. diacytic stomata, b. anisocytic stomata, c-d. anomocytic stomata, e. multicellular uniseriate trichome.

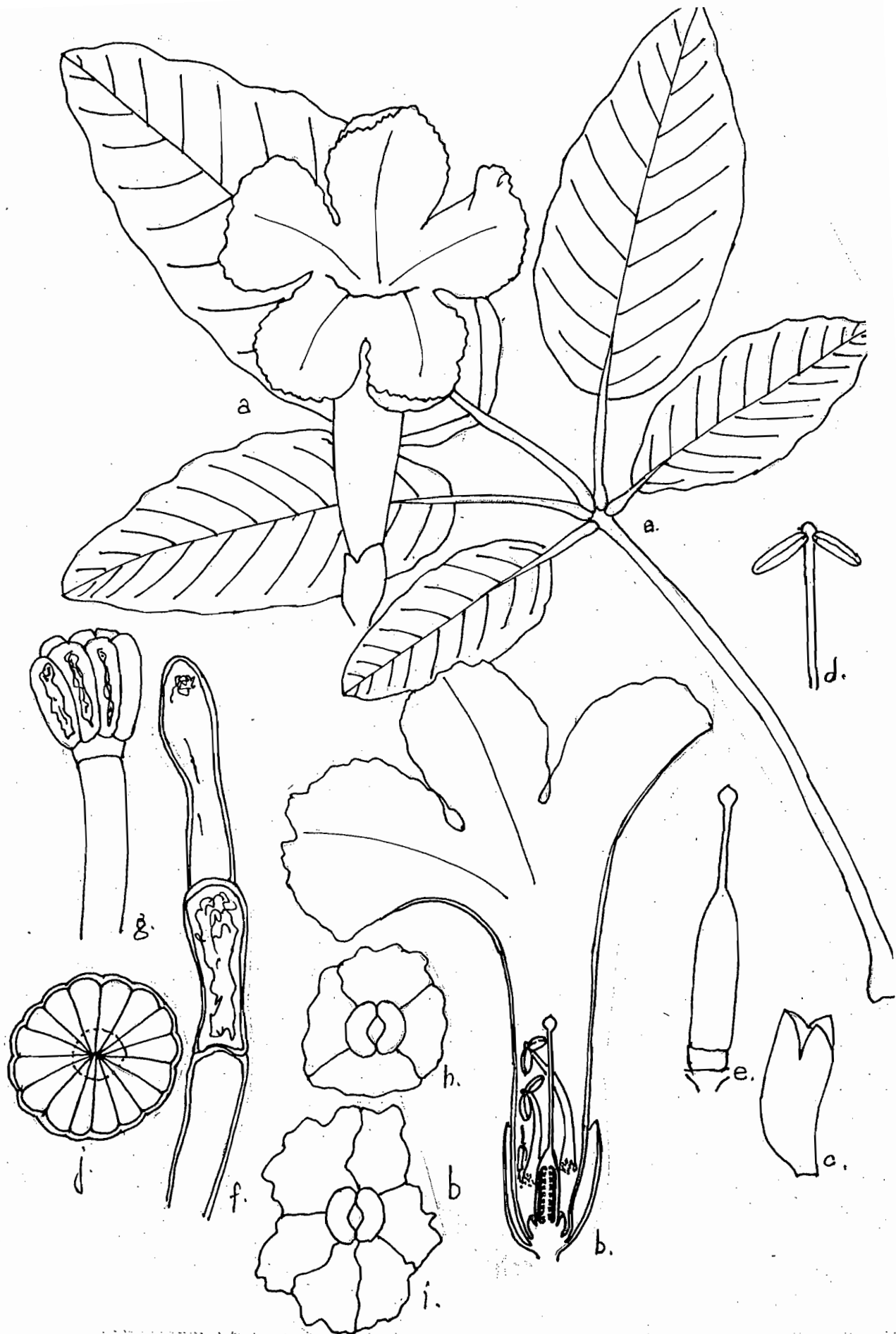


Fig. 388. *Tabebuia rosea* (Bertol) DC., a. habit, b. L.S. flower, c. calyx, d. stamen, e. gynoecium, f. three-celled uniseriate gland, g. gland with multicellular head and two-celled uniseriate stalk, h. tetracytic stomata, i. anomocytic stomata j. multicellular sessile gland.

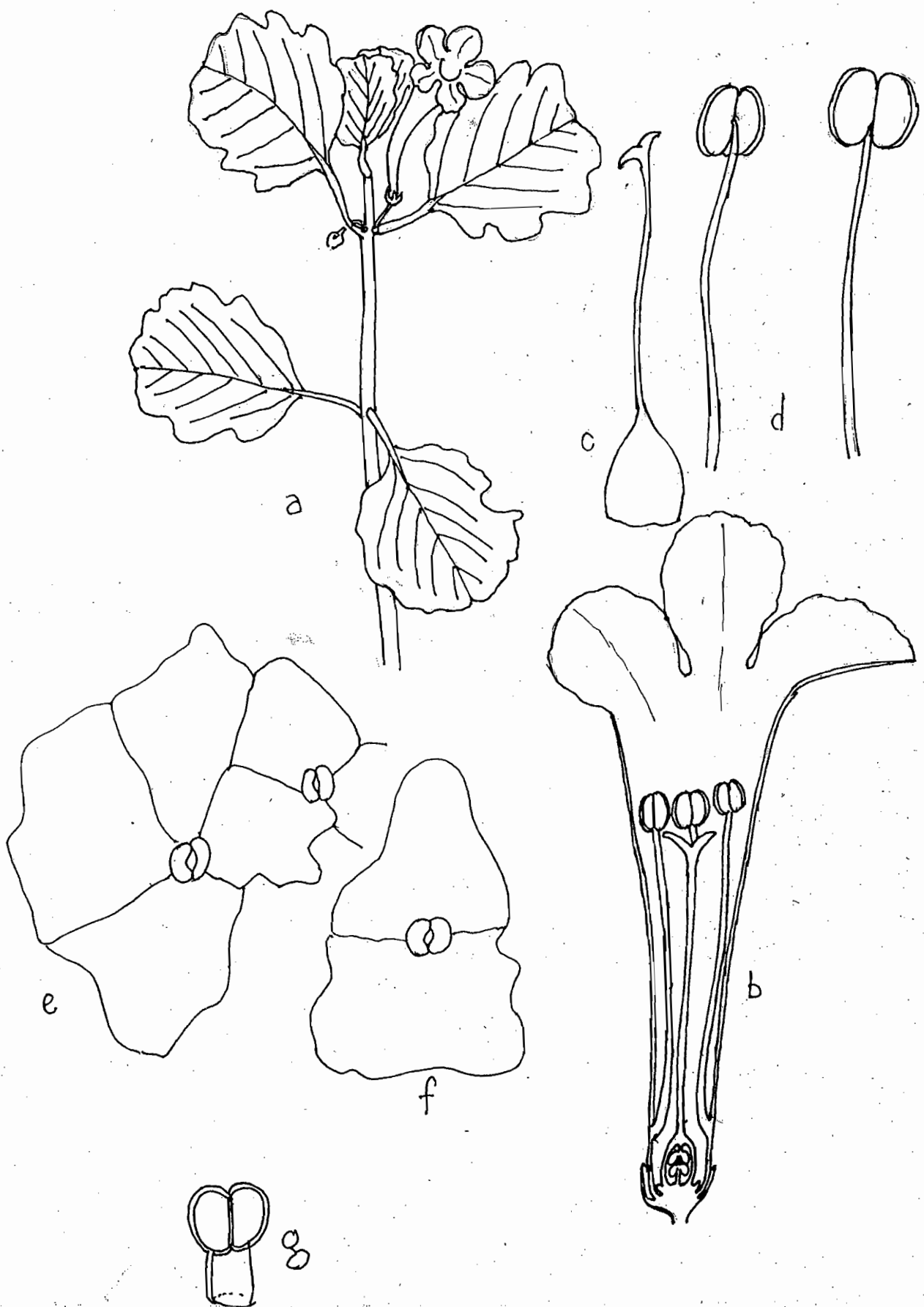


Fig. 389 *Pedalium murex* L., a. habit, b. L.S. of flower, c. gynoecium, d. stamen, e. anomocytic stomata, f. diacytic stomata, g. gland with two celled head and a single celled stalk.

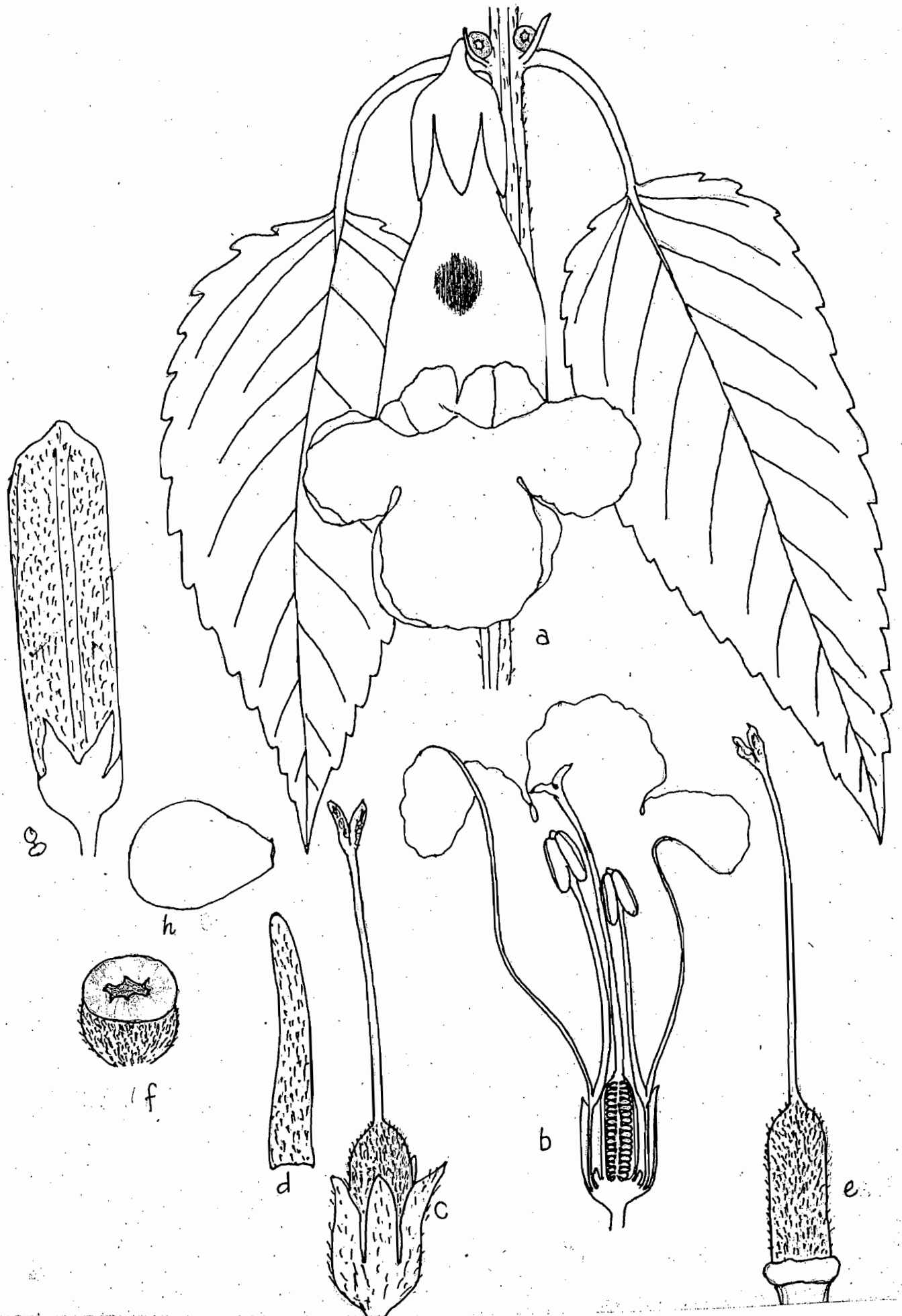


Fig. 390. *Sesamum orientale* L., a. habit, b. L.S. flower, c. gynoecium, d. stipule, e. gynoecium, f. extra floral gland, g. capsule, h. seed.

Vernacular name: Tal.

Flowers: June-October.

Micromorphology (Fig. 391)

The plant showed presence of multicellular, non-glandular, uniseriate, unbranched trichome with broad cells and the apical cells was somewhat blunt at the tip.

Stomata were of anomocytic and anisocytic type.

D/335.

Martyniaceae

1. *Martynia annua* L. Sp. Pl. 2: 618. 1753.

(*Martynia diandra* Gloxin.)

A branched herb with succulent, tomentose-glandular stem reaching to a height of 1.5 m tall. Leaves subcordate, upto 15 cm long, margin dentate. Flowers lilac, mottled red, blue or yellow inside; bracteoles 1-3, oblong, petaloid or lilac. Sepals

5, distinct, oblong-lanceolate. Corolla tube gibbous, 5-lobed; lobes tinged purple, obtuse.

Fertile stamens 2; anther lobes divaricate, oblong; staminodes 2, slightly curved. Ovary globose, situated on the subglobose disc; stigmas 2, flat. Capsule more or less ovoid, 2 valved, with the style splitting into 2 curved, lignified and spiny processes. (Fig. 392)

Variation observed: in classical texts the anthers cells are reported to be confluent, like specimens available here, all had divaricate anthers.

Vernacular name: Vinchhudo.

Flowers: August-November.

Micromorphology (Fig. 393)

Whole plant showed presence of multicellular, glandular trichome differentiated into multicellular 6-8 celled head and a multicellular, uniseriate stalk.

Stomata were of anomocytic and anisocytic type.

D/308.

Acanthaceae

1. *Adhatoda zeylanica* Medic., Hist. & Comment. Acad. Elect. Sci. Theod.-Palat. 6: 393. 1790.

(*Adhatoda vasica* Nees.)

A densely branched shrub reaching 3 m high. Leaves elliptic-lanceolate, upto 20 cm long, acuminate. Flowers in long dense axillary spikes; bracts elliptic; bracteoles oblong-lanceolate. Calyx segments imbricate, oblong-lanceolate, 3-nerved. Corolla white, 3 cm long; upper lip ovate-oblong, curved, notched; lower lip as long as the upper, rounded, the middle lobe the broadest. Anther-cells apiculate at the base. Ovary 2-celled, slightly stalked. Seeds orbicular-oblong. (Fig. 394)

Vernacular name: Arduisi.

Flowers: August-November.

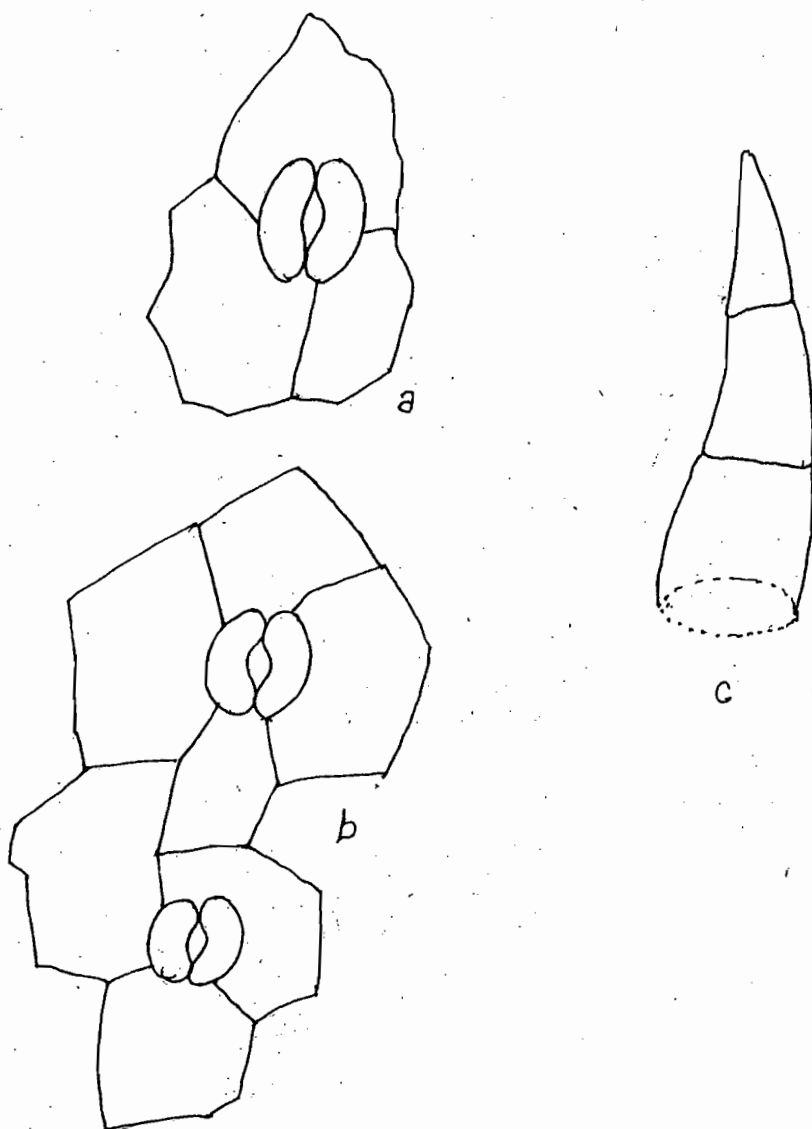


Fig. 391. *Sesamum orientale* L., a. anisocytic stomata, b. anomocytic stomata, c. multicellular uniseriate three-celled trichome.



Fig. 392. *Martynia annua* L., a. habit, b. flower, c. L.S. flower, d. gynoecium, f. bract, g. bracteole, h. sepal.

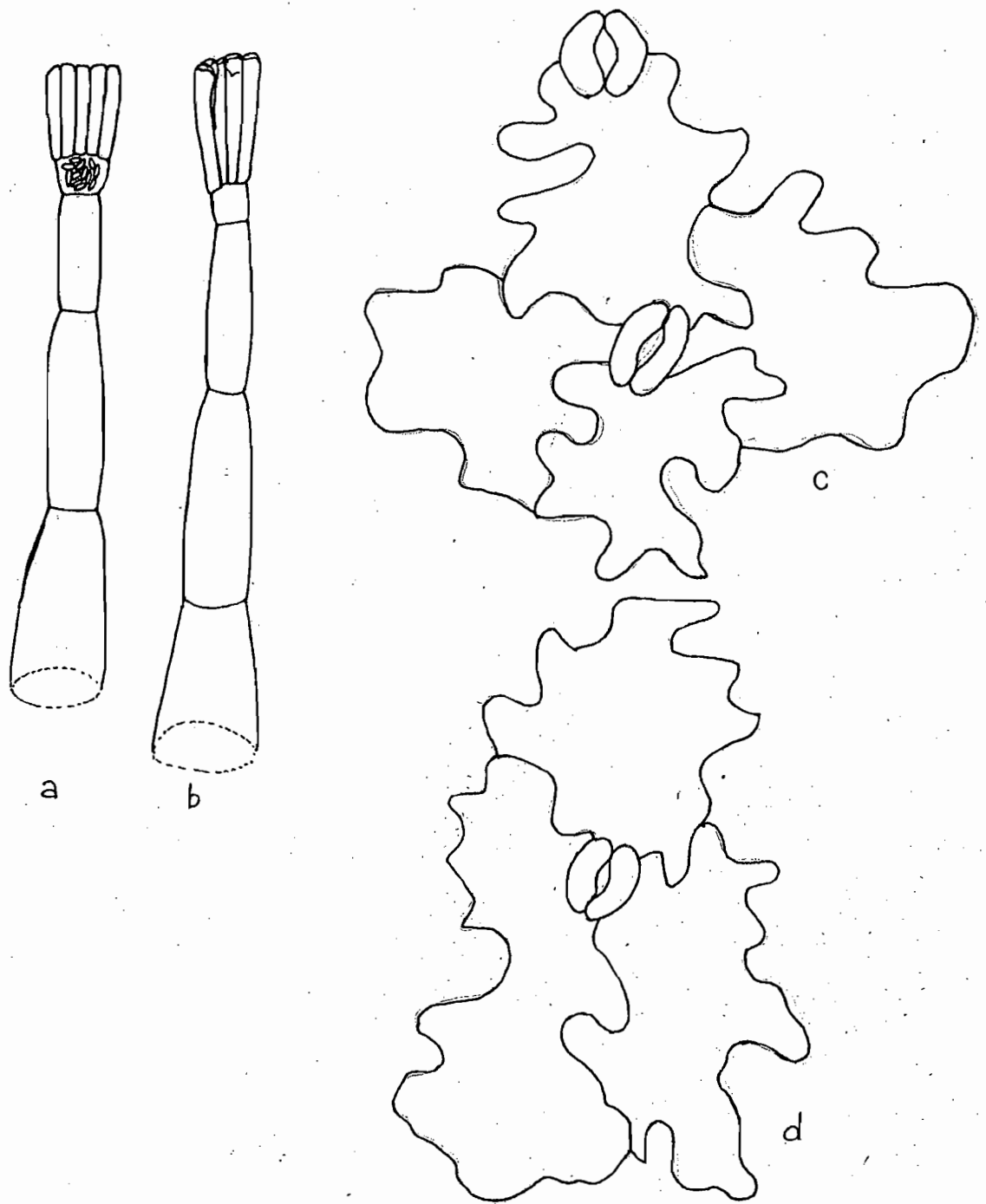


Fig. 393. *Martynia annua* L., a-b. gland with many-celled head and uniseriate stalk, c. anomocytic stomata, d. anisocytic stomata.

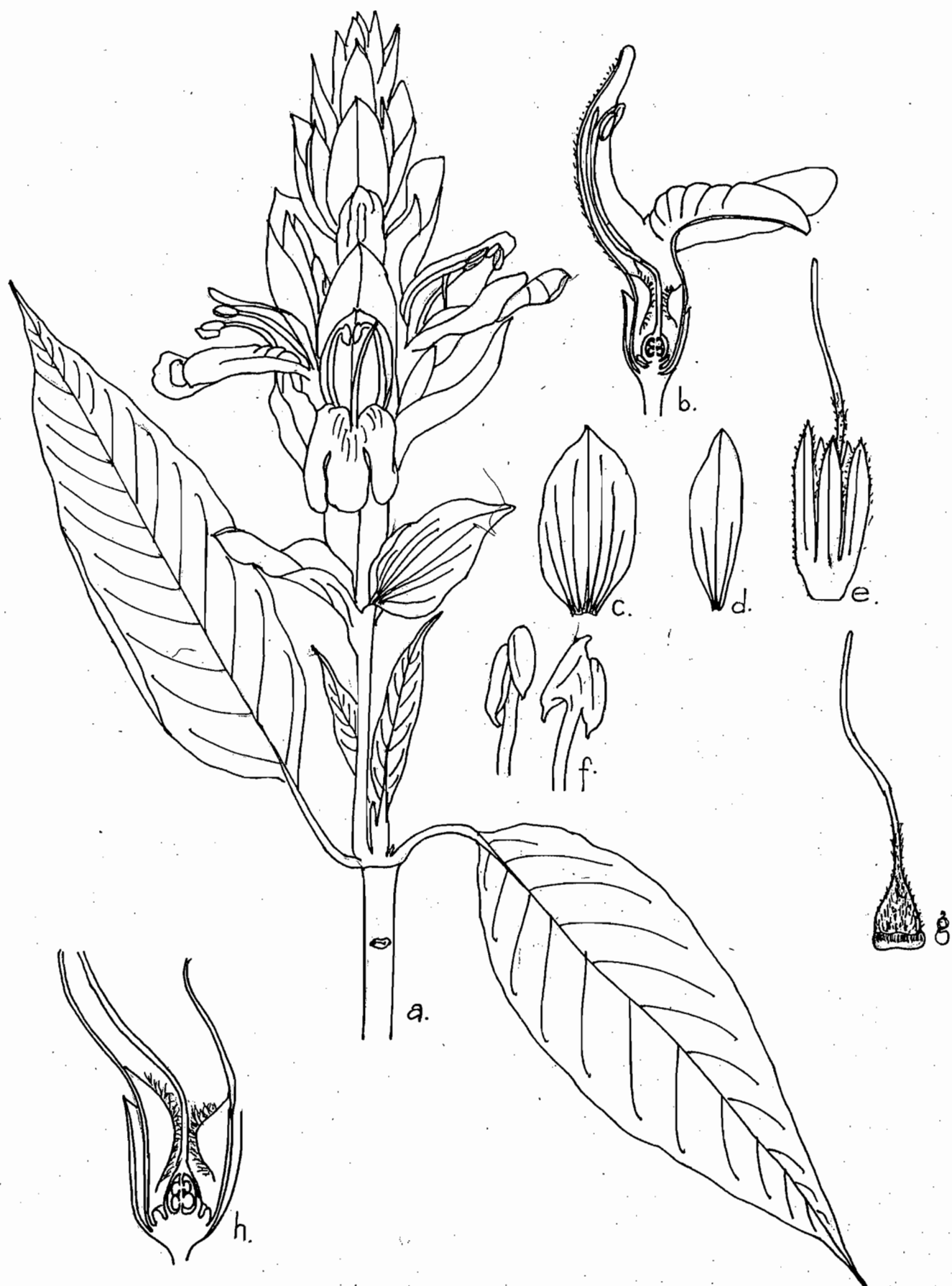


Fig. 394 *Adhatoda zeylanica* Medic., a. habit, b. L.S. flower, c. bract, d. bracteole, e. calyx with gynoecium, f. stamen, g. gynoecium, h. L.S. of flower enlarged.

Micromorphology (Fig. 395)

The leaf showed presence of multicellular, uniseriate, unbranched, non-glandular trichome with warty surface.

The corolla showed presence of multicellular, uniseriate, unbranched, non-glandular trichome with cells having a broad distal portion in one type and another type had cells with broad basal part; the cells had intercellular connections in their cross walls.

Stomata were of diacytic type.

D/135.

2. *Barleria prionitis* Linn. *Sp. Pl.* (1753) p. 636.

A prickly branched shrub upto 2 m high. Leaves elliptic, acuminate, upto 18 cm long, bristle-tipped; petioles with 3 divaricate acicular spines. Flowers solitary; bracts foliaceous, lanceolate, bristle-tipped; bracteoles linear, bristle-tipped. Calyx segments unequal, lanceolate-oblong with a mucro. Corolla 2-lipped, upto 4 cm long;

yellow; upper lip deeply 4-lobed, obovate; lower lip oblong-obovate. Stamens 2 fertile and 2 staminodes; filaments of the fertile stamens exerted beyond the corolla-tube.

Ovary 2-celled. Capsules ovoid; seeds 2 from below the middle, tomentose. (Fig. 396)

Vernacular name: Khadhaserio.

Flowers: October-January.

Micromorphology (Fig. 397)

The plant showed two types of trichomes 1) unicellular, non-glandular, thick walled acicular with round or elongated bottom. 2) multicellular, glandular trichome differentiated into a 4-5 celled head and a single celled stalk.

Stomata were of diacytic.

D/449, 556-557, 759.

3. *Blepharis boerhaviaefolia* Pers. *Syn.* V. 2 (1807) p. 180.

A divaricately branched prostrate herb upto 60 cm long. Leaves elliptic, in a whorl of 4, unequal, upto 5 cm long, serrate. Flowers axillary, 2 or 3 together; bracteoles 8 in opposite pairs, 3 pairs spatulate, strongly 3-nerved, the fourth pair rather more long, linear, strongly 3-nerved. Calyx-segments lanceolate; 3-nerved from the base. Corolla bilipped; pale blue with a yellow spot on the lower lip, upper lip subobsolete; lower lip obovate, with 3-5 rounded lobes. Stamens 4, didynamous; anthers with 1 large cell with densely bearded margins, the other cell small or obsolete. Disk annular. Ovary 2-celled, ovules 2 in each cell; stigma shortly 2-fid. Capsules ovoid, 2-seeded. Seeds echinate with obtuse spines. (Fig. 398)

Flowers: October-December.

Micromorphology (Fig. 398)

The plant contained multicellular uniseriate trichomes.

Stomata were diacytic.

D/170, 421, 841.

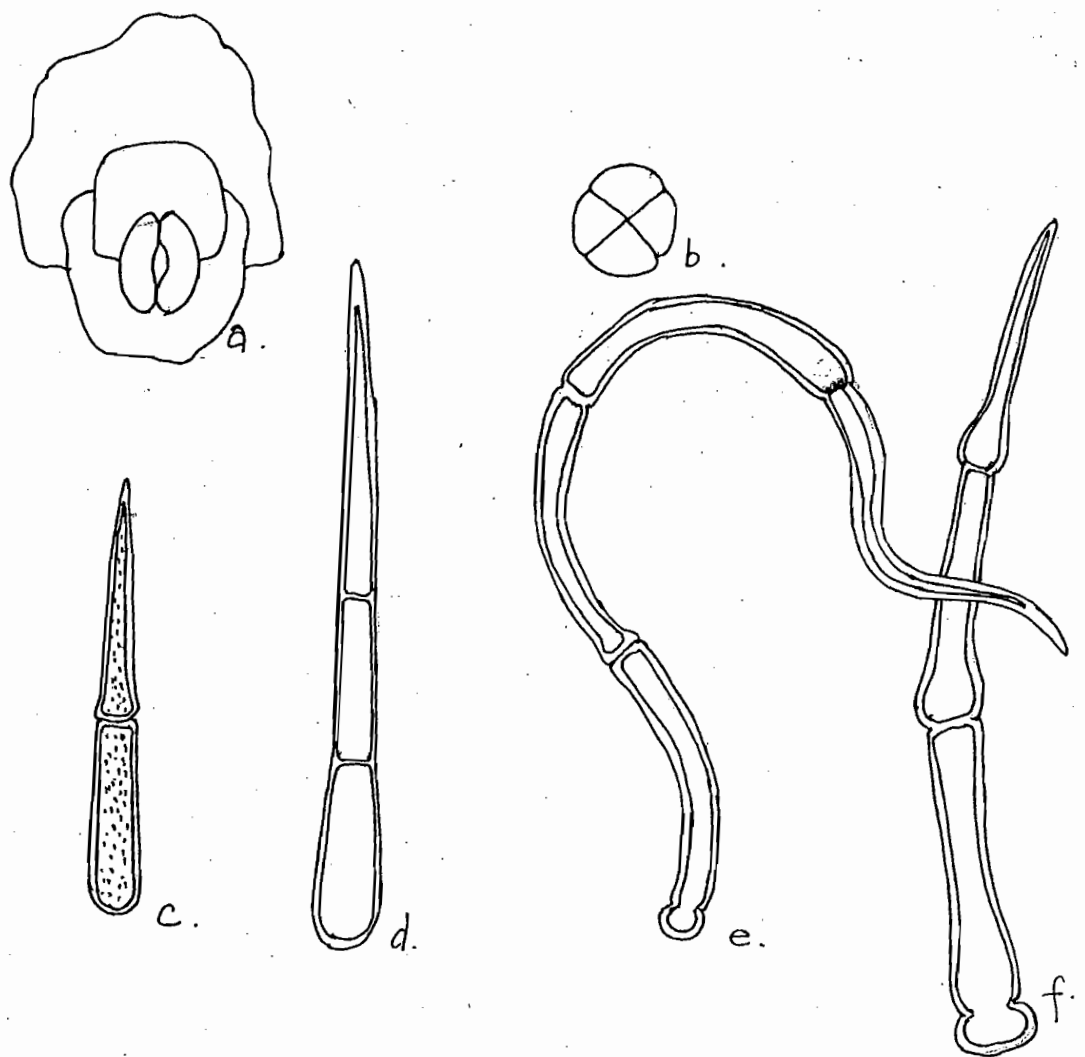


Fig. 395 *Adhatoda zeylanica* Medic., a. diacytic stomata, b. multicellular sessile gland, c-d. two-three celled uniseriate trichome with pitted wall, e-f. uniseriate three-four long celled trichome.

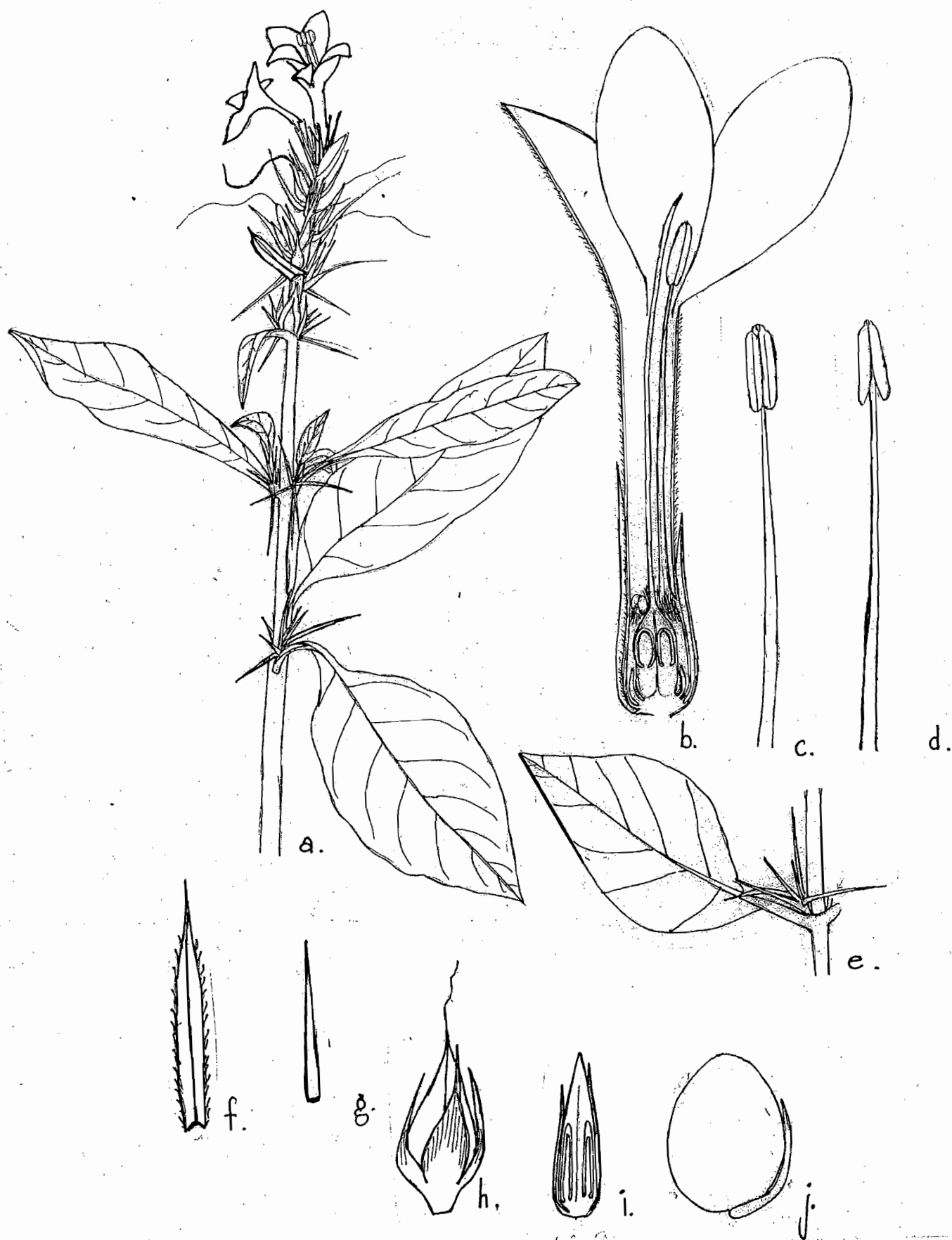


Fig. 396. *Barleria prionitis* L., a. habit, b. L.S flower, c-d. stamen, e. spines, f. bract, g. bracteole, h. capsule, i. L.S capsule, j. seed.

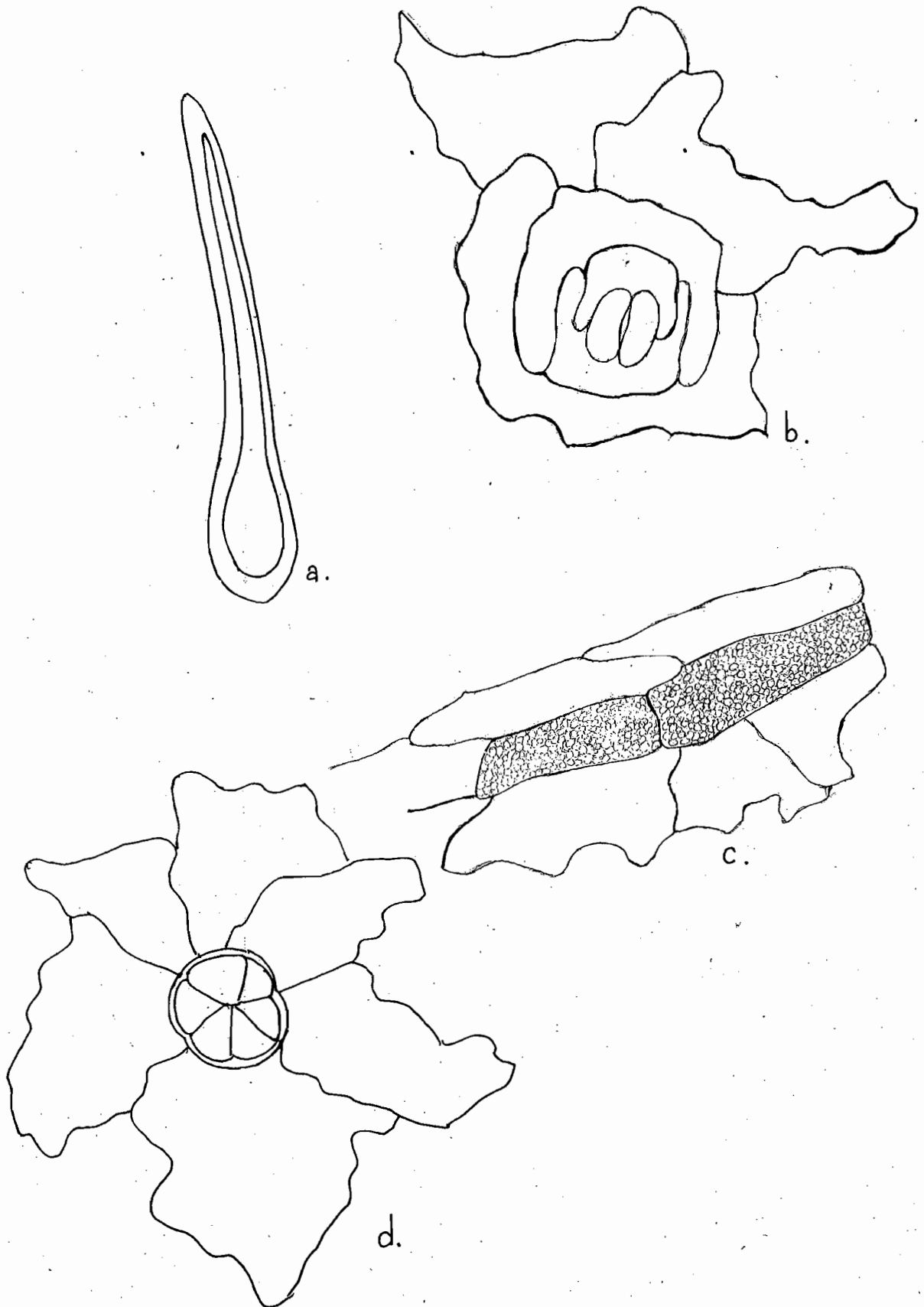


Fig. 397 *Barleria prionitis* L., a. unicellular trichome, b. diacytic stomata, c. cystolith, d. multicellular sessile gland.

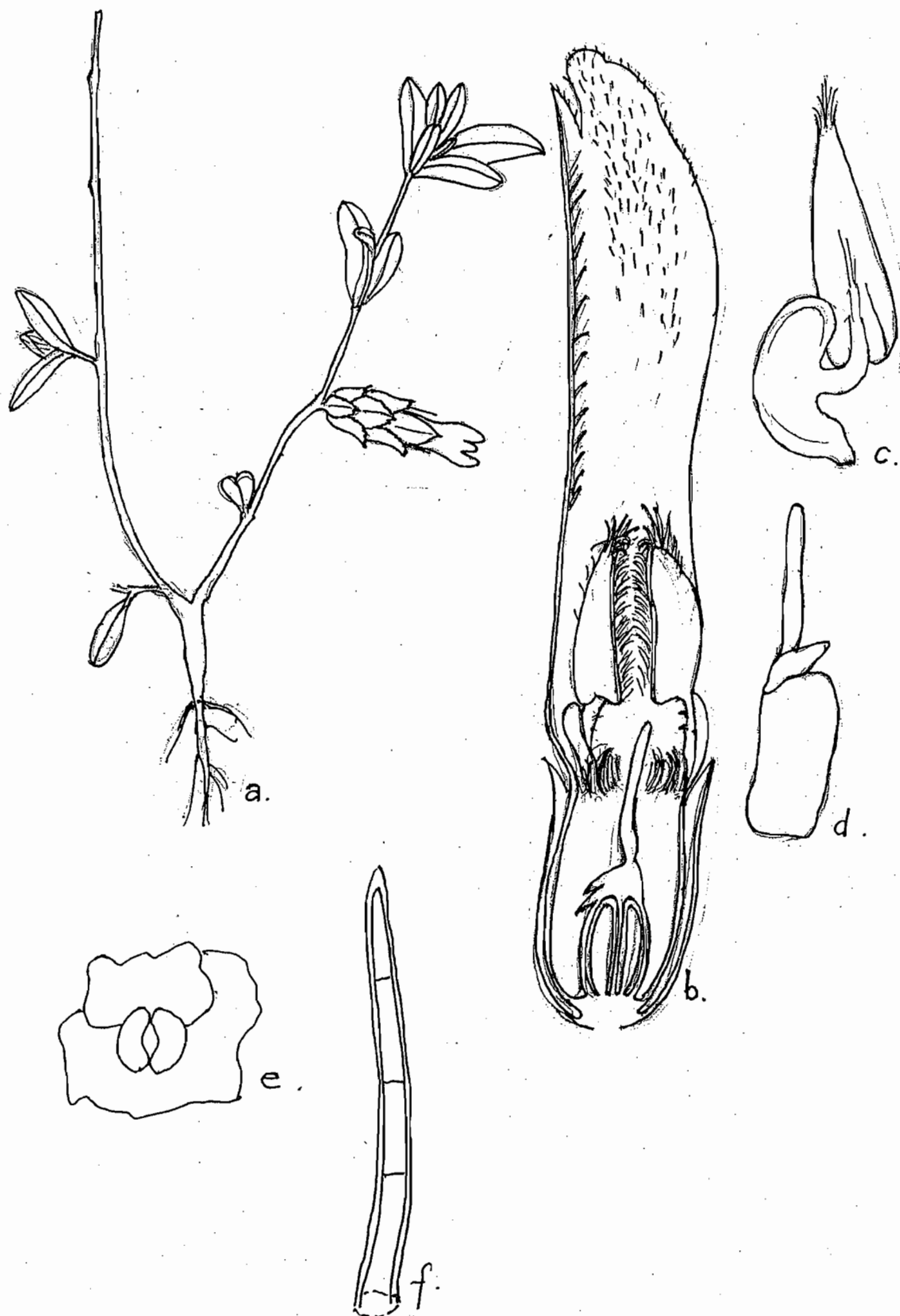


Fig 398. *Blepharis boerhaviaefolia* Pers., a. habit, b. L.S. flower, c. stamen, d. gynoecium, e. diacytic stomata, f. multicellular uniseriate trichome.

4. *Daedalacanthus roseus* T. Anders. in Journ. Linn. Soc. V. 9 (1867) p. 487.

A branched herb with stems upto 2 m high. Leaves oblong-lanceolate, upto 20 cm long, acuminate. Flowers in axillary and terminal spikes often 15 cm long; bracts obovate, with a reflexed mucro, white with very prominent raised green nerves. Bracteoles linear, acute. Calyx 5-lobed, white, lobes lanceolate with a strong midnerve. Corolla funnel-shaped, blue, fading to purple or red; tube slender, lobes oblong-obovate. Stamens 2. Ovary 2-celled; ovules 2 in each cell. Capsules clavate, pointed. Seeds hygroscopically hairy. (Fig. 399)

Vernacular name: Dashmuli.

Flowers: November-January.

Micromorphology (Fig. 399)

Whole plant was glabrous. Cystoliths were seen in leaves on surface view.

Stomata were of diacytic type.

D/273.

5. *Ecbolium ligustrinum* (Vahl) Vollesen Kew Bull. 44: 651. 1989.

An erect branched low shrub with elliptic-lanceolate, acuminate, upto 18 cm long leaves. Flower in terminal spikes; bracts foliaceous, elliptic-lanceolate; bracteoles lanceolate. Calyx segments linear-lanceolate, acute. Corolla bluish-green, reaching 4 cm long; upper lip narrowly linear, notched at the apex; lower lip divided almost to the base into 3 lobes. Stamens 2; anther cells 2, linear. Ovary 2-celled; ovules 2 in each cell; stigma of 2 short divaricate lobes. Capsules battledore-shaped, pointed. (Fig. 400)

Flowers: October-January.

Micromorphology (Fig. 401)

The leaf showed presence of two types of trichomes: 1) multicellular, uniseriate, unbranched, non-glandular trichome with swollen joints and thick walls. 2) multicellular, glandular trichome differentiated into a 6-8 celled head and a single celled stalk.

The corolla showed presence of multicellular, uniseriate, unbranched, non-glandular trichome with swollen joints and thick walls.

The sepal showed presence of multicellular, glandular trichome differentiated into a 4 celled head and 2 celled stalk with basal rounded cell.

The bract showed presence of multicellular, glandular trichome differentiated into a 4-8 celled club shaped head and a single celled stalk.

The bracteole showed two celled, non-glandular trichome in which the cells were arranged end to end.

The leaf surface also showed presence of cystolith.

Stomata were of diacytic type.

D/355.

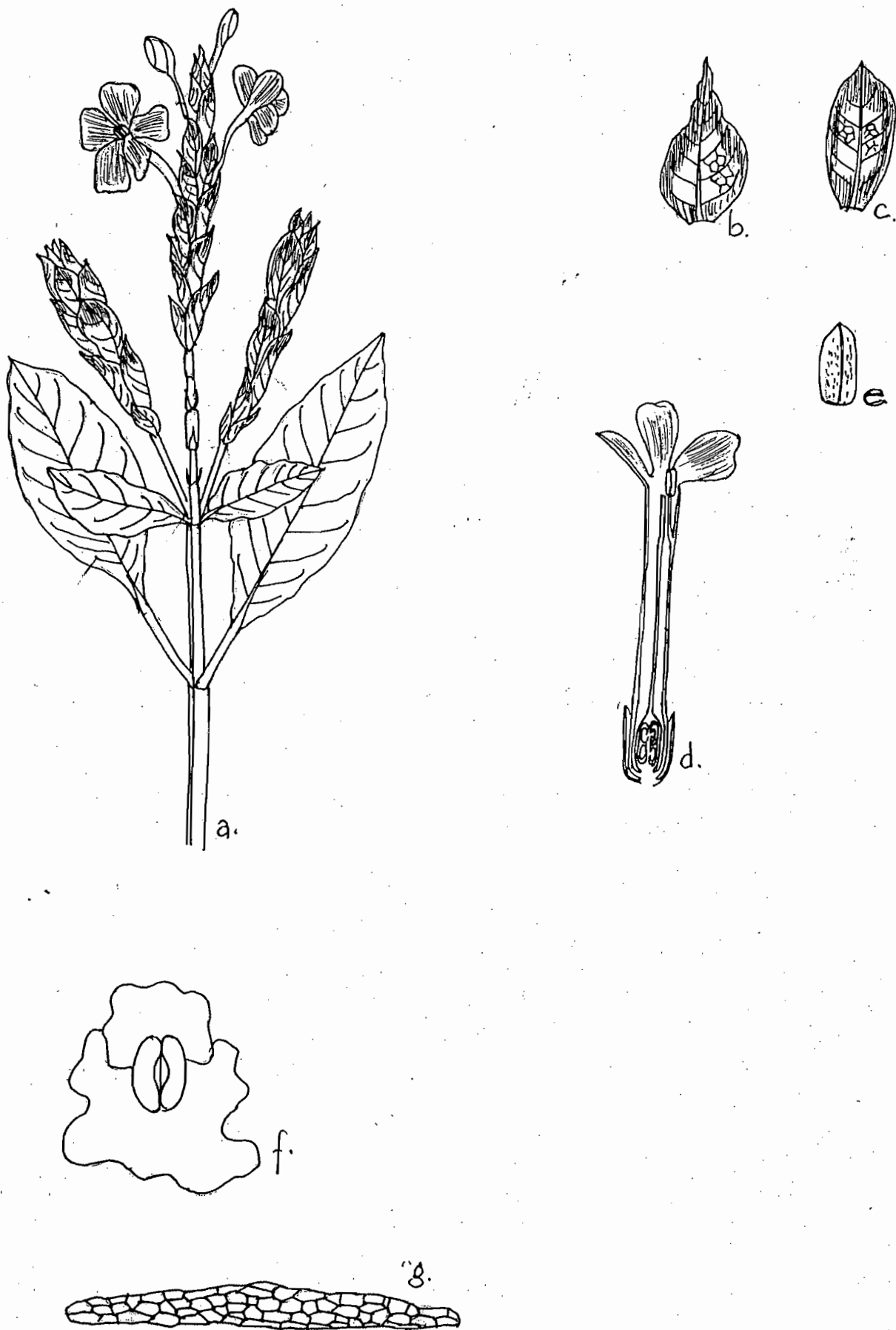


Fig. 399. *Daedalacanthus roseus* Anders., a. habit, b. bract, c. bracteole, d. L.S. of flower, e. capsule, f. diacytic stomata, g. cystolith.

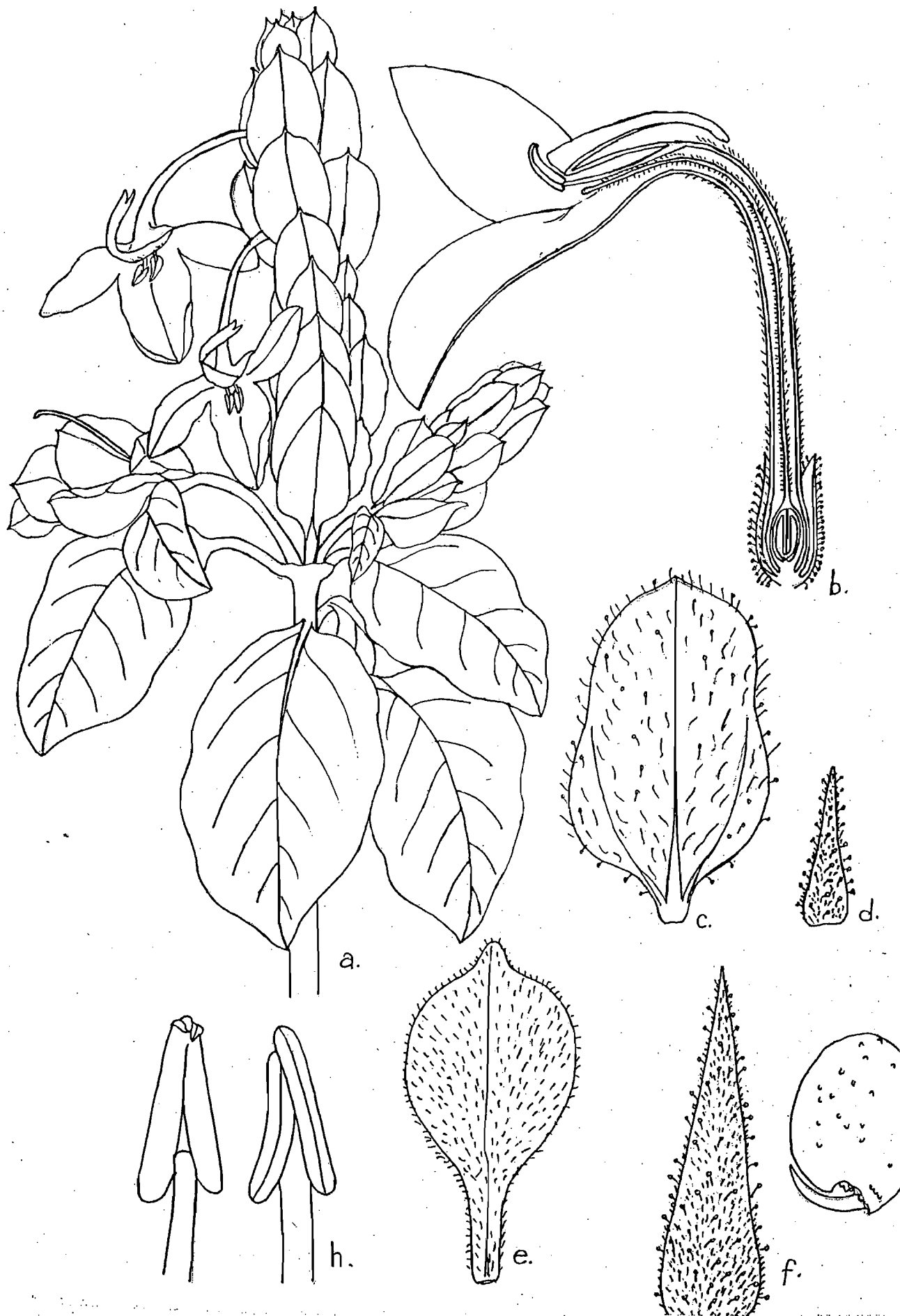


Fig. 400. *Ecbolium ligustrinum* Vollesen., a. habit, b. L.S. of flower, c. bract, d. bracteole, h. stamen, e. capsule, f. sepal, g. seed.

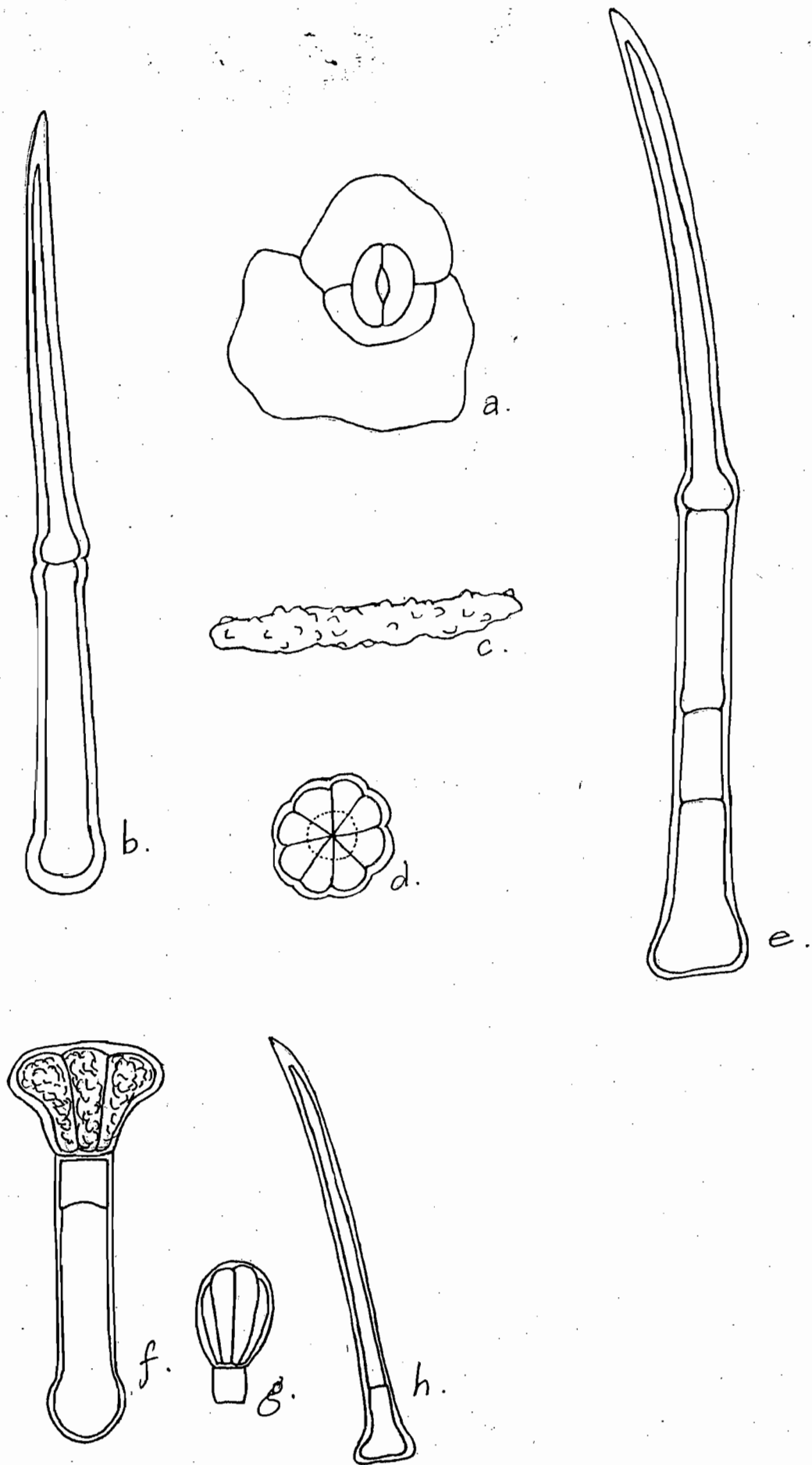


Fig. 401. *Ecbohium ligustrinum* Vollesen., a. diacytic stomata b, e, & h. two to many celled uniseriate trichome, c. cystolith, d. multicellular sessile gland, f. gland with multicellular head and 2-celled stalk, g. gland with multicellular head and single celled stalk.

**6. *Elytraria nodosa* E. Hossain, *Notes Roy. Bot. Gard. Edinburgh*, 31: 379. 1972.
(*Tubiflora acaulis* O. Kuntze.)**

A stemless herb with radiating short-petioled radical, spatulate leaves about 20 cm long. Scapes, clothed spirally throughout their length with small rigid bracts, upto 30 cm long. Flowers borne in branched spikes. Bracts ovate, with ciliate margins; bracteoles linear, penicillate at the apex. Calyx 4-partite, lobes lanceolate. Corolla pale-blue or white, funnel shaped, 2-lipped. Stamens 2, perfect; anthers elliptic, cells 2. Disk small. Ovary 2-celled; ovules 6-10 in each cell; stigma shortly 2-lobed. Capsules ovoid; valves recurved. Seeds ovoid. (Fig. 402)

Flowers: October.

Micromorphology (Fig. 403)

Whole plant was glabrous except calyx and bract; which showed multicellular, uniseriate, unbranched, glandular trichome with thick walls and an uneven lumen. Along with it a multicellular, glandular, trichome was also present which was differentiated into two celled head and two celled stalk.

Stomata were of anisocytic and diacytic type.

D/350.

7. *Haplanthus tentaculatus* Nees. in *DC. Prodr.* V. 11 (1847) p. 513.

A branched slender herb with quadrangular, glandular-pubescent stems. Leaves ovate, acuminate, upto 10 cm long. Axillary spines (cladodes) slender, upto 2 cm long, densely and softly villous with long hairs, with 2 or 3 villous teeth at the apex. Flowers sessile in the midst of the cladodes; bracts and bracteoles absent. Calyx 5-partite; sepals linear-subulate. Corolla blue, 2-lipped, funnel-shaped. Stamens 2; anthers connivent, dorsifixed. Disk prominent. Ovary 2-celled; ovules 3-8 in each cell; style acute or obliquely truncate at the apex. Capsules oblong. (Fig. 404)

Variations observed: in standard descriptions, the bract and bracteoles are said to be smaller than calyx, but I have not found any bract or bracteole in any of the specimen I collected.

Vernacular name: Kala kirayat.

Flowers: October-January.

Micromorphology (Fig. 405)

The calyx showed presence of multicellular, uniseriate, unbranched non-glandular trichome; along with a multicellular, glandular trichome differentiated into a two celled head and a multicellular, uniseriate trichome with thick walls.

Stomata were of diacytic type.

D/427, 742.



Fig. 402. *Elytraria nodosa* E. Hossain, a. habit, b. flower, c. L.S. of flower, d. gynoecium, e. stamen, f. sepal united.

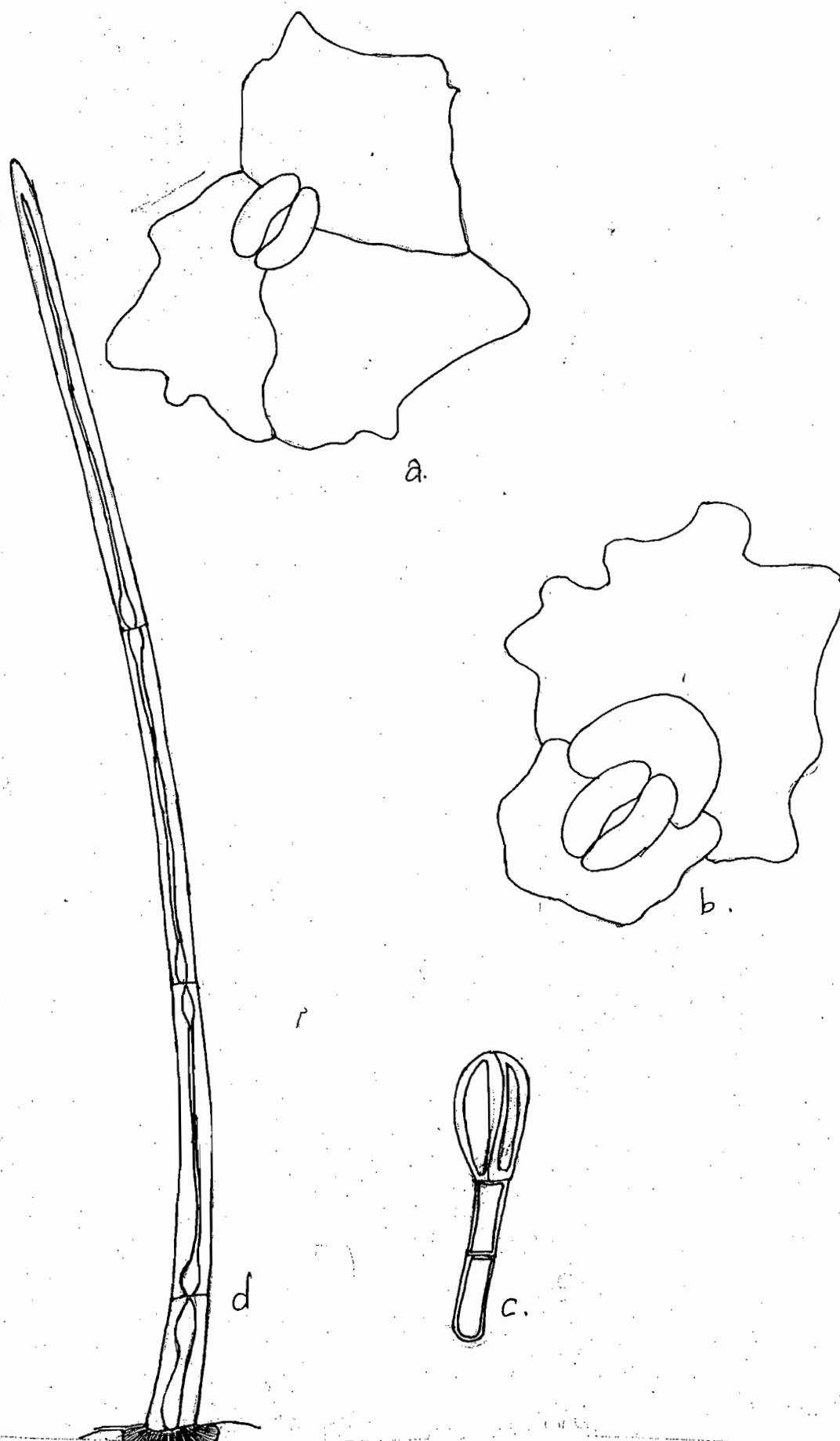


Fig. 403. *Elytraria nodosa* E. Hossain, a. anisocytic stomata, b. diacytic stomata, c. gland with two celled head and two celled stalk, d. uniseriate trichome.



Fig. 404. *Haplanthus tentaculatus* Nees., a. habit, b. bracteole, c. stamen, d. L.S. flower, e. gynocium, f. capsule.

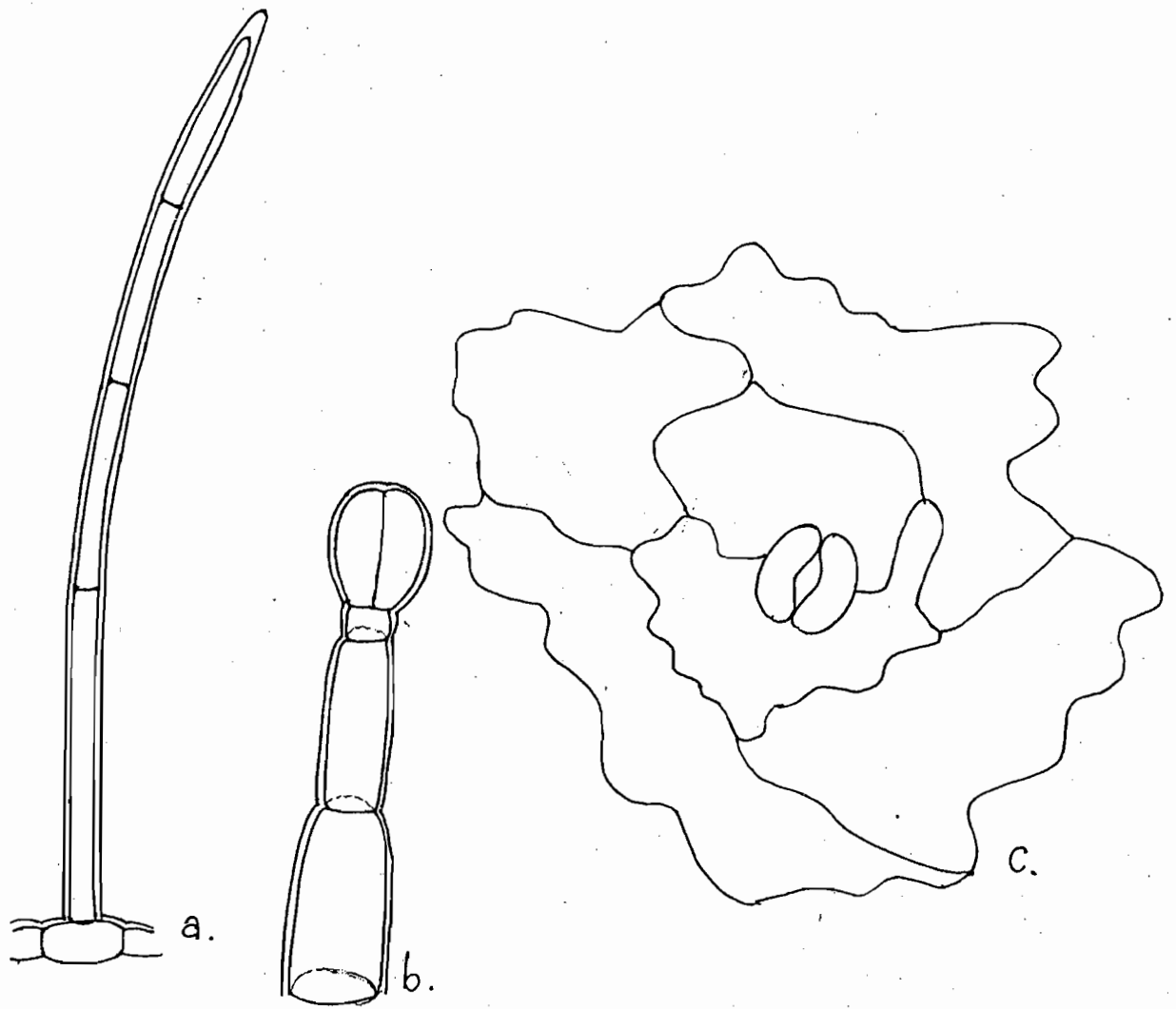


Fig. 405. *Haplanthus tentaculatus* Nees., a. multicellular uniseriate trichome, b. gland with two celled head and three celled stalk, c. diacytic stomata.

**8. *Hygrophila auriculata* Heine, Kew Bull. 16: 172. 1962.
(*Asteracantha longifolia* Nees.)**

A branched herb with subquadrangular stem and branches reaching upto 2 m high. Leaves oblong-lanceolate, in verticels of 6 at node, the 2 outer leaves large, reaching 18 cm long, the 4 inner leaves reaching about 4 cm long, each leaf with a straight sharp yellow spine, upto 5 cm long, in its axil. Flowers in a whorl; bracteoles lanceolate, hairy. Calyx segments 4, lanceolate. Corolla purplish-blue, 2-lipped; the upper lip 2-fid with longitudinal folds or callosities on the palate, lower lip deeply 3-lobed, lobes obovate. Ovary oblong, 2-celled; style filiform; stigma 2. Capsules linear-oblong, 4-8 seeded. (Fig. 406)

Vernacular name: Kantashelio.

Flowers: June-January.

Micromorphology (Fig. 407)

The plant showed presence of 1) multicellular, non-glandular, uniseriate, and thick walled with a round bottom and 2) multicellular, glandular, sessile trichomes which had 6 celled head. Elongated cystoliths were also present on the surface

Stomata were of diacytic type.

D/586, 662, 1215-1216.

9. *Hygrophila serpyllum* T. Anders. in Journ. Linn. Soc. V. 9 (1867) p. 456.

A procumbent, sparsely hairy herb upto 40 cm long. Leaves elliptic, upto 3 cm long, sessile. Flowers in axillary clusters of 2-3; bracts elliptic; bracteoles oblong-lanceolate. Calyx sepals linear. Corolla 2-lipped, the upper lip shorter than the lower, with 2 oblong obtuse lobes, the lower 3-lobed, the mid-lobe larger than the lateral ones. Stamens 4, didynamous. Anthers of the lower stamens, larger. Ovary 2-celled; ovules 4-many in each cell; stigma simple, linear. Capsules linear-oblong; valves grooved on the back. Seeds 8-10, orbicular-ovoid. (Fig. 408)

Variations observed: In floras the flowers are said to be in spikes, but the specimens which I collected contained axillary clusters of 2-3 flowers.

Vernacular name: Sarpat.

Flowers: September-January.

Micromorphology (Fig. 408)

The plant showed presence of four types of trichomes: 1) unicellular, non-glandular, thick walled trichome. 2) multicellular, uniseriate, unbranched, non-glandular trichome with thick walled with swollen joints. 3) multicellular, glandular trichome differentiated into 3-4 celled head and multicellular, uniseriate, stalk. 4) multicellular, glandular trichome with single celled head and a multicellular, uniseriate stalk.

Stomata were of diacytic type.

D/297, 454, 933.

10. *Justicia diffusa* Willd. Sp. Pl. V. 1 p. 87. 1797

A much branched herb with subquadrangular stems reaching to a height of 60 cm. Leaves ovate-elliptic, acuminate, upto 4 cm. Flowers in long axillary and terminal spikes;

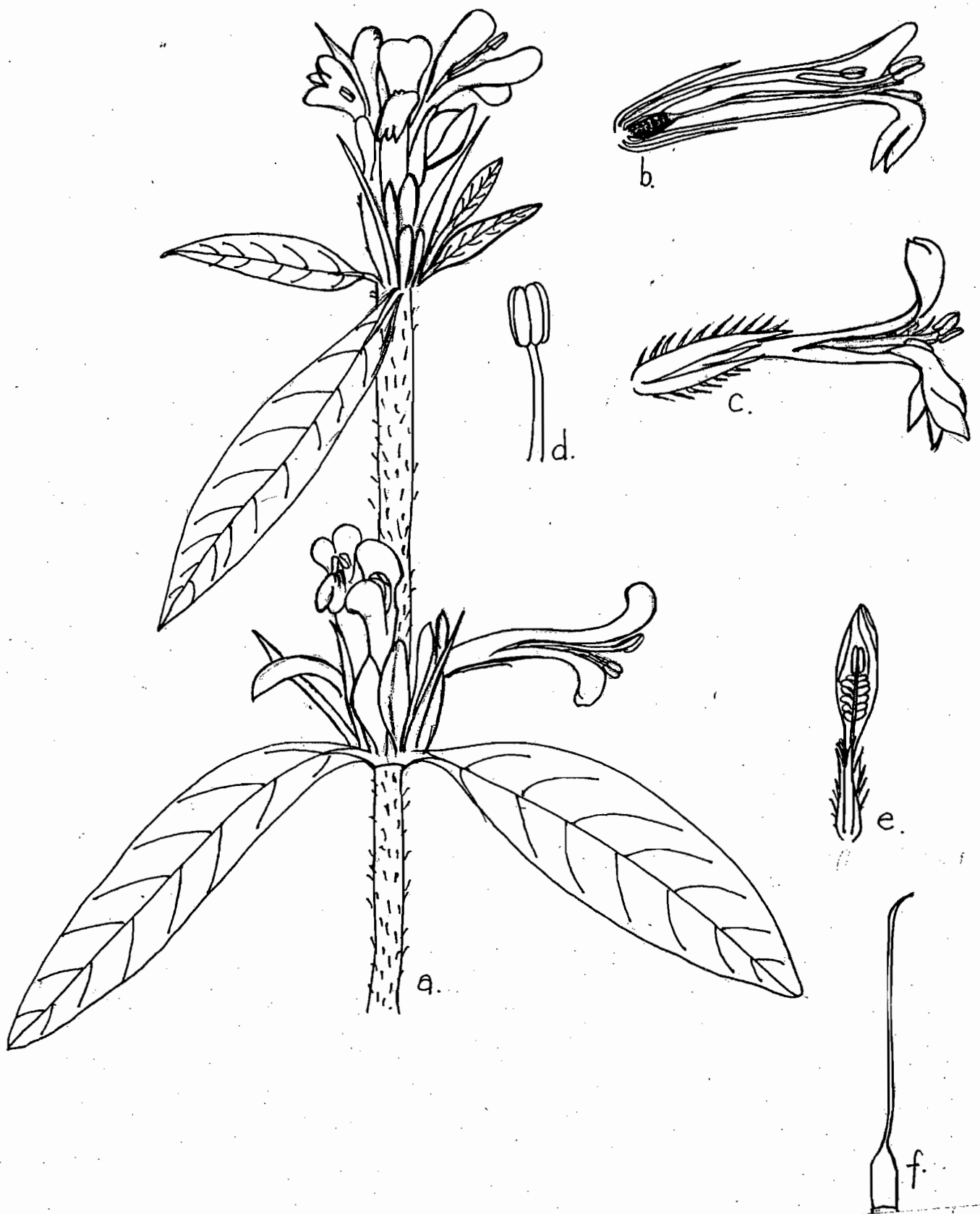


Fig. 406. *Hygrophila auriculata* Heine., a. habit, b. L.S. of flower, c. flower, d. stamen, e. flower showing ridges of corolla, f. gynoecium.



Fig. 407. *Hygrophila auriculata* Heine., a. diacytic stomata, b. multicellular sessile gland, c. multicellular uniseriate trichome, d. cystolith.

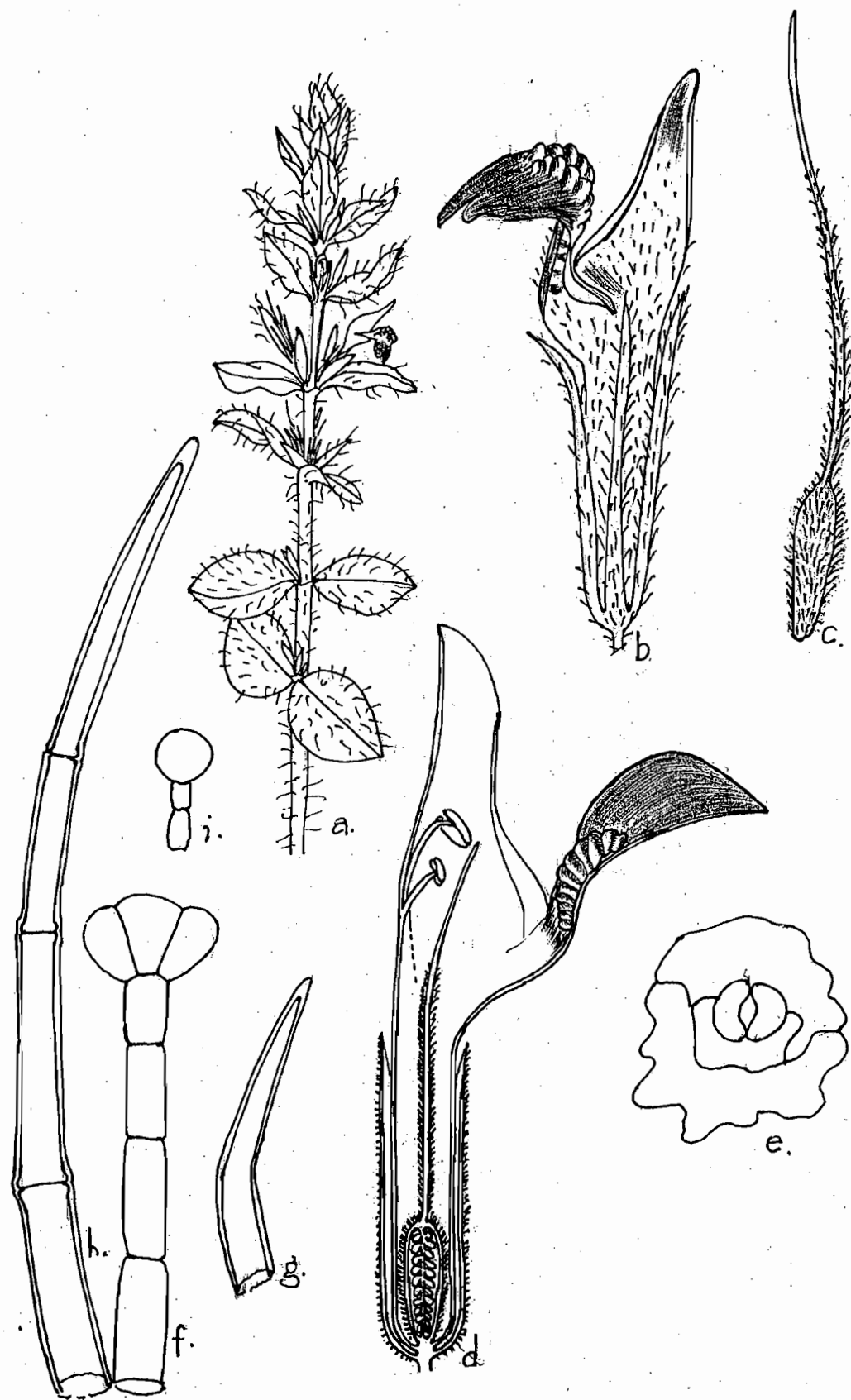


Fig. 406. *Hygrophila serpyllum* T. Anderson., a. habit, b. flower, c. gynoecium, d. L.S. of flower, e. diacytic stomata, f. gland with multicellular head and uniseriate stalk, g. unicellular trichome, h. multicellular uniseriate trichome, i. gland with single celled head and two celled stalk.

bracts and bracteoles ovate, acuminate. Calyx 4-partite; segments lanceolate, unequal. Corolla pale-purple; upper lip ovate, notched at the apex; lower lip very slightly 3-lobed at the rounded apex. Filaments glabrous except at their insertion. Ovary 2-celled; lower part of style pubescent. Capsules pointed, oblong, grooved on the back. Seeds subconcentrically rugose. (Fig. 409)

Vernacular name: Khadsaliya ni jat.

Flowers: July-December.

Micromorphology (Fig. 409)

Leaf showed the presence of a multicellular, uniseriate, non-glandular thick walled trichome with the basal cell somewhat swollen.

Stomata were diacytic.

D/906-914.

11. *Justicia japonica* Thunb. *Fl. Japan* 20. 1784.

(*Justicia simplex*, D. Don)

A branched herb with quadrangular stems reaching upto 50 cm high. Leaves elliptic-oblong, upto 5 cm long. Flowers in dense terminal and axillary spikes about 10 cm long; bracts elliptic, margin scarious and ciliate; bracteoles lanceolate. Calyx segments subequal, or 1 sometimes a little longer than the others, linear. Corolla bi-lipped; upper lip ovate and concave, 2-fid; lower lip with 3 rounded lobes. Anther cells one higher up than the other and lower with a basal spur like appendage. Capsules oblong, obtuse, mucronate, constricted between the seeds. (Fig. 410)

Vernacular name: Parpata.

Flowers: November – December.

Micromorphology (Fig. 410)

Trichomes were absent on leaf, but cystoliths were very prominently observed.

Stomata were mostly diacytic except few anisocytic types.

D/251

12. *Lepidagathis cuspidata* Nees. in *Wall. Pl. As. Rar.* V. 3 (1832) p. 97.

An branched undershrub with quadrangular stems reaching upto 1 m high. Leaves oblong-lanceolate, upto 10 cm long, mucronate; leaves of the branches elliptic-lanceolate, upto 3 cm long, subsessile, spinous-pointed. Flowers in terminal spikes upto 15 cm long; bracts elliptic-oblong, acute, spinous-pointed, 3-nerved; bracteoles linear-lanceolate, spinous-pointed, 1-nerved. Calyx segments unequal, oblong-lanceolate, spinous-pointed, 3-5 nerved. Corolla white; upper lip ovate, marked with dark transverse purplish lines; lower lip 3-lobed. Anther-cells bearded. Ovary 2-celled. Capsules ovoid-lanceolate, 2-valved. Seeds ovoid, hygroscopically hairy. (Fig. 411)

Vernacular name: Bhuyaterada.

Flowers: December-April.

Micromorphology (Fig. 412)

The plant showed presence of three types of trichomes: 1) two celled non-glandular trichome with thick walls. 2) unicellular, non-glandular trichome with narrow lumen and

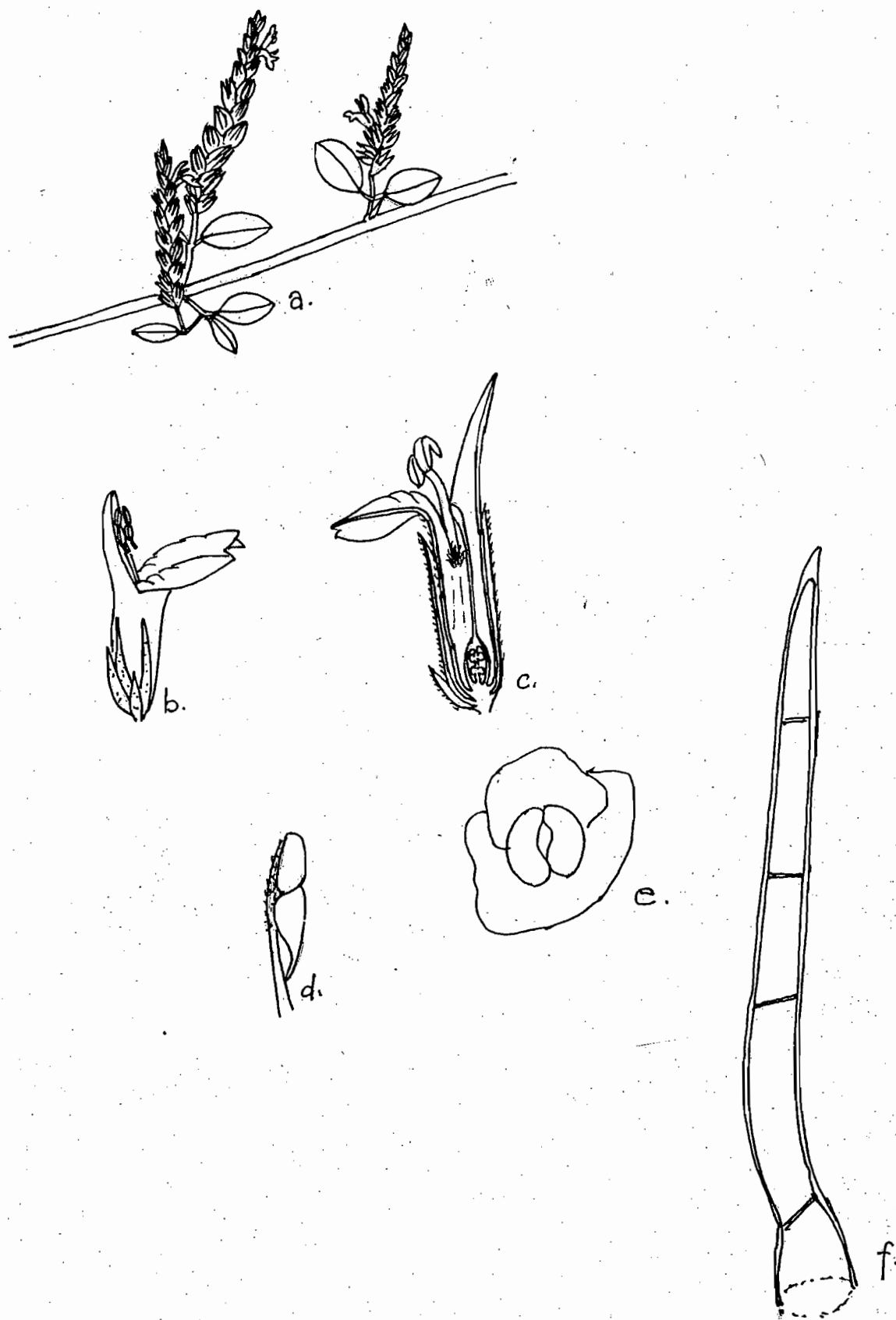


Fig. 409. *Justicia diffusa* Willd., a. habit, b. flower, c. L.S. of flower, d. stamen, e. diacytic stomata, f. multicellular uniseriate trichome.

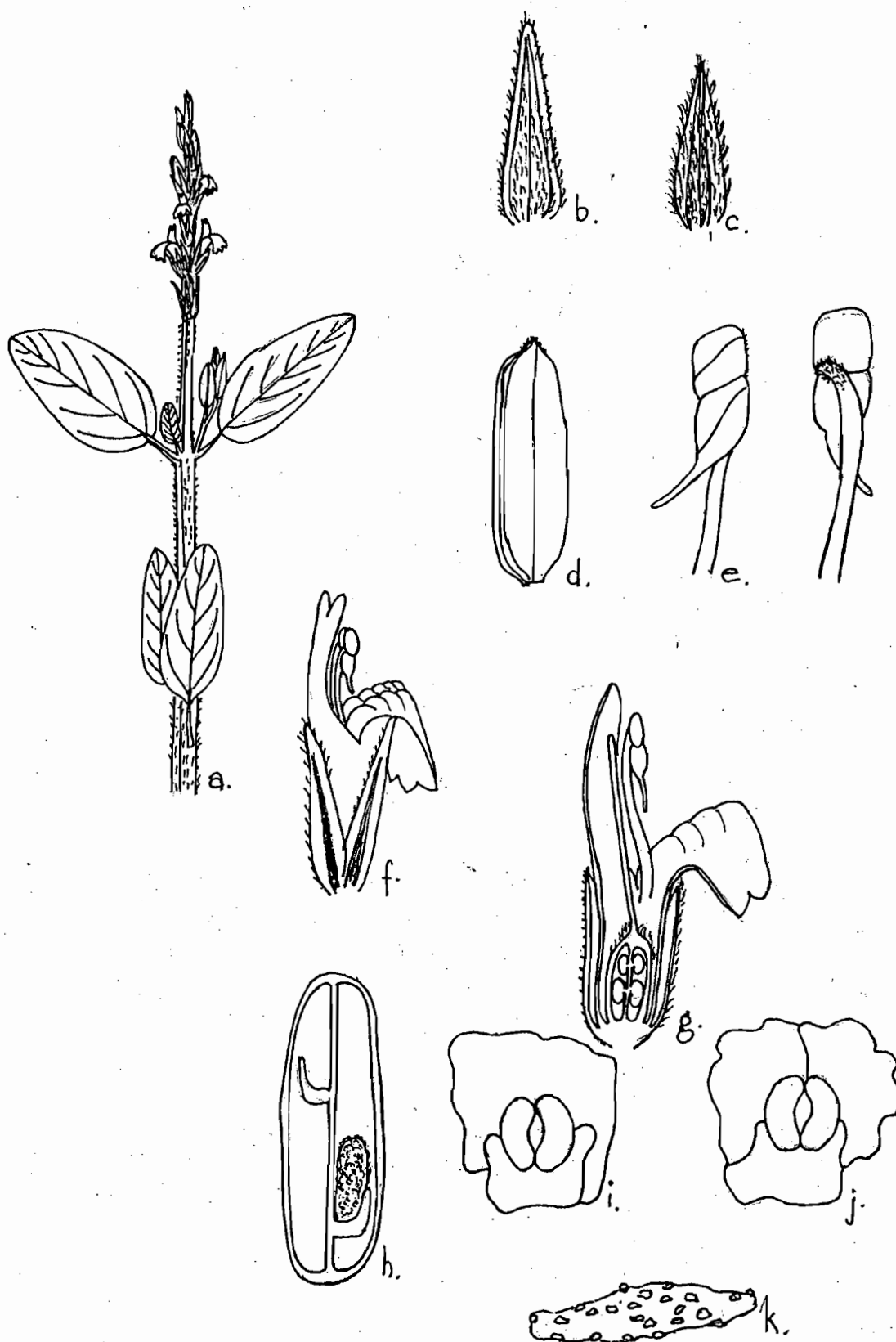


Fig: 410. *Justicia japonica* Thunb., a. habit, b. bract, c. bracteole, d. capsule, e. stamen, f. flower, g. L.S flower, h. L.S. capsule, i-j. diacytic stomata, k. cystolith.

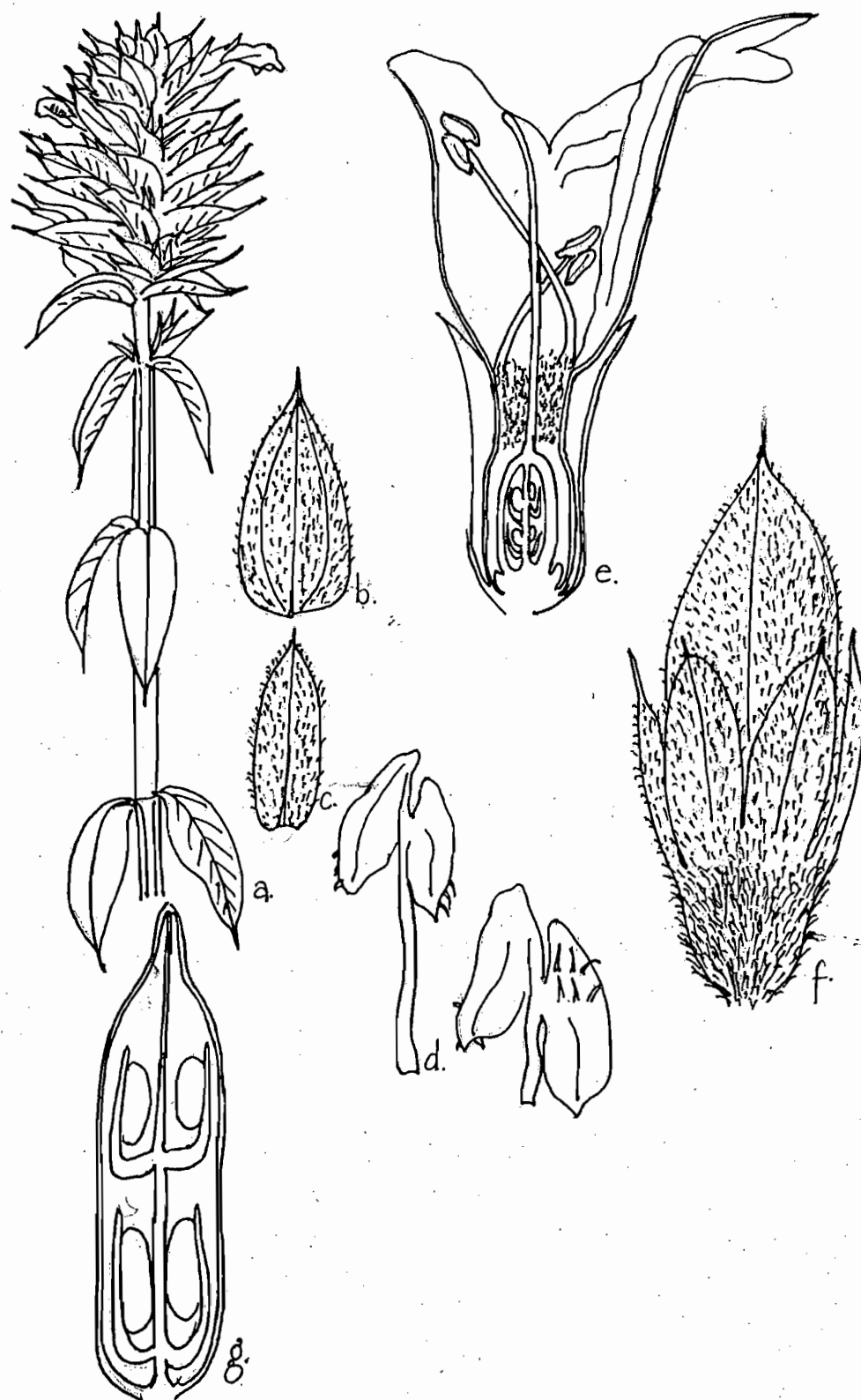


Fig. 41). *Lepidagathis cuspidata* Nees., a. habit, b. bract, c. bracteole, d. stamen, e. L.S. flower, f. capsule, g. L.S. capsule.

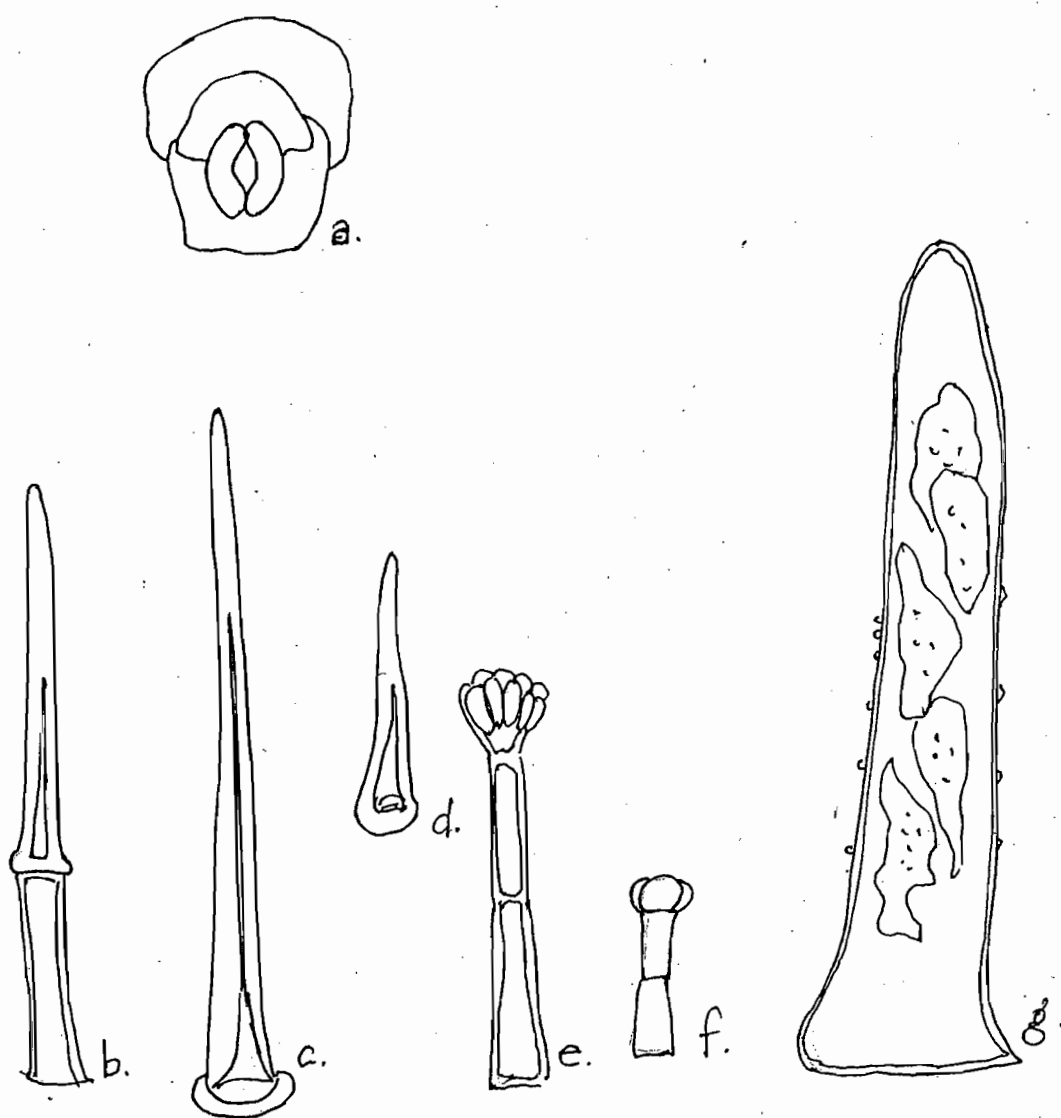


Fig. 412. *Lepidagathis cuspidata* Nees., a. diacytic stomata, b. two celled uniseriate trichome with thick wall, c-d unicellular thick walled trichome with small lumen, e-f. gland with multicellular head and two celled uniseriate stalk, g. unicellular gland.

thick wall. 3) multicellular, glandular trichome differentiated into a 6-12 radiating celled head or sometimes 3-4 celled head and a multicellular, uniseriate stalk.

Anther showed presence of unicellular, glandular trichome with broad lumen, thin walled with lot of content.

Stomata were of diacytic type.

D/320.

13. *Lepidagathis fasciculata* Nees in wall. Pl. As. Rar. V. 3. (1832) p. 95.

A branched herb with quadrangular, hairy stem reaching upto 30 cm long. Leaves ovate or elliptic, in pairs, upto 6 cm long, crenate. Flowers in terminal spikes; bracts ovate, 3-nerved; bracteoles linear. Calyx 5-partite; outer upper segment longest, linear-lanceolate, 3-nerved; two lower segment linear, 1-nerved; the 2 inner lateral segments subulate. Corolla white; upper lip short, 2-fid, lower lip 3-lobed, spotted with the middle the longest; palate glabrous. Anther-cells bearded, one attached lower than the other. Ovary 2-celled. Capsules oblong-lanceolate. Seeds suborbicular, hygroscopically hairy. (Fig. 413)

Flowers: February.

Micromorphology (Fig. 414)

The leaf showed presence of unicellular, non-glandular, thick-walled trichome which was slightly curved at the tip. The petal showed presence of unicellular, non-glandular, trichome with somewhat blunt tip; along with a multicellular, glandular trichome differentiated into a 3-4 celled or 1 celled head and a multicellular stalk. Moreover along with these trichomes leaves also showed presence of cystolith.

Stomata were of diacytic type.

D/382, 1057, 1087.

14. *Neuracanthus sphaerostachys* Dalz. in Kew Journ. Bot. V. 2 (1850) p. 140.

A perennial herb with quadrangular pubescent, stems upto 60 cm high. Leaves elliptic-oblong, subsessile, upto 10 cm long. Flowers in globose congested silky hairy sessile spikes in the opposite axils(appearing circular around the node); bracts purplish, suborbicular, strongly 5-7 nerved. Calyx 2-lipped; upper lip 3-lobed, lobes lanceolate; lower lip divided almost to the base, segments lanceolate. Corolla blue, infundibuliform; limb sub-bilabiate. Stamens 4, didynamous; anthers of the upper pair with one perfect and one imperfect cell. Ovary 2-celled; ovules 2 in each cell. Capsules ovoid. Seeds orbicular, densely silky. (Fig. 415)

Vernacular name: Ganthera.

