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AN ILLUSTRATED MANUAL OF RICE-FIELD WEEDS IN SRI LANKA

by J.P.N.R. CHANDRASENA

Illustrations by P. Arulnaam & Suneetha Medis
University of Colombo, Colombo.

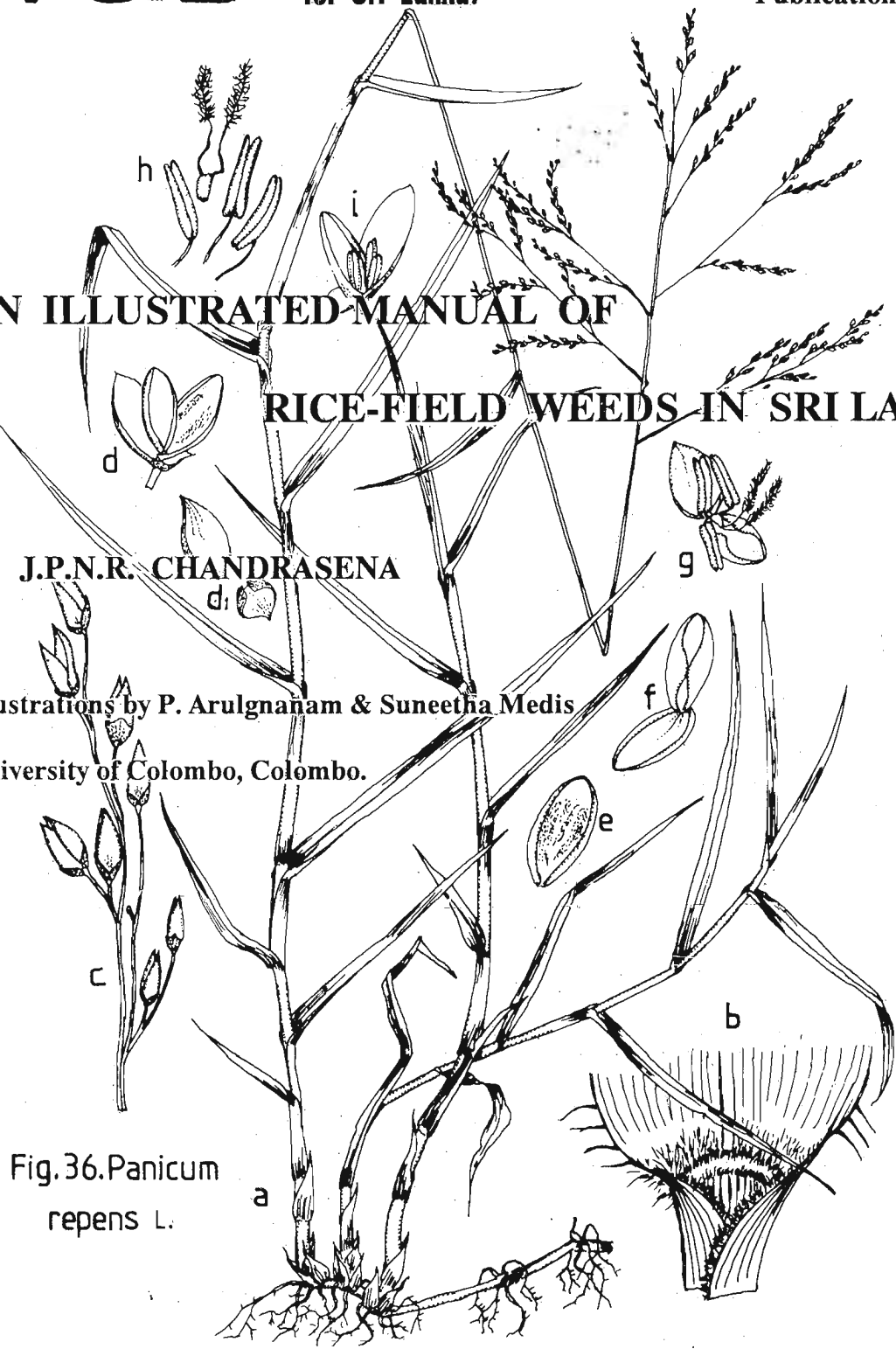


Fig. 36. *Panicum repens* L.

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IN SRI LANKA

BY

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FOREWORD

Weeds are an inescapable component of the man-made rice agroecosystem, which cause a great many problems to the rice farmer. To optimize rice production and to maintain the continuous sustainability of this agricultural system, weeds have to be managed properly. For this purpose one has to know and understand the weeds individually. One must also seek a deeper and broader understanding of the ecology, biology and physiology of rice-field weeds, in order to embark on their management without causing disruption to the environment. An essential step in all this is the identification of individual weed species by their correct names.

Publications by Soerjani et al (1987), Pancho et al (1969), Moody et al (1984), Holm et al (1977) have dealt with the identification of rice-field weeds of the Asian and South-East Asian region. Unfortunately, these publications are generally not freely available in Sri Lanka. Many persons involved in research and extension in agriculture, have expressed the need for publications that will help in correct identification of a wide spectrum of weeds, including rice-field weeds.

The weeds illustrated and described in this Manual include those that are most likely to occur in problematic proportions in the rice-field habitats of Sri Lanka. It was obviously not possible to include all weed species encountered in the rice-field habitat without making this Manual more bulky. This Manual therefore, deals only with the commonest weeds based on personal knowledge and information available in literature. It should be noted however, that the Manual includes several species (viz. *Cyperus rotundus*, *Tridax procumbens*, *Spermacoce latifolia* etc.), which are best described as weeds of high-ground near rice-fields and which may appear later in the season within the rice-field agroecosystem. Although such plants may not be regarded as 'true rice-field weeds', the presence of these species at high frequency and levels of infestation in the rice-field agricultural environment, warranted their inclusion in this Manual.

The major sources of nomenclature for the Weeds described in the Manual are: A Revised Handbook to the Flora of Ceylon, Volumes I-VI (Dassanayake & Fosberg, 1980-1989), The Grasses of Ceylon (Senaratne, 1956), A Handbook to the Flora of Ceylon, Volumes I-VI (Trimen, 1893-1900; Alston, 1931) and Weeds of Rice in Indonesia (Soerjani et al, 1987). The main purpose of this publication is to help people to identify rice-field weeds by visual comparison. The brief descriptions given for each weed, are based partly on the taxonomic treatments mentioned above and personal investigations. These descriptions will often be sufficient for confirmation of the identity. Wherever possible, synonyms of the scientific names are given, in addition to vernacular names. Based on personal knowledge, available literature and specimen collections at the National Herbarium, Peradeniya, useful notes on the ecology, distribution of the weed species, and their agricultural importance, are also presented. A glossary is also included as an aid to people unfamiliar with botanical terminology. A general overview of

rice-field weed problems, their significance, factors affecting their occurrence and control options available, is also included.

It is my hope that this publication will serve the Sri Lankan Rice-agriculture sector as a resource Manual, facilitating the correct identification of common rice-field weeds, and also providing information to understand the characteristics, ecology and importance of the rice-weeds in the rice-cropping system.

I am extremely grateful to the Man & Biosphere Committee of Sri Lanka, and the Natural Resources, Energy & Science Authority (NARESA) for recognizing the need for publications of this nature, and supporting this effort from early 1988. A good deal of credit for this work must necessarily go to Padma Arulgnanam and Suneetha Medis for their excellent illustrations done with infinite skill, patience and dedication. It was their unwavering support which helped me to finish this task within a reasonable period of time. I am also grateful to Mr. K. Pemadasa, Technician of the Department of Botany, for spending countless hours in the field with me, and for assisting this work over several years. These three persons share with me the credit for this effort.

The research and surveys of rice-field weeds, their taxonomic studies, and illustrations, were all carried out using the facilities of the Department of Botany, of the University of Colombo. I am indebted to my University, particularly to the Department of Botany, for its assistance in the preparation of this Manual. I am thankful to all my teachers and colleagues in the Department who took an interest in this work, and spurred me on.

I am also thankful to Professors of Botany, I. Balasooriya, R. N. De Fonseka, S. Balasubramaniam and M. D. Dassanayake, for giving me initial encouragement and support in many ways over several years, which enabled this work to be done. My thanks are also due to the Systematic Botanists of the National Herbarium, Mr. K. E. D. Amaratunge (now retired) and Dr. A. H. M. Jayasuriya, for allowing me to use the Herbarium extensively in this work, and helping with the identification of certain species at the initial stages.

Last but not least, I am grateful to my wife, for continuously encouraging me and supporting this work right up to its end and for typing the major part of this manuscript. Work of this nature which involved a great deal of travel for survey purposes, would not have been possible without such support from the home front. In recognition of her supporting role in this effort I dedicate this publication to my wife.

J. P. N. R. CHANDRASENA
December, 1990

SECTION 1**AN INTRODUCTION TO WEED PROBLEMS IN RICE AND THEIR CONTROL****1.1 The Importance of Rice**

Rice, a major world crop, is produced in about 82 countries both in temperate and tropical areas; average annual world production is about 372 million tons grown on 143 million ha. Approximately 93% of rice in the world is produced in Asia and South-East Asia where the most densely populated regions are located. It is widely known that one-third of all mankind almost wholly depends on rice for more than half of its food.

In Sri Lanka, the area of land devoted to rice production currently is slightly in excess of 2.3 million ha, which accounts for about one-fifth of available arable land (Anon, 1988). Rice-cultivation provides employment for about 500,000 persons mainly in the rural areas. Rice in Sri Lanka is grown over two seasons, the 'Yala' season and the 'Maha' season, which coincide with the South-West (April-August) and North-East (October-January) monsoons, respectively. Cultivation in the Wet Zone of the island (mainly the Western, Southern Provinces and the Central hills) is dependent on rain water, and the numerous major and minor irrigation schemes available. Rice-cultivation in the Dry Zone of the island (located mostly in the North, North-East, North-West, North-Central, East and South-East Provinces) depends heavily on the waters supplied by innumerable small 'tanks' still found in these areas, and more recent major and minor irrigation schemes. In the 'Yala' season the area cultivated is in the range of 0.8 to 0.9 million ha, while in the 'Maha' the extent cultivated exceeds 1.4 million ha (Anon, 1988).

Recent times have seen an encouraging and steady increase in rice production in Sri Lanka, with the annual total production increasing from 1.3 Mn Metric Tons in 1972, 1.7 Mn Metric Tons in 1977 and 2.1 Mn Metric Tons in 1987 (Anon, 1987). Nevertheless, weeds and problems caused by weeds have continued to be one of the key factors limiting the yield increases (Velmurugu, 1980).

1.2 Weed-flora of Rice-fields:

From the standpoint of weed communities, the rice agroecosystem can be divided into three broad habitat types, namely: the field, the bund (levee), and the ditch (irrigation canal) habitats (Barrett & Seaman, 1980). Each of these habitats contains a distinct weed community comprising of various kinds of aquatic, wetland and dryland weeds. The rice field habitat which is the most distinctive component of the rice agroecosystem, generally remains water-logged for extended periods providing an ideal ecological niche for the establishment of water-loving plants. It is known that early in the growing season aquatic and semi-aquatic plants dominate in the rice-field habitat, but towards the end of the growing season, when in general dryland conditions prevail in rice-fields, terrestrial weeds become more conspicuous. Ditch habitats in the rice-agroecosystems comprising of irrigation canals, ditches etc. which convey water from rivers, tanks or wells for flooding of the fields, usually remain flooded throughout much of the year. Many submerged, floating-leaved and free-floating aquatics are characteristic of these

habitats. In contrast to the field and ditch habitats, the weed communities of the bunds are mainly terrestrial in nature.

Weed species that cause problems in rice vary with soil, temperature, latitude, altitude, rice-culture, seeding method, water management, fertility level, and weed control technology (Smith & Moody, 1979). More than 350 species in more than 150 genera, and 60 plant families have been reported as weeds of rice (Akobundu & Fagade, 1978; Barrett & Seaman, 1980; De Datta, 1977; Holm et al, 1977; Noda, 1977; Singh, 1969; Smith, 1983; Pancho et al, 1969; Swain, 1973). However, Moody (1989) in his recently published survey of literature on rice-field weeds reported from different countries noted that in Asia and South-East Asia alone, more than 1800 weed species grow in association with the rice plant. Based on information available from many countries, regardless of whether the rice is transplanted or direct-seeded, Echinochloa crus-galli has been determined to be the most troublesome weed of rice in the world (Holm et al, 1977; Noda, 1977), with Echinochloa colonum taking the second place. Other rice-field weeds of world importance include: Cyperus iria, Cyperus difformis, Cyperus rotundus, Ischaemum rugosum, Fimbristylis miliacea and Monochoria vaginalis.