Flowers: September-October.

Micromorphology (Fig. 415)

The plant showed presence of two types 1) multicellular, uniseriate, unbranched non-glandular trichome with somewhat cylindrical cells. 2) multicellular, glandular trichome with two celled head and a single celled stalk.

Stomata were of diacytic type.

D/596, 1192.

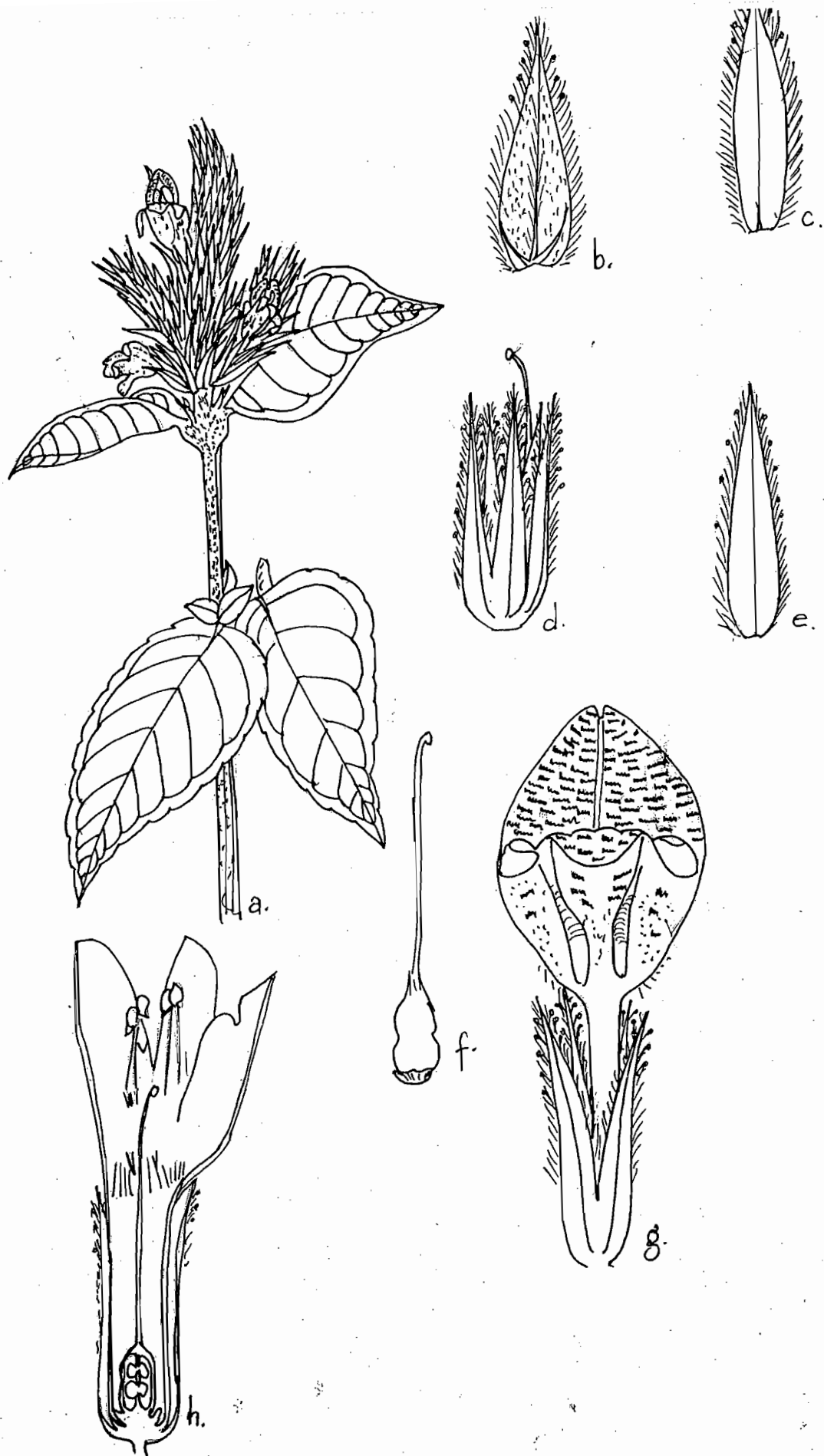


Fig. 413. *Lepidagathis fasciculata* Nees., a. habit, b. bract, c. bracteole, d. calyx, e. sepal, f. gynoecium, g. flower, h. L.S. of flower.

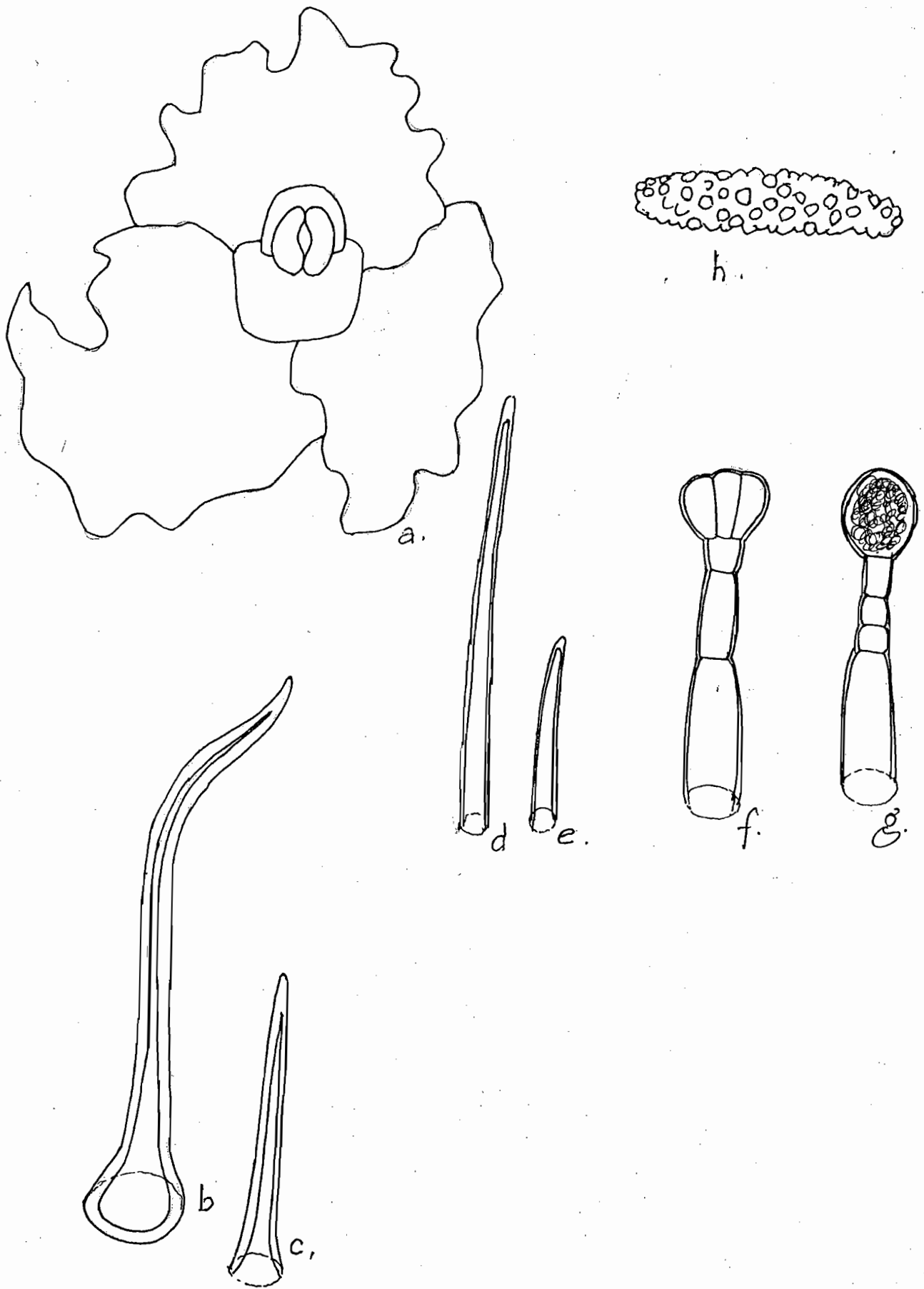


Fig. 414. *Lepidagathis fasciculata* Nees., a. diacytic stomata, b-e. unicellular trichome with thick wall and large lumen, f-g. gland with single to multicellular head and uniseriate four celled stalk.

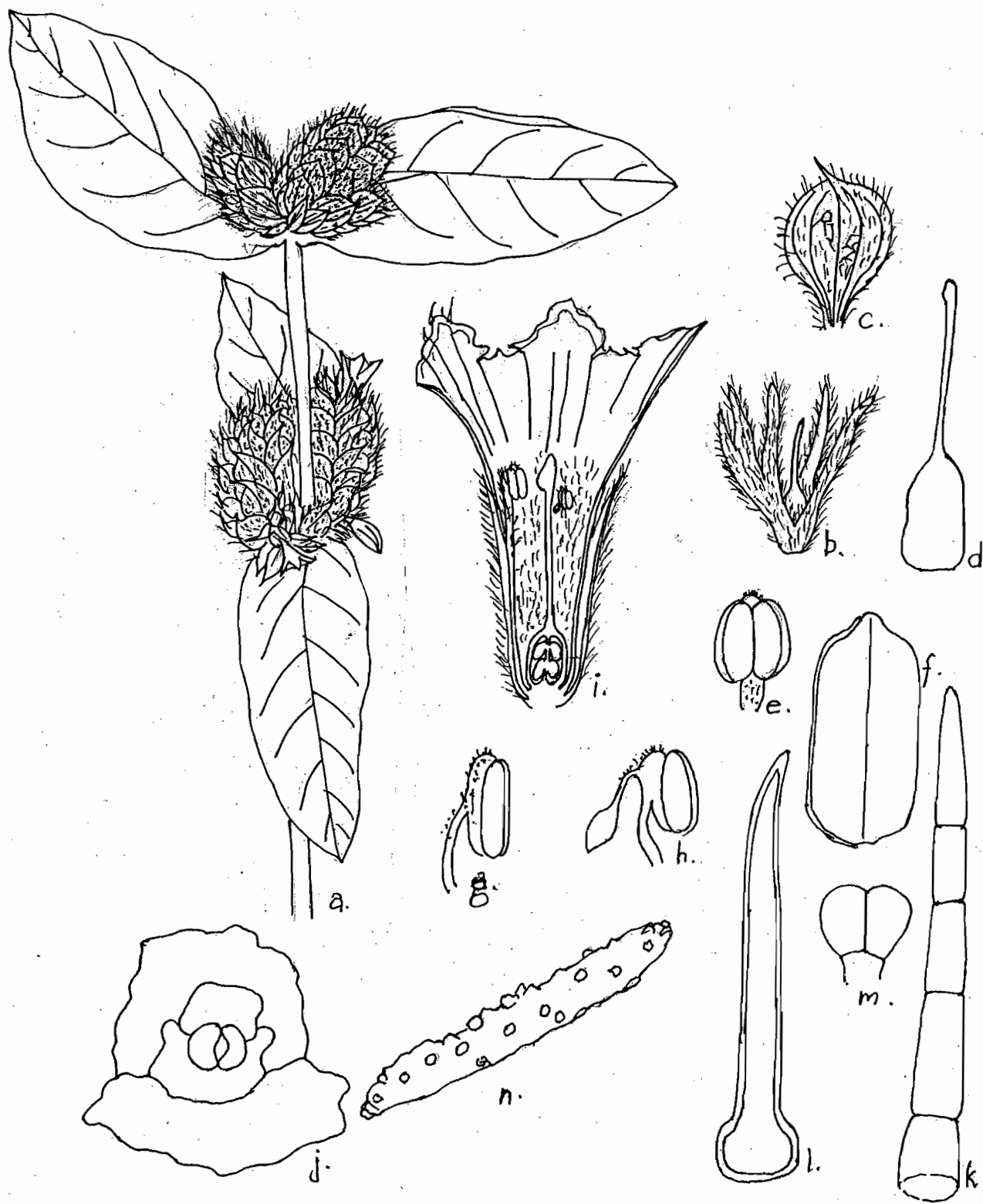


Fig. 415. *Neuracanthus sphaerostachys* Dalz., a. habit, b. calyx and gynoecium, c. bract, d. gynoecium, e. stamen, f. capsule, g-h. anther cell, i. L.S. flower, j. diacytic stomata, k. multicellular uniseriate trichome, l. unicellular trichome, m. gland with two celled head and a single celled stalk, n. cystolith.

15. *Peristrophe bicalyculata* Nees, in Wall. Pl. As. Rar. V. 3. (1832)

A much branched herb with 5-angled stem reaching a height of 1.5 m. Leaves ovate, acuminate, upto 8 cm long. Flowers in trichotomous cymes in large lax divaricate pubescent panicles; bracts linear, mucronate; bracteoles 4, similar to the bracts. Calyx segments lanceolate-subulate. Corolla rosy,; upper lip elliptic-oblong; lower lip oblong, 3-lobed. Filaments glabrous. Anther-cells one above other, muticous. Ovary 2-celled, oblong, glabrous. Capsules cylindric. Seeds orbicular, papillose and slightly rugose. (Fig. 416)

Variations observed: in the description available in floras, the plant is said to have 6-angled stem, filaments hairy, and ovary hairy at the tip, but here the stem was five-angled ovary and filaments were glabrous.

Vernacular name: Kali angedi.

Flowers: November-March.

Micromorphology (Fig. 416)

Leaves were glabrous.

Stomata were diacytic.

D/172, 411, 570-571.

**16. *Ruellia cyanea* (Nees.) T. Anderson, J. Proc. Linn. Soc., Bot. 7: 24. 1863.
(*Ruellia patula* Jacq.)**

A small usually pubescent shrub with long, straggling, much-branched stem. Leaves ovate or elliptic, upto 3 cm long. Flowers axillary, solitary or 2-3 together; bracteoles foliaceous, elliptic. Calyx lobes linear-lanceolate. Corolla purplish-blue 3 cm long, campanulate-infundibuliform; lobes of the limb broadly elliptic or suborbicular. Stamens 4, didynamous; anthers 2-celled, oblong. Ovary 2-celled. Capsules upto 2 cm long, clavate. Seeds suborbicular, margined with hygroscopic white hairs. (Fig. 417)

Flowers: June-November.

Micromorphology (Fig. 417)

The plant showed presence of multicellular, uniseriate, unbranched trichome with apical cell having swollen joint. Cystoliths were common in leaves.

Stomata were of diacytic type.

D/583.

17. *Ruellia tuberosa* L., Sp. Pl. 635. 1753.

An erect, tall herb with stout 4-angled stems reaching a height of 60 cm. Leaves oblong-obovate to oblanceolate, upto 9 cm long. Flowers blue-violet, solitary or in 1-3-flowered, terminal or axillary cymes; bracts and bracteoles linear-lanceolate. Calyx lobes linear. Corolla 5-lobed, subequal, ovate. Stamens with oblong-sagittate anthers. Ovary oblong, 2-celled. Capsule oblong, many-seeded, minutely beaked at tip. Seeds orbicular, hairy. (Fig. 418)

Vernacular name: Bandhukadi.

Flowers: Almost throughout the year.



Fig. 416. *Peristrophe bicalyculata* Nees., a. habit, b. flower, c. L.S. of flower, d. stamen, e. calyx with gynoecium, f. gynoecium, g. diacytic stomata.

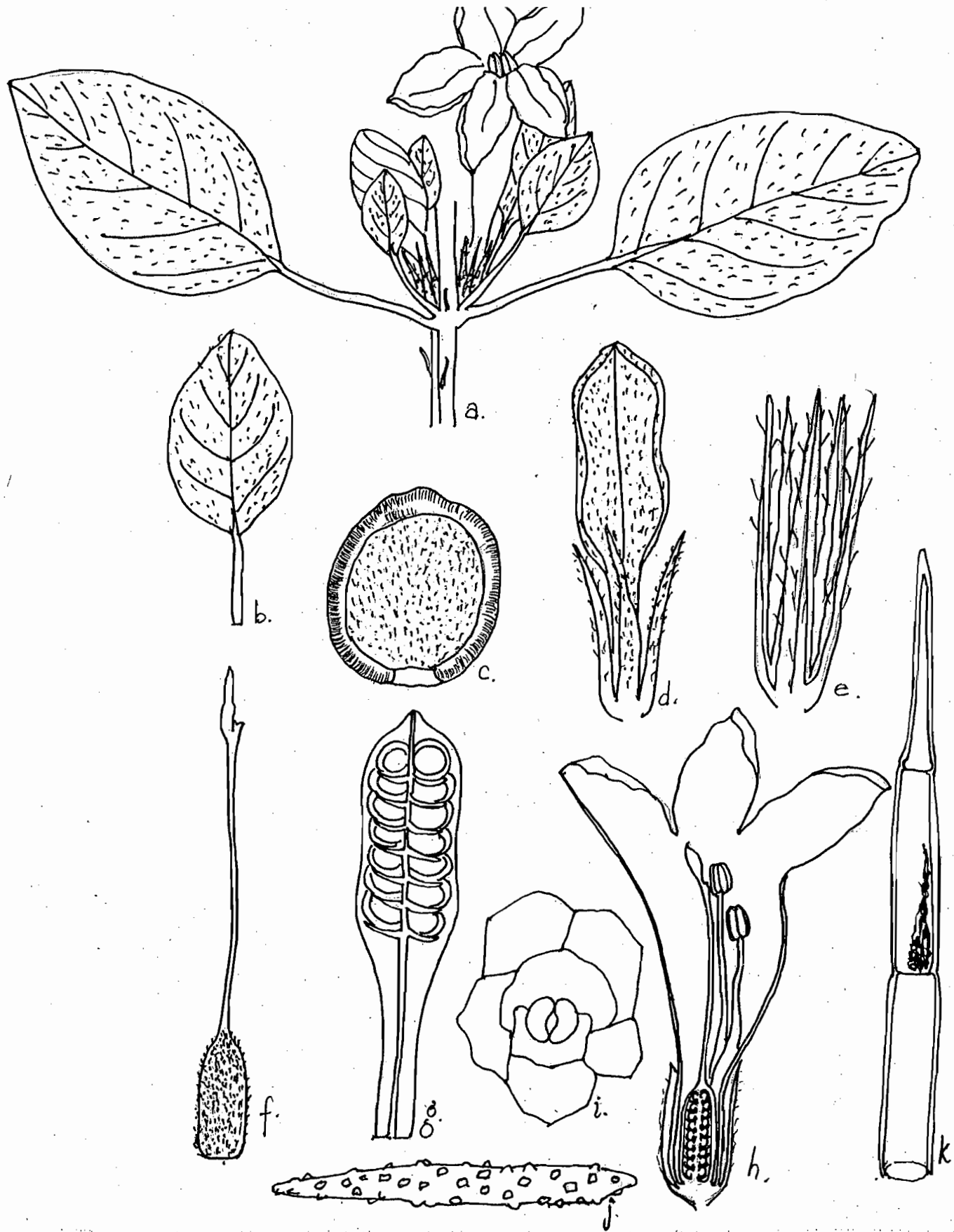


Fig. 417. *Ruellia cyanea* T. Anderson., a. habit, b. leaf, c. seed, d. capsule, e. calyx, g. gynoecium, g. L.S. of Capsule, h. L.S. of flower, i. diacytic stomata, j cystolith, k. uniseriate trichome.

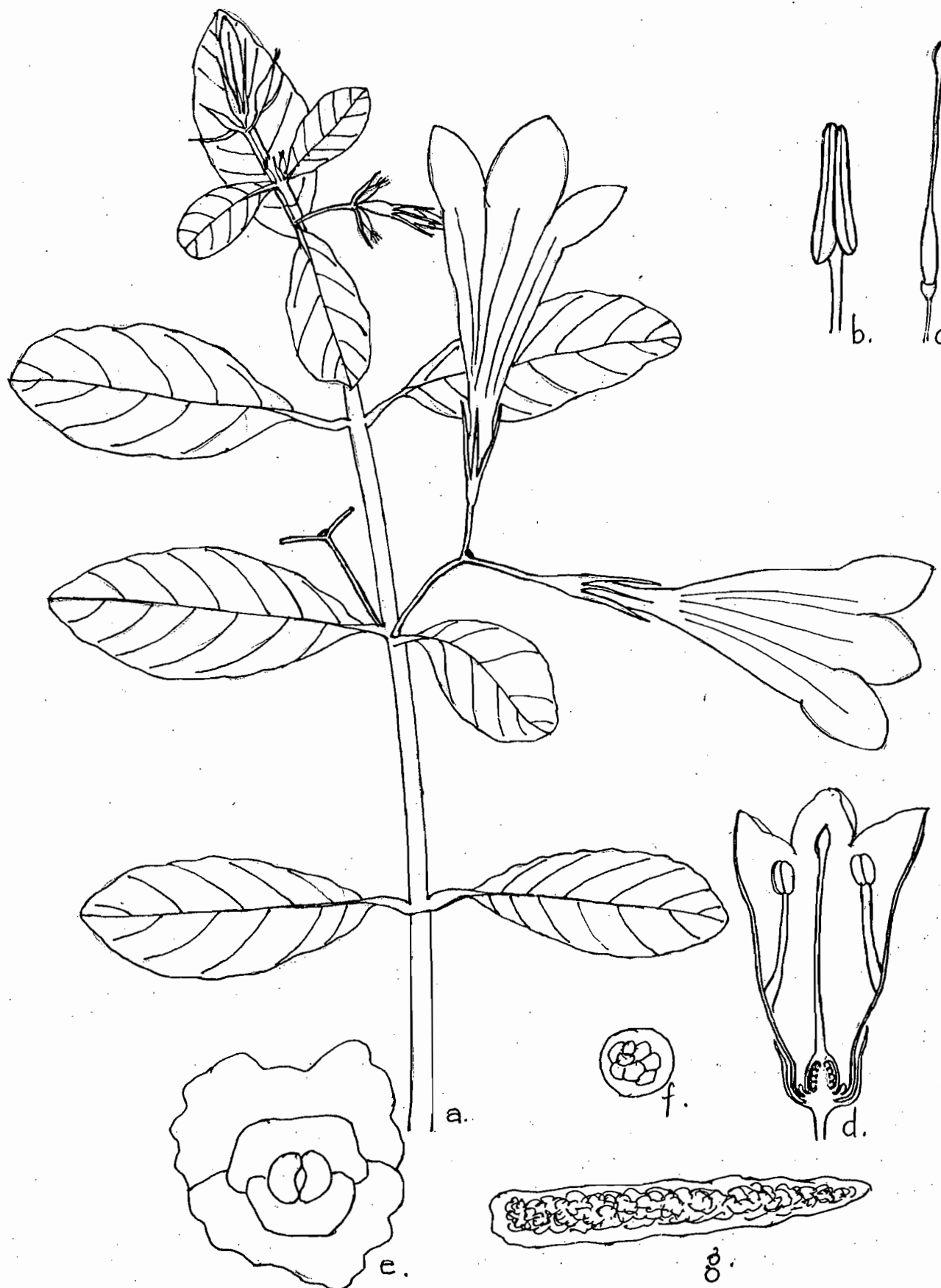


Fig. 418. *Ruellia tuberosa* L., a. habit, b. stamen, c. gynoecium, d. L.S. of flower, e. diacytic stomata, f. multicellular sessile gland, g. cystolith.

Micromorphology (Fig. 418)

Whole plant was glabrous.

Stomata were of diacytic type.

D/ 463, 999, 1159.

18. *Rungia parviflora* Nees. in *Wall. Pl. As Rar.* V. 3 1832 p. 110, var. *pectinata*

A much-branched straggling annual herb. Leaves elliptic-lanceolate, very variable in size, upto 6 cm. Flowers in terminal and axillary 1-sided subsessile spikes upto 3 cm long; bracts dimorphic, the barren, in 2 rows, lanceolate, cuspidate, with scarious margined; fertile bracts smaller, orbicular. Corolla blue; upper lip, ovate, acutely acuminate; lower lip obovate, 3-lobed. Cells of the lower anthers with a long white appendage. Capsules ovoid, compressed, with 2- or 4-seeded. (Fig. 419)

Vernacular name: Khadsaliyo.

Flowers: November-February.

Micromorphology (Fig. 419)

The whole plant was glabrous; but the leaf surface showed presence of cystolith.

Stomata were of diacytic type.

D/459.

19. *Rungia repens* Nees. in *Wall. Pl. As. Rar.* V. 3 (1832) p. 110.

A decumbent herb often rooting near the base. Leaves oblong-lanceolate, upto 5 cm long, subsessile, unequal-sided. Flowers in erect terminal, imperfectly 1-sided spikes, upto 8 cm long; bracts elliptic, cuspidate, the margins scarious; bracteoles linear-lanceolate, with scarious margins. Calyx segments lanceolate-subulate. Corolla 2-lipped; upper lip oblong, emarginated; lower lip shortly 3-lobed. Stamens 2; anthers 2-celled, the cells often superposed, the lower cell often with a white basal appendage. Disk annular. Ovary 2-celled; ovules 2 in each cell; stigma minutely 2-fid. Capsules ovoid-oblong. Seeds suborbicular, rugose with concentric furrows, pale-brown. (Fig. 420)

Vernacular name: Khatsalio.

Flowers: November-January.

Micromorphology (Fig. 420)

The plant showed presence of multicellular, uniseriate, unbranched, non-glandular trichome with very broad basal cells.

Stomata were of diacytic type.

D/731, 1045-1046.

20. *Thunbergia erecta* T. Anders. in *Journ. Linn. Soc.* V. 7 (1864) p. 18.

A glabrous, upright, upto 1.25 m tall undershrub. Leaves elliptic-ovate, upto 8 cm long, apiculate. Flowers solitary axillary. Bracts deciduous. Calyx teeth subulate. Corolla tube curved yellowish-white, lobes subequal, obtuse. Staminal filaments glandular-hairy; anthers oblong, bearded, mucronate. Style long; stigma 2-lobed, upper lobe upright, lower patent. (Fig. 421)

Flowers: November-March.

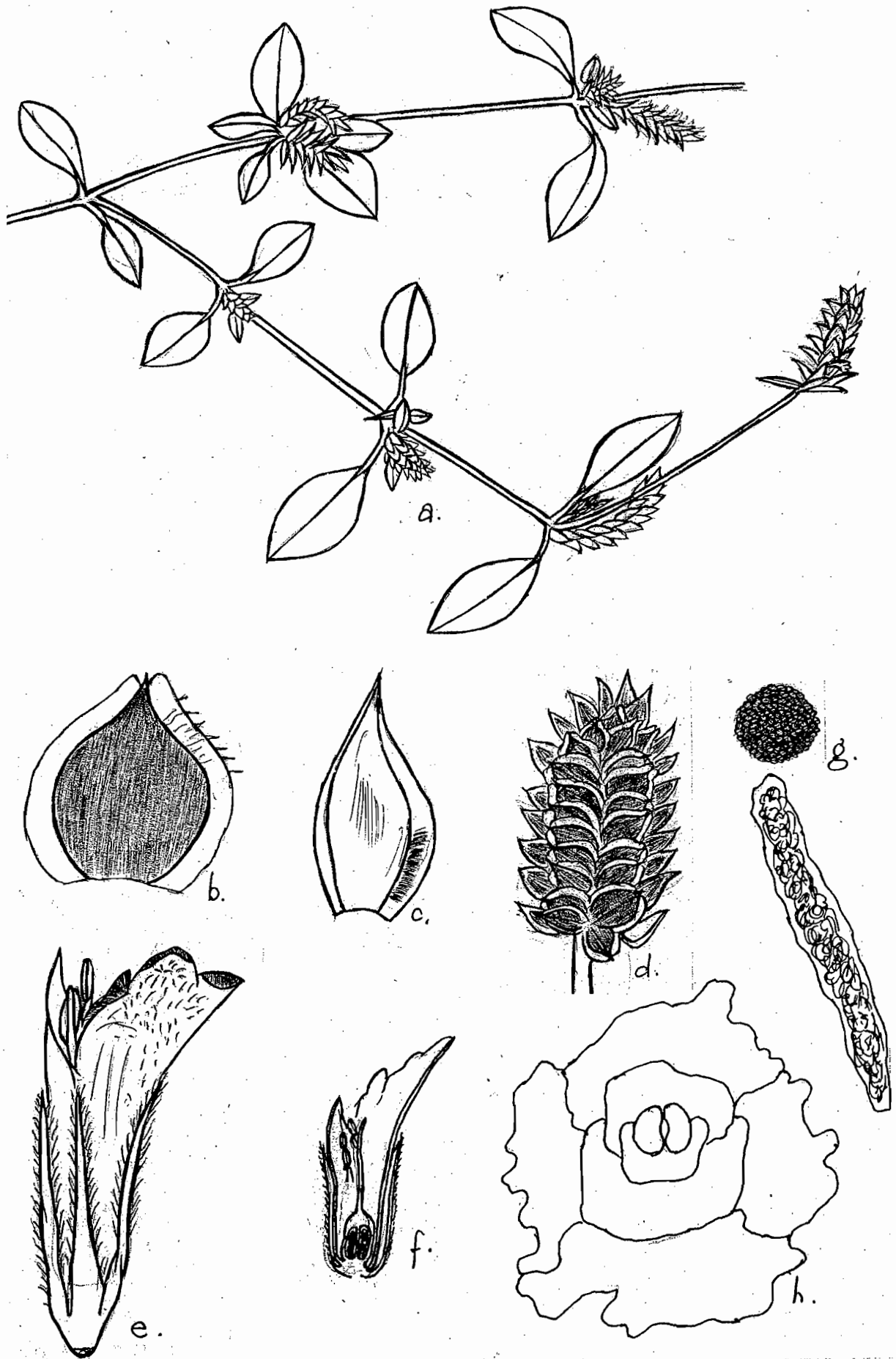


Fig. 419. *Kungia parviflora* Nees., a. habit, b. bract, c. bracteole, d. inflorescence, e. flower, f. L.S. of flower, g. seed, h. diacytic stomata, i. cystolith.

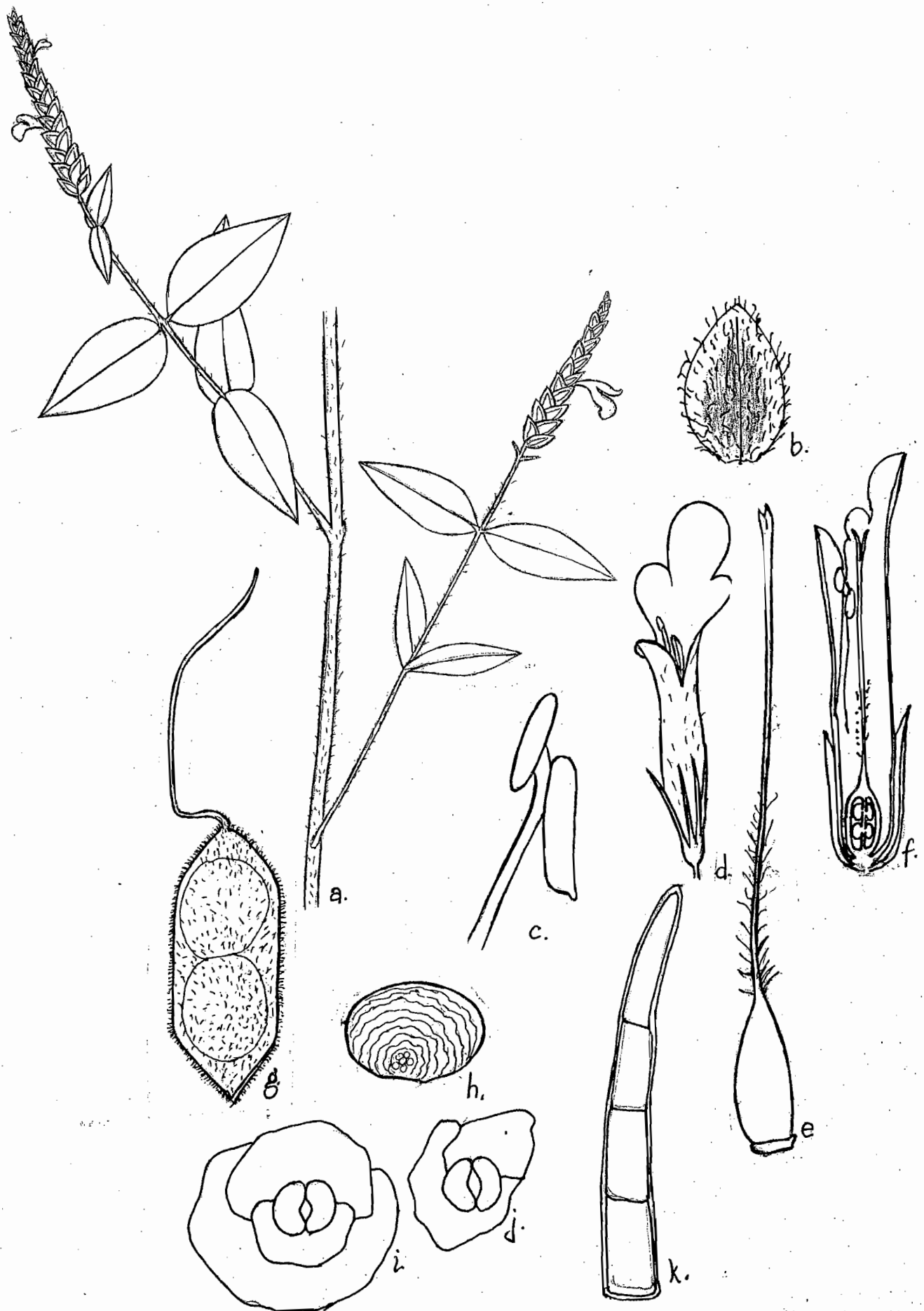


Fig. 420. *Rungia repens* a. habit, b. bract, c. stamen, d. flower, e. gynoecium, f. L.S. of flower, g. capsule, h. seed, i-j. diacytic stomata, k. multicellular uniseriate many celled trichome.

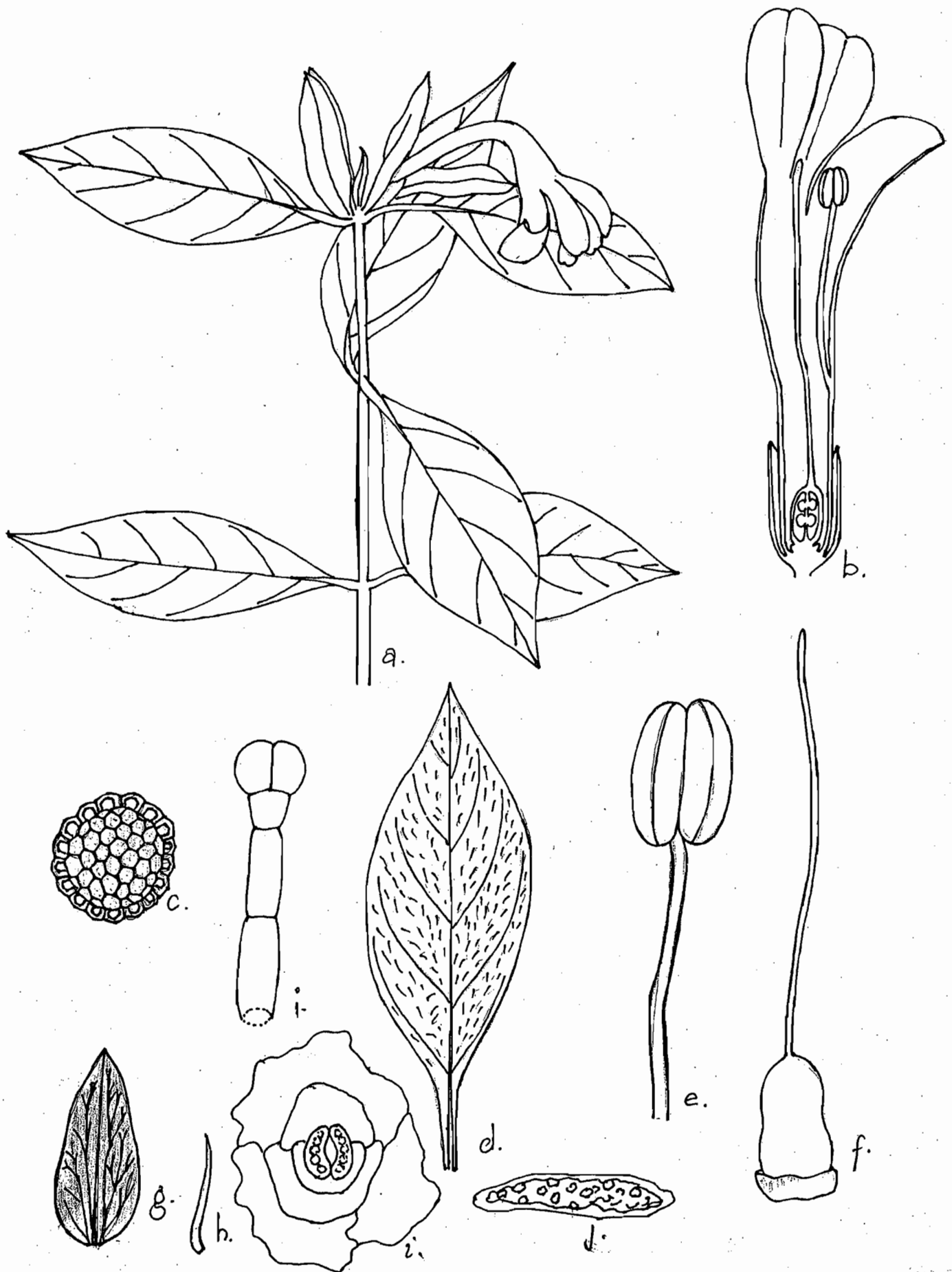


Fig. 42| *Thunbergia erecta* T. Anderson., a. habit, b. L.S. of flower, c. pollen-grain, d. leaf, e. gynoecium, g. bract, h. bracteole, i. gland with two celled head and three celled stalk, j. diacytic stomata, k. cystolith.

Micromorphology (Fig. 421)

The leaf was glabrous though it showed presence of cystolith and the corolla showed presence of multicellular, glandular trichome differentiated into two celled head and a multicellular, uniseriate, trichome.

Stomata were of diacytic type.

D/233.

Verbenaceae

1. *Clerodendrum phlomidis* Linn. f. *Suppl.* (1781) p. 292.

A small tree, reaching upto 10 m high, with more or less pubescent branches. Leaves ovate or subrhomboid, upto 6 cm long, dentate, undulate. Flowers in small dichotomous axillary cymes; bracts obovate-lanceolate. Calyx divided about ½-way down; segments ovate, acuminate. Corolla white; lobes nearly equal, elliptic. Stamens 4, didynamous. Ovary imperfectly 4-celled. Drupe broadly obovoid.

Flowers: August-February. (Fig. 422)

Micromorphology (Fig. 422)

The plant showed presence of three types of trichomes: 1) multicellular, uniseriate, unbranched, non-glandular trichome with elongated rectangular cells. 2) multicellular, glandular trichome differentiated into a 1-4 celled and sometimes two celled head or a single celled head and a single celled stalk. 3) multicellular, glandular trichome differentiated into a two celled head and a two celled stalk.

Stomata were of anomocytic type.

D/499.

2. *Clerodendrum serratum* (L.) Moon, *Cat. Pl. Ceylon* 1:46. 1824.

A shrub with 4-angled stem reaching a height of 3 m. Leaves ovate-elliptic, opposite, acutely serrate. Flowers in terminal long pyramidal panicles, each subtended by a pair of acute bracts and purplish blue in colour. Corolla bilabiate, upper lobe large. Stamens 4, didynamous. Ovary imperfectly four-celled with one ovule in each locule. Drupe subglobose, dark purple containing four pyrenes and enclosed in cupuliform calyx. (Fig. 423)

Vernacular name: Bharungi.

Flowers: August-October.

Micromorphology (Fig. 423)

Leaves were glabrous.

Stomata were diacytic, anisocytic and anomocytic.

D/256.

3. *Gmelina asiatica* Linn. *Sp. Pl.* (1753) p. 626.

A much-branched more or less spinous shrub with horizontal, rigid, puberulous, often much shortened branchlets and spinous at the end. Leaves ovate or elliptic, upto 3 cm long, sometimes irregularly lobulate, glaucescent beneath from a coating of minute round

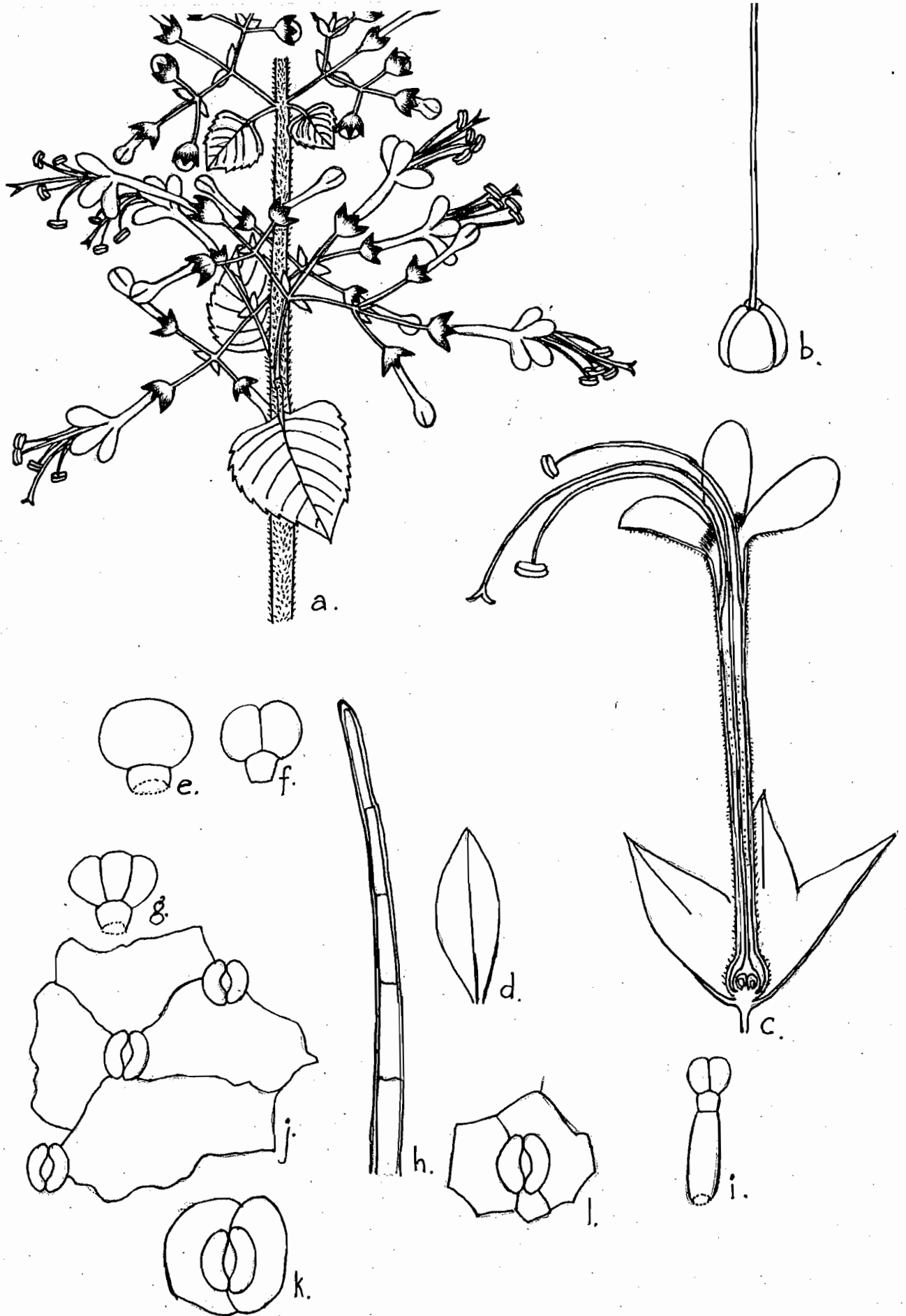


Fig. 422. *Clerodendron phlomidis* L. f., a. habit, b. gynoecium, c. L.S. flower, d. bract, e-g. gland with one to three celled head and a single celled stalk, h. uniseriate trichome, i. gland with two celled head and two celled stalk, j. anomocytic stomata, k. paracytic stomata, l. anisocytic stomata.

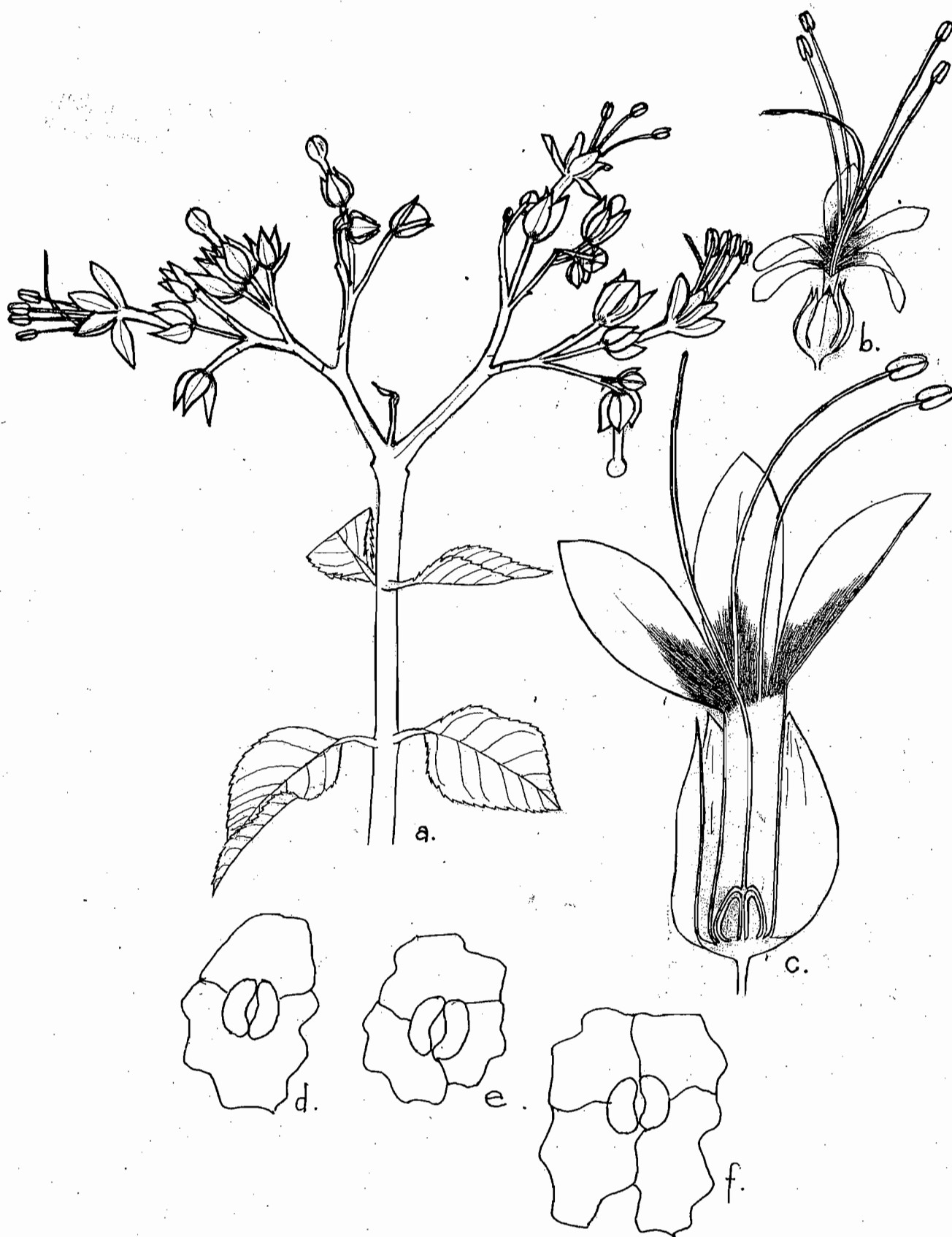


Fig. 423 *Clerodendron serratum* Moon., a. habit, b. flower, c. L.S. of flower, d. diacytic stomata, e. anisocytic stomata, f. anomocytic stomata.

glands. Flowers large, nodding, in terminal racemes or panicles; bracts small, caducous. Calyx cup-shaped, truncate, clothed with flattened round glands; lobes 4, small, triangular. Corolla 2-lipped, bright-yellow; tube narrow curved, inflated above; lobes 4, ovate, the lower one the largest. Drupes obovoid, yellow when ripe, containing 1 pyrene. (Fig. 424)

Vernacular name: Badhara.

Flowers: more or less throughout the year.

Micromorphology (Fig. 424)

The plant showed presence of two types of trichomes: 1) unicellular, non-glandular trichome with thin walls and a broad lumen. 2) multicellular, glandular trichome differentiated into 3-4 celled head and a single celled stalk.

Stomata were of anomocytic type.

D/193

**4. *Phyla nodiflora* (L.) Greene, *Pittonia* 4: 46, 1899.
(*Lippia nodiflora* Michaux.)**

A creeping perennial herb with subquadrangular stems rooting at the nodes, more or less clothed with appressed, medifixed, white hairs. Leaves spatulate, upto 4 cm long, appressedly hairy on both sides with medifixed white hairs. Flowers sessile, densely packed in long-pedunculate axillary oblong heads; bracts elliptic-obovate, mucronate. Calyx deeply 2-lobed, mitre-shaped, the 2 acuminate lobes projecting beyond it. Corolla white or pale-pink, 2-lipped; upper lip erect, bifid; lower lip 3-lobed, the middle lobe the largest. Fruit globose-oblong, splitting into two 1-seeded plano-convex pyrenes. (Fig. 425)

Vernacular name: Ratveliyo.

Flowers: more or less all the year.

Micromorphology (Fig. 425)

The plant showed presence of medifixed hairs with warty surface.

Stomata were of paracytic, diacytic and anomocytic type.

D/682, 683, 812.

5. *Vitex negundo* Linn. *Sp. Pl.* (1753) p. 638.

A large shrub with grey bark and quadrangular stem, whitish with a fine tomentum. Leaves 3-5 foliolate, leaflets lanceolate, acute, the terminal leaflet upto 10 cm long, lateral leaflets smaller, covered with a fine white tomentum beneath. Flowers in cymes; bracts lanceolate. Calyx teeth triangular. Corolla bluish-purple; upper lip divided to the base into 2 obtuse lobes; lower lip large, with 2 short oblong obtuse lateral lobes and a large broadly obovate terminal lobe. Stamens 4, didynamous; anther cells divaricate. Ovaries 2-4 celled; ovules 4; stigma 2-fid. Drupe black. (Fig. 426)

Vernacular name: Nagod.

Flowers: more or less throughout the year.

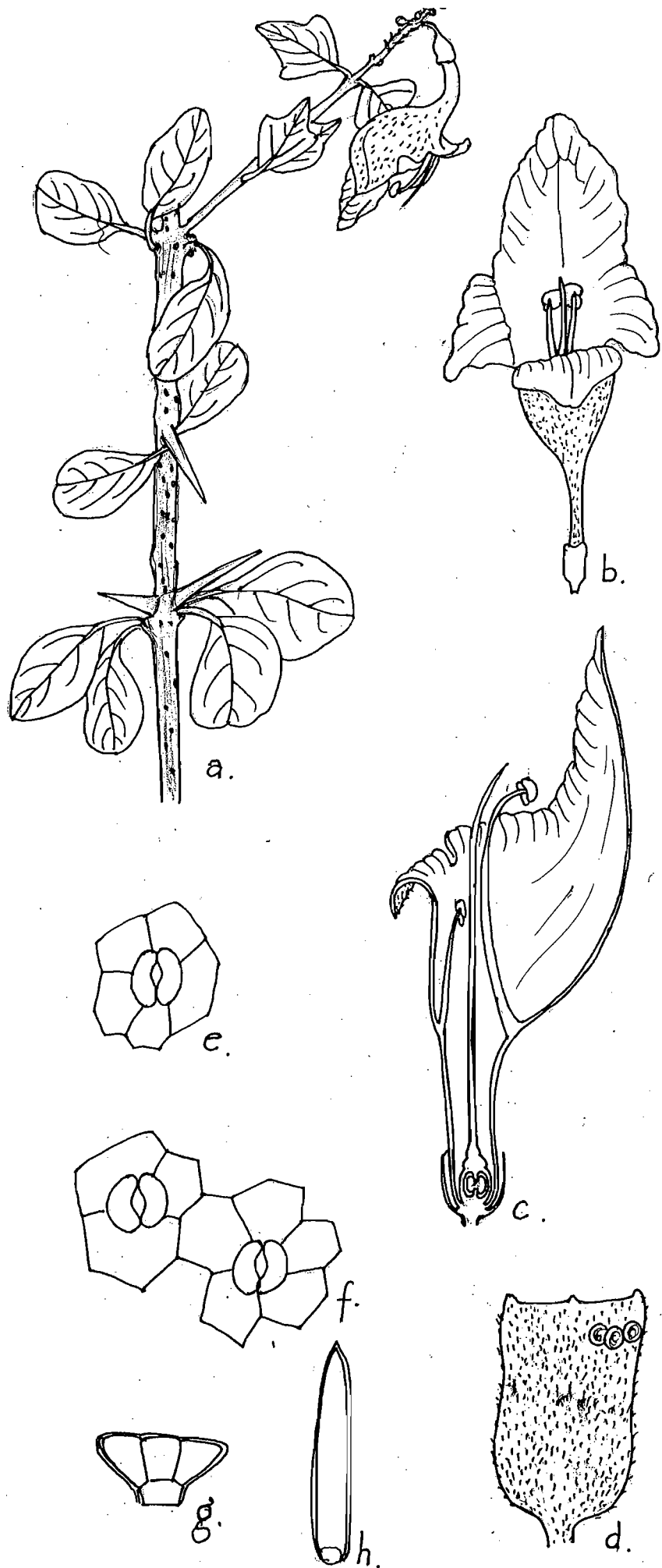


Fig. 424 *Gmelina asiatica* L., a. habit. b. flower. c. L.S. of flower d. calyx of anomocytia

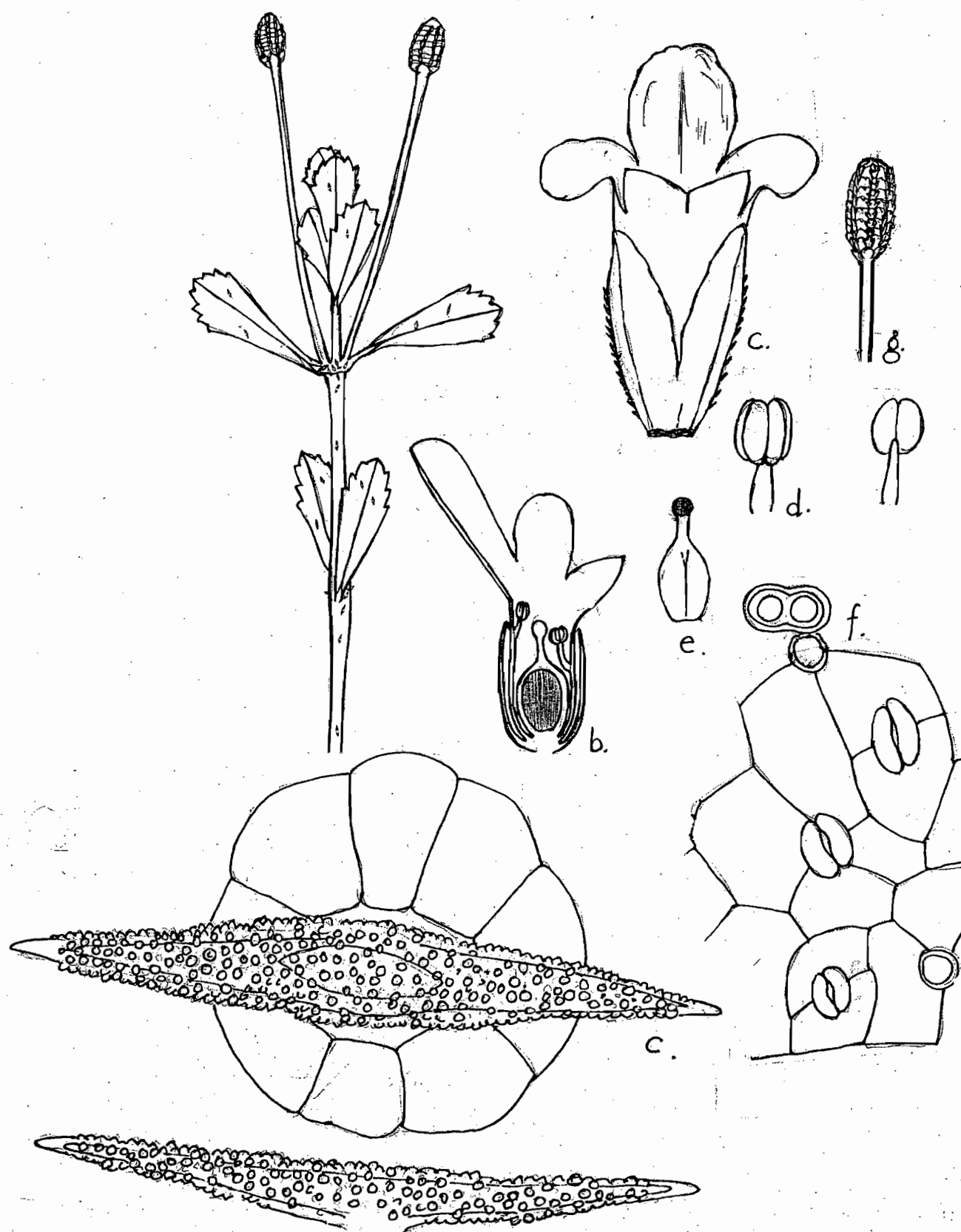


Fig. 425 *Phyla nodiflora* Greene., a. habit, b. L.S. of flower, c. flower, d. stamen, e. gynoecium, f. T.S. of ovary, g. inflorescence, g. diacytic stomata h. medifixed hair with thick warty wall.

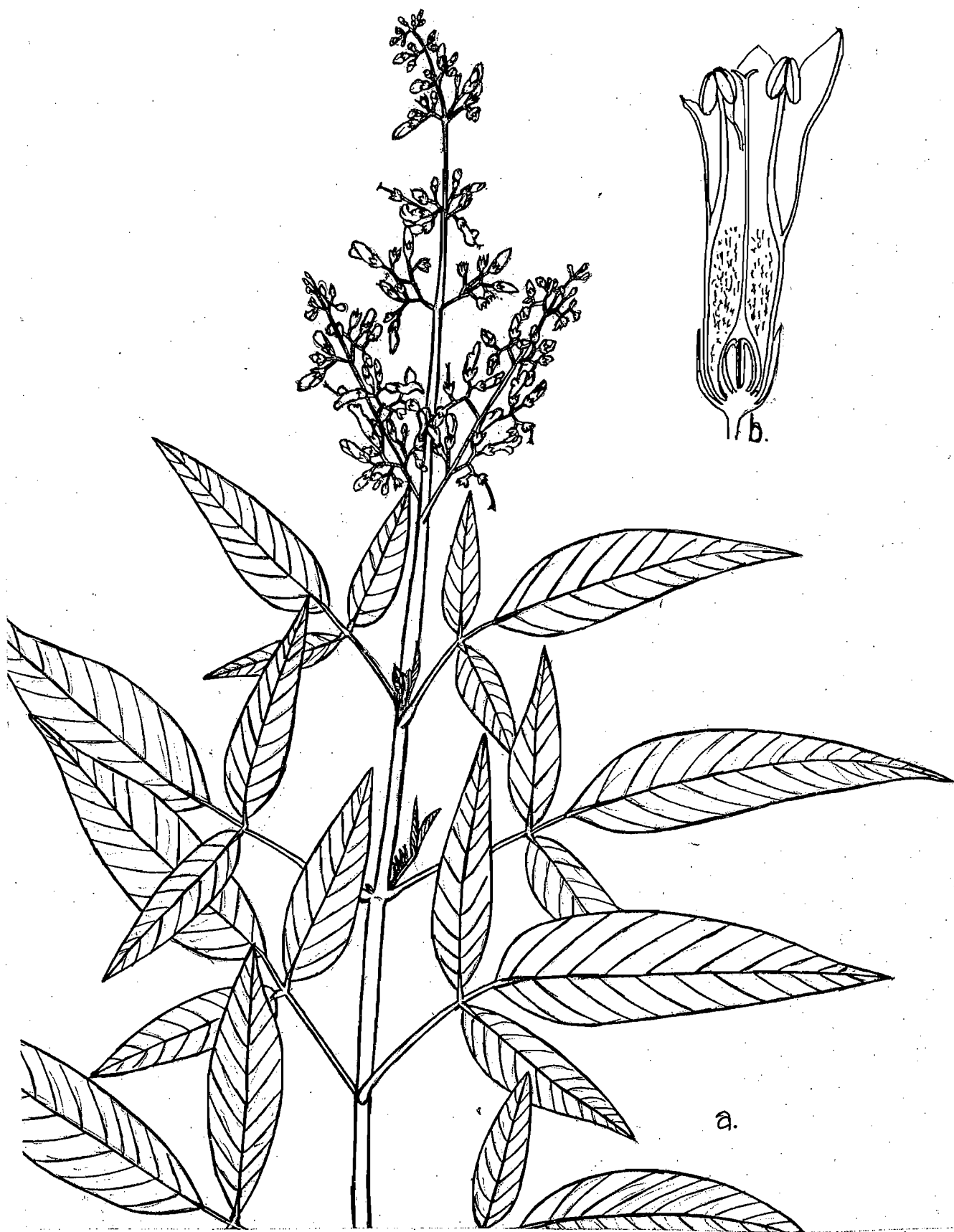


Fig. 426 *Vitex negundo* L., a. habit, b. L.S. of flower.

Micromorphology (Fig. 427)

There were three types of trichomes: 1) unicellular, non-glandular, elongated trichome with warty wall. 2) multicellular, uniseriate, non-glandular, unbranched trichome. 3) two–four celled glandular trichome which was sessile.

Stomata were can not observed because of numerous trichomes on the surface.

D/ 744.

6. *Tectona grandis* Linn. f. *Suppl.*(1781) p. 151.

A large deciduous tree, tomentose with stellate hairs reaching a height of 30 m or more. Leaves elliptic or obovate, upto 60 cm, lower surface clothed with dense stellate grey tomentum. Flowers in large terminal cymose panicles upto 1 m long, with lanceolate bracts. Calyx 5-6 lobed, stellately tomentose, semiglobose-campanulate; in fruit enlarged, bladder like, enclosing the fruit, ovoid. Corolla white, 5-6 lobed; limb with spreading subequal lobes. Stamens 5-6, equal; anther

lobes parallel. Ovary 4-celled; ovule solitary; style linear; stigma shortly 2-fid. Fruit subglobose, 4-lobed. (Fig. 428)

Vernacular name: Sag.

Flowers: June-September.

Micromorphology (Fig. 428)

Plant showed presence of stellate hairs of 3 long arms.

D/462, 665, 996- 998.

Lamiaceae

1. *Anisochilus carnosus* Wall . *Pl. As. Rar.* V. 2 (1831) p. 18.

A finely pubescent, erect, annual, with stem quadrangular reaching upto 60 cm high. Leaves broadly ovate, upto 6 cm long, crenate. Flowers sessile, in dense spikes upto 4 cm long; bracts broadly ovate, acuminate. Calyx bilipped; upper lip ovate-lanceolate, decurved over the lower lip and closing the calyx-mouth; lower-lip truncate. Corolla pale-purple, 2-lipped; upper lip with very shallow rounded lobes; lower lip concave. Stamens 4, didynamous. Disk lobed. Ovary 4 partite; style 2-fid at the apex. Nutlets suborbicular, brown. (Fig. 429)

Vernacular name: Ubhoratvelio.

Flowers: September-October.

Micromorphology (Fig. 429)

The plant showed presence of two types of trichomes: 1) multicellular, uniseriate, unbranched, non-glandular trichome. 2) multicellular, glandular trichome differentiated into a two celled head and a one celled stalk.

Stomata were of anisocytic and anomocytic type.

D/332.

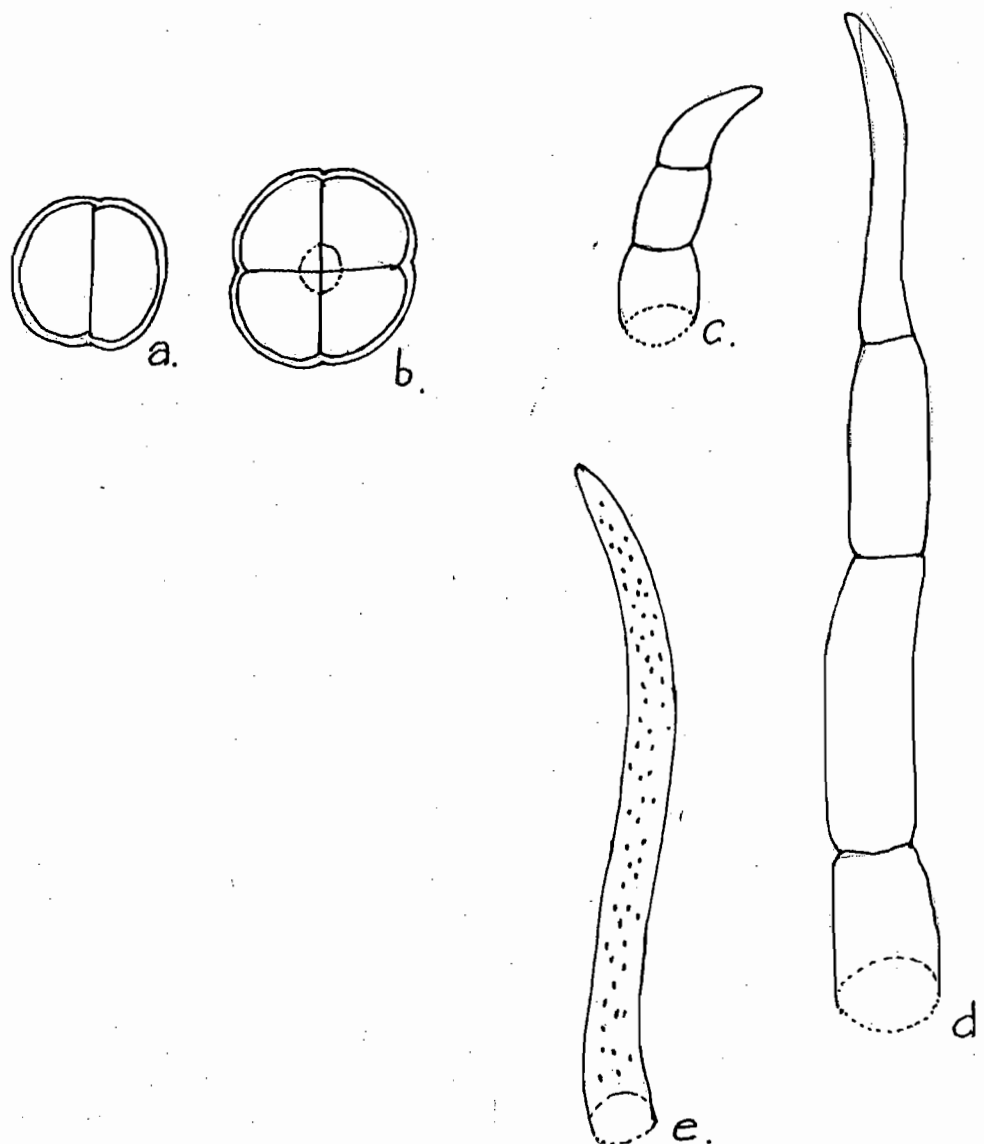


Fig. 427 *Vitex negundo* L., a & b. two to four celled sessile gland, c-d. multicellular uniseriate trichome, e. glandular unicellular trichome with warty wall.

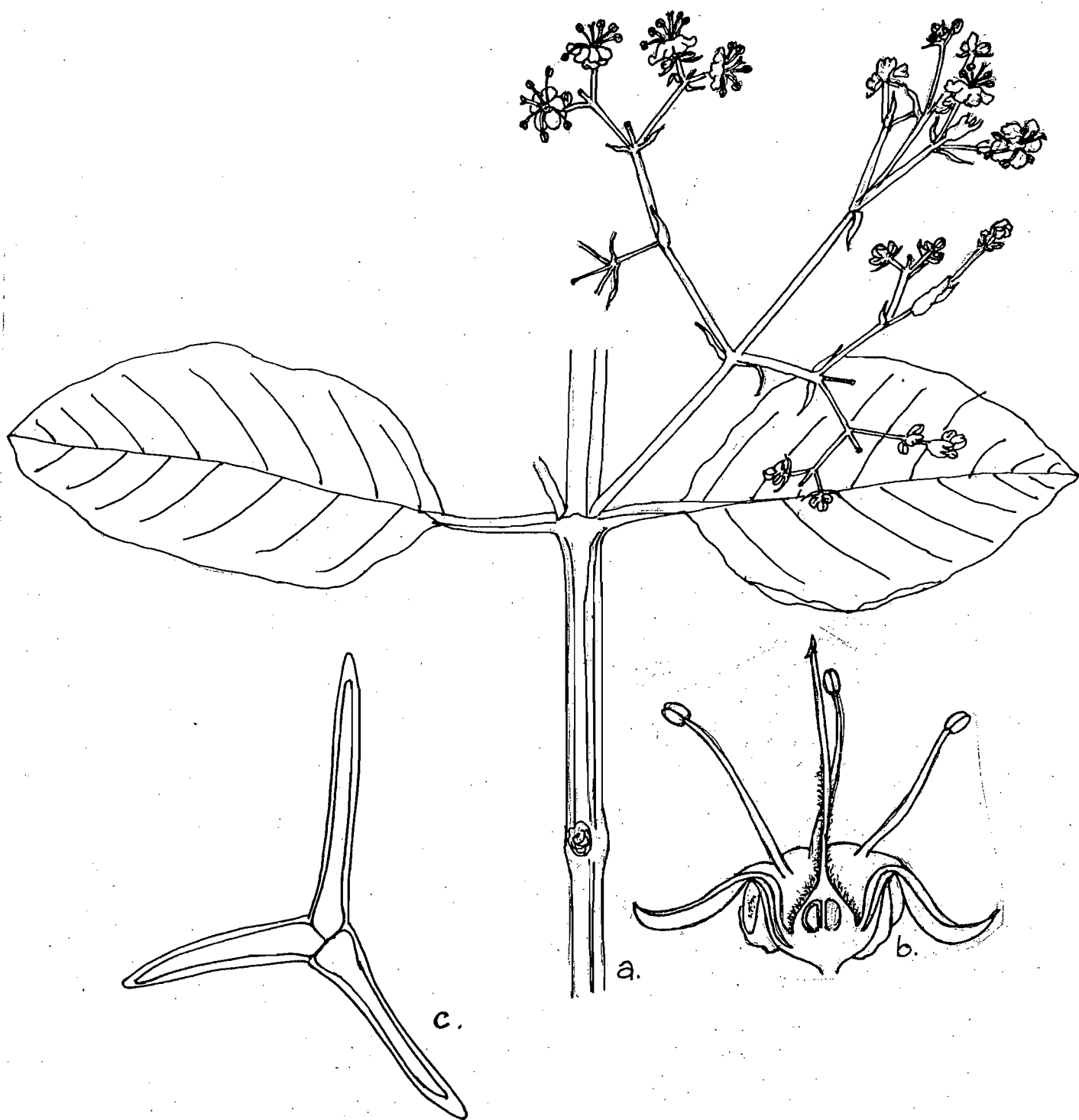


Fig. 428 *Tectona grandis* L., a. habit, b. L.S. of flower, c. three celled stellate hair.

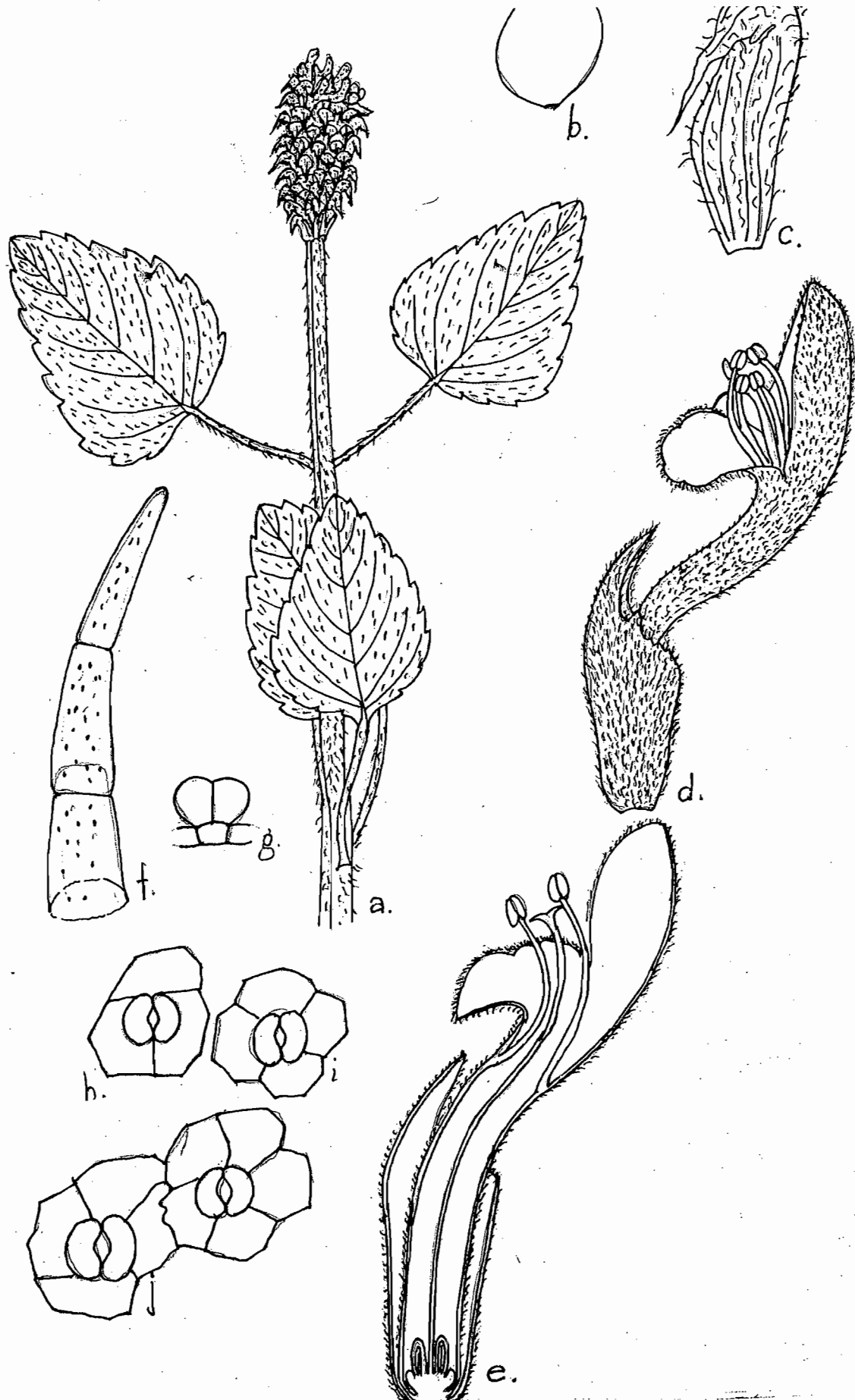


Fig. 429. *Anisochilus carnosus* Wall., a. habit, b. seed, c. calyx, d. flower, e. L.S. of flower, f. multicellular uniseriate trichome, g. multicellular sessile gland, h. anisocytic stomata, i. tetracytic stomata, j. anomocytic stomata.

2. *Anisomeles indica* (L.) Kuntze. *Revis. Gen. Pl.* 2: 512. 1891.

A suffruticose, hirsute herb reaching a height of 1 m. Leaves ovate, upto 12 cm long, serrate. Flowers sessile in dense whorls to form a dense spicate inflorescence; bracts linear. Calyx teeth lanceolate. Corolla purple; upper lip oblong, rounded, the middle lobe, deeply divided into 2 oblong lobes. Filaments bearded. Nutlets broadly ovoid with rounded ends. (Fig. 430)

Vernacular name: Chodharo.

Flowers: August-October.

Micromorphology (Fig. 430)

There were multicellular uniseriate trichomes and glands with single celled head and two celled uniseriate stalk.

Stomata were diacytic, anisocytic and anomocytic.

D/287, 489, 564, 1091, 1246.

3. *Basilicum polystachyon* L. *Suppl. Meth.* 143. 1802.

(*Moschosma polystachyon* Benth.)

This is an annual with an erect much branched, sharply quadrangular, glabrous stem reaching upto 1 m in height. Leaves ovate-elliptic, upto 5 cm, serrate. Flowers in numerous whorls of spicate racemes. Calyx 2-lipped; upper lip broad, suborbicular, reflexed; lower lip with 4 lanceolate acute teeth, longer than the upper lip. Corolla pale pink; bi-lipped; upper lip 4-lobed, the lobes subequal; lower lip entire. Stamens 4, didynamous. Ovary 4-partite; style clavate. Nutlets ellipsoid, smooth, brown. (Fig. 431)

Vernacular name: Abchi-bavchi.

Flowers: September-January.

Micromorphology (Fig. 432)

Almost the whole plant was glabrous, except for leaves. The trichome on the leaf was glandular, unicellular and thin walled.

The corolla and calyx showed presence of multicellular non-glandular uniseriate trichomes of differing nature, all of them had a pointed apex and broad basal cell. In some the walls were protruded out like teeth giving them a dendritic appearance. All the cells were thick walled with a broad lumen.

Stomata are anisocytic and diacytic.

D/575, 745.

4. *Blandinia biflora* (Vahl) Raf. *Flora Telluriana* 3: 88. 1837.

(*Leucas biflora* R. Br.)

A procumbent, pubescent, herb with quadrangular stems and branches. Leaves ovate-elliptic, variable, upto 5 cm long, serrate. Flowers in distant axillary whorls of 1-4; bracts small, subulate. Calyx teeth subequal, lanceolate, ciliate. Corolla white, 2-lipped; upper lip extremely villous, corolla tube annulate within; the middle lobe of the lower lip emarginated. Nutlets oblong, trigonous, truncate, enclosed in the persistent calyx. (Fig. 433)

Flowers: September-February.

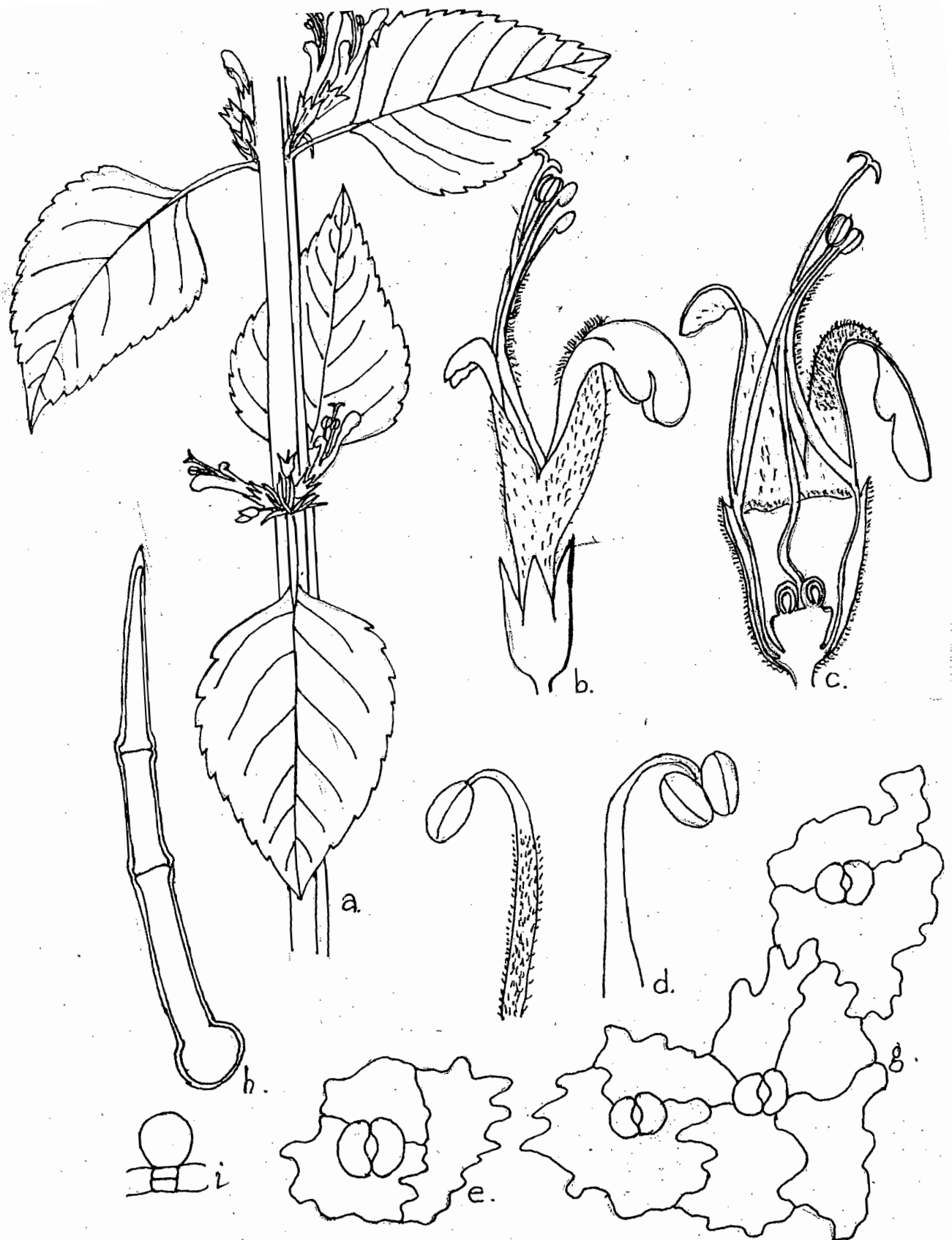


Fig. 430. *Anisomelos ovata* R. Br., a. habit, b. flower, c. L.S. of flower, d. stamen, e. diacytic stomata, f. anisocytic stomata, g. anomocytic stomata, h. multicellulr uniseriate trichome, i. gland with single celled head and two celled uniseriate stalk.

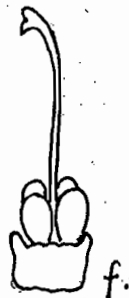
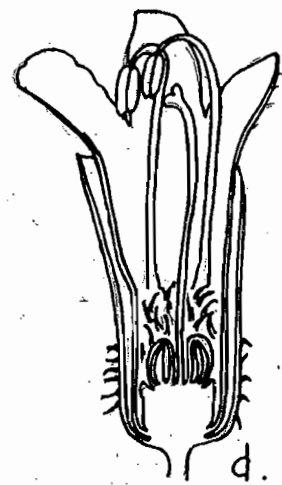
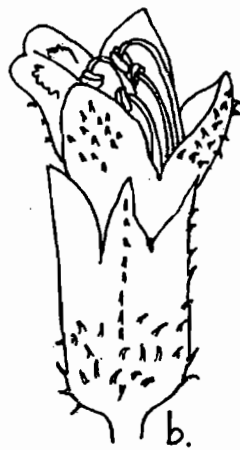
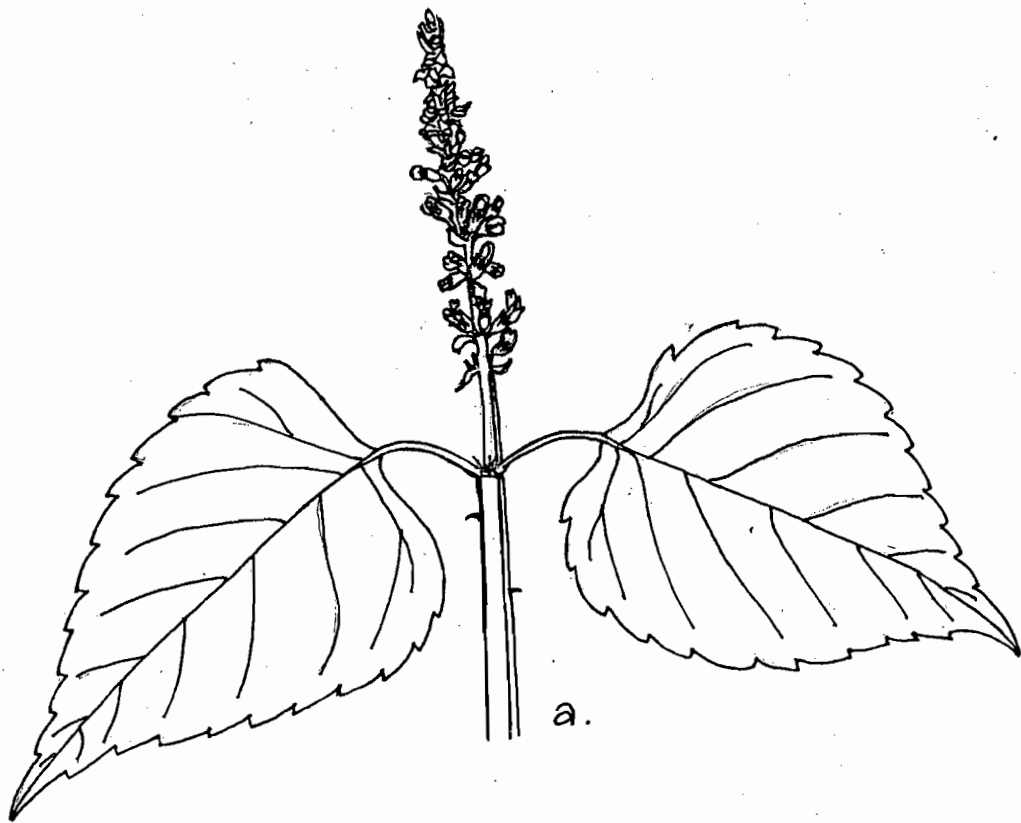


Fig. 431. *Basilicum polystachyon* (L.) a. habit, b-c. flower, d. L.S. of flower, e. calyx, f. gynoecium.

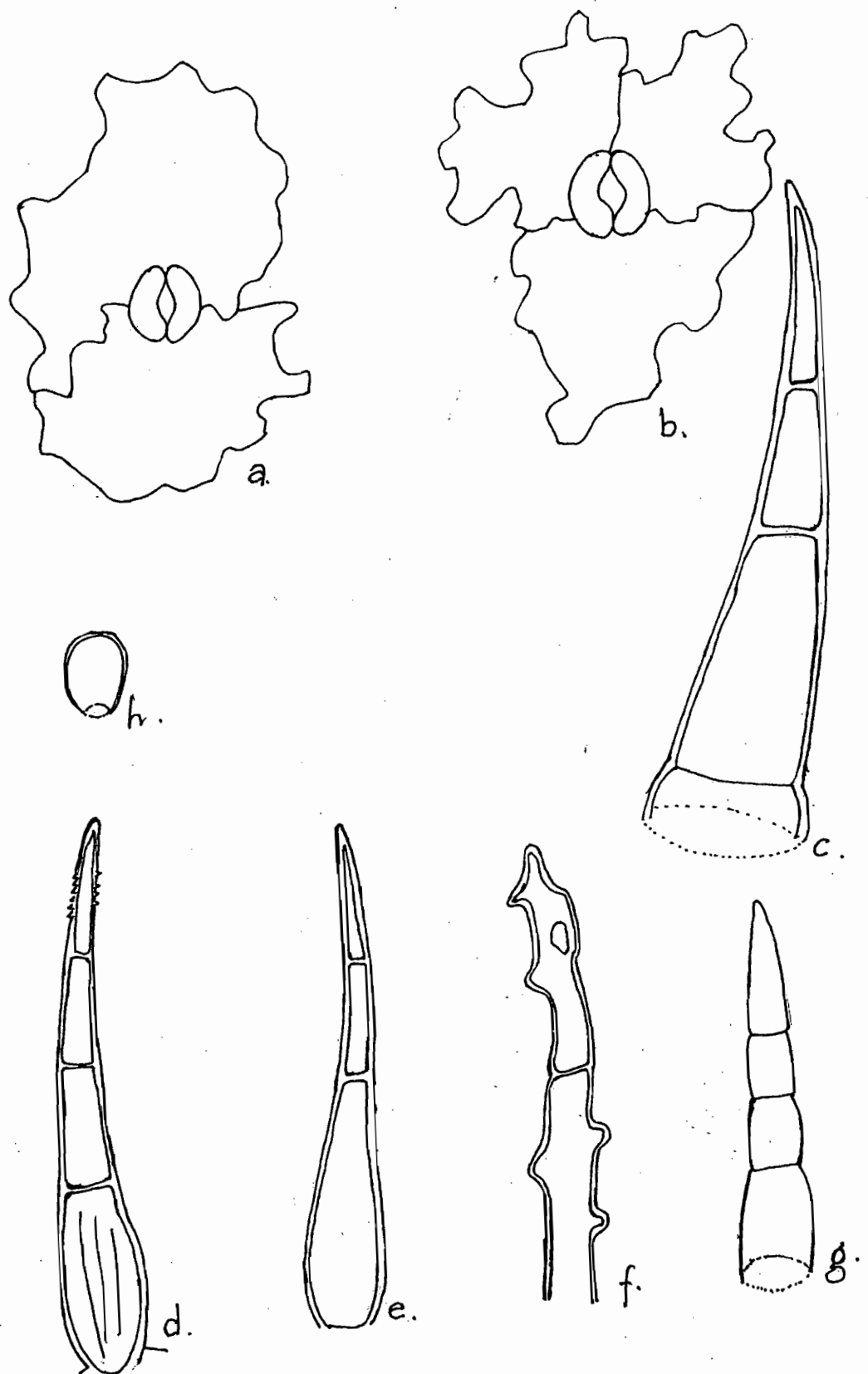


Fig. 432. *Basilicum polystachyon* (L.), a. diacytic stomata, b. anisocytic stomata, c. multicellular uniseriate trichome with broad cells d-e. multicellular uniseriate trichome, f. two celled uniseriate, slightly branched trichome g. multicellular uniseriate trichome.

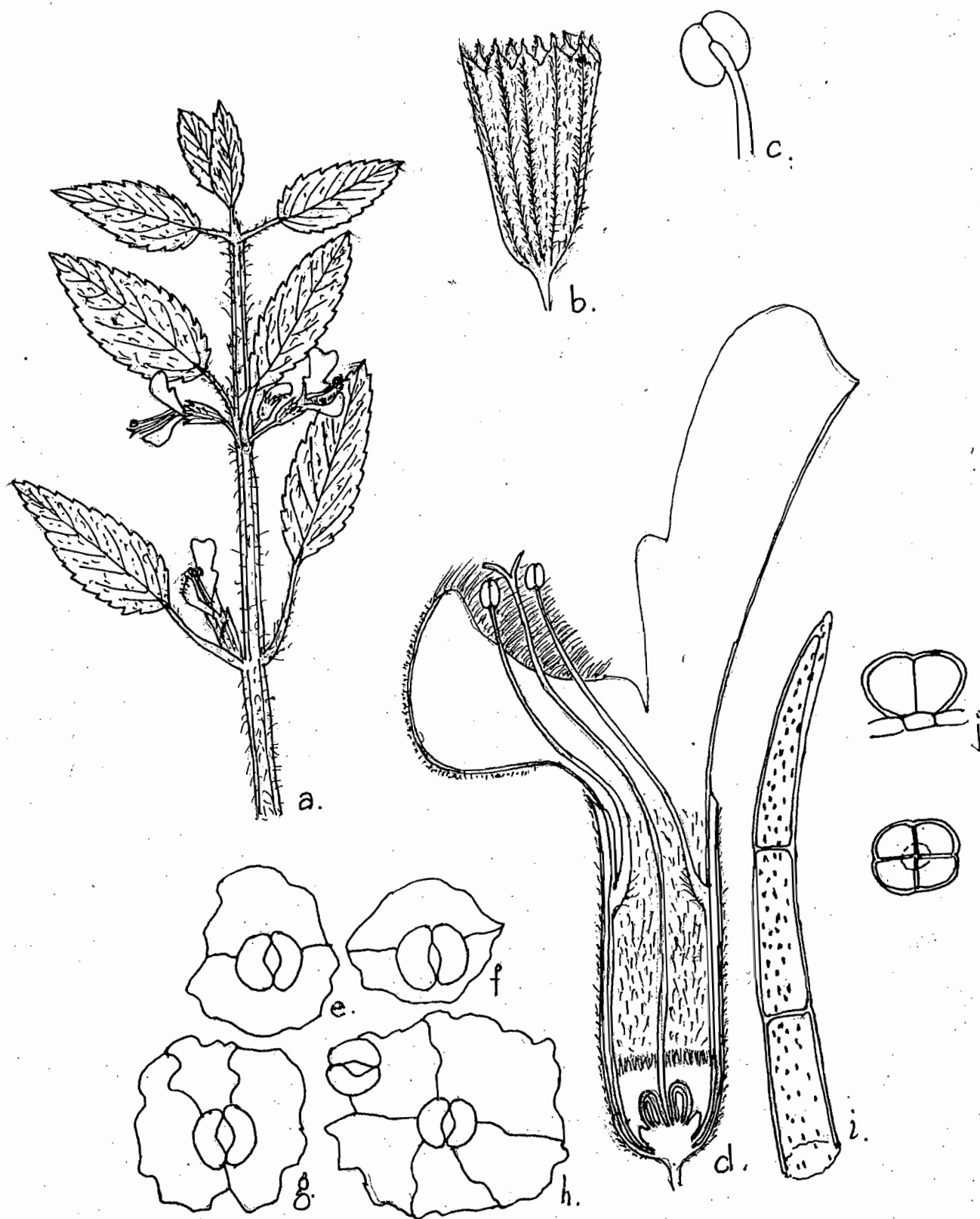


Fig. 433 *Blandinia biflora* (Vahl) Raf., a. habit, b. calyx, c. stamen, d. L.S. of flower, e-f. diacytic stomata, g. anisocytic stomata, h. anomocytic stomata, i. multicellular uniseriate trichome, j. two-four celled sessile gland.

Micromorphology (Fig. 433)

The plant showed presence of multicellular, uniseriate, unbranched, non-glandular trichome with warty thick wall. Along with it a multicellular, glandular trichome was present differentiated into a four celled sessile head.

Stomata were of diacytic, anomocytic and anisocytic type.

D/746, 1047, 1217.

5. *Glechoma bombaiensis* (Dalzell) Kuntze Revis. Gen. Pl. 2: 518. 1891.

(*Nepeta bombaiensis* Dalz.)

A branched herb reaching upto 30 cm high with stem obtusely quadrangular, clothed with soft white hairs. Leaves rounded-ovate, upto 5 cm long, crenate. Flowers in axillary 6-8 flowered cymes; bracts elliptic-lanceolate, acuminate. Calyx

2-lipped. Corolla pale-blue with purple spots; bi-lipped; upper lip 2-fid; lower lip 3-lobed, the middle lobe broadest. Stamens 4, didynamous; anther-cells diverging.

Disk uniform. Ovary 4-partite; style shortly 2-fid; lobes subequal. Nutlets ellipsoid, dark-brown, dotted with white dots. (Fig. 434)

Flowers: July-August.

Micromorphology (Fig. 434)

The plant showed presence of multicellular, uniseriate, unbranched non-glandular trichome.

Stomata were of diacytic, anisocytic and anomocytic type.

D/1200-1204.

6. *Hyptis suaveolens* (L.) Poit. in Ann. Mus. Hist. Nat. 7: 472. t. 29. f. 2. (1806)

An annual, hirsute, herb with stems and branches reaching to a height of 1 m. Leaves broadly ovate or suborbicular, upto 7 cm long, crenate-serrulate. Flowers axillary or terminal in short umbels; bracts minute, setaceous. Calyx tubular, 10-nerved; limb subequally 5-lobed. Corolla blue; bilabiate, lobes-5, lowest lobe shorter, abruptly deflexed, saccate, contracted at base. Stamens 4, declinate; anthers 2-celled; cells confluent; disk symmetrical. Ovary 2-celled; style shortly 2-fid. Nutlets usually 2, ovoid, flat, blackish brown. (Fig. 435)

Vernacular name: Vilayati tulsi.

Flowers throughout the year.

Micromorphology (Fig. 436)

There were trichomes and glands. The trichomes were: 1) multicellular uniseriate trichome, 2) two celled uniseriate trichome. The glands were: 1) gland with single celled head and two celled uniseriate stalk, 2) unicellular gland, 3) gland with two celled head and a single celled stalk, 4) gland with single celled head and a single celled stalk.

Stomata were diacytic.

D/030, 213, 817- 821.

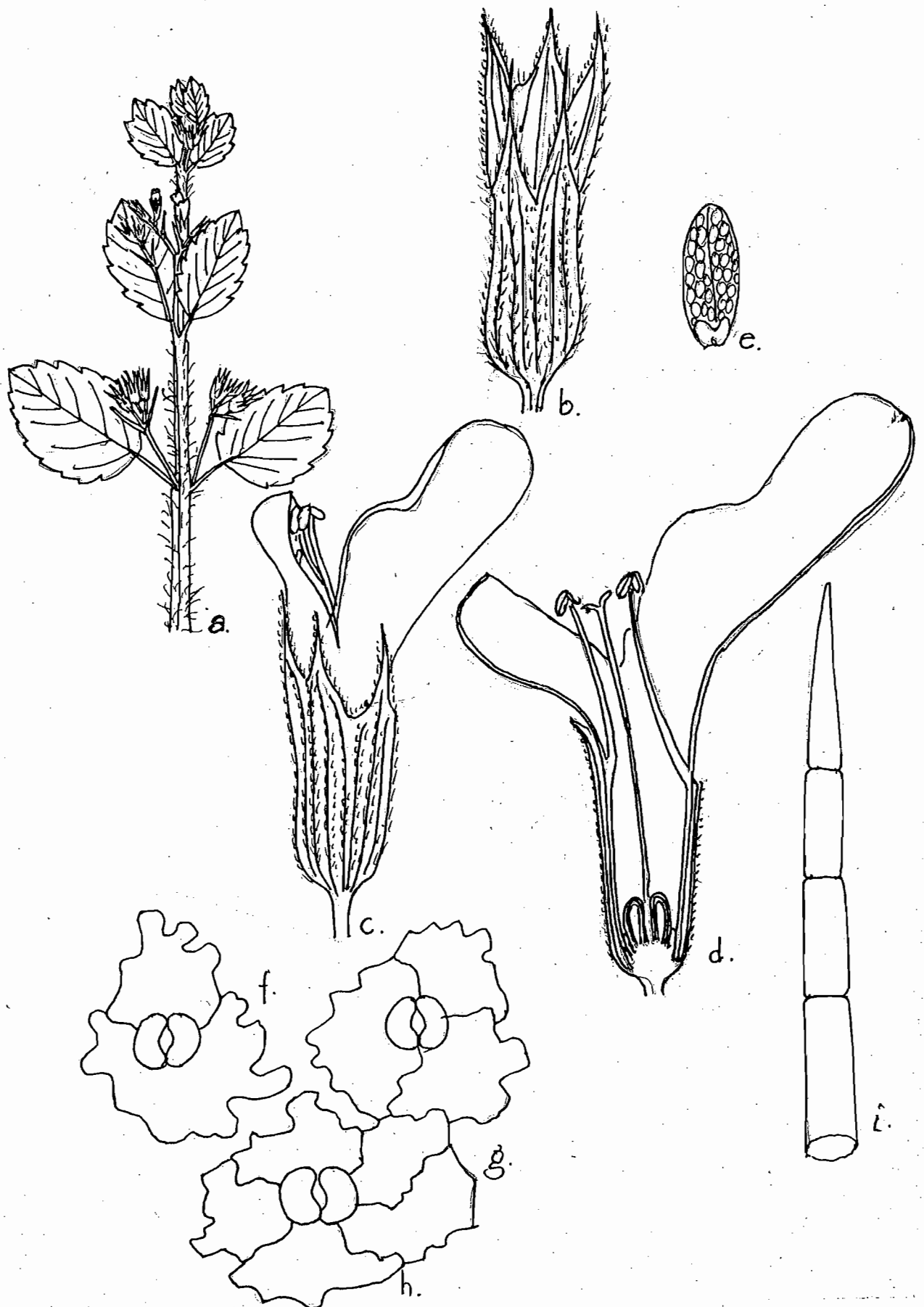


Fig. 484. *Glechoma bombaiensis* Kuntze., a. habit, b. calyx c. flower, d. L.S. of flower, e. seed, f. diacytic stomata, g. anisocytic stomata, h. anomocytic stomata i. multicellular uniseriate trichome.

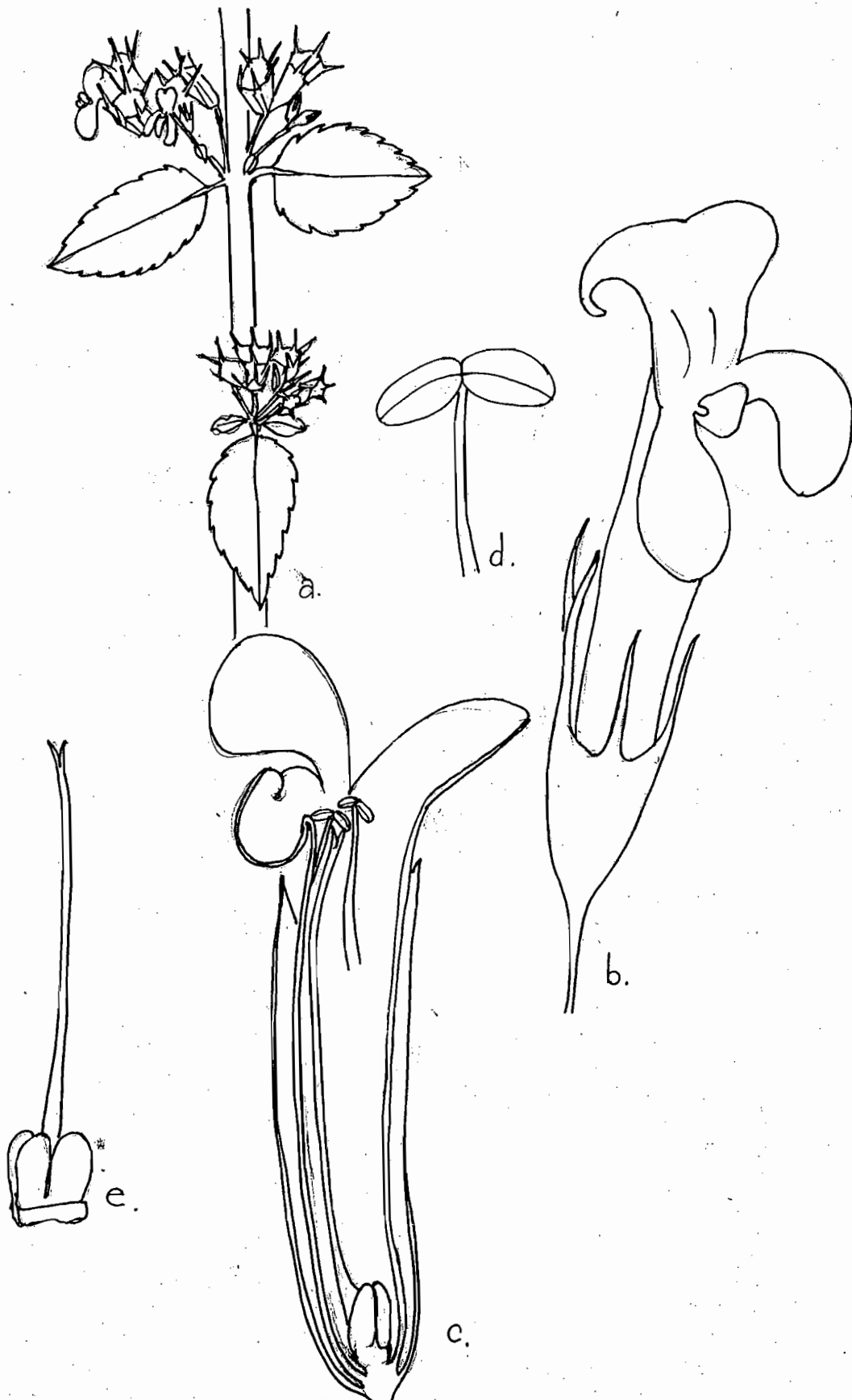


Fig. 435. *Hyptis suaveolens* Poit., a. habit, b. flower, c. L.S. of flower, d. stamen, e. gynoecium.

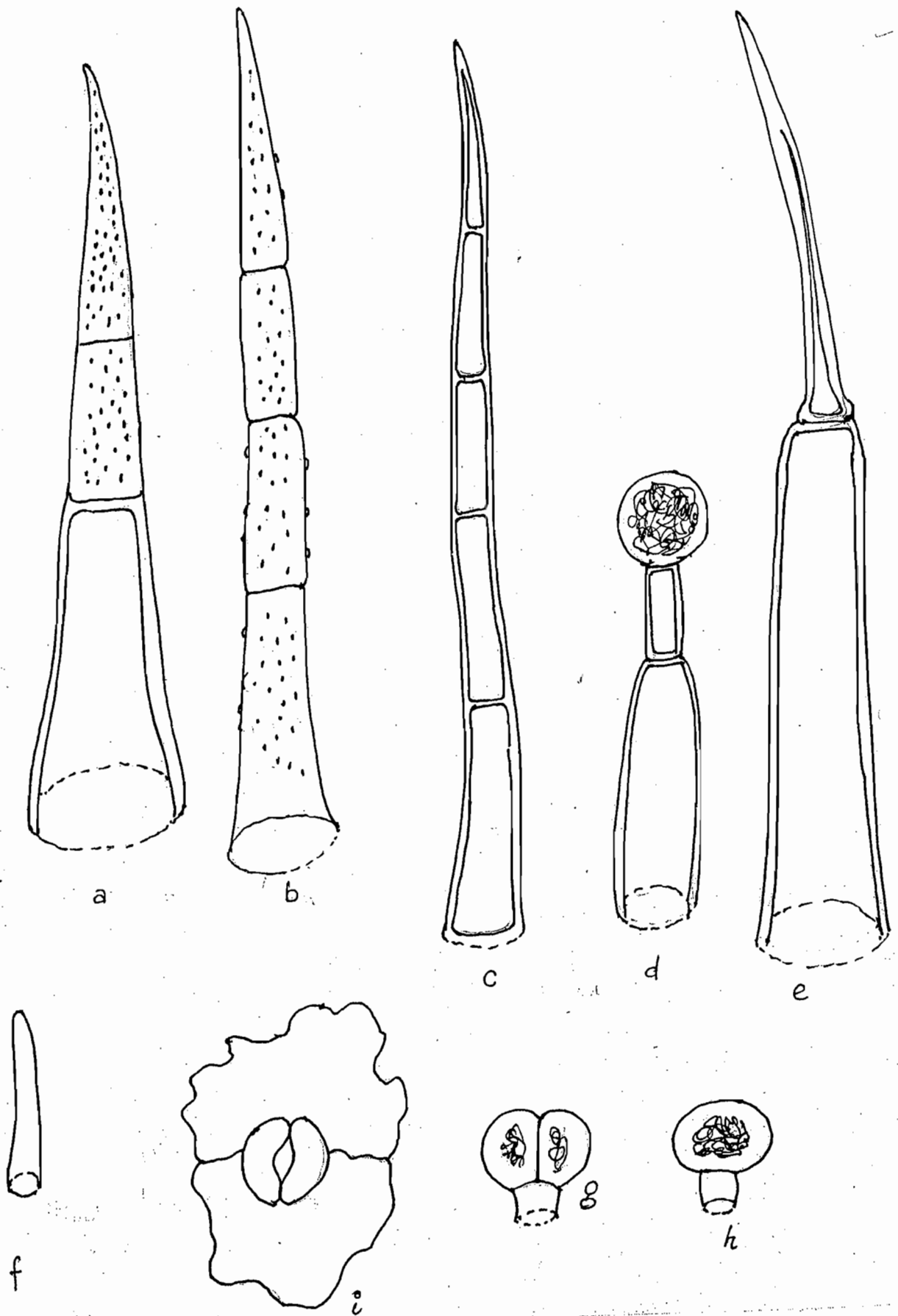


Fig. 436 *Hyptis suaveolens* Poit., a-c. multicellular uniseriate trichome, d. gland with single celled head and two celled uniseriate stalk, e. two celled uniseriate trichome, f. unicellular gland, i. diacytic stomata, g. gland with two celled head and a single celled stalk, h. gland with single celled head and a single celled stalk.

7. *Leonotis nepetifolia* R. Br. in. *Ait. Hort. Kew. ed. 2* (1811) V. 3, p. 400.

A tall erect plant upto 2 m high with stem obtusely quadrangular. Leaves ovate, upto 15 cm long, serrate. Flowers in axillary and terminal dense globose many-flowered clusters; bracts linear, spinous-pointed, deflexed. Calyx ribbed, teeth 8-9, the upper largest, all with strong sharp spinous points. Corolla orange-scarlet; densely clothed orange-scarlet hairs, annulate inside with 3 transverse parallel rings of white hairs; upper lip densely woolly with orange-scarlet hairs; lower lip deeply 3-lobed, the lobes oblong, obtuse, the middle lobe longest. Stamens 4, didynamous; anthers connivent, the cells divaricate. Disk equal. Ovary 4-partite. Nutlets oblong-obovoid. (Fig. 437)

Vernacular name: Hejurchei.

Flowers: September-October.

Micromorphology(Fig. 437)

The leaf showed presence of two types of trichomes: 1) multicellular, uniseriate, unbranched, non-glandular, trichome with basal broad cells. 2) multicellular, glandular trichome differentiated into 1-4 celled head, and a single celled stalk.

The trichomes on stamens were multicellular, glandular, with 2-celled head and a multicellular-uniseriate stalk.

The corolla showed presence of three types of trichomes: 1) multicellular, uniseriate, unbranched, non-glandular trichome with warty surface. 2) multicellular, uniseriate, unbranched, non-glandular trichome with smooth wall. 3) three celled non-glandular trichome with cells arranged end to end and with a swollen middle cell.

The stomata were of diacytic, anisocytic and anomocytic.

D/591-592, 1186-1187.

8. *Leucas urticaefolia* R. Br. *Prodr.* (1810) p. 504.

An annual with quadrangular finely tomentose, stem. Leaves ovate, upto 10 cm long. Flowers in many-flowered globose whorls; bracts linear-lanceolate, aristate. Calyx cylindric; mouth very oblique, about 10-toothed, somewhat 2-lipped, the upper lip very small with minute spinescent teeth, the lower much prolonged, the 3 lowest teeth the largest, spinescent from a triangular base. Corolla white; upper lip obovate, concave; lower lip 3-lobed. Stamens 4, didynamous; anthers conniving, the cells divaricate. Disk entire. Ovary 4-partite. Nutlets obovoid-oblong. (Fig. 438)

Vernacular name: Kubo.

Flowers: August-November.

Micromorphology(Fig. 439)

The glands present were multicellular sessile gland, and gland with single celled head and two celled stalk. The trichomes were multicellular uniseriate and two celled uniseriate trichome.

Stomata were diacytic and anomocytic.

D/282.

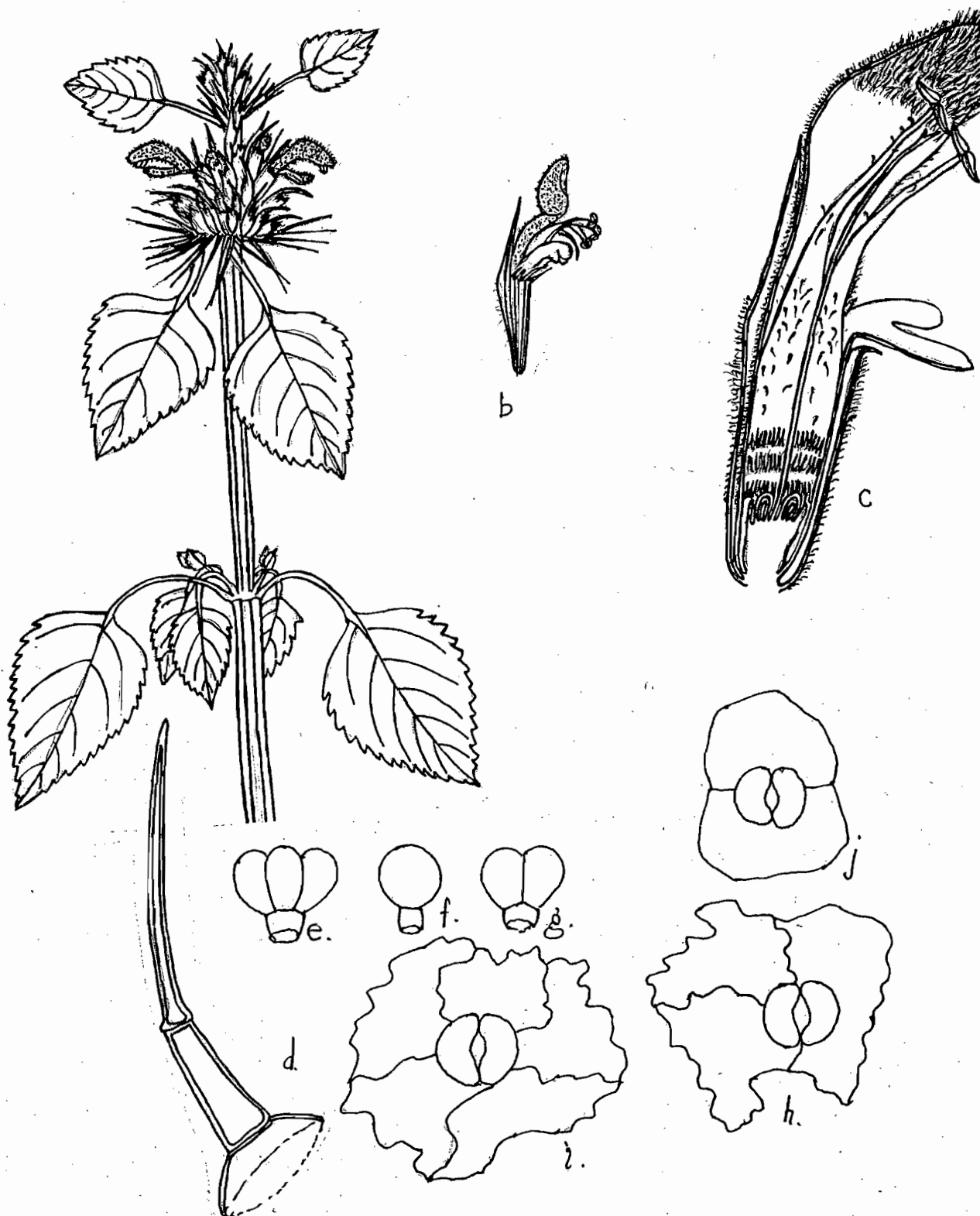


Fig. 437. *Leonotis nepetifolia* R. Br., a. habit, b. flower, c. L.S. of flower, d. multicellular trichome with basal cell broad, e-g. gland with single to three celled head and single celled stalk, h. anisocytic stomata, i. anomocytic stomata, j. diacytic stomata.

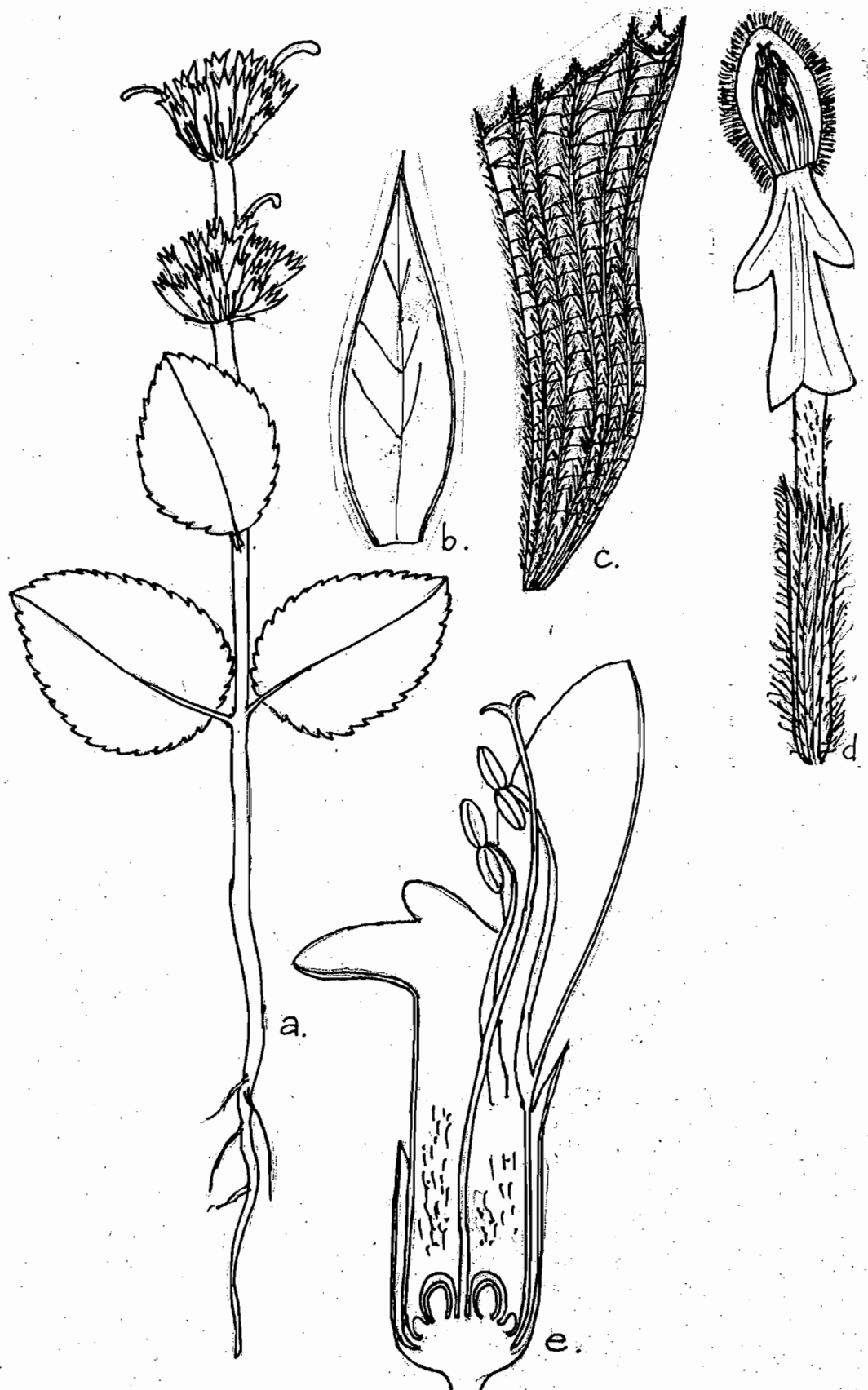


Fig. 438. *Leucas urticaefolia* R. Br., a. habit, b. bract, c. calyx, d. flower, e. L.S. of flower.

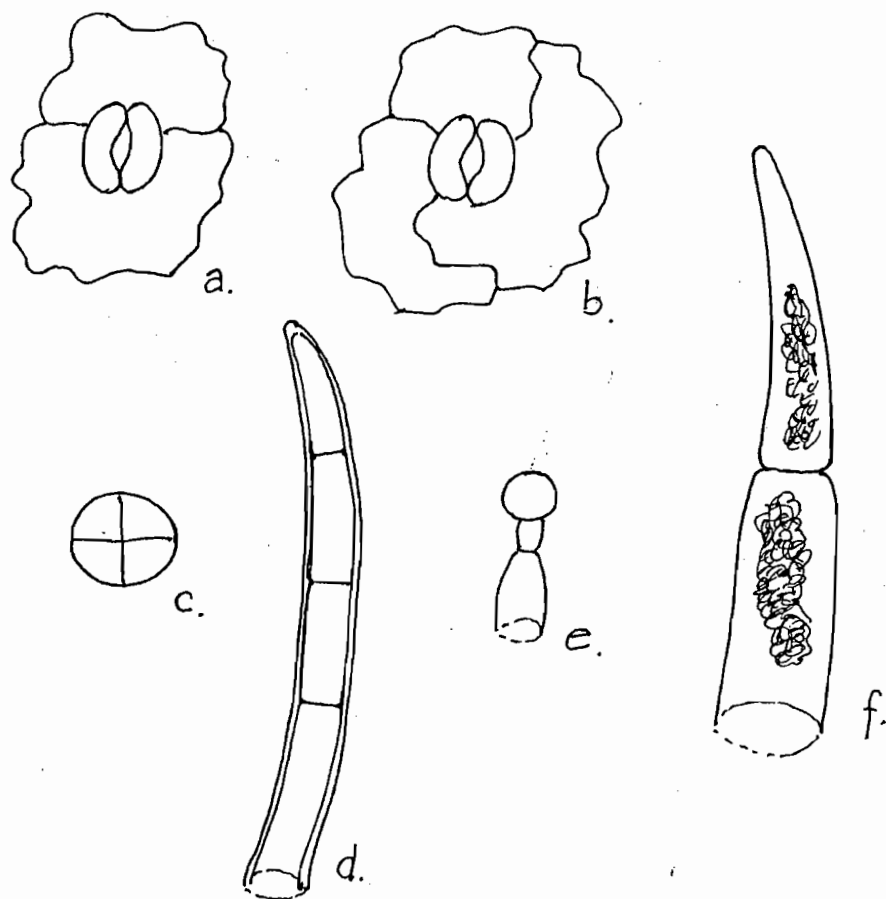


Fig. 489. *Leucas urticaefolia* R. Br., a. diacytic stomata, b. anomocytic stomata, c. multicellular sessile gland, d. multicellular uniseriate trichome, e. gland with single celled head and two celled stalk f. two celled uniseriate trichome.

9. *Leucas zeylanica* R. Br. *Prodr.* (1810) p. 504.

A much-branched, hispid annual with quadrangular stems upto 45 cm high. Leaves linear-lanceolate, upto 8 cm long, serrulate. Flowers sessile, usually in terminal whorls; bracts linear. Calyx curved, mouth broad, oblique; upper tooth of calyx longer than the others, triangular, acute, the other teeth subequal. Corolla white, 2 cm long; upper lip densely white woolly, lower lip 3-lobed, the middle lobe broadly obovate, rounded, the lateral lobes very small. Nutlets obovoid-oblong. (Fig. 440)

Vernacular name: Kuba ni jat.

Flowers: November-January.

Micromorphology (Fig. 440)

The plant showed presence of multicellular, uniseriate, unbranched, non-glandular trichome.

Stomata were of diacytic and anisocytic type.

D/957.

10. *Ocimum canum* Sims. in *Bot. Mag.* (1824) t. 2452.

A much-branched pubescent herb, upto 60 cm high with subquadrangular stems. Leaves elliptic-lanceolate, upto 4 cm long, serrate, gland-dotted. Flowers about 6 in a whorl, in racemes upto 20 cm long; bracts elliptic-lanceolate. Calyx bi-lipped; upper lip suborbicular, mucronate; lower lip with 4 lanceolate teeth, the 2 central teeth longer than the lateral. Corolla white; upper lip broadly oblong, 4-toothed; subtruncate apex; lower lip oblong, obtuse. Stamens much exserted; the 2 upper with a tooth at the base. Style exserted beyond the filaments. Nutlets ellipsoid, black. (Fig. 441)

Vernacular name: Jangali tulsi.

Flowers: July-December.

Micromorphology (Fig. 441)

The plant showed presence of four types of trichomes: 1) multicellular, uniseriate, unbranched trichome with thick wall and a round bottom cells. 2) multicellular, uniseriate, unbranched trichome with thick and warty wall and a round bottom cells. 3) multicellular, glandular trichome differentiated into a single celled head and a single celled stalk. 4) multicellular, two celled head and a single celled stalk.

The plant showed presence of diacytic type.

D/652.

**11. *Ocimum tenuiflorum* L. *Sp. Pl.* 597. 1753.
(*Ocimum sanctum* L.)**

A branched pubescent annual, with subquadrangular stem reaching upto 30 cm high. Leaves elliptic-oblong, upto 5 cm long, serrate, minutely gland-dotted. Flowers in racemes upto 15 cm long in close whorls; bracts ovate. Calyx 2-lipped; upper lip suborbicular, apiculate; lower lip with 2 central long slender awns which project beyond the upper lip. Corolla 2-lipped; purplish; upper lip broadly 4-lobed, lower lip entire. Stamens 4, didynamous, declinate, the upper pair with a small bearded appendage at the base. Ovary 4-partite. Nutlets 4, ellipsoid, yellow with small black markings. (Fig. 442)

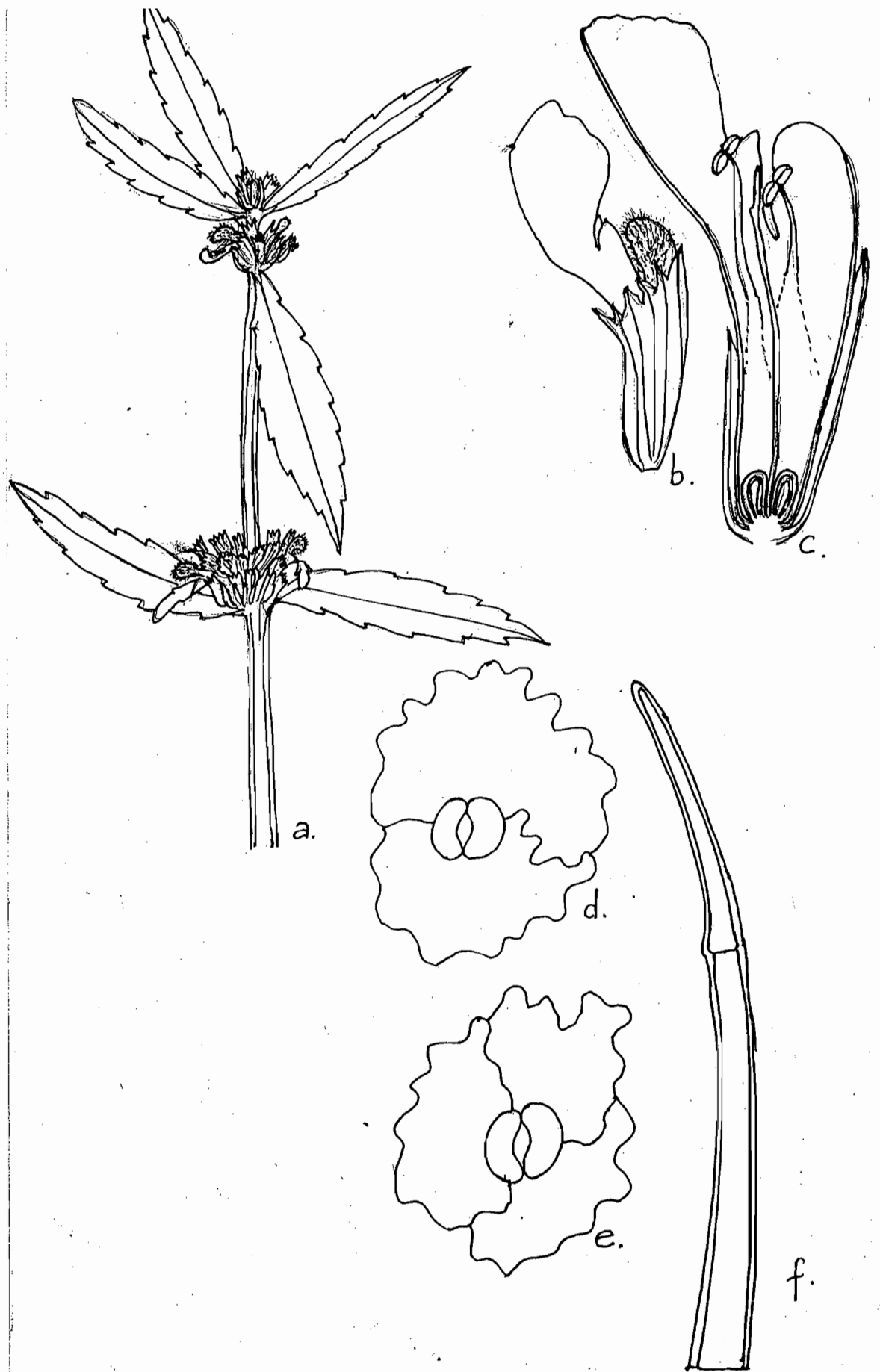


Fig. 440. *Leucas zeylanica* R. Br., a. habit, b. flower, c. L.S. of flower, d. diacytic stomata, e. anisocytic stomata, f. two celled uniseriate trichome.

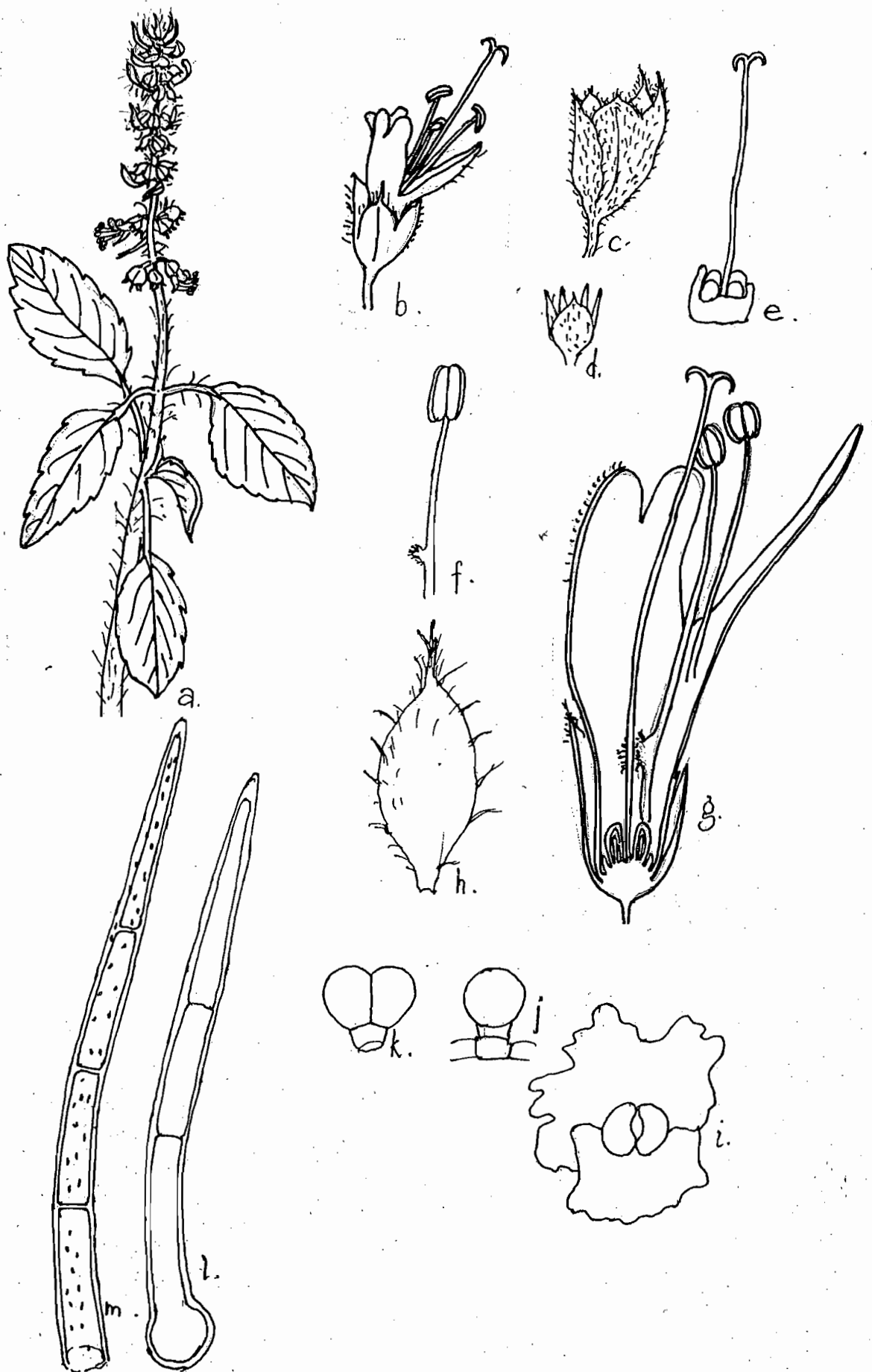


Fig. 4A1. *Ocimum canum* Sims., a. habit, b. flower, c-d. calyx, e. gynoecium, f. stamen, g. L.S. of flower, h. bract, i. diacytic stomata, j. gland with single celled head and single celled stalk, k. gland with two celled head and single celled stalk, l. multicellular uniseriate trichome with smooth wall, m. multicellular uniseriate trichome with smooth wall with warty wall.

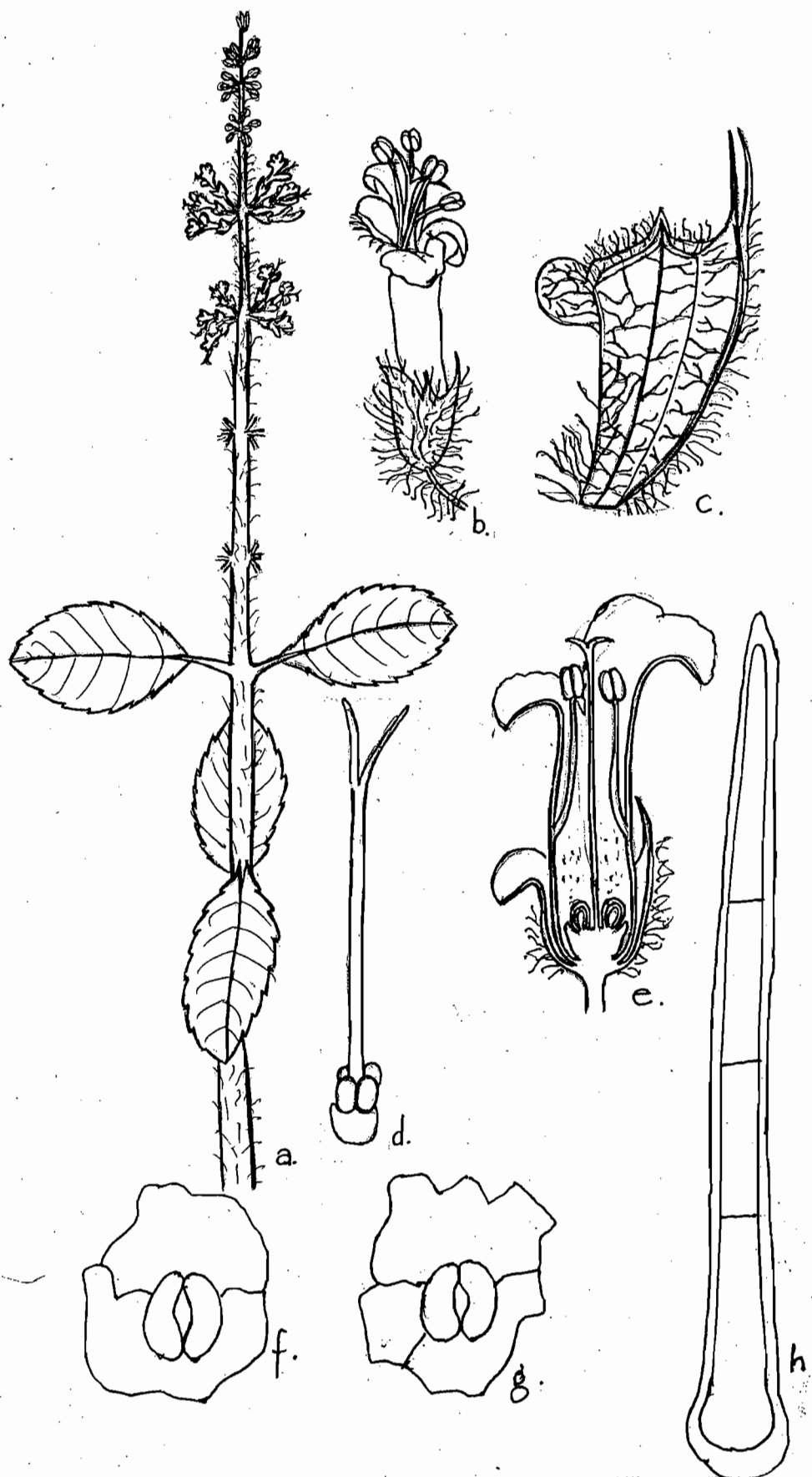


Fig. 442. *Ocimum tenuiflorum* L., a. habit, b. flower, c. calyx, d. gynoecium, e. L.S. of flower, f. diacytic stomata, g. anisocytic stomata, h. multicellular uniseriate trichome.

Vernacular name: Tulsi.

Flowers: Throughout the year.

Micromorphology(Fig. 442)

The plant showed presence of a multicellular, uniseriate, non-glandular trichome with thick wall and the lower cell with a round base.

Stomata were of anisocytic, diacytic and anomocytic type. Among these, anisocytic and anomocytic type of stomata were in majority.

D/700-701.

Nyctaginaceae

1. *Boerhaavia diffusa* Linn. *Sp. Pl.* (1753) p. 3

A glabrous prostrate or ascending divaricately branched herb with stem reaching upto 1 m long. Leaves broadly ovate or sub-orbicular, in unequal pairs at each node, the larger upto 3 cm, rounded. Flowers small, in umbels of 4-10 flowers arranged in axillary or terminal corymbose panicles; bracteoles lanceolate. Perianth petaloid, gamotepalous, limb funnel shaped, 5-lobed, plicate. Stamens 2 or 3. Ovary oblique; ovule erect; stigma peltate. Fruit broadly and bluntly 5-ribbed, glandular. (Fig. 443)

Vernacular name: Punarava.

Flowers: More or less throughout the year.

Micromorphology (Fig. 443)

Whole plant was glabrous.

Stomata were cyclocytic, tetracytic and anisocytic.

D/430, 485.

2. *Boerhavia repanda* Willd., *Sp. Pl.* 1: 22. 1797

A diffuse decumbent branched herb with long internodes and branches upto 15 cm long. Leaves deltoid-ovate, upto 7 cm long, acuminate, repand-sinuate. Flowers in 3-8 flowered umbels; bracteoles beneath the umbels lanceolate. Perianth petaloid, pink, limb funnel shaped with 5-lobed margin, the lobes plicate. Stamens 5. Ovary oblique; ovule erect; stigma peltate. Fruit clavate, ribbed, rough with glandular knobs (Fig. 444).

Flowers: October-December.

Micromorphology (Fig. 445)

The plant showed presence of multicellular, non-glandular, uniseriate, unbranched trichome with a broad basal cell.

Stomata were of anomocytic type.

D/ 441-442, 473.

4. *Commicarpus verticillatus* (Poir.) Standl. *Contr. U. S. Natl. Herb.* 18(3): 101. 1916. (*Boerhaavia verticillata* Poir.)

A glabrous branched climber. Leaves thick, broadly ovate or suborbicular, upto 6 cm long, obtuse, mucronate, sinuate margins. Flowers in long-pedunculate racemes arranged

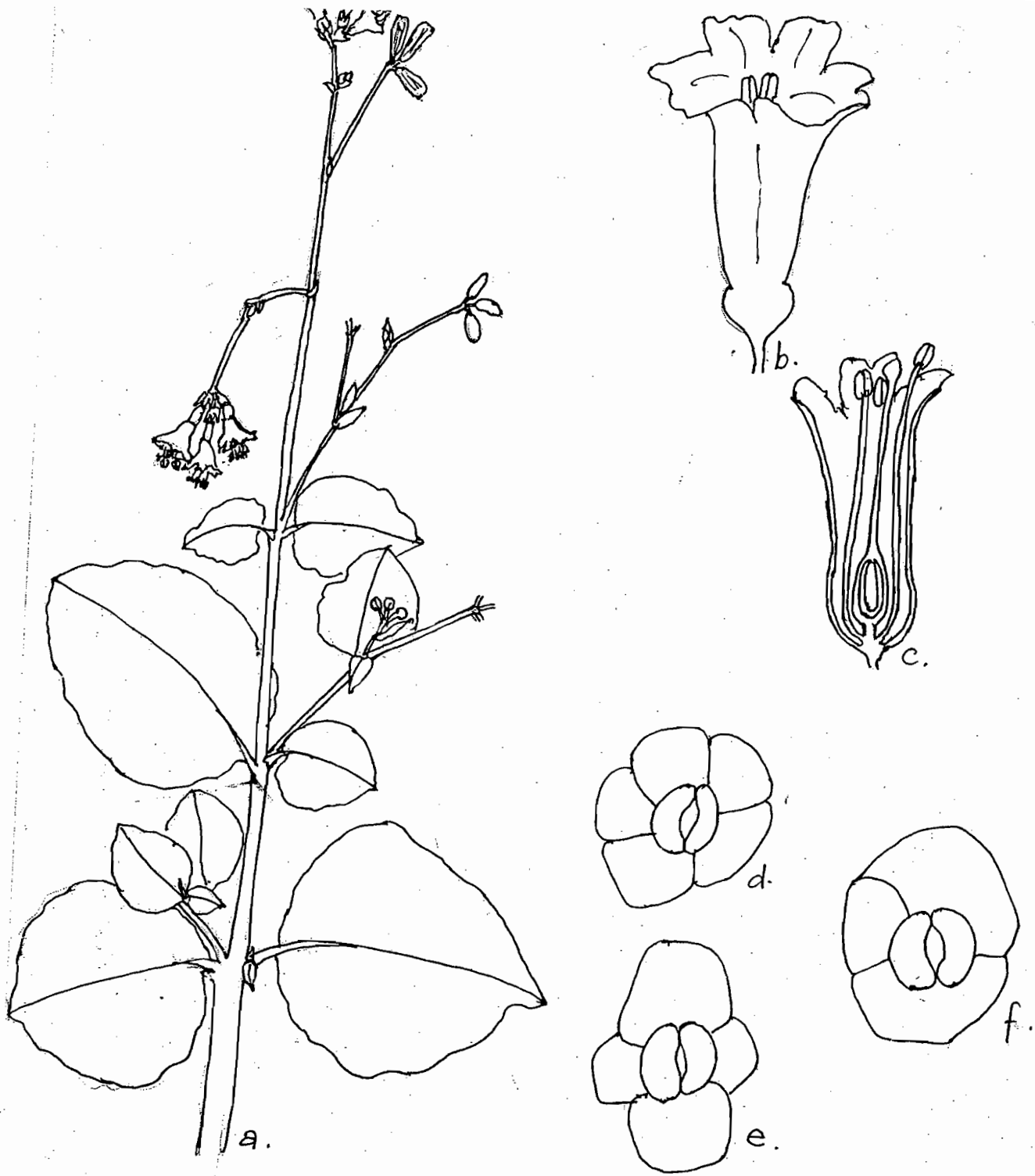


Fig 443. *Boerhaavia diffusa* L., a. habit, b. flower, c. L.S. of flower, d. anomocytic stomata, e. tetracytic stomata, f. anisocytic stomata,

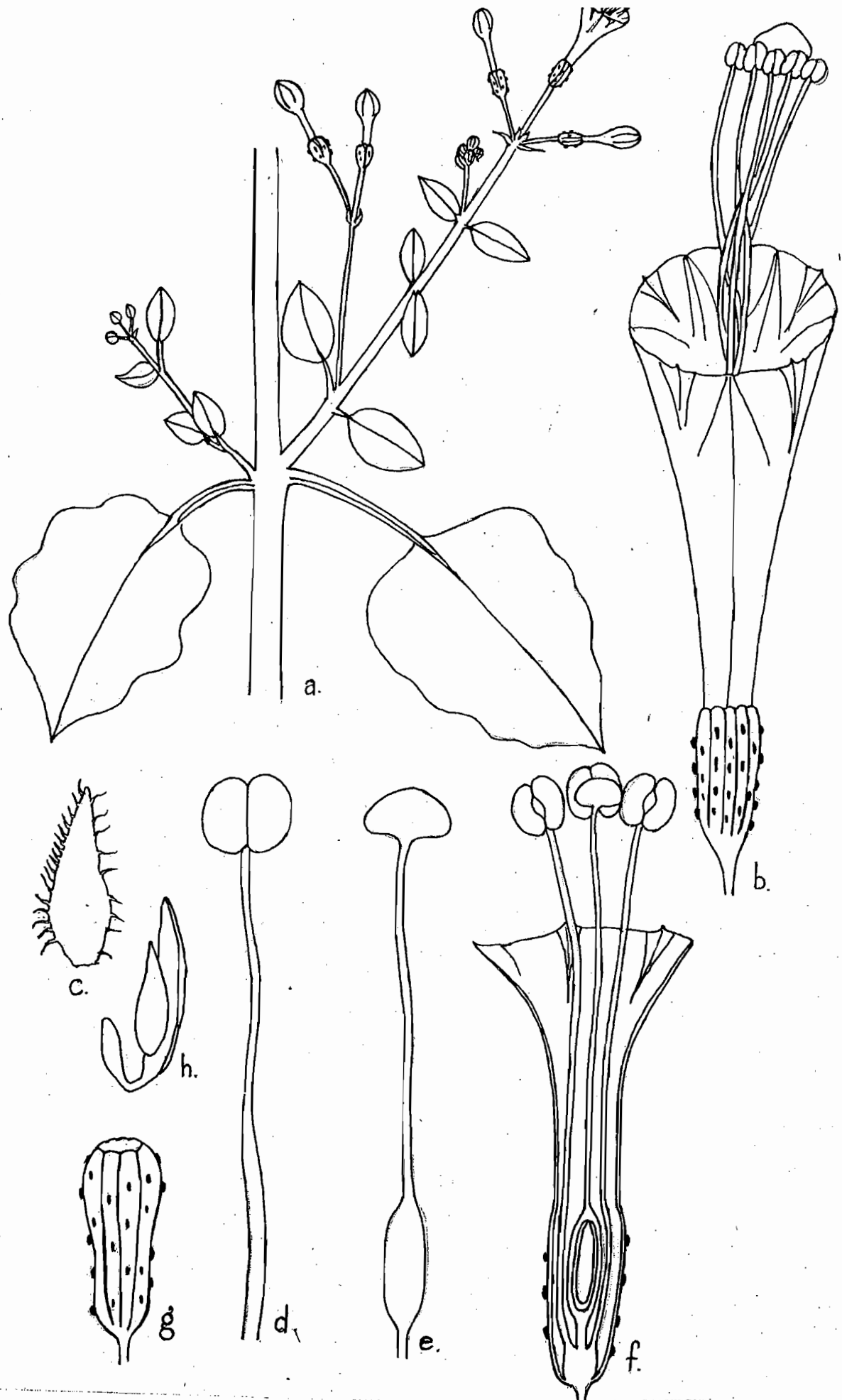


Fig. 444. *Boerhaavia repanda* Willd., a. habit, b. flower, c. bract, d. stamen, e. gynoecium, f. L.S. of flower, g. capsule, h. seed.

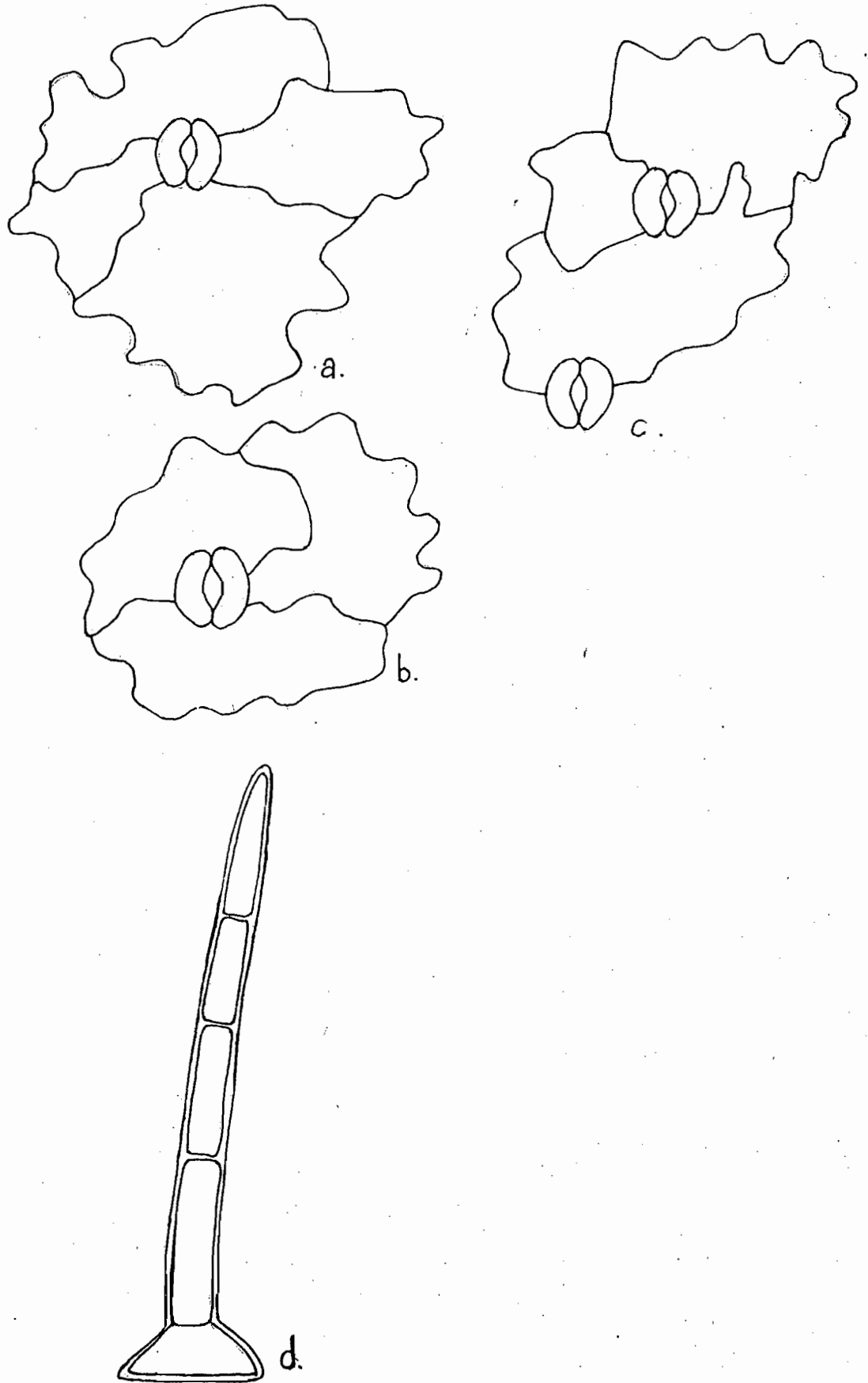


Fig. 445. *Boerhaavia repanda* Willd., a-b. anomocytic stomata, c. anisocytic stomata, d. multicellular uniseriate trichome.

in few-flowered whorls; bracteoles ovate-oblong, acute, deciduous. Perianth white, gamotepalous; tube constricted above the ovary, upper portion funnel-shaped; lobes of the limb 2-fid. Stamens 5, connate below. Ovary oblique, ovule erect; stigma peltate. Fruit furnished with large semi-globose glands round the crown (Fig. 446).

Vernacular name: Zeri Satodo.

Flowers: August-December.

Micromorphology (Fig. 446)

The leaves were covered by multicellular, glandular, trichomes having a large globose one celled head filled with ergastic substances and 3 celled stalk. the glands of the bracts were similar but the terminal cell was long rectangular.

Stomata were of anisocytic and tetracytic type.

D/362-364, 990, 1037.

4. *Bougainvillea specatilis* Willd., *Sp. Pl. V. 2* (1799) p. 348

An armed branched, evergreen, pubescent climber. Leaves orbicular-ovate, acuminate at apex. Spines upto 3 cm long. Flowers usually in clusters of 3, bracts obtuse, ternate at the ends of every branchlet and forming immense panicles of a deep magenta colour. Perianth greenish-yellow, tubular with a spreading, 5-lobed limb. Stamens 5, unequal, scarcely exerted. Ovary stipitate; style lateral; stigma linear (Fig. 447).

Vernacular name: Boganvel.

Flowers: More or less throughout the year.

Micromorphology(Fig. 447).

There were non-glandular and glandular trichomes. The non-glandular was multicellular uniseriate trichome with thick wall and glandular was multicellular uniseriate trichome.

Stomata were anomocytic, tetracytic and anomocytic.

D/78.

Amaranthaceae

1. *Achyranthes aspera* Linn. *sp. Pl.* (1753) p. 204.

An erect, herb with quadrangular branches reaching upto 1m high. Leaves elliptic or obovate, thick, pubescent on both sides. Flowers greenish-white, stiffly deflexed against the woolly-pubescent rhachis, in elongate terminal spikes reaching as much as 50 cm long. Bracts broadly ovate, aristate, bracteoles with a spine as long as the blade which hardens in fruit and falling off tepals ovate-oblong and finely pointed with narrow white membranous margins. Stamens 5 connate at base, with equal number of toothed staminodes. Ovary oblong; 1-celled; ovule solitary, pendulous from a long basal funicle; stigma capitellate. Utricle oblong-cylindric, enclosed in the hardened perianth enclosing a brown subcylindric seed. (Fig. 448)

Vernacular name: Sonar.

Flowers: November-January.



Fig. 446. *Commicarpus verticillatus* Standl, a. habit, b. flower, c. bract, d. L.S. of flower, e. anisocytic stomata, f. tetracytic stomata, g-h. glandular with single celled head and multicellular uniseriate stalk.

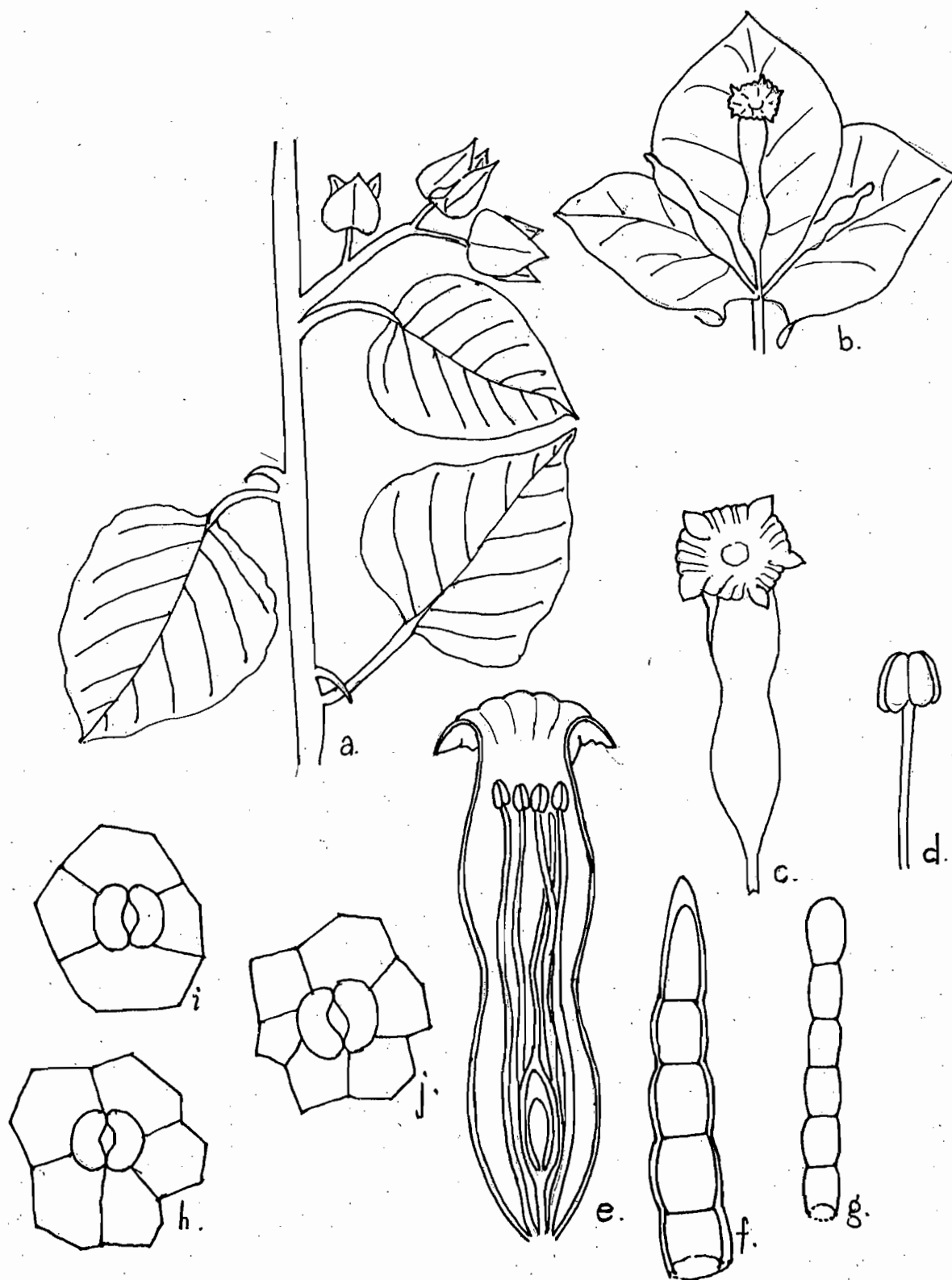


Fig. 447. *Bougainvillea spectabilis* Willd., a. habit, b. inflorescence, c. flower, d. stamen, e. L.S. of Stamen, f. multicellular uniseriate trichome with thick wall, g. glandular multicellular uniseriate trichome, h. anomocytic stomata, i. tetracytic stomata, j. anomocytic stomata.

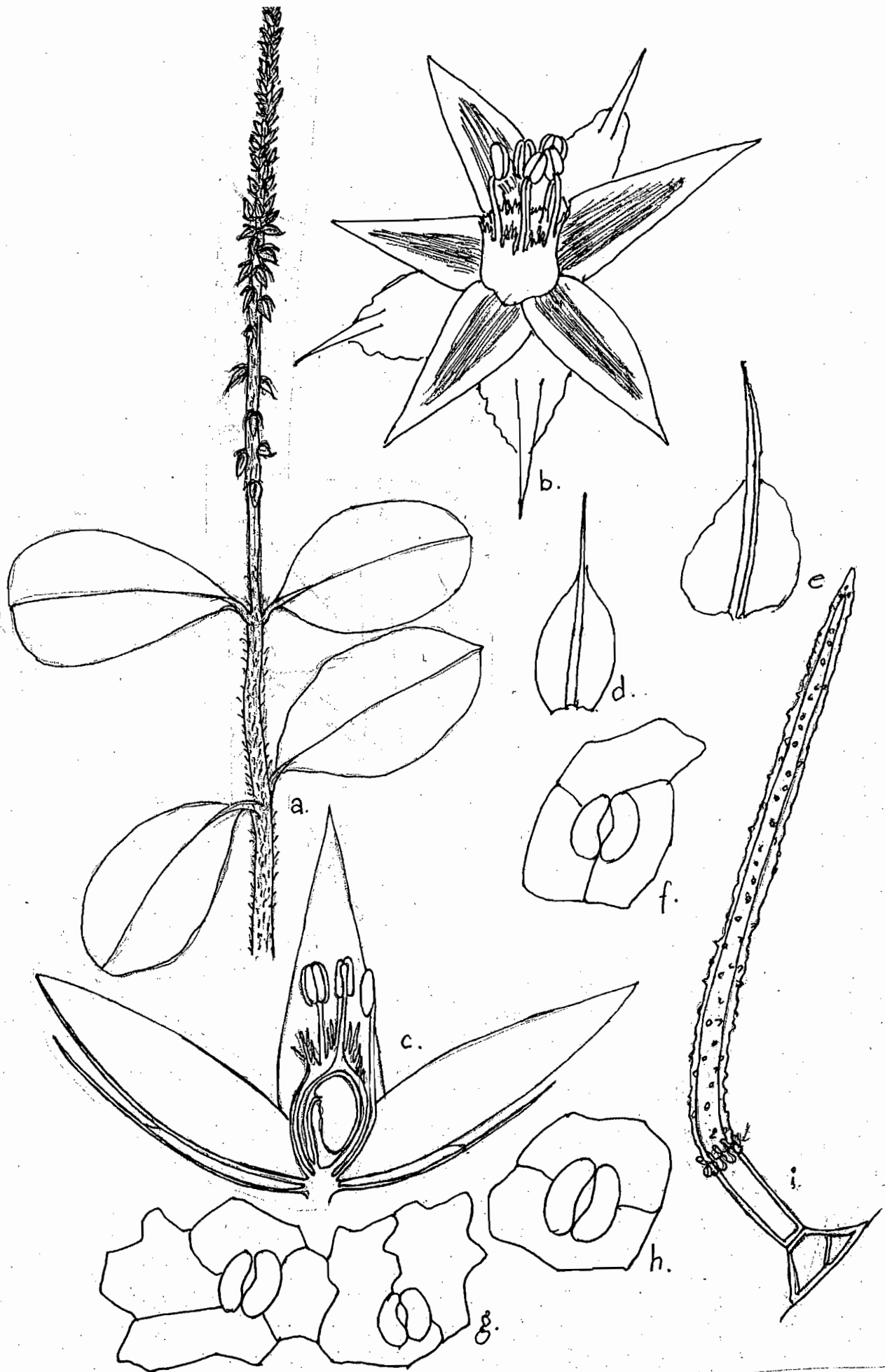


Fig. 448. *Achyranthes aspera* L., a. habit, b. flower, c. L.S. of flower, d. bract, e. bracteole, f. anisocytic stomata, g. anomocytic stomata, h. diacytic stomata, i. multicellular uniseriate trichome with upper cell long, warty and thick walled.

Micromorphology (Fig. 448)

There were three-celled uniseriate trichomes with thick papillate wall in upper long cell and projections at the septa.

Stomata anisocytic, diacytic, and anomocytic.

D/381.

2. *Aerua lanata* Juss. in *Ann. Mus. Par.* V. 2 (1803) p. 131.

An erect or prostrate pubescent, branched herb with a long tap-root. Leaves elliptic or obovate, acute, more or less white with cottony hairs beneath. Flowers greenish-white, bisexual, in small dense subsessile axillary heads or spikes often closely crowded; bracteoles membranous, broadly ovate, concave, apiculate. Tepals oblong, obtuse, sometimes apiculate, silky-hairy on the back. Utricle ovoid; stigmas 2. Seeds small, smooth and polished, black. (Fig. 449)

Vernacular name: Gorak ganjo.

Flowers: August-October.

Micromorphology (Fig. 449)

There were multicellular uniseriate trichomes with thick papillate wall and projections at the septa.

Stomata anisocytic and anomocytic.

D/951.

3. *Alternanthera bettzickiana* (Regel) Nicholson, *III Dict. Gard. ed.* 1. 59. 1884.

A migrant perennial erect or decumbent, herb with many branches reaching a length of 50 cm. Stem tinged with purple on nodes. Leaves oblong-obovate or spatulate, upto 6 cm, in subequal pairs, clothed with fine denticulate hairs. Heads axillary, sessile, usually globose or ovoid, solitary, white. Tepals lanceolate, acute, mucronate. Utricles falling off with the tepals. (Fig. 450)

Flowers: throughout the year.

Micromorphology (Fig. 450)

The plant showed presence of multicellular, uniseriate, unbranched, non-glandular trichome with walls with projects or warty walls and the joints had finger like projections.

Stomata were of diacytic and paracytic type.

D/320.

4. *Alternanthera sessilis* (Linn.) DC. *Cat. Hort. Monsp.* 77. 1813.

A prostrate or decumbent herb, often rooting at lower nodes. Leaves elliptic-obovate, narrowed into a long petiole. Inflorescence of white globose or oblong heads, sessile in the axil. Bracts and bracteoles subequal, scarious, white. Perianth lobes acuminate, with a few hairs on back, ovate, acute, scarious, one-nerved. Filaments 5, but only 3 antheriferous, united below into a short tube; staminodia subulate, filiform. Ovary obovoid; style 1; stigma capitate. Utricle, obreniform, deeply emarginated, dark-brown. Seed discoid. (Fig. 451)

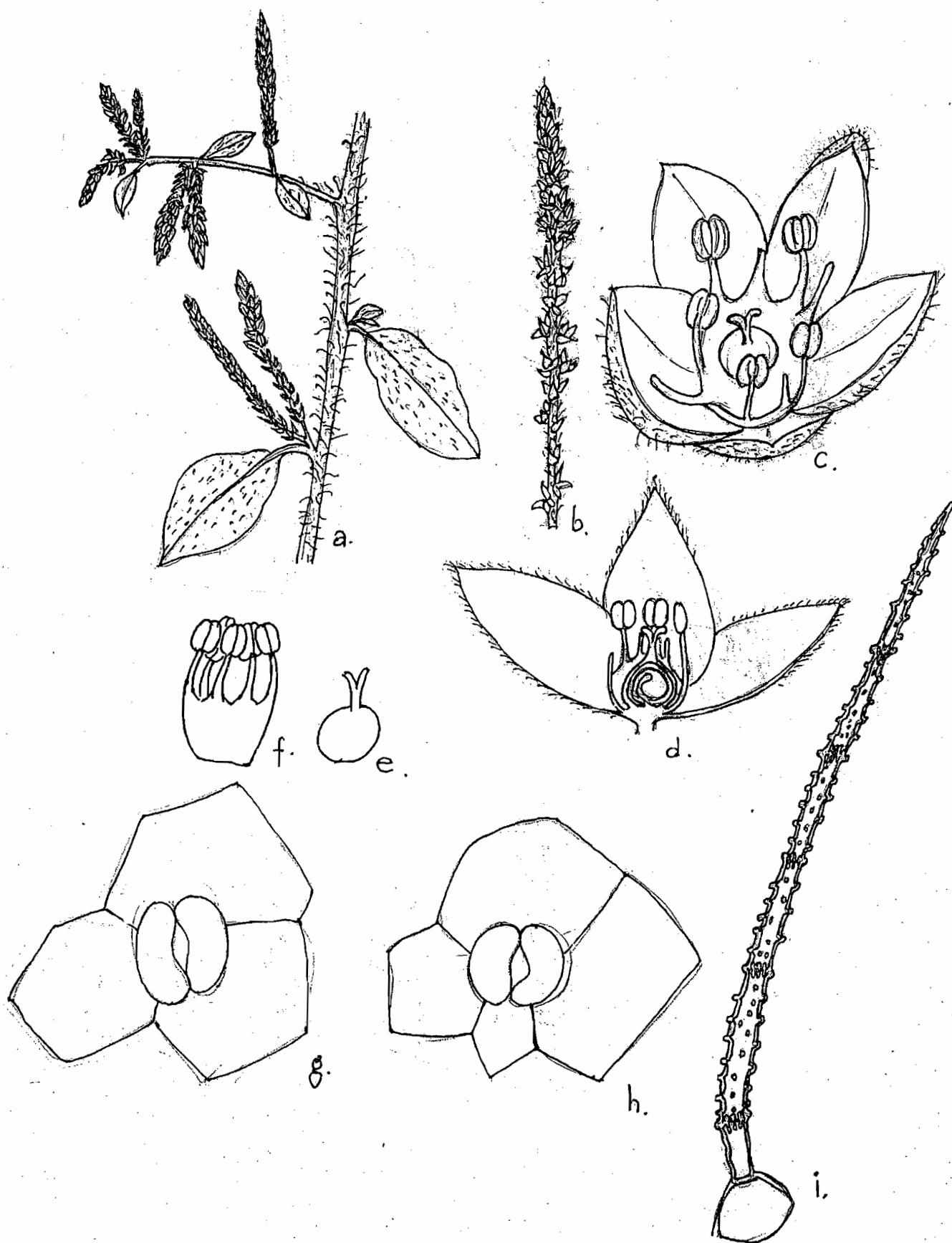


Fig. 449. *Aerua lanata* Juss., a. habit, b. inflorescence, c. flower, d. L.S. of flower, e. gynoecium, f. stamens connate, g. anisocytic stomata, h. anomocytic stomata, i. multicellular uniseriate trichome with thick papillate wall and projections at the septa.

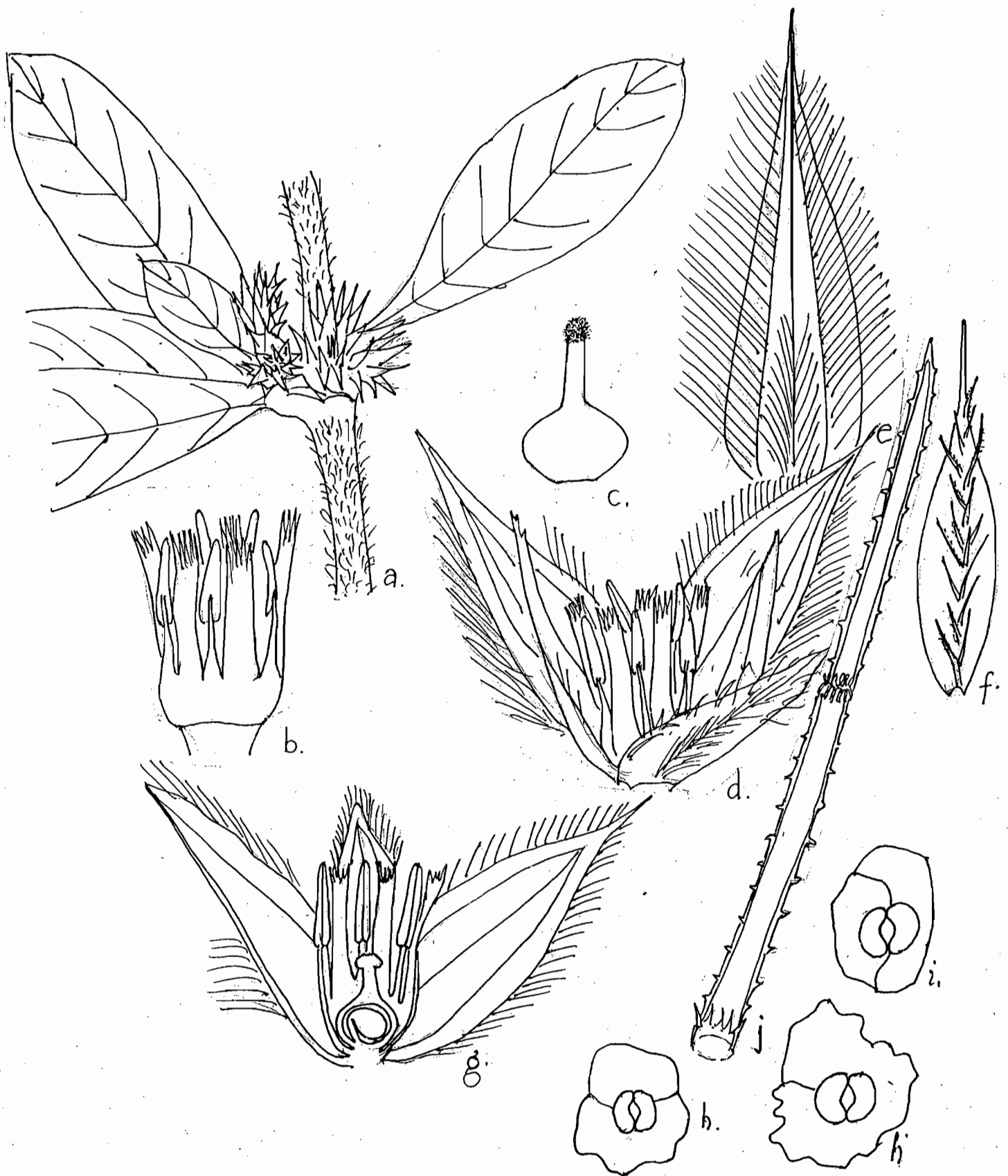


Fig. 450. *Alternanthera bettzickiana* (Regel) Nicholson., a. habit, b. staminal tube with staminodes, c. synoecium, d. flower, e. bract, f. bracteole, g. L.S. of flower, h. diacytic stomata, i. paracytic stomata, j. two to many celled uniseriate trichome with thick warty wall.

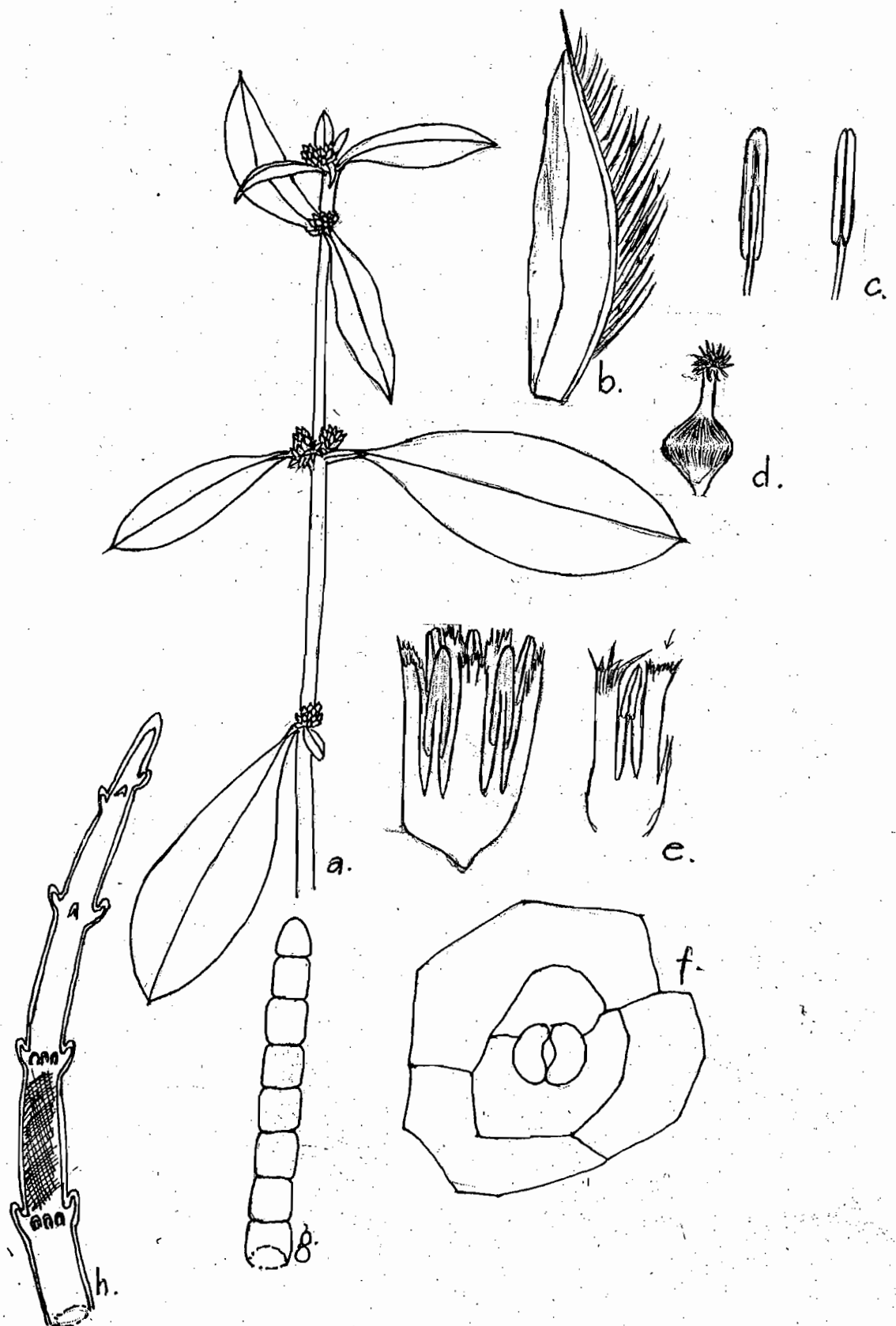


Fig. 451. *Alternanthera sessilis* DC., a. habit, b. bract, c. stamen, d. gynoecium, e. staminal tube with staminodes, f. diacytic stomata, g. multicellular uniseriate trichome with small cuboidal cells, h. multicellular uniseriate trichome with finger-like projections at the septa.

Vernacular name: Pani ni Bhaj.

Flowers: throughout the year.

Micromorphology (Fig. 451)

There was a uniseriate gland with small cuboidal cells in addition to multicellular uniseriate trichome with finger-like projections at the septa and striated wall.

Stomata diacytic. D/342.

5. *Amaranthus spinosus* Linn. *Sp. Pl.* (1753) p. 991.

An erect glabrous herb upto 30 cm high with often reddish, many grooved branches and with sharp divaricate spines. Leaves ovate or lanceolate, upto 7 cm long, spinous-apiculate. Flowers numerous, in dense axillary clusters and in terminal and axillary dense or interrupted spikes; bracteoles 2, linear, bristle-pointed. Male flowers with 5 ovate, acute, bristle-pointed tepals. Stamens 5, free; anthers 2-celled; staminodes 0. Female flowers: Perianth of female flowers scarcely long with 5 oblong tepals. Ovary ovoid, compressed, 1-celled; ovule solitary, erect; styles 2, divaricate. Capsules ovoid, circumsessile about the middle. (Fig. 452)

Vernacular name: Bhaji ni jat.

Flowers: September.

Micromorphology (Fig. 452)

Whole plant was glabrous.

Stomata were of anomocytic and anisocytic types.

D/417.

6. *Amaranthus viridis* Linn. *Sp. Pl.* ed. 2 (1763) p. 1405.

An erect glabrous herb upto 30 cm high with often purplish, many grooved branches. Leaves ovate or deltoid, upto 8 cm long, usually notched at the apex. Flowers pale green, in small axillary clusters and in slender tapering terminal and axillary spike-like racemes; bracteoles ovate-oblong, with a green keel. Sepals 3, ovate-oblong, with a strong green keel. Stamens 5, connate at the base, anthers basifixed. Ovary ovoid, 1-celled, ovule solitary, styles 3, each style branching to give distinct stigma. Utricle indehiscent. Seed very small, shining black. (Fig. 453)

Variations observed: *Amaranthus viridis* is said to have 2-3 styles, but in my specimen, styles were 3, each style branching to give distinct stigma.

Vernacular name: Dhhimdo.

Micromorphology (Fig. 453)

Whole plant was glabrous.

Stomata present were anisocytic and anomocytic, the latter more common.

D/152.

7. *Celosia argentia* Linn. *Sp. Pl.* 205. (1753)

An erect branched annual reaching a height of 1 m with strongly ribbed stems. Leaves oblong-lanceolate, upto 13 cm long, acuminate. Spikes terminal, solitary, straw-coloured, sometimes tinged reddish, upto 10 cm long. The uppermost flowers sterile, sessile; bracts

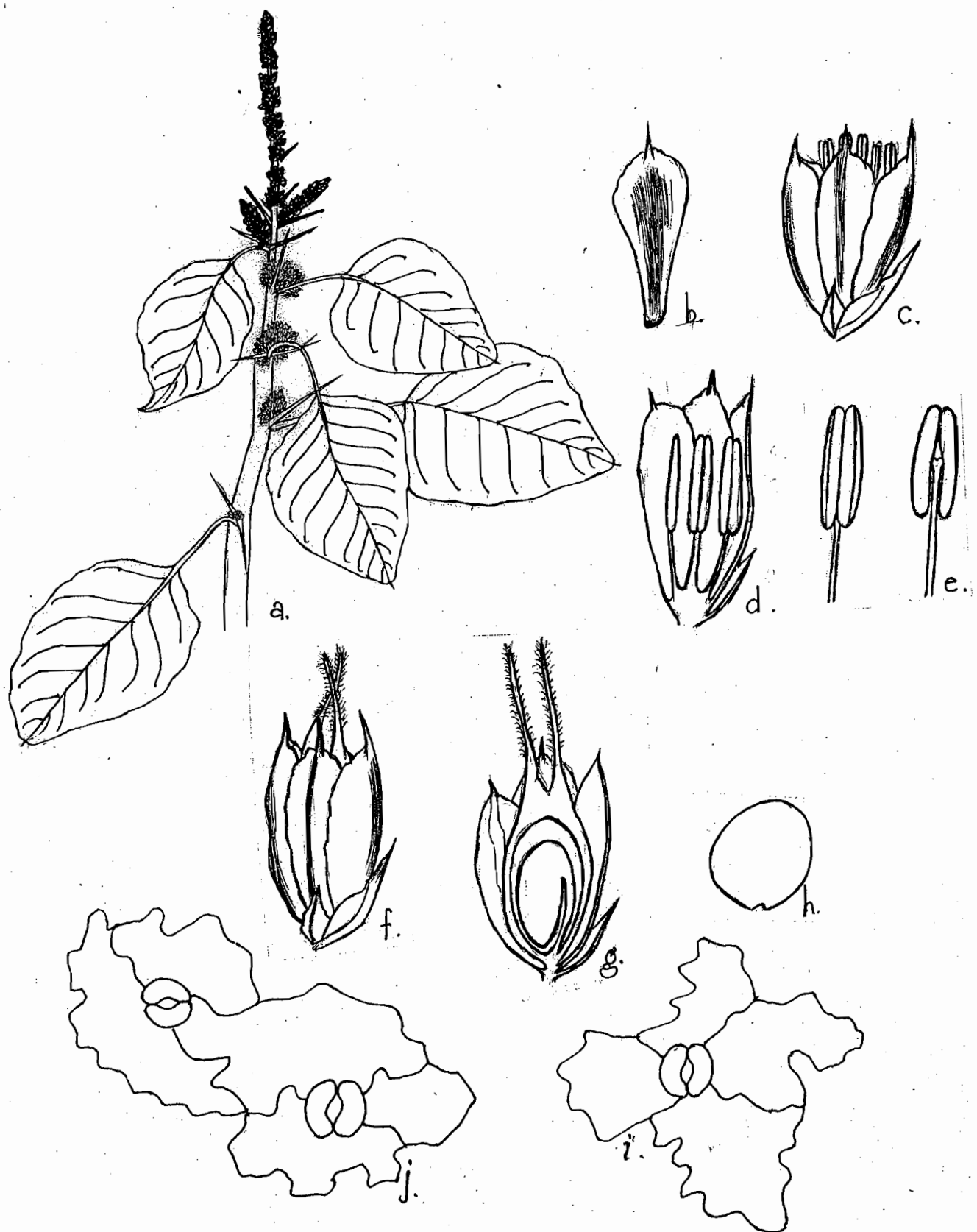


Fig. 452. *Amaranthus spinosus* L., a. habit, b. bract, c. male flower, d. L.S. of male flower, f. female flower, g. L.S. of female flower, h. seed, i-j. anomocytic stomata.

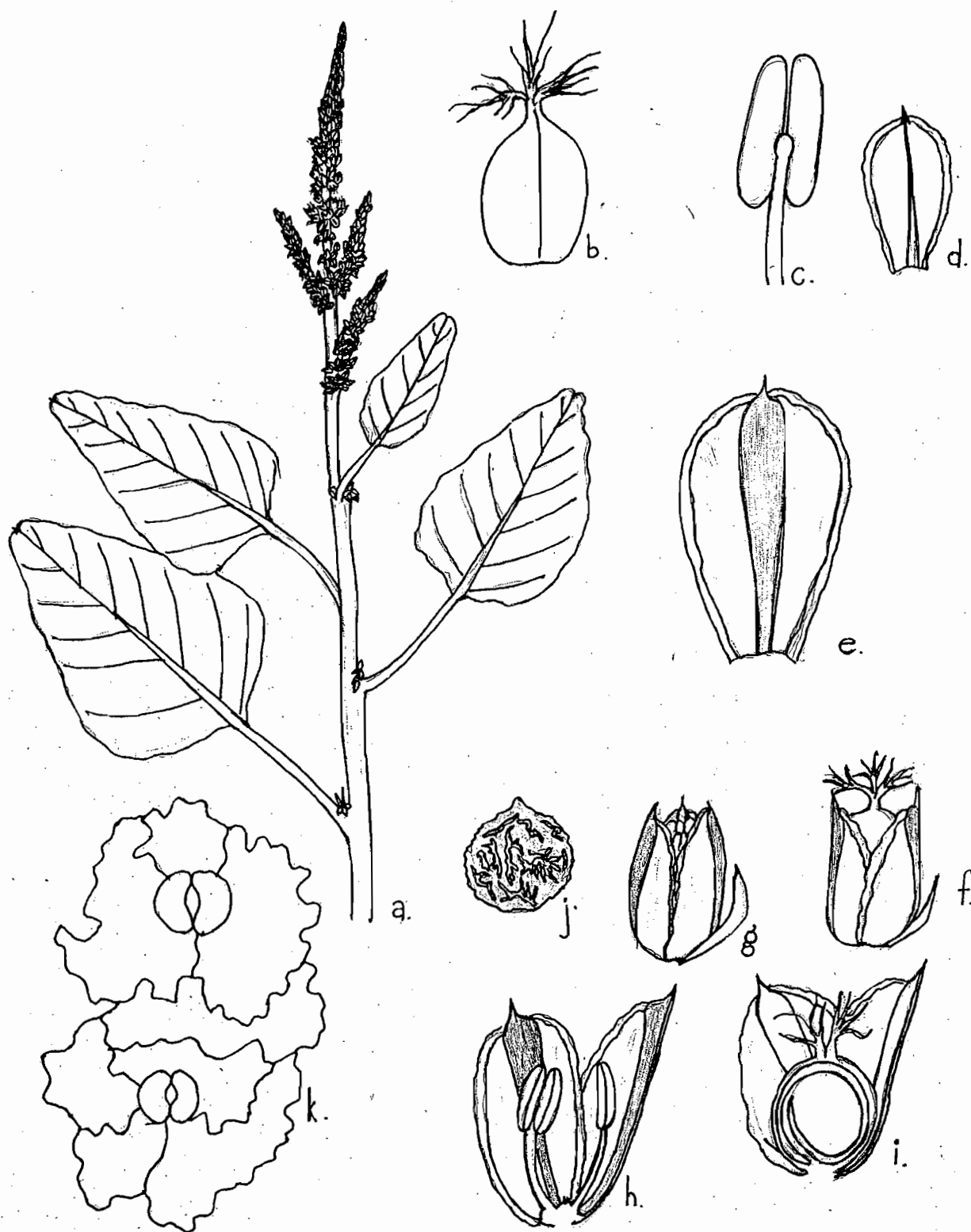


Fig. 453. *Amaranthus viridis* L., a. habit, b. gynoecium, c. stamen, d. bract, e. perianth, f. female flower, g. male flower, h. L.S. of male flower, i. L.S. of female flower, j. seed, k. anomocytic stomata.

and bracteoles subequal, ovate, mucronate, pellucid, 1-nerved, persistent. Perianth lobes subequal, ovate, concave, mucronate, white or white with pink tip. Stamens 5, united to form a high cup, and the cup shows infoldings. Pseudo-staminodes minute. Ovary ellipsoid; stigma 2, minute. Fruit an obovoid utricle. Seed reddish-brown. (Fig. 454)

Additional characters: the staminal cup showing infolding are not reported earlier.

Vernacular name: Lamdi.

Flowers: August-November.

Micromorphology (Fig. 455)

There were glands with a biseriate head and uniseriate stalk.

Stomata were anisocytic and anomocytic.

D/568, 686, 839, 840, 1043.

8. *Celosia trigyna* L. *Mantissa Plantarum* 2: 212–213. 1771.

(*Digera arvensis* Forsk.)

An annual weed of about 60 cm in height with glabrous spreading branchlets. Leaves ovate or elliptic, upto 7 cm long, acute, sometimes with reddish margins. Flowers sessile, in lax axillary pedunculate spikes upto 12 cm long. Bracts and bracteoles ovate-lanceolate, submembranous, persistent. Tepals 5, slightly connate below, oblong, rose-colored. Stamens 5; free, anthers 2-celled; staminodes 0. Ovary 1-celled; ovule solitary, erect; stigmas, recurved. Utricle globose with a green fleshy outgrowth. Seed single, yellowish-brown. (Fig. 456)

Additional characters: The globose utricle shows presence of fleshy green branched outgrowth which is branched like a pair of horns on either sides. This was not recorded earlier.

Vernacular name: Kanjro lolar.

Flowers: September-November.

Micromorphology (Fig. 456)

The plant was glabrous.

Stomata were anomocytic sometimes with sister stomata.

D/100.

9. *Gomphrena celosioides* Mart. *Beitr. Amar.* 93. 1825

A densely white-hairy prostrate annual with branches having swollen nodes. Leaves oblanceolate, subsessile upto 5 cm long. Flowers white in terminal subglobose or elongate-cylindric spikes. Tepals 5, white; usually smaller towards the apex of the raceme, absent in the highest flower. Style exserted; stigma 2, recurved. Utricle compressed, globose, margined, muriculate with a persistent style base. Seeds yellowish-brown. (Fig. 457)

Flowers: August-December.

Micromorphology (Fig. 457)

There were multicellular uniseriate trichomes characterized by broad basal cells and elongated upper cells.

Stomata anomocytic.

D/253.

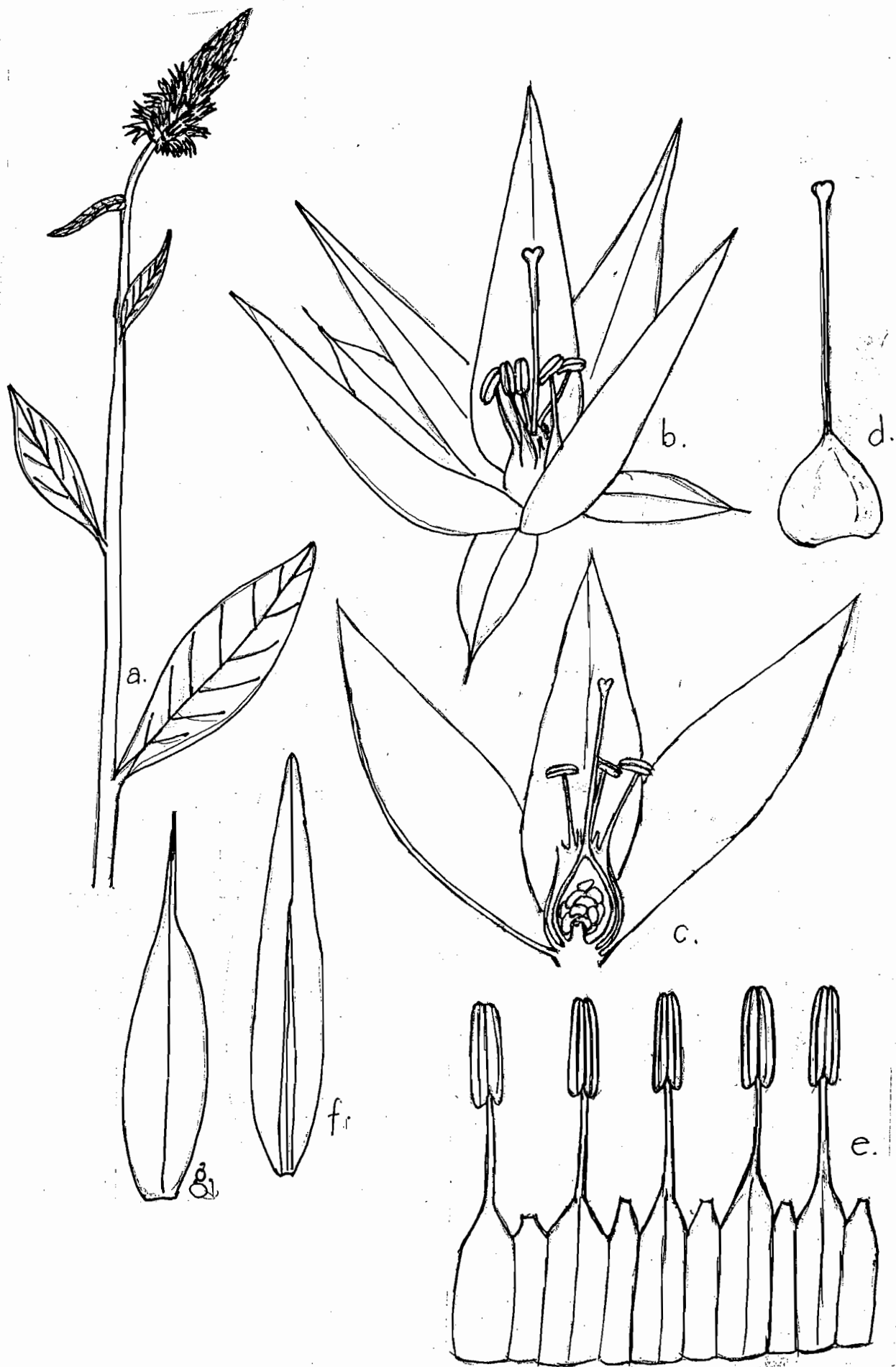


Fig. 454. *Celosia argentea* L., a. habit, b. flower, c. L.S. of flower, d. gynoecium, e. staminal filaments connate and alternate with staminodes, f. bract, g. bracteole.

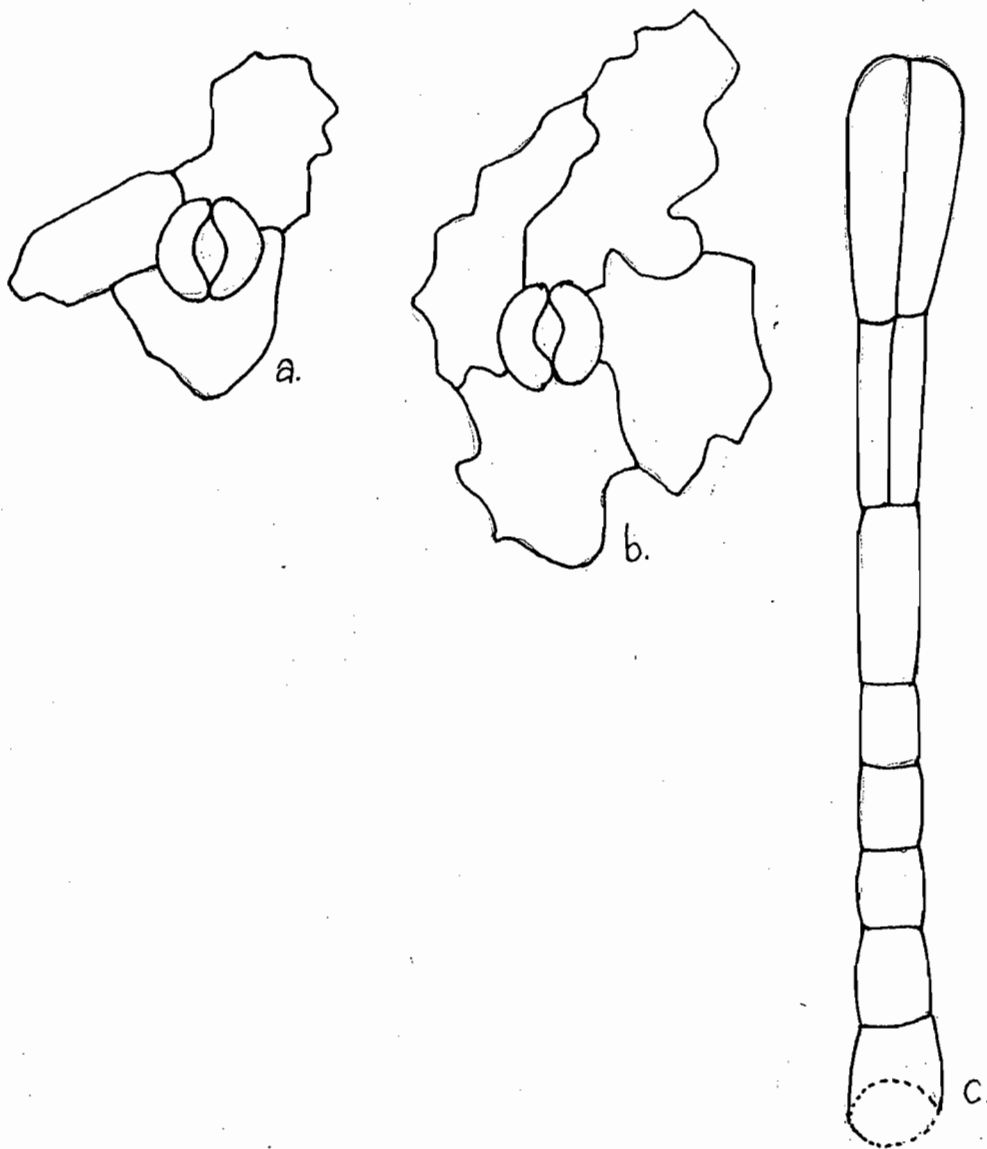


Fig. 455. *Celosia argentea* L., a. anisocytic stomata, b. anomocytic stomata, c. gland with biserial head and uniseriate stalk.

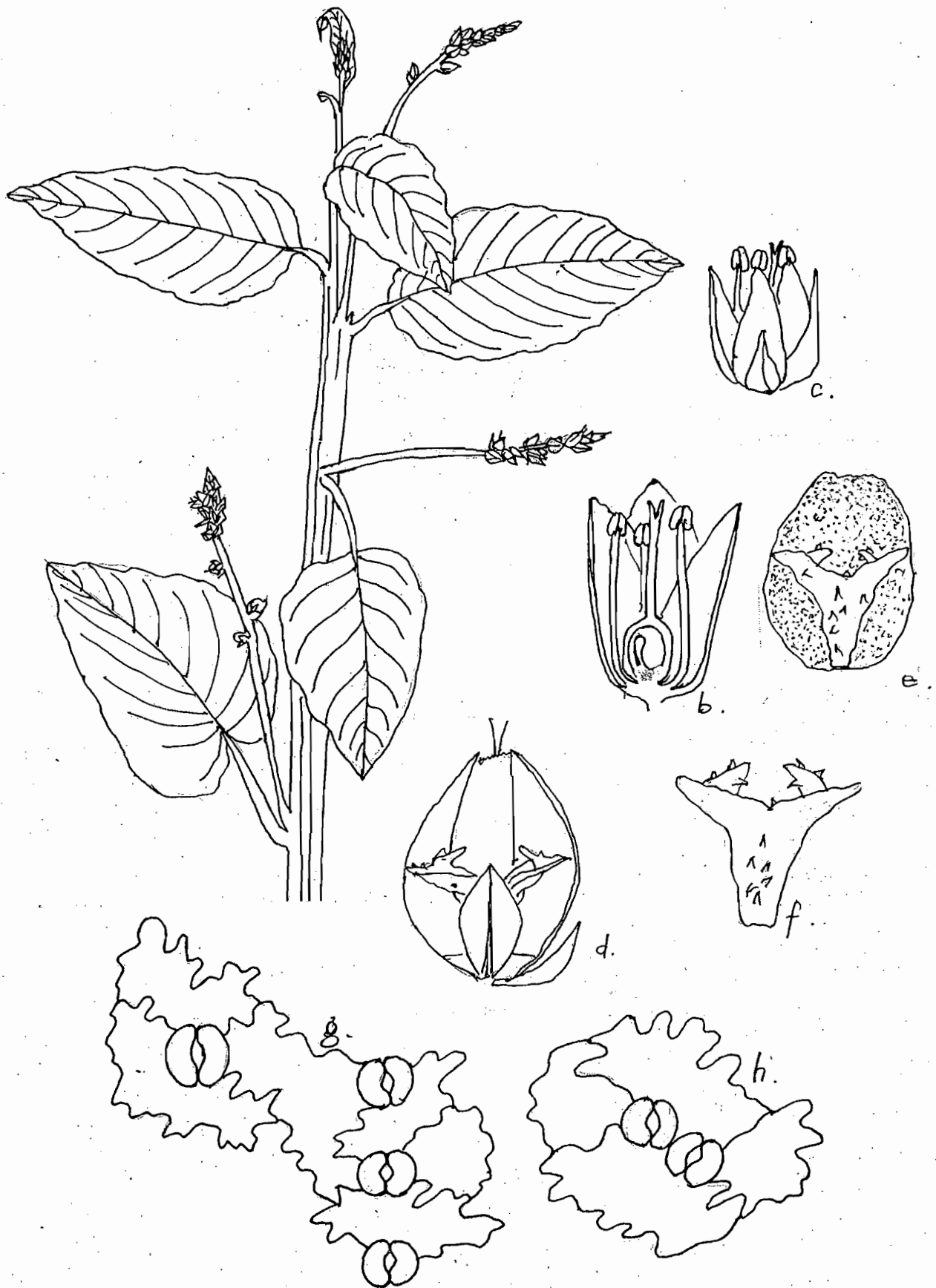


Fig. A56. *Celosia trigyna* L., a. habit, b. L.S. of flower, c. flower, d. fruit, e. fruit with bract, bracteole, tepals removed, f. fleshy outgrowth on fruit, g. anomocytic stomata, h. anomocytic stomata showing sister stomata.