Information on the rice-weeds of Sri Lanka is widely regarded as inadequate mainly because the subject has not received much attention. Taxonomic treatments such as Trimen's Handbook to the Flora of Ceylon (1893-1900), Alston's supplement to this (Alston, 1931), and Senaratne's The Grasses of Ceylon (Senaratne, 1956) have described many of the major rice-weeds of the island with notes on their distribution. In addition there are several other reports on individual rice-weeds with notes on their botanical features and distribution (Senaratne, 1940; Paul & Senaratne, 1941; Senaratne, 1952; Amaratunge, 1972), and a provisional list of weeds found in arable soils (Amaratunge, 1977) which includes many of the major rice-weeds listed under wetland species.

It has been reported that there are about 70-80 weed species which occur commonly as rice-field weeds in Sri Lanka (Velmurugu, 1980), but that most of them cause little concern to the farmer. Velmurugu (1980) also stated that the number of species that comprise the major portion of the weed flora in any rice-field in the country may not exceed 10-15, out of which only 4-5 may be categorized as important to warrant control measures. A survey of rice-field weeds in carried out in 1975/76 in 14 Government Farms and 518 villages of both the Wet and Dry Zones representing all the District Revenue Officer (D.R.O.) Divisions of the island, revealed that Fimbristylis miliacea (L.) Vahl, Isachne globosa (Thunb.) O. Kuntze. and Cyperus haspan L. were the most serious rice-field weeds in the country (Weerakoon & Gunawardena, 1983). This study also recorded the occurrence of 134 species as representative of the Sri Lankan rice-field weed flora.

During 1984 to 1987 six rice-growing Districts of the low-country of Sri Lanka were surveyed for their weed-flora by the author (Chandrasena, 1987, 1988, 1989). The prime objective of the study was to update and improve the status of knowledge of the rice-field weed flora of Sri Lanka. This task was considered essential in the light of the publications of the Revised Flora of Ceylon Volumes I-VI (Dassanayake & Fosberg, 1980-1989) updating many of the taxonomic and nomenclatural conclusions of Trimen (1893-1900) which had become outdated. In this work which systematically sampled large numbers of rice-fields mainly in the Wet Zone, 79 species in 47 genera, belonging to 22 families were found as weeds occurring at frequencies greater than 10% in 1088 rice-fields from the Districts of

Colombo, Gampaha, Kalutara, Galle, Kurunegala and Ratnapura (Chandrasena, 1989). Species of the Cyperaceae (sedges) were determined to be the most common, and species of the Poaceae (grasses) ranked next in abundance. Other families such as Asteraceae, Scrophulariaceae, Fabaceae were also well represented in the rice-field habitat. Table 1 gives the list of all species recorded in these surveys.

1.3 Losses due to Weeds in Rice:

Weeds growing with the rice crop alter the health, food supply and the economy of many people in rice-producing countries of the world (Smith, 1983).

Weeds in cultivated rice-fields reduce crop yields and quality by competing for growth requirements such as nutrients, water, light and space. Weeds intensify the problems of diseases, insects and other pests by serving as hosts. Weeds reduce the efficiency of harvesting and processing because they often cause crop lodging or trailing weeds become entwined in machines. Aquatic weeds reduce efficiency in irrigation systems, by causing reductions in flow, blocking of canals, ditches and loss of water from reservoirs (tanks) through evapotranspiration. Weeds also cause heavy consumption of energy for their control. Further, they reduce the property value and productivity of land.

Of these different types of damage due to weeds, yield loss by weed competition is by far the most widespread and serious. Percent yield losses vary according to cultural method, rice-cultivars, weed species etc. fluctuating from 10 to 70% in practice (Noda, 1977). Losses due to weeds have been estimated in several rice-producing countries. In India, losses have been estimated at 10% of the crop (De Datta, 1980). In the Philippines, losses were estimated at 11% for the dry season and 13% for the wet. Yield and quality losses were estimated at 15% in the U.S. (Smith et al, 1977), and 10% for the world (De Datta, 1980).

As pointed out by Smith (1983), in addition to yield and quality losses, there are losses due to cost of herbicides, cultural and mechanical practices and hand-weeding to prevent even greater losses. Such losses are estimated at about 5% world wide. Thus, for the world the total estimated direct losses from weeds and expenditures for their control in rice are 15% annually.

Reliable data about losses of rice-yields are not available from Sri Lanka. However, Velmurugu (1980) placed rice-yield losses due to weeds as 20% of the total on average, whilst recognizing that the actual losses would vary with factors such as cultural practices, rice-cultivars grown, time of cultivation, degree of moisture available in soil and the composition of the weed flora.

It must be noted that species or types of weeds vary in the losses they inflict. In the U.S. all-season competition from *E. crus-galli* reduced rice-grain yield more than that from broadleaf and aquatic weeds such as *Aeschynomene virginica*, *Sesbania exaltata* or *Heteranthera limosa* (Smith, 1968, 1975). De Datta (1979) reported that in direct-seeded rice in Philippines, sedges and broadleaf weeds reduced yields by 24%, grass weeds by 86%, and combinations of them by 100%. In transplanted rice, the grain yield reductions were 0, 75 and 67%.

The density of weeds obviously affects the yield loss that results. The thinner the rice stand, the greater the yield loss. Smith (1968) obtained evidence that season-long competition from *E. crus-galli* at a

TABLE 1: Rice-field weeds in Six Rice-growing Districts of Sri Lanka
(Adapted from: Chandrasena, 1987, 1988, 1989).¹ F, Field; B, Bund;
D, Ditch (Canal)

Family and Species	Occurrence	Major habitat ¹
1. ACANTHACEAE		
<i>Asteracantha longifolia</i> (L.) Nees	occasional	B
<i>Hygrophilla salicifolia</i> (Vahl) Nees	occasional	B
2. AIZOACEAE		
<i>Mollugo oppositifolia</i> L.	occasional	B
3. AMARANTHACEAE		
<i>Alternanthera sessilis</i> (L.) DC.	widespread	B, D
4. APIACEAE		
<i>Centella asiatica</i> (L.) Urb.	occasional	B
5. ARACEAE		
<i>Pistia stratiotes</i> L.	frequent	F, D
6. ASTERACEAE		
<i>Ageratum conyzoides</i> L.	widespread	B
<i>Eclipta prostrata</i> (L.) L.	widespread	B, F
<i>Epaltes divaricata</i> (L.) Cass.	occasional	B
<i>Sphaeranthus africanus</i> L.	frequent	B, F
<i>Sphaeranthus indicus</i> L.	widespread	B, F
<i>Spilanthus paniculata</i> Wall. ex DC.	occasional	B
<i>Vernonia cinerea</i> (L.) Less.	widespread	B
7. BUTOMACEAE		
<i>Limnocharis flava</i> (L.) Buchen.	widespread	F, B, D
8. CERATOPHYLLACEAE		
<i>Ceratophyllum demersum</i> L.	occasional	F
9. COMMELINACEAE		
<i>Commelina benghalensis</i> L.	frequent	B, D
<i>Commelina diffusa</i> Burm.f.	widespread	B, D, F
10. CONVULVULACEAE		
<i>Ipomoea aquatica</i> Forsk.	frequent	F, D
<i>Ipomoea triloba</i> L.	frequent	B
11. CYPERACEAE		
<i>Cyperus compressus</i> L.	occasional	B
<i>Cyperus corymbosus</i> Rottboell	occasional	B
<i>Cyperus difformis</i> L.	frequent	F, B
<i>Cyperus exaltus</i> Retz.	frequent	F, B
<i>Cyperus haspan</i> L.	widespread	F, B, D
<i>Cyperus iria</i> L.	widespread	F, B
<i>Cyperus pilosus</i> Vahl	widespread	F, B

Family and Species	Occurrence	Major habitat ¹
<i>Cyperus procerus</i> Rottboell	frequent	B
<i>Cyperus sphacellatus</i> Rottboell	frequent	B
<i>Cyperus rotundus</i> L.	frequent	B
<i>Eleocharis dulcis</i> (Burm.f.) Trin.ex Hensch.	widespread	F, B
<i>Eleocharis geniculata</i> (L.) Roem. & Schult	occasional	B, F
<i>Fimbristylis acuminata</i> Vahl	widespread	B, F
<i>Fimbristylis dichotoma</i> Vahl	widespread	B, F
<i>Fimbristylis ferruginea</i> Vahl	frequent	B
<i>Fimbristylis miliacea</i> Vahl	widespread	F, B
<i>Fimbristylis schoenoides</i> Vahl	widespread	B, F
<i>Fimbristylis tetragona</i> R.Br.	widespread	F, B, D
<i>Fimbristylis umbellaris</i> (Lam.) Vahl	frequent	B, F
<i>Fuirena capitata</i> (Burm.f.) T.Koyama	widespread	B, F
<i>Fuirena ciliaris</i> (L.) Roxb.	widespread	F, B
<i>Fuirena umbellata</i> Rottboell	widespread	F, B
<i>Kyllinga brevifolia</i> Rottboell	widespread	B
<i>Kyllinga melanosperma</i> Nees	widespread	B
<i>Kyllinga nemoralis</i> (J.R. & G. Forst.) Dandy ex Hutchins. & Dalziel	widespread	B
<i>Mariscus paniceus</i> (Rottb.) Vahl	occasional	B
<i>Pycneus polystachyos</i> (Rottb.) Beauv.	widespread	B
<i>Rhynchospora corymbosa</i> (L.) Britton	frequent	B, D
<i>Schoenoplectus grossus</i> (L.f.) Palla	frequent	F, B
<i>Schoenoplectus juncooides</i> (Roxb.) Palla	widespread	F, B
<i>Schoenoplectus supinus</i> (L.) Palla	frequent	F, B
<i>Scleria poaeformis</i> Retz.	frequent	F, B, D
<i>Scleria sumatrensis</i> Retz.	occasional	F, B, D
12. ERIOCAULACEAE		
<i>Eriocaulon quinquangulare</i> L.	widespread	F, B
<i>Eriocaulon sexangulare</i> L.	widespread	F
<i>Eriocaulon thwaitzii</i> Koern.	frequent	F
13. EUPHORBIACEAE		
<i>Croton hirtus</i> L.	frequent	B
<i>Euphorbia hirta</i> L.	frequent	B
<i>Phyllanthus debilis</i> Klein ex Willd.	widespread	B, F
<i>Phyllanthus urinaria</i> L.	frequent	B, F
14. FABACEAE (LEGUMINOSAE)		
<i>Aeschynomene aspera</i> L.	frequent	F
<i>Aeschynomene indica</i> L.	frequent	F
<i>Alysicarpus vaginalis</i> DC.	frequent	B
<i>Cassia tora</i> L.	infrequent	B
<i>Desmodium heterocarpum</i> (L.) DC.	frequent	B
<i>Desmodium heterophyllum</i> (Willd.) DC.	frequent	B
<i>Desmodium triflorum</i> (L.) DC.	frequent	B
<i>Mimosa pudica</i> L.	frequent	B