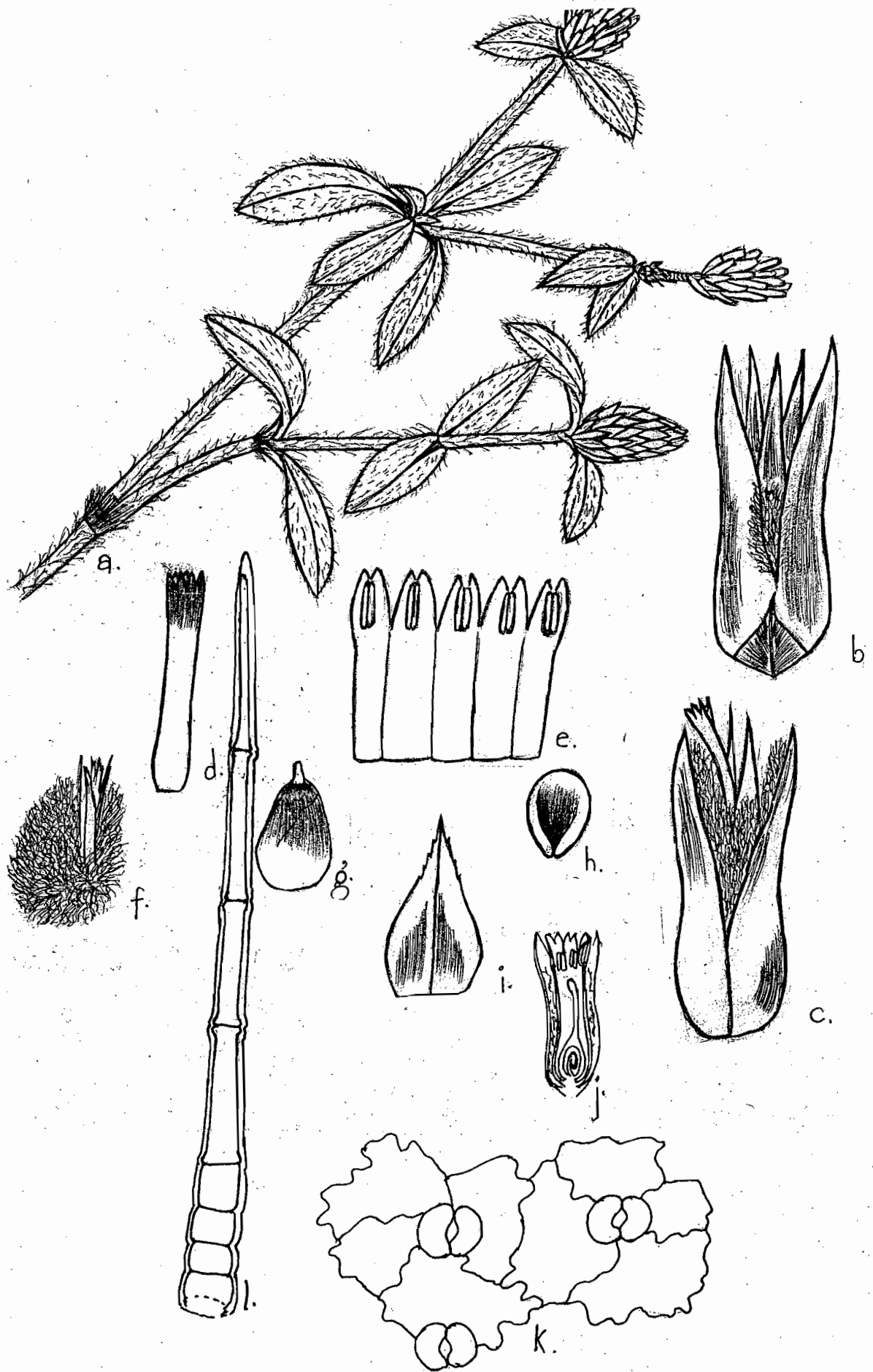


Fig. 457. *Gomphrena celosioides* Mart., a. habit, b-c. flower d. staminal column, e. staminal column showing anther cells, f. fruit with persistent pubescent perianth, g. fruit, h. seed, i. bract, j. L.S. of flower, k. anomocytic stomata, l. multicellular uniseriate trichome.

10. *Nothosaerua brachiata* Wight *Icon. V. 6* (1853) p. 1.

An erect slender branched herb upto 50 cm. high. Leaves elliptic-lanceolate, opposite, thinly membranous, reddish green, base tapering into a short often obscure petiole. Flowers sessile, borne in small dense axillary white cylindric spikes; bracts and bracteoles hyaline, acute, persistent. Tepals 3-5, hyaline. Stamens 1-2, hypogynous; filaments free; anthers 2-celled, staminodes 0. Ovary oblong; ovule solitary, pendulous from a long funicle; Fruit a membranous oblong compressed utricle enclosed in the perianth. Seeds minute, shining black. (Fig. 458)

Flowers: June-November.

Micromorphology (Fig. 458)

The plant was glabrous.

Stomata were anisocytic, anomocytic and tetracytic types.

D/576, 1054-1055, 1185.

11. *Pupalia lappacea* (L.) Juss. *Ann. Mus. Hist. Nat.* 2:132. 1803.

(*Pupalia atropurpurea* Moq.)

This is a biennial reaching a height of 2 m. with straggling branches which are often tinged with purple. Leaves ovate or elliptic-lanceolate, upto 10 cm long, mucronate. Flowers in sessile clusters in lax pedunculate terminal spikes upto 30 cm long. The sterile flowers reduced to hooked purple awns; bracts broadly ovate, persistent; bracteoles as the bracts. Perianth segments of perfect flowers ovate-lanceolate, aristate, clothed with cottony wool, 3-nerved. Stamens 5 with subulate, shortly connate filaments; anthers 2-celled; staminodes 0. Ovary 1-celled; ovule solitary, pendulous; stigma capitate. Utricle membranous. Seed oblong-ellipsoid. (Fig. 459)

Micromorphology (Fig. 459)

The plant showed presence of two celled, non-glandular trichome having a broad basal cell and long narrow acicular apical cell.

Stomata were of anomocytic type.

D/ 739, 747.

Chenopodiaceae

1. *Basella alba* Linn., *Sp. Pl.* 272. 1753.

A perennial twining herb with stem stout at the base, upper branches slender, fleshy and climbing. Leaves dark green, broadly ovate, 5-13 cm long and 2.5-8 cm broad, acute or acuminate, basally cordate, cuneate or truncate; petiole 0.5-3 cm long. Inflorescence an axillary or terminal spike, 8-14 cm long; rachis stout. Flowers white, pinkish or red, subsessile, remaining closed at anthesis. Bracts scaly, small; bracteoles similar to calyx, acute, bracts and bracteoles free from perianth. Perianth united up to the middle, cup shaped, lobes short, cucullate. Stamens included; filament short. Anther cordate. Ovary 1-locular. Fruit black or dark purple enclosed within the persistent fleshy calyx, 1.0 cm long. Seed globose, indehiscent. (Fig. 460)

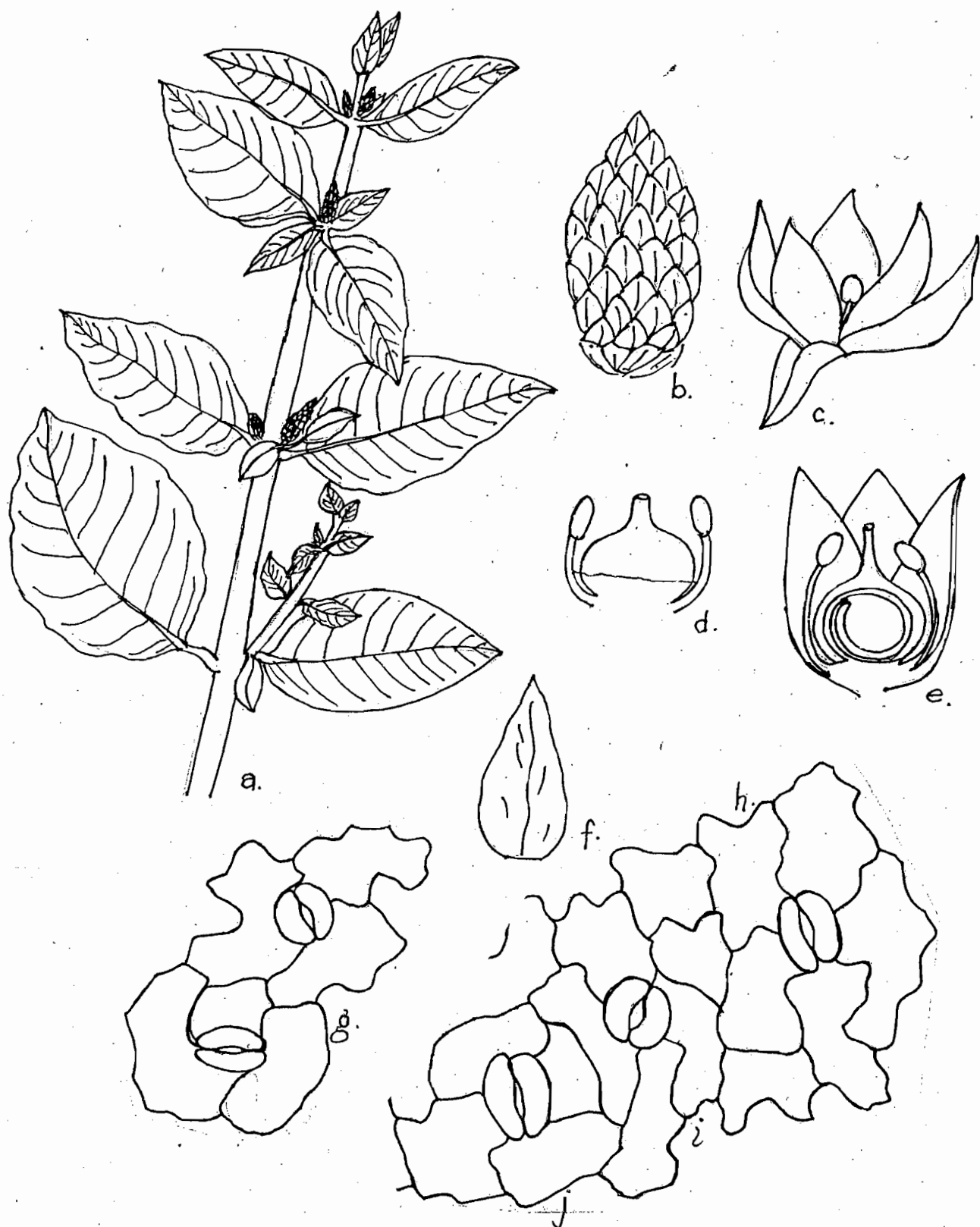


Fig. 458. *Nothosaerua brachiata* Wt., a. habit, b. inflorescence, c. flower, d. gynoecium and stamen, e. L.S. of flower, f. bract, g. anisocytic and anomocytic stomata, h-i. anomocytic and tetracytic stomata, j. anomocytic stomata.

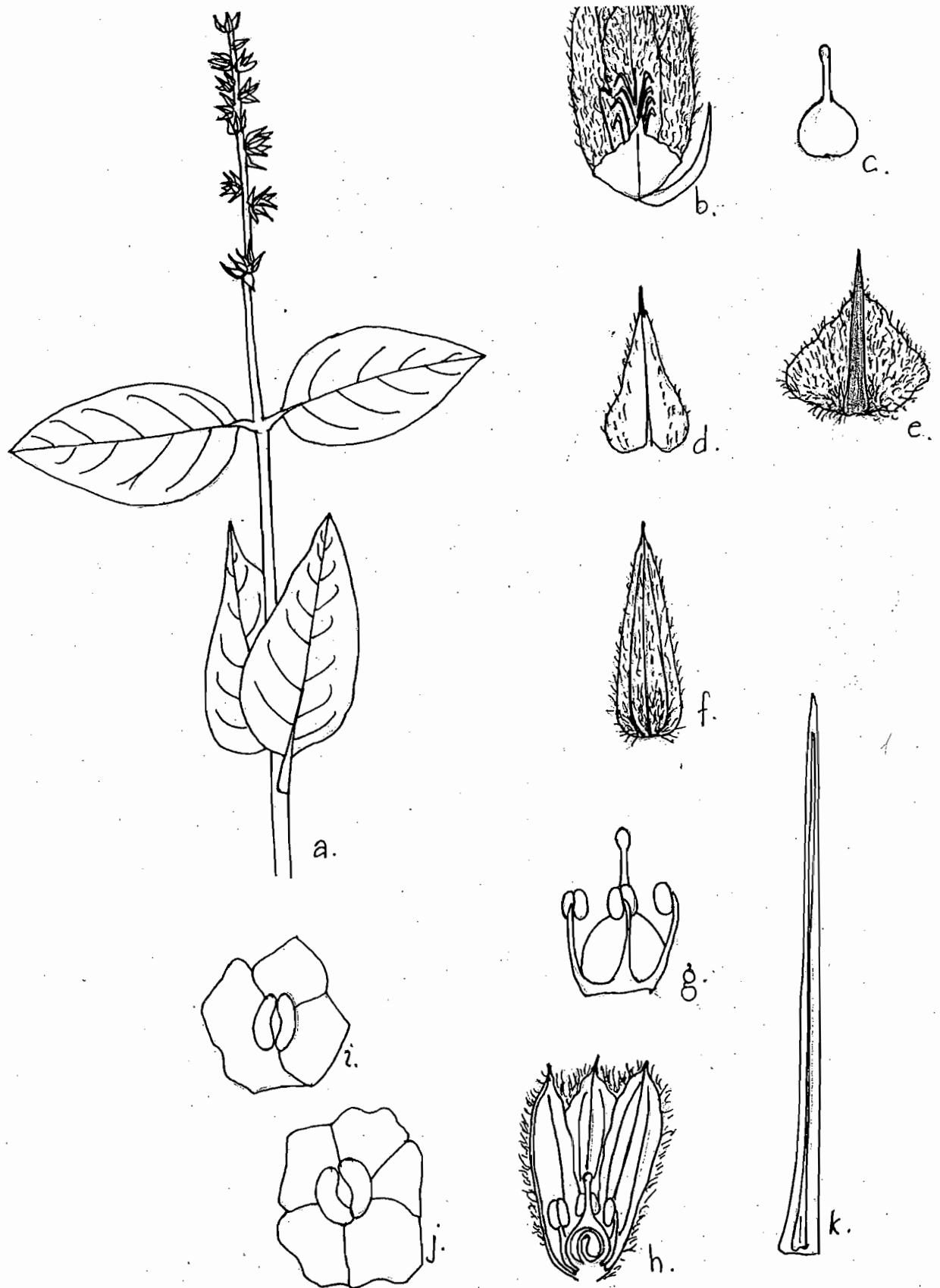


Fig. 459. *Pupalia lappacea* (L.) Juss., a. habit, b. flower, c. gynoecium, d. bract, d. bacteole, f. perianth, g. stamens connate at the base and gynoecium, h. L.S. of flower, i. anisocytic stomata, j. anomocytic stomata, k. unicellular trichome with thick wall and narrow lumen.

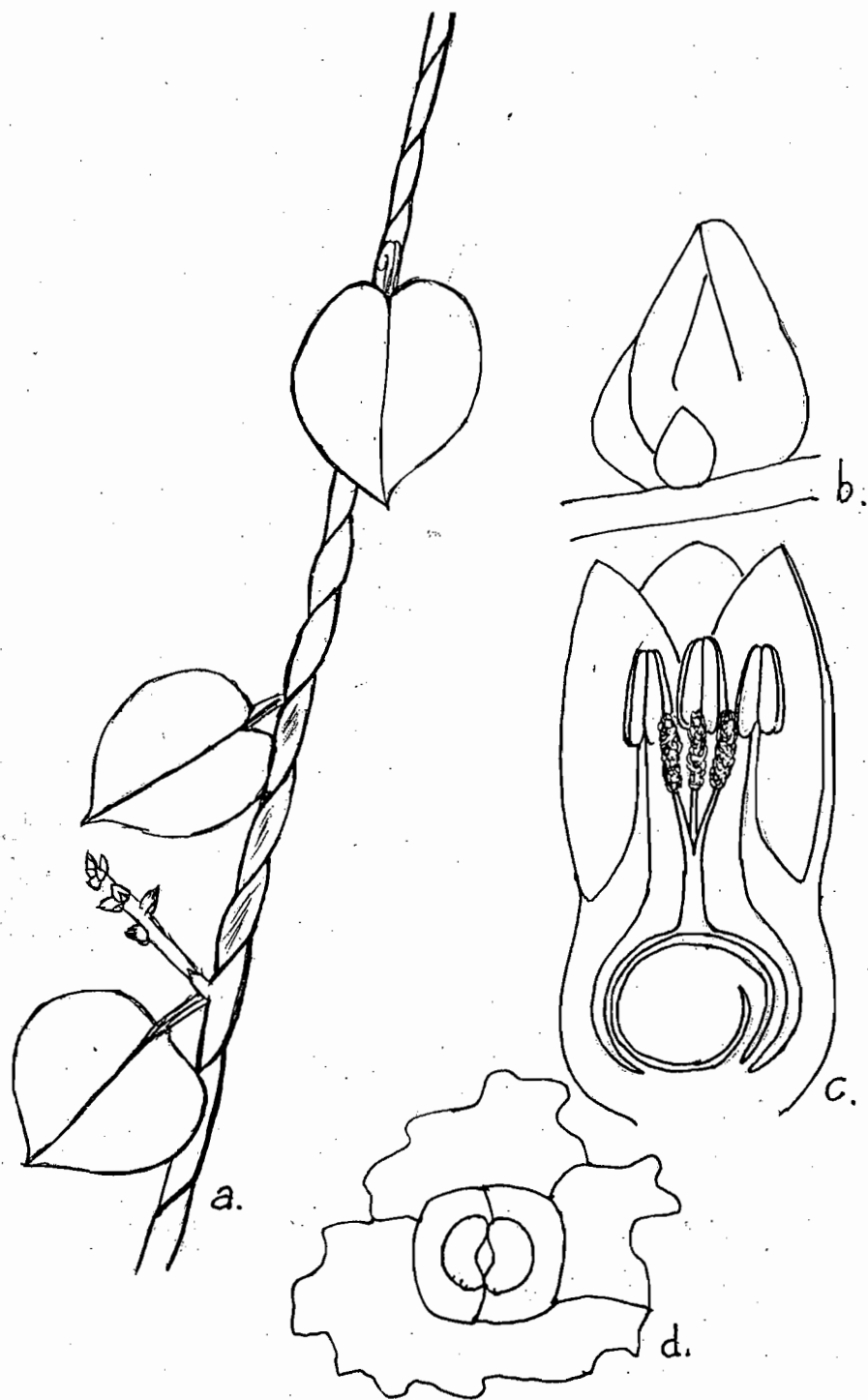


Fig. 460. *Basella alba* Linn., a. habit, b. flower, c. L.S. of flower, d. paracytic stomata.

Variations observed: In floras, bracteoles are said to be adnate to the bi-lipped perianth, but in my specimen bracteoles were found to be free from perianth and perianth was cup-shaped.

Vernacular name: Poi.

Flowers: February-March.

Micromorphology (Fig. 460)

The plant showed paracytic type of stomata, and trichomes were absent.

D/103

2. *Chenopodium album* Linn. *Sp. Pl.* (1753) p. 219.

An erect succulent herb reaching a height of 30 cm. Stems often reddish, striped. Leaves oblong/rhombic, alternate, very variable in size and shape. Flowers in clusters forming lax panicle often mealy spikes. Bracts and bracteoles 0. Tepals 5, oblong-lanceolate, fleshy. Stamens 5, anthers 2-celled; filaments connate at the base. Ovary depressed-globose; ovules solitary; style absent. stigmas 2. Fruit utricle, enclosed in the perianth. Seed orbicular, shining. (Fig. 461)

Additional characters: Cohesion of filaments at the base is not reported earlier.

Vernacular name: Chil ni bhaji.

Flowers: August-November.

Micromorphology (Fig. 461)

Whole plant was glabrous.

Stomata were of anomocytic type.

D/678.

Phytolaccaceae

1. *Rivina humilis* L. *Sp. Pl.* 121 . 1753.

A handsome erect perennial branched herb of 1 m high. Leaves ovate-oblong, upto 12 cm long, acuminate, Flowers in axillary, rarely terminal racemes, bisexual; bracts small, subulate; bracteoles 2, caducous. Flowers cream-coloured with 4 obovate-oblong tepals. Stamens 4; filaments filiform; anthers oblong, erect. Ovary subglobose, 1-locular; ovule solitary; style short; stigma capitellate. Berries crimson red on maturity, 1-seeded.(Fig. 462)

Flowers: August-November.

Micromorphology (Fig. 462)

Whole plant was glabrous.

Stomata were of anomocytic types.

D/464.

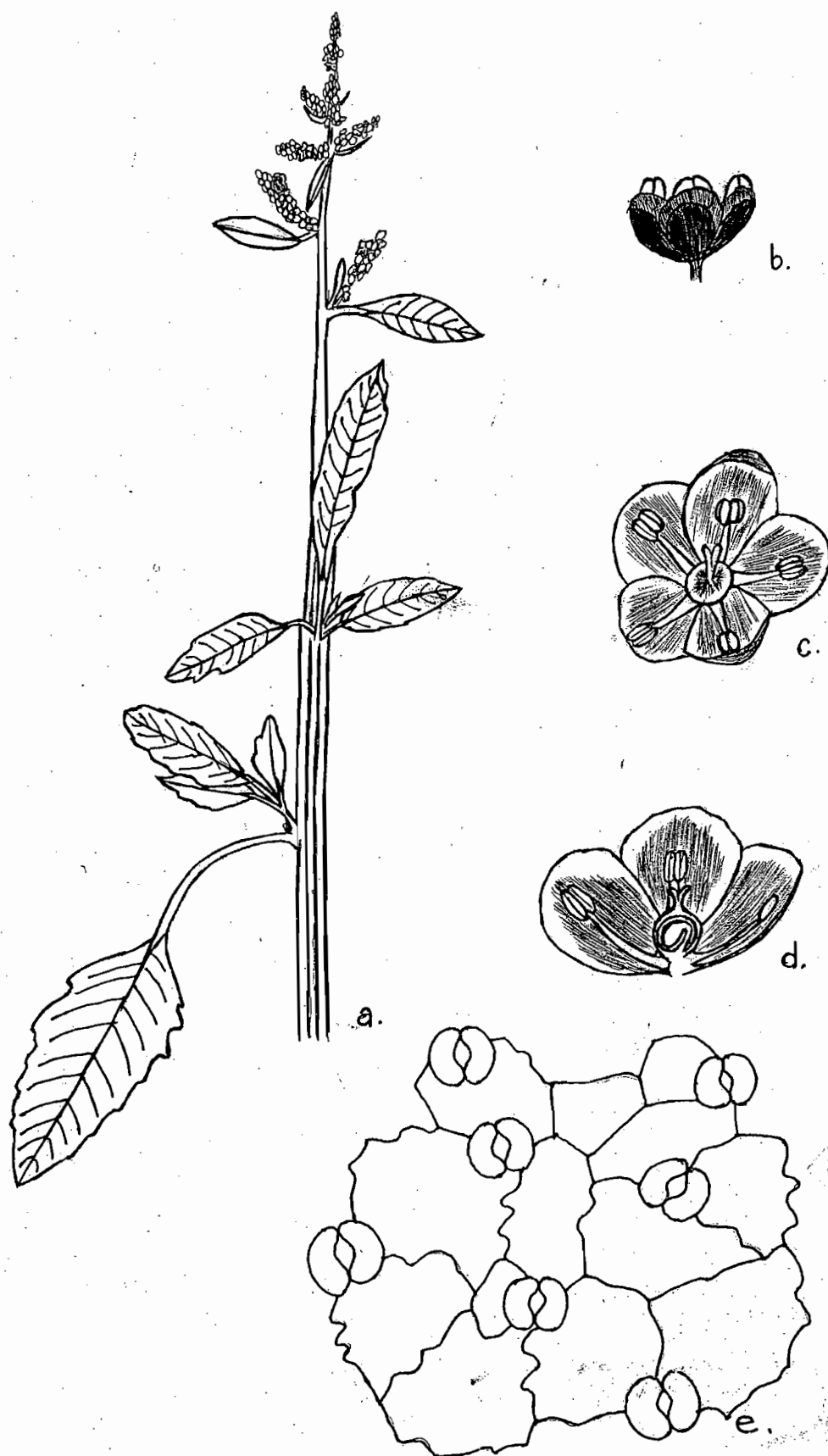


Fig. 461. *Chenopodium album* L., a. habit, b-c. flower, d. L.S. of flower, e. anomocytic stomata.

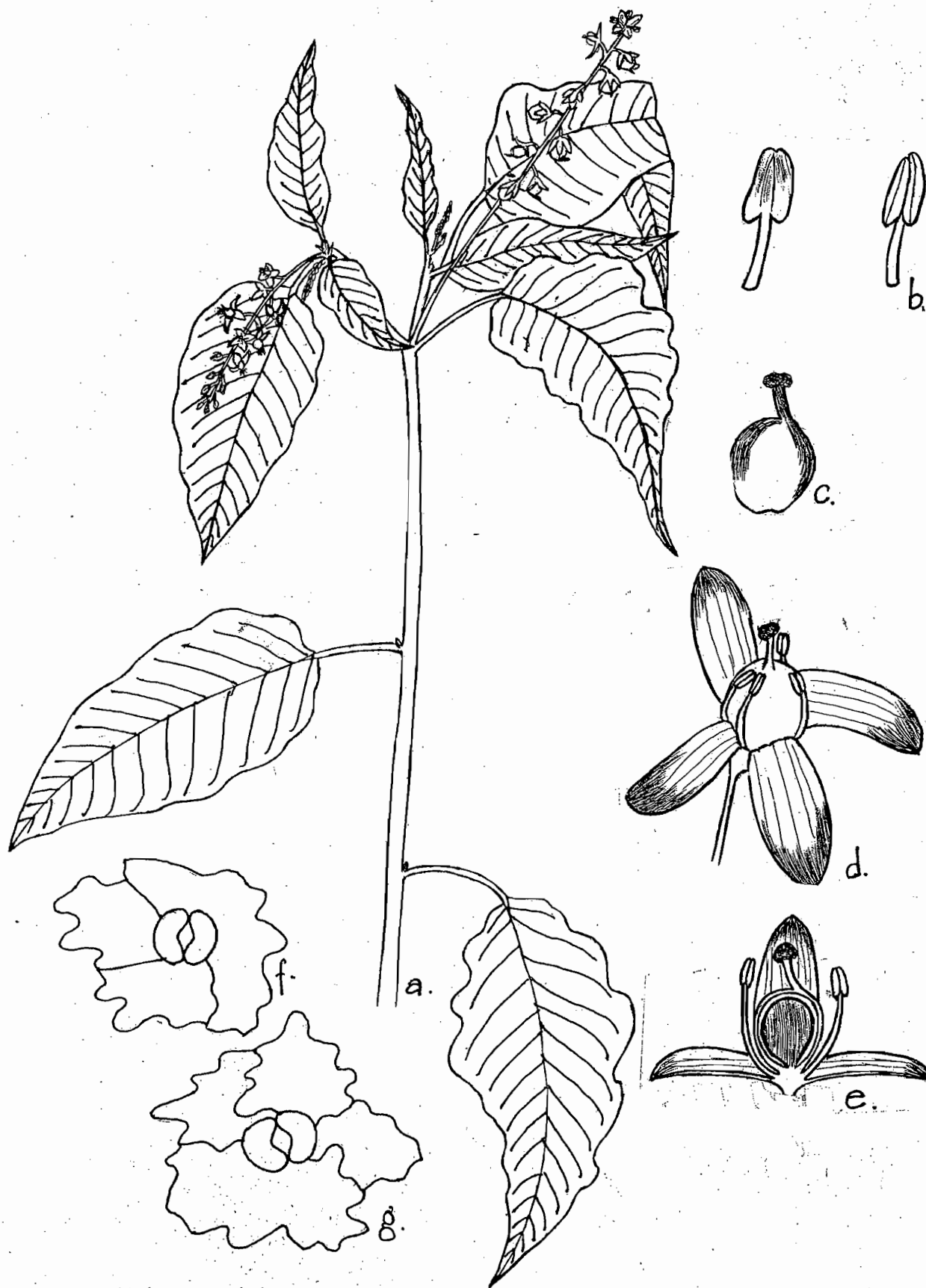


Fig. 462. *Rivina humilis* L., a. habit, b. stamen, c. gynoecium, d. flower, e. L.S. of flower, f. anisocytic stomata, g. anomocytic stomata.

Polygonaceae

1. *Antigonon leptopus* Hook. & Arnott, *Bot. Beechey Voy.* 308. t. 69. 1838.

A slender climbing shrub with branchlets and rhachis of the inflorescence often terminating in tendrils. Leaves amplexicaul at base, ovate-deltoid, upto 10 cm long, undulate; petiolate, ochrea membranous. Flowers in fascicles arranged in axillary racemes; rhachis of racemes frequently terminated by branched tendrils. Perianth 5-6 merous, pink-red, cyclic; 3 outer tepals in fruit dry, accrescent, forming wings.

Stamens 8, connate at base into a ring, with short teeth between the filaments. Ovary 3-angled; ovules pendulous; styles 2-3, free; stigmas capitate, papillose. Nuts ovoid-conical. Seeds deeply grooved. (Fig. 463)

Vernacular name: Antigonon.

Flowers: July-November.

Micromorphology (Fig. 464)

There were glandular and non-glandular trichomes. The glands were four-celled sessile, and trichomes were unicellular and small.

Stomata were paracytic, anisocytic, diacytic and anomocytic types.

D/693, 694.

2. *Persicaria decipiens* (R. Br.) K.L. Wilson, *Telopea* 3: 178. 1988.

(*Polygonum serrulatum* Lagasca)

An erect glabrous herb with often reddish stem reaching a height of 1 m or more. Leaves linear, upto 12 cm long; stipules connate into a tubular ochrea, reaching upto 4 cm high, strigose, the mouth truncate and ciliate with long stiff bristles which are nearly as long as the tube. Flowers in paniculate slender erect racemes; bracts membranous, strongly ciliate with long hairs, the margins somewhat rose-colored. Perianth white, segments ovate. Stamens 5-8, perigynous; filaments filiform; anthers 2-celled, joined by a small connective. Ovary trigonous; ovule solitary; styles 3, connate at the base, stigma capitate. Nutlets trigonous, smooth. (Fig. 465)

Flowers: November-March.

Micromorphology (Fig. 465)

The stem, leaf and stipules showed presence of unicellular, non-glandular, trichome with thick wall and tip slightly curved. The lumen was very narrow. The base of the trichome was raised on the 2-3 swollen epidermal cells.

Stomata were of anomocytic, anisocytic and paracytic type.

D/935.

3. *Polygonum plebejum* R. Br. *Prodr.* (1810) p. 420

A diffusely-branched, prostrate herb, often with a woody rootstock. Leaves oblong, alternate, 2 cm long, sessile or shortly petiolate; stipules connate into a tubular ochrea lacerate to the middle, fimbriate. Flowers pink, axillary, solitary or 2-3 together; pedicels short or 0. Bracts and bracteoles membranous, ochreate. Perianth green or colored, 4-5 cleft, divided nearly to the base. Stamens 5-8; filaments filiform, often dilated at the base;

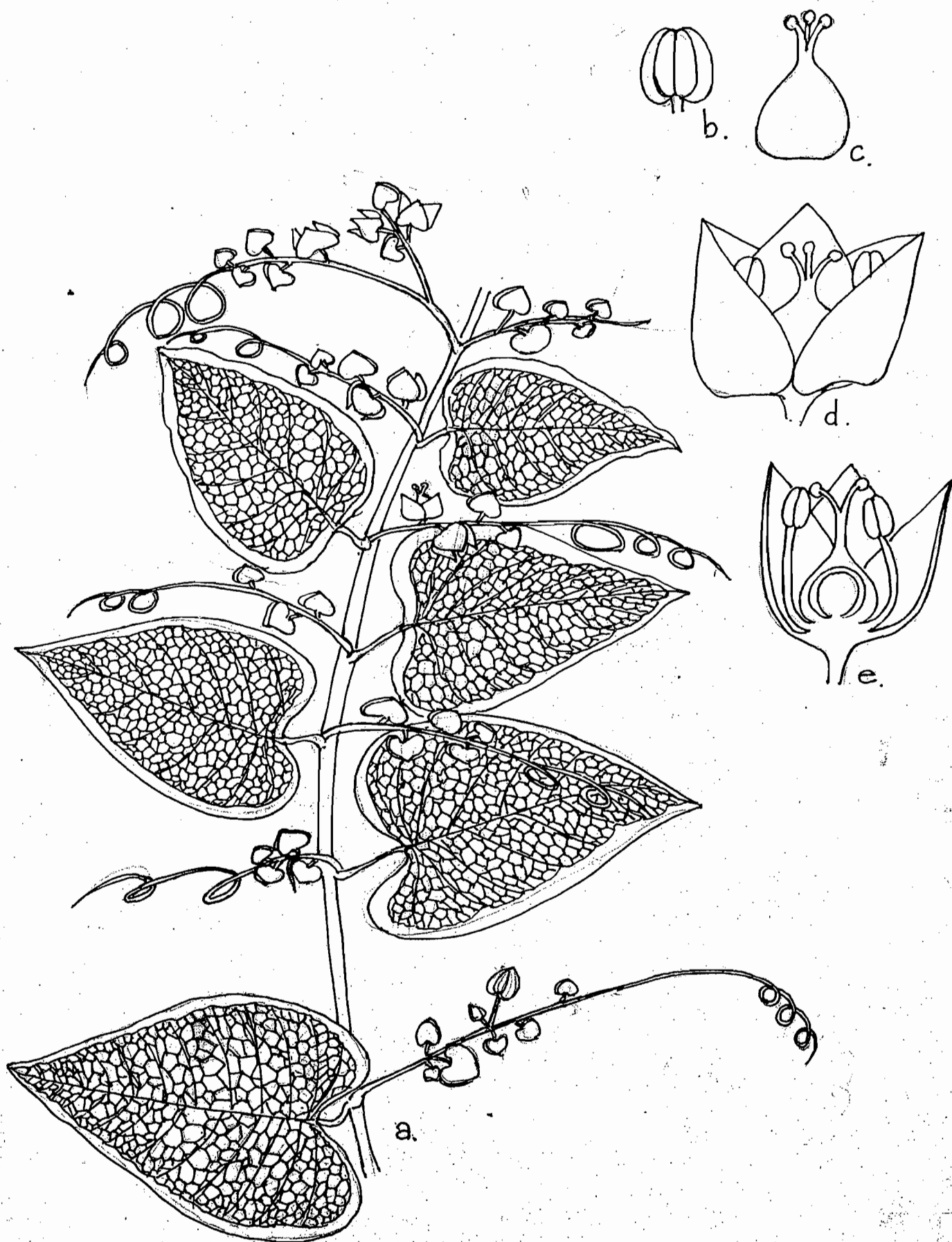


Fig. 463. *Antigonon leptopus* Hook. & Arnott., a. habit, b. stamen, c. gynoecium, d. flower, e. L.S. of flower.

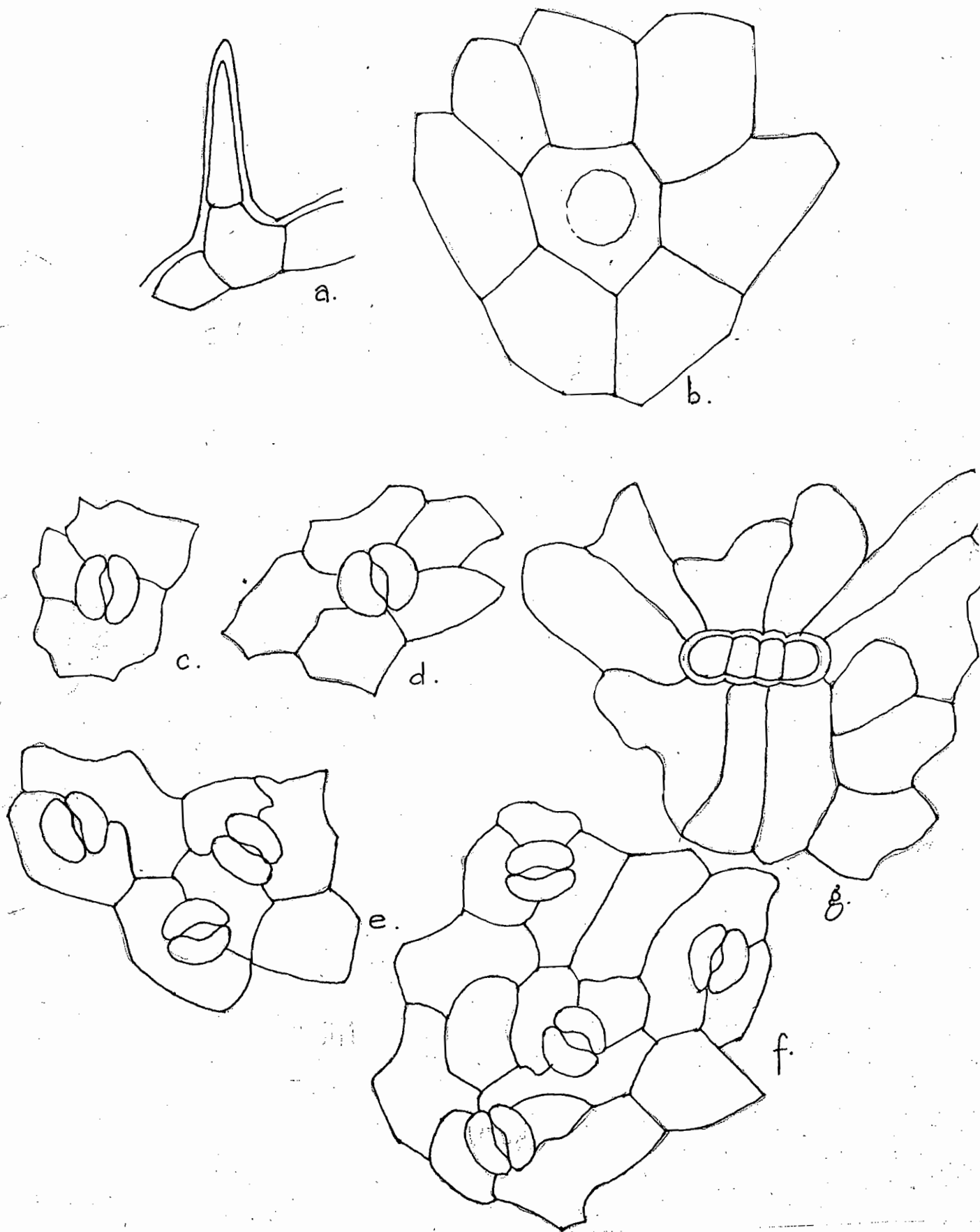


Fig. 464. *Antigonon leptopus* Hook. & Arnott., a. unicellular trichome, b. epidermal papillae, c. anisocytic stomata, d. anomocytic stomata, e. paracytic and diacytic stomata, f. paracytic, anisocytic and anomocytic stomata, g. four celled sessile gland.

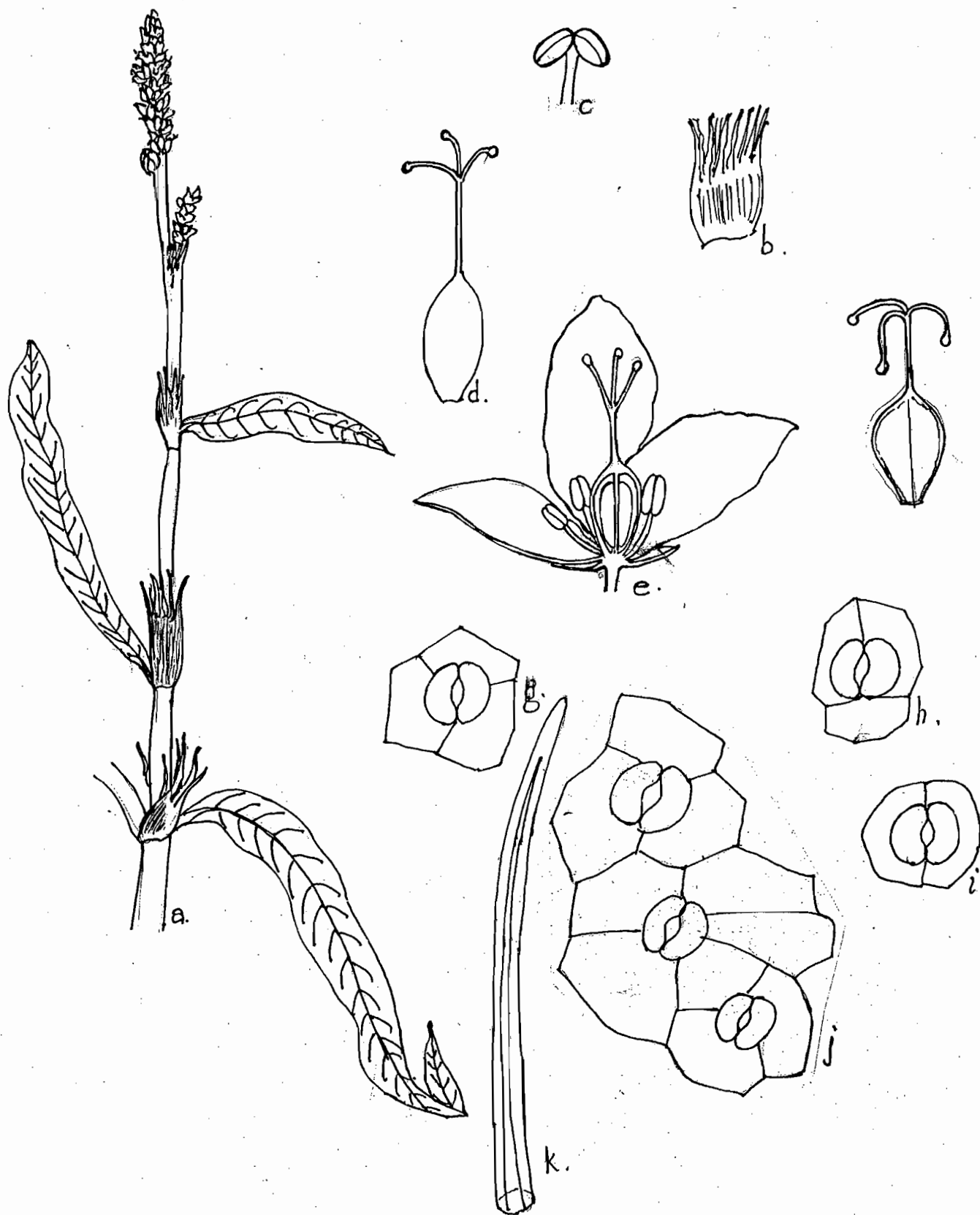


Fig. 465. *Persicaria decipiens* (R. Br.) K.L. Wilson., a. habit, b. ochreate stipule, c. stamen, d. gynoecium, e. L.S. of flower, f. nut, g-h. anisocytic stomata, i. paracytic stomata, j. anomocytic and anisocytic stomata, k. unicellular acicular trichome.

anthers 2-celled. Ovary 3-gonous. Nutlet angled; pericarp usually hard, shining. (Fig. 466)

Vernacular name: Zinko okhrad.

Flowers: December-May.

Micromorphology (Fig. 466)

Whole plant was glabrous.

Stomata were of anomocytic.

D/094.

Aristolochiaceae

1. *Aristolochia bracteolata* Lam.. *Encycl.* 1:258. 1783

A slender prostrate branched perennial upto 2 m long with reniform or broadly ovate leaves having cordate base and a wide shallow sinus. Flowers solitary; pedicels with a large sessile orbicular or subreniform bract at the base. Perianth base subglobose, tube cylindric with a trumpet-shaped mouth, dark-purple, with revolute margins. Stamens 6, adnate 1-seriately above the ovary forming a gynostegium. Ovary inferior, more or less 6-celled; ovules many, 2-seriate. Capsules oblong-ellipsoid, 12-ribbed. Seeds deltoid with a slightly cordate base (Fig. 467).

Vernacular name: Kidamari.

Flowers: August-November.

Variations observed: I could observed a number of differences, from the standard descriptions found in the flora, where in the leaf is said to be obtusely acuminate, flowers, in axillary racemes and bracts small, ovate. But in our specimens, the leaves were obtuse with a slight notch, flower axillary solitary and bract small, obtuse, rounded, and acuminate.

Vernacular name: Batak vel.

Flowers: September-November.

Micromorphology (Fig. 468)

Whole plant was glabrous

Stomata were of anomocytic type.

D/1096-1097

2. *Aristolochia littoralis* D. Parodi *Anales Soc. Ci. Argent.* 5: 155. 1878. (*Aristolochia elegans* Masters)

A slender climber, with pendulous branches and foliage, Leaves upto 5 cm long broadly ovate-cordate, obtuse at the apex, glabrous on both surfaces; petiole 3-5 cm long. Inflorescence solitary, axillary. Flowers on long pedicels, up to 7 cm long. Perianth limb inflated, pale yellowish green, swollen, contracted at the mouth, funnel-shaped at top, rich purple with creamy white markings. Stamens 6. Gynostegium short, cylindrical. Capsule 4 cm long. (Fig. 469)

Flowers: June-July.

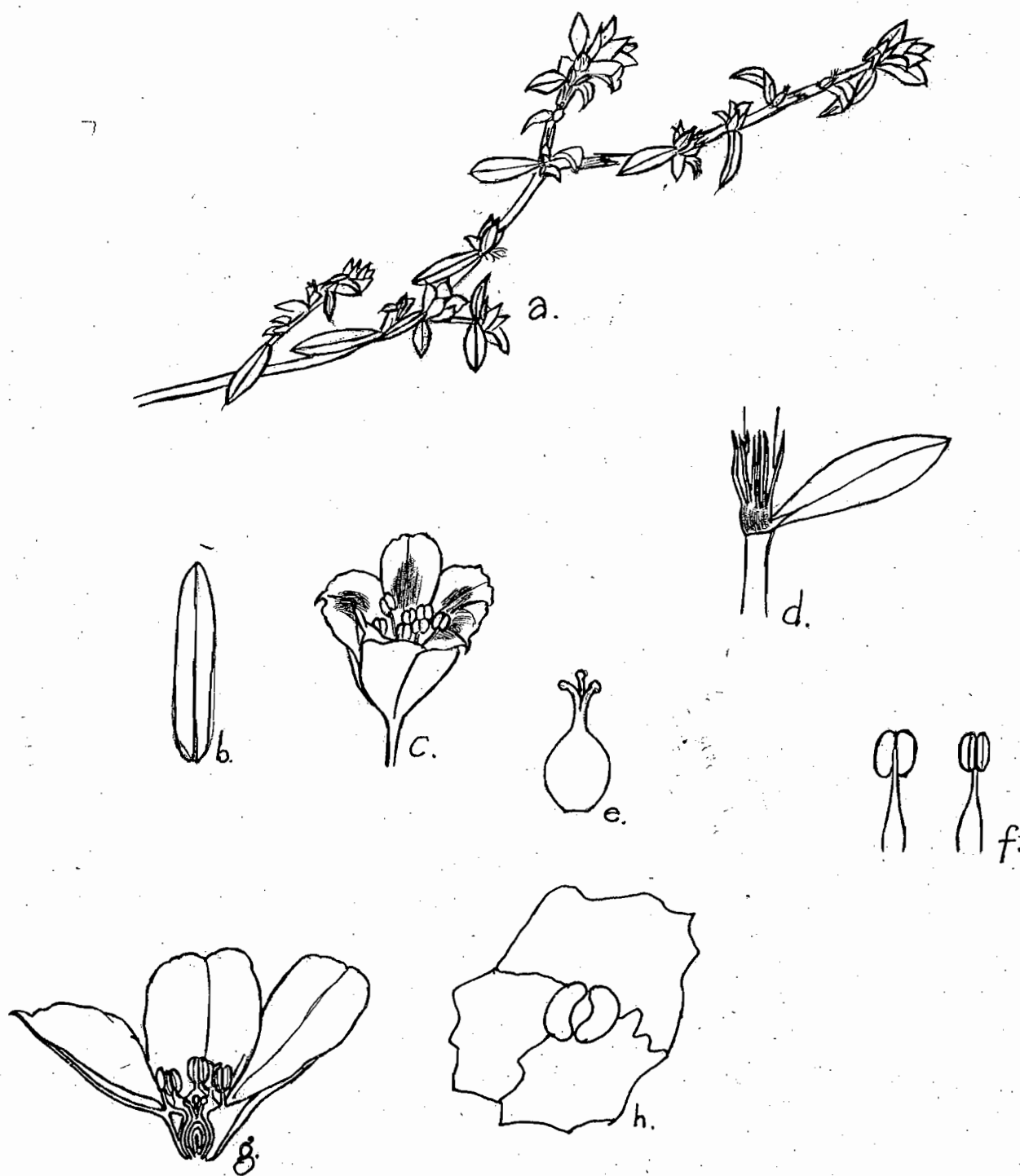


Fig. 466. *Polygonum plebejum* R. Br., a. habit, b. leaf, c. flower, d. leaf with ochreate stipule, e. gynoecium, f. stamen, g. L.S. of flower, h. anisocytic stomata.

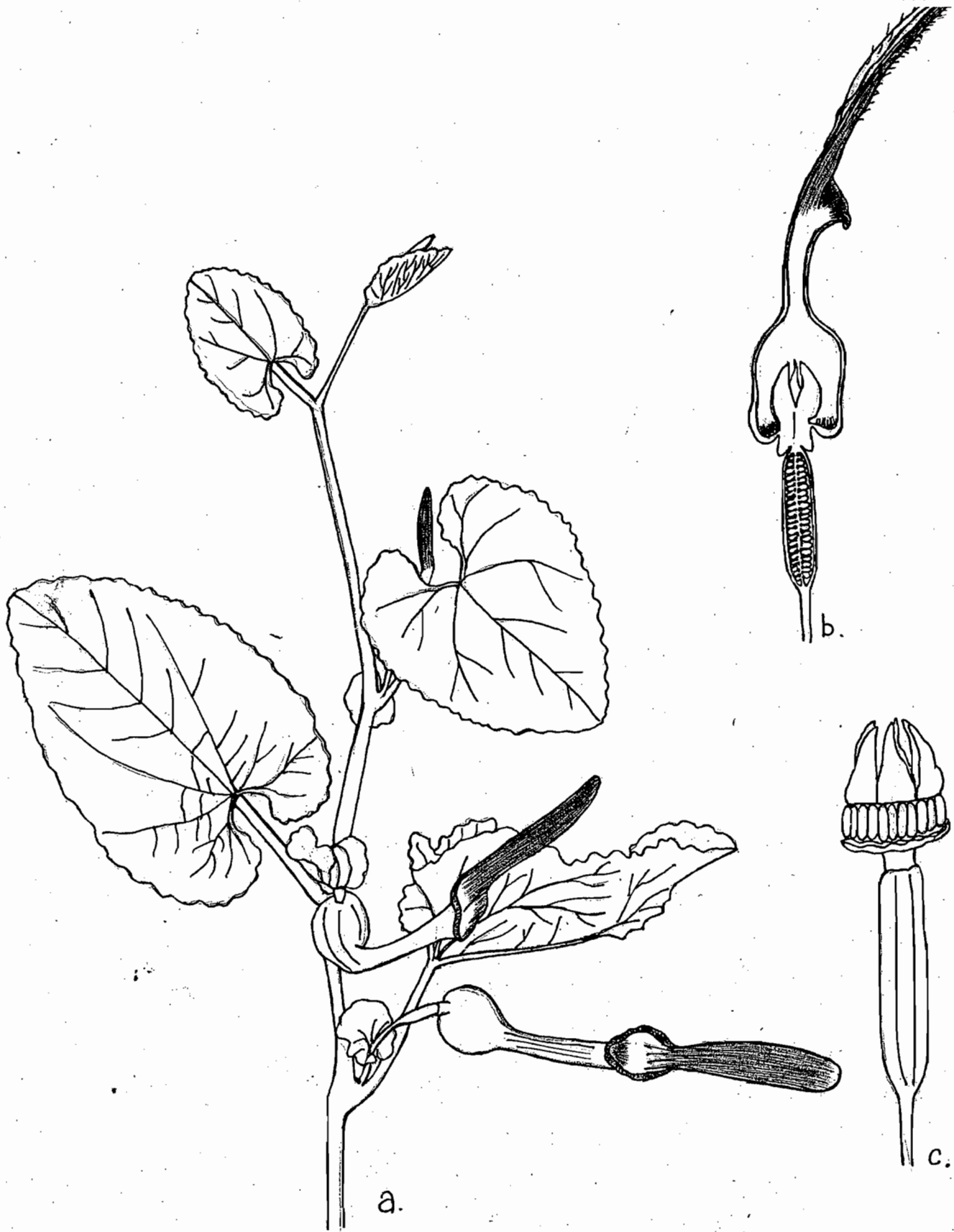


Fig. 467 *Aristolochia bracteolata* Lam., a. habit, b. L.S. of flower.

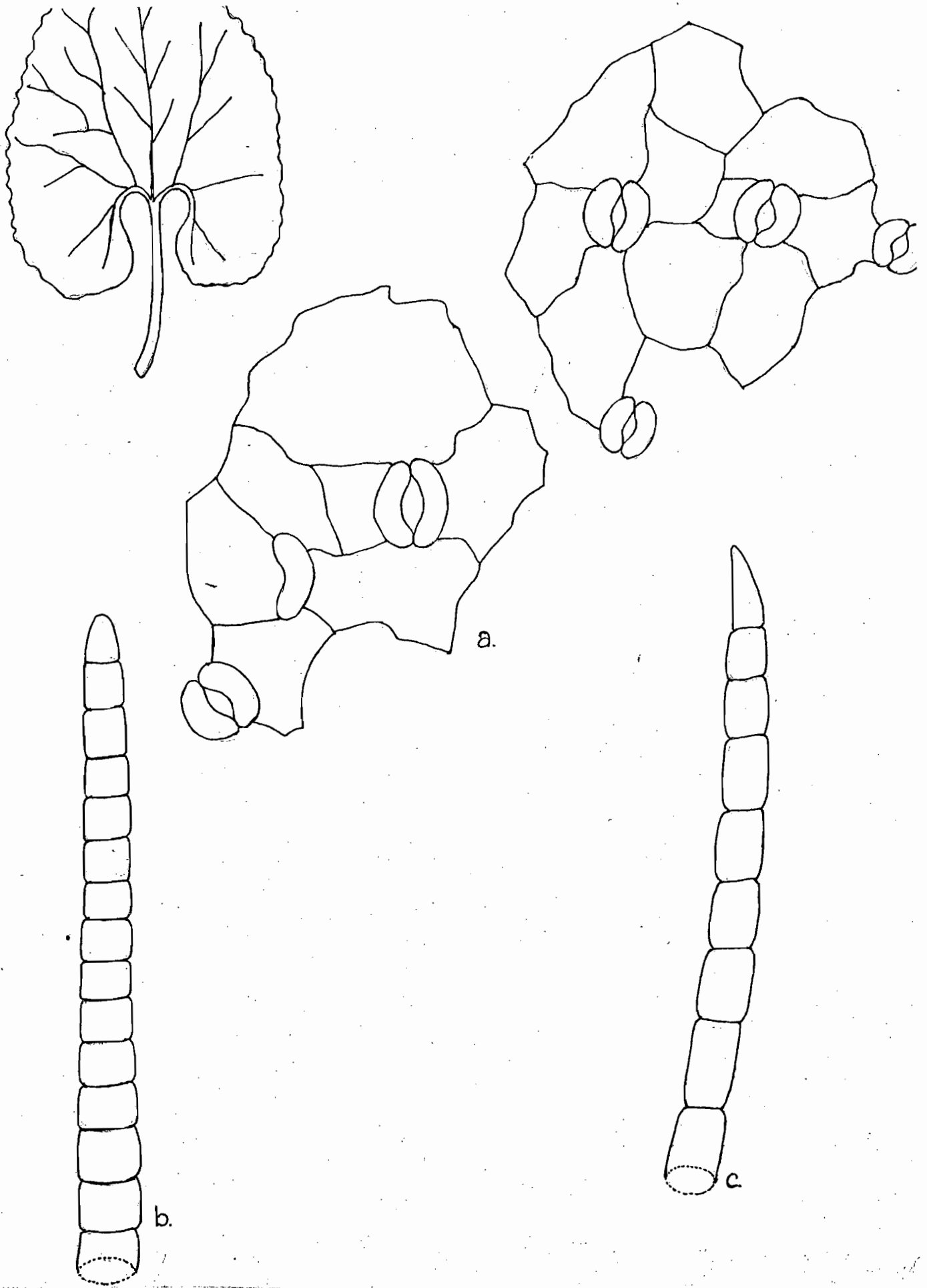


Fig. 468. *Aristolochia bracteolata* Lam., a. leaf, b. anomocytic stomata, c. multicellular uniseriate trichome having cuboidal cells.

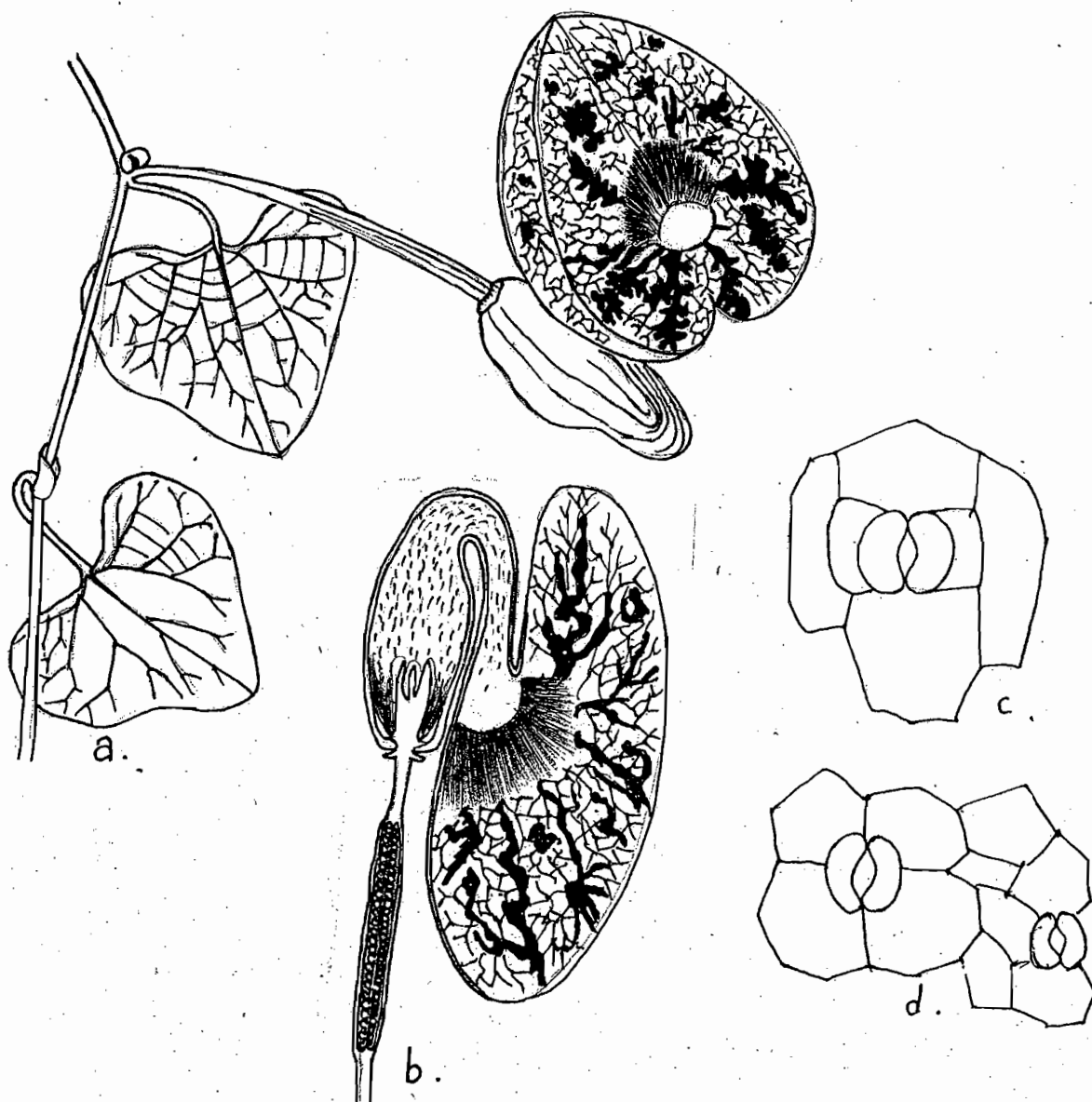


Fig. 469 *Aristolochia littoralis* D. Parodi., a. habit, b. L.S. of flower, c. tetracytic stomata, d. anomocytic stomata.

Micromorphology(Fig. 469).

Leaf was glabrous, whereas perianth showed presence of multicellular, uniseriate, trichome with short cells arranged end to end.

Stomata were of anomocytic, tetracytic and anisocytic type.

D/244.

Loranthaceae

1. *Loranthus longiflorus* Desrouss. in *Lam. Encyc. Method.* V 3 (1789) p. 598.

A large bushy glabrous partial-parasite with grey bark and opposite, thick, coriaceous, linear-oblong leaves, upto 20 cm long. Flowers in axillary unilateral racemes often 2 from the axil; bract ovate, subacute, concave; bracteoles 2, free or connate with the bract. Calyx tube copular, adnate to the ovary; limb short, truncate or 4-6 toothed. Corolla split at the back; tube curved, slightly widened upwards, scarlet or orange or pink or white; lobes 5, linear, reflexed. Stamens 4, adnate to the petals. Ovary inferior, 1-celled; ovule solitary; style quadrangular. Berry ovoid-oblong, pink. (Fig. 470)

Flowers: February-March.

Micromorphology (Fig. 470)

Whole plant was glabrous.

Stomata were of tetracytic type.

D/200.

Euphorbiaceae

1. *Acalypha indica* Linn. *Sp. Pl.* (1753) p. 1003.

A pubescent branched annual, herb upto 1 m high. Leaves rhomboid-ovate, alternate, upto 8 cm long, crenate-serrate, glabrous, thin, somewhat 3-nerved; petioles usually longer than the blade; stipules minute. Flowers in numerous axillary spikes, the males minute, clustered near the summit of the spike, the females scattered, 3-5 surrounded by a shortly pedunculate large leafy cuneiform many-nerved bract. Male flowers: tepals 4. Stamens usually 8; filaments short, free; anther cells distinct, divaricate, often at length twisted or flexuous. Pistillode 0. Female flowers: tepals 3-4, minute imbricate. Ovary 3-celled; ovules solitary in each cell; styles filiform, fimbriate. Capsules concealed by the bract, only 1-seeded. Seeds ovoid, smooth, pale-brown. (Fig. 471)

Vernacular name: Dadri.

Flowers: June-September.

Micromorphology (Fig. 471)

The plant showed presence of multicellular, uniseriate, unbranched, non-glandular trichome with pitted walls.

Stomata were of paracytic type.

D/450, 506.

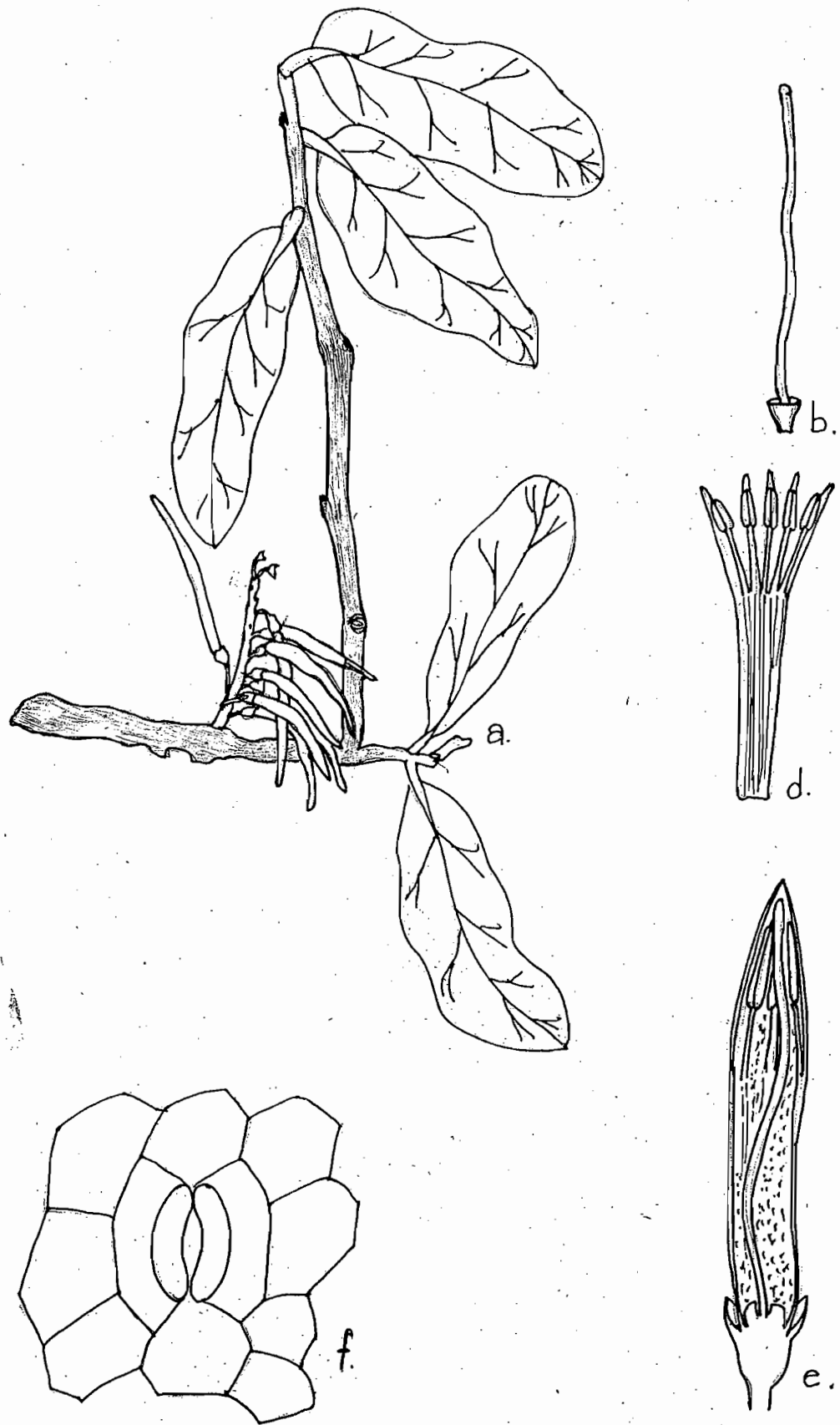


Fig. 470. *Loranthus longiflorus* Desr., a. habit, b. gynoecium, c. stigma and style, d. epipetalous stamen, e. L.S. of flower, f. tetracytic stomata.

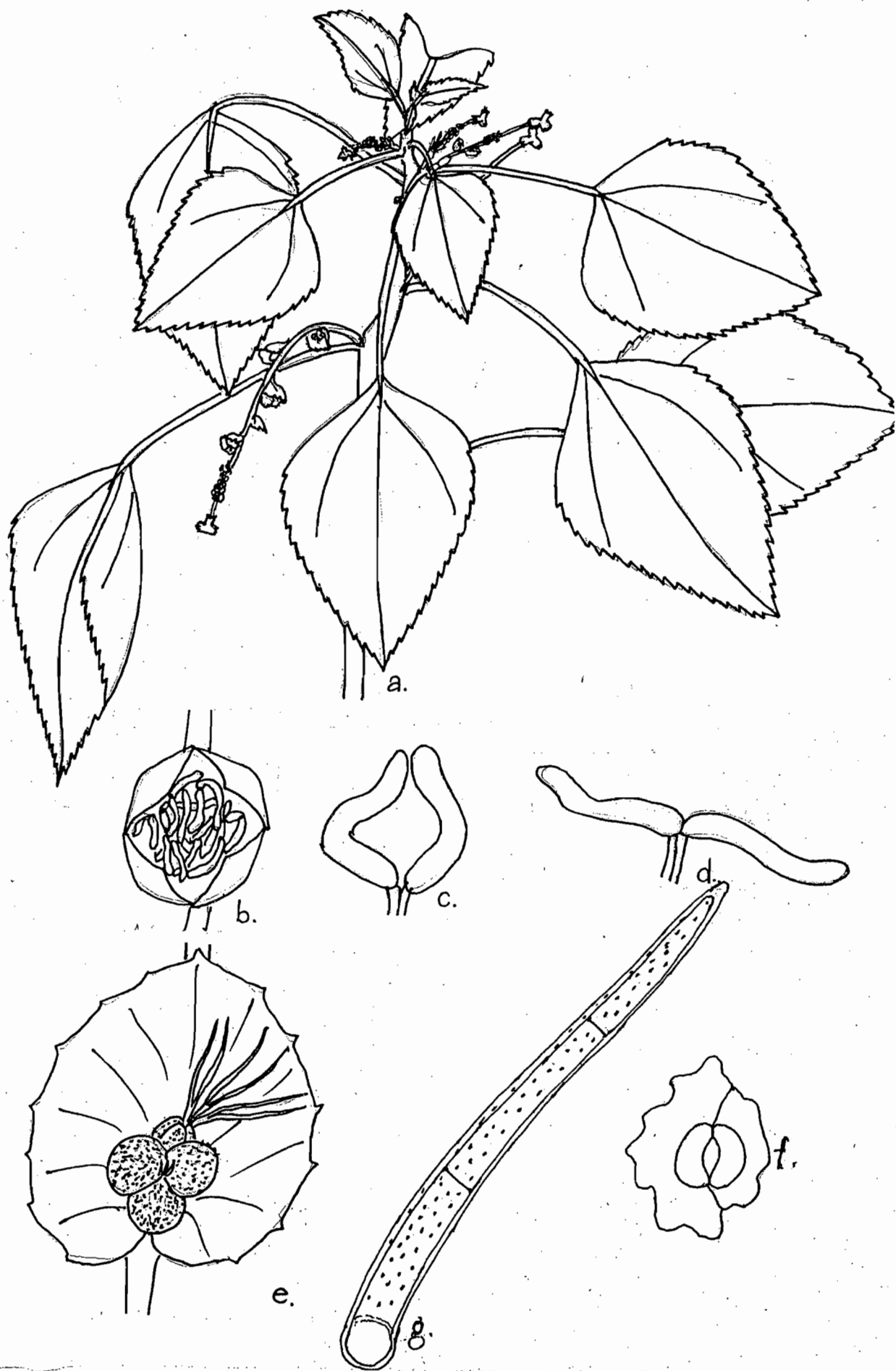


Fig. 471. *Acalypha indica* L., a. habit, b. male flower, c-d. stamen, e. female flower, f. paracytic stomata, g. multicellular uniseriate trichome with pitted wall.

**2. *Chamaesyce pycnostegia* (Boiss.) Soják, *as. Nár. Mus., Odd. PYír.* 140: 170. 1972.
(*Euphorbia pycnostegia* Boiss.)**

An annual, slender, erect, glabrous, dichotomously branched herb upto 60 cm high. Stems often tinged with purple, with swollen nodes. Leaves oblong, upto 4 cm, serrulate; floral leaves reaching 1.5 cm long, distichously imbricating, ovate-cordate, often apiculate; stipules minute, fimbriate. Involucres stalked, glabrous outside, hairy inside; lobes fimbriate; gland transversely oblong; limb white, obliquely obovate, rounded at the apex. Capsules glabrous; cocci obtusely keeled; styles short, divaricate, each deeply 2-lobed. Seeds oblong, obtusely 4-angled, tuberculate. (Fig. 472)

Flowers: October-December.

Micromorphology (Fig. 472)

Whole plant was glabrous.

Stomata were of anomocytic type.

D/324.

3. *Chrozophora prostrata* Dalzell in Dalzell & Gibson, *Bombay Fl.* 233. 1861.

A stellately hairy prostrate annual about 25 cm long with both radical and cauline leaves. Leaves broadly ovate-suborbicular upto 3.5 cm long, cordate at base, crenate, stellately woolly below. Flowers in axillary few-flowered racemes. Male flowers ; outer tepals ovate, inner tepals reddish elliptic-lanceolate. Stamens 15 in 2 whorls. Female flowers; tepals linear. Capsules subglobose, stellately woolly. Seeds globose. (Fig. 473)

Vernacular name: Betho okharad.

Flowers: November-April.

Micromorphology (Fig. 473)

Stellate hairs with five-arms were present all over the plant.

Stomata were of anomocytic and anisocytic types.

D/190.

4. *Croton bonplandianus* Baill. in *Adansonia* 4: 339. 1863.

A much branched perennial herb, perennial reaching upto 60 cm high. Leaves ovate-lanceolate, serrate, upto 7 cm, acute at apex. Flowers in racemes, greenish; male flowers above, female flowers fascicled in the axil of minute bracts. Male outer tepals obovate, minute; inner tepals linear-oblong. Stamens 10-15. female tepals lanceolate. Ovary densely stellate-hairy; stigmas 2-fid. Capsules 3-angled, stellately-hairy. seeds oblong, shining, with white caruncle. (Fig. 474)

Vernacular name: Croton.

Flowers: March-April.

Micromorphology (Fig. 475)

Stellate hairs with many arms were present all over the plant.

Stomata were of paracytic, cyclocytic and anomocytic types.

D/695, 1361.

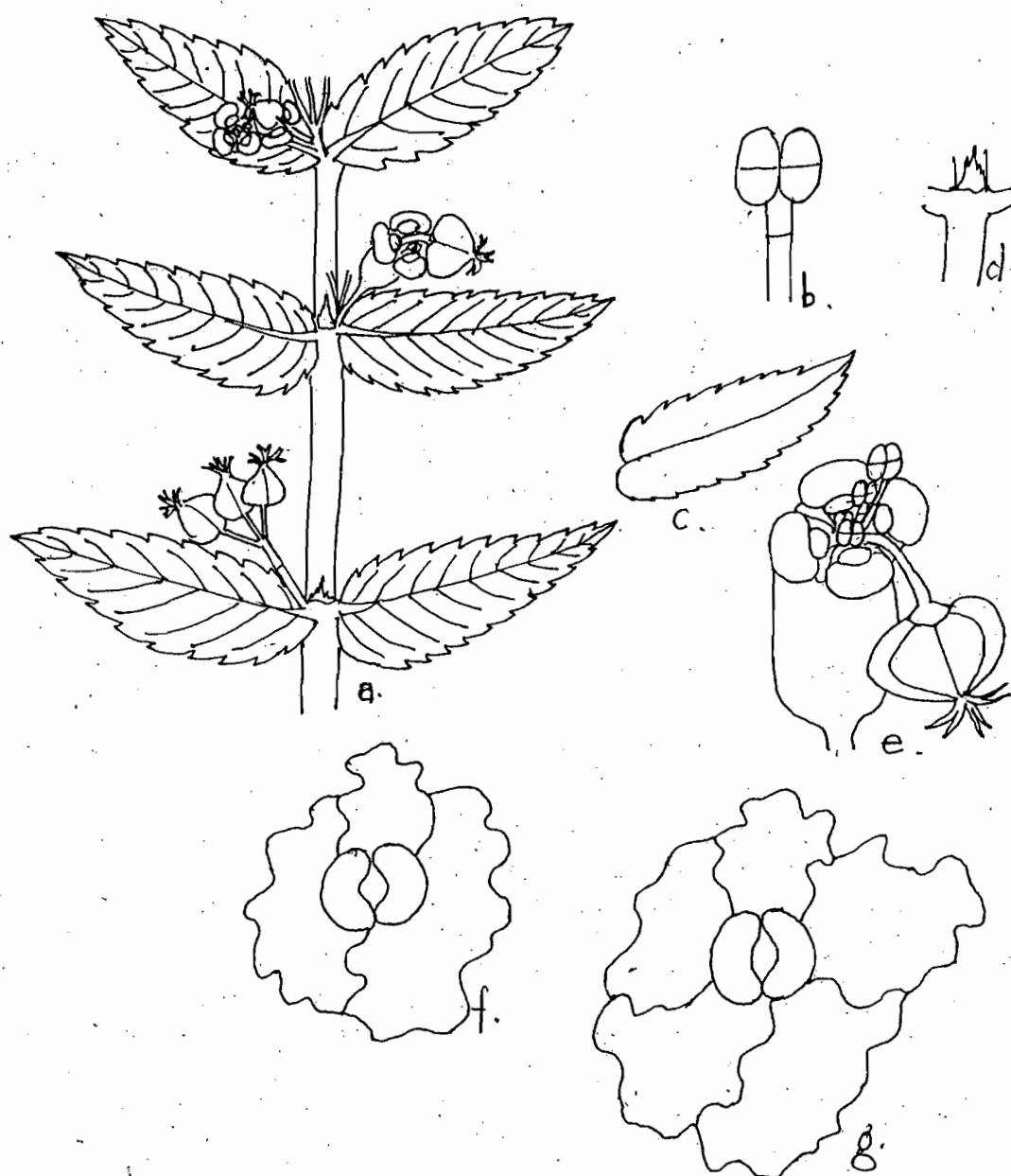


Fig. 472. *Chamaesyce pycnostegia* Boiss., a. habit, b. stamen, c. leaf, d. stipule, e. cyathium, f. anisocytic stomata, g. anomocytic stomata.

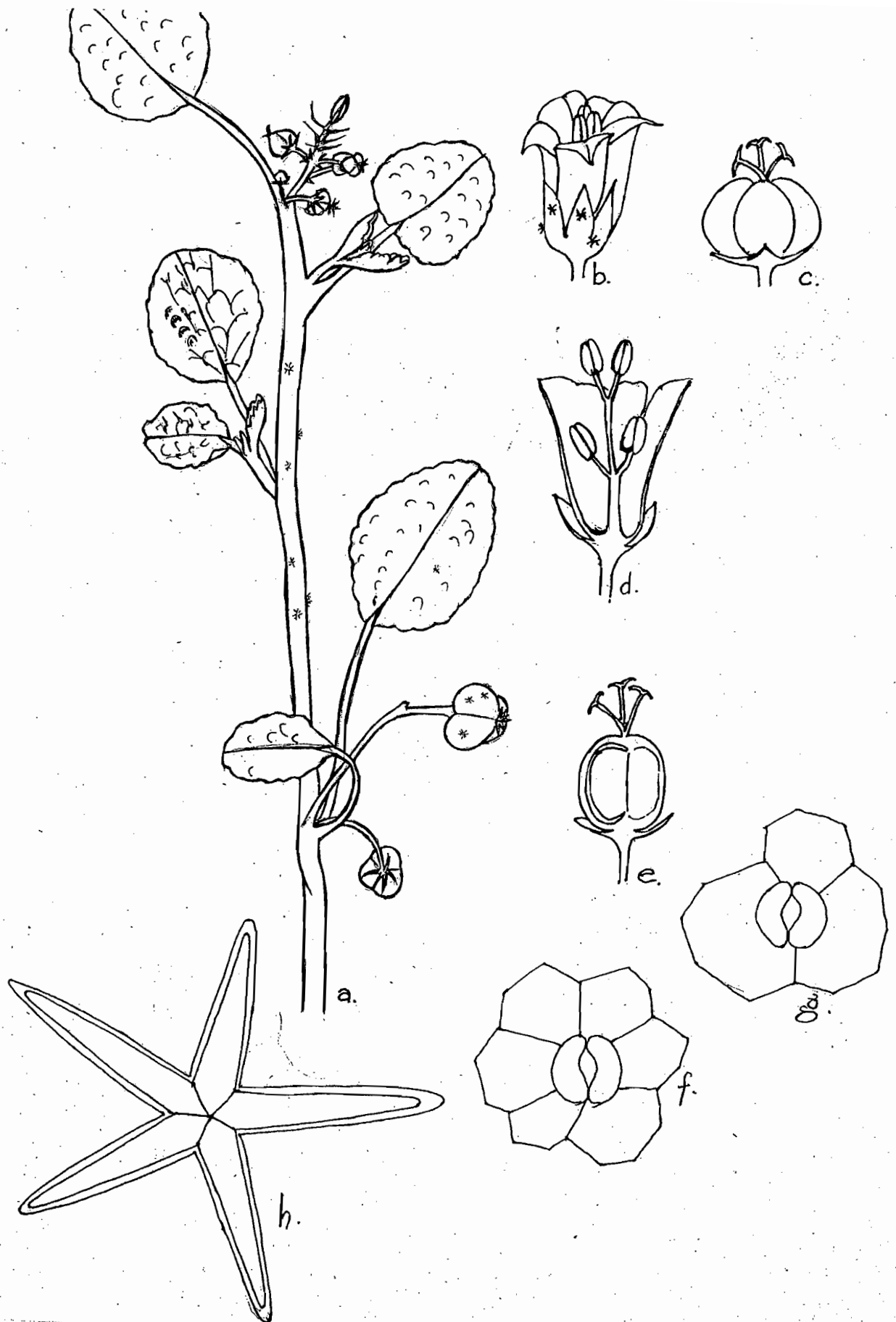


Fig. 473 *Chrozophora prostrata* Dalz., a. habit, b. male flower, c. female flower, d. L.S. of male flower, e. L.S. of female flower, f. anomocytic stomata, g. anisocytic stomata, h. stellate hair with five-arms.

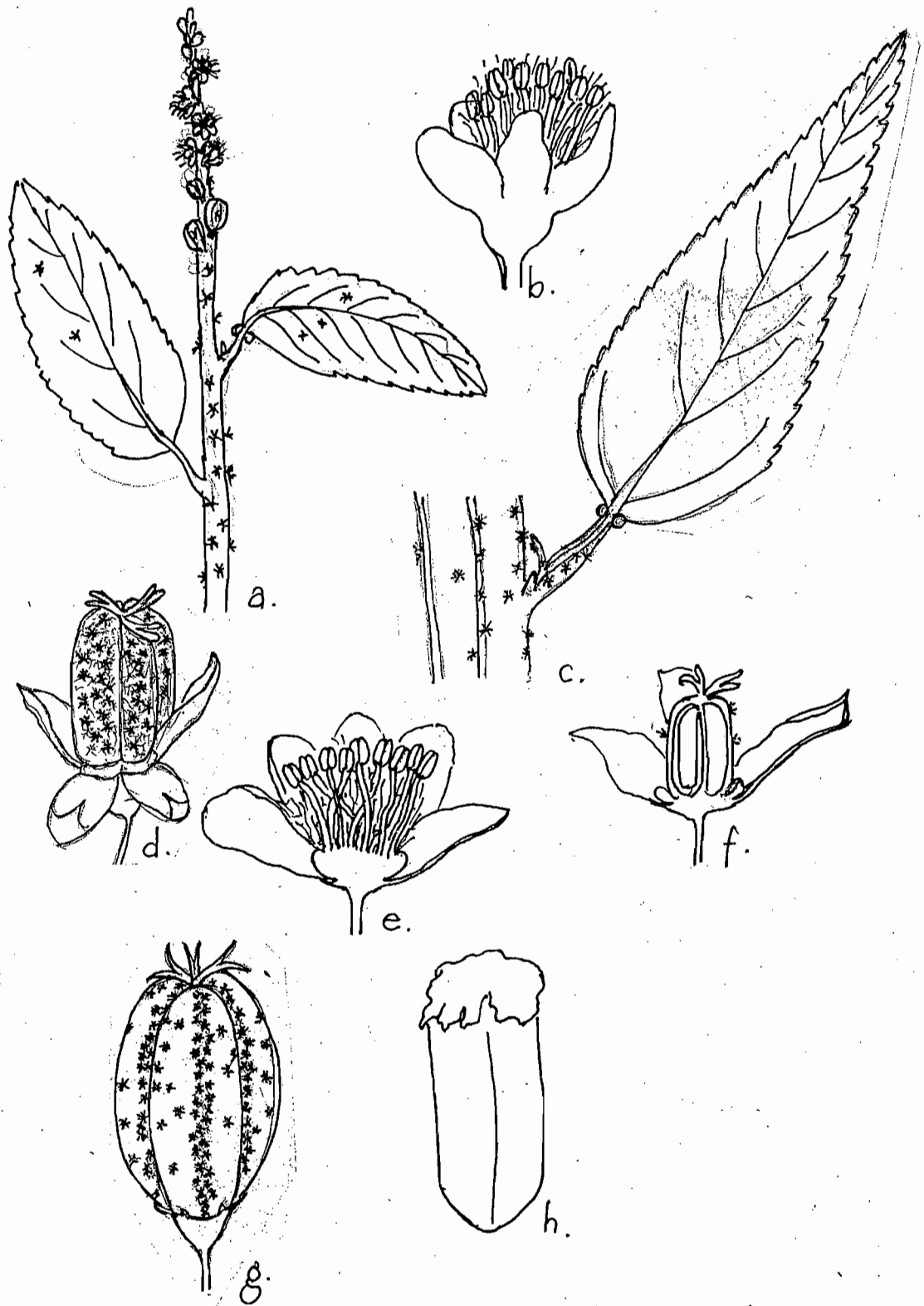


Fig. 474 *Croton bonplandianum* Baill., a. habit, b. male flower, c. leaf, d. female flower, f. L.S. of female flower, g. fruit, h. seed.

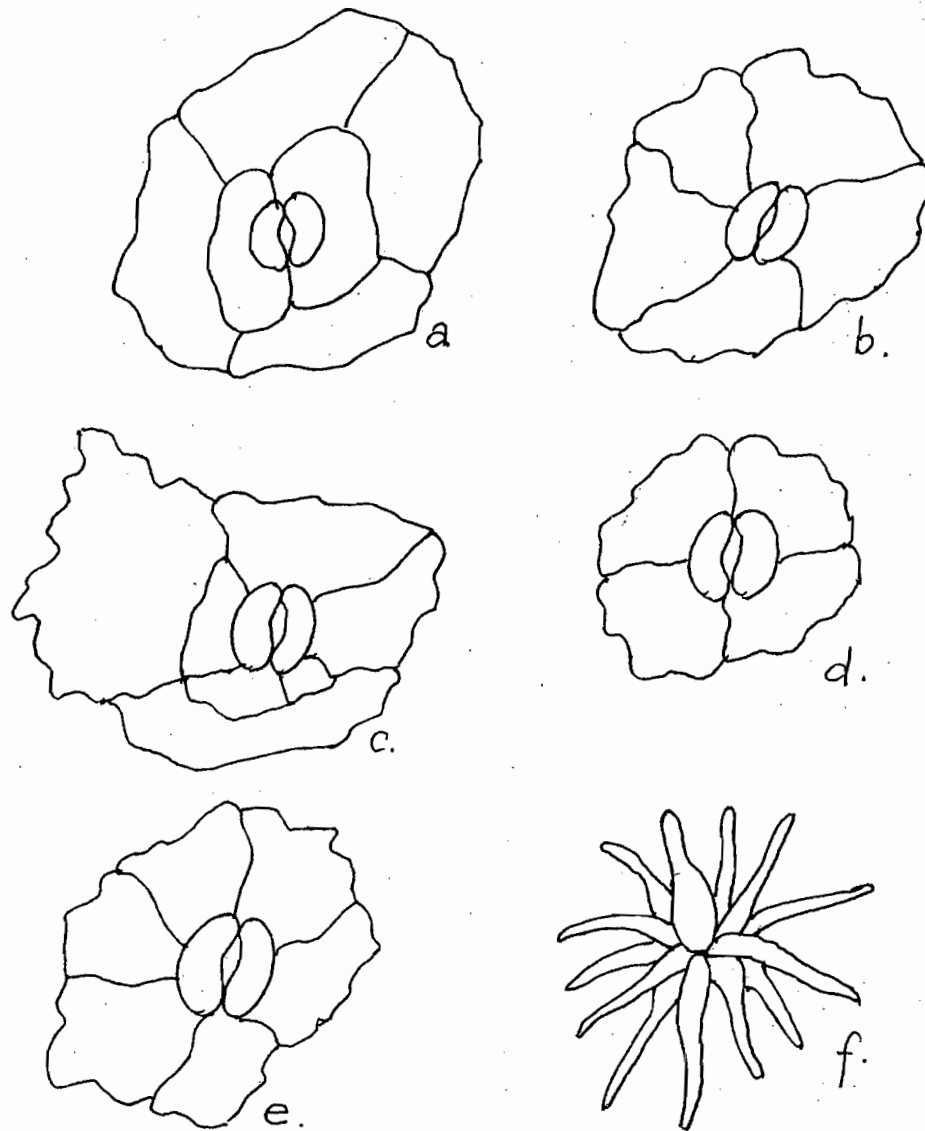


Fig. 475. *Croton bonplandianus* Baill., a. paracytic stomata, b. cyclocytic stomata, c-e. anomocytic stomata, f. stellate hair with many arm.

5. *Dalechampia scandens* var. *cordofana* (Hochst. ex Webb) Muell. Arg. in DC. Prodr. 15(2): 1245. 1866.

A puberulous slender twiner. Leaves tripartite, the median lobe elliptic-lanceolate, the laterals slightly smaller, asymmetrically lanceolate. Stipules lanceolate. The inflorescence usually axillary and is a bilaterally symmetrical pseudanthium of 2 large creamy-white, 3-lobed bracts positioned at different levels. The lower one subtend the pistillate inflorescence and the upper one the staminate inflorescence. Male flowers: sepals elliptic-ovate, becoming reflexed, greenish-yellow; staminal column; anthers minute, yellow. Female bracts ciliate. Female flowers: pedicels extending in fruit; sepals 6(-10), pinnatifid, elliptic with 4 pairs of linear gland-tipped lateral lobes, strigose-hirsute, the hairs urticating; disc 0; ovary densely pubescent; styles dilated and excavated at the apex. Fruits trilobate, pubescent, brown. Seeds spherical, grey, brown-mottled and streaked. (Fig. 476)

Vernacular name: Ekpani-panda.

Flowers: August-October.

Micromorphology (Fig. 477)

Both glandular and non-glandular types of trichomes were present, 1) non-glandular unicellular trichome with broad lumen, 2) non-glandular two-celled trichome with basal cell small and 3) glandular four celled biseriate trichome.

D/101.

**6. *Euphorbia heterophylla* L. Sp. Pl. 453. 1753.
(*Euphorbia geniculata* Ort.)**

An annual, erect herb of 60 cm height with fistular, glabrous, and green, branched stems. Leaves variable, linear-lanceolate, oblong, narrowed at base, subentire, dentate to serrate, glabrous above, hairy and whitish beneath. Involucres in cymes, densely corymbose; lobes 5, ovate, fimbriate. Capsules globose, glabrous. Seeds ovoid-subglobose, ash-colored, tuberculate. (Fig. 478)

Flowers: Throughout the year.

Micromorphology (Fig. 478)

The plant showed presence of multicellular, uniseriate, unbranched, non-glandular trichome with thick and warty walls and a swollen basal cell.

Stomata were of anomocytic type.

D/465, 1235-1237.

7. *Euphorbia hirta* L. Sp. Pl. 454. 1753.

An annual, erect-decumbent herb upto 35 cm high. Leaves ovate-oblong, up to 3 cm long, oblique, serrulate; stipules subulate. Cyathia in axillary, capituliform cymes. Involucres campanulate; lobes acute, hairy; glands orbicular, truncate at apex, with an obsolete appendage. Capsules depressed globose, 3-lobed, appressed pubescent. Seeds globose, 4-angled, slightly transversely rugose, reddish. (Fig. 479)

Vernacular name: Vadi dudhi.

Flowers: Throughout the year.

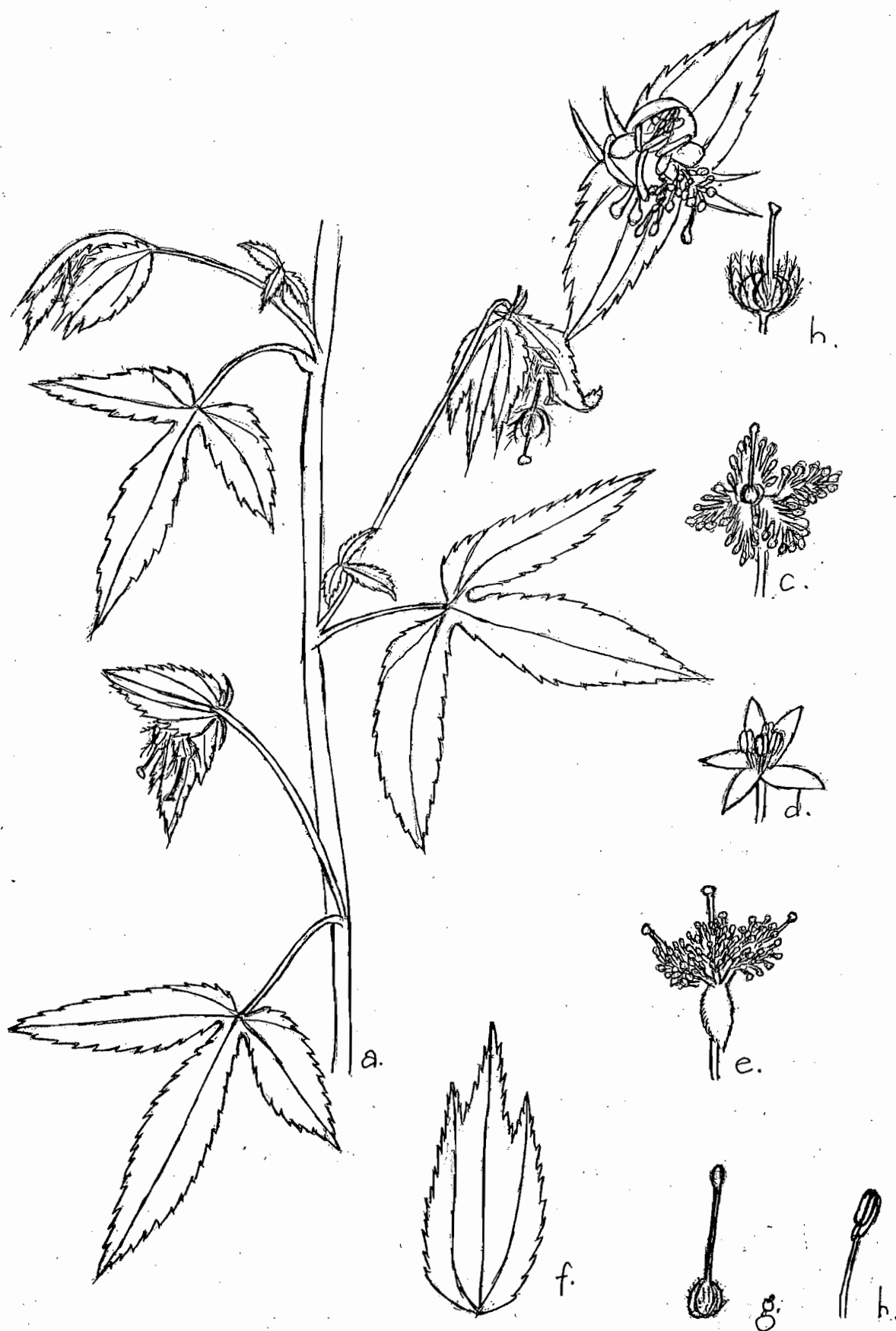


Fig. 476. *Dalechampia scandens* L., a. habit b. inflorescence b. female flower c. male flower g. gynoecium h. stamen.

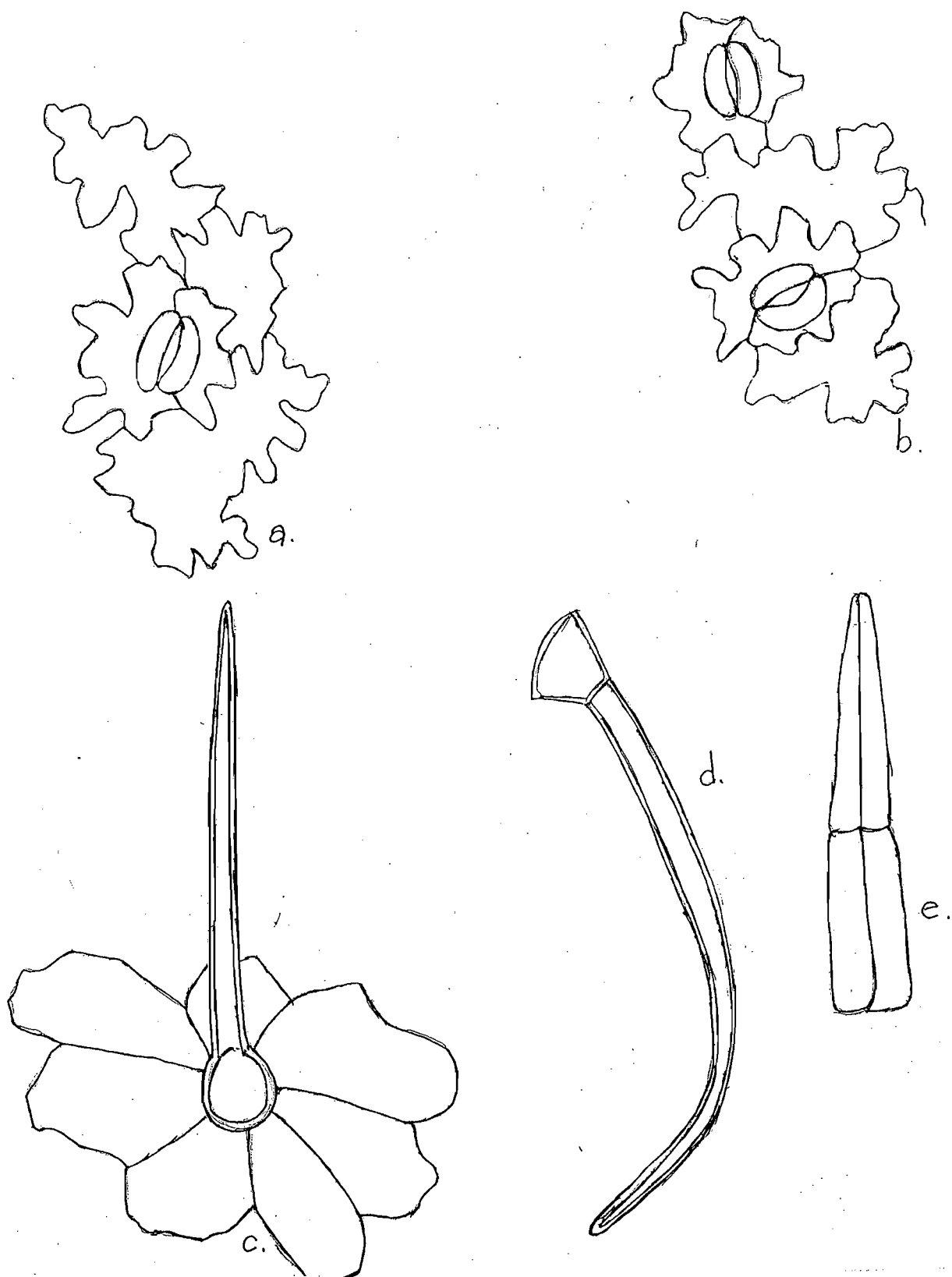


Fig. 477. *Dalechampia scandens* L., a-b. paracytic stomata, c. unicellular trichome with broad lumen, d. two-celled trichome with basal cell small, e. four celled biseriate trichome.

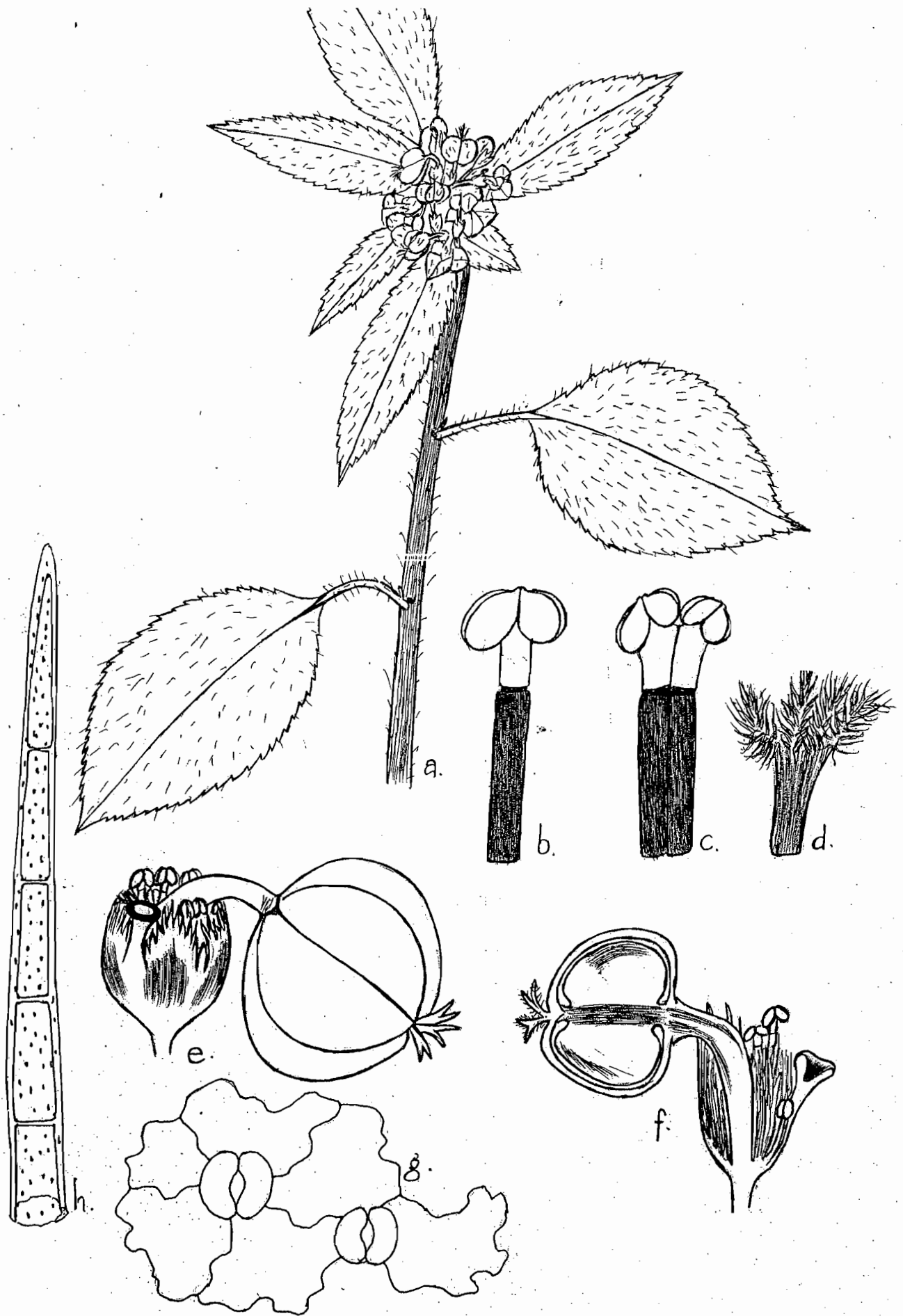
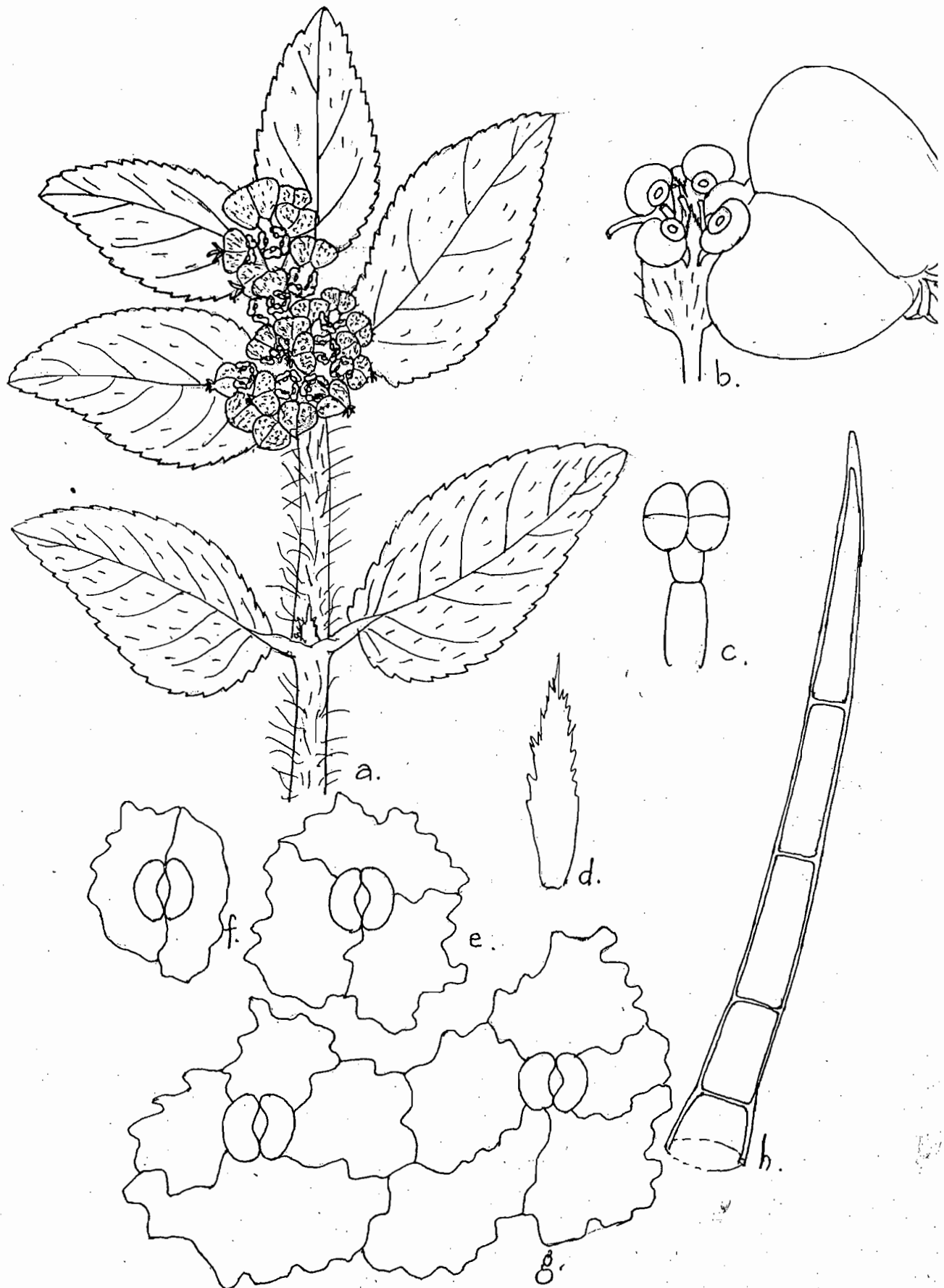


Fig. 478. *Euphorbia heterophylla* L., a. habit, b-c. stamen, d. bract, e. cyathium, f. L.S. of cyathium, g. anomocytic stomata, h. multicellular uniseriate trichome with warty wall.



• Fig. 479. *Euphorbia hirta* L., a. habit, b. cyathium, c. stamen, d. bract, e. anisocytic stomata, f. paracytic stomata, g. anomocytic stomata, h. multicellular uniseriate trichome with basal cell small.

Micromorphology (Fig. 479)

Multicellular uniseriate trichome with basal cell small and thin walled were present all over the plant.

Stomata were anisocytic, paracytic and anomocytic.

D/330.

8. *Euphorbia hypericifolia* Linn. *Sp. Pl.* (1753) p. 454.

An erect streading annual, upto 50 cm high having elliptic-oblong, upto 3 cm long, serrulate, unequal-sided leaves. Cyathia, in many-flowered cymes, possesses 4-5 lobed perianth-like involucre with thick glands at the mouth, each gland often bearing a petaloid spreading white or colored limb. Male flowers consists of a stalked stamen without floral envelope. Female flowers: ovary 3-celled on an ultimately exserted stalk in the centre of the involucre; ovule solitary in each cell; styles 3, free. Capsules subglobose, hairy; styles short 2-fid. Seeds smooth (Fig. 480).

Flowers: Throughout the year.

Micromorphology (Fig. 481).

The plant showed presence of multicellular, uniseriate, unbranched non-glandular trichome.

Stomata were of anomocytic, and anisocytic type.

D/832- 834.

9. *Euphorbia microphylla* Heyne, in *Roth, Nov. Pl. Sp.* P. 229. 1821.

A glabrous annual with numerous spreading branches reaching to a length of 24 cm. leaves obliquely oblong with pink margins. Cyathia axillary, numerous. Gland shortly stipitate with a small conspicuous limb. Capsules keeled. Seeds quadrangular. (Fig. 482).

Variation observed: in all the floras, the limb of cyathia are said to be inconspicuous but in my specimen, they were comparatively large and conspicuous.

Flowers: November-April.

Micromorphology (Fig. 482)

Leaves were glabrous.

Stomata were anisocytic, anomocytic and paracytic.

D/299.

10. *Euphorbia prostrata* Aiton, *Hortus, Kew.* 2: 139. 1789.

An annual, prostrate herb with several, spreading stems reaching upto 30 cm in length long. Leaves ovate-oblong, slightly oblique, obtuse, cordate-rounded at base. Involucres axillary, solitary, hairy outside; lobes lanceolate, ciliate; glands red, suborbicular. Capsules subglobose. Seeds narrowly ovoid, 1 mm long, 4-angled, obtuse at apex, truncate at base, transversely rugose. (Fig. 483)

Vernacular name: Lal dudheli.

Flowers: Throughout the year.



Fig. 480. *Euphorbia hypericifolia* L., a. habit, b. L.S. of cyathium, d. stamen, c. bract, e. seed.

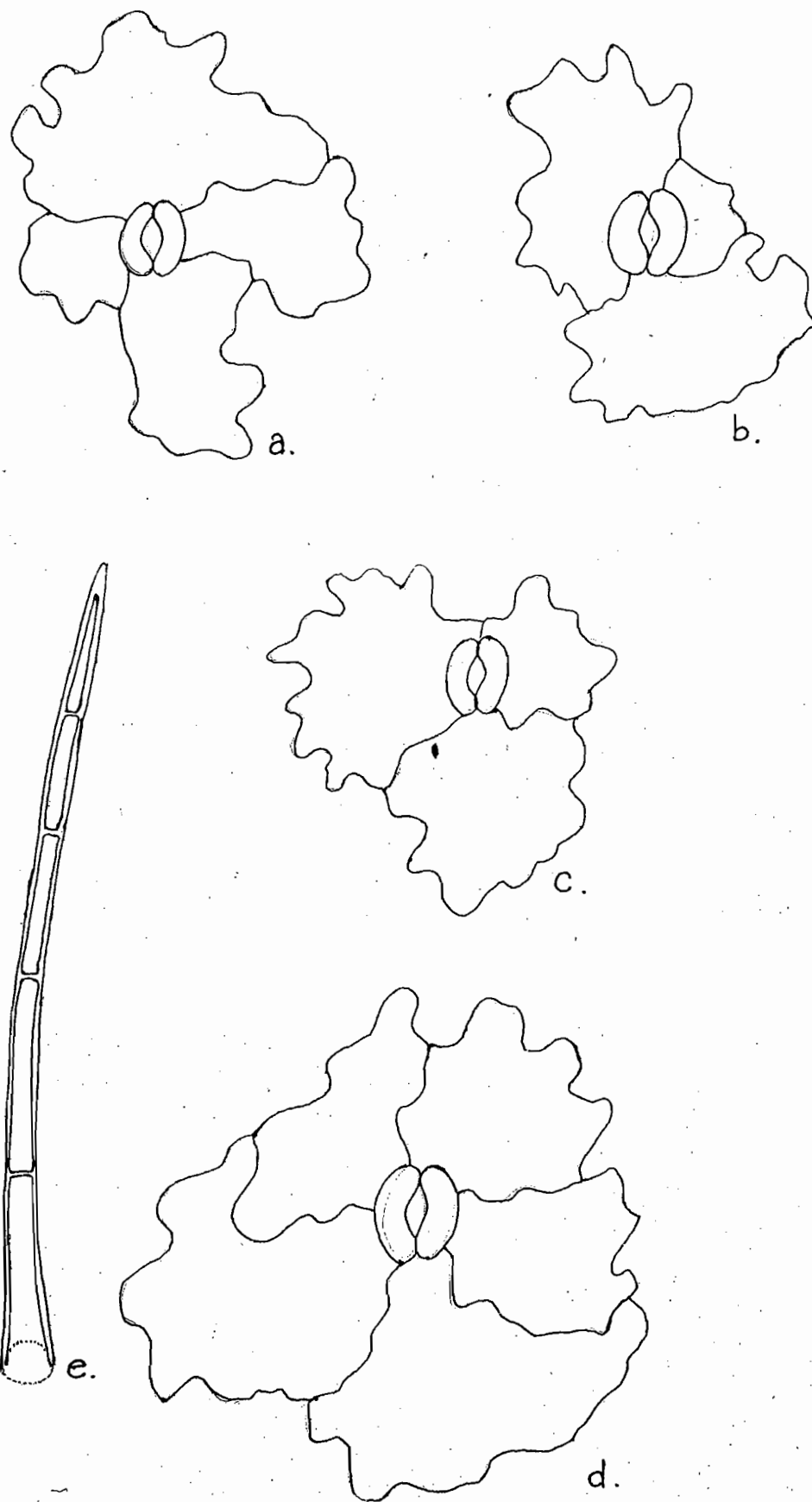


Fig. 481. *Euphorbia hypericifolia* L., a. tetracytic stomata, b-c. anisocytic stomata, d. anomocytic stomata, e. multicellular uniseriate trichome with thin wall.

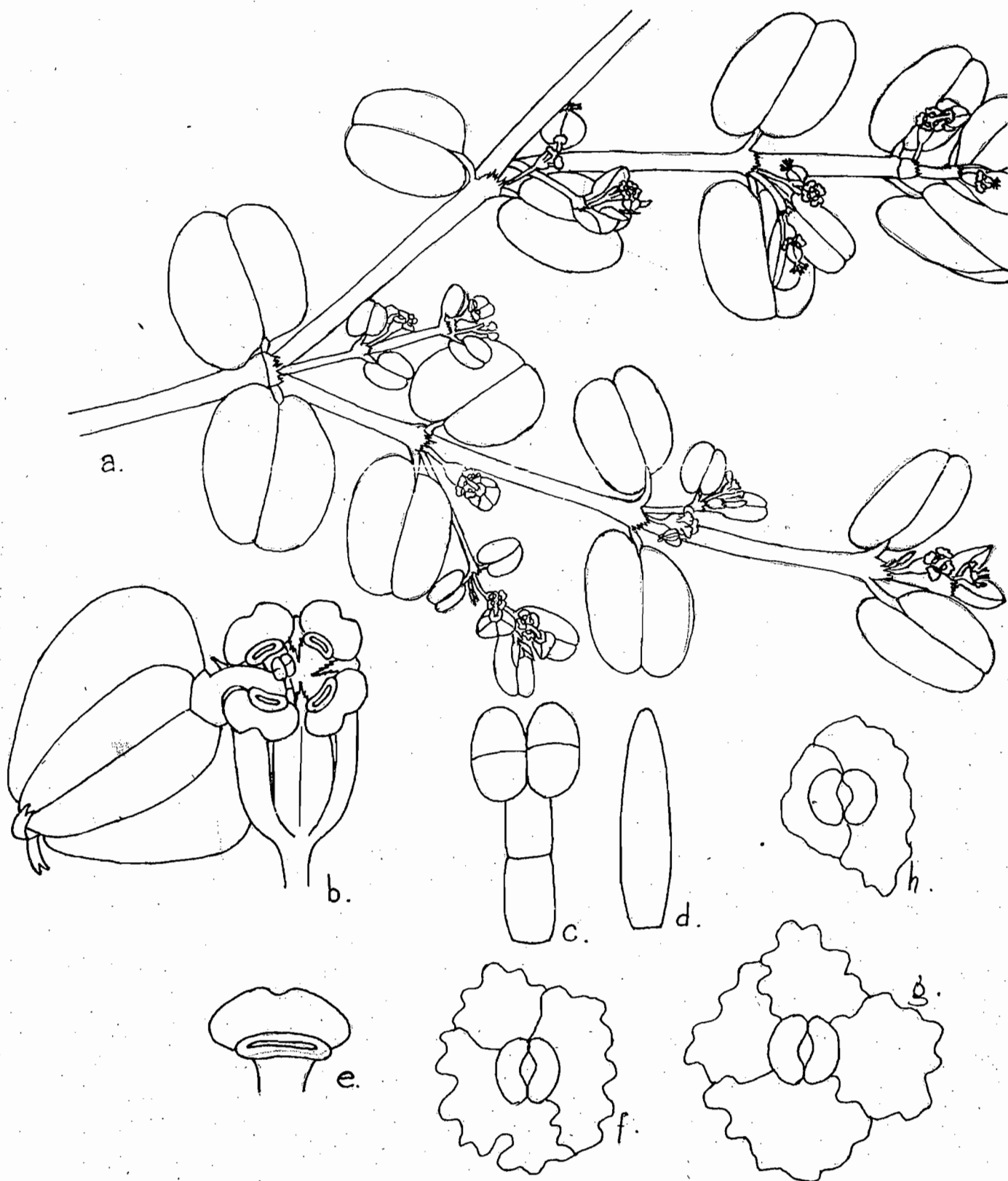


Fig. 482. *Euphorbia microphylla* Heyne., a. habit, b. cyathium, c. stamen, d. bract, e. gland, f. anisocytic stomata, g. anomocytic stomata, h. paracytic stomata.

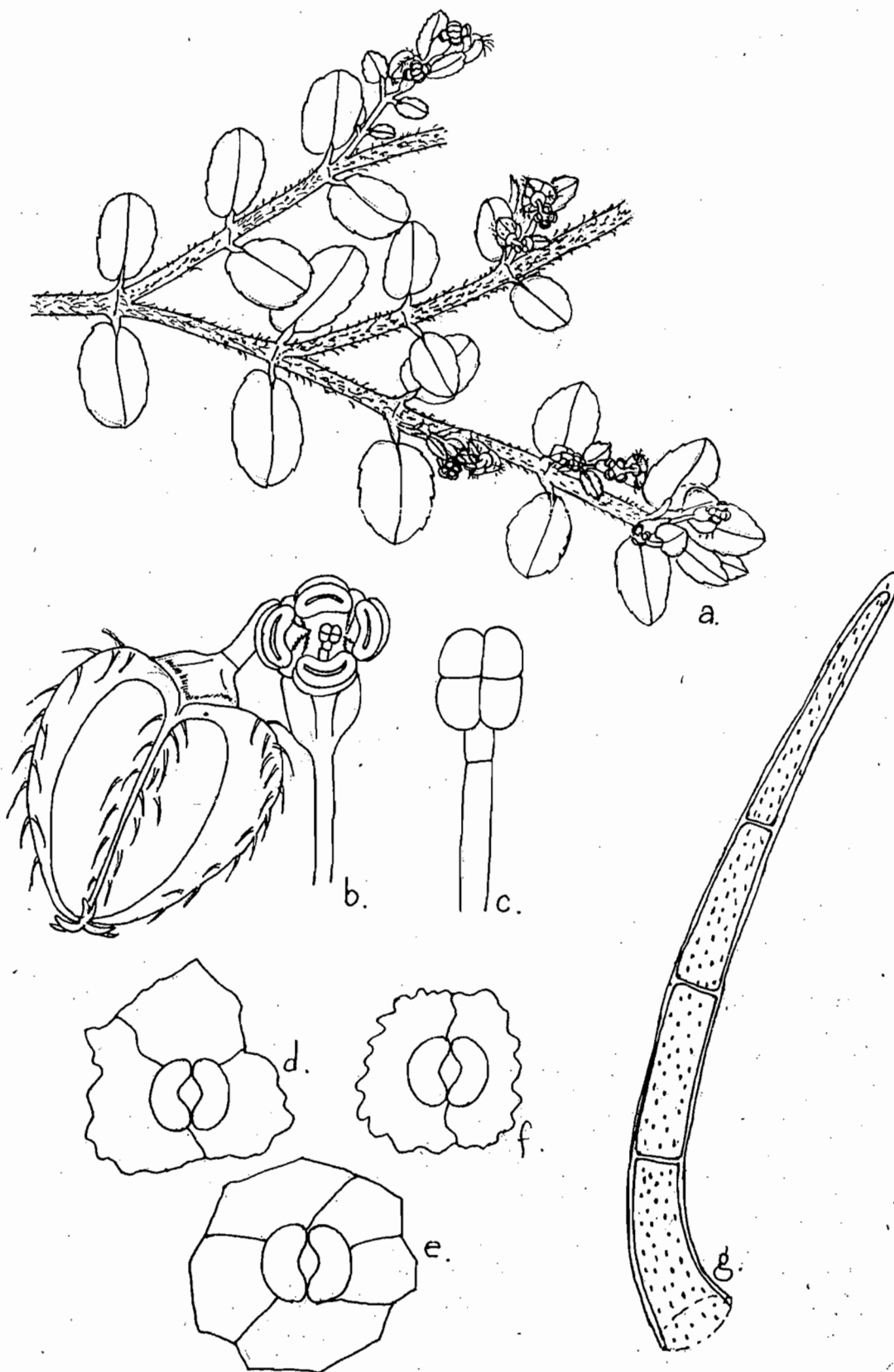


Fig. 483. *Euphorbia prostrata* Aiton., a. habit b. cyathium c. stamen, d. anisocytic stomata, e. anomocytic stomata, f. paracytic stomata, g. multicellular uniseriate trichome with pitted wall.

Micromorphology (Fig. 483)

The plant showed presence of multicellular, uniseriate, unbranched, non-glandular trichome with thick warty walls.

Stomata were of anomocytic, anisocytic, and paracytic type.

D/337.

11. *Jatropha curcas* Linn., *Sp. Pl.* 1006. 1753.

A shrub of 4 m high with broadly ovate leaves, cordiform upto 15 cm long, shallowly 5-lobed; stipules caduceous. Flowers unisexual, in terminal, cymose panicles; central flowers usually female. Male flowers small, yellowish. Perianth bi-seriate; outer tepal sepaloid, ovate-obovate, sericeous at base inside; inner petaloid. Stamens 10, 2-seriate; inner 5 stamens are connate into a central column. Female flowers: perianth single whorled, sepaline. Ovary 3-celled; styles long, 3. Capsules globose, rugose when dry. (Fig. 484)

Vernacular name: Vilayti arandi.

Flowers: Throughout the year.

Micromorphology (Fig. 484)

Two types of non-glandular trichomes were present; 1) unicellular hair with thick wall and broad lumen and 2) multicellular uniseriate trichome.

Stomata were anisocytic, paracytic, and anomocytic.

D/498.

12. *Jatropha gossypifolia* Linn. *Sp. Pl.* (1753) 1006.

A glandular hairy shrub reaching a height of 2 m. Leaves palmately lobed, upto 15 cm long, subcordate; lobes obovate, acute, glandular hairy on margin; stipules ciliate, glandular. Flowers in glandular, corymbose cymes, small, red. Outer tepals glandular, hairy, acuminate; inner tepals ovate, ciliate. Stamens 8, 5+3; filaments basally connate; inner 3 longer; anther cells parallel, contiguous. Ovary 3-celled; with single ovule in each locule. Capsules broadly oblong, 3-lobed. Seeds oblong, 3-angled, grayish brown. (Fig. 485)

Flowers: Throughout the year.

Micromorphology (Fig. 486)

Two types of trichomes were present; 1) non-glandular multicellular uniseriate trichome with two basal small cell, and 2) glandular with multicellular head and multicellular, multiseriate stalk.

Stomata were tetracytic and paracytic.

D/673.

13. *Phyllanthus maderaspatensis* Linn. *Sp. Pl.* (1753) p. 982.

A woody annual with stems reaching a height of 1m. Leaves obovate-cuneate, upto 2cm long, mucronate; stipules peltate, lanceolate, very acute. Flowers axillary, the male flowers minute in small clusters, the female larger, solitary, shortly pedicellate. Sepals 6, obovate, obtuse, green with white margins. Stamens 3; filaments connate. Styles 3,

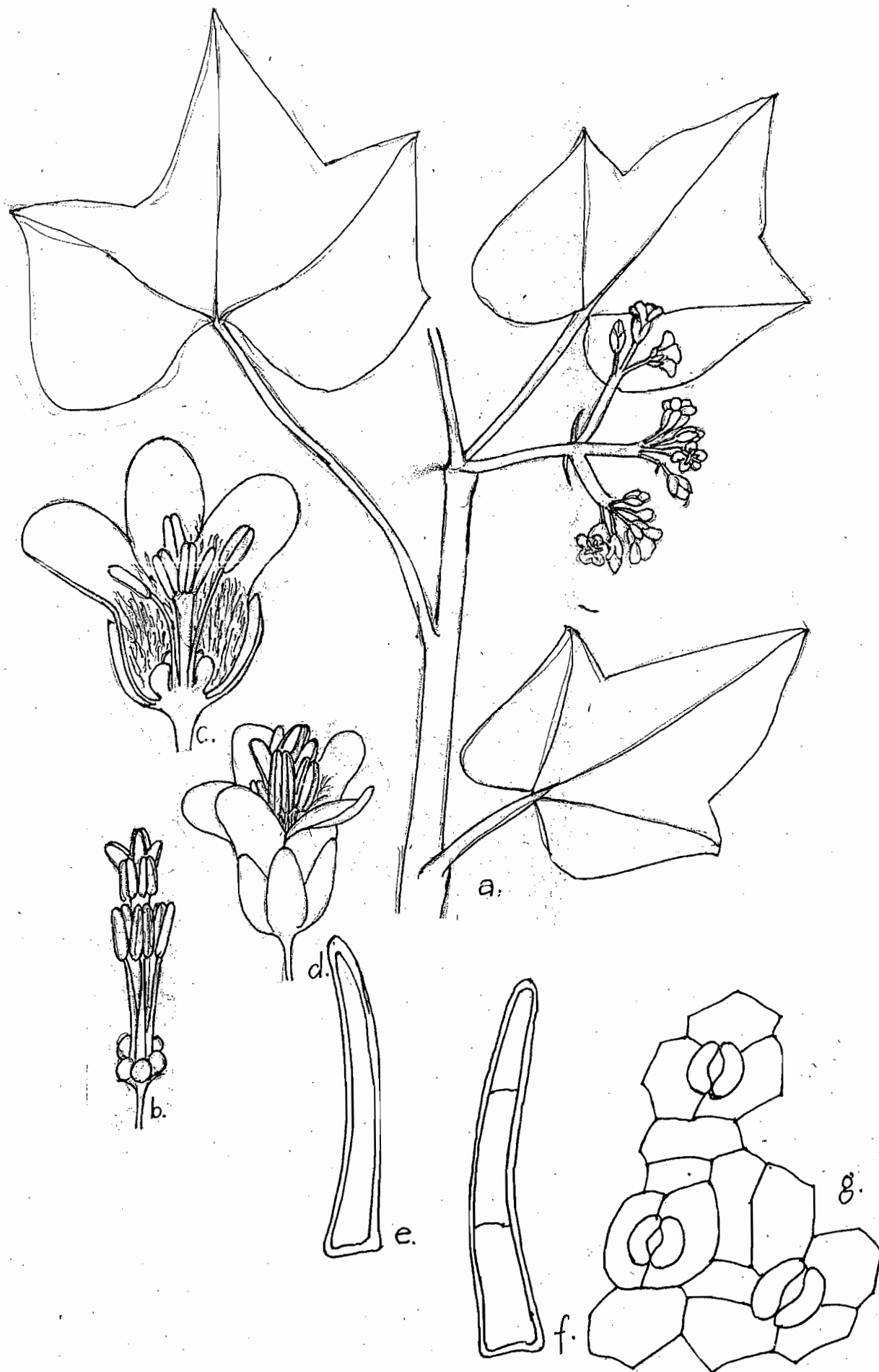


Fig. 484. *Jatropha curcas* L., a. habit, b. stamen, c. L.S. of Male flower, d. male flower, e. unicellular hair, f. multicellular uniseriate trichome, g. anisocytic, paracytic and anomocytic stomata.

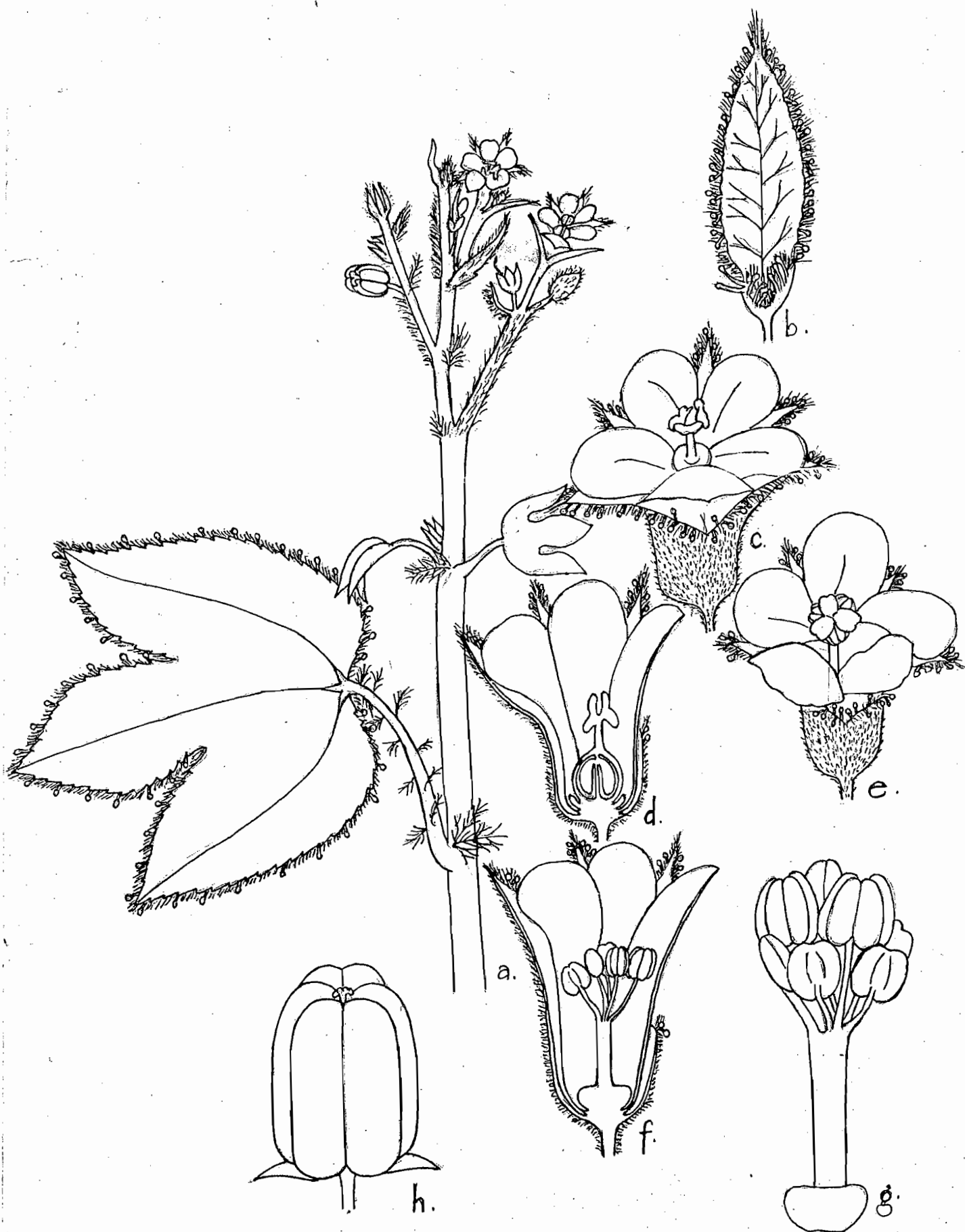


Fig. 485. *Jatropha gossypifolia* L., a. habit, b. bract, c. female flower, d. L.S. of female flower, e. male flower, f. L.S. of male flower, g. stamen, h. fruit.

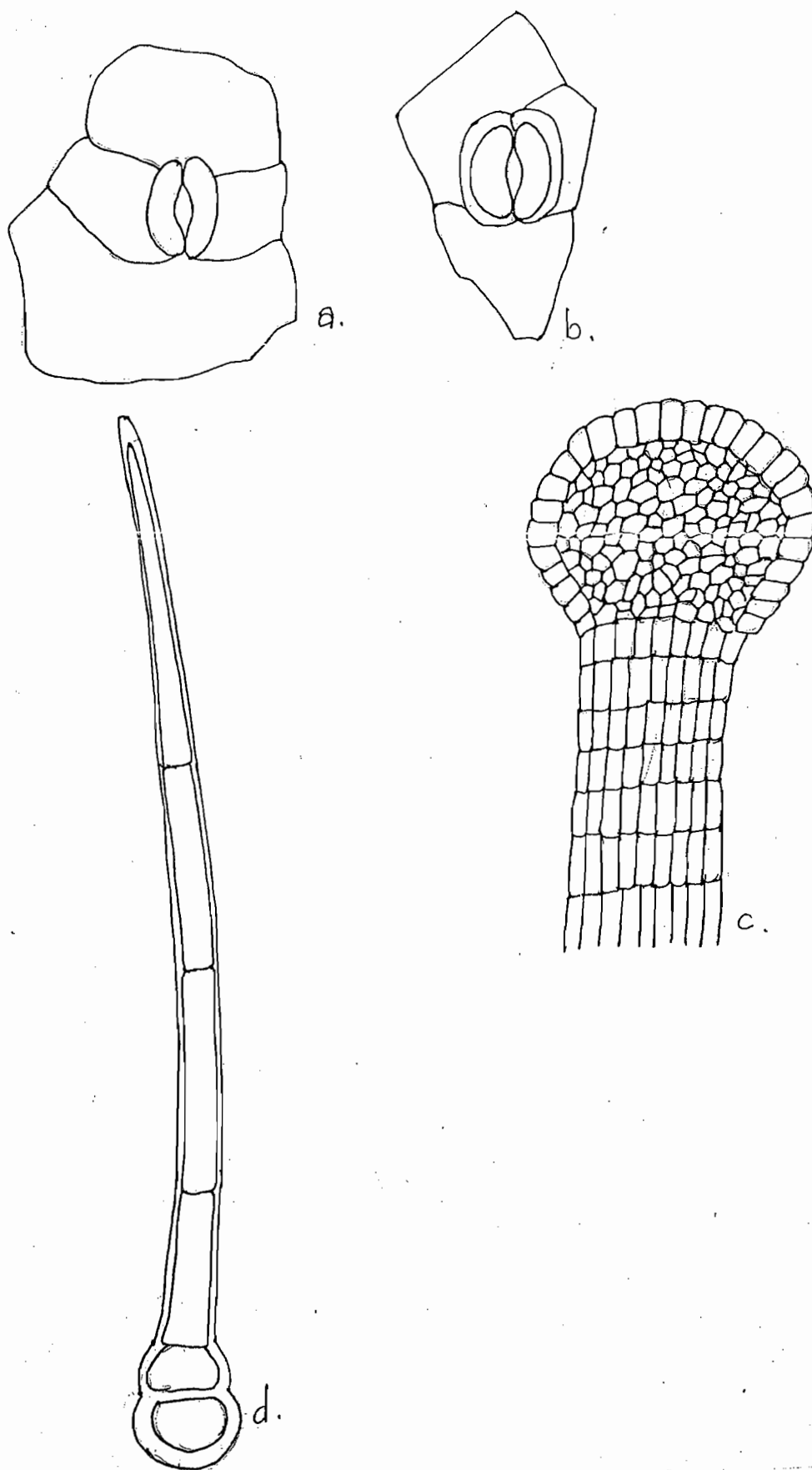


Fig. 486. *Jatropha gossypifolia* L., a. tetracytic stomata; b. paracytic stomata, d. multicellular uniseriate trichome with two basal small cell, c. gland with multicellular head and multicellular, multiserial stalk.

distinct, very small, 2-lobed. Capsules depressed-globose, 3-lobed. Capsules 3-gonous, muriculate in fine lines, brown. (Fig. 487)

Vernacular name: Kanochha.

Flowers: July-August.

Micromorphology (Fig. 487)

Whole plant was glabrous.

Stomata were of anisocytic, and paracytic type.

D/175.

14. *Phyllanthus reticulatus* Poir. *Encyc. Method.* V. 5 (1804) p. 298.

A large pubescent straggling shrub with oblong or elliptic leaves upto 3 cm lon. Flowers axillary, the males in fascicles of 2-6, the females solitary. Calyx segments oblong, alternating with the glands of the disk. Male flowers: stamens 5, the 3 inner connate into a column, the 2 outer free, shorter. Female flowers: ovary 5-10 celled; ovules 2 in each cell, superposed; styles 3, minute, 2-lobed. Fruit a purple fleshy globose berry. Seeds 8-16, irregularly 3-gonous, finely granulate. (Fig. 488)

Vernacular name: Datwan.

Flowers: throughout the year.

Micromorphology (Fig. 488)

The plant showed presence of multicellular, uniseriate, unbranched, non-glandular trichome.

Stomata were of tetracytic type.

D/102.

**15. *Phyllanthus virgatus* G.Forst. *Fl. Ins. Austr.* 65. 1786.
(*Phyllanthus simplex* Retz.)**

A perennial glabrous undershrub with a long tap root and compressed branches. Leaves distichous, numerous, oblong, upto 2 cm long; stipules peltate. Flowers solitary. Male flowers. Perianth sepaline. Stamens 3 distinct. Female flowers. Perianth similar to male flowers. Ovary triangular, trigonous. Capsule globose, rough with minute prominences. Seeds trigonous, covered with minute tubercles. (Fig. 489)

Vernacular name: Moti bhoiamli.

Flowers: August-April.

Micromorphology (Fig. 489)

Leaves were glabrous.

Stomata were paracytic, anomocytic, and anisocytic.

D/486.

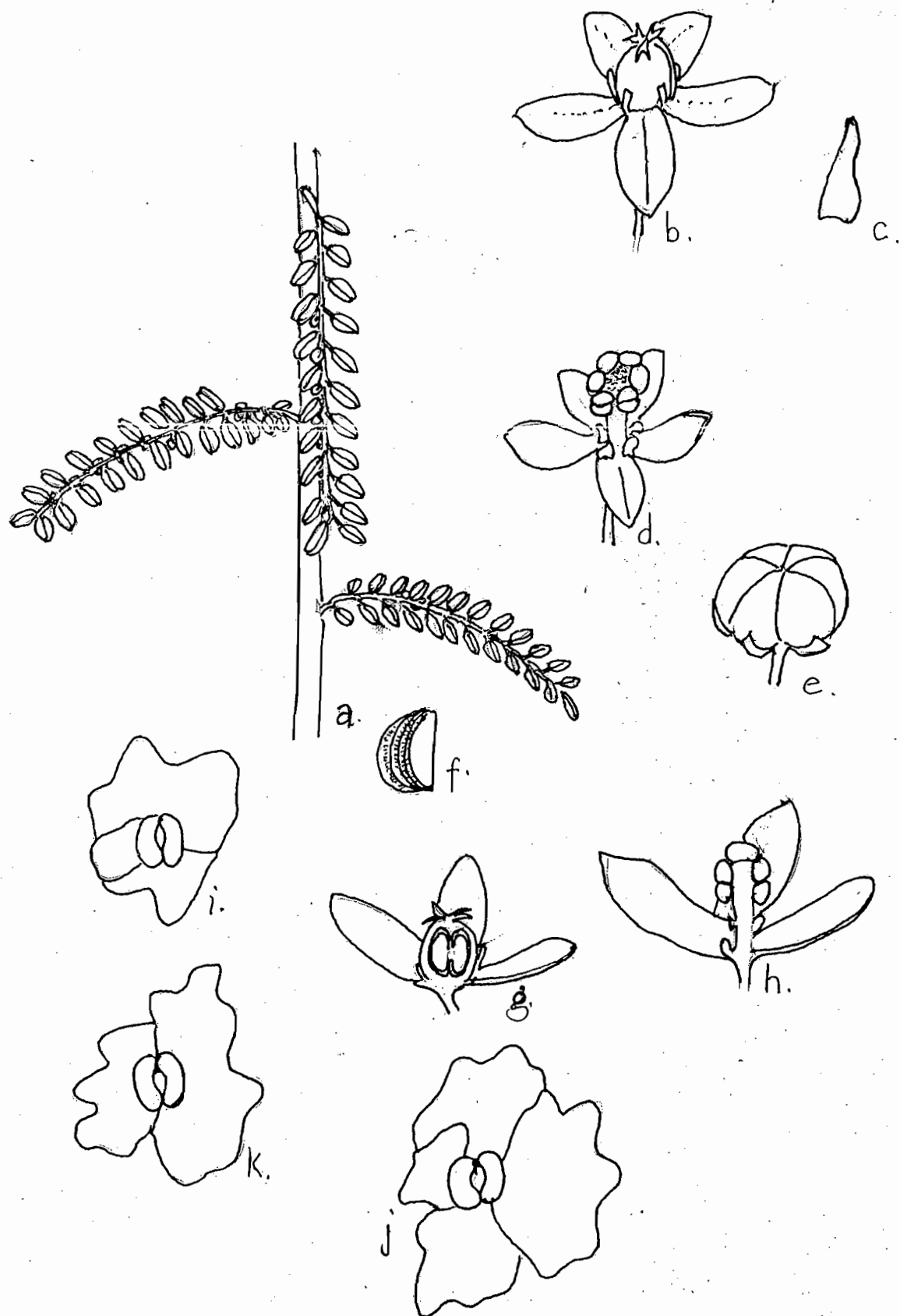


Fig. 487. *Phyllanthus maderaspatensis* L., a. habit, b. female flower, c. bract, d. male flower, e. fruit, f. seed, g. L.S. of female flower, h. L.S. of male flower, i-j. anisocytic stomata, k. paracytic stomata.

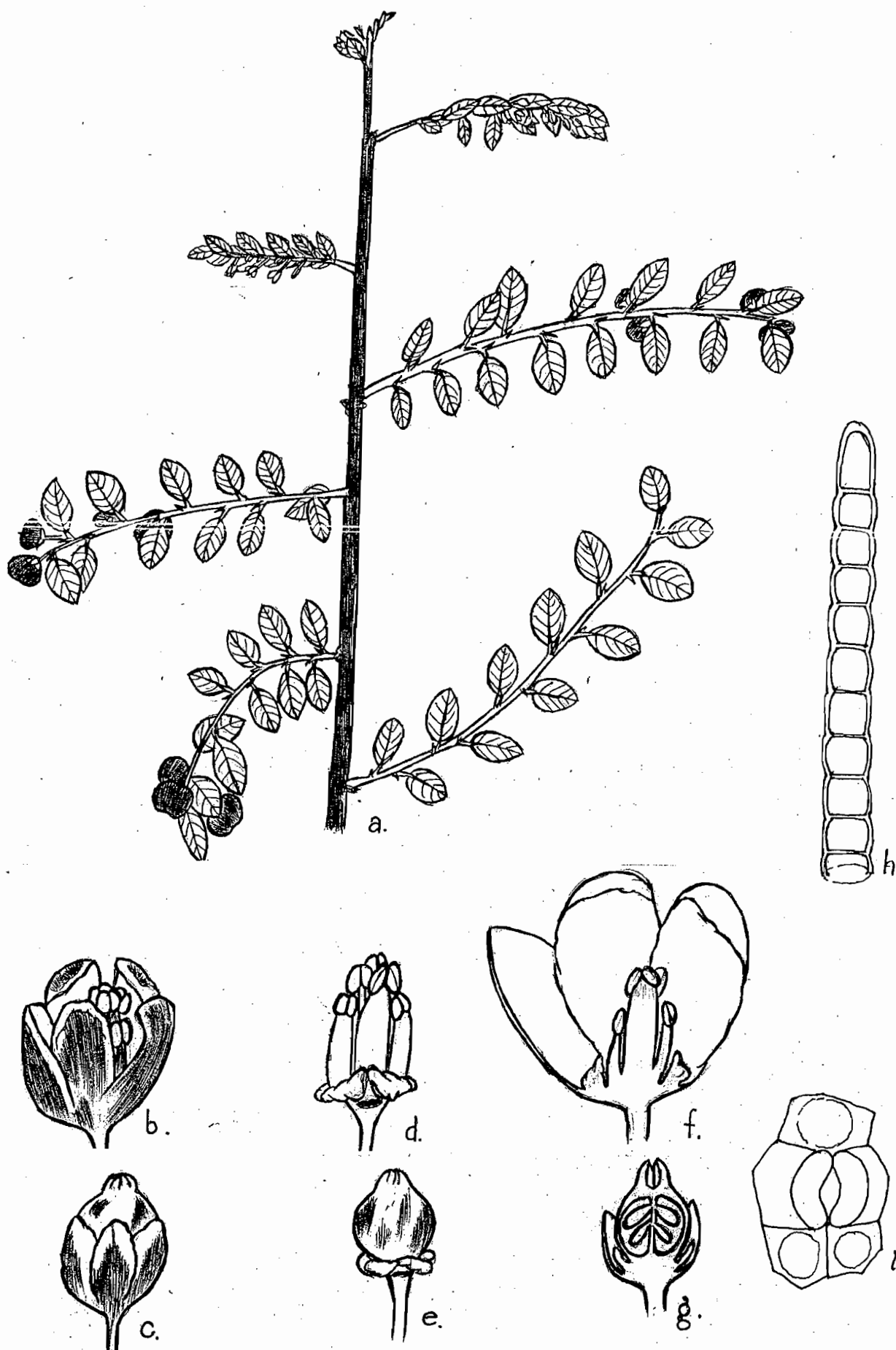


Fig. 488. *Phyllanthus reticulatus* Poir., a. habit, b. male flower, c. female flower, d. stamens with disc gland, e. gynoecium with disc gland, f. L.S. of male flower, g. L.S. of female flower, h. multicellular uniseriate trichome with small cells, i. tetracytic stomata.

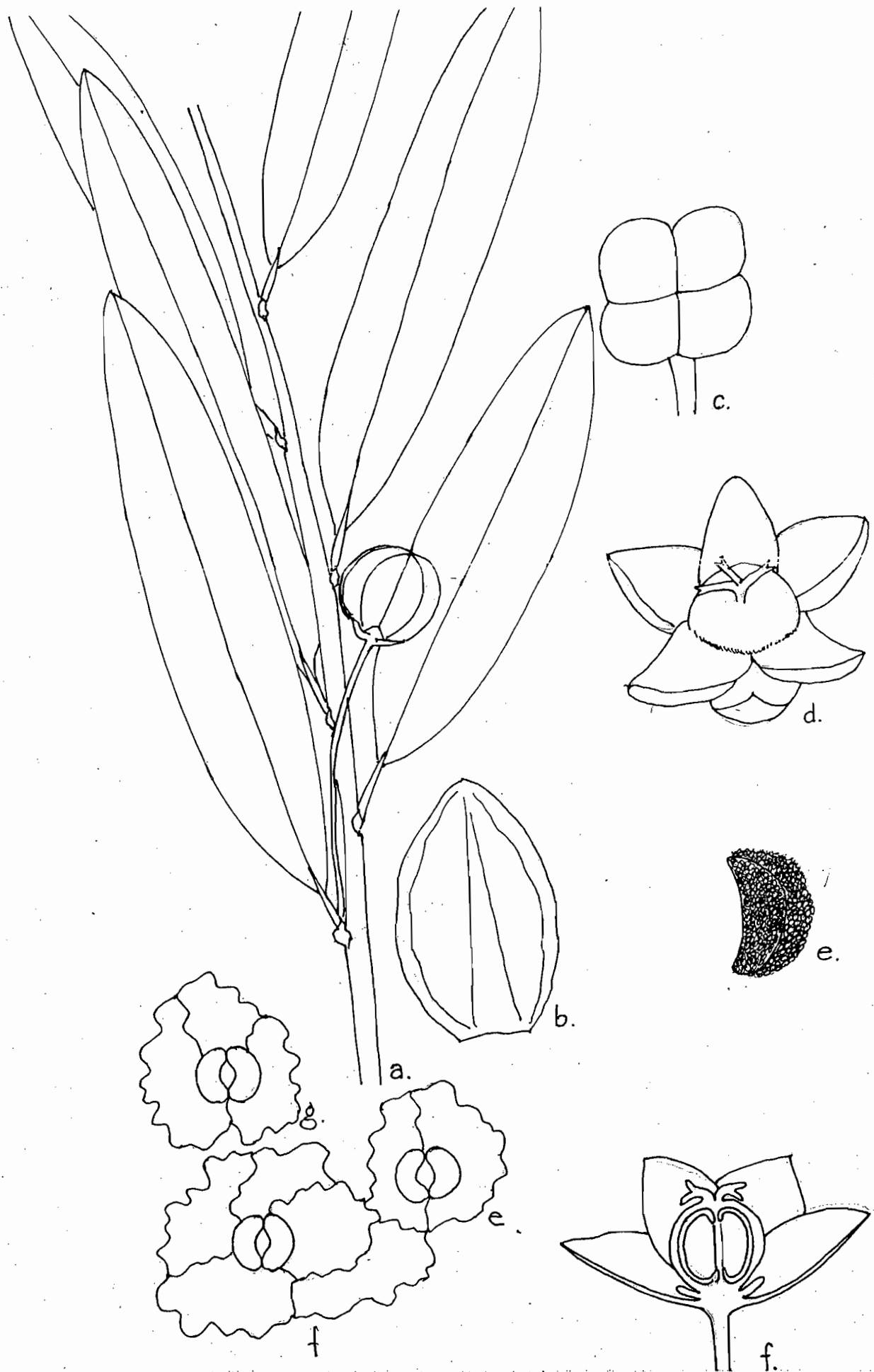


Fig. 489. *Phyllanthus virgatus* G. Forst., a. habit b. bract c. stamen d. female flower, e. seed, f. L.S. of female flower, e. paracytic stomata, f. tetracytic stomata, g. anisocytic stomata.

**16. *Ricinocarpus ciliatus* (Forssk.) Kuntze, *Revis. Gen. Pl.* 2: 617. 1891.
(*Acalypha ciliata* Forsk.)**

A stout herb upto 1 m high. Leaves ovate, often acuminate, upto 8 cm long, thin, finely serrate, 5-nerved; petioles longer than blade. Flowers in axillary androgynous spikes, males few, at the top of the spike, the females several, crowded at its base; bracts of female flowers large, 1-2 flowered, pale green, exceeding the capsules, with many nerves ending in long subulate hispid teeth. Male flowers: tepals 4, valvate. Stamens usually 8; filaments short, free; anther cells divaricate, often at length twisted or flexuous. Pistillode 0. Female flowers: tepals 3-4, minute imbricate. Ovary 3-celled; ovules solitary in each cell; styles filiform, and fimbriate. Capsules concealed by the bracts, white. Seeds globose ovoid. (Fig. 490)

Vernacular name: Dadari.

Flowers: July-December.

Micromorphology (Fig. 490)

Whole plant was glabrous.

Stomata were of anisocytic and paracytic type.

D/366, 752- 754.

Ulmaceae

1. *Trema orientalis* Blume. *Mus. Bot.* V. 2 (1856) p. 62.

A fast-growing short-lived tree about 10 m in height. Leaves obliquely ovate, upto 13 cm, acuminate, crenate-serrulate, chartaceous, clothed beneath with soft often white pubescent. Flowers dioecious, in axillary pubescent cymes, the male cymes compact than the female. Male flowers with 4-5 slightly incurved, induplicate-valvate sepals. Pistillode small or 0. Female flowers with sepals as in the male. Petals 0. Ovary sessile; ovules pendulous; style central with 2 linear arms, style-arms slightly incurved. Drupe black when ripe. (Fig. 491)

Vernacular name: Kargol.

Flowers: more or less throughout the year.

Micromorphology (Fig. 491)

The plant showed presence of three types of trichomes: 1) multicellular, glandular trichome differentiated into a single celled head and a multiseriate stalk. 2) multicellular, glandular trichome differentiated into a multicellular 3-4 celled head and a multiseriate stalk. 3) two celled trichome differentiated into a single celled head and a single cell stalk.

Stomata were of anomocytic type.

D/1084-1086.

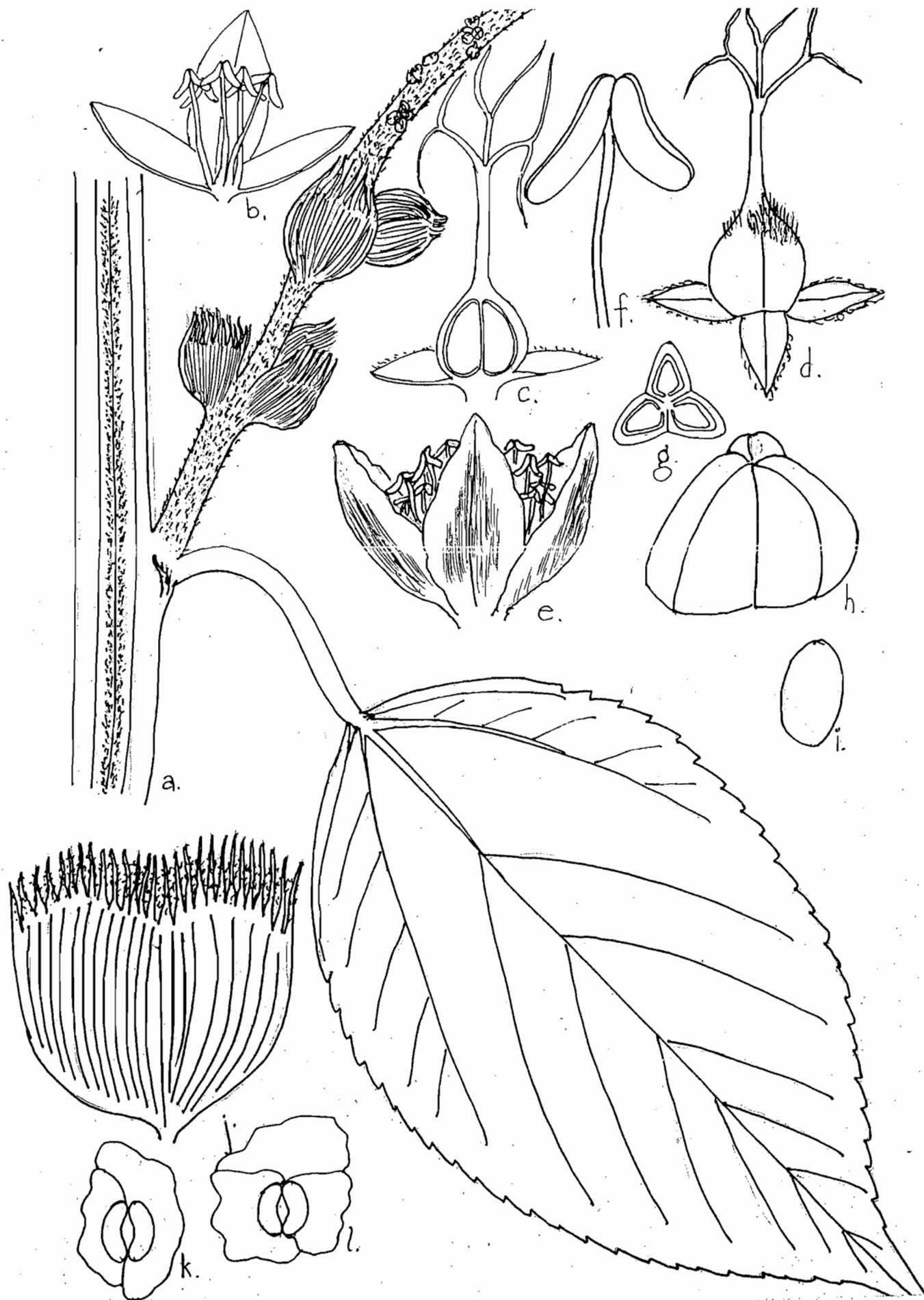


Fig. 490. *Ricinocarpus ciliatus* (Forssk.) Kuntze, a. habit, b. L. S. of Male flower, c. L.S. of female flower, d. female flower, e. male flower, f. stamen, g. T.S. of ovary, h. capsule, i. seed, j. calyx, k. paracytic stomata, l. anisocytic stomata.

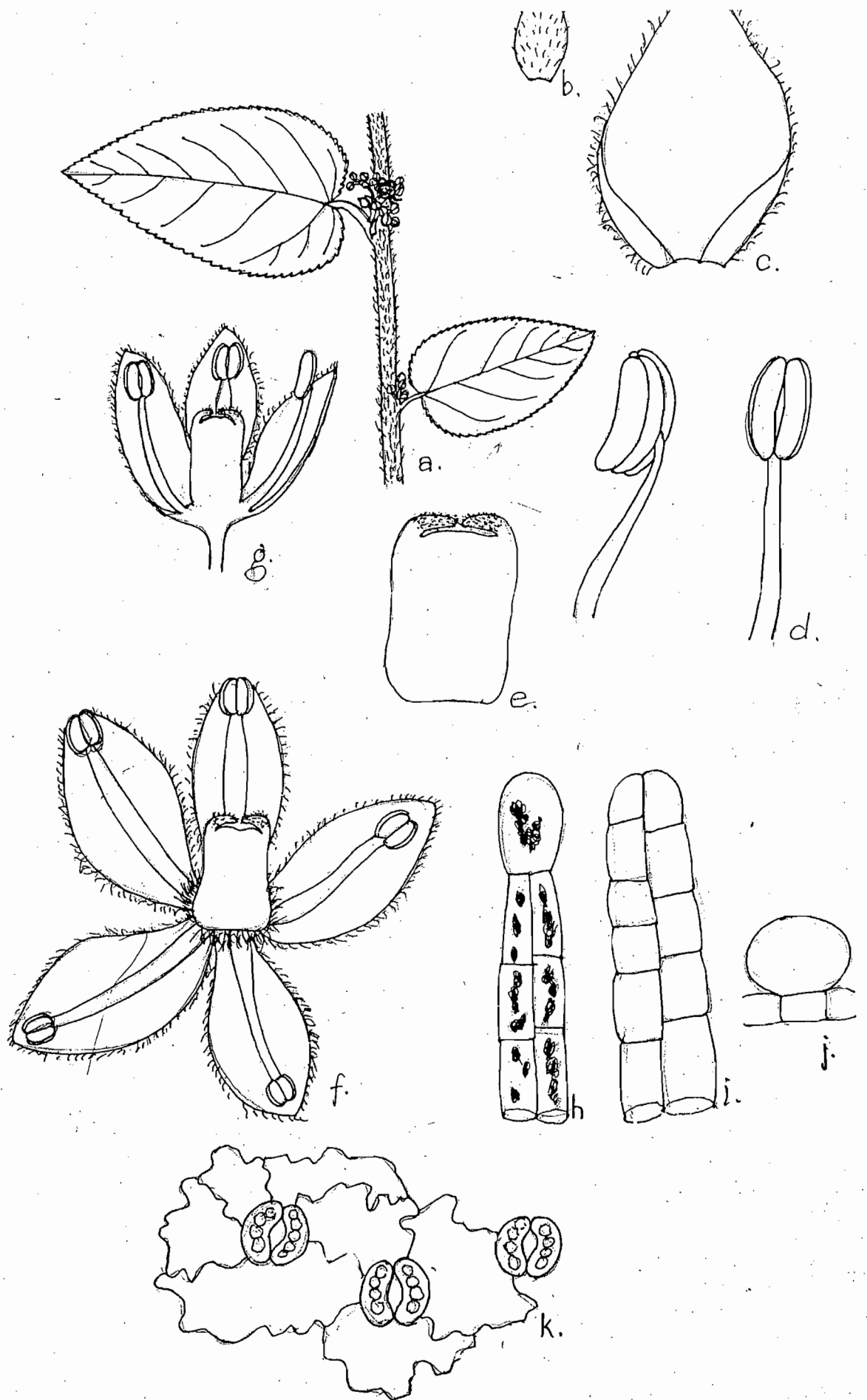


Fig. 491. *Trema orientalis* Blume., a. habit, b. bract, c. tepal, d. stamen, e. pistillode, f. flower, g. L.S. of male flower, h. gland with single celled head and biseriate stalk, i. gland with two celled head and biseriate stalk, j. unicellular sessile gland, k. anomocytic stomata.

Urticaceae

1. *Ficus hispida* Linn. f. *Suppl.* (1781) p. 442.

A small hispidly-pubescent tree,. Leaves ovate-oblong, upto 30 cm long, abruptly acuminate, toothed, the lower surface hispid-pubescent; stipules 2 to each leaf, ovate-lanceolate. Hypanthodia obovoid, upto 3 cm across, yellowish when ripe, slightly umbonate, hispid and sometimes with bracts scattered along the sides, borne on leafless hanging twigs; basal bracts 3. Male flowers numerous with two bracts, near the apex of the hypanthodium containing the galls, sepals 3, stamen one. Gall flowers pedicellate, perianth present. Perianth scaly, five lobed and gamophyllous. Female flowers with perianth 0. Ovary globose, one celled, ovule pendulous. Achenes ovoid. (Fig. 492; Fig. 493))

Variations observed: In standard descriptions, perianth in gall and female flowers were reported to be absent and the male flowers without bracts, but in our specimens, both gall and female flowers were with scaly, five lobed and gamophyllous perianth and male flowers possessed two bracts.

Vernacular name: Dhedh umaro.

Flowers: April-July.

Micromorphology (Fig. 494)

The plant showed presence on unicellular, non-glandular trichome with thick wall and a very broad lumen. The wall was warty. It also showed presence of multicellular, glandular trichome differentiated into a 1-2 celled head and a single celled stalk.

Stomata were anomocytic.

D/154.

2. *Ficus racemosa* L. *Sp. Pl.* 1060 1753. (*Ficus glomerata* Roxb.)

An evergreen tree reaching to a height of 20 m. Leaves ovate-oblong, upto 15 cm; stipules ovate-lanceolate, scarious. Hypanthodium on short leafless warted branches often only a few inches long, from the stem and larger branches, sub-globose, 3 cm across, red when ripe, with depressed umbilicus; basal bracts 3, ovate-triangular; male flowers near the mouth are sessile; perianth 3-4, membranous, inflated, enveloping the 2 elongate ovate anthers; filaments connate. The female flowers forming a zone near the walls of the receptacle has a gamophyllous, irregularly toothed perianth covering only the base of the rough ovoid ovary, stigma minute, entire and indistinct. Achene small, minutely tuberculate. (Fig. 495; Fig. 496)

Variation observed: this plant is said to have a clavate stigma in female flowers, but in my plants, the stigmas of female flowers, were minute entire and indistinct.

Vernacular name: Umaro.

Flowers: Throughout the year.

Micromorphology (Fig. 497)

Leaf showed presence of three types of trichomes one was unicellular, non-glandular, elongated, curved trichome with thick wall and a round bottom. The second type of trichome was multicellular, glandular differentiated into a head and a stalk. The head was

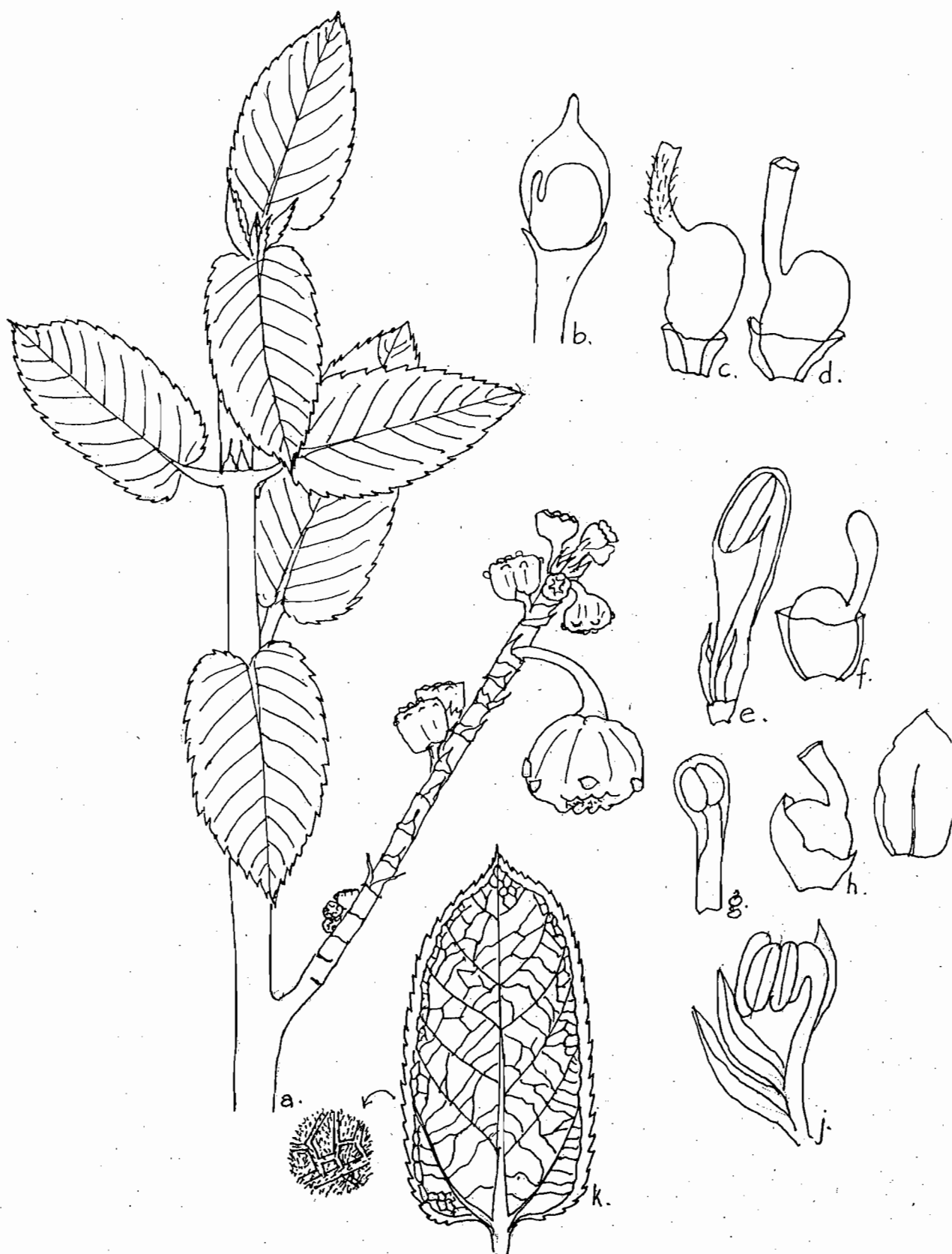


Fig. 492. *Ficus hispida* L., a. habit, b. sterile flower, c-d, f & h. female flower, e, g & j. male flower, i. bract.

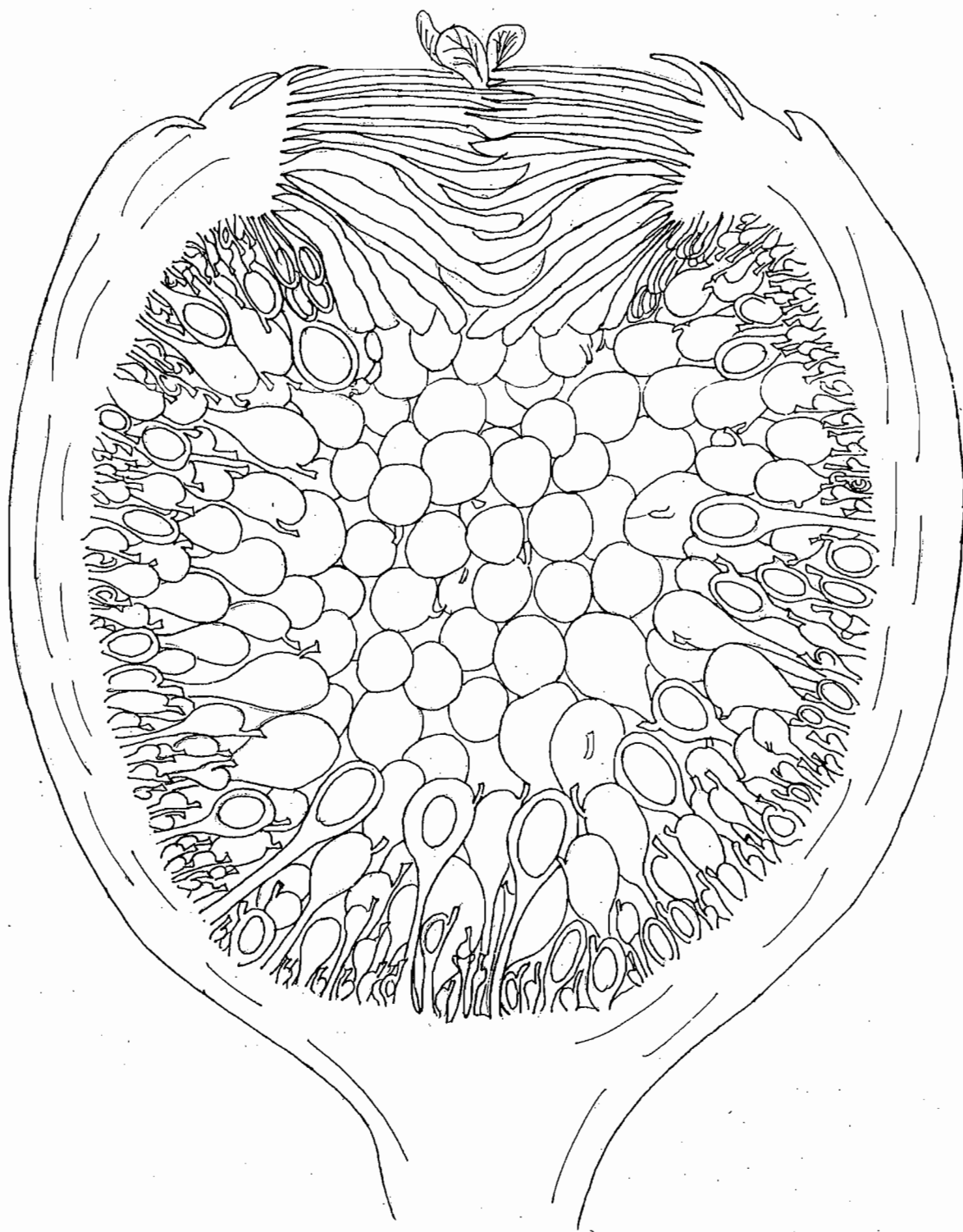


Fig. 493. *Ficus hispida* L., L.S. of inflorescence.

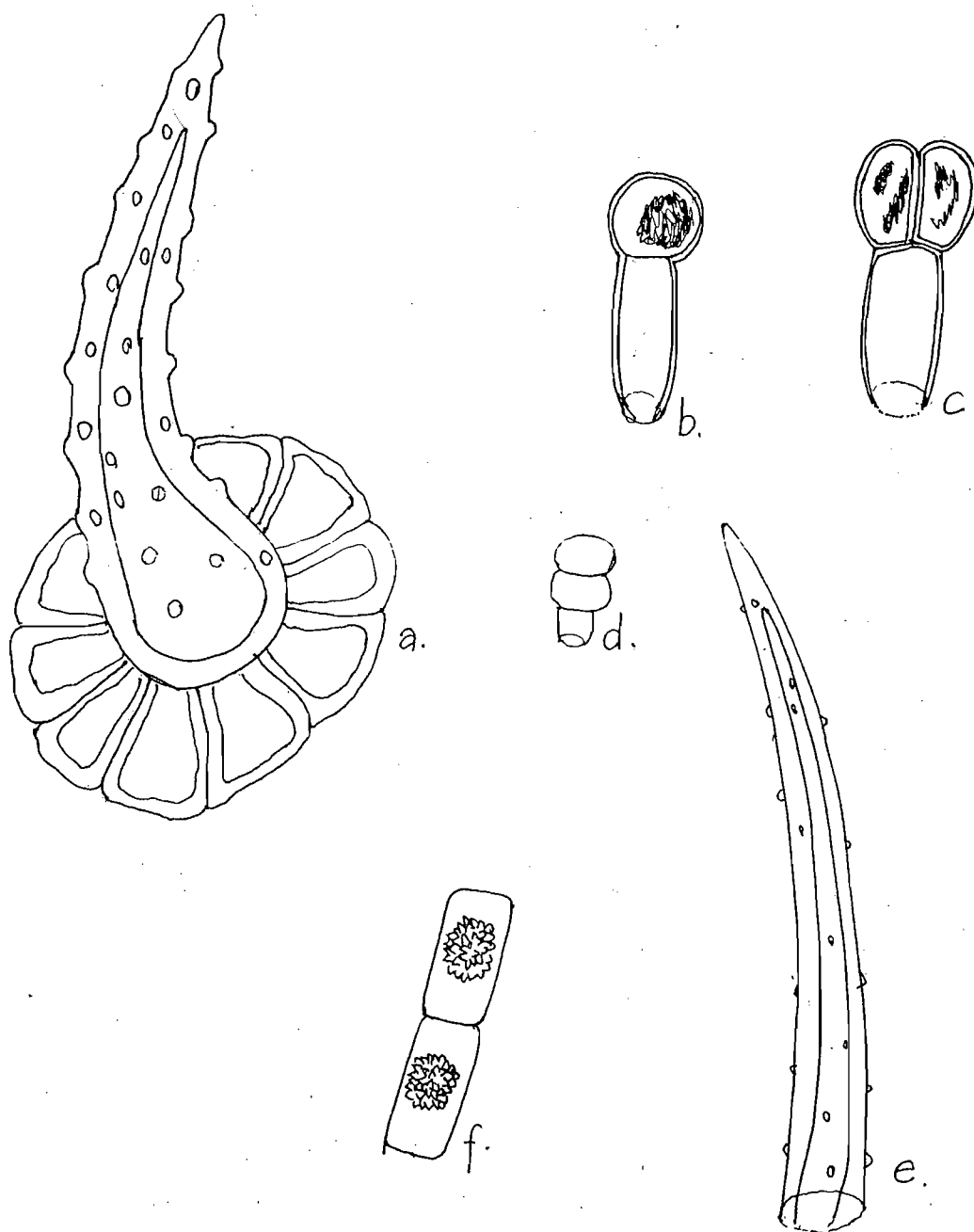


Fig. 494. *Ficus hispida* L., a. unicellular thick walled papillate trichome with broad lumen, b-c. gland with single to two celled head and unicelled stalk, d. gland with head having two cells in two tiers and unicelled stalk, e. unicellular trichome with thick warty wall and broad lumen, f. crystals.



Fig. 495. *Ficus racemosa* L., a. habit, b-c. female flower, d. scale, e-f. male flower with perianth, g-h. sterile flower, j. bract, k. bracteole, l. perianth.

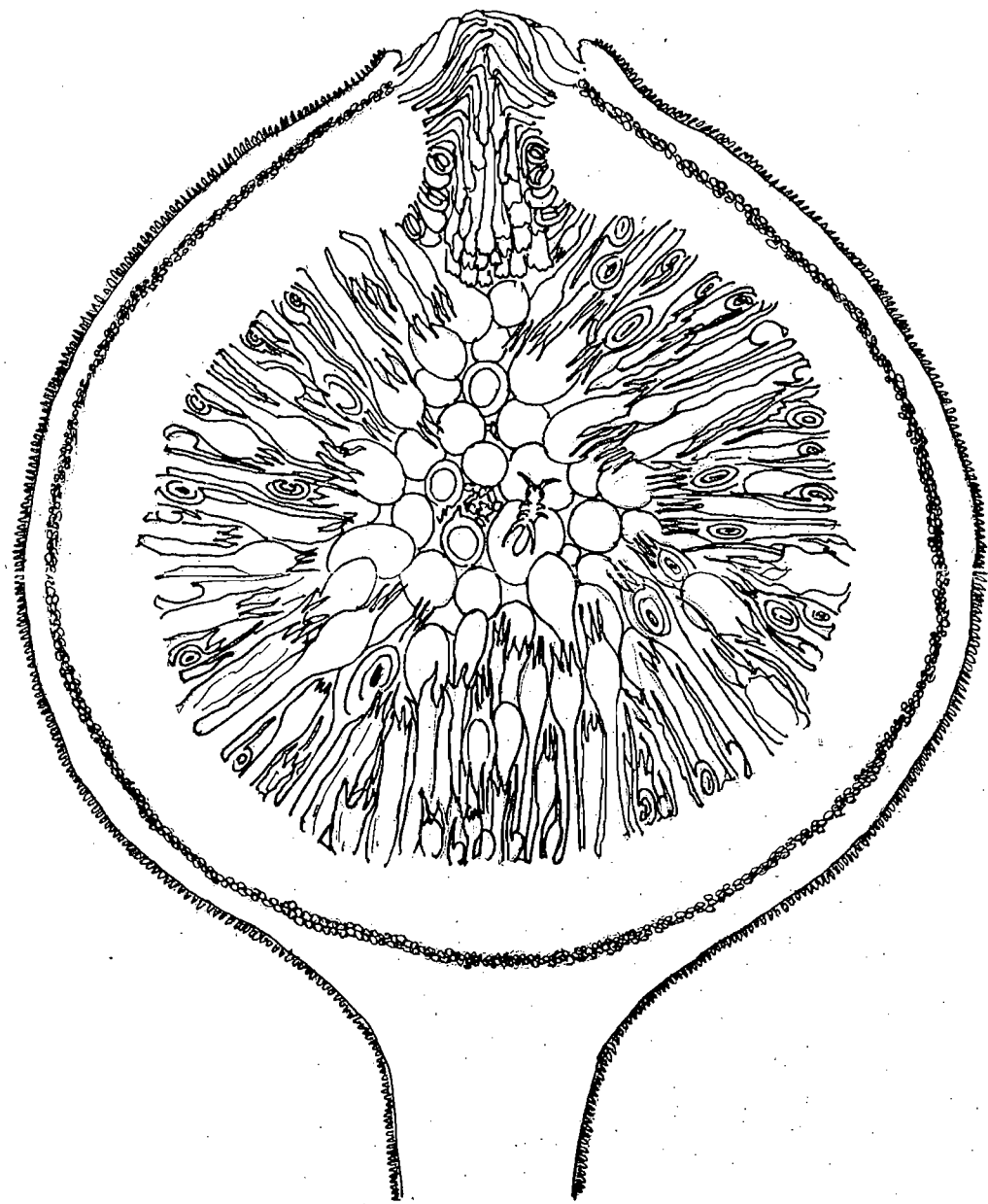


Fig. 496. *Ficus racemosa* L., L.S. of inflorescence.

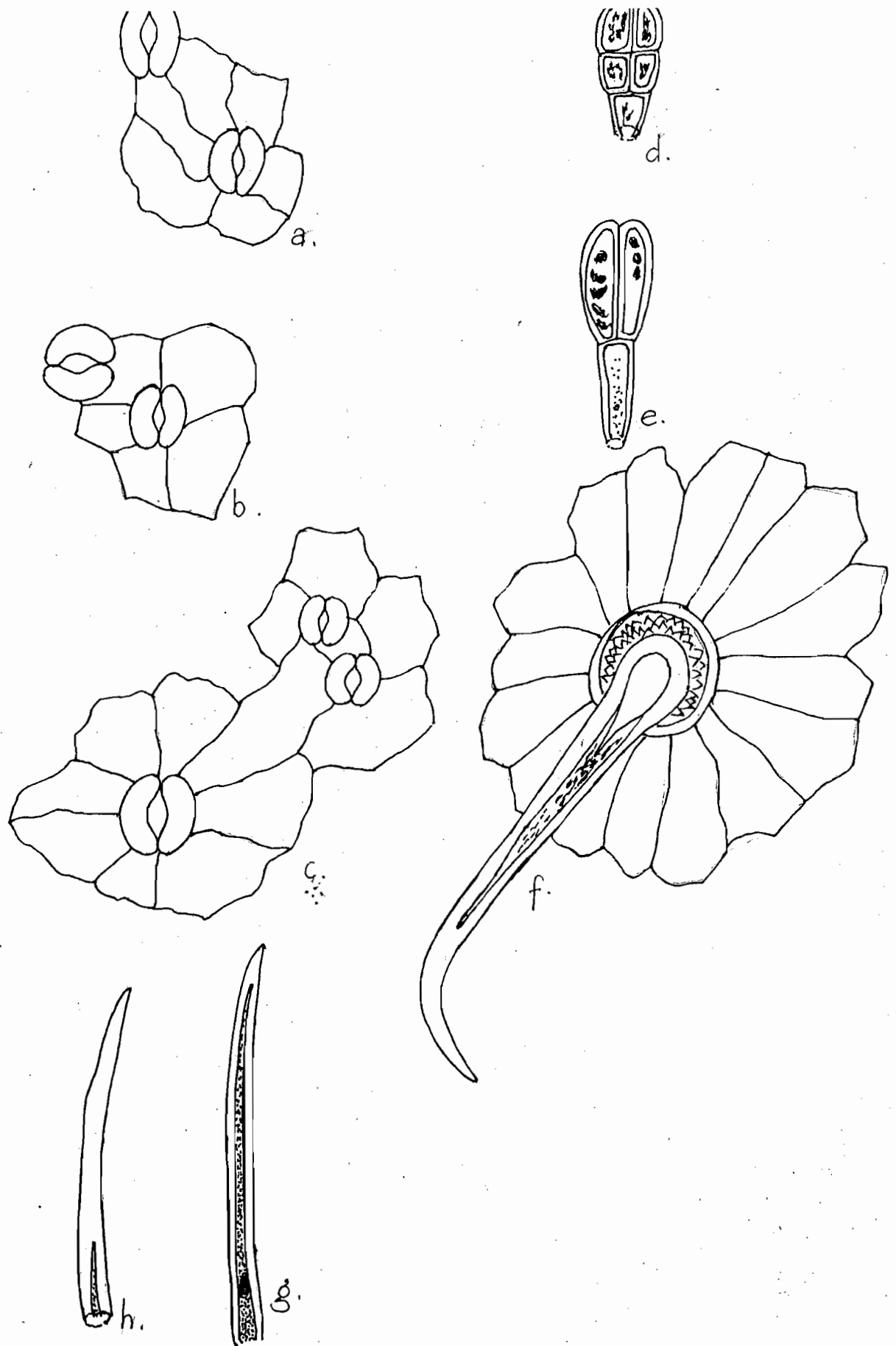


Fig. 497. *Ficus racemosa* L., a-c. anomocytic stomata, d. gland with four celled head and single celled stalk, e. gland with two celled head and a single celled stalk, f. unicellular trichome with thick wall and a crystal at the base of the trichome, g. unicellular trichome with thick wall and narrow lumen filled with ergastic substances, h. unicellular trichome with small lumen.

two celled and stalk was unicellular; the third trichome was similar to the second one except the four celled head in which cells was arranged in two tiers. Stipule showed presence of unicellular, non-glandular, elongated trichome with thick wall. Stomata were of anomocytic and cyclocytic type; anomocytic type was present in majority.
D/1219-1220.

Hydrocharitaceae

1. *Hydrilla verticillata* Presl, *Bot. Bemerk.* P. 112. 1844.

An aquatic fresh water plant, occurring as large masses in water with slender much branched stems reaching 30 cm or long and often rooting at nodes. Leaves linear, upto 1 cm long, sessile. Flowers minute dioecious, solitary in a subglobose, muricate spathe. Sepals and petals 3 each. Stamens 3 with reniform anthers. Female flowers sessile, in a tubular 2-toothed spathe. Sepals and petals as in male flowers. Ovary one-celled; ovules numerous. Fruit subulate, smooth or muricate. Seeds 2-3, oblong. (Fig. 498)
Vernacular name: Kureli.
D/252.

Musaceae

1. *Musa paradisiaca* Linn. *Sp. Pl.* (1753) p. 1043.

A large coarse, often tree like, perennial herb rising from a massive sympodial corm with the sheathing leaf bases closely overlapping and appressed to each other forming a hollow false trunk (pseudostem). Lamina oblong, with pinnate parallel venation and reaches a length of 3 m. Axis of the inflorescence arising from the corm growing up through the tube formed by the leaf sheaths, commonly turned towards one side or drooping. At the end of axis is a large cone shaped structure bearing a close succession of large leathery-firm form boat shaped spirally arranged branches each of which subtends a compact few flowered bractless monochasial cyme. Flowers epigynous, irregular, and strongly nectariferous, tepals 6. the 3 outer tepals and 2 inner tepals join together into a usually 5 toothed or 5 lobed initially tubular structure that soon splits on one side. The odd tepal or inner tepal free, boat shaped and contains nectar. Stamens mostly 5. gynoecium tricarpellary, syncarpous, trilocular, ovary inferior with many ovules in axile placentation, Fruit cylindric, fleshy, up to 20 cm long, yellowish when ripe, the pulp sweet, edible. (Fig. 499)

Vernacular name: Kela.

Flowers: Throughout the year.

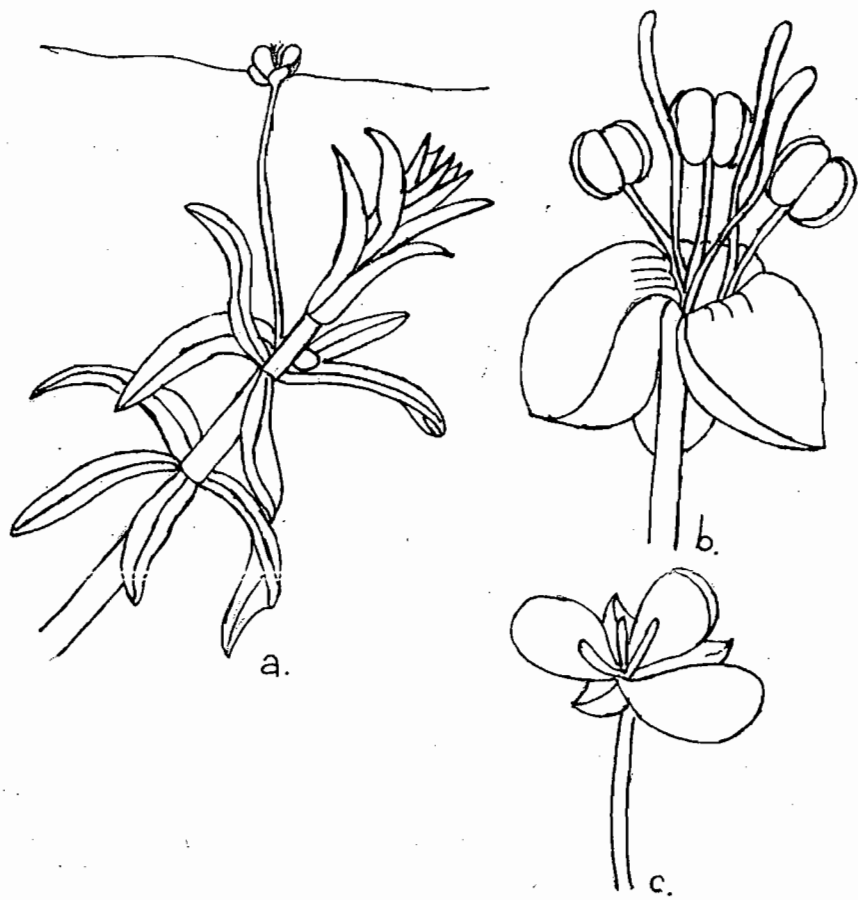


Fig. 498. *Hydrilla verticillata* Presl., a. habit, b. male flower, c. female flower.

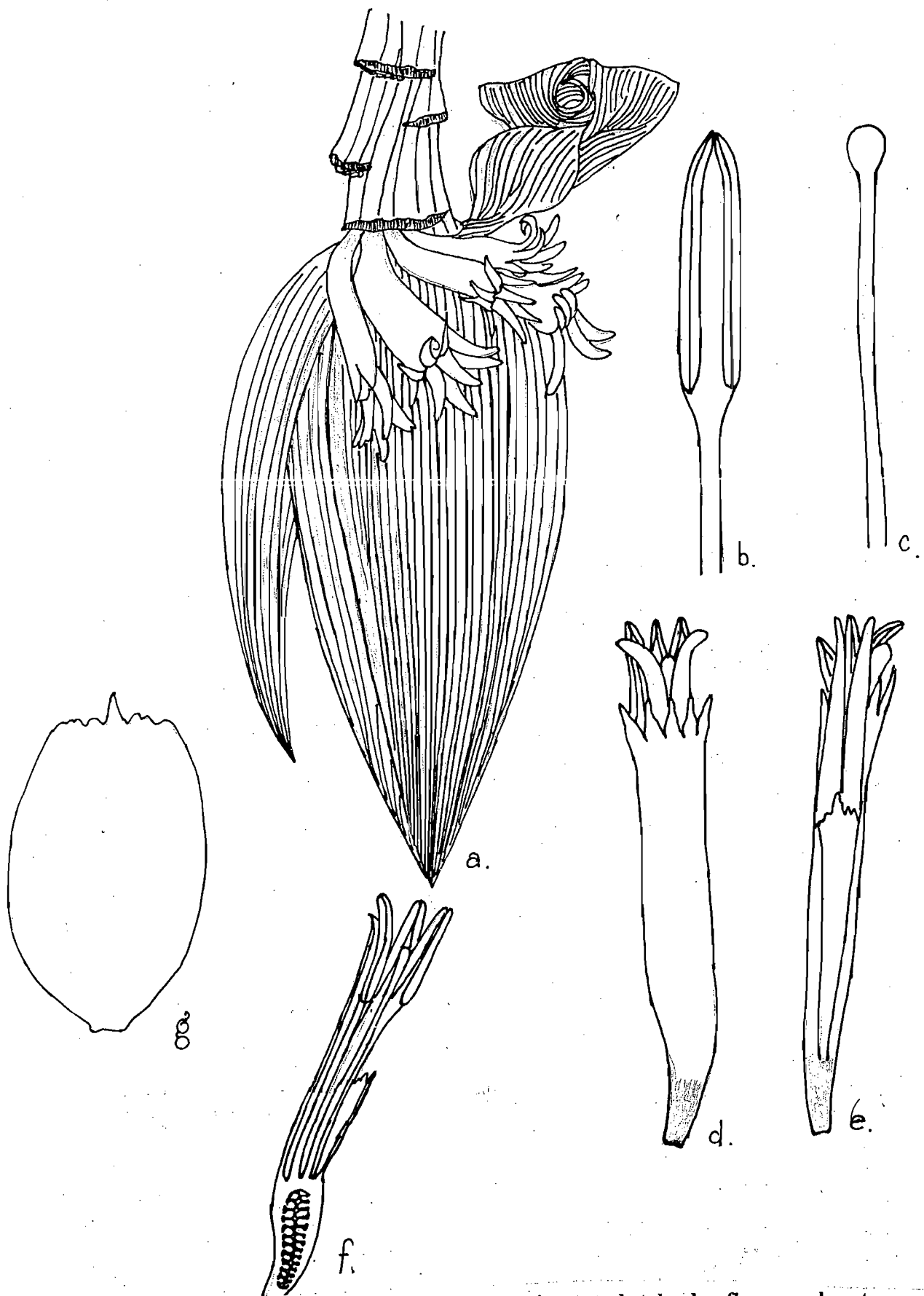


Fig. 499. *Musa paradisiaca* L. a. habit, b. stamen, c. stigma and style, d-e. flower, g. bract.

Zingiberaceae

1. *Alpinia nutans* Roscoe. in Smith, *Exot. Bot.* V. 2 (1805) p. 93.

A handsome ornamental herb with stem reaching upto 3 m in height. Leaves oblong lanceolate having a length upto 60 cm. Flowers white, borne in panicles reaching 30 cm long. Rachis hairy, and bracts large concave, ivory white with pink tips. Corolla with a tinge of pink. The labella variegated with red and yellow. Stamen 1, perfect. Lips spreading, with incurved margins. Ovary 3-celled. Fruit globose, containing many seeds. (Fig. 500)

Vernacular name: Nag-champa

Micromorphology (Fig. 500)

Three types of unicellular trichomes were observed, with different thickness of the walls.

Stomata were tetracytic.

D/105.

2. *Curcuma pseudomontana* Grah. *Cat. Pl. Bomb.* (1839) p. 210.

A stemless herb with small tuberous rootstock, bearing small almond-like or subglobose tubers at the ends of the fibres. Leaves lanceolate-oblong, acuminate, reaching 60 cm or more long. Flowers in dense compound spikes, crowned by a coma of enlarged mauve-purple colored bracts, 2 or 3 flowers in each bract; lower bracts ovate, enclosing bracteolate fugacious flowers. Calyx cylindric, minutely toothed. Corolla-tube funnel shaped; corolla-lobes oblong, the upper longer and somewhat concave. Stamen 1 perfect; anthers cells spurred at the base; staminodes oblong, petaloid, connate with the filament. Ovary 3-celled; ovules numerous on axile placentas. Fruit globose 3-valved capsule. Seeds obovoid; usually arillate. (Fig. 501)

Vernacular name: Halдар ni jat.

Flowers: July-September.

Micromorphology (Fig. 501)

Whole plant was glabrous.

Stomata were of tetracytic type.

D/272.

Amaryllidaceae

1. *Curculigo orchioides* Goerin. *Fruct.* V. 1 (1788) p. 63, t. 13.

A herb with a tuberous stout rootstock and copious fleshy tuberous root. Leaves linear-lanceolate, upto 3 cm long, plicate, base sheathing. Scape short, clavate, flattened; bracts, and ovary hidden among the leaf-sheaths. Flowers bright-yellow, distichous, the lowest in the raceme 2-sexual; the upper male; bracts lanceolate, membranous. Perianth 6-partite, separated from the ovary by a solid stipe bearing the rotate limb, segments elliptic-

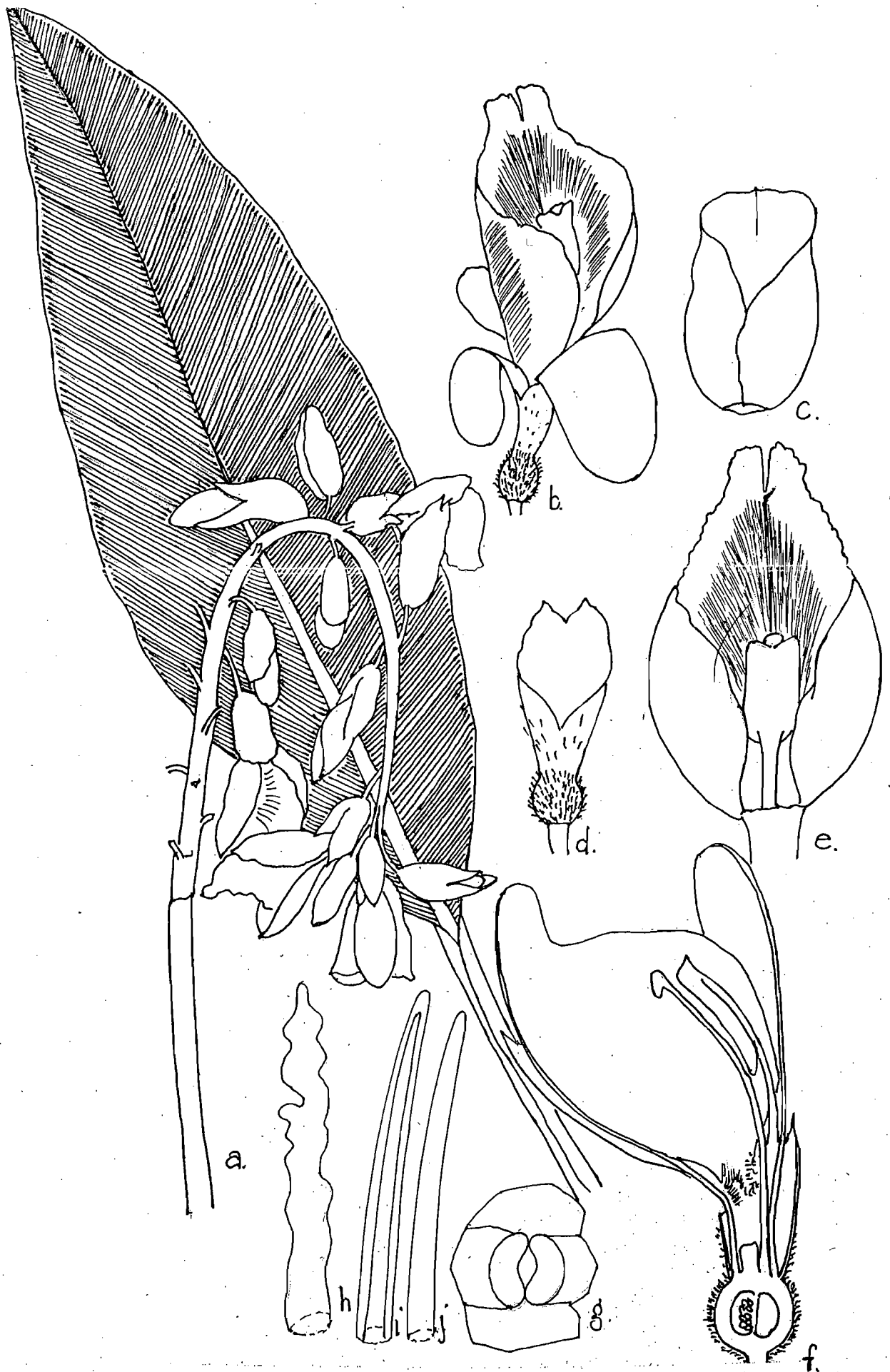


Fig. 500. *Alpinia nutans* Roscoe., a. habit, b. flower, c. bract, d. calyx, e. flower showing stamen, f. L.S. of flower, g. tetracytic stomata, h. gland unicellular trichome, i. unicellular trichome, j. unicellular trichome with thick wall and narrow lumen.