Family and Species	Occurrence	Major habitat ¹
<i>Isachne globosa</i> (Thunb.) Kuntze	widespread	B, F, D
<i>Ischaemum indicum</i> (Houtt.) Merr.	frequent	B
<i>Ischaemum muticum</i> L.	frequent	B
<i>Ischaemum rugosum</i> Salisb.	widespread	F, B
<i>Leersia hexandra</i> Sw.	occasional	B, D, F
<i>Leptochloa chinensis</i> (L.) Nees	occasional	B, D, F
<i>Oryza perennis</i> Moench	occasional	F, D
<i>Oryza rufipogon</i> Griff.	occasional	F, D
<i>Panicum repens</i> L.	widespread	B, F, D
<i>Paspalum commersonii</i> Lam.	widespread	B, F
<i>Paspalum conjugatum</i> Berg.	widespread	B, F
<i>Sacciolepis indica</i> (L.) Chase	widespread	B
<i>Sacciolepis interrupta</i> (Willd.) Stapf	frequent	F, B
<i>Setaria geniculata</i> (Lam.) Beauv.	frequent	F, B
<i>Sporobolus diandrus</i> (Retz.) Beauv.	frequent	B
24. POLYGONACEAE		
<i>Polygonum barbatum</i> L.	widespread	B
<i>Polygonum glabrum</i> Willd.	frequent	B
25. PONTEDERIACEAE		
<i>Monochoria vaginalis</i> (Burm.f.) Kunth.	widespread	F, B, D
<i>Eichhornia crassipes</i> (Mart.) Solms	frequent	F, D
26. RUBIACEAE		
<i>Hedyotis auricularia</i> L.	widespread	B
<i>Hedyotis corymbosa</i> L.	frequent	B
<i>Knoxia zeylanica</i> L.	frequent	B
<i>Mitracarpus villosus</i> (Sw.) DC.	frequent	B
<i>Spermacoce hispida</i> L.	frequent	B
<i>Spermacoce latifolia</i> Aubl.	widespread	B
27. SCROPHULARIACEAE		
<i>Bacopa monnieri</i> (L.) Pennell	widespread	F, B
<i>Dopatrium junceum</i> (Roxb.) Ham.	widespread	F
<i>Dopatrium lobelloides</i> (Retz.) Benth.	frequent	F
<i>Limnophila aquatica</i> (Roxb.) Alston	frequent	F, B
<i>Limnophila aromatica</i> (Lam.) Merr.	occasional	F, B
<i>Limnophila repens</i> (Benth.) Benth.	widespread	F, B
<i>Lindernia anagallis</i> (Burm.f.) Pennell	widespread	F, B
<i>Lindernia antipoda</i> (L.) Alston	frequent	F, B
<i>Lindernia hyssopioides</i> (L.) Haines	widespread	F, B
<i>Lindernia rotundifolia</i> (L.) Alston	widespread	B
<i>Scoparia dulcis</i> L.	widespread	B
28. SALVINIACEAE		
<i>Azolla pinnata</i> Lam.	frequent	F, D
<i>Salvinia mollesta</i> D.S. Mitchell	widespread	F, D

Family and Species	Occurrence	Major habitat ¹
29. STERCULIACEAE Melochia corchorifolia L.	widespread	F, B
28. TILIACEAE Corchorus olitorius L. Triumfetta rhomboideae Jacq.	occasional occasional	B B
29. XYRIDACEAE Xyris indica L.	widespread	F, B

stand of 11 plants/meter, caused 57, 40 and 25% yield losses respectively, when present in rice stands 32, 108 and 334 plants/meter. Increasing the weed density from 11 to 269 plants/meter, caused a great increase in yield loss in the range of 25 to 79% (Smith, 1968).

Weed species at different densities vary in their competitiveness with rice (Chang, 1970). *Echinochloa crus-galli* at densities of 100 and 200 plants/m reduced rice-yields 86 and 91%; *Monochoria vaginalis* at same densities reduced yields 58 and 60%; and *Spirodela polyrhiza* at both densities reduced yields only 7%. Yield losses caused generally increase with increasing lengths of weed competition, as evident from numerous studies. Smith (1968) reported from U.S. that *E. crus-galli* competition for 20, 40 and 65-days caused yield losses of 9, 20 and 43% respectively in drill-seeded rice. In these studies, season-long competition caused 79% yield loss, indicating that the duration of competition affects yield losses very greatly. De Datta (1979) reported that rice yields of IR8 were reduced by 11, 23 and 40% respectively, when hand-weeding was carried out 21, 56 and 63 days after transplanting. Again, the level of this reduction caused by weeds would depend on the particular weed species present in the field, as pointed out by Smith (1983).

1.4 Factors that influence Weeds in Rice:

Many ecological factors and crop production practices influence the presence as well as abundance of rice-weeds in the rice-field habitats. An understanding of these factors is essential to realize the extent of the problem.

a) Seeding Method:

Rice is produced by two principal cultural methods, i.e. direct-seeded and transplanted methods. Rice may be direct-seeded by drilling or broadcasting seeds into moist soil or by broadcasting dry or sprouted seed on the floodwater. In the second method, rice is transplanted by setting plants that have been previously grown in nurseries into wet paddy-fields.

In general weed growth and weed problems are known to be greater in direct-seeded rice than in transplanted rice. In India, all-season competition reduced grain yields by 11% in transplanted rice, 20% in direct wet-seeded rice, and 46% in direct dry-seeded rice (De Datta, 1979). It is commonly known that 'transplanting' of rice seedlings in the well-prepared ricebed gives a competitive advantage to the crop over the emerging weed seedlings, which as a result suffer a permanent setback.

In Japan, Noda (1977a) reported that adverse effects from weeds were greater in machine-transplanted rice, because machine-transplanting used smaller seedlings, and required a longer interval between puddling and transplanting to allow the soil to become firm. Studies by Matsunaka (1976) have shown that weed competition for 9-weeks after puddling of soil reduced grain yields by 59% in hand-transplanted rice, and 80% in machine-transplanted rice compared with the hand-weeded control.

b) Moisture Regime:

Direct-seeded and transplanted rice are grown under different

moisture regimes: controlled irrigation, deep-flooding or rainfed (De Datta, 1980; Smith & Moody, 1979). Special weed problems are associated with each seeding method and moisture regime. It is known that some weeds are well adapted for submerged growth, others for growth in non-flooded yet everwet conditions, and that still others are suppressed by water. In any case, water/moisture regime seems to be one of the major factors influencing the presence and diversity of weeds in the rice-field habitat.

The diversity of the weed-flora inhabiting rice-fields is known to decrease with increase in flooding and puddling (Moody & Drost, 1983). Mabbayad et al (1983) reported more weed species and higher weed weights in puddled rainfed conditions than in puddled irrigated conditions. Various authors (Arai et al, 1955; Bhan, 1983; Carbonell & Moody, 1983; Chang, 1967; Civico & Moody, 1979; De Datta et al, 1973; Janiya & Moody, 1982; Mabbayad et al, 1983; Navarez et al, 1979) have reported that good water management significantly reduced weed growth, and poor water control leads to an increase in the time and energy spent on weed control. It has also been shown (Mabbayad et al, 1983) that the yields of transplanted rice are not significantly reduced by weeds when water management is good, but yield losses increase with poor water management.

A major reason for flooding is the selective depression of C4 weeds (Moody & De Datta, 1986). Submergence may have a large influence on rice photosynthesis through the control of C4 weeds, which strongly compete with rice, which is a C3 species (Tanaka, 1976). Moody & De Datta (1986) have pointed out that in irrigated fields, competition for water is not important, but in rainfed cultivation where the water supply is limited and erratic C4 weeds may be serious competitors with rice, especially during periods of irregular rainfall distribution. Major rice-weeds such as Echinochloa crusgalli, E. colonum, Cyperus iria, Cyperus rotundus, Panicum repens, several species of Fimbristylis and Schoenoplectus (=Scirpus) are well-known to be C4-weeds.

In an early report Arai et al (1955) discussed the distribution of weed species and their growth with respect to soil moisture conditions. Tanaka (1976) rearranged the results of Arai et al and found that under saturated (80-90% of maximum moisture capacity) and upland (40-60% of maximum moisture capacity) conditions, C4 species accounted for more than 90% of the total weed dry weight, compared with only 10% under submerged (6 cm standing water) conditions.

Moody & De Datta (1986) have pointed out that yield losses due to weeds are greater in rainfed than in irrigated lowland rice. In rainfed lowland areas, moist, shallow-water conditions last for extended periods during early crop growth, followed by prolonged periods of flooding to variable depths. These favour the growth of a more diverse weed flora and more competitive weed species inclusive of a large number of C4 Weeds (Moody & De Datta, 1986). In general, in rainfed cultivation water control is poor and this is the main reason for increased problems with weeds.

Smith et al (1977) reported that direct-seeding of rice in floodwater reduced problems with annual grasses in southern U.S.A., but enhanced problems with aquatic weeds. Seeding presprouted rice on a well-prepared, well flooded seedbed reduced E. crus-galli, but increased the occurrence of aquatic species, such as Ammania and Bacopa, and blue-green algae.

c) Land preparation:

Land preparation before direct-seeding or transplanting rice

influence the presence of weeds. In the Philippines, puddling the soil instead of dry-tillage (such as commonly done in Sri Lanka) reduced by 96% the weight of broadleaf, grass and sedge weeds 4-weeks after direct-seeding or transplanting (Moody, 1979). Tillage practices during the dry season increased problems with annual grasses such as E. colonum in transplanted rice grown during the wet season, but decreased the prevalence of Cyperus rotundus and Cynodon dactylon (Moody, 1979).

d) Fertilization:

Many weed species are favoured by the application of fertilizers, a regular practice in rice-culture. Chang (1970) reported that in Taiwan E. crus-galli and Cyperus difformis reduced yields of rice that had received high rates of nitrogen, more than did Monochoria vaginalis or Spirodela polyrhiza, but the converse was true of rice that received low nitrogen levels. Smith et al (1977) found that nitrogen and phosphorous applied to rice at preplanting stimulated the growth of many weeds including annual grasses such as E. crus-galli and aquatic species such as blue-green algae, and species of Ammania and Bacopa.

Moody (1982) recommended that fertilizer N applications to rice should be timed to prevent weed proliferation and yet obtain maximum benefit to the crop. Matsunaka (1970) recommended that in situations where effective weed control is not possible, N applications should be delayed until the quantity of N uptake is reduced and more will be taken up by the rice crop. Ahmed & Moody (1981) found that a delay in N application until the first weeding resulted in reduced initial weed growth and increased the grain yield. De Datta ((1977) suggested that it is better to apply fertilizer at some lower rate than needed to produce maximum yields, when weed control is inadequate. In general, as pointed out by both De Datta (1977) and Moody (1981) grain yield of non-weeded fertilized plots tend to be considerably lower than that of weeded plots to which no fertilizer had been added.

The relationship between fertility and weed-rice competition is obviously a complex issue, and enhanced knowledge in this regard can probably help the farmer manipulate fertilizers to favour the crop at the expense of weed growth.

e) Rice Cultivar:

De Datta (1980) pointed out that the replacement of the traditional tall rice cultivars with modern short-statured ones, has increased problems with annual grass weeds in tropical Asia. Broad-leaf and sedge weeds which were prevalent in rice-fields planted with traditional tall cultivars, were reduced by rapidly growing grass weeds that infested modern rice cultivars.

It is well documented that short-statured, early-maturing (high-yielding) modern rice cultivars are less competitive with weeds, than tall, late-maturing, drooping-leaved traditional cultivars. De Datta (1974) reported that in the Philippines, the medium-height IR442-2-58 competed better with weeds than semidwarf IR20. Rice types with high vegetative vigour, rapid leaf area expansion, and vigorous nitrogen absorption are known to have a competitive advantage over less vegetatively vigorous types. However, studies by Lopez et al (1980) failed

to establish that rice cultivar type had an effect on weed population or weed dry weight.

f) Crop Rotation:

The occurrence of a particular weed species in rice is related to the crop rotation associated with the land. Smith & Frans (1969) reported that in fields continuously planted with rice for 10 years, the infestations of E. crus-galli, Oryza rufipogon (red-rice) and Cyperus iria increased with time, but fields in which rice and soybean crop rotation had been established, contained few of the same weeds. Studies of Jereza & De Datta (1977) in Philippines indicate that in continuously grown transplanted rice, Scirpus maritimus infestations were at constantly high levels in a 3-year period, but Cyperus rotundus was not present. When upland crops were rotated with rice, S. maritimus infestations were reduced, but C. rotundus infestations increased. Further, S. maritimus reduced rice yields less in the rotated system than in continuous cropping.

g) Weed Control Technology:

Clear evidence is emerging that the weed flora of rice-fields change over time with the control technology employed. In this regard the greatest pressure has been from the use of herbicides.

In countries where herbicides have been used to control annual weeds for many years, perennial weeds have increased. De Datta (1977) reported of significant increases of Cyperus serotinus, Eleocharis acicularis, Sagittaria pygmaea and a few other perennial weed infestations in Korea, where the same or similar herbicides have been used continually for control of annual weeds. Sakamoto et al (1979) reported from Japan that in a 5-year experiment, successive applications of the same herbicides caused a change in weed-flora from one that was dominated by annuals (i.e. Cyperus difformis, Rotala indica) to one that mostly had Cyperus serotinus and Sagittaria pygmaea.