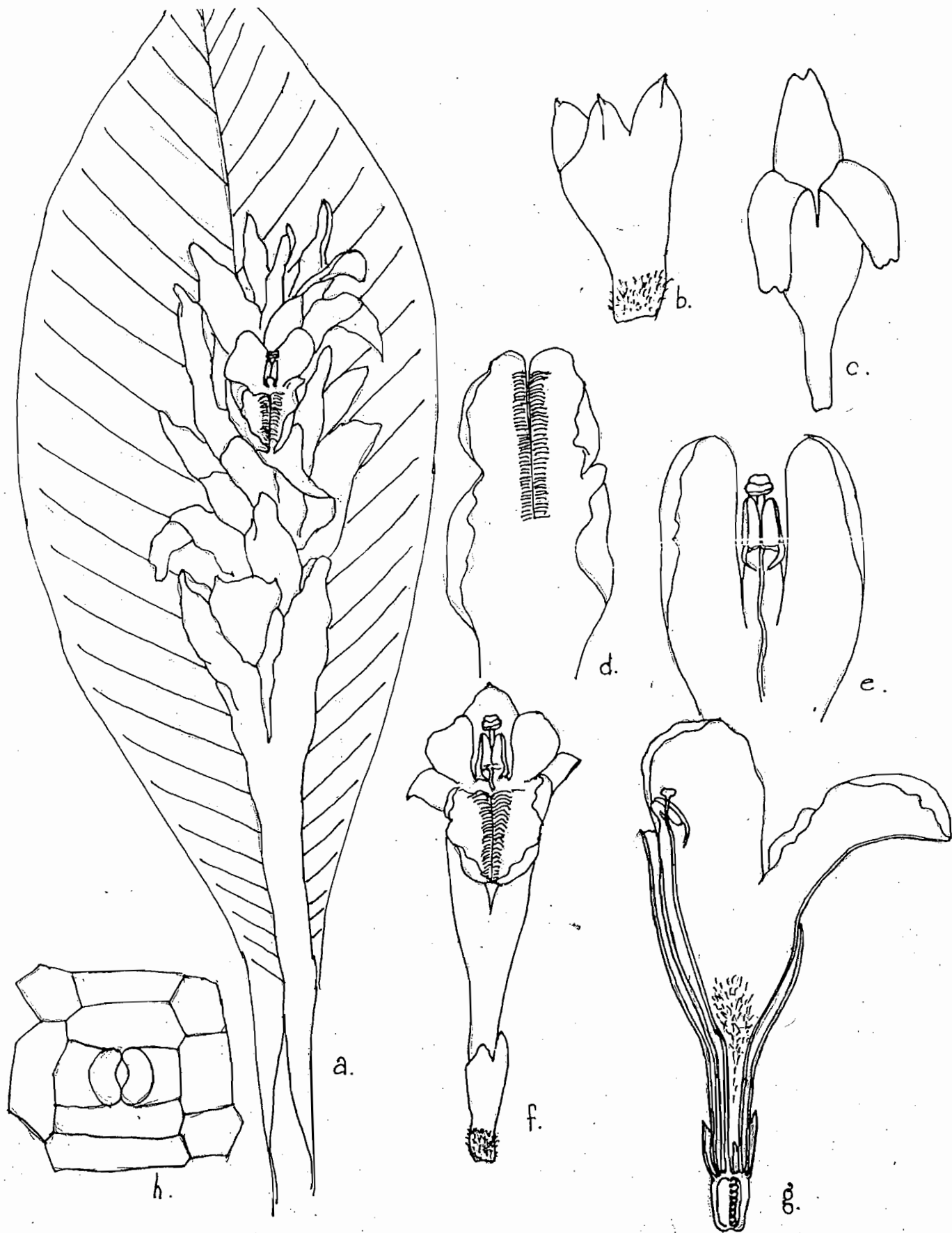


Fig. 50f. *Curcuma pseudomontana* Grah., a. habit, b. calyx, c. corolla, d. upper lip of the corolla, e. lower lip of the corolla showing epipetalous stamen enclosing style and stigma, f. flower, g. L.S. of flower, h. tetracytic stomata.

oblong, the stipes slender. Stamens 6, adnate to the base of the perianth-lobes; anthers linear. Ovary inferior, 3-celled, lanceolate, the cells 6-8-ovulate; stigma 3-cleft. Capsules 1-4 seeded; septa spongy. Seeds oblong, black, shining. (Fig. 502)

Vernacular name: Kali musli.

Flowers: July-September.

Micromorphology (Fig. 502)

Whole plant was glabrous.

Stomata were of tetracytic type

D/296.

Liliaceae

1. *Asparagus racemosus* Willd. *Sp. Pl. V. 2* (1799) p. 152.

An extensive scandent spinous much-branched undershrub with a number of tuberous fusiform roots. Leaves reduced to minute spinescent structure subtending the leaf like falcate cladodes, borne in axillary clusters of 2-6. Flowers white, strong scented in solitary or fascicled racemes; bracts scarious. Perianth six-partite, segments, oblong, reflexed and connivent below; stamens 6, filaments free, opposite to the perianth segments, anthers 2-celled; ovary trigonous, three chambered, style short, columnar, ending in three recurved stigmatic lobes; fruits are globose berries. (Fig. 503)

Vernacular name: Shatavari.

Flowers: June-September.

Micromorphology (Fig. 503)

Whole plant was glabrous.

Stomata were of tetracytic type.

D/326.

2. *Asphodelus fistulosus* var. *tenuifolius* (Cav.) Baker *J. Linn. Soc., Bot. 15*: 272 1876. (*Asphodelus tenuifolius* Cav.)

An annual herb upto 60 cm in height. Leaves radical, terete, fistular with a sheathing leaf base and upto 30 cm long. Scapes several from the root, much branched, upto 60 cm high. Flowers white, solitary in each broadly ovate, scarious bract with a strong brownish keel. Perianth petaloid, segments 6, shortly connate below oblong, with a strong brownish costa. Stamens 6. Ovary 3-celled; ovules 2 in each cell; style fusiform; stigma sub-capitate, 3-lobed. Capsules globose. Seeds sharply 3-gonous and black. (Fig. 504)

Vernacular name: Dungaro.

Flowers: December-March.

Micromorphology (Fig. 504)

Stomata were tetracytic

D/374.

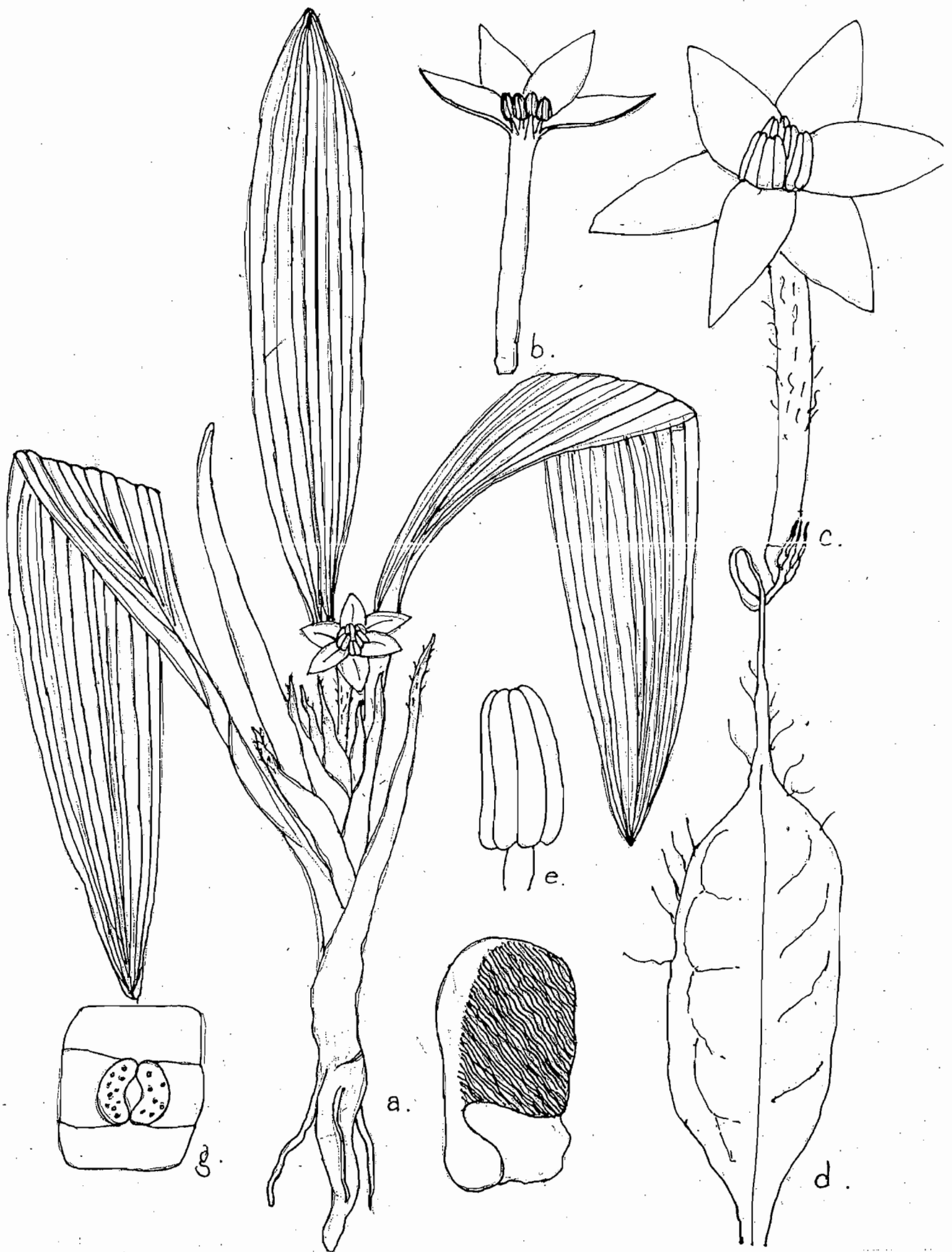


Fig. 502. *Curculigo orchiioides* Gaetrn., a. habit b. epipetalous stamen, c. flower, d. fruit, e. stamen, f. seed, g. tetracytic stomata.

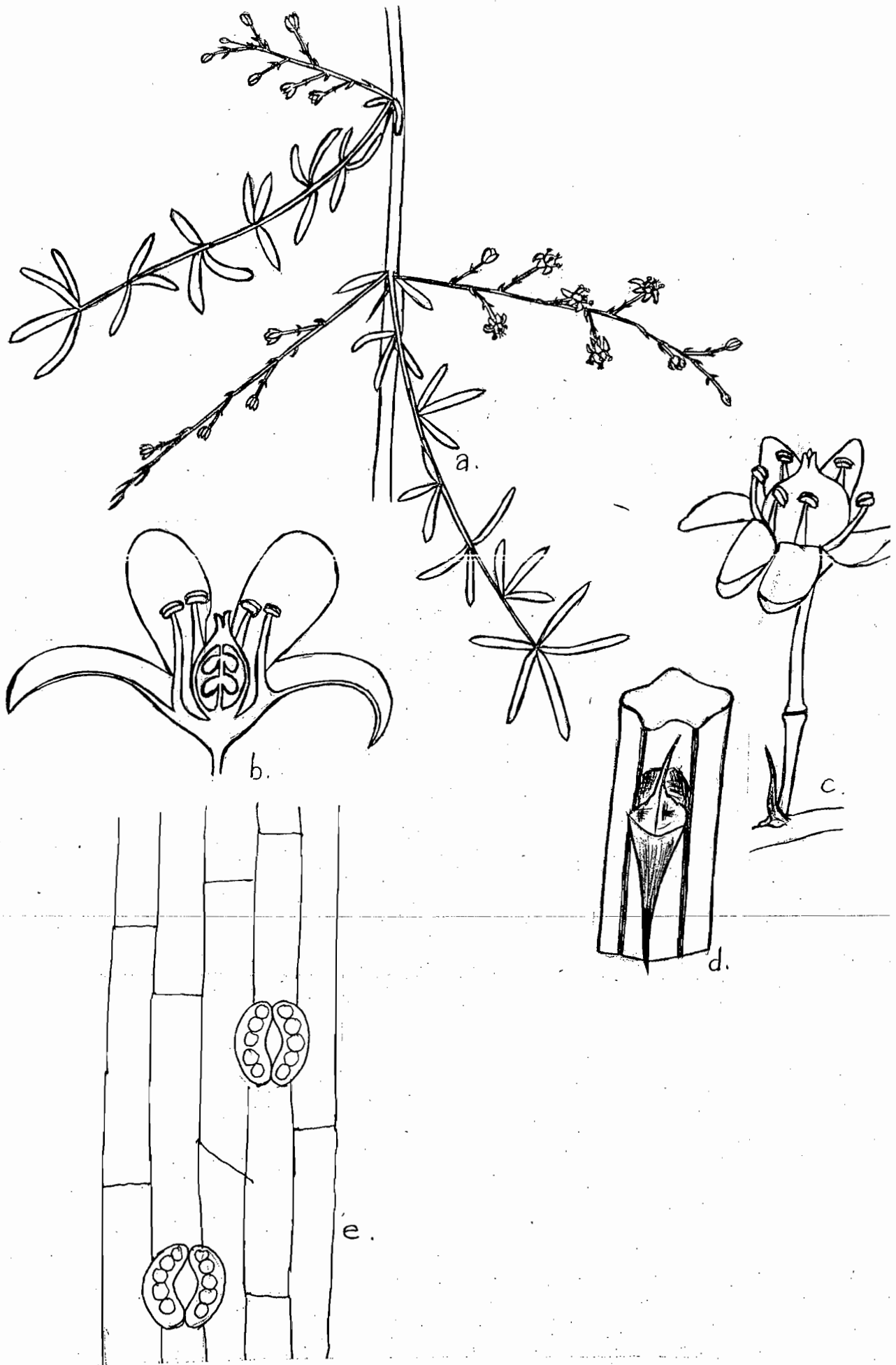


Fig. 503 *Asparagus racemosus* Willd. a. habit b. L.S. of flower c. flower d. scaly leaf with spiny spur e. tetracytic stomata.

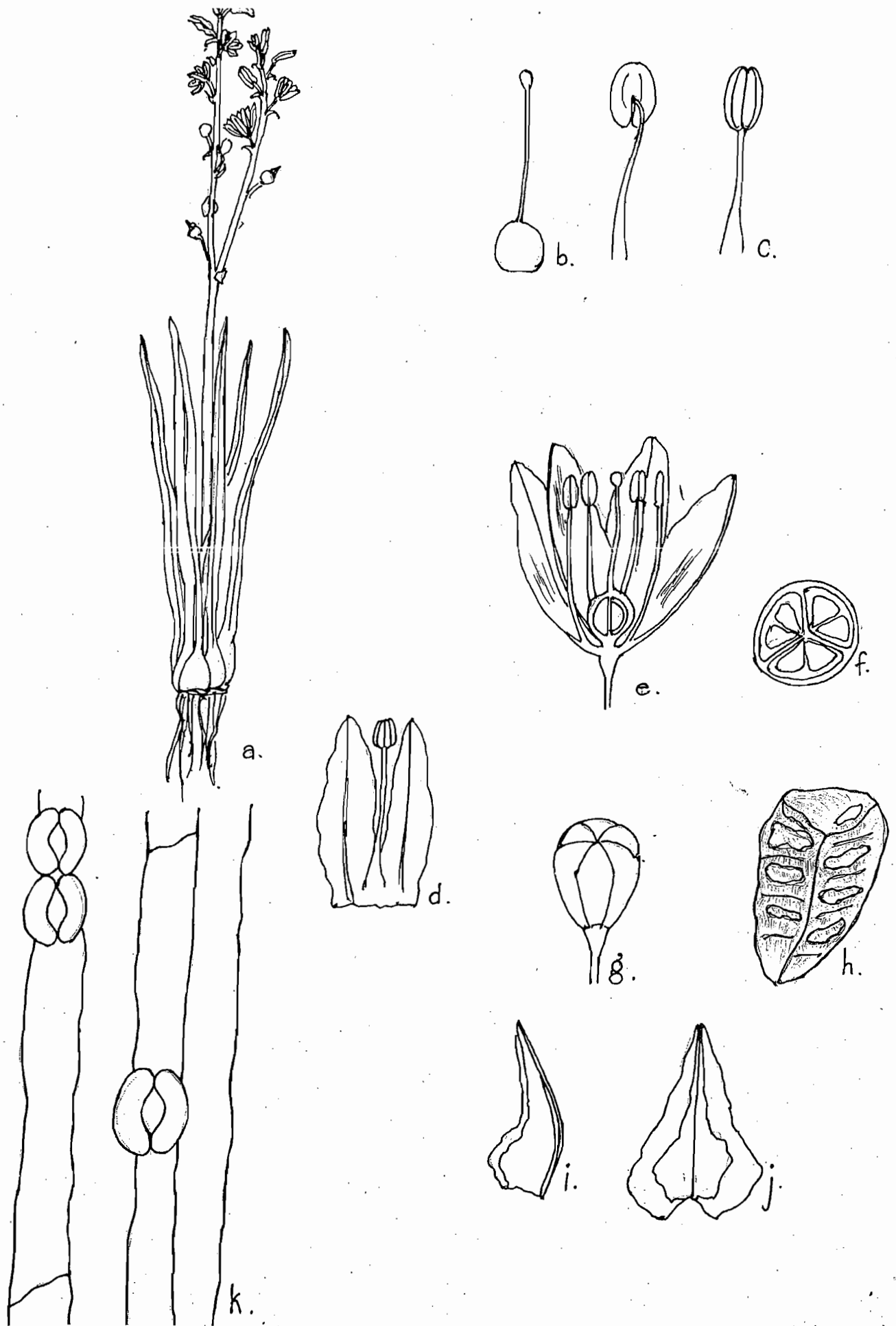


Fig. 504. *Asphodelus fistulosus* var. *tenuifolius* (Cav.) Baker, a. habit, b. gynoecium, c. stamen, d. epipetalous stamens, e. L.S. of flower, f. T.S. of ovary, g. fruit, h. seed, i-j. bract, k. tetracytic stomata.

3. *Dracaena terniflora* Roxb. *Fl. Ind.* V. 2 p. 159. 1832.

(*Dracaena spicata* Baker)

A slightly branched straggling shrub. Leaves elliptic-lanceolate, upto 30 cm, acuminate, coriaceous; petioles with a widened subamplexicaul base. Flowers white, often 2-3 together on the rhachis of a usually simple scarious, ovate bract. Perianth coralline, tubular; lobes linear, obtuse. Stamens 6, adnate to the base of the perianth tube; anthers versatile. Ovary 3-celled; ovules solitary in each cell. Fruit a red globose berry, 1-seeded. (Fig. 505)

Micromorphology (Fig. 505)

Stomata were of tetracytic type.

D/227.

4. *Gloriosa superba* Linn, *Sp. Pl.* (1753) p. 305.

A herbaceous tall branching climber with solid, fleshy-white, cylindric tubers upto 30 cm long. Stems annual, reaching to a length of 6 m long, given off from the angles of the young tubers. Leaves ovate-lanceolate, about 15 cm, acuminate, tip ending in a tendrillike spiral, base cordate. Flowers axillary, solitary, or sub-corymbose towards the ends of the branches. Perianth-segments linear-lanceolate with crisply waved margins, basal half bright yellow, upper half red, reaching 7 cm, deflexed. Stamens 6; anthers versatile. Ovary 3-celled; style deflexed. Capsules linear-oblong. Seeds numerous, subglobose. (Fig. 506)

Vernacular name: Kankasni.

Flowers: July-September.

Micromorphology (Fig. 506)

Whole plant was glabrous.

Stomata were anomocytic.

D/617, 659- 661.

Pontederiaceae

1. *Eichhornia crassipes* (Mart.) Solma in *DC., Phan.* 4:527. (1883).

A free floating with stoloniferous aquatic herbs upto 50 cm high with short stem and many long fibrous roots having root pockets. Leaves broadly ovate to rhomboid, rosulate. Petiole glabrous and spongy with a fusiform bulbous portion about the middle, about 30 cm long. Inflorescence 3-35 flowered raceme. Flowers lilac, tinged blue, withering soon. Perianth 6-partite, tube green; segments obovate, posterior segment with a yellow spot. Stamens unequal in 2-series, filaments curved glandular hairy; anthers purple-blue. Ovary ovoid, 3-locular; style glandular; stigma 3-lobed, glandular. capsule trilocular. (Fig. 507)

Vernacular name: Kanphutti.

Flowers: September-November.



Fig. 505. *Dracena terniflora* Roxb., a. habit, b. gynoecium, c. stamen, d. L.S. of flower, e anomocytic stomata,

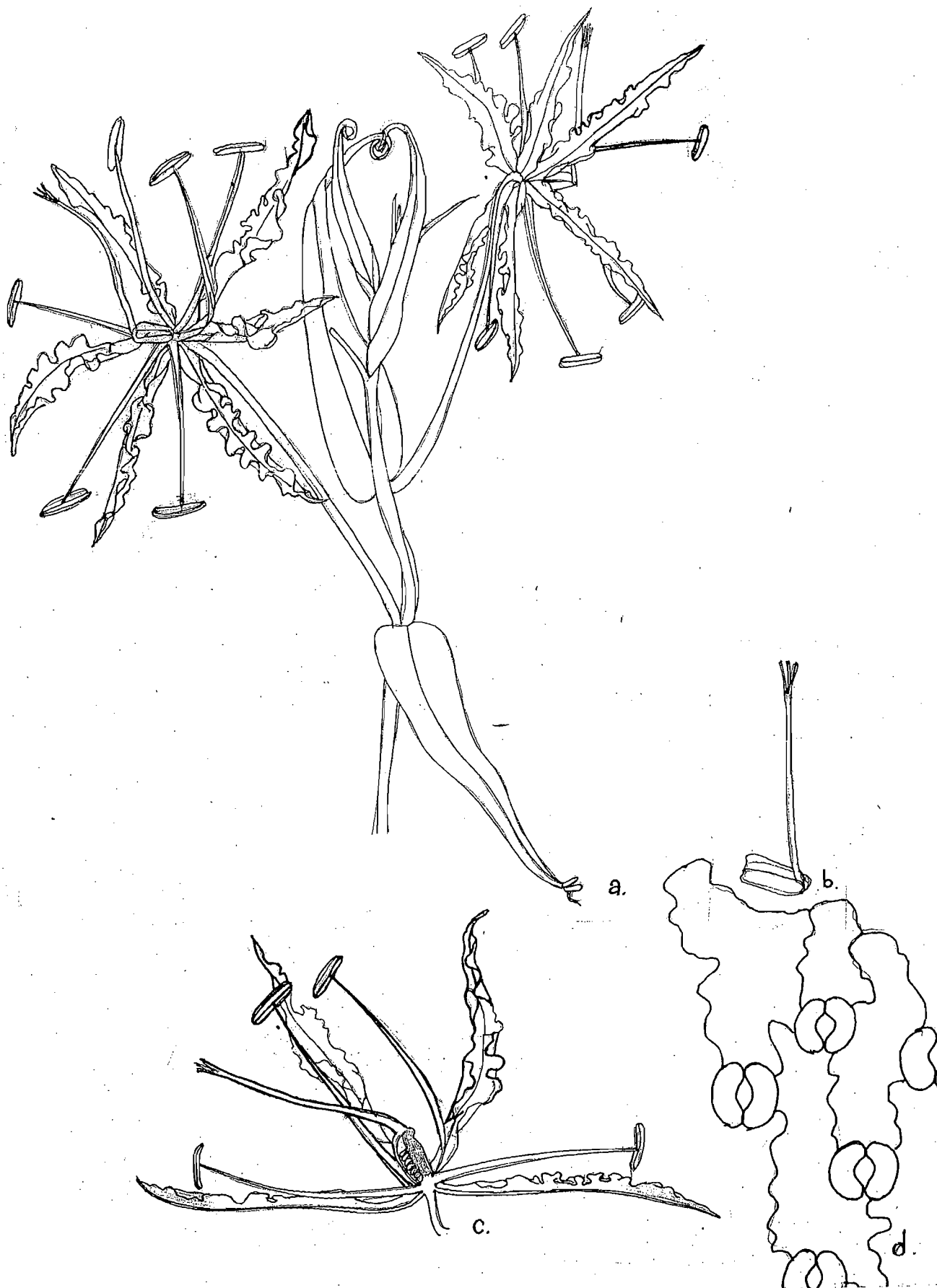


Fig. 506. *Gloriosa superba* L., a. habit, b. gynoecium, c. L.S. of flower, d. anomocytic stomata.



Fig. 507. *Eichhornia crassipes* (Mart.) Solma., a. habit, b. L.S. of Flower, c. stamen, d. gynoecium.

Micromorphology (Fig. 508)

Whole plant was glabrous except the stamens which showed the presence of multicellular, glandular, unbranched trichome differentiated into a single celled head and a multicellular, uniseriate stalk.

Stomata were of tetracytic and actinocytic. Among which tetracytic was present in majority

D/190.

2. *Monochoria vaginalis* Prestl Reliq. Haenk. V. 1 (1830) p. 128.

(*Pontederia vaginalis* Burm.)

Aquatic herb with short, suberect, spongy rootstock, clothed with leafsheaths. Leaves radical and solitary at the top of the emerging stem, ovate-cordate, upto 10 cm, acuminate; the peduncles emerges from the channeled sheaths of the uppermost leaves. Inflorescence racemose; flowers blue, usually spotted with red. Perianth campanulate, 6-partite, 3 of them narrowly obovate. Stamens 6, adnate to the base of the perianth-lobes; filaments of the large anther with an acute horn at one side, the filaments of the smaller anthers filiform; anthers basifixed, linear-oblong. Ovary 3-celled, ellipsoid, ovules many in each cell; stigma 3-lobed. Fruit ellipsoid, membranous capsule. Seeds ellipsoid, with many brown ribs. (Fig. 509)

Vernacular name: Monochoria.

Flowers: August-October.

Micromorphology (Fig. 509)

Stomata were tetracytic.

D/855.

Commelinaceae

1. *Commelina benghalensis* Linn. Sp. Pl. (1753) p. 41

A slender herb, dichotomously branched from the base upwards creeping and rooting below. Leaves ovate or oblong, upto 7 cm long, villous and unequal-sided.

Spathes 1-3 together, funnel-shaped, auricled on one side, pubescent; upper branch of cyme 2-3 flowered; the lower 1-2 flowered. Sepals 3, membranous, the 2 inner often connate. Petals 3, 2 larger clawed and third smaller. Stamens 6, adnate to the base of the perianth; anthers oblong; fertile stamens 3; 3 imperfect. Ovary 3-celled, 2 cells, 2-ovulate, 1 cell 1-ovulate. Capsules pyriform, 5-seeded. Seeds oblong. (Fig. 510)

Flowers: August-December.

Micromorphology (Fig. 510)

The whole plant was glabrous.

Stomata were of tetracytic type.

D/1240.

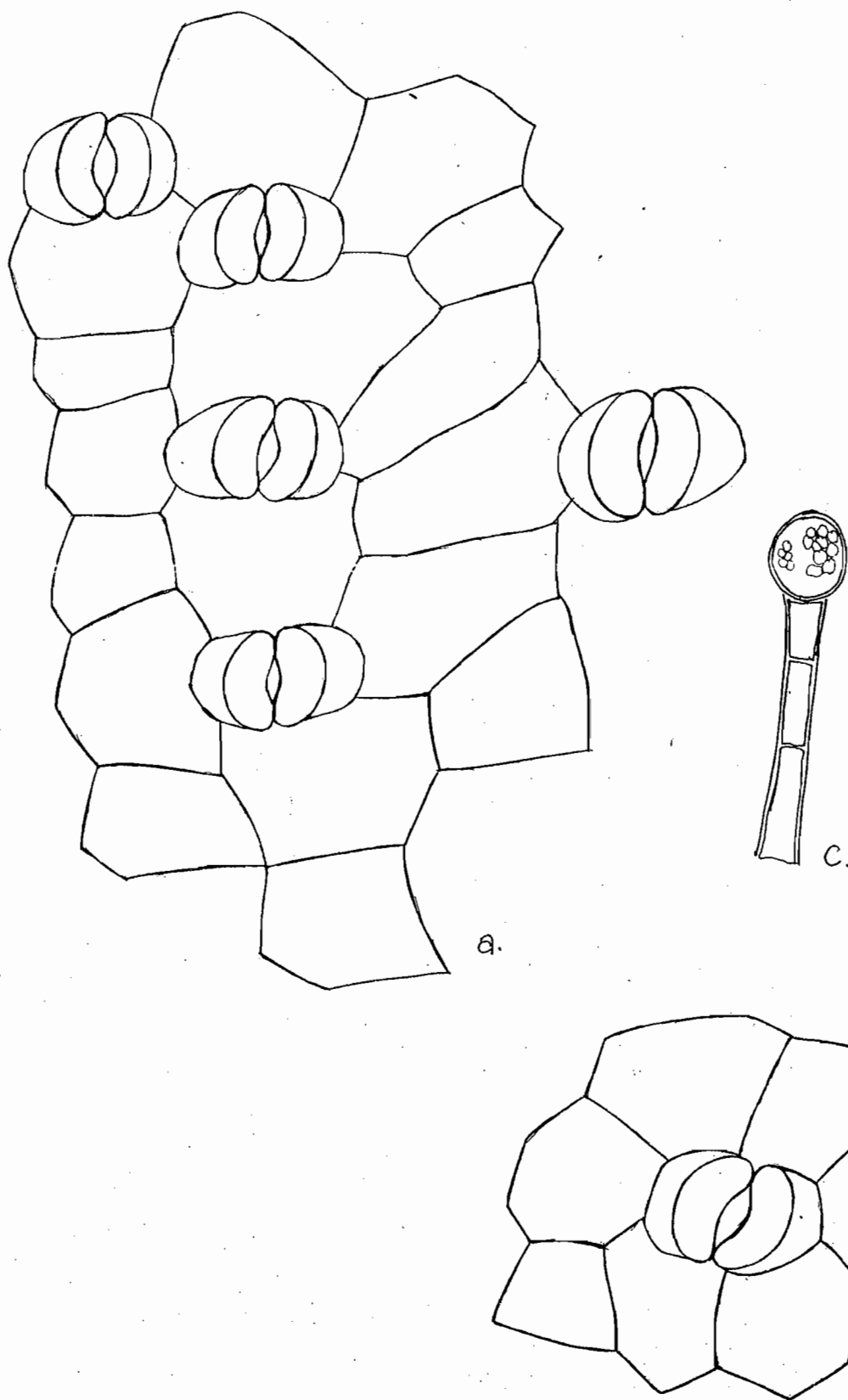


Fig. 508. *Eichhornia crassipes* (Mart.) Solma., a. anomocytic stomata, b. tetracytic stomata
c. gland with one celled head and tri-celled stalk.

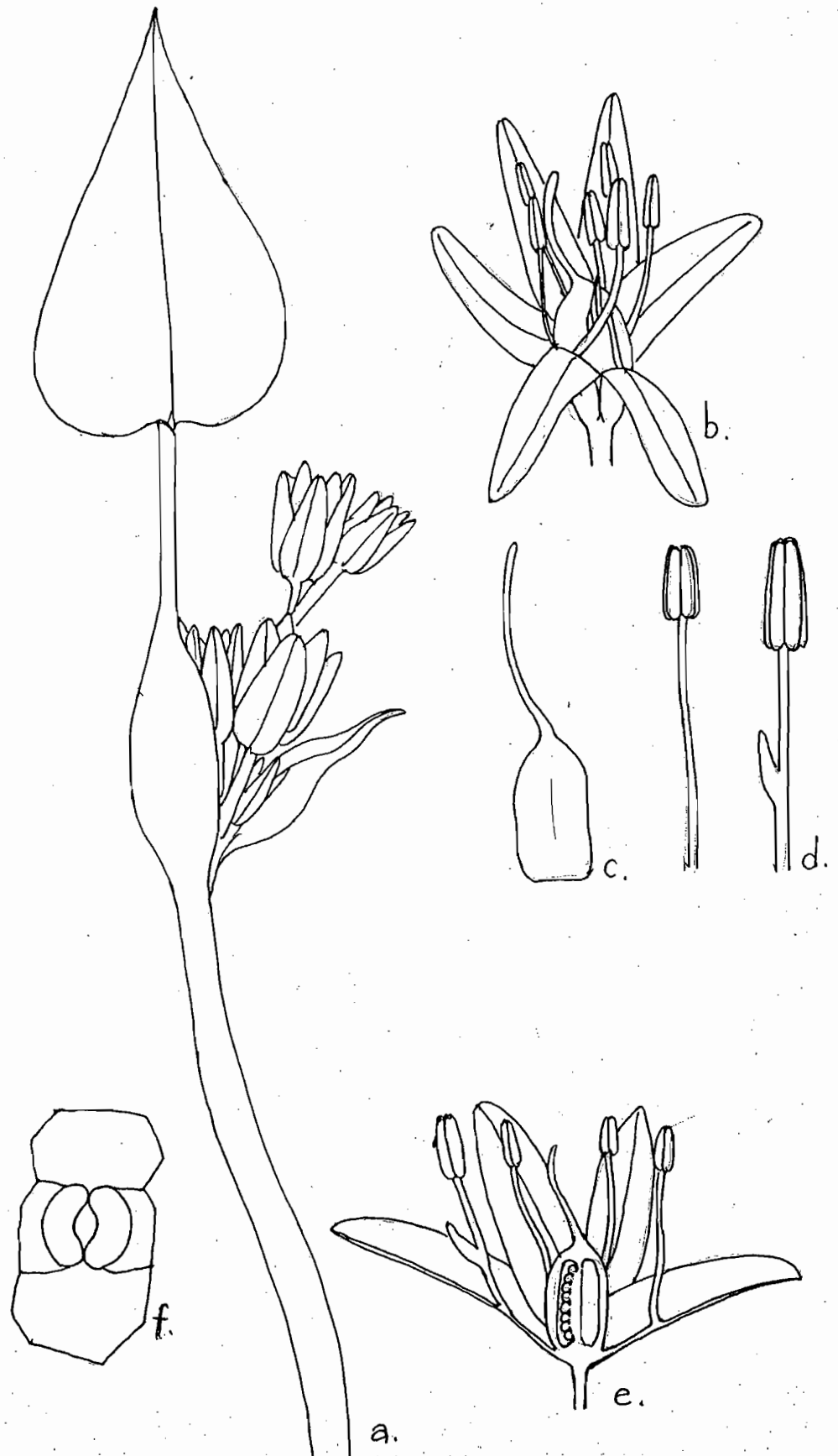


Fig. 509. *Monocharia vaginalis* (Burm. f.) Presl., a. habit b. flower, c. gynoecium, d. stamen, e. L.S. of flower, f. tetracytic stomata.

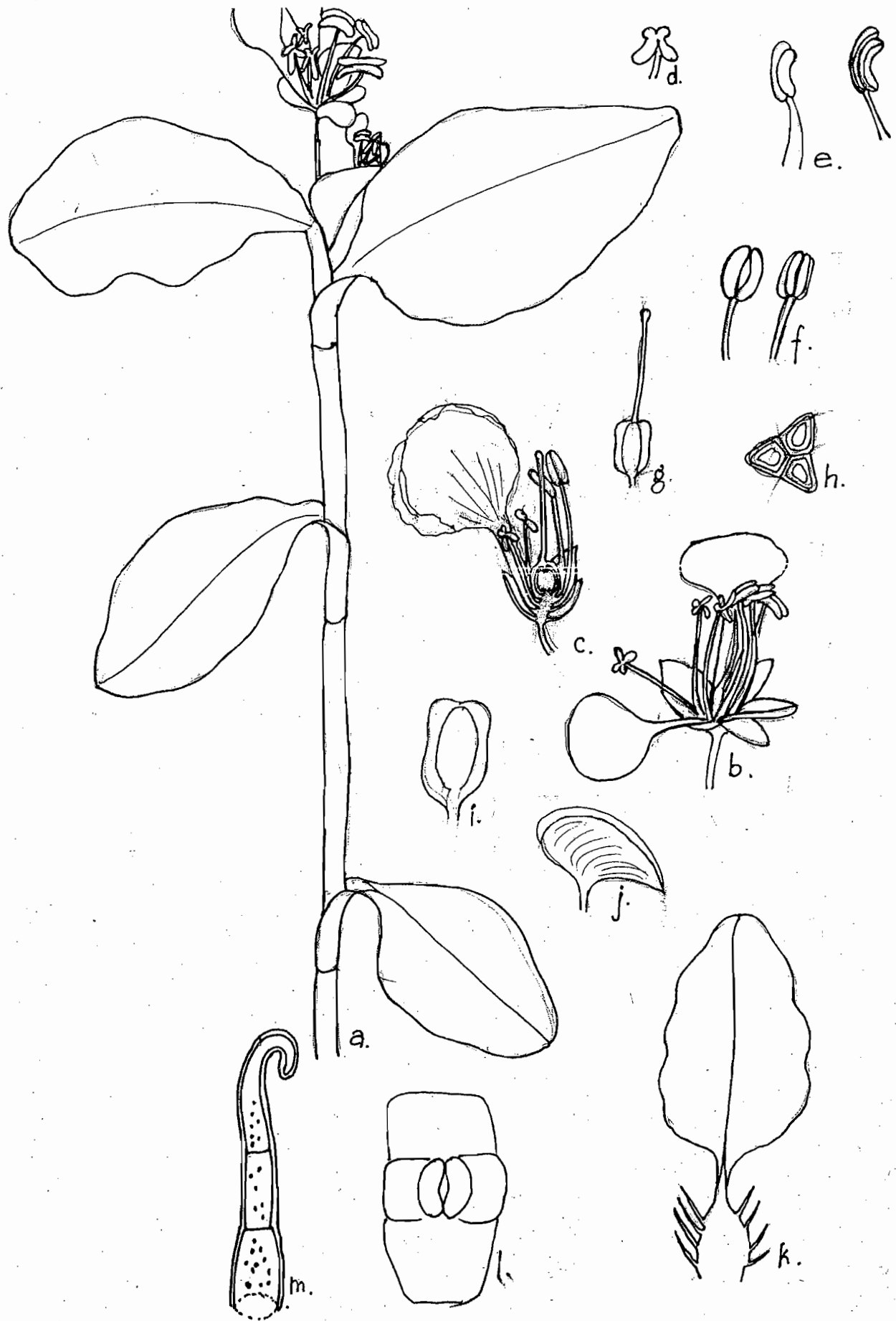


Fig. 510. *Commelina benghalensis* L., a. habit, b. flower, c. L.S. of flower, d-f. stamen, g. gynoecium, h. T.S. of ovary, i. capsule, j. spathe, k. leaf, l. tetracytic stomata, m. three-celled trichome with upper cell hook shaped.

2. *Cyanotis cristata* Schultes f. *Syst. V. 7* (1830) p. 1150.

A slender herb branched from the base upwards, creeping and rooting below. Leaves upto 5 cm long, sessile, ovate-oblong, with villously ciliate margins. Flowers in scorpioidly recurved cymes upto 2 cm long, longer than the bracteoles; peduncles upto 10 cm long; bracts ciliate with long hairs. Sepals 3, free, lanceolate, acuminate. Corolla fused; lobes 3, ovate. Stamens 6, all perfect, subequal, epipetalous; filaments fusiform below the tip, bearded above; anthers oblong. Ovary 3-celled; ovules 2 in each cell, collateral, one erect, the other pendulous. Capsules oblong, 3-gonous. Seeds 3-gonous, striate and with 2 large pits on two of the faces, black. (Fig. 511)

Vernacular name: Shishmuliya ni jat.

Flowers: August-October.

Micromorphology (Fig. 511)

Whole plant showed presence of multicellular, uniseriate, non-glandular, unbranched, elongated and thick walled trichome. The staminal hairs were also multicellular but they were beaded, uniseriate, unbranched, and the cells of the trichomes were globular, thin walled.

Stomata were of tetracytic type.

D/929, 954.

3. *Phaeneilema scapiflorum* (Roxb.) G. Brückn. *Notizbl. Bot. Gart. Berlin-Dahlem* 10: 56. 1927.

(*Aneilema scapiflorum* Wight)

A tufted herb with root of elongate pisiform tubers. Leaves narrowly ensiform, upto 20 cm long, acuminate, glabrous. Flowers in erect elongate panicles on terminal leafless scapes; sheaths on the scape embracing the scape below, finely acuminate with an oblique mouth; upper bracts amplexicaul, ovate, acuminate, membranous, often spotted with small spots. Sepals elliptic-oblong, purple-green. Petals blue, obovate. Stamens 3 and staminodes 3; filaments all bearded with blue hairs; anthers of fertile stamens blue, those of the staminodes yellow. Ovary sessile 3 celled; cells 1-ovulate. Capsules obovoid. Seeds 5 or 6 in a cell, superposed, sharply 3-gonous. (Fig. 512)

Flowers: May-June.

Micromorphology (Fig. 512)

The plant showed presence of staminal hairs. The hairs were glandular, multicellular, uniseriate, elongated trichome whose wall was warty and thick. The cells of the trichome were at right angles to the previous or the preceding ones.

Stomata were of tetracytic type.

D/893-897, 1038.

4. *Rhoeo discolor* Hance, in *Walp. Ann. V. 3* (1853) p. 659.

Tradescantia discolor L'Herit.

A prostrate slender herb. Leaves large, lanceolate, and sheathed at the base, green above and purple beneath. Flowers blue or purple almost included within the bracts. Perianth oblong-ovate, clawed; white. Stamens 6; filaments long and hairy with staminal hairs;

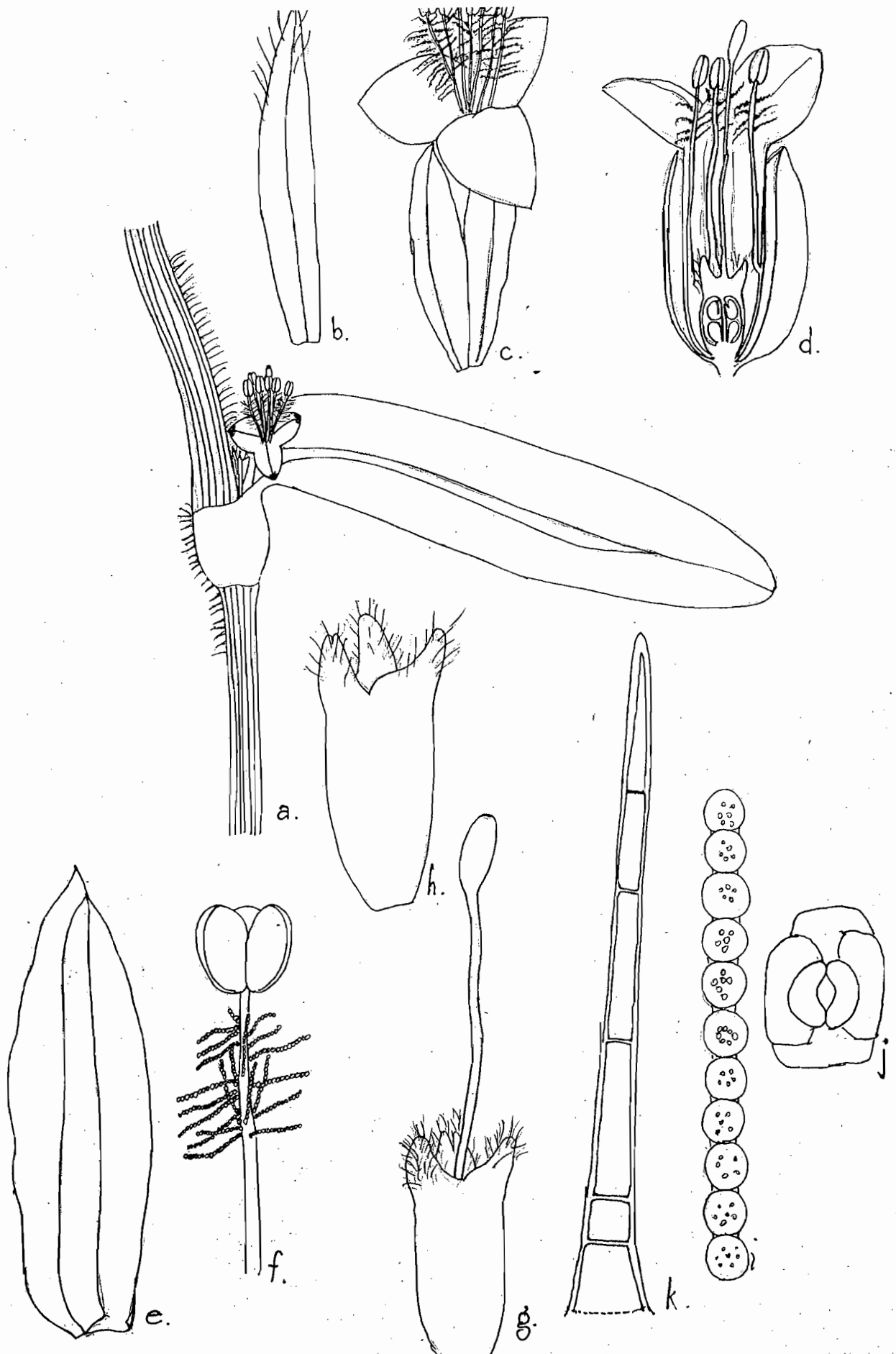


Fig. 511. *Cyanotis cristata* Schultes f., a. habit b. bract c. flower d. L.S. of flower h. calyx e. bracteole f. stamen g. calyx with gynoecium i. uniseriate staminal gland with small round cells having some inclusions, j. tetracytic stomata, k. multicellular uniseriate trichome with thin wall and large cells with narrow lumen.

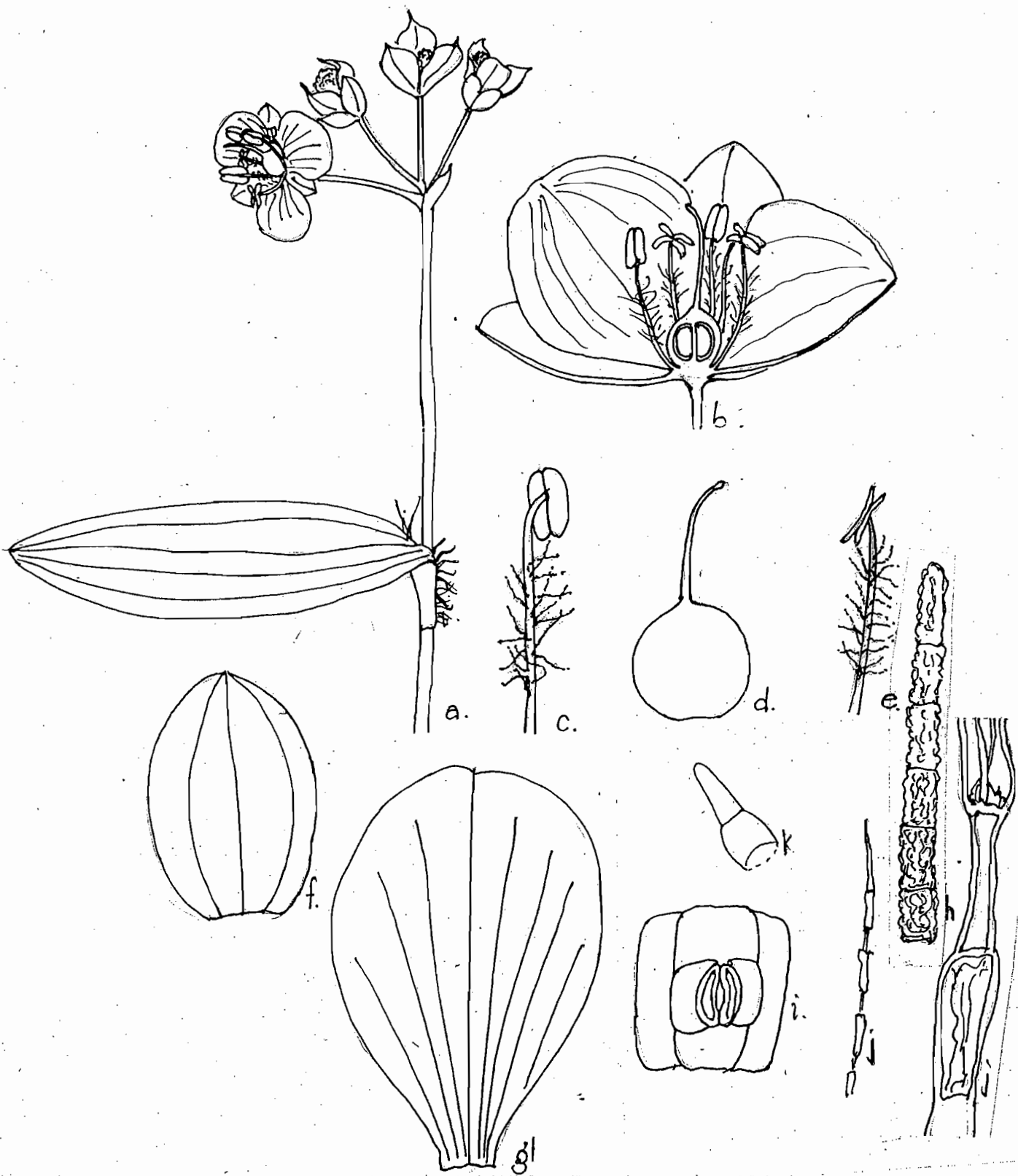


Fig. 512. *Phaenillema scapiflorum* (Roxb.) G. Brückn., a. habit, b. L.S. of flower, c and e. stamen, d. gynoecium, f. sepal, g. petal, h. gland with thick and warty wall, i. tetracytic stomata, j. enlarged view of the glandular trichome, k. two-celled gland.

anthers separated at the tip by a broad connective; anther cells kidney shaped. Ovary globular; 3 celled; ovules 2 in each cell; style long; stigma capitate. (Fig. 513)

Micromorphology (Fig. 513)

Staminal hairs were multicellular, beaded, unbranched, uniseriate, and thick walled. Stomata were of tetracytic type. D/171.

Arecaceae

1. *Caryota urens* Linn. *Sp. Pl.* (1753) p. 1189.

A tall palm having an unbranched trunk reaching a height of 20 m, cylindric, annulate. Leaves bipinnate, fasciculate or alternate, upto 7 m; arched and drooping; leaflets cuneiform, obliquely truncate, upto 20 cm long, irregularly serrate-toothed on the truncate margin; petiole with fibrous netted margins at the base; sheath smooth. Spadix upto 4 m long; branched forming a dense tassel drooping from the stout short peduncle. Spathes 50 cm long, closely embracing the peduncle of the spadix. Flowers monoecious, solitary. Male flowers: sepals 3, short rounded. Petals 3 larger, linear, oblong, reddish. Stamens about 40; filaments short, white; anthers acuminate, as long as the petals. Female flowers subglobose, smaller than the male. Sepals and petals as in male flowers. Stamens 3. Ovary obovoid, trigonous, 3-celled. Ovule solitary in each cell, erect. Fruit reddish; pericarp acrid, stinging. Seeds 1 or 2. (Fig. 514)

Vernacular name: Shivjata.

Flowers during most of the year.

D/104.

Typhaceae

**1. *Typha australis* K. Schum. & Thonner, *Beskr. Guin. Pl.* 401. 1827
(*Typha angustata* Bory & Chaub.)**

A robust marshy herb of about 3 m in height. Leaves erect, spongy, exceeding the flowering stem, semicylindric above the sheath. Spikes cylindric, the male and female spikes often separated by a considerable interval. Flowers small, the female spikes pale brown. Perianth of capillary hairs or in the male flowers obsolete. Stamens 3; connective thickened at the tip. Female flowers mixed with clavate-tipped pistillodes; bracteoles subspathulate, equaling the linear stigmas, both longer than the hairs. Pollen simple. (Fig. 515)

Vernacular name: Gha bajriyo.

Flowers: October-June.

D/848-849.

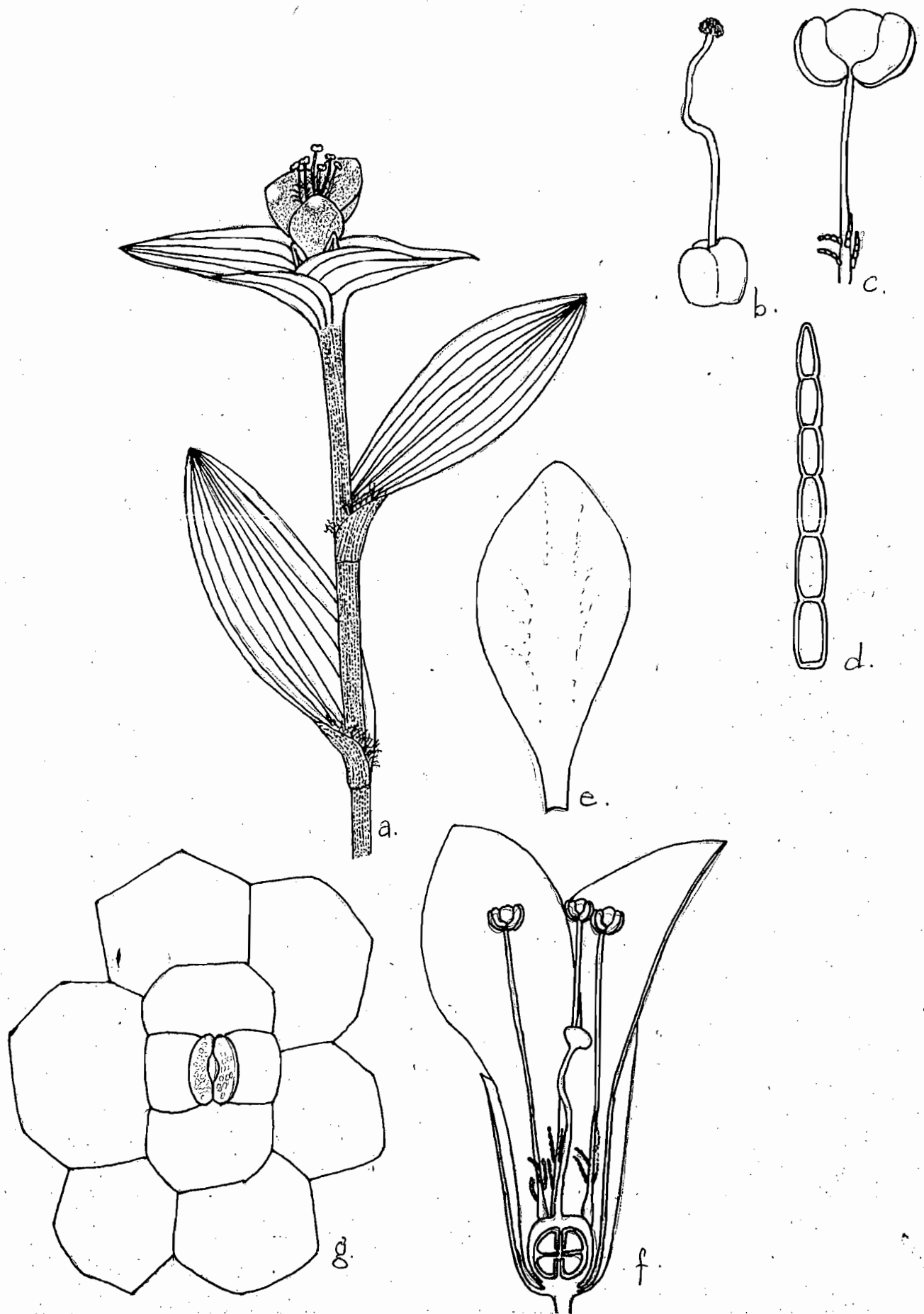


Fig. 513 *Rhoeo discolor* Hance., a. habit b. gynoecium c. stamen d. uniseriate gland with thick wall and small cells, e. petal, f. L.S. of flower, g. tetracytic stomata.

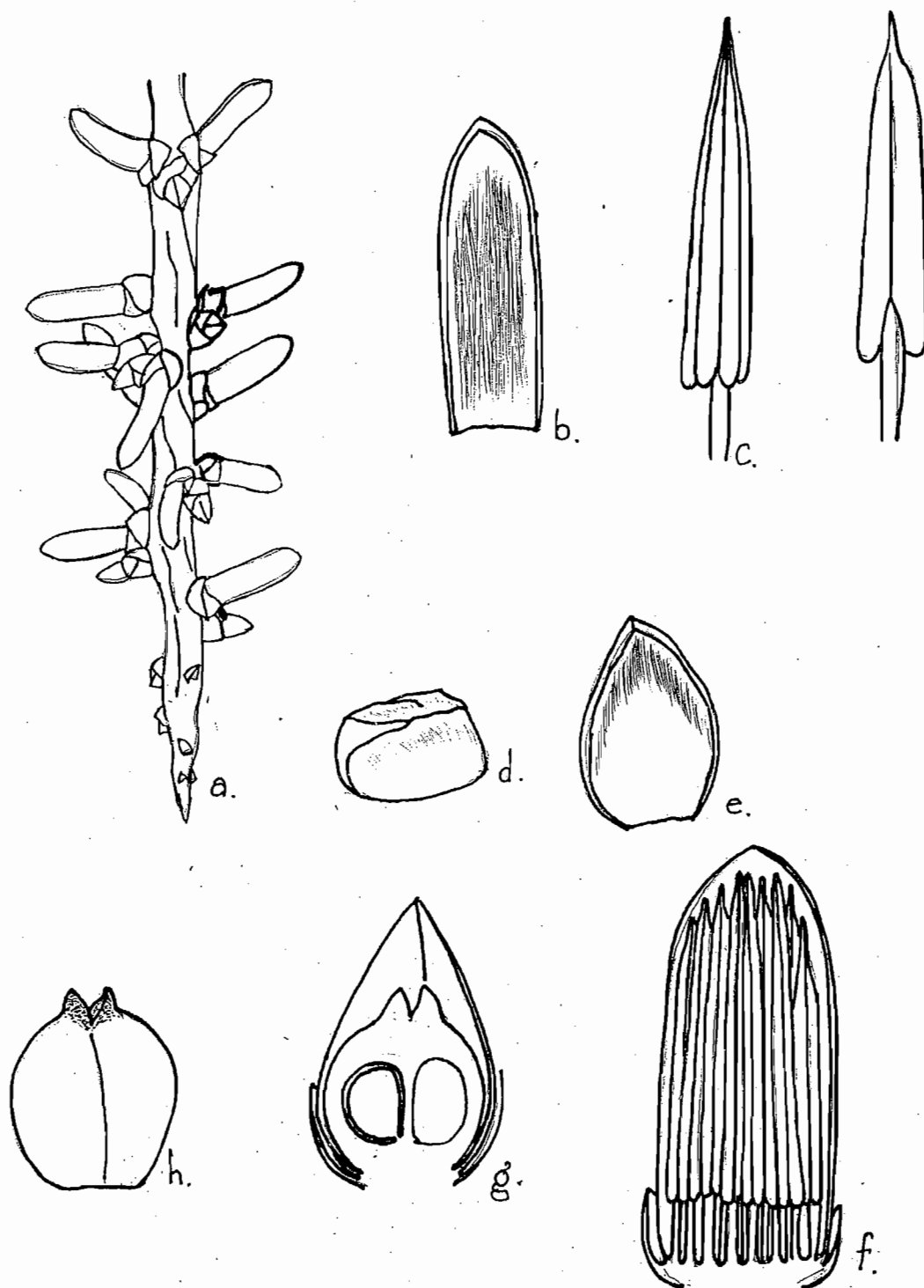


Fig. 514 *Caryota urens* L., a. habit, b. petals, c. stamen, d. flower bud, e. sepal, f. L.S. of male flower, g. L.S. of female flower, h. gynoecium.



Fig. 515. *Typha australis* K. Schum. & Thonner., a. habit, b. female flower, c. male flower, d. female flower.

Araceae

1. *Pothos scandens* Linn. *Sp.Pl.* (1753) p. 968.

A climbing evergreen plant with much branched, tough, terete, smooth, leafy stem. Leaves elliptic or lanceolate, upto 10 cm long, acuminate; petiole broadly winged, upto 7 cm, the base semi-amplexicaul. Peduncles upto 1 cm long, axillary. Spathes cymbiform, cuspidate, green. Spadix yellow, as long as the spathe, globose, ovoid, the stipes as long as the inflorescence. Perianth of 6 segments with hooded tips. Stamens 6; filaments linear; anther cells divaricate. Ovary depressed, 3-celled, ovules solitary in each cell, truncate; stigma minute, sessile, lobulate. Berries 1-1.5 cm long, oblong, scarlet. (Fig. 516)

Flowers: May-July.

Micromorphology (Fig. 516)

Whole plant was glabrous but is showed the presence of crystals.

Stomata were of tetracytic type.

D/176.

Alismataceae

1. *Limnophyton obtusifolium* Miq. *Fl. Ind. Bat.* V. 3. (1855)

A scapigerous perennial herb with short stout rootstock with numerous root fibres possessing radical leaves. The leaves are deltoidly sagittate upto 30 cm long. Petiole very long, striate channeled above. Flowers polygameous (male and bisexual) in paniculate whorls borne on a 1 m long stout angular scape. Flowers white, sepals 3, green. Orbicular ovate, petals 3, obovate, white. Stamens 6 with flattened filaments. Carpels upto 20, ovules solitary. Fruit hard achenes in globose head. (Fig. 517)

Vernacular name: Nalkut.

D/108.

Cyperaceae

1. *Cyperus iria* Linn. *Sp. Pl.* (1753) p. 45.

A glabrous annual with triquetrous, striate, tufted stems reaching 50 cm in length. Leaves linear, grass-like, 3-ranked, finely acuminate. Umbel decomposed, of many primary rays upto 12 cm long, bearing irregularly fascicled umbellules formed of narrow interrupted spikes of 5-20 small few-flowered spikelet; bracts 3-5, the longest sometimes reaching 20 cm long. Spikelets small linear-oblong, obtuse, compressed, 6-20 flowered. Glumes apiculate, loosely or scarcely imbricate, 3-5 nerved, with broad hyaline margins. Stamens 2 or 3; anthers small, oblong, muticous, yellow. Ovary compressed. Nut obovoid, triquetrous, brown or black, slightly exserted from the glume. (Fig. 518)

Flowers: Throughout the year.



Fig 516. *Pothos scandens* L., a. habit, b. gynoecium, c. stamen, d. flower, e-f. tepal, g. L.S. of flower, h. T.S. of ovary, i. tetracytic stomata, j. crystals.

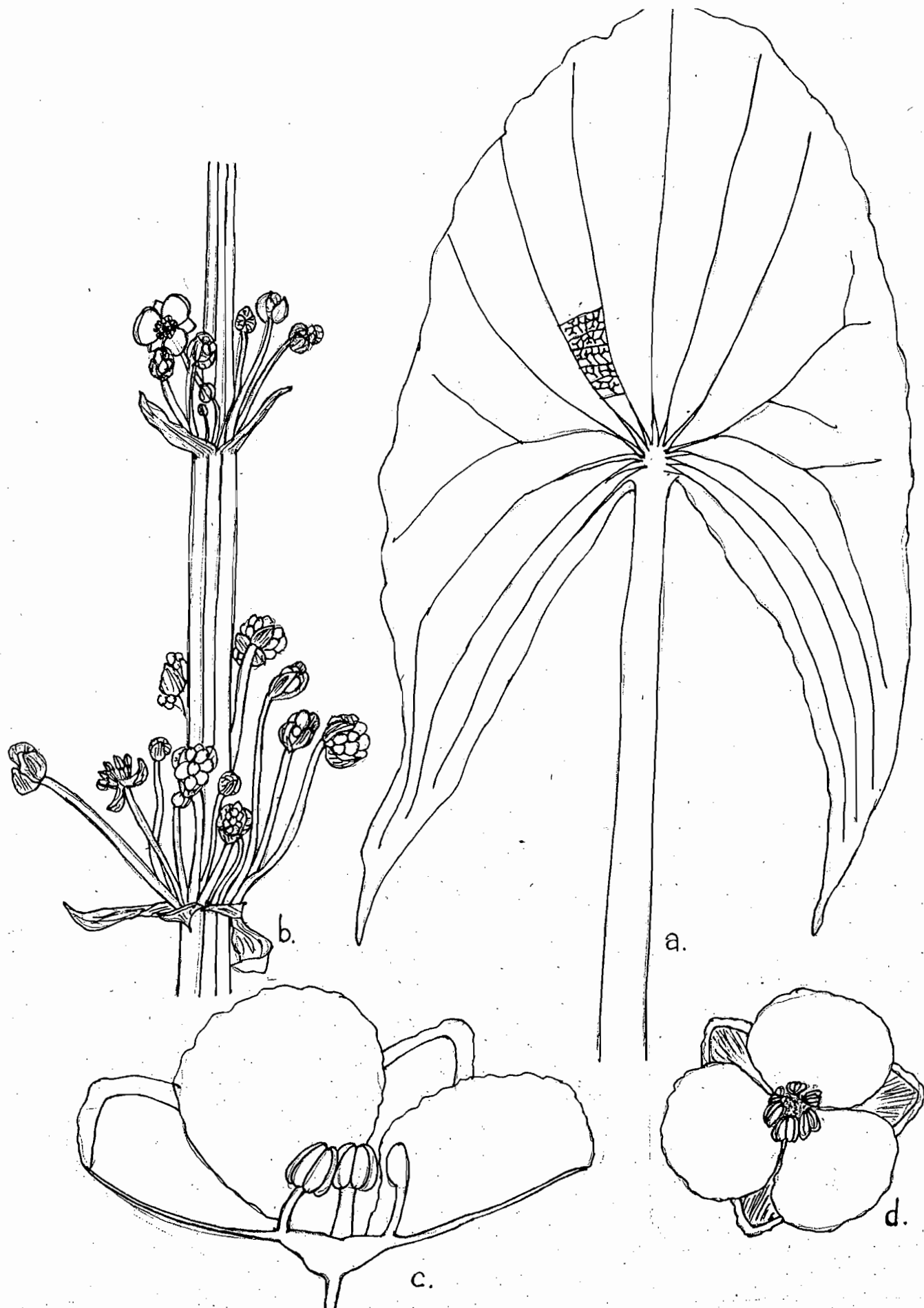


Fig. 617. *Limnophyton obtusifolium* Miq., a. habit, b. inflorescence, c. L.S. of male flower, d. male flower.

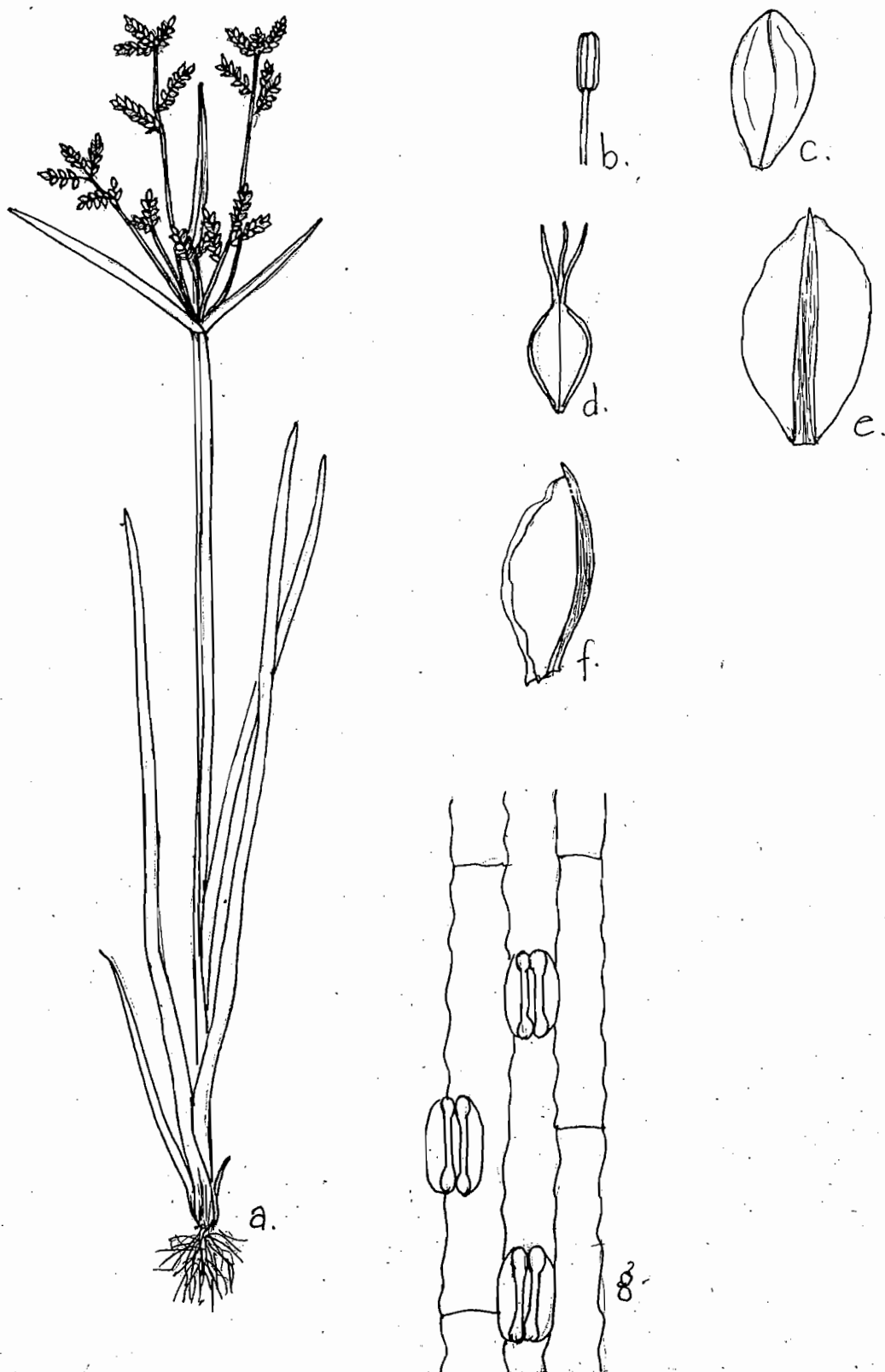


Fig. 518. *Cyperus iria* L., a. habit, b. stamen, c-d. floral glume, e. gynoeceium, f. empty outermost glume, g. graminaceous stomata.

Micromorphology (Fig. 518)

Stomata were graminaceous.

D/921-924.

2. *Cyperus leucocephalus* Retz. Obs. Fasc. 5 (1789) p. 11.

A glabrous rhizomatous herb with caespitose, very slender stems. Leaves linear, shorter than the stem, many-nerved. Heads dense, globose, white, containing 8-50 spikelets; bracts 3, the longest reaching 7 cm long, narrowly linear, long-acuminate, many-nerved. Spikelets compressed, elliptic, 10-18 flowered. Glumes oblong-lanceolate, subobtuse, whitish or pale-brown, with hyaline margins. Stamen 1; anthers oblong, muticous. Nut oblong-ellipsoid, trigonous, shortly apiculate, granulate, black. (Fig. 519)

Flowers: August-October.

Micromorphology (Fig. 519)

Stomata graminaceous.

D/240.

3. *Cyperus rotundus* Linn *Sp.Pl.* (1753) p. 45.

A stoloniferous herb with stolons bearing hard ovoid tunicate black fragrant tubers upto 2.5 cm in diameter; stems triquetrous, about 75 cm long. Leaves narrowly linear, finely acuminate, flat, 1-nerved. Umbel simple or compound; rays 2-8, the longest reaching 8 cm long, bearing short spikes of 3-10 slender spreading red brown; bracts 3, the longest reaching 15 cm long. Spikelets upto 4 cm long, linear, red-brown, 10-50 flowered, compressed; rhachilla with hyaline wings. Glumes oblong, slightly apiculate; back reddish-brown, 3-7-nerved. Stamens 3, anthers oblong. Nut obovoid, trigonous, grayish-black. (Fig. 520)

Vernacular name: Moth.

Flowers: Throughout the year.

Micromorphology (Fig. 520)

Stomata graminaceous and epidermal cell walls appeared pitted.

D/977-978.

**4. *Eleocharis acutangula* (Roxb.) Schult. *Mant.* 2: 91, 1824
(*Eleocharis fistulosa* Link.)**

A stoloniferous, herb with triquetrous, stems concave on one face and reaching upto 1 m height. Leaves represented by ovate, acute or lanceolate hyaline limb with obliquely truncate sheaths. Inflorescence a single solitary ovoid or cylindric many-flowered spikelets. Spikelets upto 4 cm long, greenish; lowest glumes bract-like, ovate, coriaceous, with narrow membranous margins; rhachilla slender, angular. Glumes imbricate, membranous or coriaceous, the lowest usually empty, bract-like; the uppermost empty, the remainder 2-sexual. Fertile glumes ovate-oblong or subobovate, multistriate on the back, often with minute brown spots inside; bristles longer than the nut, brown, retrorsely scabrid. Stamens 3; anthers linear, muticous. Ovary orbicular-

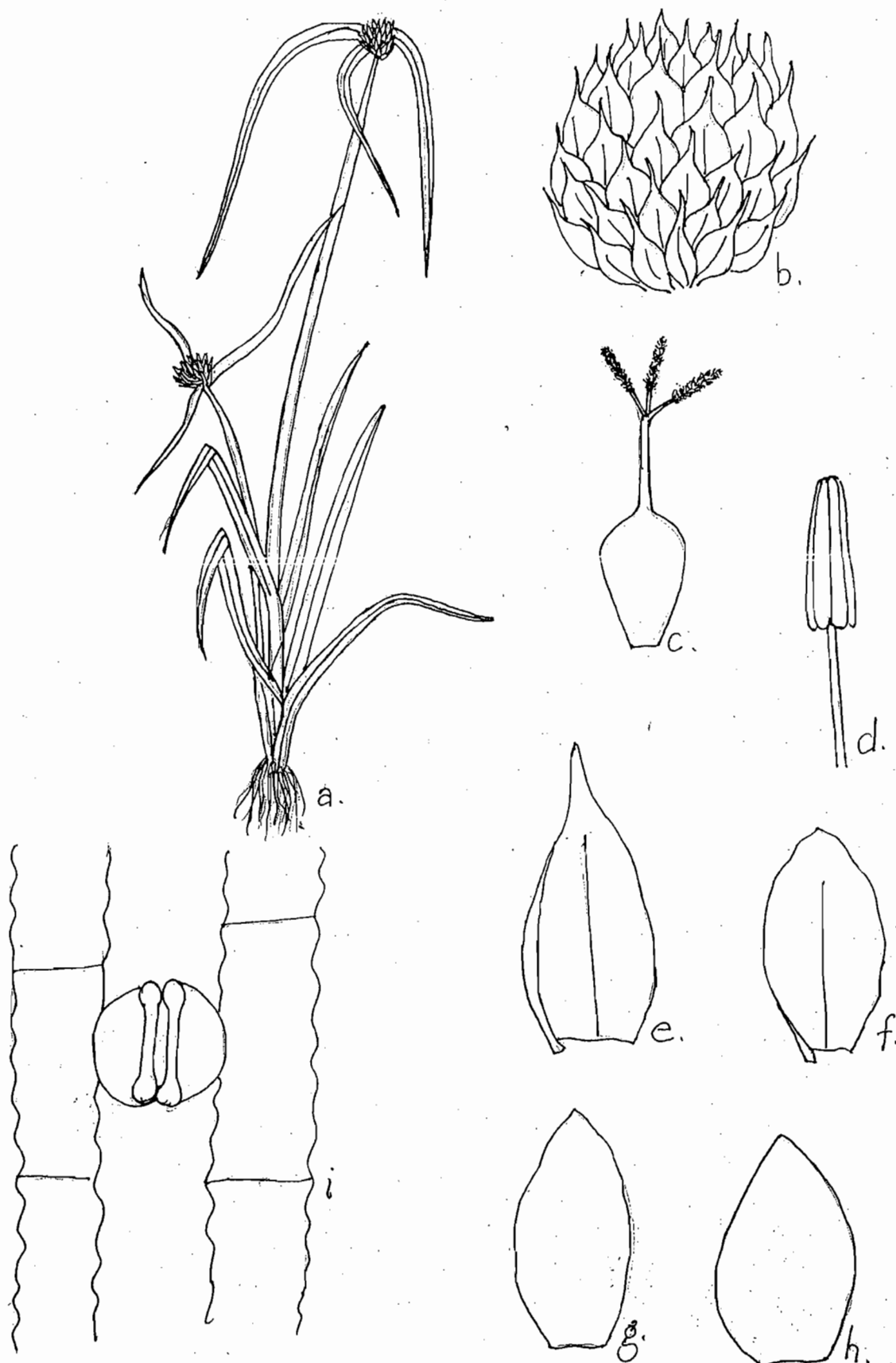


Fig. 519 *Cyperus leucocephalus* Retz., a. habit, b. inflorescence, c. gynoecium, d. stamen, e-f. involucral glume, g-h. floral glume, i. graminaceous stomata.



Fig. 520. *Cyperus rotundus* L., a. habit, b. rhachilla, c. stamen, d. gynoecium, e. inflorescence, f. glume, g. nut, h. graminaceous stomata.

ovoid; style with a swollen base; stigmas 3, filiform. Nut obovoid, striate, pale, tipped with the annular somewhat saucer-shaped style-base. (Fig. 521)

Micromorphology (Fig. 521)

Whole plant was glabrous.

Stomata graminaceous.

D/888- 890.

5. *Eleocharis atropurpurea* Kunth, *Enum. V. 2* (1837) p. 151.

An annual with densely tufted stems upto 15 cm long. Leaves represented by a membranous sheath. Inflorescence a single solitary ovoid or cylindric many-flowered spiketlets at the tip of the stem. Spikelets ovoid, obtuse, many-flowered; rhachilla pitted. Glumes broadly ovate-oblong, concave, loosely imbricate, easily detached; back green; sides membranous with a chestnut-brown band along each; bristles 4-7, slender, as long as the nut, white. Anthers small, oblong, alternate with bristles. Nut obovoid, biconvex, smooth, black, apiculate with the short stout white style-base. (Fig. 522)

Flowers: September-December.

Micromorphology (Fig. 522)

Stomata graminaceous.

D/971-973.

6. *Eleocharis plantaginea* R. Br. *Prod.* (1810) p. 224.

(*Scirpus plantagininus* Roxb.)

A stoloniferous densely tufted herb reaching 1 m high and upto 1 cm diameter, appearing transversely septate when dry; sheaths 5-20 cm long, very thin, soon torn, bright red-brown, shining. Inflorescence a single solitary ovoid or cylindric many-flowered spiketlets. Spikelets upto 4 cm long, straw-colored; rhachilla stout, angled. Glumes closely imbricate, broadly ovate, 1-nerved, coriaceous, persistent. Bristles 7, equaling or exceeding the nut, retrorsely scabrid, yellow. Stamens 3; anthers narrowly linear, with a long setaceous tip. Ovary orbicular-ovoid; style with a swollen base; stigmas 2, filiform. Nut orbicular-obovoid, smooth, yellowish. (Fig. 523)

Flowers: Throughout the year.

Micromorphology (Fig. 523)

Whole plant was glabrous.

Stomata graminaceous.

D/892.

7. *Fimbristylis dichotoma* Vahl. *Enum. V. 2* (1806) p. 287.

An annual herb with tufted, filiform stems and very narrow leaves tapering to a fine point and having softly villous leaf sheaths. Umbel laxly compound upto 5 cm in diameter; rays upto 2.5 cm long, suberect; bracts filiform. Spikelets angular due to the acute keels to the glumes, ellipsoid, many-flowered; rhachilla stout, angular with large pits. Glumes loosely imbricate, all, or all but the lowest fertile, ovate, reddish-brown, 1-3 nerved on the back, the midnerve forming a conspicuous acute

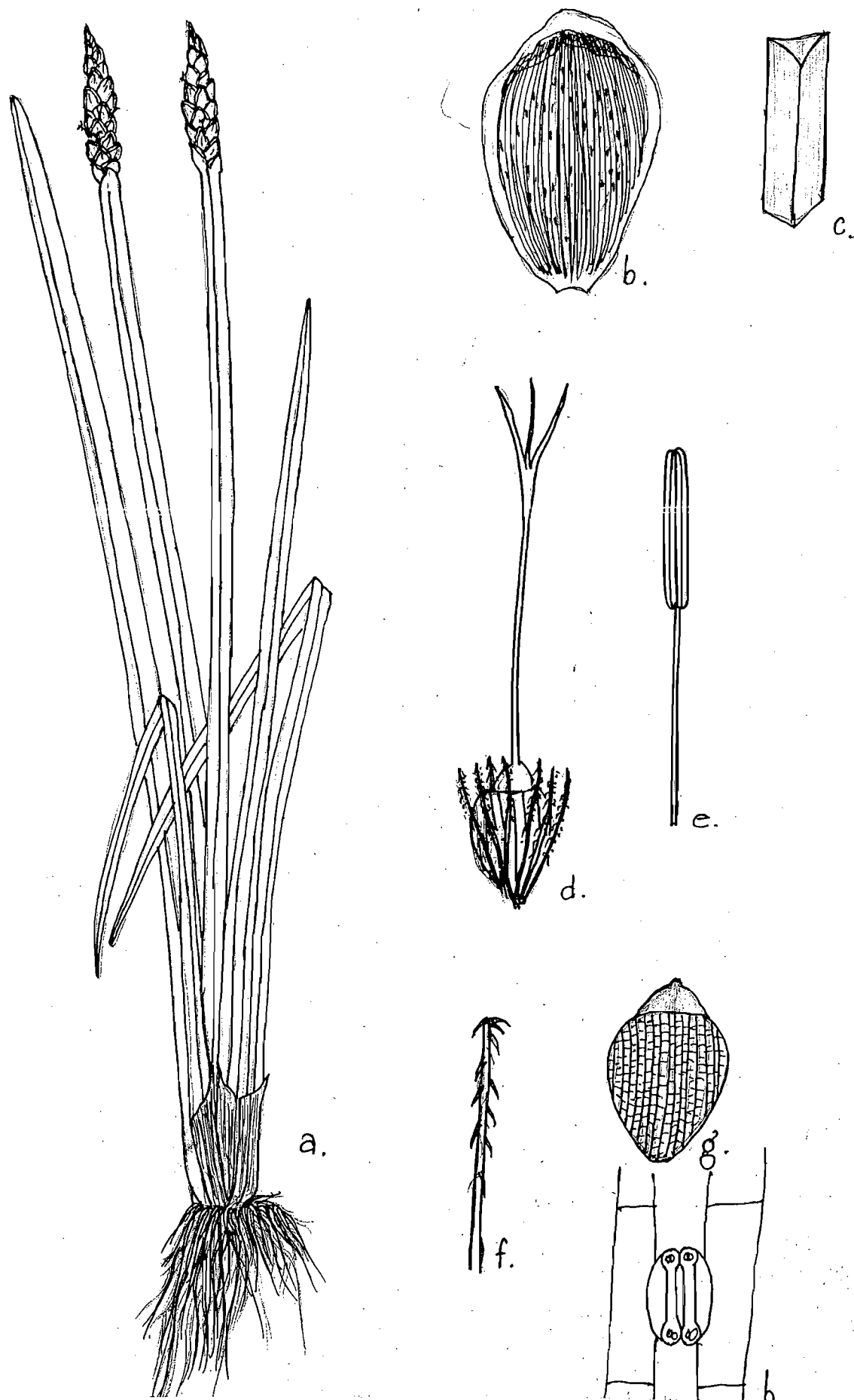


Fig. 521. *Eleocharis acutangula* (Roxb.) Schult., a. habit, b. inflorescence axis triangular, d. gynoecium with bristles, e. stamen, f. bristles, g. nut, h. graminaceous stomata.

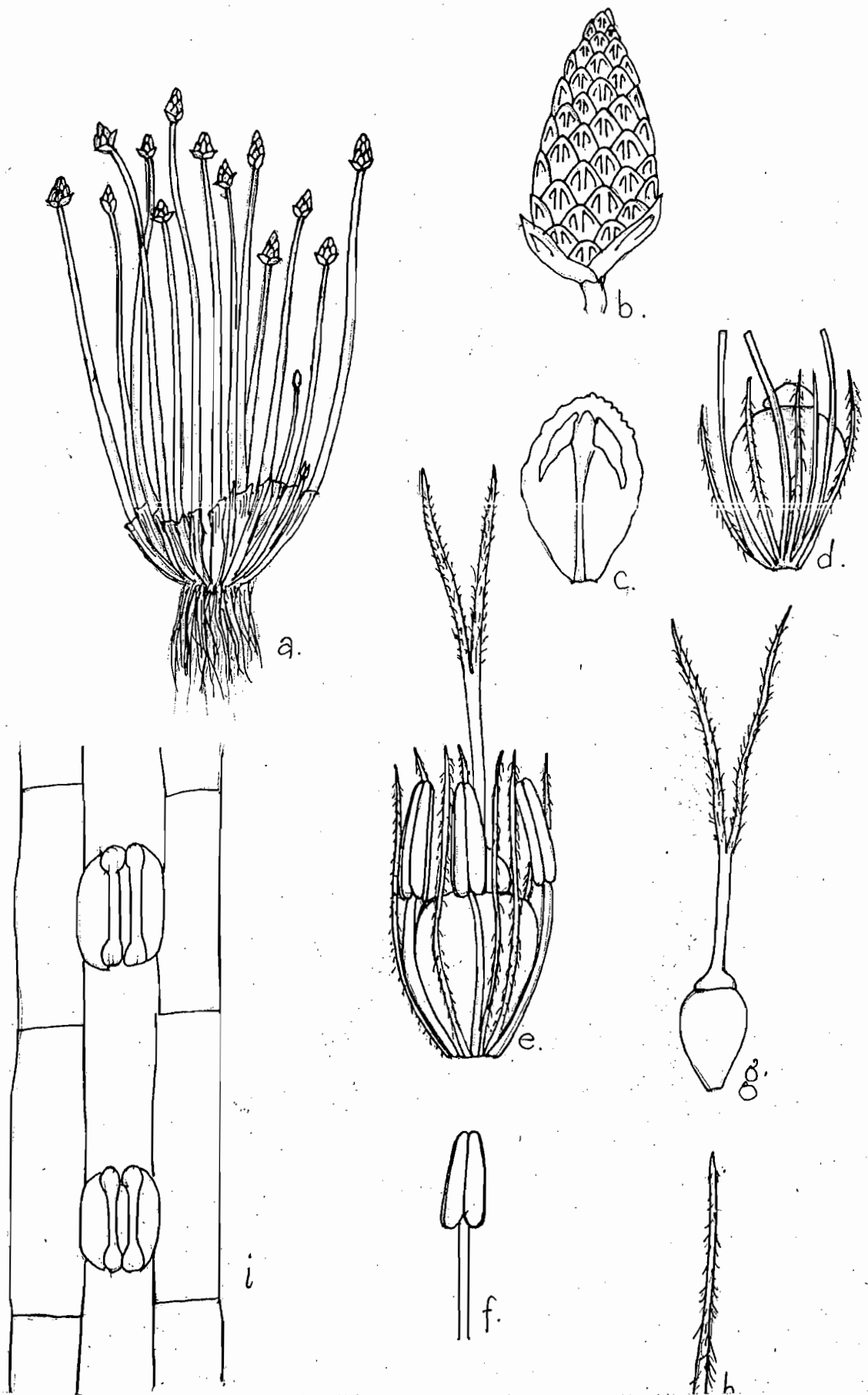


Fig. 522. *Eleocharis atropurpurea* Kunth., a. habit, b. inflorescence, c. involucre glume, d. nut with bristles and filaments, e. gynoeuim with stamens and scales, g. gynoeuim, f. stamen, h. bristles, i. graminaceous stomata.

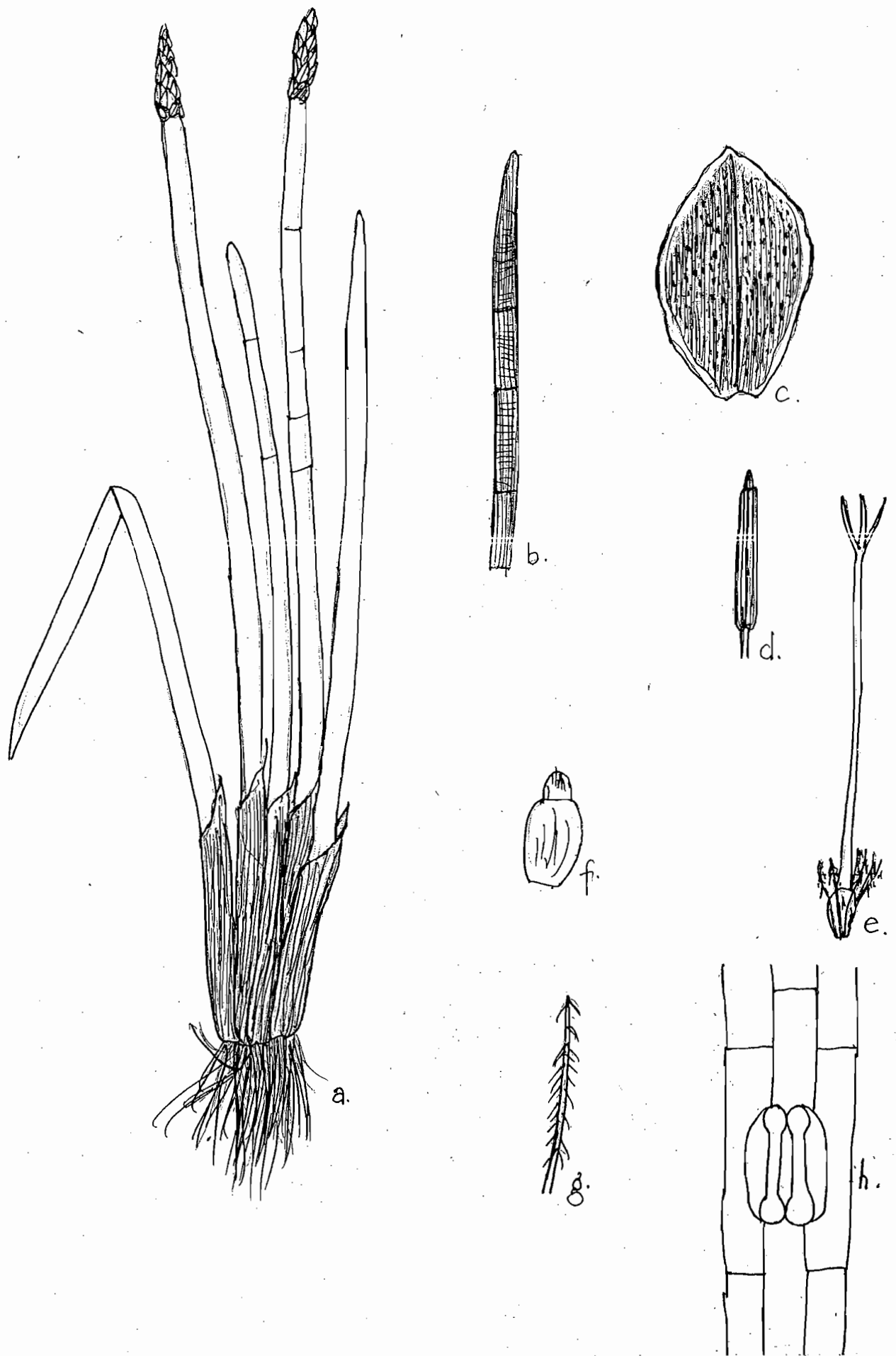


Fig. 523. *Eleocharis plantaginea* R. Br., a. habit, b. leaf showing longitudinal and transverse ridges, c. glume, d. stamen, e. gynoecium with bristles, g. bristles, h. graminaceous stomata.

green keel which is prolonged in to a cuspidate point. Stamens 1-3; anthers small, obtuse. Ovary obovoid, somewhat flattened; style long, base more or less flattened, pubescent; stigma 2. Nut broadly turbinate, minutely stipitate, umbonate, compressed, biconvex, with 6-9 broad trabeculate ribs, pale straw-colored or almost white; style densely villous in the upper part, with a small globose bulbous base; stigmas 2, recurved. (Fig. 524)

Flowers: October-April.

Micromorphology (Fig. 524)

Leaf showed presence of unicellular, non-glandular, elongated trichome with thin wall and a broad lumen.

Stomata were of graminaceous type.

D/916-920.

8. *Fuirena ciliaris* (L.) Roxb. Hort. Bengal. 81. 1814.

A perennial rhizomatous tufted creeping herb with leaves throughout the length of the culms. Leaf sheaths well developed at base; ligule tubular, leaf blades cauline, flat, usually hairy. Involucral bracts mostly short, not exceeding the inflorescence. Inflorescence of 2 or more head like clusters of spikelets. Spikelets mostly sessile many flowered; rachilla persistent, with vertically elongated pits. Flowers bisexual, glumes spirally arranged, caducous. Perianth with three bristles and three scales. Perianth scales clavate but hastate at the base, about 1.5 mm long. Stamens 3, styles caducous, not swollen at the base; stigmas 3. Nut 3-sided, obovoid, falling off enclosed in perianth. (Fig. 525)

Flowers: June-September.

Micromorphology (Fig. 525)

The plant showed presence of non-glandular unicellular trichome with round base.

Stomata graminaceous.

D/106.

9. *Kyllinga triceps* Rottb. Descrip. et Icon. (1773) p. 14, t. 4.

A tufted glabrous herb with a short rhizome and stems reaching 30 cm long. Leaves shorter than the stem, linear, acute. Spikes ovoid-oblong or sub-cylindric, in threes, the middle one the largest. , rachis covered with the persistent lower glumes; bracts beneath the head 3-4, leaf-like, up to 8 cm long. two lower glumes hyaline, the lowest and second lanceolate and hyaline, the third and fourth larger, green, ovate-lanceolate, strongly nerved. Stamens 2. Ovary suborbicular; style short, stigmas 2, linear. Nut oblong or ellipsoid-oblong, yellowish-brown, much compressed, surface papillose. (Fig. 526)

Flowers: Sept.

Micromorphology (Fig. 526)

Stomata graminaceous.

D/986-988, 1224-1226.

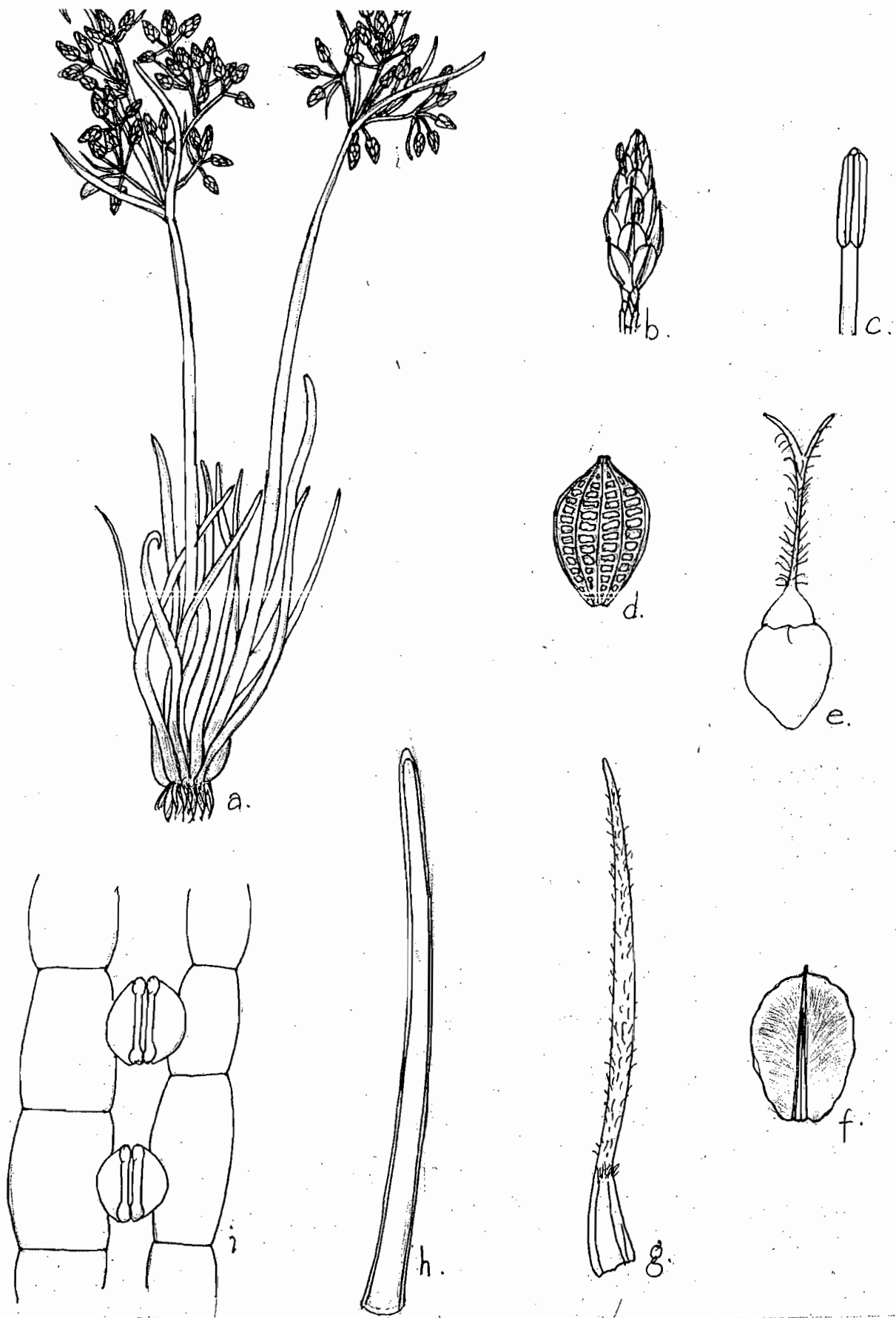


Fig. 524. *Fimbristylis dichotoma* Vahl., a. habit, b. inflorescence, c. stamen, d. nut, e. gynoecium, f. glume, g. leaf with leaf sheath, h. unicellular trichome with thin wall and broad lumen, i. graminaceous stomata.

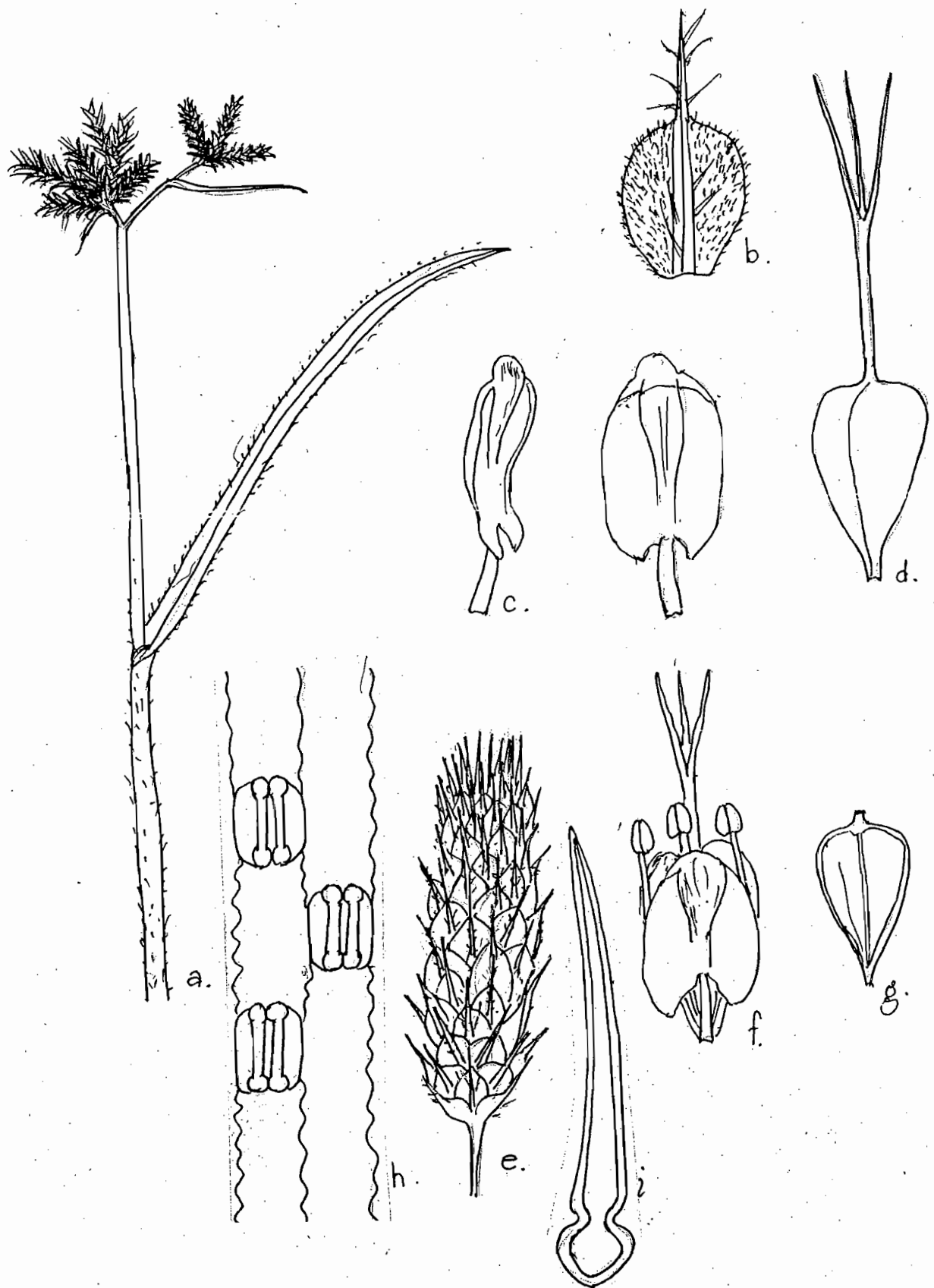


Fig. 525 *Fuirena ciliaris* (L.) Roxb., a. habit, b. glume, c. stamen, d. gynoecium, e. inflorescence, f. gynoecium with stamen and spathaceous scales, g. nut, h. graminaceous stomata, i. unicellular trichome with thick wall, broad lumen and constriction towards the base which gives the appearance of presence of small basal cell.

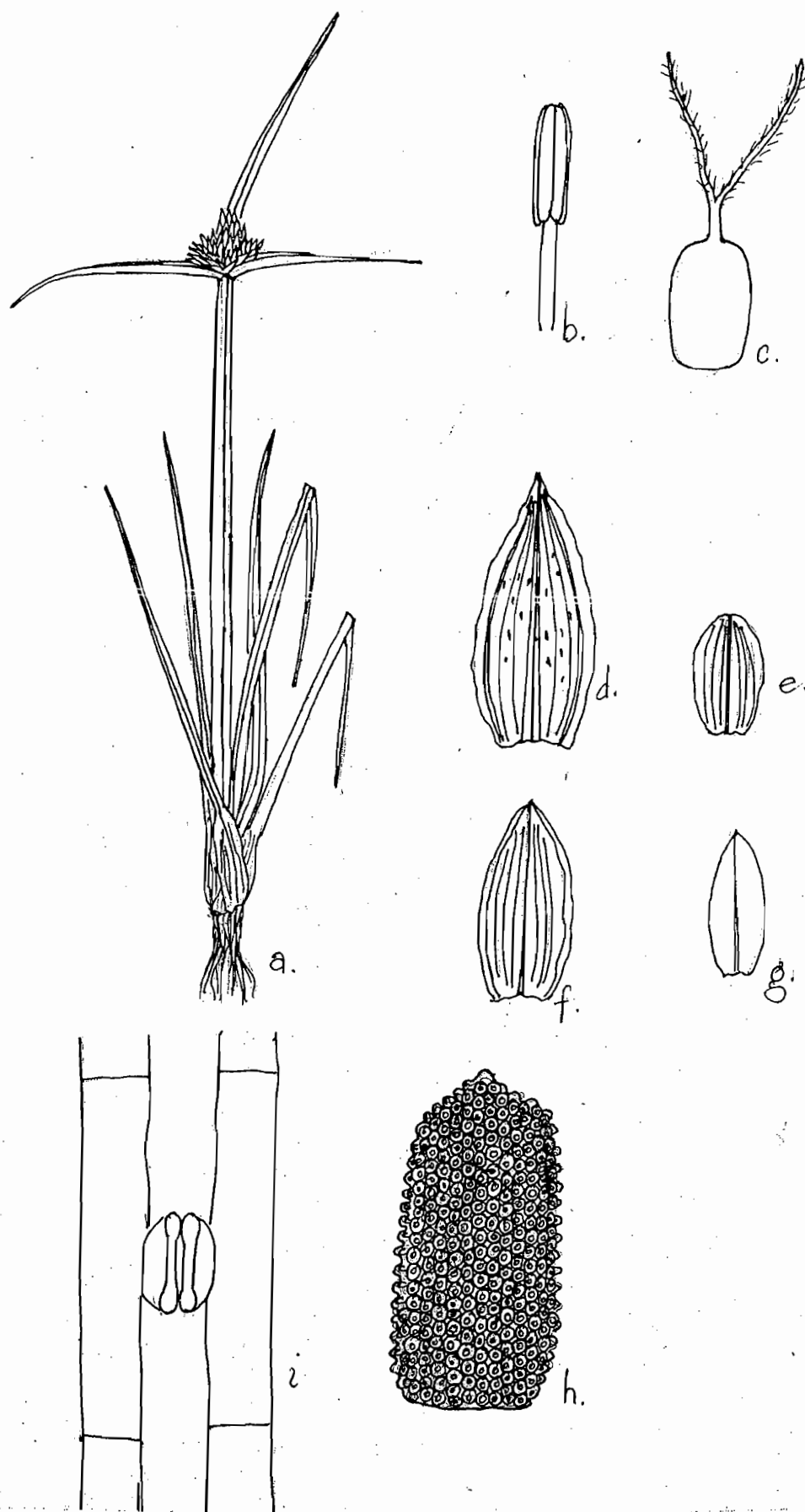


Fig. 526. *Kyllinga triceps* Rottb., a. habit, b. stamen, c. gynoecium, d. outermost involucre, f. innermost involucre, e. outermost floral glume, g. innermost floral glume, h. nut, i. graminaceous stomata.

**10. *Lipocarpa squarrosa* (L.) Goetgh. *Wageningen Agric. Univ. Pap.* 89 (1): 71. 1989.
(*Scirpus squarrosus* Linn.)**

A glabrous tufted annual with filiform, terete and striate stem reaching upto 15 cm high. Leaves filiform, acuminate; sheaths short, open. Spikelets solitary or 2-4 in a cluster, globose or oblong, many-flowered; bracts 1-3, finely acuminate, leaf-like, dilated at the base, one or two sometimes 2.5 cm long. Glumes imbricate, squarrosely spreading and recurved cusp as long as or longer than the blade with a stout central nerve; hypogynous bristles 0. Stamens 1 or 2; anthers minute, oblong, apiculate, yellow. Nut obovoid-ellipsoid, trigonous, yellow, brown or ultimately black. (Fig. 527)

Flowers: October-December.

Micromorphology (Fig. 527)

Stomata graminaceous.

D/241.

**11. *Pycneus pumilus* Nees. in *Linnea*, 9: 283, 1834
(*Cyperus pumilus* Linn.)**

An annual with 30 cm long tufted slender stems and linear, 1-nerved leaves. Spikelets in heads, sometimes umbellate, the rays of the umbel 1-6, occasionally though rarely reaching 8 cm long; bracts 3-4, leaf-like, up to 10 cm long. Spikelets 20-50 flowered, much compressed; rhachilla stout. Glumes distichous, ovate, boat-shaped, 2-fid at the tip with a narrow herbaceous keel which is cuspidately produced at the apex, with 3-5 conspicuous brown nerves and rounded hyaline margins. Stamen 1; anthers linear. Nuts ellipsoid-oblong or subovoid, apiculate, biconvex, laterally compressed and brown. (Fig. 528)

Flowers: July-October.

Micromorphology (Fig. 528)

Stomata graminaceous and epidermal cell walls appeared pitted.

D/947-952, 1151-1153.

**12. *Schoenoplectus articulatus* (L.) Palla *Bot. Jahrb. Syst.* 10: 299. 1888.
(*Scirpus articulatus* Linn.)**

A glabrous tall perennial herb with densely tufted, spongy and transversely septate stems upto 1 m long. Leaves 0, or the sheaths with a membranous acute tip sometimes upto 2.5 cm long. Spikelets variable in length, upto 2 cm long, ovoid-oblong, obscurely angular, rusty-brown, sessile in laterally stellately spreading clusters; bracts 0. Glumes broadly ovate, mucronate, imbricate, membranous, concave, persistent, with a subcordate base and hyaline margins. Stamens 3; anthers linear, yellow. Nut obovoid, triquetrous, black, opaque, striate with transverse wavy lines; style short; stigmas 3. (Fig. 529)

Vernacular name: Chichora

Flowers: September-April.

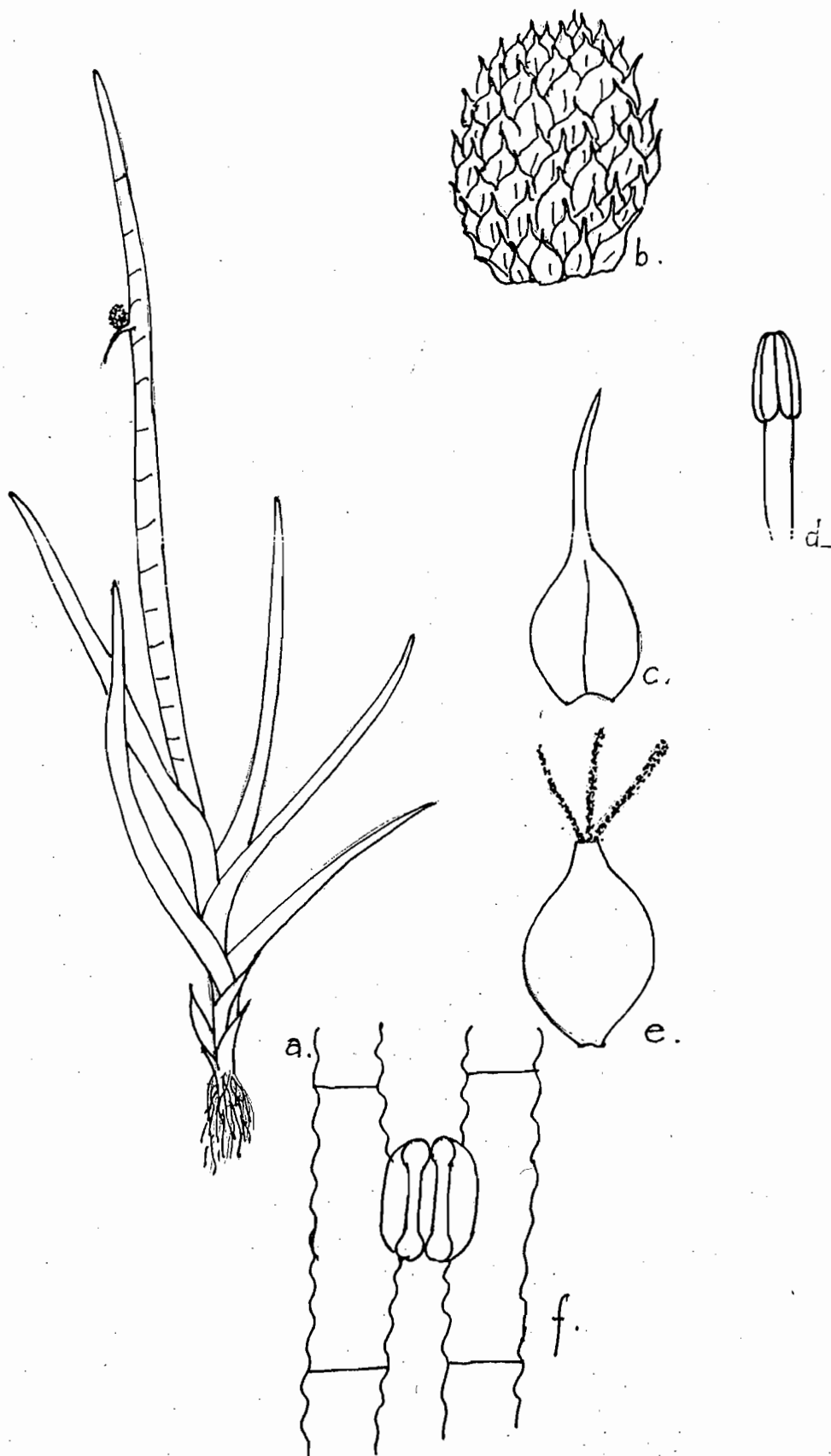


Fig. 527. *Lipocarpa squarrosa* (L.) Goetgh., a. habit, b. inflorescence, c. glume, d. stamen, e. gynoecium, f. graminaceous stomata.

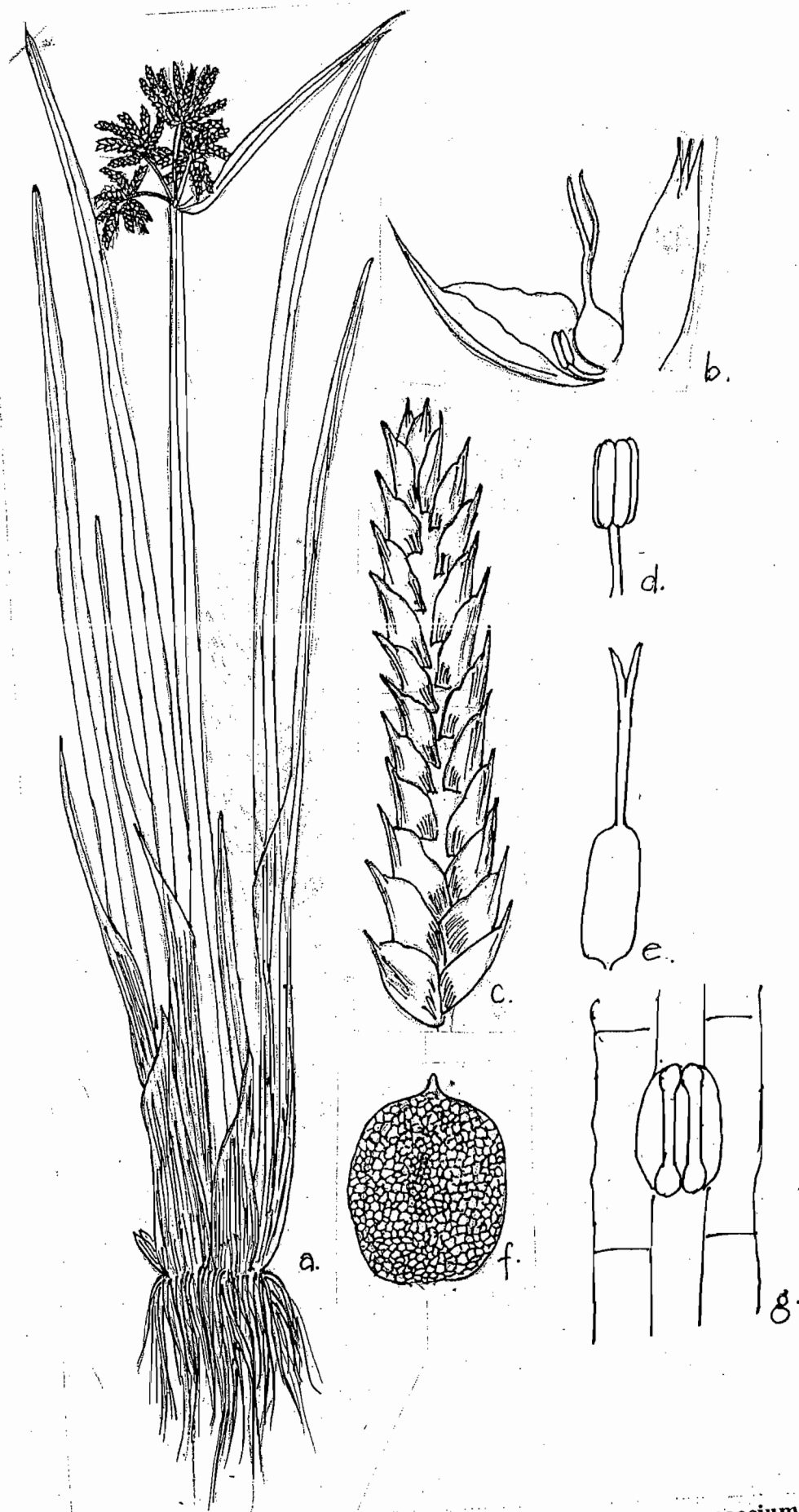


Fig. 528. *Pycreus pumilus* Nees., a. habit, b. spikelet open to show gynoecium and stamen, c. inflorescence, d. stamen, e. gynoecium, f. nut, g. graminaceous stomata.

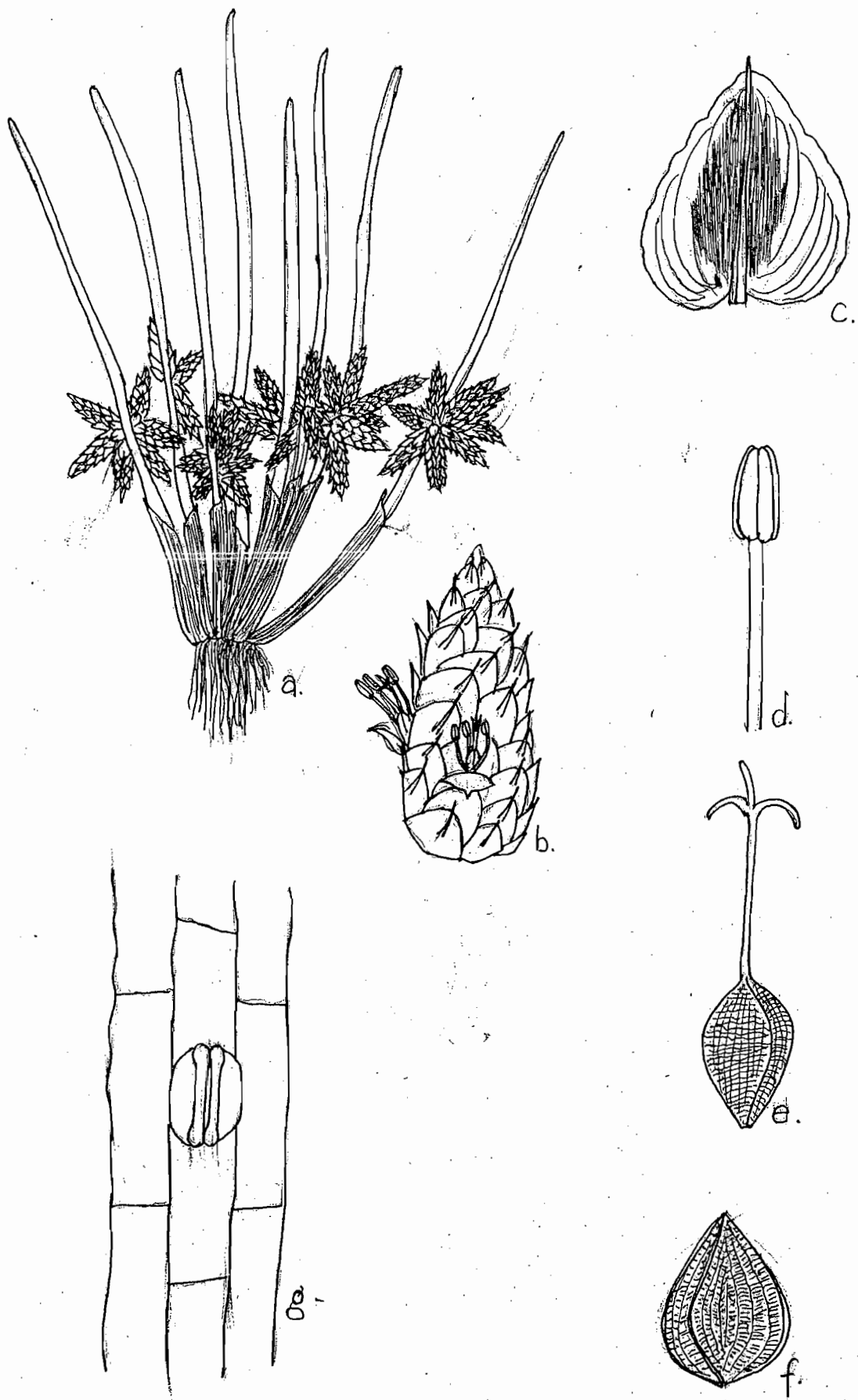


Fig. 529. *Schoenoplectus articulatus* (L.) Palla., a. habit, b. inflorescence, c. glume, d. stamen, e. gynoecium, f. nut, g. graminaceous stomata.

Micromorphology (Fig. 529)

Whole plant was glabrous.

Stomata were of graminaceous type.

D/429, 439, 939.

13. *Stenophyllus barbata* (Scirpus) Rottb. *Descrip. et Icon.* (1773) p. 52.

(*Bulbostylis barbata* Kunth.)

An annual reaching upto 30 cm high with tufted, filiform stems. Leaves capillary, scaberulous upwards, acuminate; sheaths short, membranous, with bearded mouths. Spikelets small, crowded in a imbricate head or umbellate; few-flowered, oblong-lanceolate, reddish-brown, crowded in a terminal head; bracts shorter than or rarely exceeding the spikelets; rachilla stout. Glumes few or many, imbricate all round the rachilla, 1-2 lowest and often the upper-most empty; ovate, compressed, boat-shaped, with the stout acute keel ending in a mucro. Hypogynous bristles 0. Stamen 1; anther linear. Ovary obovoid; style slender; stigmas 3. Nut globosely obovoid, trigonous with prominent angles. (Fig. 530)

Micromorphology (Fig. 530)

Whole plant was glabrous.

Stomata were of graminaceous type.

D/925-928.

Poaceae

1. *Chloris barbata* Sw. *Fl. Ind. Occ.* V. 1 (1797) p. 200.

A perennial grass with tufted stems and strong rootfibres reaching upto 1 m height. Leaves flat, narrowly linear, ligule short. Spikes 5-20 in a truncate fascicles, spikelets 3-awned. Involucral glumes two, persisting. Sterile glume bearing two small turgid awned barren glumes. Involucral glumes hyaline. Floral glumes broadly elliptic, shortly awned with densely bearded margin above the middle. Palea oblanceolate. Lodicules two, small. Stamens three. Ovary glabrous. (Fig. 531)

Flowers: November.

Vernacular name: Gondvel.

Micromorphology (Fig. 531)

Stomata were of graminaceous type.

D/941.

2. *Coix lachryma-jobi* Linn. *Sp. Pl.* (1753) p. 972.

The plant is an erect herb with a stout stem reaching a height of 2 m. Leaves narrowed from a broad cordate base to an acuminate tip, upto 40 cm long, serrate margins; midrib stout; sheaths long, smooth; ligule a very narrow membrane. Racemes about 7 cm long, nodding or drooping from long peduncles; lower spikelets solitary, female enclosed in a ultimately hardened polished nut like bract, through the apex of which the male portion of the spike protrudes. Male spikelets;

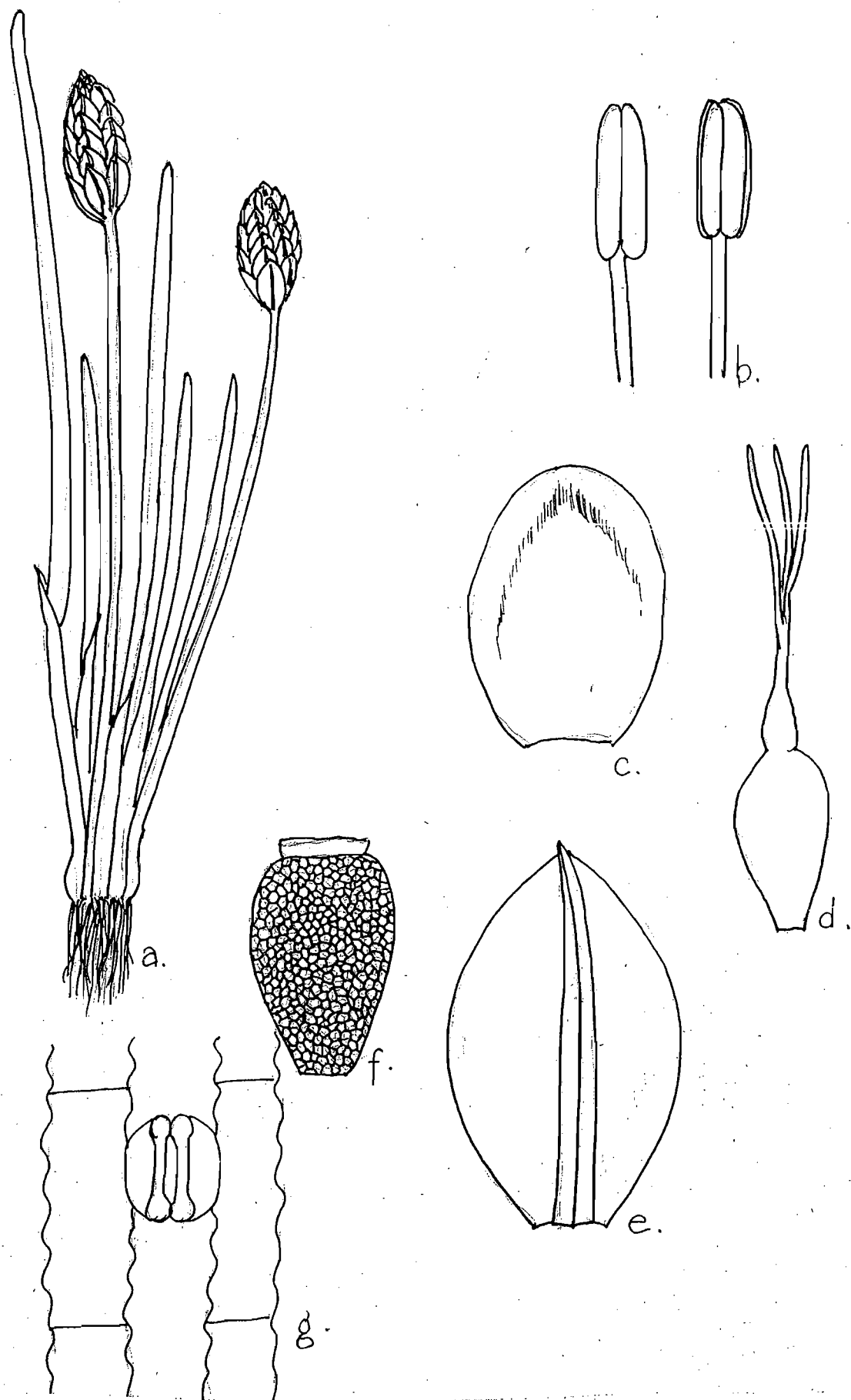


Fig. 530. *Stenophyllus barbata* Rottb., a. habit, b. stamen, c. floral glume, d. gynoeceium, e. involucral glume, f. nut, g. graminaceous stomata.

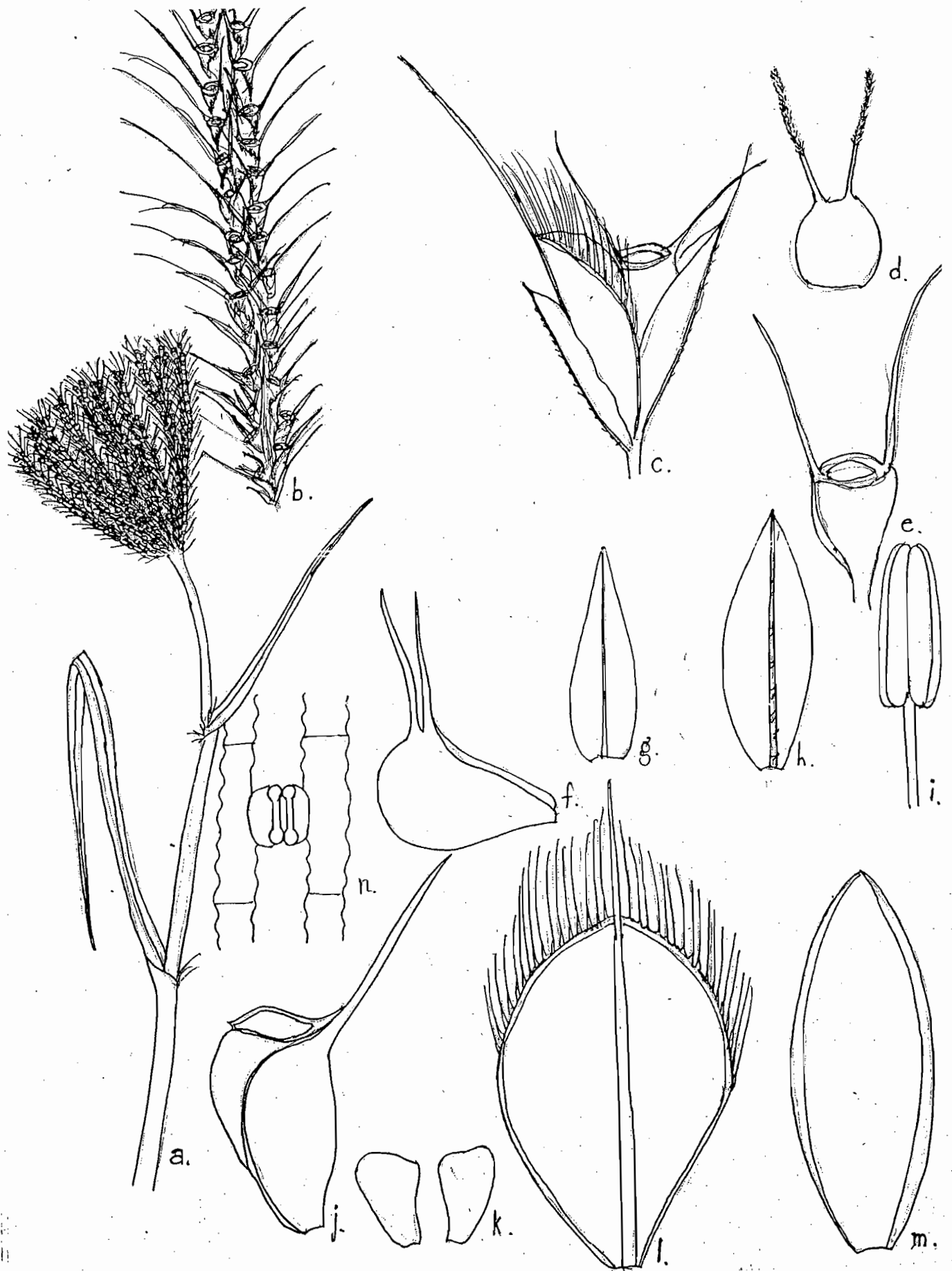


Fig. 53) *Chloris barbata* Sw. a. habit, b. inflorescence, c. spikelet, d. gynoecium, e. floret, f. empty lemma, g-h. glume, i. stamen, j. oblongate empty lemma, k. lodicules, l-m. floral glume, n. graminaceous stomata.

glumes 3, lower involucre glume elliptic-lanceolate winged. Floral glumes hyaline. Stamens 3. Female spikelets ovoid, glumes 3, lower involucre glume chartaceous. Upper three thinner. Staminate minute. Ovary ovoid. Grain orbicular, bluish-grey, ventrally furrowed enclosed in the hardened globose, ovoid cylindric involucre.

Variation observed: In floras the number of glumes in spikelets were reported to be four, but the specimen I had only three glumes in both male and female spikelets (Fig. 532).

Vernacular name: Kahudo.

Flowers: August-December.

Micromorphology (Fig. 532)

Trichomes absent but dumb-bell shaped silica bodies was observed in the epidermis of leaves.

Stomata graminaceous.

D/850- 853.

3. *Dendrocalamus strictus* Nees in *Linnaea*, V. 9 (1834) p. 476.

Bambusa stricta Roxb.

A deciduous densely tufted bamboo with strong solid stems upto 18 m high with long internodes and stem sheaths with long triangular blade. Leaves shortly petiolate, linear-lanceolate, 25 cm long; rough and often hairy above, softly hairy beneath, with scabrous margins; nerves 3-6 pairs, with interposed pellucid glands. Inflorescence a large branching panicle of dense globular heads about 2.5 cm in diameter, upto 5 cm apart. Spikelets spinescent, the fertile 2-3. Involucral glumes 2 or more, ovate, spinescent, many-nerved; floral glumes ovate, ending in a sharp spine, surrounded by ciliate tufts of hairs; palea ovate or obovate, emarginated, the lower ones 2-keeled, the uppermost keelless, 6-8 nerved. Stamens long-exserted; anthers yellow shortly apiculate. Ovary stipitate, turbinate; style long; stigma simple, plumose. Grain ovoid to subglobose, brown. (Fig. 533)

Vernacular name: Manvel vans.

Flowers: December-March.

Micromorphology (Fig. 533)

The plant showed presence of unicellular, non-glandular, elongated, thick walled trichome with a round bottom. Along with trichomes it also showed presence of silica bodies of oblong shaped.

Stomata were graminaceous.

D/1051, 1058, 1060.

5. *Desmostachya bipinnata* (Linn.) Stapf in *Thiselt.-Dyer, Fl. Cap.* 7:632. 1900.

A tall perennial with stout creeping rootstock and stout stolons clothed with leaf sheaths. Leaves many basal, fascicled very long, ligule margins with long hairs. Ligule absent. Panicle erect, columnar interrupted with branches containing unilateral spikelets. Spikelets biserial deflexed. Floral glume coriaceous. Keels minutely scabrid. Stamens 3. Grain obliquely ovoid, trigonous and laterally compressed. (Fig. 534)

Flowers: July-November.

Vernacular name: Darbha.



Fig. 532. *Coix lachryma-jobi* L., a. habit, b. spikelet, c-d. involucre glume, e. lodicules, f-g. floral glume, h. gynoecium with floral glumes, i. palea, j. stamen, k. gynoecium, l. graminaceous stomata, m. dumbbell shaped silica body.

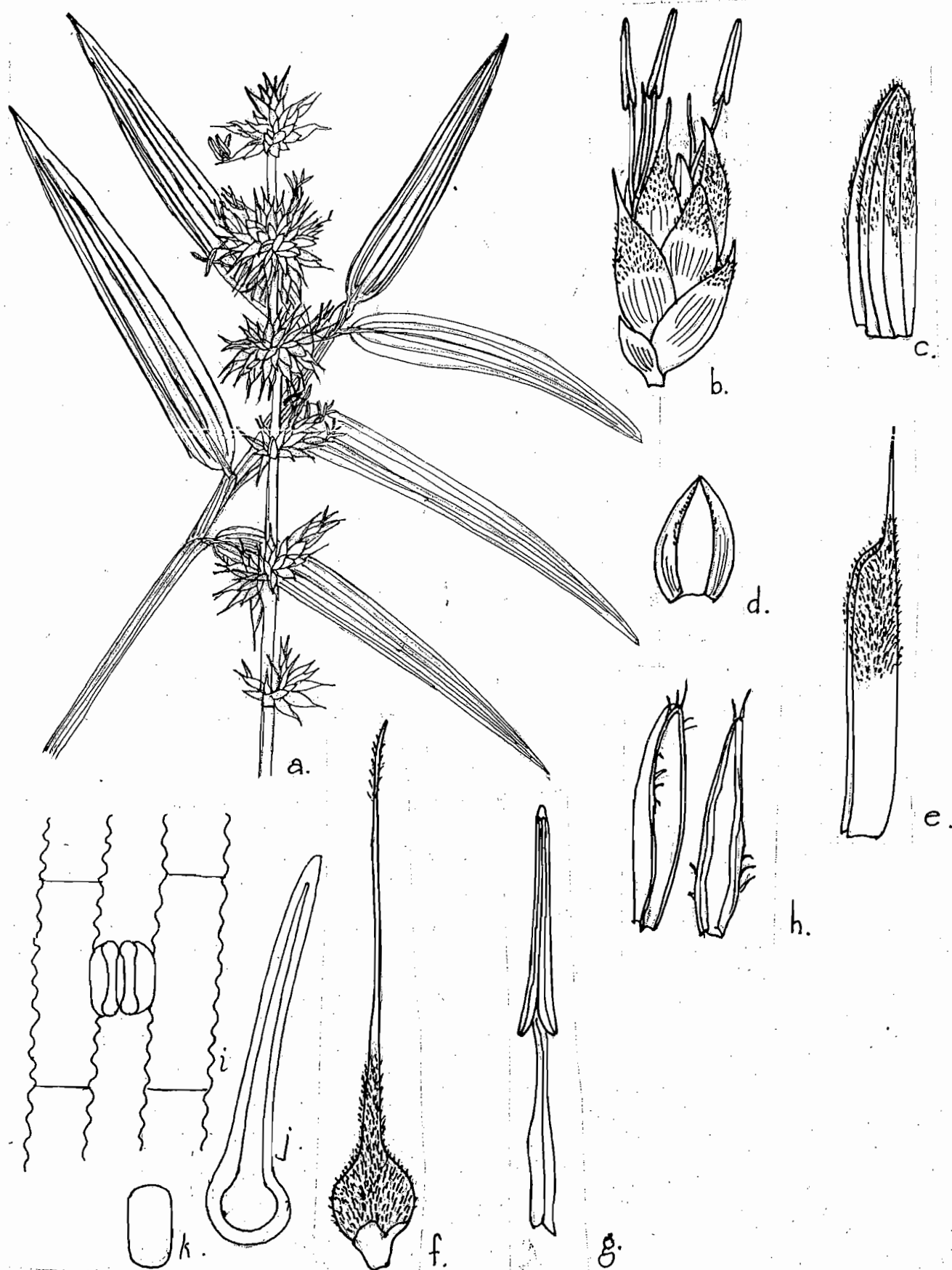


Fig. 533 *Dendrocalamus stricta* Nees., a. habit, b. spikelet, c-d. empty glumes, e. involucral glume, f. gynoecium, g. stamen, h. floral glume, i. graminaceous stomata, j. unicellular trichome, k. silica body.



Fig. 534. *Desmostachya bipinnata* Stapf. a. habit, b-d. glumes, e. spikelet, f. gynoecium, g. stamen, h-i. floral glume, j. graminaceous stomata.

Micromorphology (Fig. 534)

Stomata were graminaceous.

D/937-938, 1222.

4. *Dinebra retroflexa* (Vahl) Panz. in *Denskshr. Acad. Wiss.* 491.

(*Dinebra arabica* Jacq.)

An annual leafy grass with tufted, stout stems upto 1 m high. Leaves linear, finely acuminate, upto 20 cm long; sheaths thin, loose, glabrous; ligule a narrow lacerate membrane. Spikes racemosely arranged along the axis of an inflorescence upto 30 cm long, single or in fascicles of 2-3 together; rhachis dorsally flattened, ventrally trigonous. Spikelets 2-3 flowered, alternate. Glumes 4-5; Involucral-glumes, 1 nerved, keeled, lanceolate, hyaline, with slightly recurved minutely scaberulous awns, the lower involucral-glume shorter than the upper; floral glumes small broadly ovate, hyaline, 1-nerved; palea hyaline, shorter than the glume, linear-oblong, with finely ciliolate keels. Lodicules 2 minute. Stamens 3; anthers minute, didymous. Styles free, short; stigmas exerted at the apex of the glume, shortly penicillate. Grain ovoid, trigonous, ellipsoid-oblong, pale brown. (Fig. 535)

Flowers: August-December.

Micromorphology (Fig. 535)

Leaf showed presence of linear, two celled trichome and more or less dumbbell shaped silica bodies.

Stomata were graminaceous.

D/179.

5. *Echinochloa colonum* (L.) Link. *Hort. Berol.* 2:209, 1833

Annual; stem upto 60 cm long, slender, decumbent or shortly creeping below; nodes glabrous or puberulous. Leaves upto 20 by 1 cm, narrowly lanceolate or linear, acuminate, flat, glabrous, with scaberulous margins; sheathes up to 15 cm long; ligule 0. Spikes 8-20, suberect, on the angles. Spikelets 0.5 cm long, globosely ovoid, acute or subcuspidate, more or less hispidly pubescent, second, sessile, 3-5-seriate. Glumes 6; lower involucral glume about $\frac{1}{2}$ as long as the lower floral glume, broadly ovate or suborbicular, membranous, 3-nerved, ciliolate; upper involucral glume about equal to the lower floral glume, broadly ovate, cuspidate, concave, 5-7 nerved, hairy; lower floral glume similar, empty, with a hyaline palea; upper floral glume coriaceous, broadly ovate, turgid, acute, finely striolate, polished, yellowish-white, with a coriaceous palea. (Fig. 536)

Flower: Throughout the year.

Variations observed: in the specimens I dissected there were six glumes in every spikelets, but only four glumes reported in the literature.

Micromorphology (Fig. 536)

Whole plant was glabrous but it showed presence of beaded (moniliform) silica bodies.

Stomata graminaceous.

D/587, 961, 962.

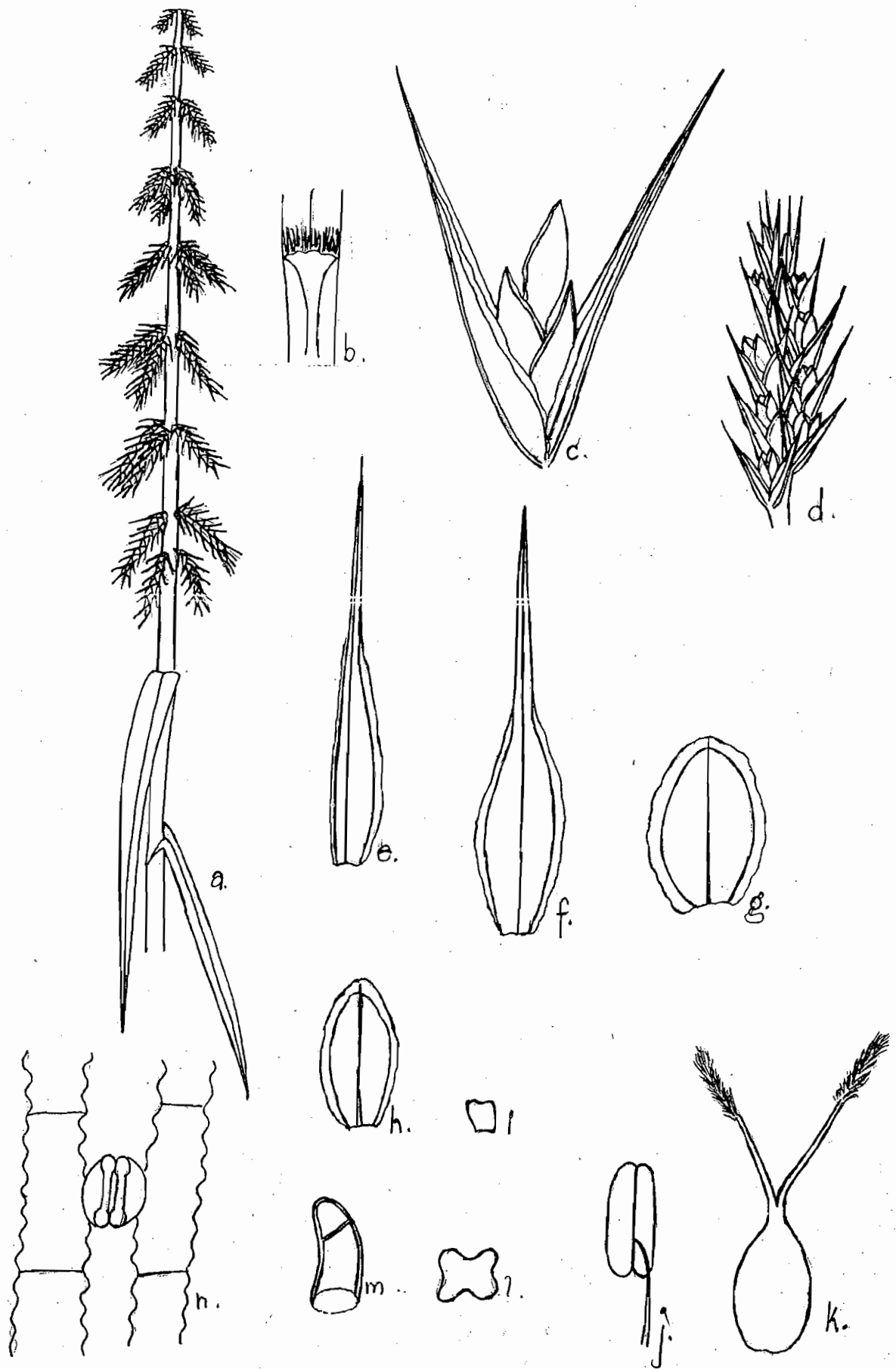


Fig. 535. *Dinebra retroflexa* (Vahl.) Panz., a. habit, b. ligule, c. spikelet, d. inflorescence, e-f. empty glume, g-h. floral glume, i. lodicule, j. stamen, k. gynoecium, l. silica body (dumbel shaped), m. two-celled uniseriate trichome, n. graminaceous stomata.

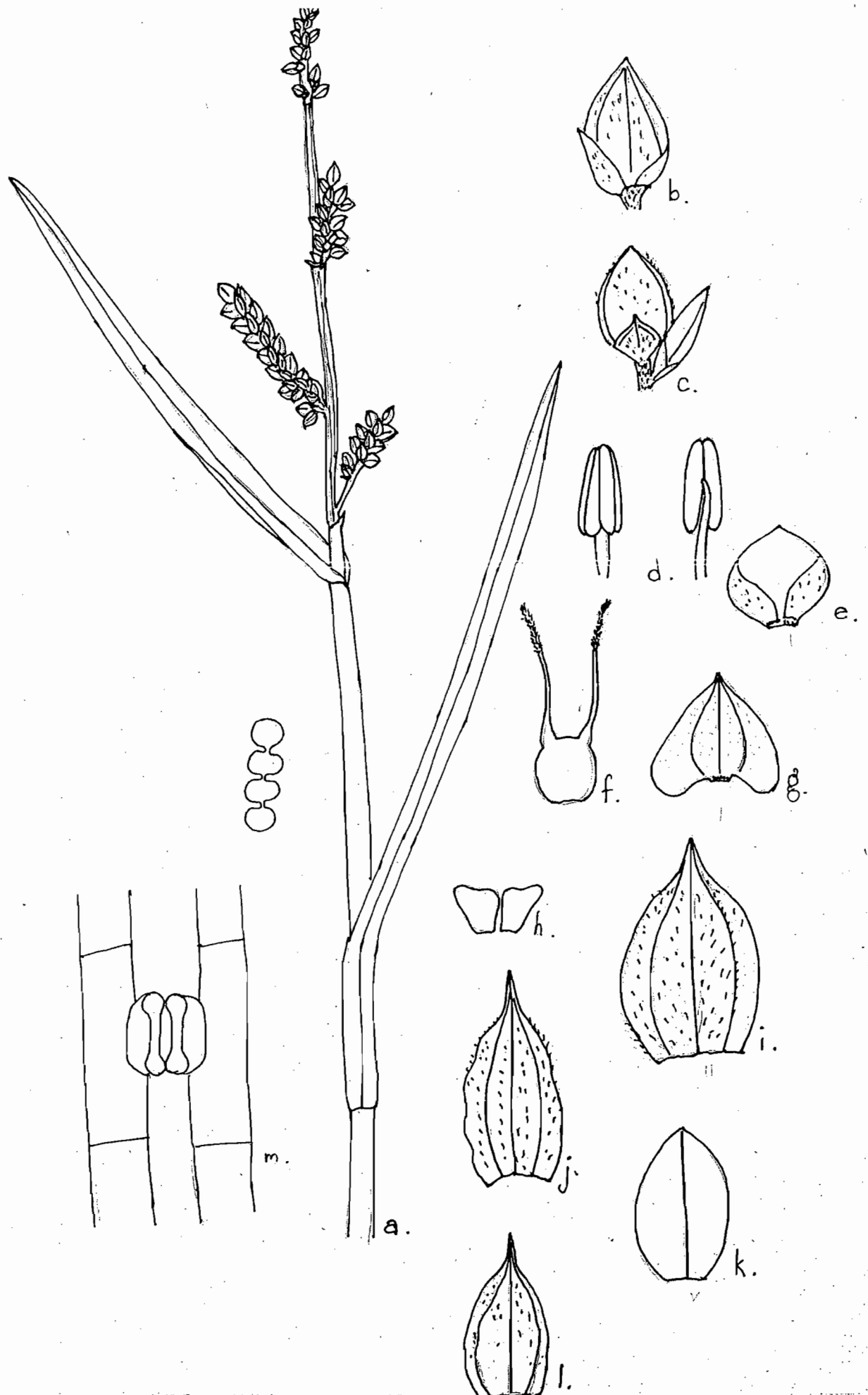


Fig. 536. *Echinochloa colonum* (L.) Link., a. habit, b-c. spikelet, d. stamen, e. empty outermost glume, f. gynoecium, g. empty involucre glume, h. lodicule, i-j. floral outermost glume, k-l. inner floral glume, m. graminaceous stomata

6. *Eleusine aegyptiaca* Desf. *Fl. Atlant.* V. 1 (1798) p. 85

Annual of variable habit, 15-22 cm high; stems sometimes prostrate, rooting from the proliferously branched nodes, geniculately ascending, compressed, glabrous, smooth. Leaves linear, 3-12 by 0.2-0.5 cm, tapering to a fine point, flat, glaucous, glabrous or hairy or hispidly ciliate with bulbous-based hairs; ligule a slightly ciliolate line. Spikes 2-6, digitately radiating, 1-4 cm long; rachis trigonous or dorsally flattened, rigid, often excurrent into a pungent mucro. Spikelets many, 3-5 flowered, spreading at right angles to the rachis. Glumes divaricate; lower involucre glume ovate, acute; upper involucre glume smaller (excluding the awn), suborbicular, the mid-nerve produced into a usually curved awn often as long as or sometimes longer than the glume; floral glumes gibbously ovate, mucronate or awned; palea rather shorter than its glume, ovate-oblong, obtuse or 2 fid. Anthers small. Grain subglobose, reddish, very rugose. (Fig. 537)

Micromorphology (Fig. 537)

Stomata were of graminaceous type.

Silica body is somewhat globular or dumb bell shaped.

D/214.

7. *Eragrostis ciliaris* Link, *Hort. Reg. Berol.* V. 1 (1827) p. 192.

Stems upto 25 cm long, tufted, geniculately ascending, glabrous, smooth. Leaves upto 7 cm, linear, tapering to a fine point; sheaths striate, usually bearded at the mouth with long hairs; ligule a fringe of short hairs. Panicle short, upto 4 cm long, oblong, cylindric, appearing hairy from the long cilia of the palea; branches short, suberect. Spikelets 0.25 cm long, crowded, 6-12 flowered, strongly compressed; rhachilla breaking up; pedicels very short. Glumes many Involucre glumes subequal, ovate-lanceolate, acute; floral glumes oblong, subtruncate, mucronulate, spreading; palea equal to their glumes and falling with them, the keels with long rigid cilia. Stamens 3; anthers very short. Grain elongate-ovoid. (Fig. 538)

Flowers: November.

Micromorphology (Fig. 538)

Whole plant was glabrous, but it showed presence of small oblong silica bodies.

Stomata were graminaceous.

D/856-857, 898-901.

8. *Eragrostis unioides* Nees. ex. Stued. *Syn. Gram.* (1855) p. 264.

Annual, glabrous ; stems 15-45 cm long, tufted, slender, erect, or geniculately ascending, leafy chiefly at the base ; internodes long. Leaves upto 15 cm, narrowed from a broad subcordate base to an acute tip, smooth; sheaths smooth, glabrous; ligule 0 or obscure. Panicle oblong or ovoid, upto 10 cm long, sparingly branched; rhachis and nodes glabrous. Spikelets 0.6 cm long, compressed, ovoid-elliptic or oblong, 20-50 flowered, shortly pedicellated, often purple; rhachilla tough, internodes very short. Glumes elegantly distichous, spreading, keeled; involucre glumes subequal or the upper slightly longer than the lower, ovate, acute, 1-nerved; floral glumes broadly ovate or suborbicular, mucronulate, punctulate; palea shorter than its glume and deciduous with it. Stamens 3;

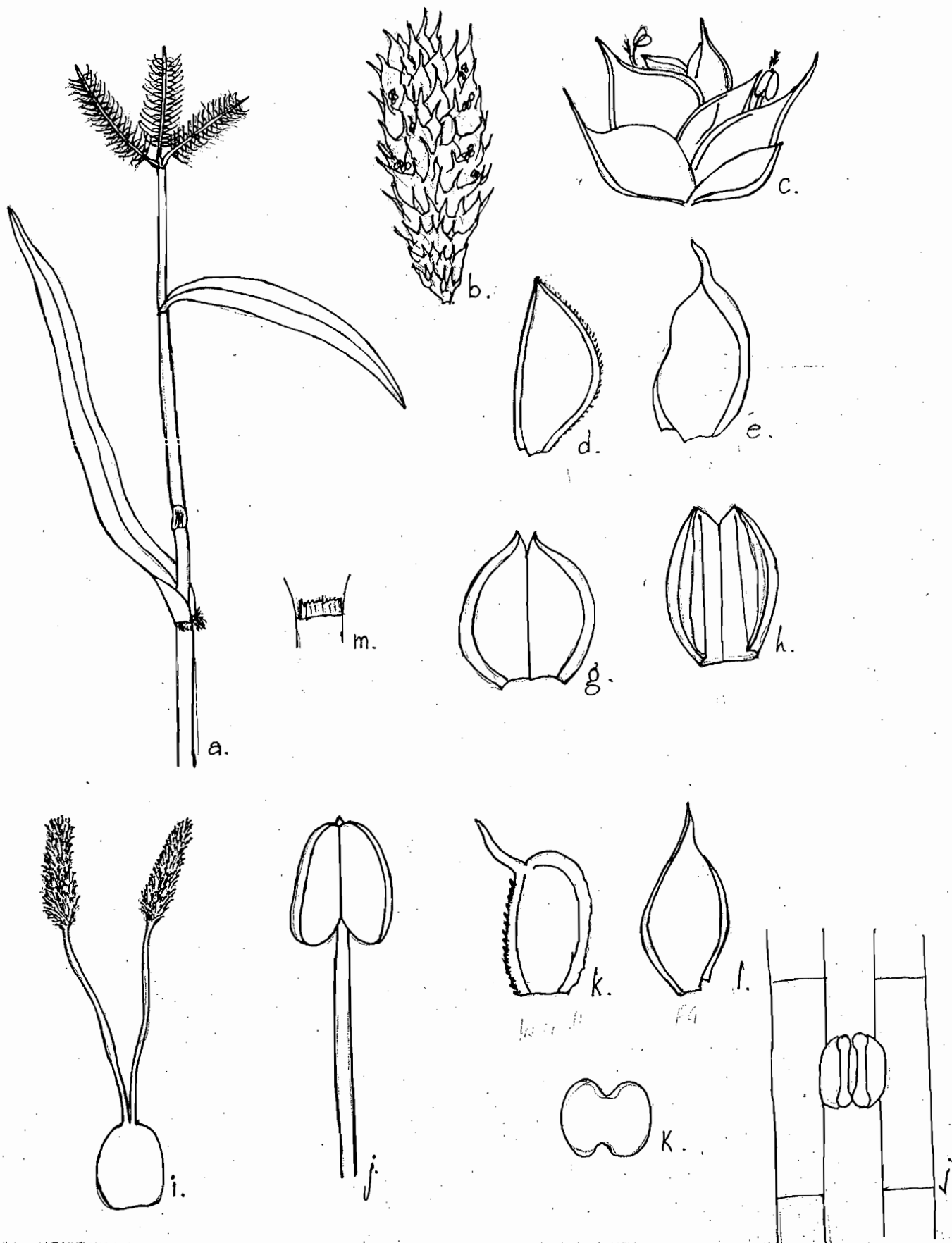


Fig. 537 *Eleusine aegyptiaca* Desf., a. habit, b. inflorescence, c. spikelet, d. involucre glume I, e. floral glume I, f. palea I, g. Palea II, h. involucre glume II, i. floral glume II, j. ligule, k. stamen, l. gynoecium, m. graminaceous stomata, n. silica body (dumbel shaped).

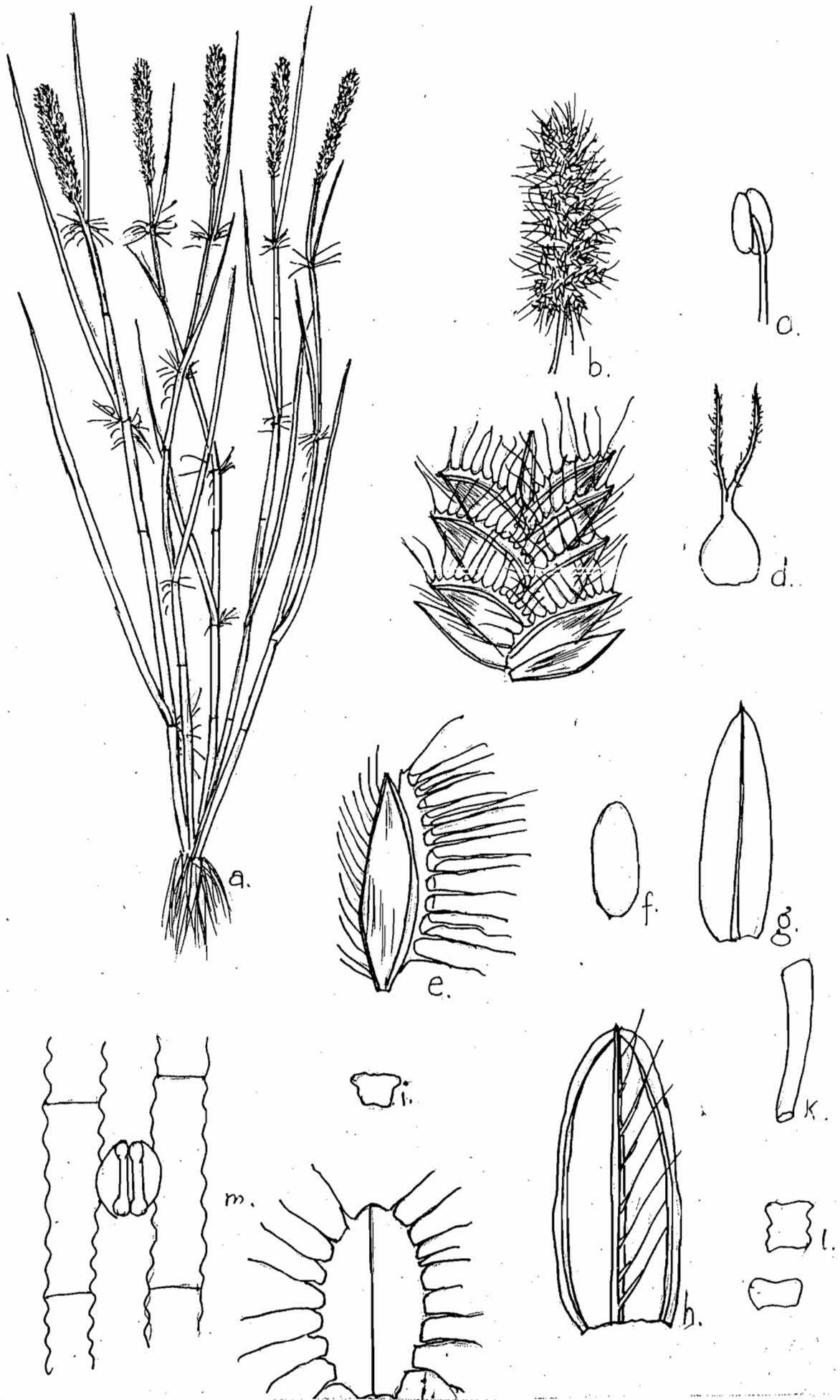


Fig. 538. *Eragrostis ciliaris* Link., a. habit, b. inflorescence, c. stamen, d. gynoecium, e. floret, f-g. floral glume, i. lodicule, j & h. involucre glume, k. unicellular trichome, l. silica body, m. graminaceous stomata.

thers minute. Grain obovoid or ellipsoid, laterally compressed, about orange-brown, smooth. (Fig. 539)

Flowers: July-November.

Micromorphology (Fig. 539)

Whole plant was glabrous.

Stomata were of graminaceous type.

D/270.

9. *Ischaemum rugosum* Salisb. *Ic. Stipe. Rar.* (1791) p. 1, t. 1.

Annual; stems upto 60 cm long, erect or ascending, slightly thickened beneath the inflorescence, leafy, compressed; nodes glabrous or bearded. Leaves upto 15 cm, linear-lanceolate, acuminate, flat, glabrous or sparsely hairy, the margins scabrid, the uppermost leaves often reduced to spathiform lanceolate sheaths which partially enclose the racemes; sheaths compressed, loose, glabrous, the mouth auricled, the auricles membranous, confluent with truncate ligules. Racemes usually 2, erect, pale yellow, glabrous, upto 8 cm long, fragile; rhachis trigonous, ciliate on the dorsal angle. Spikelets reaching 0.7 cm long or more, linear-oblong, the sessile and pedicellate closely pressed together; pedicel of the latter very short and thick, clavate, angular, confluent with the bristly thick callus of the sessile spikelet. Sessile spikelets: lower Involucral glumes cartilaginous for 2/3 of its length from the base, the cartilaginous portion pale yellow, shining, concave, crossed by 3-6 deep smooth ridges, the upper third flattened, thinner, membranous, obtuse, with green veins, the margins narrowly incurved, the outer margin winged; upper Involucral glume oblong-lanceolate, acuminate, keeled, the keel with a narrow ciliolate wing below the tip; lower floral glume ovate-lanceolate, acuminate, hyaline, male or empty, paleate, the palea hyaline, narrow; upper floral glume 0.4 cm. long, deeply cleft into 2 acute lanceolate lobes; palea linear-lanceolate; awn reaching 2 cm long or more. pedicellate spikelets variable, rather shorter than the sessile; lower involucral glume like that of the sessile or with fewer or sometimes more or less obscure transverse ridges, the upper half of the glume broader and more oblique; upper involucral glume not keeled, otherwise as in the sessile spikelet; lower floral glume as in the sessile; upper floral glume oblong, obtuse, not awned. (Fig. 540)

Flowers: September-November.

Micromorphology (Fig. 540)

Whole plant was glabrous, but silica bodies were present, which were dumbbell shaped.

Stomata were graminaceous.

D/979, 1174-1178.

10. *Oplismenus burmanni* Beauv. *Agrost.* (1812) p. 54.

A very slender diffusely branched leafy grass; stems 15-45 cm long; nodes glabrous or hairy. Leaves upto 5 cm long ovate or ovate-lanceolate, acuminate, sparsely pilose with long slender white hairs; sheaths glabrous or hairy. Panicle 6 cm long; peduncle slender, usually very long; branches of panicle spike-like, few, distant, subsessile, upto 2 cm long; rhachis slender, angular, clothed with long slender white hairs nearly as long as the spikelets. Spikelets 0.25 cm long, second, solitary or 2-nate; pedicels short, hairy. Glumes

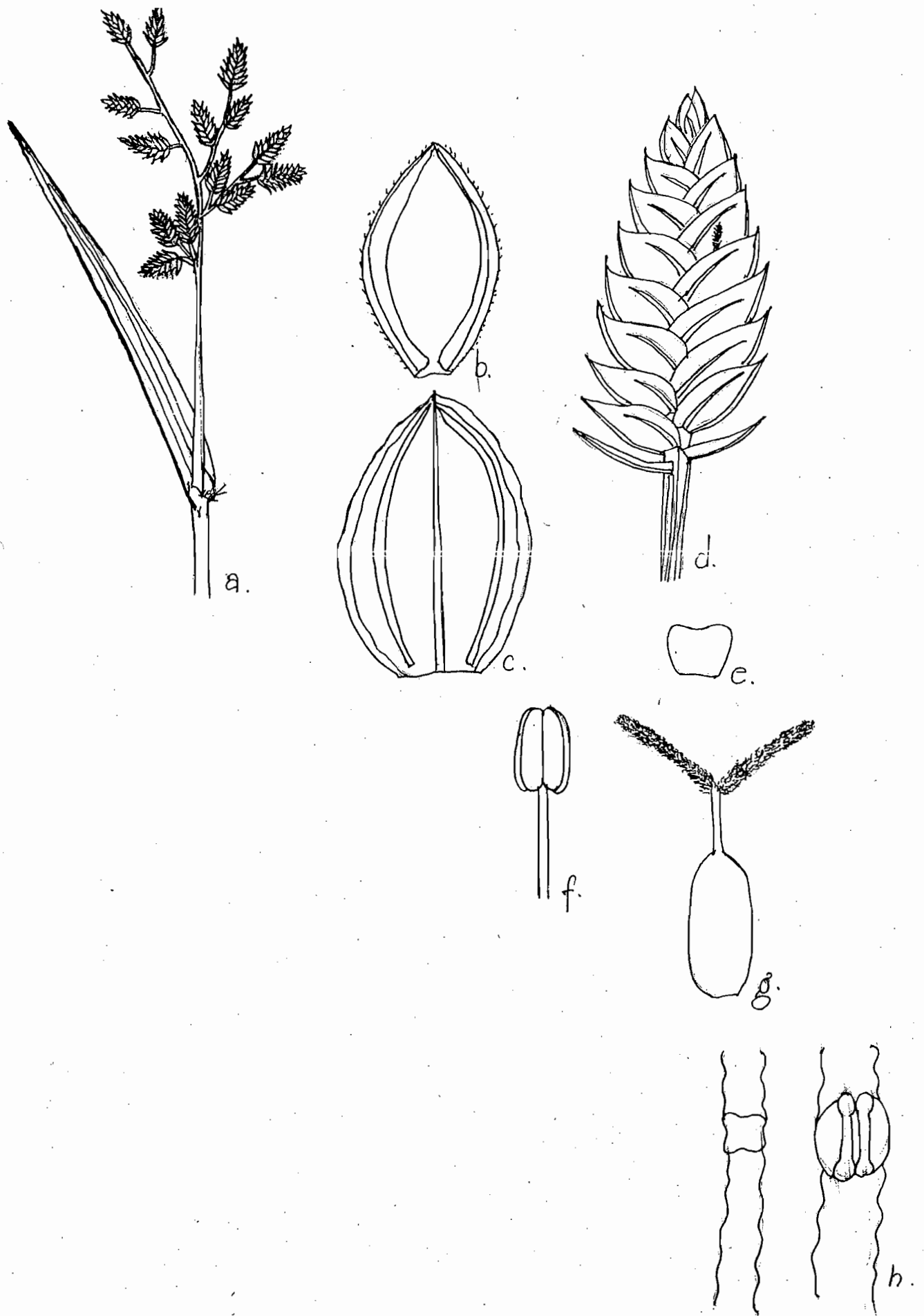


Fig. 539. *Eragrostis uniloides* Nees., a. habit, b. involucrel glume, c. floral glume, d. inflorescence, e. lodicule, f. stamen, g. gynoecium, h. graminaceous stomata.

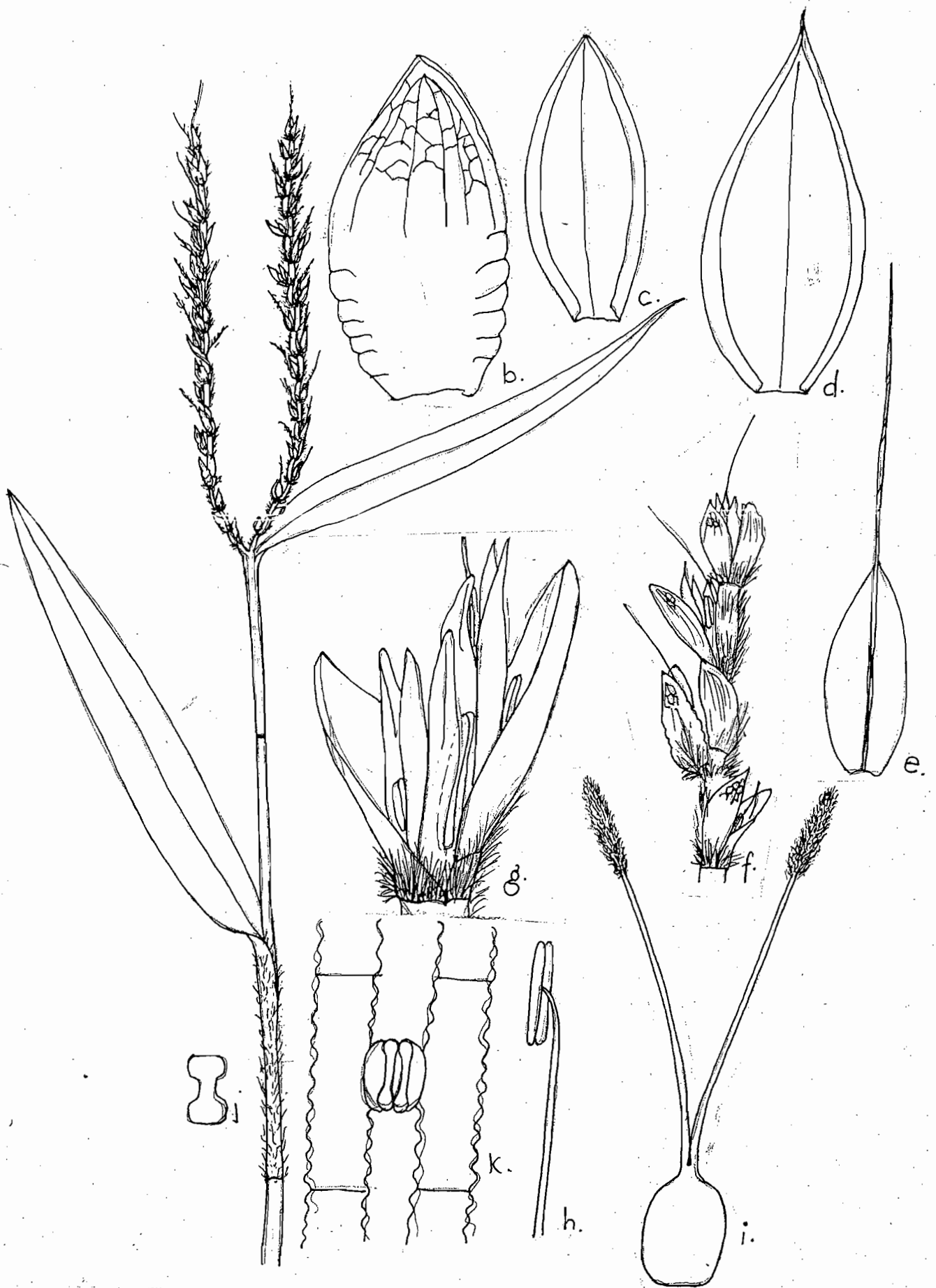


Fig. 540. *Ischaemum rugosum* Salisb., a. habit, b. empty glume, c. involucral glume, d. floral glume, e. palea with an awn, f. inflorescence, g. spikelet, h. stamen, i. gynoecium, j. silica body (dumbel shaped), k. graminaceous stomata.

4; lower involucral glume ovate, obtuse, 3- 5 nerved, hyaline, silky-hairy and ciliate; upper involucral glume similar and subequal to the lower, 5-nerved, with an awn reaching 0.5 cm long; lower floral glume reaching 0.25 cm long, broadly ovate, subobtuse, concave, hyaline, silky-hairy, and ciliate, 7-9 nerved, empty, epaleate; upper floral glume as long as the lower, ovate, acute, membranous, with incurved margins; palea as long as the glume, membranous, ovate-oblong, acute, with strongly involute margins. Lodicules 2, minute, cuneate. Stamens 3. styles distinct, long; stigmas exserted at the top of the glume. Grain oblong-ellipsoid, free within the hardened glume and palea. (Fig. 541)

Vernacular name: Venupatrika.

Flowers: September-October.

Micromorphology (Fig. 541)

The plant showed presence of multicellular, uniseriate, unbranched non-glandular trichome with apical cell pointed.

Stomata were of graminaceous type.

D/434- 435.

11. *Paspalum scrobiculatum* L. Mant. Pl. 1: 29. 1767

A perennial, culms reaching a height of 150 cm. Leaves linear-lanceolate, upto 40 cm long. Leaf-sheaths keeled, ligules membranous. Inflorescence composed of 1-20 racemes, these digitate or borne on an axis up to 8 cm long, the lowest raceme 4-15 cm long, with spikelets borne singly on a ribbon-like rhachis. Spikelets broadly elliptic, obovate or suborbicular, green, becoming brown; lower glume absent; upper glume papery; lower lemma similar or rarely coriaceous, 3-5-nerved (in the latter case the nerves evenly spaced or the laterals close together); upper lemma finely striate, brown at maturity. (Fig. 542)

Flowers: April-May, October-December.

Micromorphology (Fig. 542)

Stomata were of graminaceous type.

D/104.

12. *Pennisetum setosum* Rich. in Pers. Syn. V.1 (1805) p. 72

An erect annual, often fastigiate branched at the nodes, with stem green or purplish. Leaves 15-25 cm long, linear, finely acuminate, glabrous or hairy; sheaths glabrous; ligule a line fringed with rather long soft hairs. Racemes 5-10 cm long, usually purplish-brown; rhachis glabrous, notched; involucl sessile; bristles unequal, the outer not ciliate, short, the inner longer, ciliate below the middle with long silky hairs (1 of the inner bristles is often much longer than the others, reaching 1.25 cm, the others 0.6-1 cm long). Spikelets 0.4 cm long, solitary within the involucl. Glumes 3 or 4; lower involucral glume minute or wanting; upper involucral glume, ovate-oblong, gradually or suddenly cuspidate, 5-nerved, hyaline; lower floral glume, oblong, obtuse, with 2 sub-obtuse lateral and an acute median tooth at the apex, 5-nerved, paleate, male, the palea, narrowly oblong, hyaline; upper floral glume, ovate-oblong, truncate, fimbriately ciliate at the tip, coriaceous, smooth and shining; palea as long as the glume, oblong, truncate,

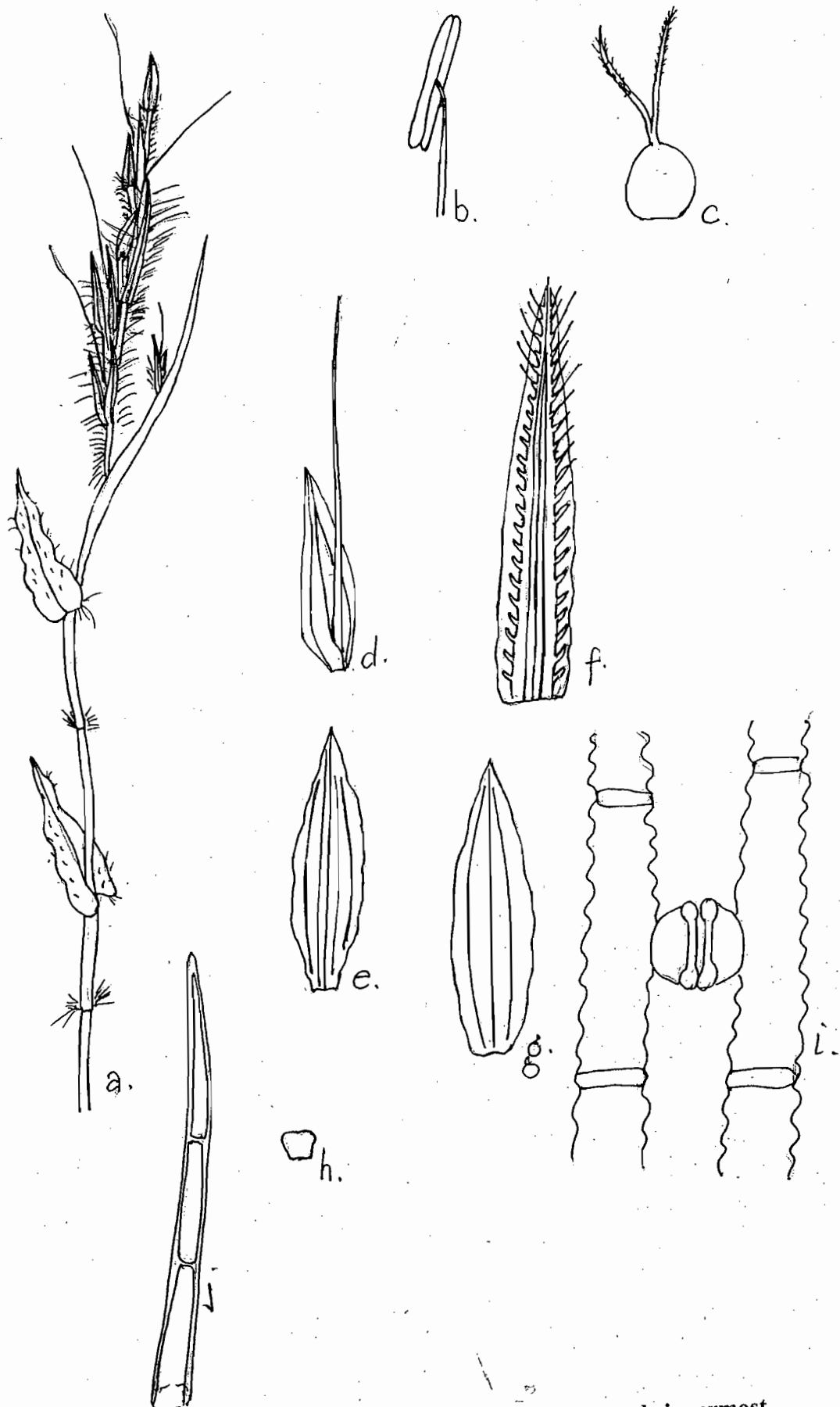


Fig. 54t. *Oplismenus burmanii* Beauv., a. habit, b. stamen, c. gynoecium, d. innermost glume with an awn, f. outermost involucre glume, e-g. floral glume, h. lodicule, i. graminaceous stomata, j. multicellular uniseriate trichome.

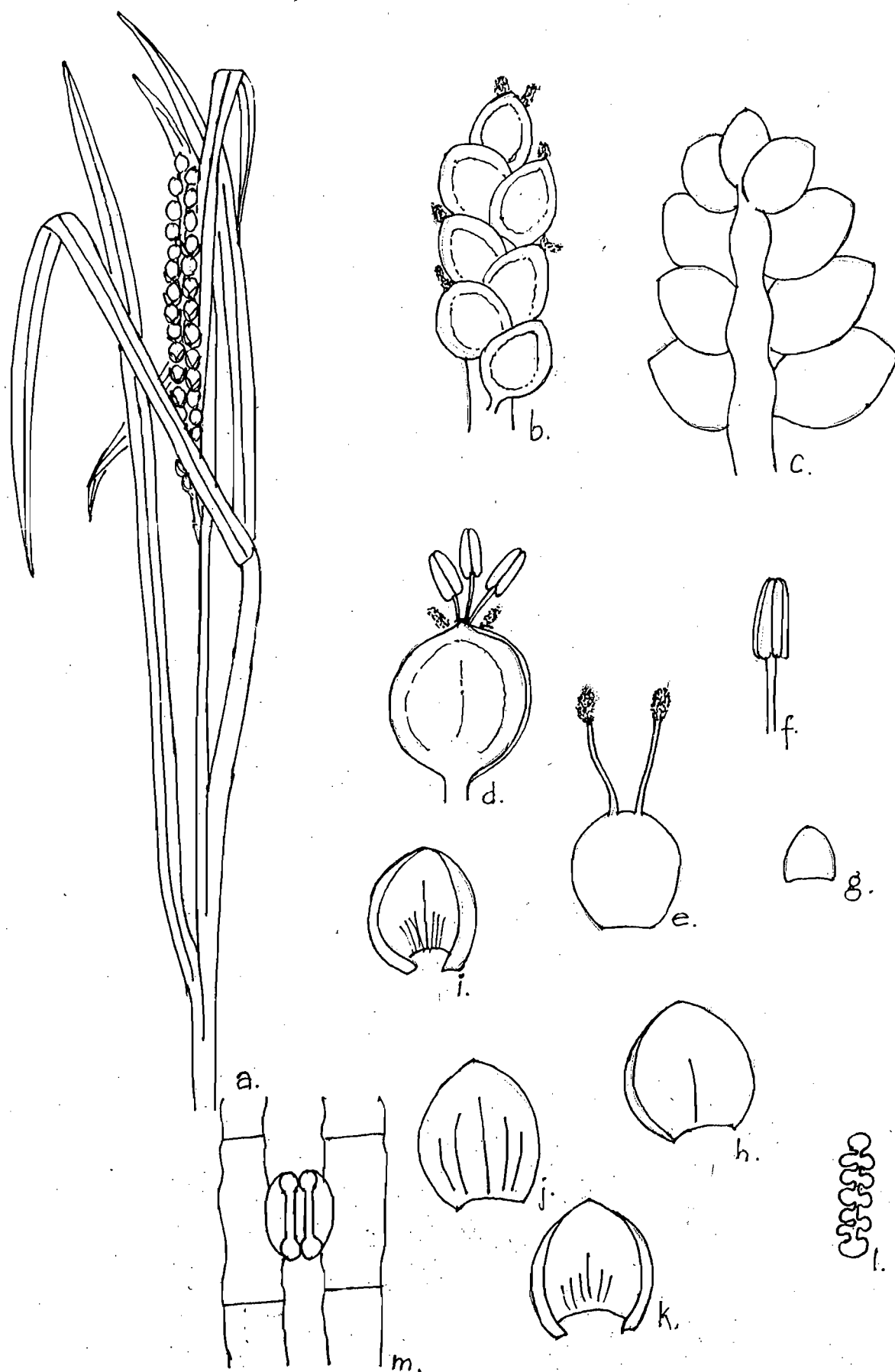


Fig. 542. *Paspalum scrobiculatum* L., a. habit, b-c. inflorescence, d. spikelet, e. gynoecium, f. stamen, g. empty glume, h. glume IV, i. palea, j. glume II, k. glume III, l. moniliform silica body, m. graminaceous stomata.

toothed or ciliate at the tip. Stamens 3; anthers linear, anthers nearly. Styles long, much exerted beyond the spikelet. (Fig. 543)

Flowers: August-December.

Micromorphology (Fig. 543)

The plant showed presence of unicellular, non-glandular, elongated trichome with thick wall.

Stomata were of graminaceous type.

D/940, 946.

13. *Setaria glauca* Beauv. *Agrost.* (1812) p. 51.

An erect branched glabrous annual. Leaves upto 18 cm long linear, finely acuminate, flat, glabrous, with scabrid margins, ligule a ridge of hairs. Inflorescence a cylindric densely flowered spike-like raceme; bristles of involucre 6-12, pale or reddish-brown, with very short teeth. Spikelets numerous, closely set along the rachis of the spike. Glumes 4; lower involucre glume less than $\frac{1}{2}$ as long as the spikelet, broadly ovate, 3-nerved, hyaline; upper involucre glume slightly longer than the lower, broadly ovate, 5-nerved; lower floral glume thinly membranous, as long as the upper one, the palea hyaline; upper floral glume coriaceous, elliptic, obtuse, dorsally convex transversely rugose, pale. (Fig. 544)

Flowers: October.

Micromorphology (Fig. 545)

Unicellular non-glandular trichome with thick wall and broad lumen was observed along with dumbbell shaped and moniliform silica-bodies.

Stomata were of graminaceous type.

D/930.

14. *Themeda quadrivalvis* (L.) Kuntze *Revis. Gen. Pl.* 2: 794. 1891.

A suberect annual with rooting from the lower nodes. Leaves upto 30 cm long, linear, acute, flat, glabrous; sheathes glabrous or the upper with scattered bulbous-based hairs towards the mouth; ligules membranous, rounded, glabrous. Panicle sub-solitary or 2-3 nate, filiform, glabrous, undivided often to the middle, then bearing at equal distances usually shortly pedunculate dense clusters of racemes; spathes linear to subulate from a broad based bristles; racemes 1-1.5 cm long, erect. Involucre spikelets whorled, sessile, persistent, linear-lanceolate, acute or acuminate, glume beset along the winged keels with stiff bristles from large not winged, glabrous. Bisexual spikelet solitary, not exerted from the involucre, long, narrow, linear-lanceolate; callus very short, subobtusely bearded with short reddish hairs; lower Involucre glume obtuse, brown, shining, obscurely 6-7 nerved; upper Involucre glume glabrous; lower floral glume awned; awn 2.5-4 cm long, slender. (Fig. 546; 547)

Flowers: September-January.

Micromorphology (Fig. 548)

Stomata were of graminaceous type. Dumbbell shaped silica bodies were also present.

D/902-904.

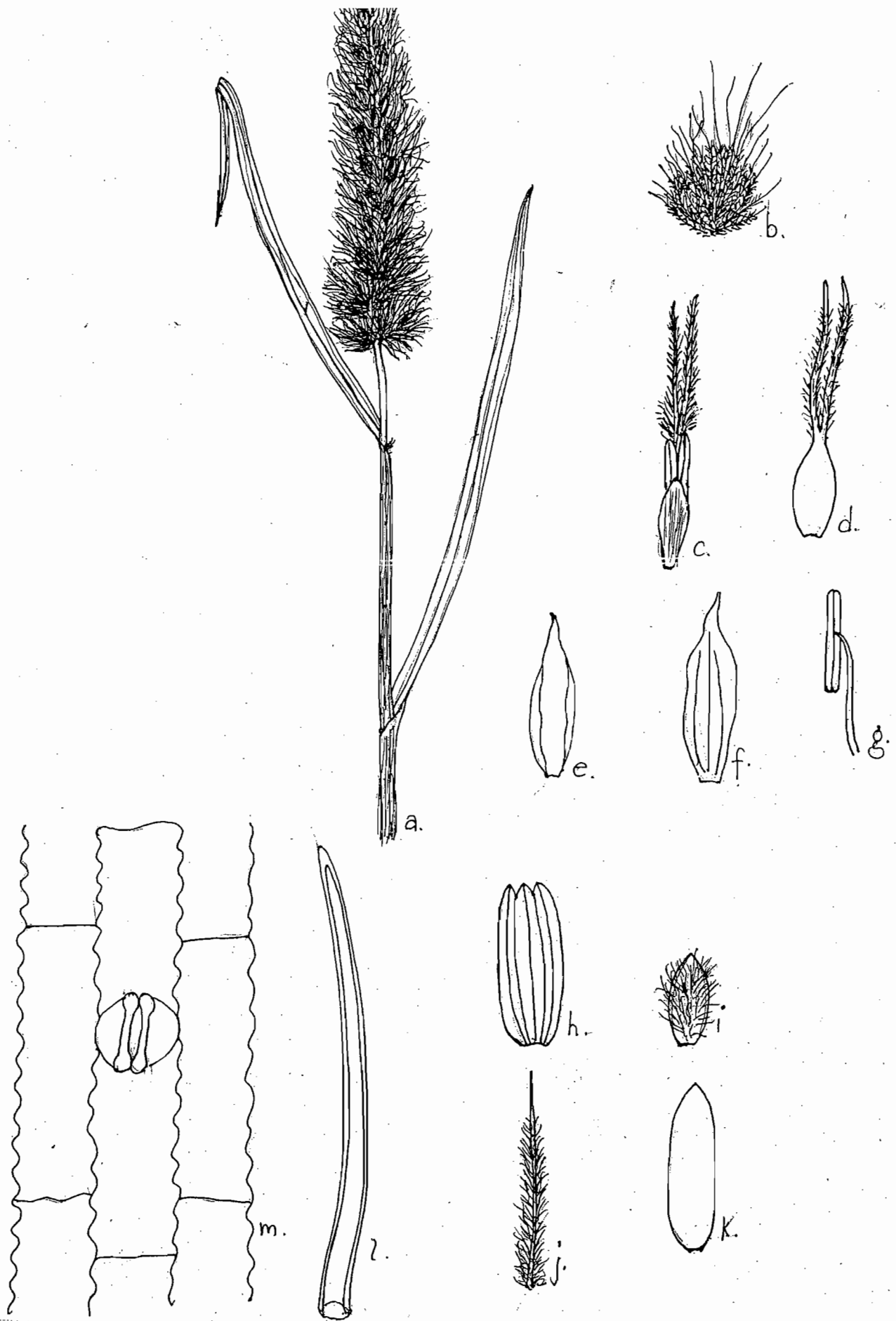


Fig. 543. *Pennisetum setosum* Rich., a. habit, b. involucre, c. spikelet, d. gynoecium, e. glume II inner side, f. glume II outer side, g. stamen, h. glume III, i. glume I, j. bristles, k. glume IV, l. unicellular trichome with thin wall and broad lumen, m. graminaceous stomata.

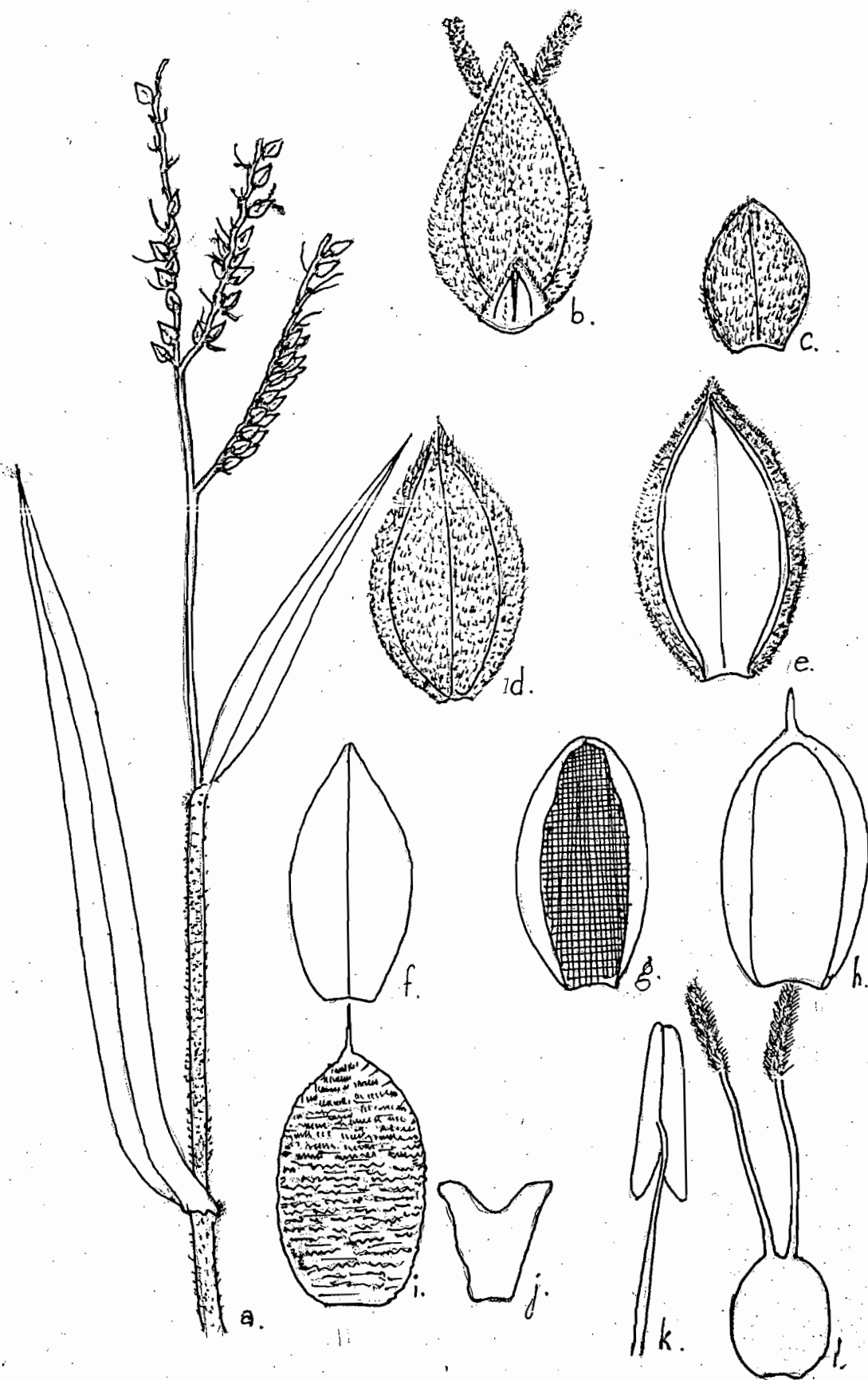


Fig. 544. *Setaria glauca* Beauv., a. habit, b. spikelet, c. empty glume, d-e. outer involucral glume, f-g. inner involucral glume, h-i. foral glume, j. lodicules, k. stamen, l. gynoecium.

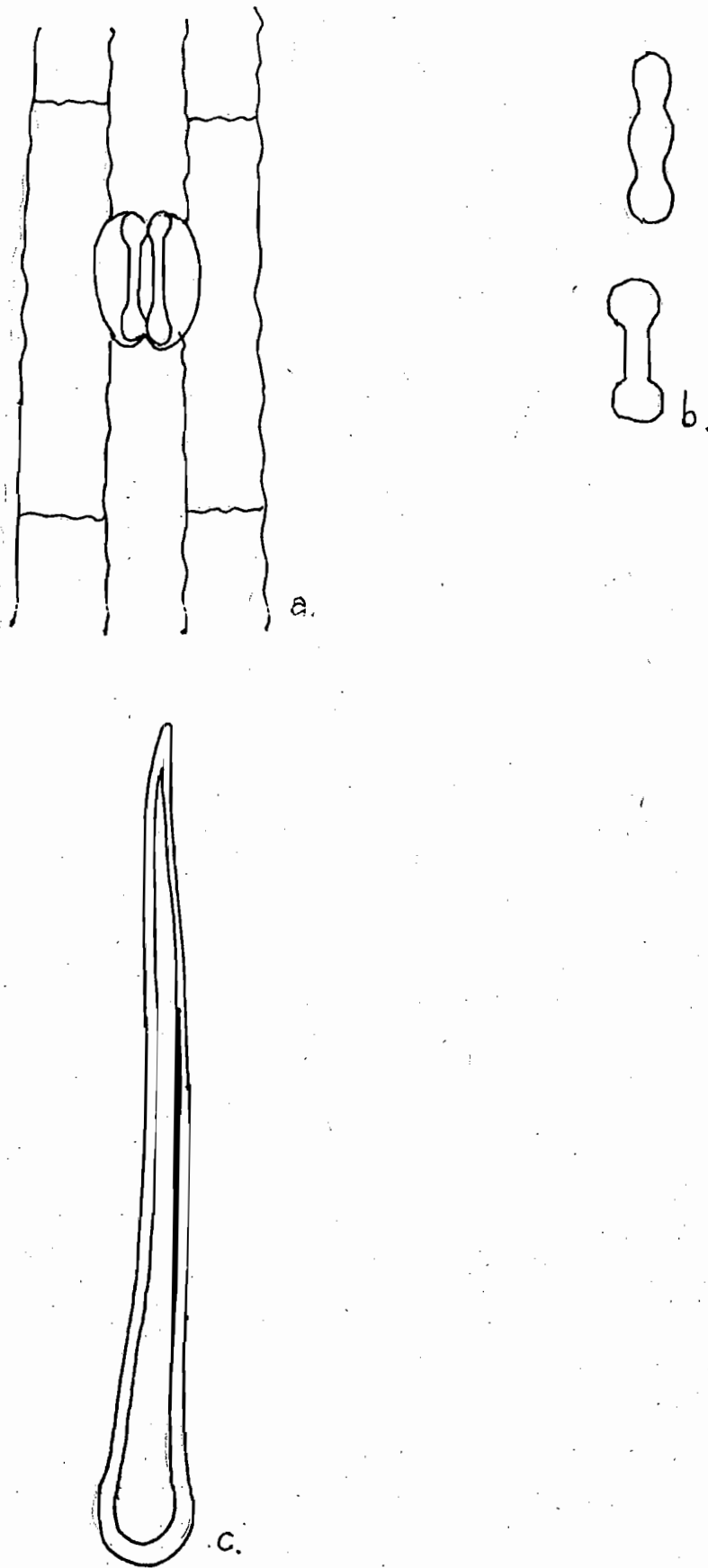


Fig. 545. *Setaria glauca* a. graminaceous stomata, b. moniliform and dumbbell shaped silica body, c. unicellular trichome with thick wall and broad lumen.

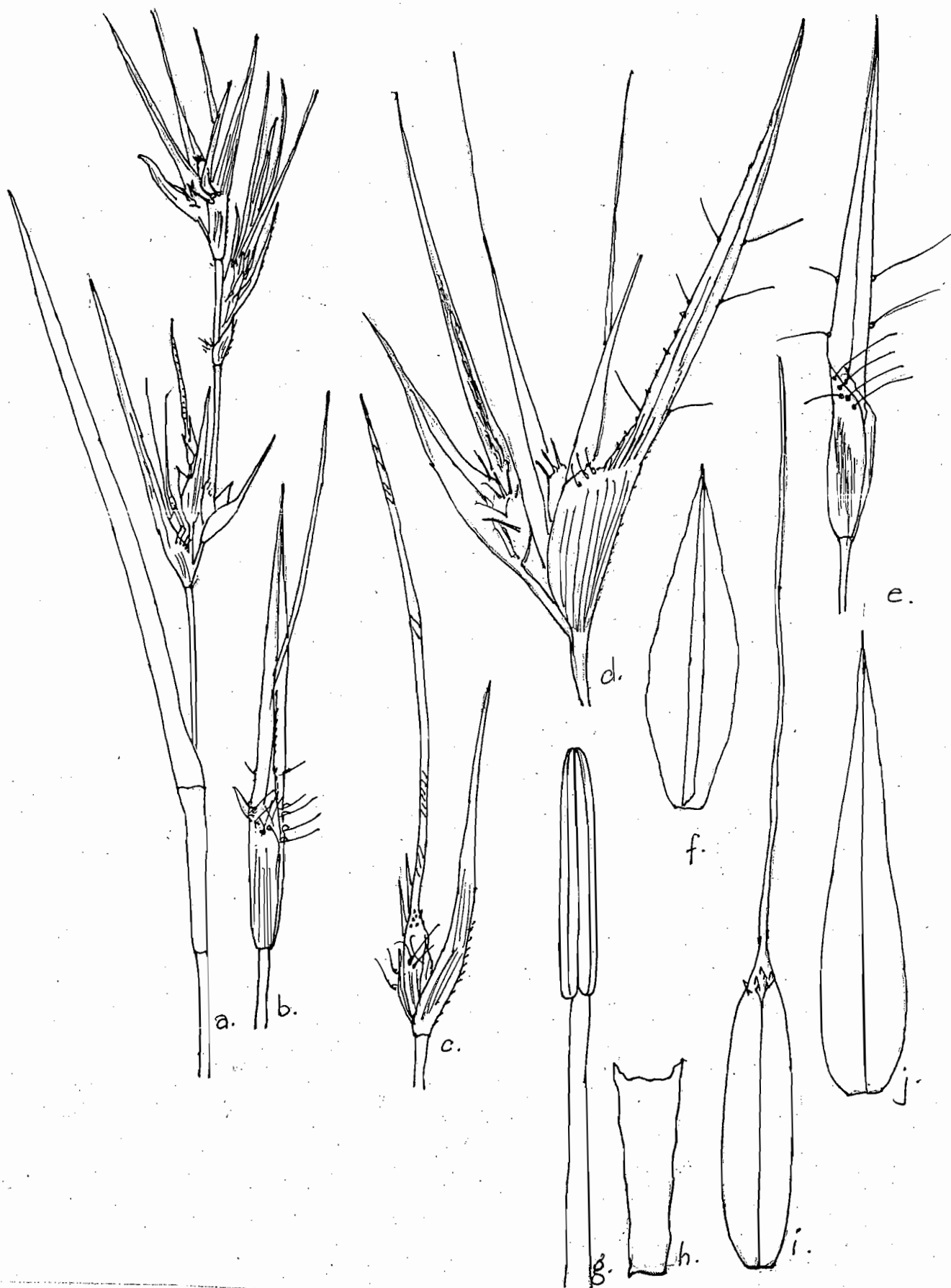


Fig. 546. *Themeda quadrivalvis* Kuntze., a. habit, b. involucre spikelet, c. pedicellate spikelet, d. inflorescence, e. spathe, f, & j. pedicellate glumes.