1.5 Methods used for Weed Control in Rice:

When compared with control of plant diseases and control of insect pest problems, scientific weed control lags considerably behind the times (Noda, 1977). According to Ennis (1967) and Furtick (1969) the reason for this may be that the impact of weeds is much less dramatic when compared with attacks of plant pathogens and insect pests, though the losses through weeds are often far more serious.

The following are the main methods of weed control used in rice-crop production:

a) Preventive measures:

Based on the simple principle 'prevention is better than cure' this approach involves taking care to prevent the setting of weed seeds, or preventing the establishment of weeds within the rice crop or between one

crop and the next. The use of high quality 'clean crop seed' and clean equipment, the prevention of weed seed spread by irrigation waters or soil runoff, control or removal of any weed(s) that has got established in fields before they 'set seed', are important preventive measures. In the United States, very high priority has been placed on these approaches, and the spread of several major weeds of rice has been arrested. This approach, although highly valued for its potential, has made relatively little impact on rice-weed control in the developing countries of Asia and South-East Asia,

b) Soil Preparation and tillage-measures:

A weed-free seed bed is a prerequisite for growing any crop and rice is no exception. In general rice-fields undergo a fallow period of about 2-3 months (or more) in between seasons. During this period, depending on the available moisture regime in the fields, a wide range of weeds begin to colonize the fields. Removal of these weeds is usually accomplished by land preparation which includes ploughing, harrowing, soil-puddling, land-levelling and their combination.

Keeping rice-fields as weedy fallows in the off-season creates difficult weed problems when the rice crop is grown the following rainy season. Post-harvest dry season tillage has been recommended to prevent weeds from seeding and to expose underground rhizomatous organs to drying and desiccation, so that a significant reduction is achieved in weed seed reserves and propagules in soil (Moody & Mian, 1979). Repeated dry season tillage (during the fallow) which may be conducted as several harrowings, is generally known to improve soil moisture conservation, keep the soil in good tilth, as well as weed-free.

In rice-culture land levelling and soil-puddling are important essential features, which provide a uniform, favourable environment for the rice that is sown or transplanted. The same activities contribute to removal of weeds which have become established, and also prevent other weeds from emerging. Generally, soil should be left as loose and uncompacted as possible, because weed seed germination is favoured by a firm, compacted seed-bed. The effective kill of weeds is accomplished either at dry or wet soil conditions, by dryland- or wetland-tillage.

In wet-tillage, the soil is ploughed to a depth of about 15 cm and the soil is then flooded. for about 7-10 days. This creates anaerobic conditions which in turn decay the vegetative parts of weeds and kill many of the buried weed seeds. Several harrowings are also done at 7-10 day intervals to destroy any weeds that were missed during the first ploughing or have grown since then. Increasing the number of harrowings and deeper tillage enhances the weed-kill. In general, although a considerable amount of water is needed for proper wet-tillage, this methods destroys weeds more effectively.

In dry-tillage the weeds are left exposed to dry and desiccate. The overall success of dry-tillage depends on factors such as textural properties of soil, source of power for the ploughs, types of implements used etc. If successful overturning is not accomplished in dry-tillage (which is the case most often), weed control becomes unsatisfactory.

In general deep-tillage accomplished by deep-ploughing of soil (up to 20-25 cm) is known to provide the best soil conditions for the growth of wetland or upland rice and also achieve the best weed control, compared to shallow-ploughing or minimum-tillage.

Another approach to weed control is the 'stale seedbed' technique. After land preparation by conventional tillage, weeds that emerge following rain are destroyed by chemicals such as paraquat or by a single harrowing. The rice is then seeded with minimum soil disturbance. This method is expected to reduce the amount of labour required later for weed control. The use of the stale seedbed technique at IRRI resulted in weed weight reduction, but rice yields were not significantly different between weeded and unweeded plots (IIRI, 1979).

c) Manual and mechanical Weeding:

Hand-removal of weeds after their establishment is perhaps the simplest and oldest means by which rice-weeds can be managed. Destroying weed seedlings in rice-fields using hands or feet is still a common practice in the developing Asian and South-East Asian countries. Hand-pulling of older weeds is also frequently performed. Although hand-weeding if carried out successfully gives satisfactory weed control, it is the most tedious, time-consuming and labour-intensive out of all possible methods, and hence is not appropriate in areas where large extents have been cultivated, or the labour demand is very heavy.

Very often hand-weeding cannot be completed to the degree that is required. It is commonly known that by the time hand-weeding is undertaken the weeds have competed with crop and already reduced the yields.

A great disadvantage of the manual method is the inability to recognize and distinguish rice-weeds from rice-seedlings at an early stage. Evolution of several rice-field weeds over the last several thousand years has resulted in several of them such as *Echinochloa* spp., *Ischaemum* spp. displaying a pronounced ability to 'mimic' the rice plant, and thus avoid being detected when young. It is possible to deduce that manual weeding by man, carried out for thousands of years, may have provided the evolution pressure which resulted in the development of the 'crop-mimicry' syndrome in several major rice-weeds.

Adoption of simple tools to remove weeds makes manual weeding more efficient, as has been demonstrated amply in Japan with the Japanese Rotary-weeder. Although rotary-weeding necessitates row-planting, and the degree of success depends on the moisture status of soil, it is currently regarded as a useful improvement of manual-weeding in rice.

d) Water Management:

As pointed out previously, one of the most critical factors that determines the density and types of weeds in rice-cultivation is the moisture regime of soil and the depth of standing water (Yamada, 1965). Usually emergence of weeds is negatively correlated with the depth of standing water, and it is well known that a fair degree of weed control could be achieved with 5-7 cm of standing water. In general, deep flooding, without suppressing growth of the rice crop is effective in controlling a variety of grass and broad-leaved weeds. Furthermore, timely and thorough drainage of water from the field helps in the control of many aquatic weeds including algae.

It is also well known that herbicides, particularly soil-applied chemicals may be combined advantageously with water management practices. Moody & De Datta (1986) have discussed at length how poor water

control leads to reduced efficiency with all methods of weed control in rice, particularly with herbicides. De Datta et al (1970) reported that weed control was less efficient and grain yields lower when herbicides were applied to plots kept saturated for the first 20 days, than when they were kept flooded to a depth of 5 cm for the same period. Others (Janiya & Moody, 1982; Navarez et al, 1979) have also reported increased herbicidal efficiency with continuous flooding.

However, control of weeds by standing water is not always possible due to various factors such as time of cultivation, frequency of water issues, erratic distribution of rainfall etc. Under such circumstances the emerging weeds have to be controlled by more direct methods.

e) Manipulation of Crop and Crop rotation:

It has been known for a long time that increasing the number of crop (rice) plants per unit area tends to modify the crop-weed interaction more in favour of the crop, provided the same density of the weed is maintained. Kim & Moody (1980) have reported that as the planting distance between hills of transplanted rice is reduced, the crop offers a greater competition to weeds and the yield losses are reduced. Use of higher seed rates as a means of controlling weeds is a common farmer-practice in most Asian and South-East Asian countries. Reports from Sri Lanka indicate that there is a significant decline in the weed growth with increasing the seed rate from 100 to 400 kg/ha in lowland broadcast rice, with a simultaneous increase in crop yields (Amarasinghe, 1984). However, dwarf and semi-dwarf rice cultivars do not bring about a significant response in this respect.

It is also known that the taller, more traditional varieties and cultivars with droopy leaves compete well with weeds and the tall stature allows the crop to smother the weeds. In contrast, improved rice cultivars seem to have low competitive vigour which is often attributed to their dwarf nature. Moody & De Datta (1977) have clearly shown that plant height is strongly negatively correlated with yield reduction.

The method of crop establishment is also a means by which some degree of weed control is achieved. Transplanting of rice seedlings, offers a more competitive advantage for the crop, over broadcasting of the rice seeds. Often this advantage is maintained throughout the crop growth at some expense of the weeds. Besides, transplanting provides a greater scope for using selective herbicides because seedlings are less sensitive to herbicide injury. 'Random-transplanting' does not allow the use of a mechanical-weeder, and may require the use of herbicides for any subsequent weed control. On the other hand, 'row-transplanted' rice is suitable for mechanical weeding.

Crop rotation is practiced in countries such as U.S.A., Australia and Italy, not only to promote high yields of rice by means of alleviating soil disorders, but also to combat weeds in rice (Noda, 1977). In U.S.A. rice-pasture rotations, or rice-soybean-oats rotations have conspicuously reduced weed infestations. In Japan, according to Noda (1977) a system of double-cropping of rice and a winter crop such as wheat and rape was in practice 30 to 40 years ago and adequately prevented serious infestations of perennial weeds such as Cyperus serotinus and Sagittaria pygmaea in lowland rice-fields.

f) Chemical Control with Herbicides:

The era of Chemical weed control at the international level started soon after World War II, influenced by the impracticability of traditional manual weeding due to the rise in cost of agricultural labour. With the introduction of organic herbicides developed one after another since 1944 when 2,4-D was first used for weed control, the means for effectively controlling noxious weeds that are a threat to crop lands was provided.

By and large the most commonly and widely practiced method of post-planting rice-weed control is through the use of herbicides. Chemical weed control in rice also began with the use of 2,4-D for the control of broad-leaved weeds. Use of chemicals caused a revolutionary change in weed control, particularly in Japan. By 1974, Japan was using rice-herbicides extensively in nearly all of its land under rice culture. The other principal countries which used significant amounts of rice-herbicide are U.S.A., Italy, Australia, Spain, South Korea and Taiwan (Noda, 1977). In the developing countries of Asia, Africa and South America, herbicide usage in rice is considerably less, although these countries too have accepted the potential benefits of chemical weed control. The reasons for less dependence on herbicides in these countries are: (i) availability of cheaper labour (ii) extents cultivated are often in smaller farmer-holdings (iii) advanced mechanized techniques for rice production have not yet been introduced, and (iv) lack of efficient herbicides against harmful perennial weeds, which are widespread in tropical and sub-tropical areas.

The hormonal herbicides 2,4-D and MCPA are the most widely used for weed control in rice in several countries, mainly for controlling broadleaf weeds. These are applied post-emergence at rates ranging from 2 to 4 kg/ha. Post-emergence applications of Propanil (3,4-DPA) at rates ranging from 3 to 4 kg/ha are also popular, mainly for control of grass weeds and some sedge weeds. Pre-emergence butachlor (at 2 kg/ha), thiobencarb (at 1.5 to 2.5 kg/ha) and oxadiazon (at 1-3 kg/ha) are reported to give effective weed control in rice.

In addition, nitrofen, oxyfluorfen, anilofos, pendimethalin, bensulfuron-methyl, naproanilide, piperophos and dinitramine have also been determined to be effective herbicides in rice. However, many of them are not used by farmers because they are not commercially available or are too expensive.

In Sri Lanka, herbicidal control of rice-weeds has progressed at a slow pace through the 1960's with the introduction of MCPA and Propanil (Amarasinghe, 1984). These two herbicides continue to be the most widely used herbicides in rice even at the present time. Propanil which is the more popular of the two, is mainly effective on grass-weeds, but the time of its application has been found to be very critical to prevent injury to rice plants. MCPA however, is selective towards rice, and is effective against sedge-weeds and broad-leaved weeds. Among other notable herbicides used in rice are: 2,4-D, Molinate, Butachlor, Benthiocarb, and Quinclorac.

g) Biological Control:

Biological control, which is a form of population management, involves the purposeful use of an organism (a natural enemy) to reduce a pest population that has become troublesome. Using beneficial biological agents, an undesirable plant or animal population may be eliminated locally, or more usually, its numbers are suppressed to a level where it

is no longer a nuisance nor cause economic damage.

Successful control of noxious weeds by biological agents has been mainly limited to a number of pasture weeds and the aquatic weeds Salvinia molesta D.S. Mitchell and Eichhornia crassipes (Mart.) Solms (Waterhouse & Norris, 1987). In rice there has been no biological control of weeds in practice until recently.

A fungal pathogen Colletotrichum gloeosporioides (Penz.) Sacc. f. sp. aeschynomene (referred to as C.g.a.) has been developed and registered as a 'mycoherbicide' against nothern jointvetch (Aeschynomene virginica (L.) B.S.P.), a weed in rice-fields in Arkansas, U.S.A. (Smith, 1986). The development of this 'mycoherbicide' now available in U.S. market under the trade name COLLEGO has been one of the most fascinating success stories in Biological Weed Control. Although this is the only demonstration of a field method of biological control for a rice-weed, it clearly indicates that future research should pay more attention to develop this line of attack against rice-weeds.

The above mentioned weed control methods are employed in combination with each other or independently according to the agricultural situation of each country or region for rice production. Table 2 gives the main methods of weed control employed by different major rice-producing countries of the World.

1.6 The Need for Integrated Weed Control in Rice:

Each of the above mentioned weed control measures employable in rice, has merits and disadvantages or limitations. For example, manual weeding is cheap but labour-intensive and also provides incomplete control. Water management, particularly flooding can greatly reduce weed problems, but erratic rainfall distributions or irrigation water supplies discourage too much dependence on water for weed control. Crop rotations are very useful for reducing weed communities, but are best suited for large scale farming as seen in U.S. or Australia. Herbicides are efficient tools for use against rice-weeds, but there is no complete control for all weeds with a single pre- or post-emergence herbicide application. In addition, herbicide use in rice-fields and nearby aquatic ecosystems often comes under criticism for their potential environmental impact.

When no single weed control method is suitable for all situations, a logical solution is to attempt weed control using a combination or integration of more than one method of control. Accordingly, an integrated weed management (IWM) approach in rice has been developed as discussed by Noda (1977), Ennis (1977), De Datta (1981), De Datta et al (1986), Lopez et al (1980), and Walker and Buchanan (1982). The IWM is based on a combination or integration of preventive measures, cultivations and land preparation, manual and mechanical weeding, crop rotation, soil and fertilizer management, use of competitive crops, biological control agents (natural enemies), and herbicides (Ennis, 1977). The primary objective of integrating control measures is to exert such pressure that the growth of the crop is favoured over that of weeds (Walker and Buchanan, 1982). This approach can reduce the building up of difficult-to-control perennial weeds, caused by the continuous use of same herbicide, control method, and cropping system. However, the integrated approach must necessarily be compatible with other management practices of rice

Table 2: Weed Control Methods used in Rice-culture by Countries
(modified from Noda, 1977)

Area & Country	Main Culture	1	2	3	4	5	6	7	8
Asia & Pacific:									
Japan	T		*	*		*		*	*
Korea	T		*	*	*	*	*	*	*
China	T		*	*	*	*	*	*	*
Taiwan	T		*	*	*	*		*	*
Thailand	T		*	*		*	*	*	*
Malaysia	T		*	*		*		*	*
Philippines	T		*	*	*	*		*	*
Indonesia	T		*	*		*		*	*
South Vietnam	T		*	*		*		*	*
Sri Lanka	DW		*	*	*	*		*	*
Australia	D	*	*				*	*	*
India	D		*	*	*	*		*	*
North & South America:									
U.S.A.	D	*	*		*		*	*	*
Cuba	D,U			*			*	*	*
Colombia	T,D		*	*		*		*	*
Peru	T		*	*		*		*	*
Brazil	D		*	*		*	*	*	*
Europe:									
Italy	DW					*	*	*	*
Spain	DW,T		*	*		*		*	*
Portugal	DW,T		*	*		*		*	*
Africa:									
Egypt	T		*	*		*	*	*	*
Nigeria	D,U		*	*		*	*	*	*

1: preventive means; 2: soil preparation; 3: manual weeding; 4: mechanical weeding; 5: water management; 6: crop rotation; 7: chemical control; 8: biological control; T: transplanted; D: direct-seeded; DW: direct-wet-seeded; U: upland rice

production directed at increased production, in order to be effective both economically and environmentally.

Increasing knowledge about rice crop-weed interactions, damage and yield losses due to weeds, emergence patterns of weed communities, the life-cycles of weeds, the ecological and physiological nature of weeds, crop and weed sensitivity to different herbicides and herbicide combinations, etc. will make significant contributions to IWM systems. Herbicides will be key components of IWM approach. Applications of herbicides Propanil, 2,4-D, MCPA, butachlor or pendimethalin have been effectively combined with hand or hoe weeding quite frequently, to give better weed control (De Datta et al, 1986). It is often suggested that there is still scope to develop new, selective, broad-spectrum herbicides or herbicide combinations, which can be effectively integrated with soil-water-crop management practices. These herbicides should be cost-effective and be able to control existing weed problems and newly emerging weed species in rice-agroecosystems.

Further to IWM, Ennis (1977) has emphasized the need to evolve systems which integrate weed control with other crop protection technologies, since the farmer is not interested in just one kind of pest or crop protection for a single class of pest on one crop. Ennis (1977) draws attention to the increasing need to develop total integrated protection systems that reduce the losses caused by weeds and other pests, and which are compatible with the total farming operation. These integrated systems must necessarily involve a strategy of using plant resistance, good husbandry, cultural practices, irrigation and water management, fertilization, biological control agents, pesticides, and others.

It is understood now that certain decisions and assessments are needed to implement an effective system of integrated measures for weed control. The kind of decisions that need to be made in devising a system of protecting a crop against the damages caused by weeds are shown in Figure 1. In this process, one of the weaknesses we suffer from is our inability to monitor accurately the dynamics of the weed or other pest populations and to predict the magnitude of the population to expect, or the species that would cause most damage. Methods are needed to predict population changes and to assess the importance of the changes, in order to determine when it would be most beneficial to apply a particular control option. Some inadequacies are there in our ability to deal with a number of current and potential weed problems, but the healthy rate at which control technology has been developing may prevent catastrophic losses due to weeds.

Finally, it is appropriate to look at the models that were developed (Noda, 1977) during the planning of integrated control of barnyardgrass (Echinochloa crus-galli), widely regarded as the biggest rice-weed problem in the world. Figure 2 shows the routes of barnyardgrass infestation into a rice-field, and Figure 3 the possibilities of integrating several control procedures to make satisfactory control reducing environmental risks. Figure 4 depicts a conceptual model of integrated weed control in rice as proposed by Ennis (1976).

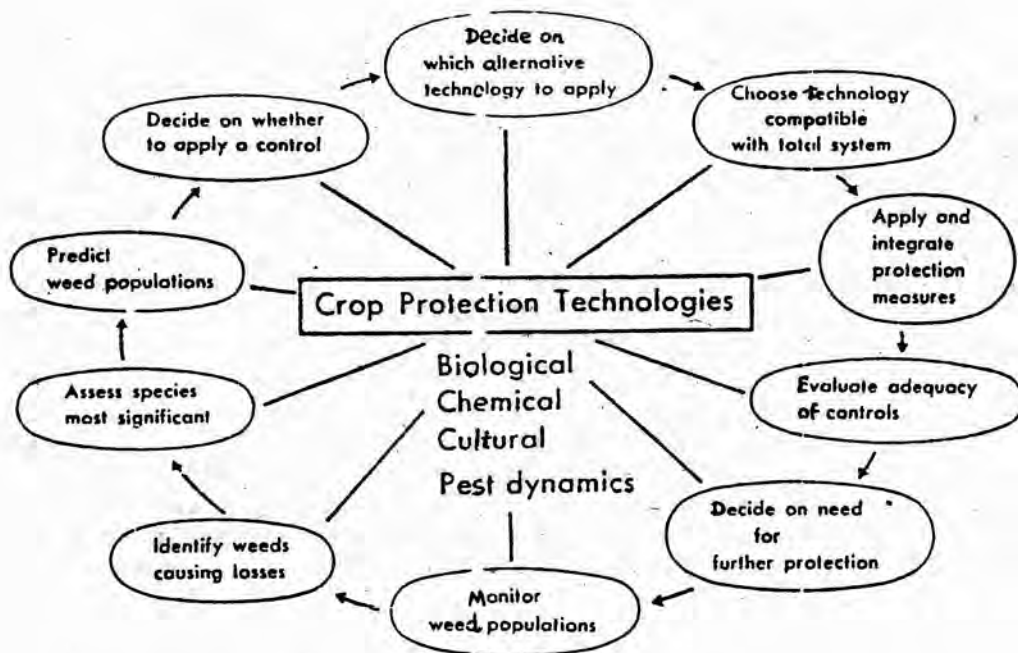


FIGURE 1: Actions and Decisions on Crop Protection for weed Control. (adapted from Ennis, 1976)

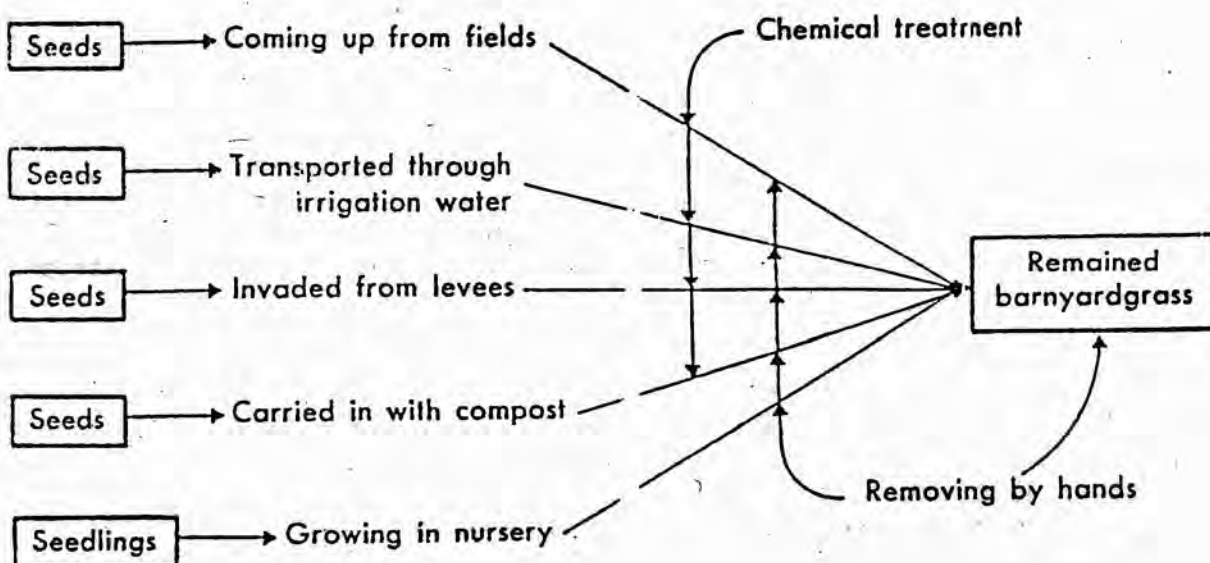


FIGURE 2: Supposed routes of barnyardgrass infestations in rice (in Japan). (adapted from Noda, 1977)