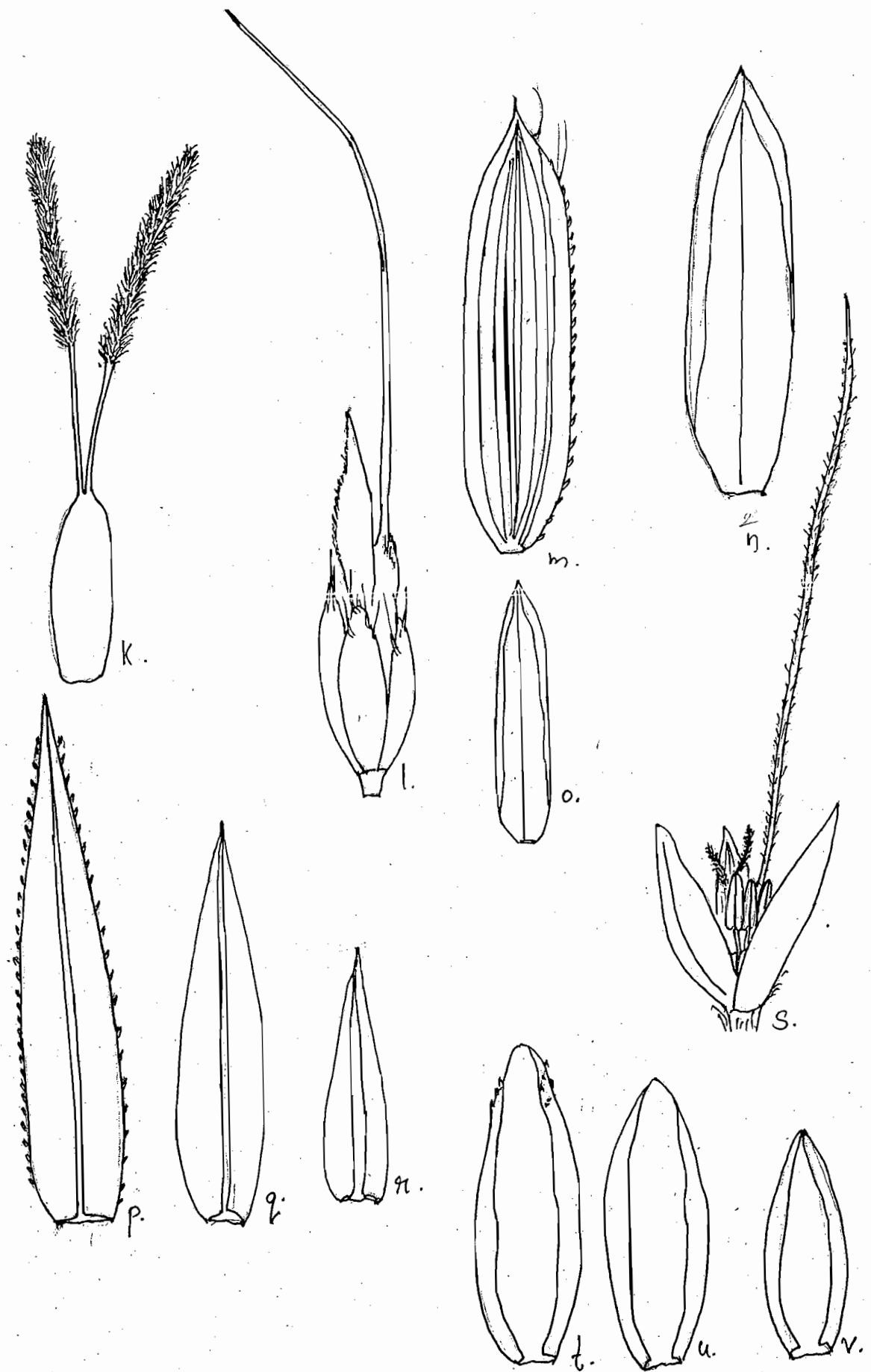


Fig. 547 *Themeda quadrivalvis* Kuntze., i. pedicellate glumes, h. lodicule, g. stamen, k. gynoecium, l. involucral and pedicellate spikelets, m-o. involucral spikelet glumes, s. bisexual spikelet, p-r. pedicellate spikelet glumes, r-v. bisexual spikelet glumes.

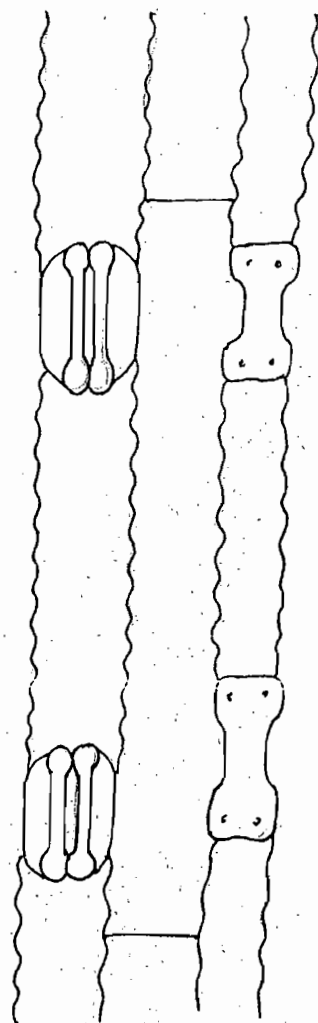


Fig. 548. *Themeda quadrivalvis* Kuntze., a. graminaceous stomata and Silica body (dumbbell shaped)

Results

B. Bioprospecting

a. *Alternanthera sessilis* Linn. (DC) - Flower flavonoids and Phenolic acids

Alternanthera sessilis is a well known medicinal plant occurring as a weed everywhere. The herb is used as a galactagogue, cholagogue, abortifacient and febrifuge. It is also used for indigestion. It is claimed to be a good fodder which increases milk in cattle. In some parts of Bihar, the plant is used for hazy vision, night blindness, diarrhea, dysentery and post-natal complaints. Then, the roots are used externally, for inflamed wounds. The poultice of the herb is reported to be used for boils (Anon. 1985). The plant is reported to contain hydrocarbons and steroids and absolutely no data are available on the phenolics or flavonoids which are now considered as the best antioxidants. These compounds are also having a number of medicinal properties and that is, why *A. sessilis* is selected for a study on their flavonoids.

The flowers which form a major portion of the drug were analysed using standard procedures described in chapter 2.

The flowers are found to be rich in flavonoids. The flavonoids located include both flavones and flavonols. The flavones identified were two; luteolin (λ -max 255, 267' and 350) and 4'-OMe luteolin (λ -max 255, 267' and 347). The flavonol located were 3' -OMe quercetin (λ -max 255, 267' and 355). The identity of these compounds was confirmed by studying the spectral shifts and co-chromatography with authentic samples. The phenolics acids located were four in number and they were *cis* and *trans*- ferulic acid, vanillic acid and syringic acid. In addition, Ecdysterone also was located in flowers. The identity was confirmed by co-chromatography with authentic ecdysterone.

All the compounds identified from the flowers of this plant possessed distinct pharmacological properties. The flavonoids are known to have a positive role in strengthening the capillary walls, thinning blood by reducing the agglutination of RBCs and even preventing cancer. The anti-inflammatory properties of flavonoids also are well known. **Luteolin** exerts a number of pharmacological actions, such as antiallergic, antibacterial, anti-inflammatory, antipolio and antiherpetic. It is found to have profound

effect against tumours in the colon, kidney, lung, ovary, skin, stomach, pancreas, thyroid and brain. **4'-OMe Luteolin** is also similar to luteolin in its pharmacological properties. **3'-OMe Quercetin** is a derivative of quercetin which is a well known flavonol exhibiting cardiovascular protection, anticancer and anti-ulcer effects, anti-allergic activity and cataract prevention as well as antiviral and anti-inflammatory effects. It is antiarthritic, antiasthmatic, antibacterial, anticoncataract, antidiabetic, antiherpetic, antiviral, hepatoprotective and antimalarial in nature. It is known to act against tumours in the bladder, colon, lung, ovary and skin (Duke's database).

The phenolic acids obtained from *Alternanthera sessilis* also exert a number of medicinal properties. **Ferulic acid** is analgesic, antiallergic, anti-inflammatory, hepatoprotective and antihepatotoxic. It is antiviral, immunostimulant, antiallergic and acts as an arteriodilator. It is also found to act against cancer in the colon, forestomach, liver and skin. **Vanillic acid**, one of the most commonly found phenolic acids in plants, is known to be anthelmintic, anti-fatigue, anti-inflammatory, antileukemic, antiseptic and anti-sickling. **Syringic acid** is known to be allelopathic, antioxidant, anti-peroxidant and anti-radicular.

b. *Alternanthera bettzickiana* – Flavonoids and Phenolic acids

This is a plant migrated from Northern India and has replaced almost all other weeds everywhere. It has got a gregarious growth and the plant is very sturd. Since, it is a migrant, no local uses are available. Since all other species of *Alternanthera* like *Alternanthera sessilis* and *Alternanthera pungens* to assume that this plant also may have similar uses and that is the reason why this species is taken up for bioprospecting.

The ethyl acetate fraction obtained after the hydrolysis of water soluble fraction of the methanolic extract yielded three flavonoids when they were chromatographed on paper, using 30% acetic acid. All these three compounds fluorescent yellow when viewed in UV-365nm. The areas of these three compounds in chromatograms are marked and portions were cut out and eluted in spectroscopic methanol. The first compound having R_f value of 0.4 gave the λ maxima of 255nm and 270' then 300', and 370'. The second compound having a slightly higher R_f value i.e., 0.45 gave a λ -maxima of 255, 267', 300', and 368'. The third compound having an R_f value of 0.6 showed a λ -maxima of

261, 290', 320', and 366'. These compounds were tentatively identified as Quercetin, IsoRhamnetin, and Kaempferol. The identity of these compounds was confirmed by co-chromatography with authentic sample.

The same ethyl acetate fraction (containing flavonoids) was analyzed for steroids by TLC. Two major spots (having R_f value 0.62 and 0.71 both gave a violet colour with sulphuric acid) were observed when the Thin layer chromatograms were sprayed with 25% sulphuric acid and warmed. On co-chromatography with standard samples, these steroids were identified as Ecdysterones and β -sitosterols.

The discovery of Ecdysterone in *Alternanthera bettzickiana* is highly significant. Ecdysteroids are now considered as anabolic steroids having stimulatory effect, hypocholesterolaemic effects, hypoglycaemic effect, and having specific effect of muscle (increase muscle mass) by regeneration. It restores normal glomerular filtration rate in kidney, improves skin quality, and acts as a brain tonic (inducing neuro-transmitter synthesis and protecting neurons). Beta-sitosterol the other steroid located in this plant also exhibits androgenic, antibacterial, anticancer, antiestrogenic, antigonadotrophic, antiinflammatory, antileukemic, antioxidant, febrifuge, hypocholesterolemic properties.

The significance of locating flavonoids in this plant is of great importance. The pharmacological importance of quercetin is already explained above. **Isorhamnetin** is found to have antibacterial, antihistaminic, anti-inflammatory, antioxidant, antispasmodic, cancer-preventive, hepatoprotective, pesticide, vasodilator properties. **Kaempferol** induces growth inhibition and apoptosis in A549 lung cancer cells. It shows antihistaminic and antioxidant properties and is a reliable inhibitor of topoisomerase I. Kaempferol is known to be antiinflammatory, antiherpetic, antileukemic, antiseptic, antiviral, hepatoprotective and acts as a vasodilator.

c. *Aloe barbadensis* Mil. Quinones from flowers

Aloe barbadensis is an extremely well known medicinal plant useful in many ailments and in cosmetics preparations. Normally, the plant never flowers in cultivation. But, they flower and produce seeds abundantly in certain parts of Saurashtra. Since the flowers, bracts, or seeds are almost unknown to commercial world, no data are available on their

constituents. Since, *Aloe* leaves are rich sources of quinones, the flowers and bracts were analyzed for this quinine content.

Quinones of *Aloe* flowers were extracted by methanol in a Soxhlet's apparatus for 24 hours. The methanol extract is then concentrated. The residue is dissolved in water. To this aqueous extract petroleum ether is added in a separating funnel. Petroleum solubles are then discarded, and the water soluble are concentrated, this extract is spotted in Silica gel G TLC plates, and the solvent system used was, ethyl acetate: methanol: water (100: 13.5: 10); the developed chromatogram are viewed under UV 365 nm, where, the quinones appeared as fluorescent yellow spots. The chromatograms are then sprayed with 10% ethanolic KOH reagent. There were 4-5 fluorescent spots in TLC chromatograms. On co-chromatography with Aloin and Emodin, isolated from *Aloe* leaves, it was found that two-spots corresponded to Aloin and Emodin. Aloin appeared at an R_f value of 0.5 and *Aloe* Emodin appeared near the solvent front (R_f-0.95). Flavonoids were found to be absent in the flowers but it contained the phenolic acids such as *p*-hydroxy benzoic, *p*-coumaric (both *cis* and *trans*), vanillic and syringic acids.

The discovery of aloin and emodin from the flowers of this plant is very significant, because these flowers are never utilized for any purpose and are going waste. Therefore, the flowers may be used as raw material for the extraction of these two pharmacologically important chemicals. Aloin is found to exhibit allergenic, antifertility, antiherpetic, antispermatic, antiviral, cholagogue, hypothermic, laxative, peristaltic, pesticide, purgative and uricosuric properties. Similarly, emodin also exhibit antibacterial, anticytomegalovirus, antiinflammatory, antileukemic, antimutagenic, antineoplastic, antiplaque, antiulcer, antiviral, cathartic, hypolipidemic, immunostimulant properties.

The phenolic acids identified also possess a number of medicinal properties. *p*-Hydroxy benzoic acid is antibacterial, anti-sickling, immunosuppressant, cancer preventive and fungistat. *p*-Coumaric acid is antibacterial, antiseptic and antitumour. The compound is also antiseptic, antioxidant and fungicidal. It is proved to inhibit the oxidation of L-tyrosine, which is an important precursor for the biosynthesis of a number of compounds. The properties of vanillic and syringic acids are explained above.

d. *Stemodia viscosa* – volatile oil.

Stemodia viscosa is an aromatic weed very common in the fields in and around Baroda. Though it is having a pleasant smell, there are no scientific data on its volatile oil. Therefore, this plant is taken up for bioprospecting of its volatile oil.

The volatile oil of *Stemodia viscosa* was light yellow in colour with a very pleasant clove like smell. On analysis using TLC, five major compounds were located, of which only two compounds *i.e.* eugenol and acetugenol could be identified with the help of standards isolated from clove oil. The eugenol had an R_f value 0.6 and yellowish brown colour while acetugenol was pinkish yellow at a low R_f value of 0.252. The other three monoterpenes could not be identified.

The extraction and analysis of the volatile oil from this species is significant in that one more additional source of eugenol could be identified. This plant, being abundant as a weed in cultivated fields, can be profitably used as sources of volatile oil which could be employed in perfumery or in medicines. The properties of eugenol includes acaricide, analgesic, anticonvulsant, antiedemic, antiestrogenic, antifeedant, antimitotic, antimutagenic, antipyretic, antiseptic, antispasmodic, antiviral, carminative, hepatoprotective, insecticide, vasodilator and vermifuge (Dukes' data). Acetugenol also is found to have antispasmodic and sedative properties (Sung et al., 1998)

e. *Stemodia serrata* – Volatile oil

This is an endemic plant restricted in distribution to the Timbi region of Baroda. There were only few plants available and absolutely no work is conducted on any of the other chemical components. Since it is found sweet smelling, it is taken up for the analysis of volatile oil.

The volatile oil of *Stemodia serrata* was similar to the oil extracted from *Stemodia viscosa* in that it was light greenish yellow in colour with a pleasant clove like smell. On TLC analysis it gave four monoterpenes, of which two were identified as Eugenol and Acetugenol. The other two compounds which were not identified were similar to those obtained from *Stemodia viscosa*.

In addition to *S. viscosa*, this plant also can be considered as a commercial source of eugenol. But the rarity of this plant in the study area does not permit its harvesting and

utilization, since it is an important commercial source, it has to be propagated in large scales so that commercial exploitation can be achieved.

f. *Bombax ceiba* Linn. - Flower calyces; Mucilages and Flavonoids

Bombax ceiba is a well known plant yielding gums and fibres. The flowerbuds and fleshy calyces are eaten; the immature calyx known as semargulla, is consumed as vegetable. The flowers are made into a conserve by boiling with the seeds of poppy and sugar goat's milk. The dried and powdered flowers are made into bread with or without corn (Anon. 1988). The bark exudes a gum known as Semul gum from natural wounds, or caused by insect or fungal attack. This gum is similar to gum Tragacanth. Since this gum is obtained from bark, it is not commercially available. But, during our survey, we have found that the fleshy calyx-cup of the flowers contained gums. This gum is never isolated or studied. Since, the flower fall off after or before fertilization it will form a good raw material which can be commercially exploited. This is the reason why the fleshy calyx of *Bombax ceiba* is selected for a detailed study on its mucilage and flavonoids.

The calyx of *Bombax ceiba* flowers is found to contain 20% dry weight mucilage. On hydrolysis, this gum yielded two sugars galacturonic acid and galactose. Therefore, it is a polymer of these two sugars. The calyces are found to be a rich source of phenolics, especially flavonols and phenolic acid. The flavonols located are quercetin, isorhamnetin and rhamnetin. The phenolic acids identified were vanillic acid and syringic acid.

The isolation of gums from the fleshy calyces of *Bombax ceiba* is of great economic importance because these compounds are extracted from a waste product that is the calyces get rotten when the flowers fall down. They possess a number of medicinal properties and are often used as emollients or demulcent, and thus act as remedies for wounds, to soothe itching, irritation and pain and also for drying and binding a tissue that is damaged. The demulcent action is continued in the lining of the digestive tract and this explains the remedies that mucilage bring for ulcers, lesions, inflammations in the gastrointestinal tract and for reducing the excessive acid secretions. The mucilage causes the irritation due to diarrhea, flatulence; colic and abdominal pain to get soothed and die down that the symptoms may be reduced. The mucilaginous remedies are also used in the

urinary and the respiratory system. The mucilaginous remedies have properties that are soothing for the urinary tracts, the bronchial tissues, and acts as a comfort where there is vigorous coughing syndrome and they increase the bronchial secretions if they go dry and also in an asthmatic condition they help to reduce the spasms.

All the three flavonoids isolated from the calyces show a number of pharmacological properties. The pharmacological properties of quercetin are explained above in *Alternanthera sessilis* and that of isorhamnetin in *Alternanthera bettzikiana*. The properties of rhamnetin includes antiaflatoxin, antibacterial, anticancer, antimutagenic, antioxidant, antitumor and hepatoprotective. The medicinal properties of the phenolic acids are explained earlier. Therefore, the consumption of the calyces as vegetable impart all the above mentioned health benefits to the consumer.

***g. Ageratum conyzoides* Linn. (Goat weed, White weed)**

This is an aromatic, annual herb, 1 m in height, native to tropical America, naturalized as a weed throughout India, upto an altitude of 1,800 m. The plant is used internally as a stimulant tonic. The juice is reported to be a good remedy in *prolapsus ani*. Boiled with oil, it is applied in rheumatism. A decoction or infusion of the herb is given in stomach ailments such as diarrhoea, dysentery, and intestinal colic with flatulence. The data on the volatile oil of this plant is available. A large number of compounds such as flavonoids, chromones, and coumarins are reported from this plant. During the present study, the leaves are found to contain two flavones, which are derivatives of 6-hydroxy flavones. They are 6-hydroxy 4'-methoxy apigenin, and 6-hydroxy, 7, 4'-dimethoxy apigenin. The other flavonoids reported such as quercetin, kaempferol, scutallerin were found absent in the leaves. The phenolic acid located was vanillic acid. Apigenin and its derivatives are known to reduce DNA oxidative damage; inhibit the growth of human leukemia cells and induced these cells to differentiate; inhibit cancer cell signal transduction and induce apoptosis; act as an anti-inflammatory; and as an anti-spasmodic or spasmolytic. Therefore, the compounds isolated known from this plant also may exceed these properties. The pharmacological effects of vanillic acid are already explained above.

h. *Ageratum houstonianum* -volatile oil.

Ageratum houstonianum is an ornamental herb native to tropical America. This plant does not find much use even though its relative *Ageratum conyzoides* (Ajagandha) is a well known medicinal plant yielding a volatile oil i.e. used against leprosy and other cutaneous diseases. Since, *A. houstonianum* also possess aromatic leaves, this plant is taken up for a detailed study on its volatile oil and constituents.

The volatile oil from fresh shoots was extracted by steam distillation, and the amount of the oil obtained was 0.2%. This oil was analyzed by GC-MS from SICART, Vallabh vidyanagar, Gujarat. The GC-MS analysis was done by electron impact ionization method on auto system XL gas chromatography (Perkin Elmer Instrument, Germany) coupled to a Turbo Mass Spectrophotometer. The column was fused silica capillary column, 30x 0.25 mm ID; coated with D-I, 0.25 μ m film thickness. The temperature of column was programmed at 70 to 250 °C at the rate of 10 °C/min. increase, injection port temperature at 250 C. Helium was used as carrier gas at constant pressure of 100 kpa and flow rate of 20 ml/min. Samples, dissolved in methanol, were run fully at range of 60-550 amu and the result were compared by using NIST 107 Spectral library search programme. Gas chromatogram resolved seven compounds of which three were having very low concentration. The compounds present in good concentration are precocene-II (74.25%); demethoxy ageratochromene (19.65%); caryophyllene (5.11%) and alpha-cubebene (0.39%). This oil is similar to the volatile oil of *Ageratum conyzoides* and can be used likewise for flavouring tobacco. Precocene II is found to be pesticidal in nature and therefore, this oil can be used as a biopesticide.

i. *Balanities aegyptiaca* – Seed oil.

This is a medicinally important plant of Gujarat and used to cure many diseases. The seeds are other plant parts which are known to contain steroidal sapogenins such as Diosgenin. The seed also yield a fixed oil. The amount of which varies from 30 to 40%. But, there is no data on the yield of oil from Gujarat plants. From the initial studies it is found that the seeds of plants growing in Sindh road, near Baroda contained 42 % dry weight of oil. This work is not completed because of publication of a patent on this oil

and its conversion to biodiesel. The potential of this plant as a source of biodiesel is very great and that is why it is selected for a detailed study on seed oil.

j. *Riedleia corchorifolia* - Flavonoids and Phenolic acids

The **Chocolate Weed**, or *Riedleia corchorifolia* DC., is a tropical weed that is typically seen in the wastelands and in open areas, such as highways. This plant was common in most areas of Maharastra state but now, it has now migrated to many places of Gujarat. Though this is not considered as a useful plant, it has been utilized as a homeopathic remedy. The leaves of *Riedleia corchorifolia* are eaten as a potherb in West Africa and southern Africa. The cooked leaves provide a popular, slimy side-dish in Malawi. Similar use of the leaves is reported from Indo-China and India. *Riedleia corchorifolia* is eagerly browsed, either green or dry, by cattle in Sudan but less so in Senegal. Fibres extracted from the bark are fine and strong and are used like those of *Triumfetta*, *Urena* and *Hibiscus*. The stems are used for tying bundles and are used in the construction of conical roofs for local houses. Leaves are used for unspecified stomach disorders in coastal East Africa. In Benin the seed is used to treat stomachache. In Malaysia and India the leaves and roots are used to treat a wide range of medical problems: urinary disorders, abdominal swelling, dysentery, snakebites and sores. An aqueous solution of leaves has insecticidal properties. Pulses stored in gunny bags treated with the solution have shown a reduction in the number of eggs laid and in damage done by the storage pest *Callosobruchus*. A number of compounds have been identified from this plant. They are Phytochemical analysis of leaves of *Riedleia corchorifolia* has revealed the presence of triterpenes (friedelin, friedelinol and β -amyrin), flavonol glycosides (hibifolin, triflin and melocorin), aliphatic compounds, flavonoids (vitexin and robunin), β -D-sitosterol and its stearate, β -D-glucoside and alkaloids. A pyridine alkaloid, 6-methoxy-3-propenyl-2-pyridine carboxylic acid, may be important as related pyridine derivatives are physiologically active.

During the present work a number of flavonoids which were not reported earlier were located. From the leaf quercetin, kaempferol and acacetin and a glycoflavone, ie., 6-C glucosyl acacetin were identified. The phenolic acids were vanillic and syringic acids.

The stem yielded quercetin, vanillic acid and syringic acid. The roots did not contained any flavonoid but being red in colour it yielded an anthocyanidin, cyanidin.

The presence of bioactive flavonoids such as quercetin, kaempferol and acacetin and a glycoflavone are very important because they form one of the best antioxidants available from the plants (Grubben, G.J.H. & Denton, O.A). So, this plant can be used as a commercial source for the extraction of these compounds. The presence of cyanidin in roots also is important because this compound also possesses a number of pharmacological properties besides being an effective antioxidant.

k. *Hygrophila schulli*(Ham.) M. R. & S.M. Almeida - Flavonoids

Hygrophila schulli (Ham.) M. R. & S.M. Almeida is a very well known medicinal plant of India known as **Kokilaksah**. It is concerned as a reputed remedy for arthritis and also possesses aphrodisiac, and demulcent properties. During field collections it was found that in majority of the places, these plants had bluish-white flowers. But, the plants growing in certain areas of Rajpipla possessed white flowers. Both these populations were subjected to a chemical study to find out taxonomic relevance of these variations in flower colour. The blue flowers contain anthocyanins like cyanidin while; the white flowers were devoid of them. The leaves of both these 'varieties' were then analyzed. The leaves of blue flower plant yielded luteolin, 4'-OMe luteolin and 3',4'-diOMe luteolin, while that of the white flowered plant contained luteolin and apigenin. The stems of these two plants also differed in their flavonoids. The stem of blue flower plant contained apigenin, and acacetin, whereas, the stem of the later plant, possessed luteolin, 4'-OMe luteolin and 3', 4'-diOMe luteolin. The phenolic acids of both the plant were the same.

Pharmacological properties of all these flavonoids are explained earlier. Apart from that the data obtained here are taxonomically important in that these two 'varieties' (blue and white flower) are chemically different, in their flavonoid composition in the vegetative parts (leaves and stem). The fact that, the flowers are chemically different in their flowers, *i. e.*, the blue flower contains anthocyanins, while, the white flowers are devoid of them. The fact adds to the phytochemical differences between these two 'varieties'.

More data are to be accrued before arriving at any conclusion on the taxonomic identities of these plants.

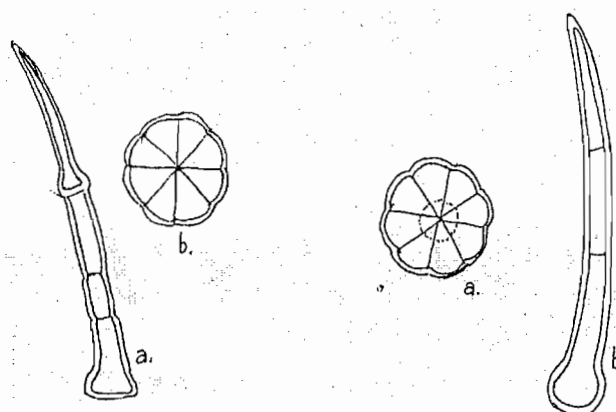
Chapter 4

Discussion

Discussion

The contribution of present project to the field of taxonomy especially that of floristics is of great importance. The 400 Line drawings of plants showing distinct and characteristic features of each plant will help students of taxonomy to understand the plants correctly and group them. Most of these plants are illustrated for the first time. This will act as a guide to the students in the field, where the characters presented in the book will give the distinctive features of the plants in question. Even to the teachers of taxonomy, this report will be of immense help in understanding the plants. The elaborate and extensive database on the micromorphological characters of 400 taxa are made available for the first time and this will be of immense importance in identifying almost all these plants even in the vegetative states. In case of economically useful plants such as drug plants or narcotics, these characters will be of great significance in identifying the raw material or adulteration, as these characters are observable under microscopes. This data will be useful in identifying the adulterant plants also.

The micromorphological characters especially those of trichomes are found to be of great use in classifying and identifying taxa at various levels of hierarchy. The two papers already published; 1) **Foliar trichomes of some members of the family Acanthaceae and their taxonomic utility** (*Int. J. Pharma and Bio Sci.* 2 (3), 2011, 231-235.) and 2) **Foliar micromorphological studies on some members of the family Fabaceae** (*Int. J. Pharma and Bio. Sci.* 2 (4), 2011, 603-611) are clear examples of this fact. In the first paper, 13 members of the family Acanthaceae had been studied for their foliar trichomes, to examine their utility in identification. Out of the 13 plants studied, two plants, *Daedalacanthus roseus* Anders. and *Rungia parviflora* var. *pectinata* Nees. were found to be glabrous. Of the remaining 11 plants, 6 possessed glandular trichomes and each of these trichomes was found to be different from those of others. Of the plants containing glandular trichomes, both *Ecbolium linneanum* Kurz. *Asteracantha longifolia* Nees. contained sessile, disc shaped glands with 4-8 cells. Both contained a non-glandular uniseriate trichome also. But the uniseriate trichomes of *Ecbolium linneanum*

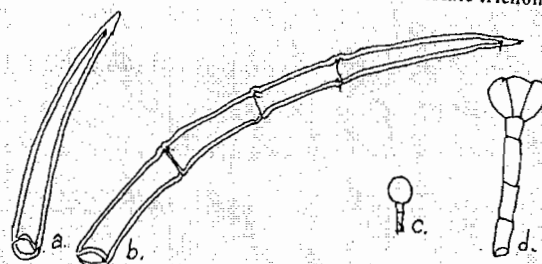


Ecbolium linneanum Kurz.

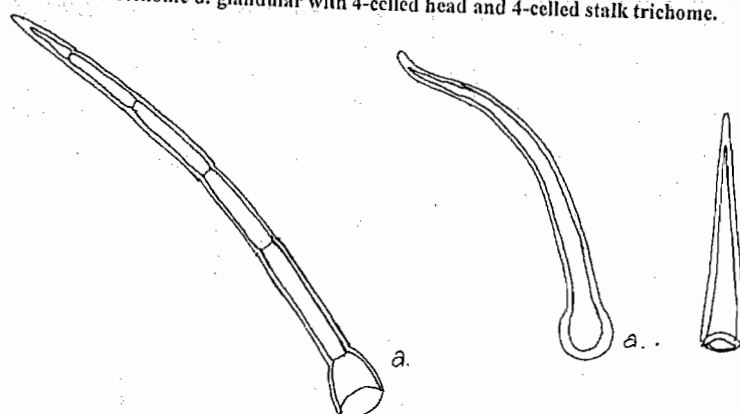
a. non-glandular multicellular uniseriate trichome
b. glandular sessile trichome.

Astercantha longifolia Nees.

a. glandular sessile trichome
b. non-glandular multicellular uniseriate trichome

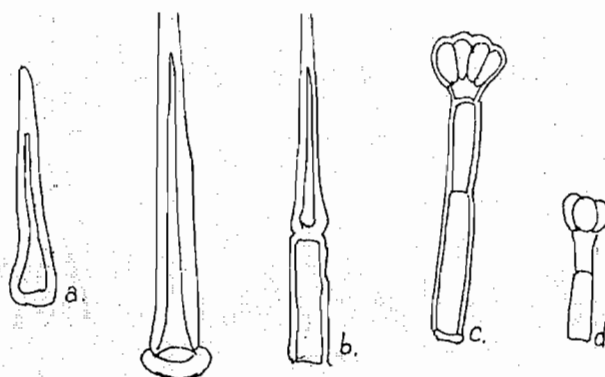


Hygrophila serpyllum Anders. a. non-glandular unicellular trichome b. non-glandular multicellular uniseriate trichome c. glandular with one celled head and 2-celled stalk trichome d. glandular with 4-celled head and 4-celled stalk trichome.

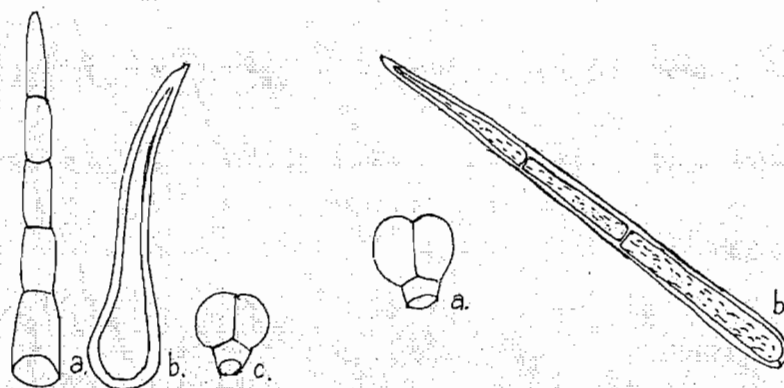


Justicia diffusa Willd. a. non-glandular multicellular uniseriate trichome

Lepidagathis fusciculata Nees a. non-glandular unicellular trichome



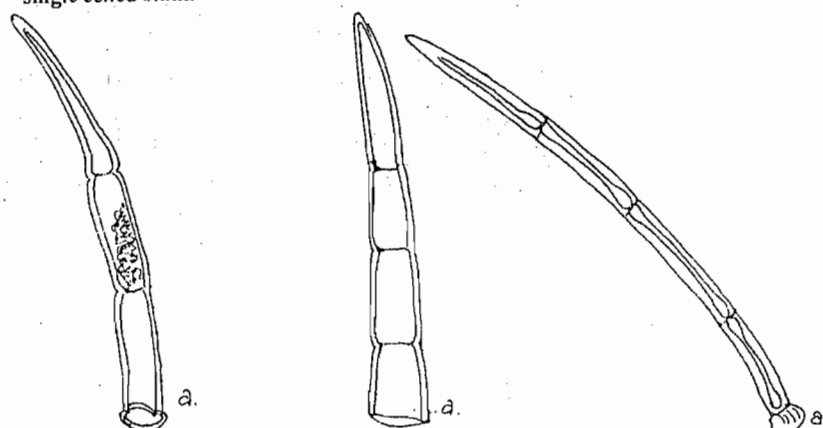
Lepidagathis cuspidata Nees. a. non-glandular unicellular trichome, b. Non-glandular two celled trichome, c. glandular trichome with 4-celled head and 2-celled stalk, d. glandular trichome with 4 celled head and 2-celled stalk.



Neuracanthus sphaerostachys Dalz.

a. non-glandular multicellular uniseriate trichome, b. non-glandular unicellular trichome, c. glandular trichome with 2-4 celled head and a single celled stalk.

Adhatoda zeylanica Medic. a. glandular trichome with 2-4 celled head and a single celled stalk, b. non-glandular multicellular uniseriate trichome.



Ruellia patula Jacq. a. non-glandular multicellular uniseriate trichome

Rungia repens Nees. a. non-glandular multicellular uniseriate trichome

Tubiflora acaulis Kuntz. a. non-glandular multicellular uniseriate trichome

Fig. 1. (Contd.)

had the apical cell which is long and swollen at the base. All the remaining four plants contained stalked glandular trichomes. The glandular trichomes of *Adhatoda vasica* Nees. and *Neuracanthus sphaerastachys* Dalz. were having a single celled stalk and 4 celled head but later plant possessed unicellular trichomes also. In *Lepidagathis cuspidata* Nees. and *Hygrophila serpyllum* Anders. there were two types of glandular trichomes. The large trichome of *Lepidagathis cuspidata* Nees. had 2 celled stalk (with thick walls) and 4 celled head. But in glands of *Hygrophila serpyllum* Anders. the stalk was 4-celled. The small trichome of the former possessed four celled head while that of latter had a single celled head.

Unicellular trichome was the only type of trichome in *Lepidagathis fasciculata* Nees. The remaining 5 plants contained uniseriate 3-4 celled long trichomes. These trichomes were distinguished by the thickening of the trichome walls. Both *Ruellia patula* Jacq. and *Rungia repens* Nees. had broader cells in trichomes. But the former plant contained a number of cells inclusions, while such type of inclusions were not observed in the latter. Of the remaining 2 plants *Tubiflora acaulis* Kuntz. and *Justicia diffusa* Willd., the trichome of the former plant had very thick walls and very narrow lumen whereas that of *Justicia diffusa* Willd. had a swollen basal cell.

An artificial key using trichome character for the identification of some species belonging to the Acanthaceae is prepared and presented below.

1. Plants glabrous.....*Daedalacanthus roseus* Anders and *Rungia parviflora* var. Nees.
1. Plants with trichomes:
 2. Glandular trichome present, non-glandular trichome present or absent:
 3. Glandular trichome sessile;
 4. Non-glandular trichome 3-celled with upper cell long and swollen at the base.....*Ecbolium linneanum* Kurz.
 4. Non-glandular trichome 3-celled without any cell being swollen.....*Asteracantha longifolia* Nees.
 3. Glandular trichome stalked:
 5. Stalk of glandular trichome unicellular
 6. Unicellular non-glandular trichome present

Neuracanthus sphaerostachys Dalz.

6. Unicellular trichome absent.....*Adhatoda zeylanica* Medic.

5. Stalk multicellular:

7. Stalk 2-celled.....*Lepidagathis cuspidata* Nees.

7. Stalk more than 2-celled.....*Hygrophila serpyllum* Anders.

2. Glandular trichome absent:

8. Non-glandular trichome unicellular.....

Lepidagathis fasciculata Nees.

8. Non-glandular trichome multicellular:

9. Cells broad:

10. Cells with brown contents.....*Ruellia patula* Jacq.

10. Cells empty.....*Rungia repens* Nees.

9. Cells narrow:

11. Cell wall thick, lumen very narrow.....*Tubiflora acaulis*
Kuntz.

11. Cell wall thin, with swollen basal cell.....*Justicia diffusa*
Willd.

In case of the second paper, the **distribution and characteristics of trichomes in 24 members of the Fabaceae** are presented. Out of the total 29 plants studied, five plants viz. *Canavalia ensiformis*, *Aeschynomene indica*, *Desmodium gangeticum*, *Rhynchosia bracteata* and *Sesbania aculeata* are found glabrous. Of the remaining 24 plants with trichomes, seven possessed various unicellular and multicellular glandular trichomes. Unicellular glandular trichomes were seen in three plants, i.e., *Alhagi camelorum*, *Crotalaria retusa* and *Clitoria ternatea*. *Alhagi camelorum* possessed oblong thin walled trichome whereas *Crotalaria retusa* had spindle shaped (pointed at the ends) trichome (Fig I and II). In *Clitoria ternatea* elongated obovate trichome was present with slightly warty walls. Glandular trichomes of the remaining four plants were multicellular differentiated into a head and a stalk or sessile. The trichome of *Dolichos lablab* had a biseriate two or four tiered head and a single celled stalk. In addition, this plant contained two types of non-glandular trichomes; one unicellular and the other linear and three-celled. The unicellular trichome here was curved at the tip while the three-celled

trichome had a very long apical cell and two-square shaped lower cells. The glandular trichomes of *Desmodium velutinum* had one or three tiered heads. This plant also possessed characteristic non-glandular trichomes having single basal cell and very long narrow pointed apical cells, which were smooth or warty. The glandular trichomes of *Desmodium triflorum* had two-celled head. The non-glandular trichomes of this plant were of two types; one two-celled with a spreading small basal cell and a narrow pointed apical cell. The second type of trichome was unicellular and curved. Trichomes of the fourth plant *Teramnus labialis* were sessile, flat, linear and four-celled.

All the remaining 17 plants possessed only non-glandular trichomes. The four species of *Indigofera* were characterized by medifixed hairs (Fig. I). The hairs of each of these plants were distinct in one or other features. The hair in *Indigofera trita* had a thick and papillate wall and very broad lumen. *Indigofera cordifolia* possessed 'L' shaped medifixed hairs having one arm shorter than the other, though 'V' shaped trichomes also were present. They had warty thick walls and broad lumen along with conical tips and a distinguished circular base point by which they were attached. In addition, the plant contained a non-glandular unicellular trichome. The trichomes of other species of *Indigofera*; *I. tinctoria* and *I. enneaphylla* had thick warty walls with broad lumen. Both these species had flat, sessile, medifixed hairs, but that of *I. enneaphylla* was constricted in the middle (both arms almost spindle shaped) and more warty compared to that of *I. tinctoria* where the middle portion of hair was the broadest.

Of the remaining 13 plants, three, *Tephrosia villosa*, *Stylosanthes hamatus*, and *Pongamia pinnata* possessed a very characteristic two-three celled trichome, having one or two basal square or rectangular cells and a long pointed apical cell. A number of trichomes of *Tephrosia villosa* had an oblique partition wall separating the two basal cells. This plant, in addition, contained a unicellular long pointed warty trichome having a marked curve at the base also. *Stylosanthes hamatus* possessed a three-celled trichome in which the middle cell was rectangular filled with yellowish brown inclusions and a basal oval cell. Large prismatic crystals, one each in every epidermal cell, were another added feature of this plant. *Pongamia pinnata* possessed a trichome similar to that of *Tephrosia villosa* but the entire structure was wavy in appearance.

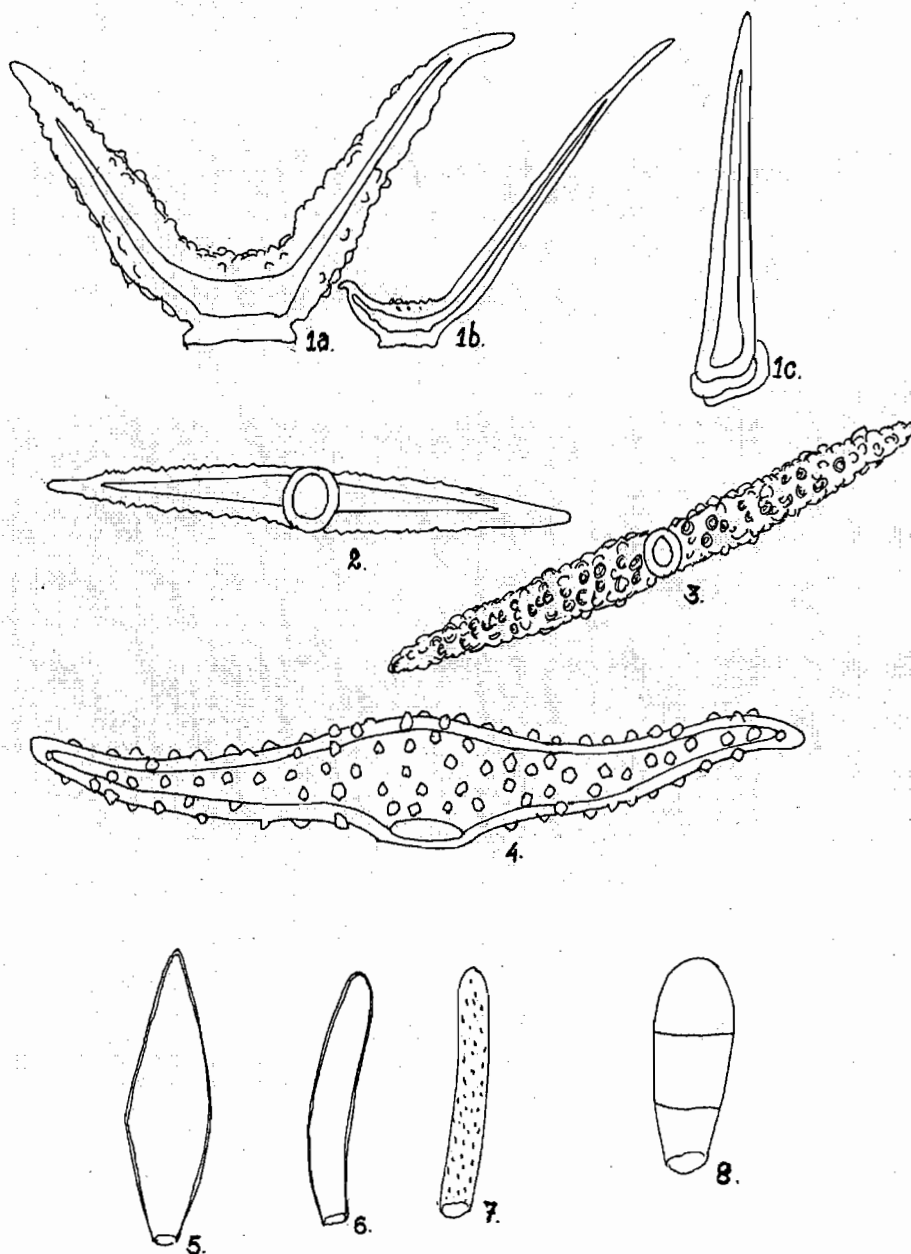


Fig. 1. Different type of medifixed hairs and glandular hairs

1. *Indigofera cordifolia* a. medifixed hair b. medifixed hair with one arm short c. unicellular non-glandular hair.
2. *Indigofera tinctoria* medifixed hair.
3. *Indigofera enneaphylla* medifixed hair.
4. *Indigofera trita* medifixed hair.
5. *Crotalaria retusa* glandular unicellular spindle shaped trichome.
6. *Albani camelorum* glandular unicellular oblong trichome.
7. *Clitoria ternatea* glandular unicellular oblong pitted trichome

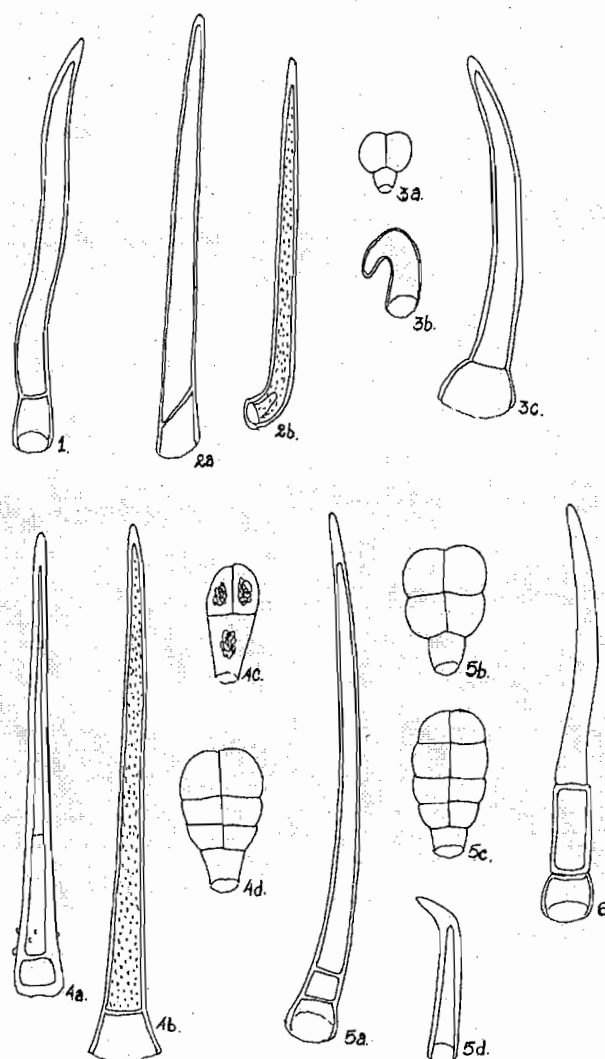


Fig. II. Non-glandular two-three celled trichome with some glandular trichomes.

1. *Pongamia pinnata* non-glandular multicellular, two-celled trichome.
2. *Tephrosia villosa* a. non-glandular multicellular, two-celled trichome b. unicellular non-glandular trichome with pitted wall.
3. *Desmodium triflorum* a. glandular multicellular trichome with two-celled head and a single celled stalk b. unicellular non-glandular trichome with a curve at tip c. non-glandular two-celled trichome.
4. *Desmodium velutinum* a. non-glandular multicellular, two-celled trichome with thick and smooth wall b. non-glandular multicellular, two-celled trichome with thick and warty wall; basal cell small and spreading c. glandular multicellular trichome with biseriate two celled head and a single celled stalk d. glandular multicellular trichome with biseriate three-tiered 12-celled head and a single celled head
5. *Dolichos lablab* a. non-glandular multicellular three-celled trichome; with two basal small cell and a long upper cell b. glandular multicellular trichome with biseriate two-tiered eight celled head and a single celled stalk c. glandular multicellular trichome with biseriate four-

Of the remaining 10 plants, six showed simple unicellular trichomes with a flat base and whereas those of other four plants possessed a round base (Fig. III). Trichomes of the former group were pitted or smooth walled. Pitted walls were present in three, *Tephrosia tenuis*, *Crotalaria sericea* and *Mucuna pruriens*. *Tephrosia tenuis* had a trichome with an extended apiculate tip whereas *Mucuna pruriens* possessed smooth walled and barbed walled trichome in addition to pitted walled trichome. Remaining plants having trichomes of flat base, i.e., *Crotalaria hirsuta*, *Crotalaria leptostachya* and *Sesbania grandiflora* had smooth wall. Of these, *Sesbania grandiflora* contained some cell inclusions at the base. The trichomes in *Crotalaria hirsuta* had broad lumen. The remaining four plants containing unicellular trichomes with round bases were *Crotalaria medicaginea*, *Alysicarpus vaginalis*, *Tephrosia purpurea* and *Melilotus indica*. Of these, *Crotalaria medicagenia* had papillate walls and rest had smooth walls. Trichomes of both *Alysicarpus vaginalis* and *Tephrosia purpurea* had broad lumen, but the walls of the latter plant were very thick when compared to that of the former. The trichomes in *Melilotus indica* possessed a narrow lumen and thick wall.

Artificial key for identification of some members of the Fabaceae based on trichome characters:

1. Plant tomentose/hirsute; with glandular and/or non-glandular trichomes:
 2. Glandular trichomes present:
 3. Glandular trichomes unicellular:
 4. Wall of the trichomes warty (pitted).....*Clitoria ternatea* L.
 4. Wall of the trichome smooth:
 5. Glandular trichome spindle shaped (pointed at both ends).....
Crotalaria retusa L.
 5. Glandular trichome oblong.....*Alhagi camelorum* Fisch.
 3. Glandular trichome multicellular:
 6. Trichome differentiated into head and stalk:
 7. Head two celled:
 8. Stalk of the trichome broad merging with the head making the trichome club shaped.....*Desmodium velutinum* DC.

- 8. Trichome differentiated into a broad two-celled head and a narrow one-celled stalk.....*Desmodium triflorum* DC.
- 7. Head multicellular.....*Dolichos lablab* L.
- 6. Trichome multicellular sessile.....*Teramnus labialis* (L.f.) Spreng.
- 2. Glandular trichome absent; non-glandular trichome present:
- 9. Non-glandular trichome unicellular:
- 10. Trichome medifixed:
 - 11. Medifixed type of trichomes only present:
 - 12. Trichome wall papillate.....*Indigofera trita* L.
 - 12. Trichome Wall warty:
 - 13. Ends of the trichome broad.....*Indigofera enneaphylla* L.
 - 13. Ends of the trichome conical.....*Indigofera tinctoria* L.
 - 11. Medifixed hair present along with unicellular simple trichome.....*Indigofera cordifolia* Heyne. ex Roth.
- 10. Trichome linear, not medifixed:
 - 14. Unicellular trichome without any swollen base:
 - 15. Wall warty or pitted:
 - 16. Tip of the trichome apiculate.....*Tephrosia tenuis* Wall. ex Dalz.
 - 16. Tip of the trichome simple conical:
 - 17. Only one type of pitted unicellular trichome.....
Crotalaria sericea Retz.
 - 17. Three type of unicellular trichome; one pitted; second smooth walled and third barbed walled.....*Mucuna pruriens* DC.
 - 15. Wall smooth:
 - 18. Lumen empty throughout the trichome:
 - 19. Wall thick; lumen narrow.....*Crotalaria leptostachya* Benth.
 - 19. Wall thin; lumen broad.....*Crotalaria hirsuta* Willd.
 - 18. Lumen containing cell inclusions at the base.....
Sesbania grandiflora Poir.
 - 14. Unicellular trichome with a swollen base:
- 20. Wall of the trichome warty (papillate); lumen broad.....
Crotalaria medicagenia Lamk.
- 20. Wall of the trichome smooth:
 - 21. Lumen broad.....*Alysicarpus vaginalis* DC.
 - 21. Lumen narrow:
 - 22. Wall very thick.....*Tephrosia purpurea* Pers.

22. Wall thin; lumen very narrow at apex.....

Melilotus indica (L.) All.

9. Non-glandular trichome two or three celled:

23. Trichomes homogenous:

24. Two celled trichome.....*Pongamia pinnata* Pierre.

24. Three celled trichome*Stylosanthes hamatus* Taub.

23. Trichomes of two types; unicellular pitted trichome and 2-celled trichome.....*Tephrosia villosa* Pers.

1. Plants glabrous.....*Sesbania aculeata* Poir., *Canavalia ensiformis* DC., *Rhynchosia bracteata* Benth., *Desmodium gangeticum* DC. and *Aeschynomene indica* L.

The above mentioned cases are just two examples in which the trichome/gland characters can be used effectively in identifying plants even in the absence of flowers or fruits. The dichotomous keys prepared are very easy to understand. Similar studies among all the families will provide excellent taxonomic data which can be used effectively. The utility of these characters is so pronounced that they can be incorporated in classical dichotomous keys. Similarly, the description of a taxon/plant will be more effective if these characters are included. Such studies should be an indispensable and mandatory part of every taxonomic study.

The two examples cited above, clearly bring out the taxonomic utilitarian aspects of the trichome characters. Such keys of identification are possible in all the major families of angiosperms. This will increase the data based on which even the classification can be proposed. But, more data involving almost all the plants or representative taxa are needed before such a venture.

The 11 cases of **bioprospecting** also provided much needed data on the new sources of useful phytochemicals. The new source plants of bioflavonoids are *Alternanthera sessilis* Linn. (DC), *Alternanthera bettzickiana*, *Ageratum conyzoides*, *Riedleia corchorifolia*, *Hygrophila schulli*, and *Bombax ceiba* and the bioflavonoids identified are luteolin, 4'-OMe luteolin, 3'-OMe quercetin, isorhamnetin, 6-hydroxy 4'-methoxy apigenin, 6-hydroxy, 7, 4'-dimethoxy apigenin, quercetin, kaempferol and acacetin and a glycoflavone, ie., 6-C glucosyl acacetin.

The new sources of volatile oil identified are *Stemodia viscosa*, *Stemodia serrata*, and *Ageratum houstonianum*, and the monoterpenes identified are eugenol, acetegenol, precocene-II, demethoxy ageratochromene, caryophyllene and alpha-cubebene.

New sources of important quinones like emodin and aloin are found to be the flowers of *Aloe* which normally are discarded considered worthless.

A new source of dietary fibre/mucilage also is located in the present study and *i.e.*, the flower calyces of *Bombax ceiba* which also was considered a waste. Another discovery is the location of new sources of fixed oils and they are seeds of *Aloe barbadensis* and *Balanites aegyptiaca*.

The results discussed above are highly encouraging. All the 11 plants screened provided useful phytochemicals and this can be profitably counted as alternate sources of these chemicals. Similar studies are to be conducted on all the wild relatives of useful plants and such efforts will be highly rewarding in terms of unexplored world of useful phytochemicals.

Chapter 5

Conclusions

Conclusions

In the present research project entitled “In-Depth Studies on some of the Floristic Components of Baroda and Panchmahal Districts with Reference to Bioprospecting and Speciation.” detailed morphological studies on 400 plants have been conducted. These plants were dissected carefully and identified using the standard floras and ‘true to life’ line drawings of all these plants were prepared. The variations in morphological characters of the dissected specimens from those described in floras, if any, were observed and noted. Detailed studies on their micromorphological characters like stomatal types and trichome characters were done and their sketches were made. In addition, bioprospecting of 11 plants mostly related to certain useful plants was carried out to find out substitute or alternate sources of important phytochemicals. The highlights of the Ph.D. programme are the following:

1. **Line drawings of 400 plants** showing distinct and characteristic features of each plant will help any student of taxonomy to understand the plant correctly and group them. Most of these illustrations are made for the first time.
2. Twenty-nine plants showed **variations** in some or the other characters from the standard descriptions. **These variations may lead to speciation** and therefore, they are recorded for further studies.
3. In a few plant specimens **certain additional characters** which were not reported earlier also were observed. They form additional data in the morphological descriptions of these plants.
4. **An elaborate and extensive database on the micromorphological characters of 400 taxa** are made available for the first time. This data will be of immense importance in identifying almost all these plants even in the vegetative states. In case, of

economically useful plants such as drug plants or narcotics, these characters will be of great significance in identifying the raw material or adulteration.

5. The micromorphological characters especially those of trichomes are found to be of great use in classifying and identifying taxa at various levels of hierarchy or in quality control analysis of useful plants as evidenced by the three papers published;

1) Micromorphological characters as biomarkers for some of the medicinal plants of Gujarat.: In *Herbal Technology: Recent Trends and Progress* (M. Daniel Ed.) Scientific Publishers, Jodhpur (2007), 77- 84

2) Foliar trichomes of some members of the family Acanthaceae and their taxonomic utility (*Int. J. Pharma and Bio Sci.* 2 (3), 2011, 231-235.) and

3) Foliar micromorphological studies on some members of the family Fabaceae (*Int. J. Pharma and Bio. Sci.* 2 (4), 2011, 603-611).

6. Eleven new sources of economically important products are located during the course of bioprospecting, they are 1) new sources of volatile oils (*Stemodia serrata*, *Stemodia viscosa* and *Ageratum houstonianum*- new sources of eugenol in the first two plants), 2) new sources of bioflavonoids (*Alternanthera bettzickiana*, *A. sessilis*, *Ageratum conyzoides*, *Riedleia corchorifolia* and *Hygrophila schulli*), 3) mucilage (*Bombax*), 4) quinones- in flowers of *Aloe* and 5) fixed oils from (*Aloe* seeds and *Balanites aegyptiaca*).

Chapter 6

Summary and Highlights

Summary and Highlights

The flora of any region is of immense importance as it refers to the availability and proper utilization of all the plants in that region. Apart from the monumental work of Hooker (Flora of British India) in which the floristic elements of Gujarat are represented, only G. L. Shah (1978) ventured to prepare a flora of Gujarat. A large number, of regional floras of Districts and Talukas are prepared by scholars of different Universities and research institutions of the State. A flora with elaborative illustrations of all the plants will facilitate greatly the proper recognition of all the plant taxa. But, there is no illustrated flora available for any student of taxonomy to refer to. Therefore, in the present work proper illustrations, description and micromorphological studies have been done on all the plants. The significance of micromorphological characters, such as trichomes, glands, stomata types, nectaries, etc. in providing additional aid for identification and descriptions is understood of late and these characters are highlighted in a large number of scientific papers appeared in recent botanical journals. These characters, when present in a vegetative organ would aid in the identification of a plant even in a vegetative state. Since, in our studies we have found a number of taxa showing many variations in characters from the type specimens mentioned in earlier floras and that these variations, which are passed on from generations to generations and being cumulative may lead to formation of smaller categories and later, higher categories like species. The overexploitation of useful plants by indiscriminate collection, make them threatened and even endangered. Since, the related plants may produce the same compounds or similar compounds to the chemicals in question, Bioprospecting in which biologically related plants are screened for quality phytochemicals also is done at many places.

With the above objectives in mind, in the present research project, 400 plants collected from regions of Baroda and Panchmahal Districts have been subjected to a detailed study on morphological and micromorphological characters such as stomatal types, types of trichomes, glands and corolline nectaries, both in the vegetative

as well as reproductive parts. Detailed line drawings of these plants and their micromorphological characters are prepared and compiled. Variations in characters from the standard descriptions given in a flora were noted. In addition, 11 plants have been studied for bioprospecting of chemical compounds such as quinones (*Aloe* flowers, fruit walls and seeds); volatile oils (*Stemodia serrata*, *Stemodia viscosa* and *Ageratum houstonianum*); flavonoids (*Alternanthera bettzickiana*, *A. sessilis*, *Ageratum conyzoides*, *Riedleia corchorifolia* and *Hygrophila schulli*); mucilage (calyx of *Bombax ceiba* flower); and fixed oils (*Aloe* seeds and *Balanites aegyptiaca*)

The objectives of the project were the following:

1. To study flora of Baroda and Panchmahal district with special emphasis on all the morphological and micromorphological characters of the plants collected.
2. To prepare diagrammatic illustrations of the plants studied.
3. To look for variations, if any, in morphological characters in plants which may give any idea of trends in speciation.
4. Bioprospecting of certain plants for useful chemicals.

Methodology

1. Collection of plants from different locations of Baroda and Panchmahal Districts.
2. Detailed study of plants for its morphological and micromorphological characters using simple and compound microscopes.
3. Comparing the descriptions thus prepared with those of a standard flora and noting down variations.
4. Analysis of plants for useful chemicals by standard methods of extraction and analysis.

Results and Discussion

The line drawings of 400 plants containing the details of plants including the micromorphological characters of these plants were prepared, that resulted in a total of

655 line drawings. On comparison with the data of available floras it is found that Twenty-nine plants showed variations in some or the other characters from the standard descriptions.

The plants and their variations are the following:

Name of plants	Reported characters	Variations observed
1. <i>Mollugo oppositifolia</i> Linn.	Stamens usually 3	Stamens 4-5.
2. <i>Peristrophe bicalyculata</i> Nees.	Stem 6-angled. Ovary hairy at the tip. Filaments hairy	Stem 5-angled. Ovary glabrous. Filaments glabrous.
3. <i>Solanum nigrum</i> Linn.	Calyx glabrous Calyx not enlarged in fruit. Filaments hairy.	Calyx hairy. Calyx enlarged in fruit Filaments glabrous.
4. <i>Physalis minima</i> Linn.	Filaments glabrous	Filaments hairy.
5. <i>Oxalis corniculata</i> Linn.	Stigma papillose	Stigma not papillose.
6. <i>Cassia occidentalis</i> Linn.	Staminodes 3	Staminodes 4-6.
7. <i>Vicoa indica</i> DC.	Ray floret epappose	Ray floret pappose.
8. <i>Hygrophila serpyllum</i> Anders.	Flowers in spikes	Flowers axillary in 2-3 clusters.
9. <i>Haplanthus tentaculatus</i> Nees.	Bract, bracteole smaller than calyx	Bract, bracteole absent.
10. <i>Basella rubra</i> Linn.	Bracteole adnate to perianth. Perianth bi-lipped.	Bracteoles free from perianth. Perianth cup shaped.
11. <i>Caesulia axillaries</i> Roxb.	Pappus scale-2	Pappus absent.
12. <i>Euphorbia microphylla</i> Heyne.	Limb of involucre-gland inconspicuous	Limb of involucre-gland conspicuous.
13. <i>Euphorbia pilulifera</i> Linn.	Limb of involucre-gland inconspicuous.	Limb of involucre-gland conspicuous.
14. <i>Ficus hispida</i> Linn.	Gall flower and female	Gall flower and female

	flower with 0 perianth. male flower without bract.	flower with perianth. Male flower with 2 bracts.
15. <i>Nymphaea alba</i> L.	Stigmatic rays 16. Flower colour white.	Stigmatic rays 10. Flower colour light yellow.
16. <i>Parthenium hysterophorus</i> Linn.	Pappus present. Male flower tubular with 5 lobe.	Pappus present only in ray florets. In case of disc floret pappus is absent.
17. <i>Corchorus trilocularis</i> Linn.	Capsule hairy when young with stiff stellate hairs. 3-4 angled capsule. Seed trigonous black.	Capsule glabrous, without any stiff stellate hair. Capsule cylindrical. Seed truncate at both ends.
18. <i>Biophytum sensitivum</i> DC.	Dimorphism in flower	No dimorphism was noticed.
19. <i>Spergula arvensis</i> Linn.	Styles 5. Capsule 5 valved.	Very often 3-4 style. Capsule 3- valved.
20. <i>Stemodia viscosa</i> Roxb.	Both the cells of stamen fertile.	One cell aborted.
21. <i>Bauhinia purpurea</i> Linn.	Fertile stamens 3 staminodes 2-7	All stamens fertile. stamens 5, no staminodes.
22. <i>Ficus glomerata</i> Roxb.	Stigma clavate	Stigma minute, entire and indistinct.
23. <i>Amaranthus viridis</i> Linn.	Style 2-3	Style 3, each style branches to give distinct stigma
24. <i>Grewia salvifolia</i> Heyne.	Petal obtuse, with notch. Gland hairy, 1/3rd of the petal	Petal not obtuse and notch divide its tip in unequal half gland 1/4th of the petal.
25. <i>Aristolochia bracteolata</i> Lam.	Leaf usually obtusely acuminate. Flower few in axillary racemes. Bract small ovate,	Leaf apex obtuse with a slight notch. Flower axillary solitary. Bract small obtuse , rounded. acuminate.
26. <i>Martynia diandra</i> Glox.	Anther cell confluent	Anther divaricate.
27. <i>Coix lachryma-jobi</i> Linn.	Glumes 4.	Glumes 3.
28. <i>Bonnaya brachiata</i> Link.	Staminode short pubescent.	Staminode glabrous.
29. <i>Panicum colonum</i> Linn.	Glumes 4.	Glumes 6.

Apart from these variations, certain additional characters which were not reported earlier also were observed. They were as follows; *Digera arvensis* (fleshy outgrowth on fruit); *Oxalis corniculata* (show articulations like that of bone joints on pedicels and petiole); *Celosia argentea* (show connate filaments with infoldings); *Heylandia latebrosa* (projections or outgrowth at the base of petal); and *Chenopodium alba* (filaments connate at the base).

Almost all the plants studied contained trichomes in leaves or stems and these trichomes vary from glandular to eglandular. Glandular trichomes were of many different types such as with unicellular stalk and unicellular head; unicellular stalk with multicellular head or multicellular head with multicellular stalk. Non-glandular trichomes also varied in sizes ranging from unicellular to multicellular ones, and were filamentous branched or unbranched. Floral glands or nectaries were also of varied nature and sizes with equal diversity as that of the trichomes of the vegetative organs. The line diagrams were prepared on all these type of vegetative as well as reproductive trichomes and a key is prepared as an aid to the identification of plants.

Along with these characters several types of silica bodies were observed in almost all the graminaceous plants which had been studied like *Panicum colonum*; *Coix -lachyrma-jobi*; *Desmostachya bipinnata* and *Dinebra retroreflexa*.

Studies in Bioprospecting resulted in identification or quantification of a number of economically and pharmacologically important phytochemicals. They are the following:

The seed oil of *Balanites aegyptiaca* was found to be 45% of the kernel. Mucilage in calyces of *Bombax ceiba* was estimated to be 20.06% and it contained galacturonic acid and galactose as sugars. *Ageratum houstonianum* yielded a volatile oil containing precocene-II; demethoxy ageratochromene; caryophyllene and alpha-cubebene as the principal component in abundance, and this is a new source of linalool. *Stemodia viscosa* yielded volatile oil rich in eugenol and acetegenol. *Stemodia serrata* yielded a volatile oil containing eugenol and acetegenol as the principal components. *Alternanthera bettzickiana* showed the presence of steroids ecdysterone and β -sitosterol and bioflavonoids (antioxidants) such as kaempferol, iso-rhamnetin, and quercetin.

Alternanthera sessilis flower showed presence of 4'OMe Luteolin. The phenolics acids were *cis* and *trans*- ferulic acid, vanillic acid and syringic acid. In addition, ecdysterone also was present in flowers. *Ageratum conyzoides* leaves contained two flavones, 6-hydroxy 4'-methoxy apigenin, and 6-hydroxy, 7, 4'-dimethoxy apigenin. The phenolic acid located was vanillic acid. The blue flowered *Hygrophila schulli* yielded luteolin, 4'-OMe luteolin and 3',4'-diOMe luteolin from leaves, while that of the white flowered plant contained luteolin and apigenin. The stems of these two plants also differed in their flavonoids. The stem of blue flower plant contained apigenin, and acacetin, whereas, the stem of the later plant, possessed luteolin, 4'-OMe luteolin and 3', 4'-diOMe luteolin. Leaves of *Riedleia corchorifolia* contained quercetin, kaempferol and acacetin and a glycoflavone, 6-C glucosyl acacetin. *Aloe barbadensis* flowers, fruit walls and seeds showed presence of aloin and emodin.

The highlights of the presence investigation are the following:

1. **Line drawings of 400 plants** showing distinct and characteristic features of each plant will help any student of taxonomy to understand the plant correctly and group them. Most of these illustrations are made for the first time.
2. **An elaborate and extensive database on the micromorphological characters of 400 taxa** are made available for the first time. This data will be of immense importance in identifying almost all these plants even in the vegetative states. In case, of economically useful plants such as drug plants or narcotics, these characters will be of great significance in identifying the raw material or adulteration, as in the case of our paper entitled 'Micromorphological characters as biomarkers for some of the medicinal plants of Gujarat'. (*Herbal Technology:Recent Trends and Progress* (M. Daniel Ed.) Scientific Publishers, Jodhpur (2007) 77- 84.)
3. **The micromorphological characters especially those of trichomes are found to be of great use in classifying and identifying taxa at various levels of hierarchy** as evidenced by the two papers published; 1) Foliar trichomes of some members of the family Acanthaceae and their taxonomic utility (*Int. J. Pharma and Bio Sci.* 2 (3), 2011,

231-235.) and 2) Foliar micromorphological studies on some members of the family Fabaceae (*Int. J. Pharma and Bio. Sci.* 2 (4), 2011, 603-611)

4. Ten new sources of economically important products are located during the course of bioprospecting, they are 1) new sources of volatile oils (*Stemodia serrata*, *Stemodia viscosa* and *Ageratum houstonianum*- new sources of eugenol in the first two plants), 2) new sources of bioflavonoids (*Alternanthera bettzickiana*, *A. sessilis*, *Ageratum conyzoides*, *Riedleia corchorifolia* and *Hygrophila schulli*), 3) mucilage (*Bombax*), 4) quinones- in flowers of *Aloe* and 5) fixed oils from (*Aloe* seeds and *Balanites aegyptiaca*).

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PROTA 2: Vegetables/ Legumes

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Appendix

Appendix

List of papers published: Three

- 1) Micromorphological characters as biomarkers for some of the medicinal plants of Gujarat. *Herbal Technology: Recent Trends and Progress*. (M. Daniel *et.al.*, Eds.) Scientific Publishers, Jodhpur, (India), 77-84.
- 2) Foliar trichomes of some members of the family Acanthaceae and their taxonomic utility (*Int. J. Pharma and Bio Sci.* 2 (3), 2011, 231-235.)
- 3) Foliar micromorphological studies on some members of the family Fabaceae (*Int. J. Pharma and Bio. Sci.* 2 (4), 2011, 603-611).

MICROMORPHOLOGICAL CHARACTERS AS BIOMARKERS FOR SOME OF THE MEDICINAL PLANTS OF GUJARAT

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ABSTRACT

Twelve medicinal plants of Gujarat have been screened for their micromorphological characters such as epidermal cell complex, stomatal complex, and trichomes. Trichomes were found to be very distinctive and useful in identifying each taxon. Therefore, a key for identification of these plants have been prepared. The trichomes thus form a valid biomarker.

INTRODUCTION

Micromorphological studies of any taxa include characteristic features of epidermal cell complex, stomatal complex, trichome complex, or any other epidermal inclusions. Importance of micromorphological characters; specifically those of trichomes are widely recognized for taxonomic considerations of Angiosperms (Banerjee, 2002). A majority of the flowering plants can readily be identified with as much easy by their vegetative characters as by their floral characters (Davis and Heywood, 1973; Praveen, 2000). These characters aid as biomarkers for easy identification of plants even in vegetative state.

In the present study, the emphasis is given on trichome studies. Trichomes are epidermal appendages of diverse form, structure and functions. They may occur on all parts of the plants. Trichomes show wide

variations within families and the smaller plant groups and even in the same plant. On the other hand, one may observe considerable uniformity in trichomes within a plant group also.

Structurally, trichomes are classified as unicellular and multicellular. The unicellular may be unbranched or branched. Multicellular trichomes may consist of a single row (uniseriate) or of several layers (multiseriate). Some multicellular trichomes are branched in dendroid manner; others have the branches oriented largely in one plane.

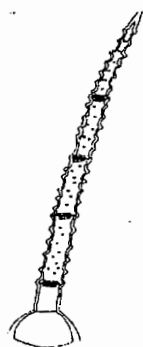
In the present work 12 medicinal plants found in Baroda have been studied for their micromorphological characters especially trichomes and stomatal features.

MATERIALS AND METHODS

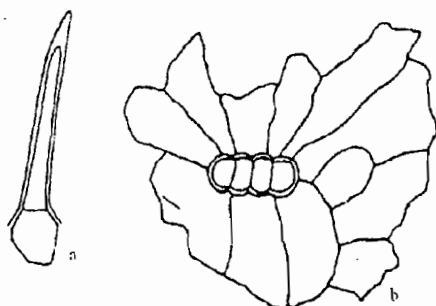
All the plants were collected from the campus of M.S.U. The voucher specimens were deposited in the herbarium of M.S. University of Baroda. For trichome studies, the leaves were boiled in 10% KOH for 5-10 min. and after decanting the KOH, these leaf samples were washed in water. These treated leaf samples were then stained with saffranin and mounted in glycerin and observed under compound microscope.

Observations

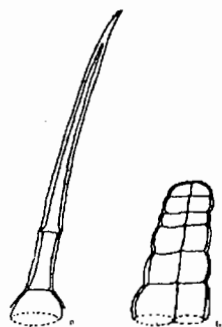
The trichomes observed in the plants studied are described below and data on trichome frequency and trichome index are provided in Table 2. The data on epidermal cells and stomata such as epidermal frequency, stomatal index and their frequency are presented in Table 1. The details of trichomes of each plant studied are presented below.



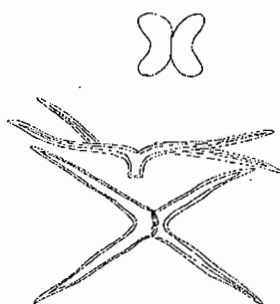
1. *Aerva lanata* Juss. Only eglandular trichome is present here. It is multicellular and uniseriate. The surface shows wartiness due to small protuberances. The walls of joints of the trichome show many finger like projections on either side. The basal cell is swollen.



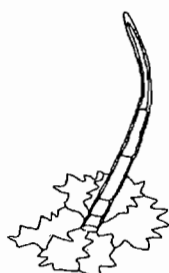
2. *Antigonon leptopus* H. & A. This plant also has both glandular and eglandular trichomes. The glandular trichome shows 3-4 celled sessile head and the polar end of the head show hemispheric cell. The eglandular trichome is unicellular and very short in length. Tip of trichome is conical.



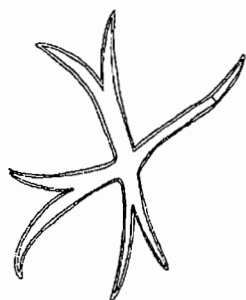
3. *Blumea membranacea* DC. Here also both glandular and eglandular trichomes are present. The eglandular trichome (a) shows swollen basal cell. Basal cell is somewhat hemispheric. Eglandular trichome is multicellular, uniseriate and the joints show swellings as those of *Jatropha*. Glandular trichome (b), is multicellular, biseriate and the head is not well differentiated and 3-4 celled.



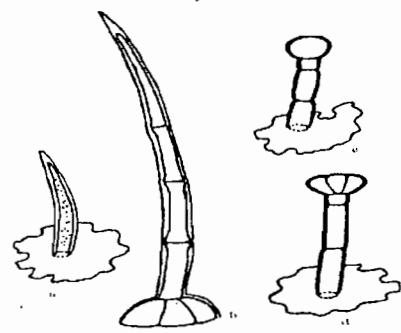
4. *Buddleia asiatica* Lour. Trichomes are of two types, glandular and eglandular. The eglandular trichome is two celled joined at the base and each cell is further dichotomously branched. Hence, it shows four arms and each arm is spread in the form of a cross. This trichome shows a small stalk formed of the bending of the base of two cells. The glandular trichome is 2-celled with kidney shaped cells joined at the back.



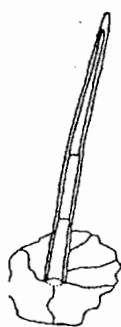
5. *Euphorbia hirta* L. The trichomes observed are eglandular uniseriate unbranched filaments. Apical cell is pointed.



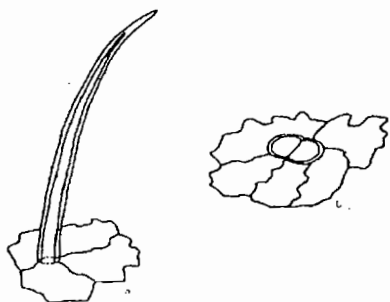
6. *Glinus lotoides* Loefl. This plant shows presence of 3-5 armed stellate hairs. Each arm of the stellate hair is dichotomously branched. Sometimes the arm shows presence of cross septa.



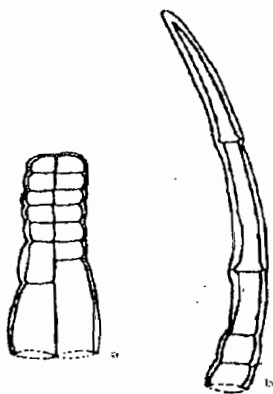
7. *Hygrophila serpyllum* Anders. Here also, both eglandular and glandular types of trichomes are present. Eglandular trichomes are of two types, viz. unicellular (a) and multicellular uniseriate trichome (b). Unicellular trichome show pitted surface. Multicellular uniseriate filamentous trichome show swollen base. The base is hemispheric and formed of 3 swollen cells. The glandular trichomes are of two types one is with single cell head (c) and another one with 3-celled head (d). Both trichomes are stalked (multicellular uniseriate stalk).



8. *Jatropha gossypifolia* L. Trichome observed here is multicellular, uniseriate, and eglandular. The apical cell of the trichome is pointed. Surface of the trichome is smooth.

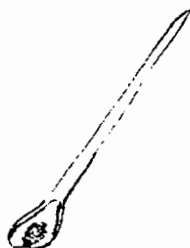


9. *Lantana camara* L. Both glandular and eglandular trichomes are present. Eglandular trichome is unicellular with slight curve at its tip. The glandular trichome is sessile and 2-celled. Each cell is hemispheric.

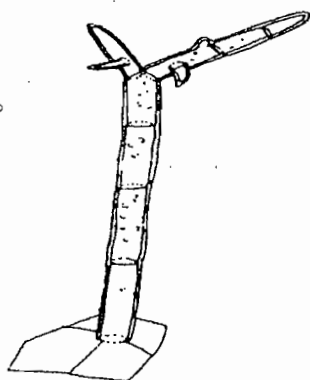


10. *Sphaeranthus indicus* L. Here two types of trichomes viz. glandular and eglandular are present. The glandular trichome is multi-cellular filamentous and biseriate. The trichome shows an undifferentiated head (4-5 celled). Stalk is absent and basal cells are swollen.

Eglandular trichome is multicellular filamentous uniseriate. The basal 2-3 cells are swollen. The joints are swollen similar to the joints of bones.



11. *Terminalia arjuna* W. & A. Here very long unicellular glandular trichomes are present. It shows a very narrow lumen at the base only.



12. *Withania somnifera* Dun. Only eglandular trichome is present here. It is multicellular, uniseriate and branched. Many a times these trichomes are vigorously branched. The branches appear like horns. Surface of the trichome is warty.

The general description and types of trichomes along with stomata of the investigated taxa are described below.

Epidermal cell complex

Epidermal cells were four to many sided. All the taxa investigated show epidermal cells with irregular cells with wavy and curved walls except *Withania somnifera*, Dun. and *Antigonon leptopus*, H. & A. which showed cells with straight walls. Epidermal cell frequency ranged from 18 to 61.2 per mm².

Stomatal complex

Stomata observed were of different types such as anisocytic, anomocytic, diacytic, tetracytic, polycytic, pentacytic and paracytic. Stomatal frequency ranged from 7 to 12 per mm² and stomatal index ranged from 11.56 to 26.67 per mm².

Trichome complex

Both glandular and eglandular types of trichomes were present. The trichome were unicellular/multicellular uniseriate or multicellular multiseriate.

All the investigated taxa studied showed unbranched trichomes except for *Withania somnifera*, Dun. where branched trichomes were observed. The data on stomata and trichomes in the investigated taxa are presented in Tables 1 & 2.

Table 1. Stomatal and Epidermal characters in some Medicinal Plants of Baroda

Taxa	Epidermal Cell Shape	Epidermal Cell Frequency (per mm ²)	Stomatal Type	Stomatal Frequency (per mm ²)	Stomatal Index (per mm ²)
<i>Aerva lanata</i> Juss.	Irregular	41.2	Anisocytic	12	22.56
			Anomocytic		
<i>Antigonon leptopus</i> H. & A.	Irregular	61.2	Anisocytic	8	11.56
			Anomocytic		
			Tetracytic		
			Paracytic		
<i>Blumea membranacea</i> DC.	Irregular	21.8	Anomocytic	7	24.30
<i>Buddleia asiatica</i> Lour.	Irregular	63.2	Anomocytic	21.4	25.29
<i>Euphorbia hirta</i> L.	Irregular	30	Anisocytic	8	21.05
			Anomocytic		
<i>Glinus lotoides</i> Loefl.	Irregular	81.2	Anomocytic	10.8	25.71
			Polycytic		
<i>Hygrophila serpyllum</i> Anders.	Irregular	25.6	Diacytic	8.6	25.14

<i>Jatropha gossypifolia</i> L.	Irregular	31.6	Tetracytic	9.8	23.67
<i>Lantana camara</i> L.	Irregular	28.6	Diacytic Anisocytic Anomocytic	10.4	26.67
<i>Sphaeranthus indicus</i> L.	Irregular	18	Anisocytic Anomocytic	6.2	25.61
<i>Terminalia arjuna</i> W. & A.	Irregular	23.4	Anomocytic Anisocytic Pentacytic	10.2	30.35
<i>Withania somnifera</i> Dun.	Irregular	24.4	Anisocytic	6.4	20.78

Table 2. Trichomes in some medicinal plants of Baroda.

Taxa	Trichome Type	Trichome Frequency (per mm ²)		Trichome Index (per mm ²)	
		Eglandular	Glandular	Eglandular	Glandular
<i>Aerva lanata</i> Juss.	Multicellular uniseriate eglandular	2.4	---	5.50	---
<i>Antigonon leptopus</i> H. & A.	Both multicellular glandular & unicellular eglandular	1	1	1.6	1.6
<i>Blumea membranacea</i> DC.	Both multicellular glandular and eglandular	1	1	4.38	4.38
<i>Buddleia asiatica</i> Lour.	Both eglandular and glandular	14.8	2	18.97	3.16
<i>Euphorbia hirta</i> L.	Multicellular uniseriate eglandular	1	---	3.22	---
<i>Glinus lotoides</i> Loef.	Stellate hair	1.2	---	3.70	---
<i>Hygrophila serpyllum</i> Anders.	Both eglandular and glandular	10.6	2.2	29.28	7.91
<i>Jatropha gossypifolia</i> L.	Multicellular uniseriate eglandular	1.2	1.8	3.31	6.56
<i>Lantana camara</i> L.	Multicellular uniseriate eglandular	8.5	---	9.71	---
<i>Lantana camara</i> L.	Both multicellular glandular and unicellular eglandular	1.2	1.2	4.02	4.02
<i>Sphaeranthus indicus</i> L.	Both eglandular and glandular	1	1.6	5.26	8.16
<i>Terminalia arjuna</i> W. & A.	Unicellular glandular	1	---	1.6	---
<i>Withania somnifera</i> Dun.	Multicellular uniseriate branched eglandular	1.6	---	6.15	---

DISCUSSION

The present study of micromorphological characters of the leaf epidermis revealed that these characters are useful for the identification of these investigated taxa. These features are now considered important in taxonomic studies and they can be considered as biomarkers. In this study, the trichomes of the plants screened are very much distinct from each other. The nature, branching and surface of the trichomes are variable and hence, they appear very sound biomarkers.

A dichotomous key for identification of these investigated taxa is given below

1. Trichomes eglandular only:
 2. Trichomes branched:
 3. Trichomes dichotomously branched like Stellate hairs *Glinus lotoides* Loefl.
 3. Trichome multicellular uniseriate randomly branched *Withania somnifera* Dun.
 2. Trichome unbranched:
 4. Trichome multicellular uniseriate with Smooth surface:
 5. Stomata only tetracytic *Jatropha gossypifolia* L.
 5. Stomata both anisocytic and anomocytic *Euphorbia hirta* L.
 4. Trichome multicellular uniseriate with spiny surface *Aerva lanata* Juss.
1. Trichomes both eglandular and glandular or only glandular:
 6. Eglandular trichome absent, glandular unicellular trichome *Terminalia arjuna* W. & A.
 6. Eglandular trichome present with glandular trichomes.
 7. Eglandular unicellular trichomes:
 8. Multicellular glandular trichome with two celled head *Lantana camara* L.
 8. Multicellular glandular trichome with 3-4 celled head *Antigonon leptopus* H. & A.
 7. Eglandular multicellular trichomes:
 9. Eglandular trichome with dichotomous branching *Buddleia asiatica* Lour.
 9. Eglandular trichome unbranched:
 10. Eglandular both unicellular and multicellular uniseriate *Hygrophila serpyllum* Anders.
 10. Eglandular but only multicellular:
 11. Stomata only anomocytic... *Blumea membranacea* DC.
 10. Stomata both anisocytic and anomocytic..... *Sphaeranthus indicus* L.

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RESEARCH ARTICLE

PHARMACOGNOSY

**FOLIAR TRICHOMES OF SOME MEMBERS OF THE FAMILY ACANTHACEAE
AND THEIR TAXONOMIC UTILITY**

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ABSTRACT

Looking into the importance of micromorphological characters in classification of taxa at various levels and for identifying the important plants even in the absence of floral characters, a preliminary study is conducted in 13 members of the family Acanthaceae. Trichomes were a common feature in the plants screened having located in 11 out of the 13 plants studied. Both glandular and non-glandular trichomes were present. A key based on the trichome characters was prepared to identify the plants bearing them even in the vegetative conditions. These characters can serve as pharmacognostic biomarkers in cases of medicinally important plants.



KEY WORDS

Acanthaceae, micromorphological characters, biomarkers, trichomes.

INTRODUCTION

Micromorphological characters including the trichomes of plants have assumed great taxonomical significance recently as viable taxonomic markers. These characters which would be of help in identifying plants even in vegetative state will be of great use for field taxonomists in identifying plants in the absence of flowers and fruits which are available only in certain seasons of the year. It was Solereder¹ and Metcalfe and Chalk² who made some significant contributions to the micromorphological characters of plants. Plant morphologists had used many micromorphological characteristics as foliar trichomes to resolve the taxonomic conflicts and thus these characters have played an important role in plant taxonomy^{3,4}. Recently, foliar trichomes are used for the discrimination of different taxa within the genus *Artemisia*. In case of medicinal plants, trichome characters act as biomarkers to identify the plant even in the raw material or powder form⁵. The presence of glandular trichomes in many of the medicinal

plants is considered indicative on the concentration of secondary metabolites with pesticidal, pharmacological, and fragrant properties⁶. The family Acanthaceae and Asteraceae are the families which are particularly rich in different types of trichomes which are used as an aid for identification⁷⁻⁸. Therefore, in the present work, 13 members of the family Acanthaceae were studied for their foliar trichomes, to examine their utility in identification.

MATERIALS AND METHODS

The epidermis was peeled or was cut into suitable sizes. One end of leaf was held firmly with a thumb and the other end scraped gently with a razor blade, until a thin clear peel was cut off. The pieces were washed off in water and was stained with in safranin, and mounted in glycerin on a clean slide.

RESULTS AND DISCUSSION

The trichomes of the plants of Acanthaceae screened is presented in Fig. 1. Out of the 13 plants studied, two plants, *Daedalacanthus roseus* Anders. and *Rungia parviflora* var. *pectinata* Nees. were found to be glabrous. Of the remaining 11 plants, 6 possessed glandular trichomes and each of these trichomes was found to be different from others. Of the plants containing glandular trichomes, both *Ecbolium linneanum* Kurz. *Asteracantha longifolia* Nees. contained sessile, disc shaped trichomes with 4-8 cells. Both contained non-glandular uniseriate trichomes also. But the uniseriate trichomes of *Ecbolium linneanum* had the apical cell which is long and swollen at the base. All the remaining

four plants contained stalked glandular trichomes. The glandular trichomes of *Adhatoda vasica* Nees. and *Neuracanthus sphaerostachys* Dalz. were having a single celled stalk and 4 celled head but the latter plant possessed unicellular trichomes also. In *Lepidagathis cuspidata* Nees. and *Hygrophila serpyllum* Anders. there were two types of glandular trichomes. The large trichome of *Lepidagathis cuspidata* Nees. had 2 celled stalk (with thick walls) and 4 celled head. While, that of *Hygrophila serpyllum* Anders. the stalk was 4-celled. The small trichome of the former possessed a four celled head while that of latter had a single celled head.

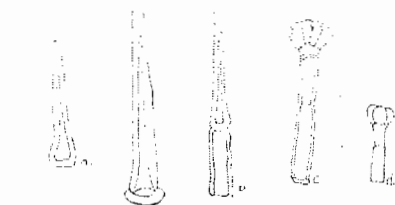
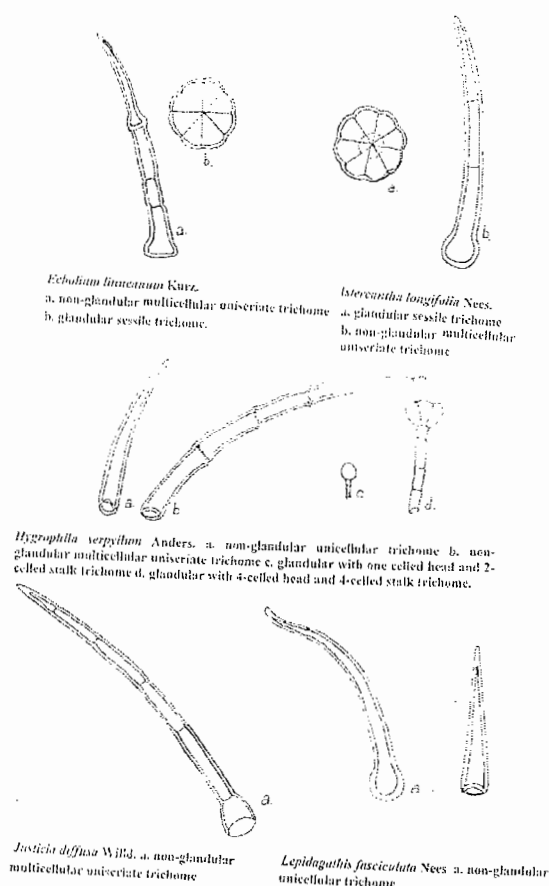


Fig. 1. (Contd.)

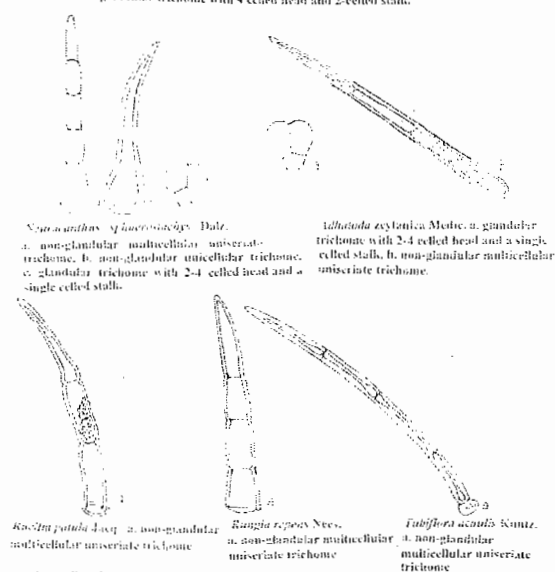


Fig. 1. (Contd.)

Unicellular trichome was the only type in *Lepidagathis fasciculata* Nees. The remaining 5 contained uniseriate 3-4 celled long trichomes. These trichomes were distinguished by the thickening of the trichome walls. Both *Ruellia patula* Jacq. and *Rungia repens* Nees. had broader cells in trichomes. But the former plant contained a number of cell inclusions, while such type of inclusions were not observed in the later plant. Of the

remaining 2 plants, *Tubiflora acaulis* Kuntz. and *Justicia diffusa* Willd. the trichome of the former plant had very thick walls and very narrow lumen whereas that of *Justicia diffusa* had a swollen basal cell.

An artificial key using trichome character for the identification of some species belonging to the Acanthaceae is prepared and presented below.

ARTIFICIAL KEY USING TRICHOME CHARACTERS FOR THE IDENTIFICATION OF SOME SPECIES BELONGING TO THE ACANTHACEAE:



1. Plants glabrous.....*Daedalacanthus roseus* Anders and
Rungia parviflora var. Nees.
1. Plants with trichomes:
 2. Glandular trichome present, non-glandular trichome present or absent:
 3. Glandular trichome sessile;
 4. Non-glandular trichome 3-celled with upper cell long and swollen at the base.....*Ecbolium linneanum* Kurz.
 4. Non-glandular trichome 3-celled without any cell being swollen.....*Asteracantha longifolia* Nees.
 3. Glandular trichome stalked:
 5. Stalk of glandular trichome unicellular
 6. Unicellular non-glandular trichome present
Neuracanthus sphaerostachys Dalz.
 6. Unicellular trichome absent.....*Adhatoda zeylanica* Medic.
 5. Stalk multicellular:
 7. Stalk 2-celled.....*Lepidagathis cuspidata* Nees.
 7. Stalk more than 2-celled.....*Hygrophila serpyllum* Anders.
 2. Glandular trichome absent:
 8. Non-glandular trichome unicellular.....*Lepidagathis fasciculata* Nees.
 8. Non-glandular trichome multicellular:
 9. Cells broad:
 10. Cells with brown contents.....*Ruellia patula* Jacq.
 10. Cells empty.....*Rungia repens* Nees.
 9. Cells narrow:
 11. Cell wall thick, lumen very narrow.....*Tubiflora acaulis* Kuntz.
 11. Cell wall thin, with swollen basal cell.....*Justicia diffusa* Willd.

CONCLUSION

The significance of micromorphological features is proved beyond doubt in the present study. The utility of the artificial key in identification of plants in the absence of floral

characters is a proof to this. In case of medicinal plants the trichomes aid as biomarkers useful in identifying the plants in the powder form.

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RESEARCH ARTICLE

PHARMACOGNOSY

**FOLIAR MICROMORPHOLOGICAL STUDIES ON SOME MEMBERS OF THE
FAMILY FABACEAE**

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ABSTRACT

Twenty-nine plants belonging to the family of Fabaceae were investigated for their foliar trichome characters. Five plants were found glabrous, and the rest showed both glandular and non-glandular trichomes, which ranged from unicellular to multicellular structures. Three plants contained both glandular and non-glandular trichomes whereas four contained only the former and the rest non-glandular trichomes. These trichome characters being specific to the plants containing them are diagnostic features which can also be utilized as biomarkers to recognize the drug plants and to identify the plants in vegetative state.



KEY WORDS

Fabaceae, micromorphological characters, glandular trichomes, non-glandular trichomes, biomarkers, taxonomy.

INTRODUCTION

The family Fabaceae is one of the largest families among Angiosperms which is extensively studied for anatomical as well as epidermal characters¹⁻⁶. Carlquist⁷, Metcalfe⁸ and Stace⁹ had stated that the leaf characters are the most varied anatomical features in Angiosperms. These features can be employed as useful taxonomic characters. Leaf or foliar and floral micromorphological characters are considered as some of the primary diagnostic features in segregating the major groups of plants. In fact, the leaf characters are considered as second to those of flowers and fruits in taxonomic studies. Foliar and floral epidermal characters are used successfully in the delimitation of a number of taxa¹⁰⁻¹³. Cutler¹⁴ had stated that apart from the usefulness of those characters in taxonomy, they are also used efficiently in the identification of fossil specimens, specifically the leaf impressions in Paleobotany. In addition to this, the epidermal micromorphological features help in

authentication of foliar drugs in pharmacognosy and thus serve as biomarkers¹⁵. Chandra *et al*¹⁶ had emphasized of the significance of epidermal morphology and arrangement of phylogenetic considerations. Looking into the importance of these characters, in the present work, 29 plants, belonging to Fabaceae, are subjected to an analysis of micromorphological features in their leaves with a view to find out, the relevance of these characters, in identifying the taxa and if possible, defining the taxonomic affinities.

MATERIALS AND METHODS

All the 29 plants screened were collected from in and around Vadodara, Gujarat, India. For studying the trichomes, epidermal peels were taken out manually with the help of a blade and stained with safranin. Stained peel was mounted in glycerine and then observed under the microscope.

RESULTS AND DISCUSSION



S.No.	Plant name	Glandular trichome					Non-glandular trichome			
		unicellular	multicellular trichome differentiated into head and stalk				multicellular sessile trichome	unicellular		modified
			head two-celled and stalk one celled	four-eight celled head and one celled stalk	12-celled and one celled stalk	16-celled head and one celled stalk		base flat	base round	
1.	<i>Indigofera cordifolia</i> Heyne ex Roth.							+		+
2.	<i>Indigofera tinctoria</i> L.									+
3.	<i>Indigofera enneaphylla</i> L.									+
4.	<i>Indigofera trita</i> L.									+
5.	<i>Crotalaria retusa</i> L.	+								
6.	<i>Alhagi camelorum</i> Fisch.	+								
7.	<i>Clitoria ternatea</i> L.	+								
8.	<i>Teramnus labialis</i> (L.f.) Spreng.						+			
9.	<i>Pongamia pinnata</i> (L.) Pierre.									+
10.	<i>Tephrosia villosa</i> (L.) Pers.							+		+
11.	<i>Desmodium triflorum</i> (L.) DC.		+					+		+
12.	<i>Desmodium velutinum</i> (Willd.) DC.		+		+					+
13.	<i>Dolichos lablab</i> L.			+		+		+		+
14.	<i>Stylosanthes hamatus</i> (Linn.) Taub.									+
15.	<i>Crotalaria medicagenia</i> Lamk.							+		
16.	<i>Alysicarpus vaginalis</i> (L.) DC.							+		
17.	<i>Melilotus indica</i> (L.) All.							+		
18.	<i>Tephrosia purpurea</i> (L.) Pers.							+		
19.	<i>Crotalaria sericea</i> Retz.							+		
20.	<i>Tephrosia tenuis</i> Wall. ex Dalz.							+		



21.	<i>Crotalaria leptostachya</i> Benth.	+
22.	<i>Sesbania grandiflora</i> (L.) Poir.	+
23.	<i>Crotalaria hirsuta</i> Willd.	+
24.	<i>Mucuna pruriens</i> (L.) DC.	+

The distribution and characteristics of trichomes in 24 members of the Fabaceae is presented in Table I. Out of the total 29 plants studied, five plants viz. *Canavalia ensiformis*, *Aeschynomene indica*, *Desmodium gangeticum*, *Rhynchosia bracteata* and *Sesbania aculeata* are found glabrous. Of the remaining 24 plants with trichomes, seven possessed various unicellular and multicellular glandular trichomes. Unicellular glandular trichomes were seen in three plants, i.e., *Alhagi camelorum*, *Crotalaria retusa* and *Clitoria ternatea*. *Alhagi camelorum* possessed oblong thin walled trichome whereas *Crotalaria retusa* had spindle shaped (pointed at the ends) trichome (Fig I and II). In *Clitoria ternatea* elongated obovate trichome was present with slightly warty walls. Glandular trichomes of the remaining four plants were multicellular differentiated into a head and a stalk or sessile. The trichome of *Dolichos lablab* had a biseriate

two or four tiered head and a single celled stalk. In addition, this plant contained two types of non-glandular trichomes; one unicellular and the other linear and three-celled. The unicellular trichome here was curved at the tip while the three-celled trichome had a very long apical cell and two-square shaped lower cells. The glandular trichomes of *Desmodium velutinum* had one or three tiered heads. This plant also possessed characteristic non-glandular trichomes having single basal cells and very long narrow pointed apical cells, which was smooth or warty. The glandular trichomes of *Desmodium triflorum* had two-celled heads. The non-glandular trichomes of this plant were of two types; one two-celled with a spreading small basal cell and a narrow pointed apical cell. The second type of trichome was unicellular and curved. Trichomes of the fourth plant *Teramnus labialis* were sessile, flat, linear and four-celled.