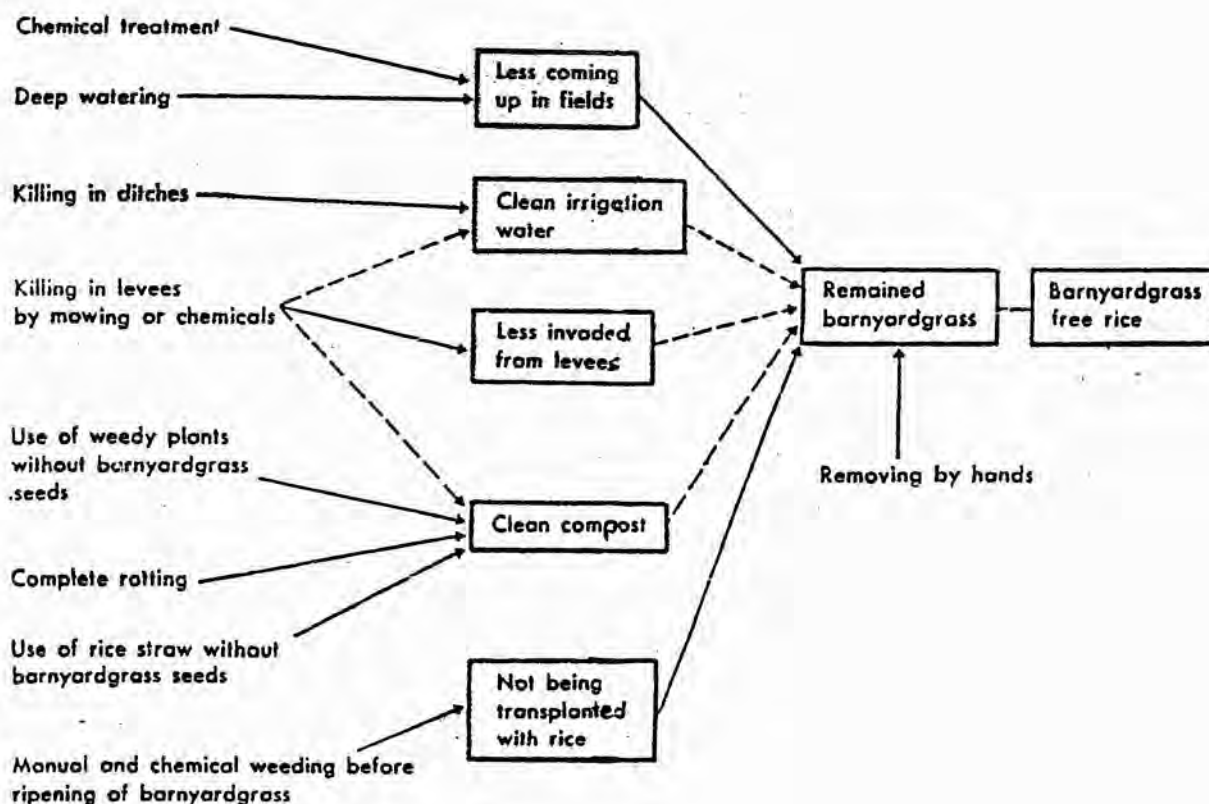


FIGURE 3: A model of integrated barnyardgrass control in rice (in Japan). (adapted from Noda, 1977)

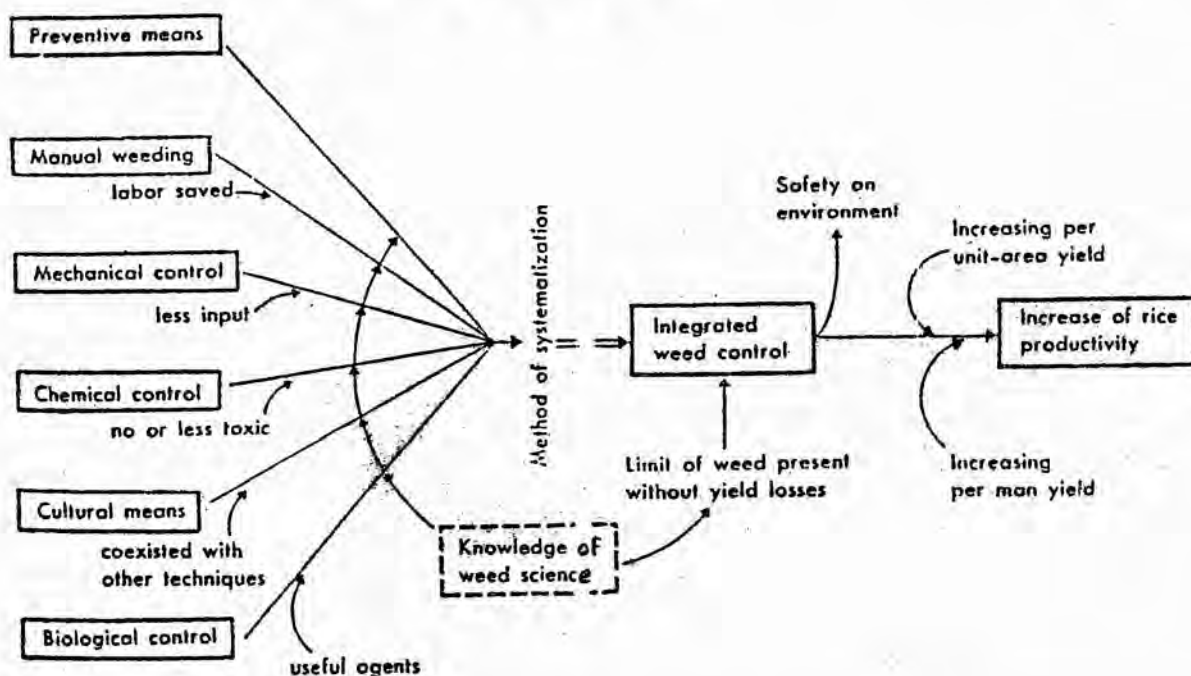


FIGURE 4: A conceptual model of integrated weed control. (adapted from Noda, 1977)

2.1 CYPERACEAE WEEDS (Sedge-Weeds)

1. CYPERUS DIFFORMIS

Family: Cyperaceae

Botanical Name: Cyperus difformis L.

Vernacular Names: Thunessa (S)

Description:

An annual, relatively large sedge, without much tillering, with masses of fibrous roots. Culms slender, soft, 10-75 cm high, sharply 3-angled, bearing 2-4 linear, lanceolate basal leaves on each culm. Leaves 15-45 cm by 2-5 mm wide. Involucral bracts 2-4, patent, the longest up to 25 cm long. Inflorescence, a terminal simple or compound umbel, with 5-10 unequal primary rays, up to 5 cm long; secondary rays 5-10 mm long bearing spikes which are globose, very dense with numerous sessile spikelets, 8-15 mm across; each spikelet linear to oblong, slightly swollen crowded with 10-30 bisexual flowers, first green later brown. Glumes 1 mm, membranous, orbicular; Stamens 1(2), Stigmas 3. Nut (Achene) sharply 3-angular, ellipsoid to subobovoid, straw-coloured.

Propagation: Reproduction is by seed (nuts).

Ecology: Usually in inundated or very wet irrigated or rainfed lowland rice-fields associated with C. haspan and C. iria, less frequently on bunds of rice-fields, found growing in open wet places, on the banks of ditches, drains and small irrigation channels.

Distribution: Pantropical. Less common in Sri Lanka than C. iria or C. haspan; found mainly in the low-country up to about 1000 m altitude.

Agricultural Importance: Although it is not one of the commonest sedge-weeds in Sri Lanka, this is widely regarded as a major weed of rice-fields in most other rice-growing countries of Asia.

Figure 1: a. Habit (x 1/5); b. rachilla (x40); c. spikelet (x 40); d. glume- dorsal view (x 40); d1. glume- lateral view; e. flower (x 50); f. nut (x 40)

SECTION 2

DESCRIPTIONS AND ILLUSTRATIONS OF RICE-FIELD WEEDS

- 2.1 CYPERACEAE WEEDS (Sedge-Weeds)
- 2.2 POACEAE (GRAMINEAE) WEEDS (Grass-Weeds)
- 2.3 DICOTYLEDONOUS WEEDS
- 2.4 OTHER MONOCOTYLEDONOUS WEEDS
- 2.5 FERNS & ALLIES

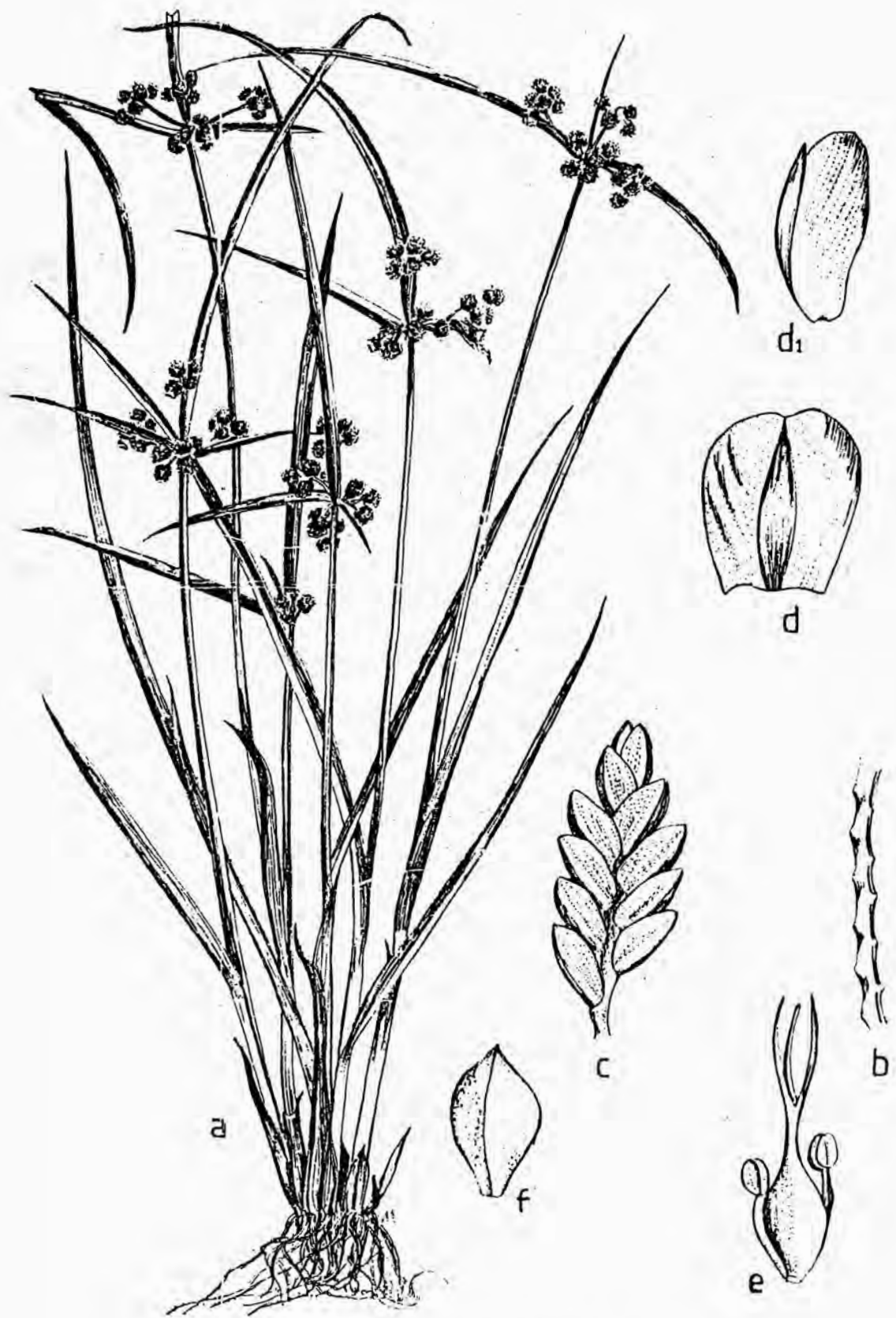


Fig.1. *Cyperus difformis* L.

2. CYPERUS HASPAN

Family: Cyperaceae

Botanical Name: Cyperus haspan L.

Vernacular Names: Halpan (S)

Description:

A short-lived perennial sedge resembling an annual, tufted with short rhizomes and masses of fibrous roots. Culms slender, soft, relatively short (10-40 cm high), sharply 3-angled, bearing 2-4 linear, lanceolate basal leaves on each culm. Leaves 2-20 cm by 2-5 mm wide. Involucral bracts 2-3, usually shorter than inflorescence, the largest up to 10 cm long. Inflorescence, a compound umbel with 10-20 unequal primary rays, each up to 2-10 cm long; secondary rays 1-4 cm long bearing sessile spikelets which are digitately arranged in clusters of 3-6; each spikelet crowded with 10-40 bisexual flowers. Glumes membranous, 1-1.5 mm long, oblong-ovate; Stamens 1(3), Stigmas 3. Nut (Achene) sharply 3-angular, obovoid to globose, yellow at maturity.

Propagation: Reproduction is by seed (nuts).

Ecology: Usually in inundated or very wet rice-fields and on bunds of rice-fields. Frequently found growing on the banks of ditches, drains and small irrigation channels.

Distribution: Pantropical, widely distributed throughout much of Sri Lanka mainly in the low-country up to about 1000 m altitude. Dominant in the Wet Zone.

Agricultural Importance: Although this is a very common rice-field weed, it is often not considered as a major problem because of its smaller size. However, massive infestations are known to occur in rice-fields.

Figure 2: a. Habit (x 1/2); b. spikelet (x 40); b1. rachilla (x 40); c. glume- dorsal view (x 40); c1. glume- lateral view; d. flower (x 50); e. stamen; f. nut (x 40)

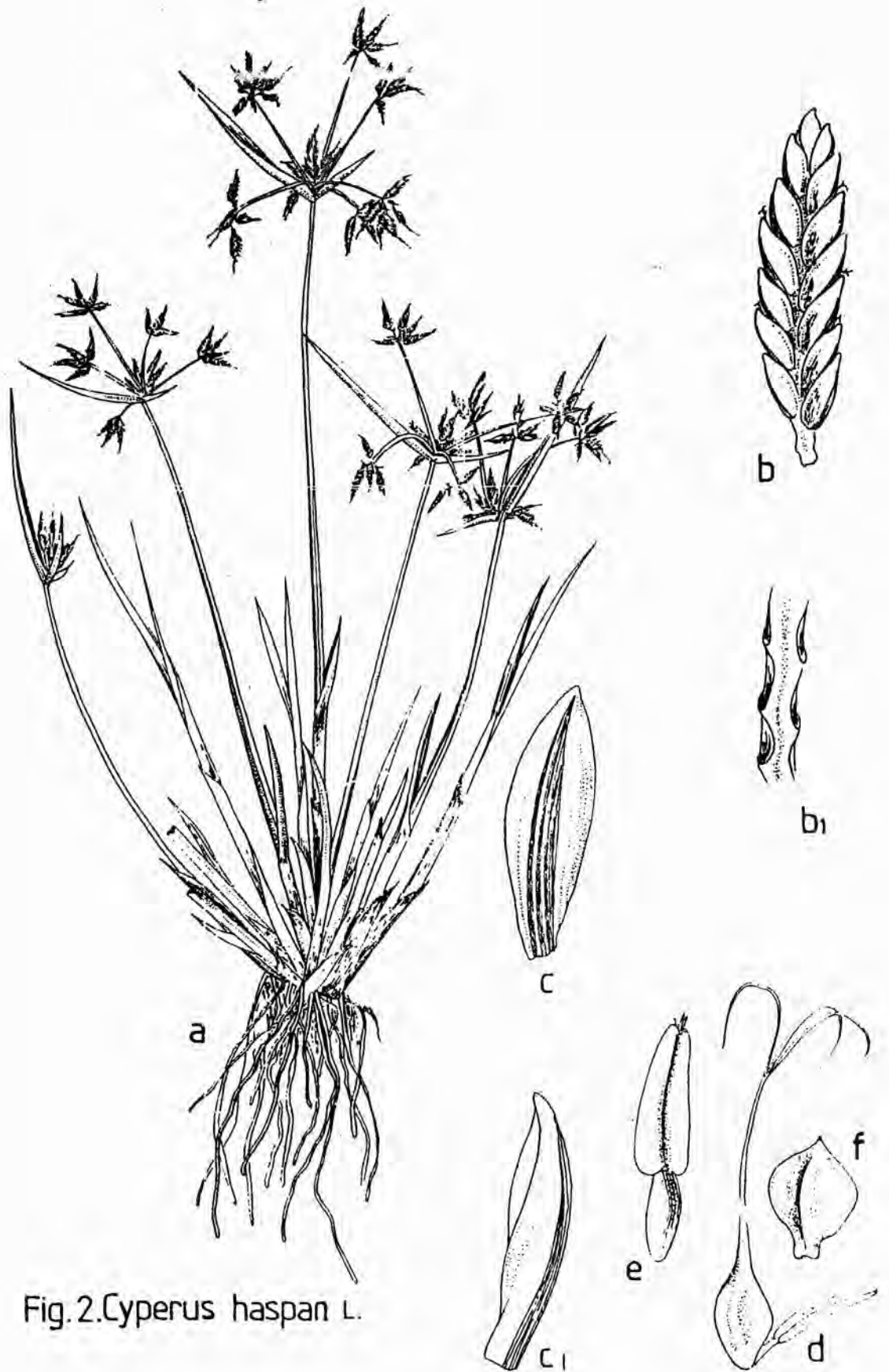


Fig.2. *Cyperus haspan* L.

3. CYPERUS IRIA

Family: Cyperaceae

Botanical Name: Cyperus iria L.

Vernacular Names: Wel-hiri (S); Thunessa (S); Rice-flat sedge (E)

Description:

A tufted annual herbaceous sedge with masses of fibrous roots. Culms 10-60 cm high, sharply 3-angled. Basal leaves linear, lanceolate, usually shorter than culm, 3-6 mm wide. Involucral bracts 3-7, foliaceous, the largest up to 40 cm long. Inflorescence, a compound umbel much variable in size, with 3-5 primary rays, each up to 2-15 cm long, very unequal; secondary rays very short bearing 5-10 spikes; Spikes loosely spicate, 1-5 cm long crowded with 5-25 spikelets; Spikelets sessile, linear-oblong, composed of 6-24 bisexual flowers. Glumes membranous, broadly ovate; Stamens 2-3, Style slender and with 3 stigmas. Nut (Achene) sharply 3-angular, obovoid-ellipsoid, brownish-black.

Propagation: Reproduction is by seed (nuts).

Ecology: Usually restricted to innundated or very wet rice-fields and on bunds of rice-fields. Frequently found growing on the banks of ditches, drains and small irrigation channels.

Distribution: Pantropical. Widely distributed throughout much of Sri Lanka, mainly in the low-country up to about 1000 m altitude. Dominant in Wet Zone.

Agricultural Importance: One of the most noticeable and troublesome rice-field weeds. Probably the commonest sedge-weed in Sri Lankan rice-fields. A principal weed in all rice-growing countries of Asia and S.E. Asia.

Figure 3: a. Habit (x 1/5); b. spikelet (x 40); b1. rachilla (x 40); c. glume- lateral view (x 40); d. mature pistil (x 40); e. nut and its cross-section (x 40)

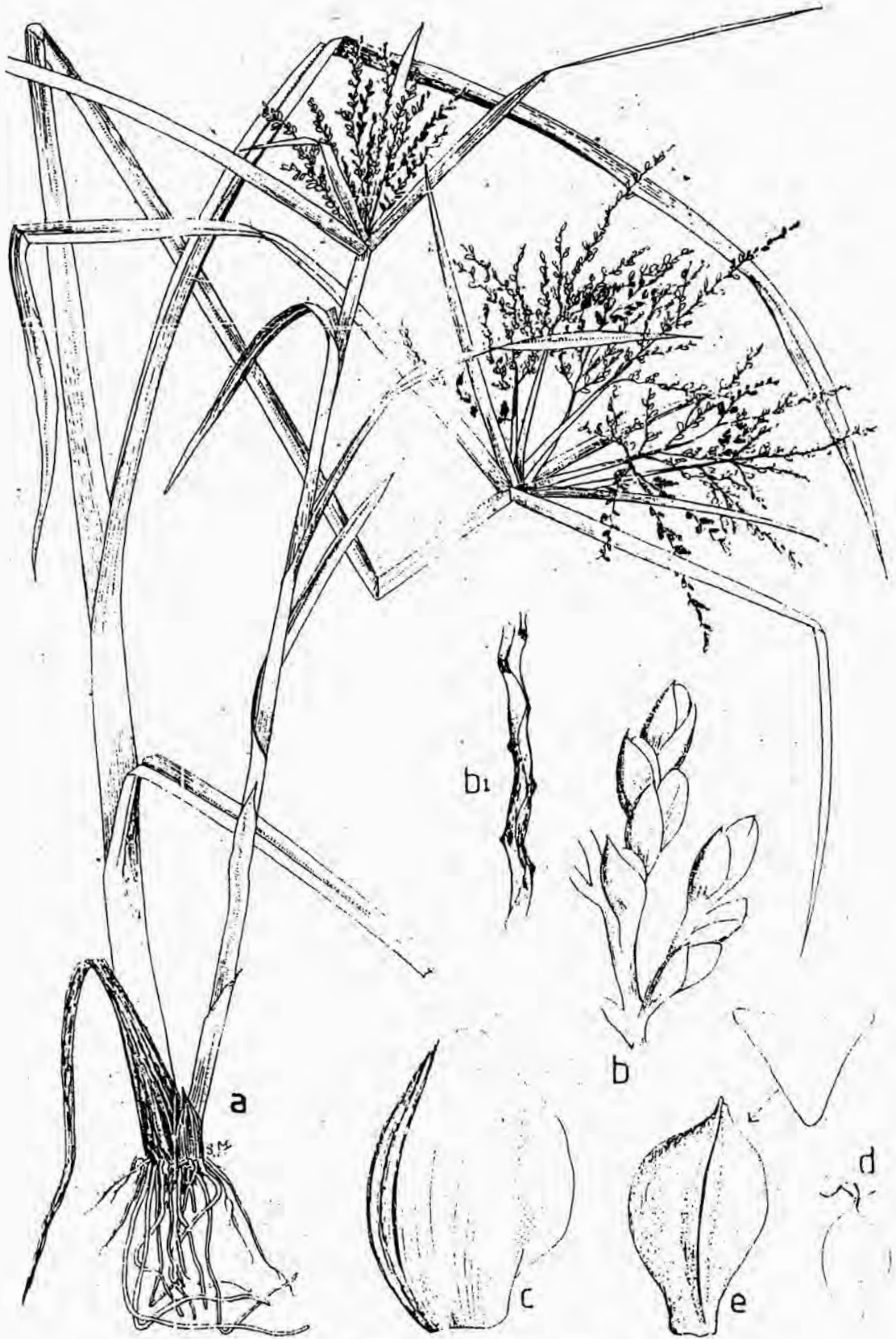


Fig.3. *Cyperus iria* L.

4. CYPERUS PILOSUS

Family: Cyperaceae

Botanical Name: Cyperus pilosus Vahl

Vernacular Names: Thunessa (S)

Description:

A tufted relatively large perennial sedge with slender rhizomes, stolons and masses of fibrous roots. Culms rather rigid, 50-120 cm high, sharply 3-angled. Basal leaves linear, lanceolate, usually shorter than culm, up to 15 mm wide. Involucral bracts 3-5, foliaceous, mostly exceeding the inflorescence with the largest up to 50 cm long. Inflorescence, a compound umbel much variable in size, with several primary rays (3-7), each up to 2-20 cm long, very unequal and branched to form 2-6 secondary rays bearing spikes; Spikes 2-3 cm long, 1-2 cm wide, crowded with 5-25 spikelets. The rachis of spike is very densely hairy. Spikelets sessile, elliptic, 5-20 mm long, 1-3 mm wide, composed of 6-25 bisexual flowers. Glumes membranous, elliptic-obtuse; Stamens 3, Stigmas 3, slender and as long as style. Nut (Achene) sharply 3-angular, obovoid-ellipsoid, blackish-brown.

Propagation: Reproduction is by seed (nuts).

Ecology: Common in open wet places, swampy areas, inundated or very wet rice-fields and on bunds of rice-fields. Frequently found growing on the banks of ditches, drains and small irrigation channels.

Distribution: Pantropical, widely distributed in Sri Lanka mainly in the low-country up to about 500 m altitude. Dominant in the Wet Zone.

Agricultural Importance: A major rice-field weed which infests very wet to dry wetland fields forming very conspicuous heavy infestations.

Figure 4: a. Habit (x 1/10; b. spikelet (x 40); b1. rachilla (x 40); c. glume- dorsal view (x 40); c1. glume- lateral view; d. flower (x 50); e. nut and its cross-section (x 40)

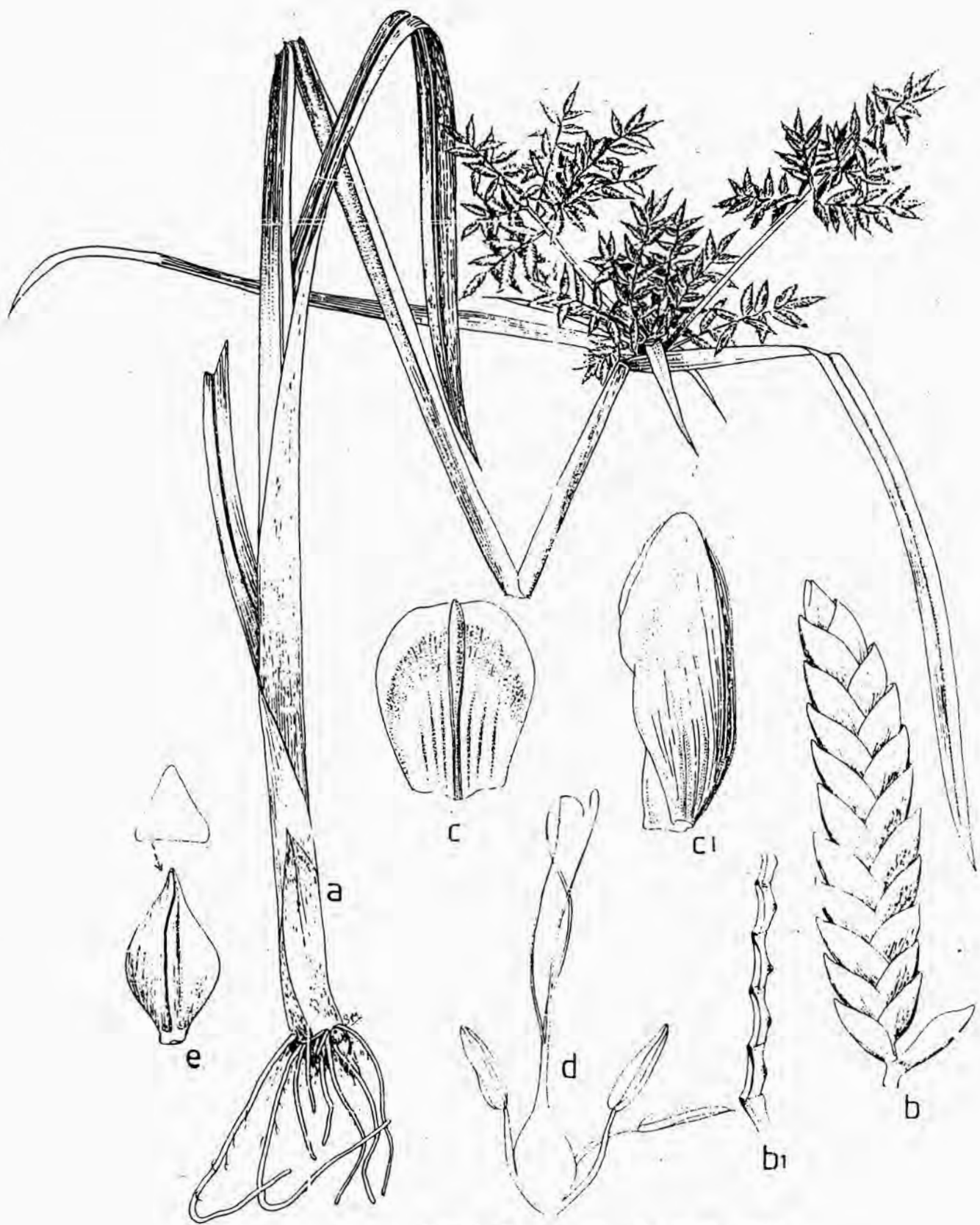


Fig. 4. *Cyperus pilosus* Vahl

5. CYPERUS ROTUNDUS

Family: Cyperaceae

Botanical Name: Cyperus rotundus L.

Vernacular Names: Kalanduru (S); Purple-nutsedge (E); Nutgrass (E)

Description:

Perennial small sedge, tuberous, rhizomatous or stoloniferous. Rhizomes initially fleshy, thin, ultimately wiry, blackish, ending in tubers; Tubers small irregularly shaped or sub-globose, continuing to form chains of tubers. Culms solitary or few together, 10- 40 cm high, slender, triquetrous; base of culm thickened like a corm, with leaves 5-20 cm long, 3 mm wide or less, rather stiff, flat, linear; lower sheaths reddish brown, partly underground. Inflorescence, a simple or compound umbel 3-8 cm long, 2-10 cm wide; Involucral bracts 2-4, foliaceous, up to 30 cm; Primary rays 2-10, very unequal, up to 10 cm long; Spikes bearing 3-10 spikelets, reddish or purplish-brown, slightly compressed, spreading, 1-3 cm long, 2 mm wide; spikelets 10-30 flowered, flowers bisexual; Glumes ovate-elliptic; Stamens 3, Stigmas 3. Nut brownish, 3-sided, oblog-ovate.

Propagation: mainly by tubers and rhizomes, but also by seed.

Ecology: In sunny to lightly shaded locations, home gardens, lawns, roadsides, wastepieces. Very common on rice-field bunds and upland rice-fields. Not abundant in wetland fields.

Distribution: A Cosmopolitan weed found in all tropical, sub-tropical and temperate countries. Found throughout Sri Lanka.

Agricultural Importance: A weed of minor importance in wet rice-fields. However, C. rotundus is widely regarded as the World's worst weed. It can cause major problems in almost any upland habitat because of its perennial nature.

Note: A plant whose tubers and rhizomes are extensively used in native medicine.

Figure 5: a. Habit (x 1/2); b. Cross-section of culm (x 10); c. leaf base area (x 10); d. spikelet (x 20); e. flower with glume (x 10); f. glume- dorsal view (x 40); g. flower (x 40); h. nut (x 20)

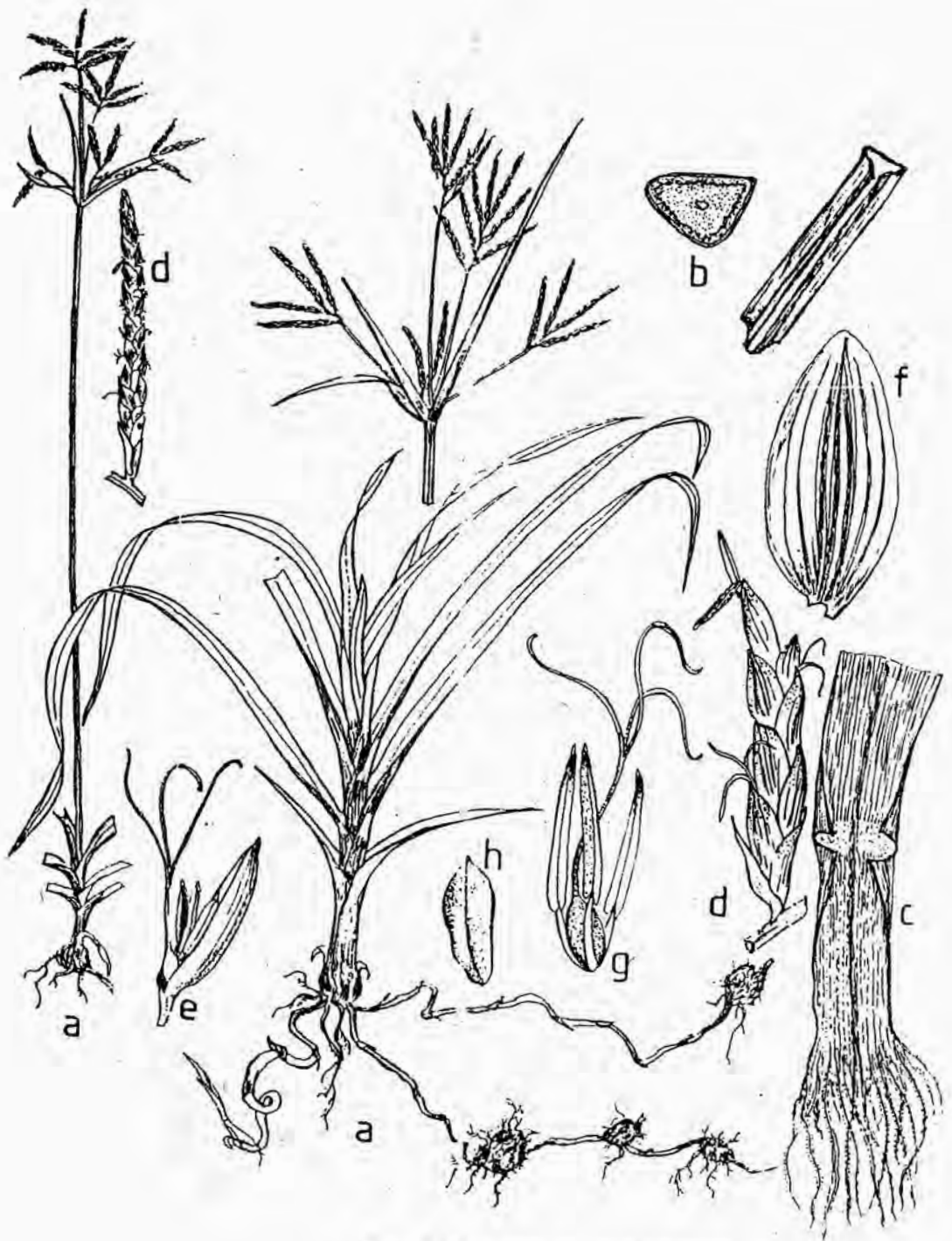


Fig.5. *Cyperus rotundus* L.

6. CYPERUS SPHACELATUS

Family: Cyperaceae

Botanical Name: Cyperus sphacelatus Rottb.

Description:

An annual sedge with fibrous root masses. Culms usually tufted or solitary, slender, stiff, 10-40 cm high, 1-2 mm wide, sharply 3-angled. Basal leaves few, linear, much shorter than culm, 2-4 mm wide and flat. Inflorescence terminal, simple or compound, lax, 4-6 cm long, 4-12 cm wide. Involucral bracts 3-5, foliaceous, erect, unequal, lowermost ones up to 20 cm and exceeding the inflorescence. Primary rays, 3-8, unequal, up to 10 cm long, bearing spikes; Spikes broadly ovate, loosely bearing 5-10 spikelets. Spikelets sessile, spreading, linear-lanceolate, 1-2 cm long, up to 1 mm wide, flattened, straw coloured, composed of 10-20 bisexual flowers. Glumes elliptic to ovate; Stamens 3, Style with 3 stigmatic clefts. Nut (Achené) sharply 3-angular, slightly oval, brown.

Propagation: Reproduction is by seed (nuts).

Ecology: Fairly common in wet, soggy grasslands, on upland rice-fields, or dry wetland rice-fields and on rice-field bunds. Frequently found growing on the banks of ditches, drains and small irrigation channels.

Distribution: In Sri Lanka found widely distributed mainly in the low-country up to medium altitudes.

Agricultural Importance: Generally a weed of minor importance, but occasionally forms dense patches.

Figure 6: a. Habit (x 1/4); b. rachilla (x 40); c. spikelet (x 40); d. glume- dorsal view (x 40); e. flower (x 50); f. nut (x 40)



Fig.6. *Cyperus sphacelatus* Rottb.

7. ELEOCHARIS DULCIS

Family: Cyperaceae

Botanical Name: Eleocharis dulcis (Burm.f.) Henschel

Synonyms: Eleocharis equisetina Presl.
Eleocharis indica Druce
Eleocharis plantaginea R. & S.
Eleocharis tuberosa Schult.

Vernacular Names: Boru-pan (S); Water chestnut (E)

Description:

A highly variable erect perennial; rhizomatous with long stolons sometimes bearing brownish tubers. Stems tufted, culms cylindrical or angularly compressed, transversely septate (visible from outside), rather stiff, 50-100 cm tall, grey to dark-green. Leaves reduced to a bladeless, tubular, membranous sheath purplish in colour with oblique tip. Inflorescence a single, terminal, ebracteate, cylindrical spikelet, 2-5 cm long; many flowered, glumes densely helically imbricate, bisexual flowers with 6-8 hypogynous bristles forming perianth; Stamens 3, Stigmas 2. Nuts obovoid, grey-brown.

Propagation: Propagation by stolons, tubers and seed (nuts).

Ecology: Open wet places, brackish and fresh water, swamps, often forming pure stands in abandoned rice-fields.

Distribution: Pantropical. Throughout much of the low-country Wet Zone in Sri Lanka.

Agricultural Importance: Not a major weed in cultivated rice-fields; however, this species can be a considerable nuisance when neglected or fallowed fields become infested.

Note: Water-buffaloes and cattle often graze the pure-stands of Eleocharis; stems are used for making mats.

Figure 7: a. Habit (x 1/5); b. mature spikelet (x 20); c. glume (x 40); d. nut with bristles (x 40)

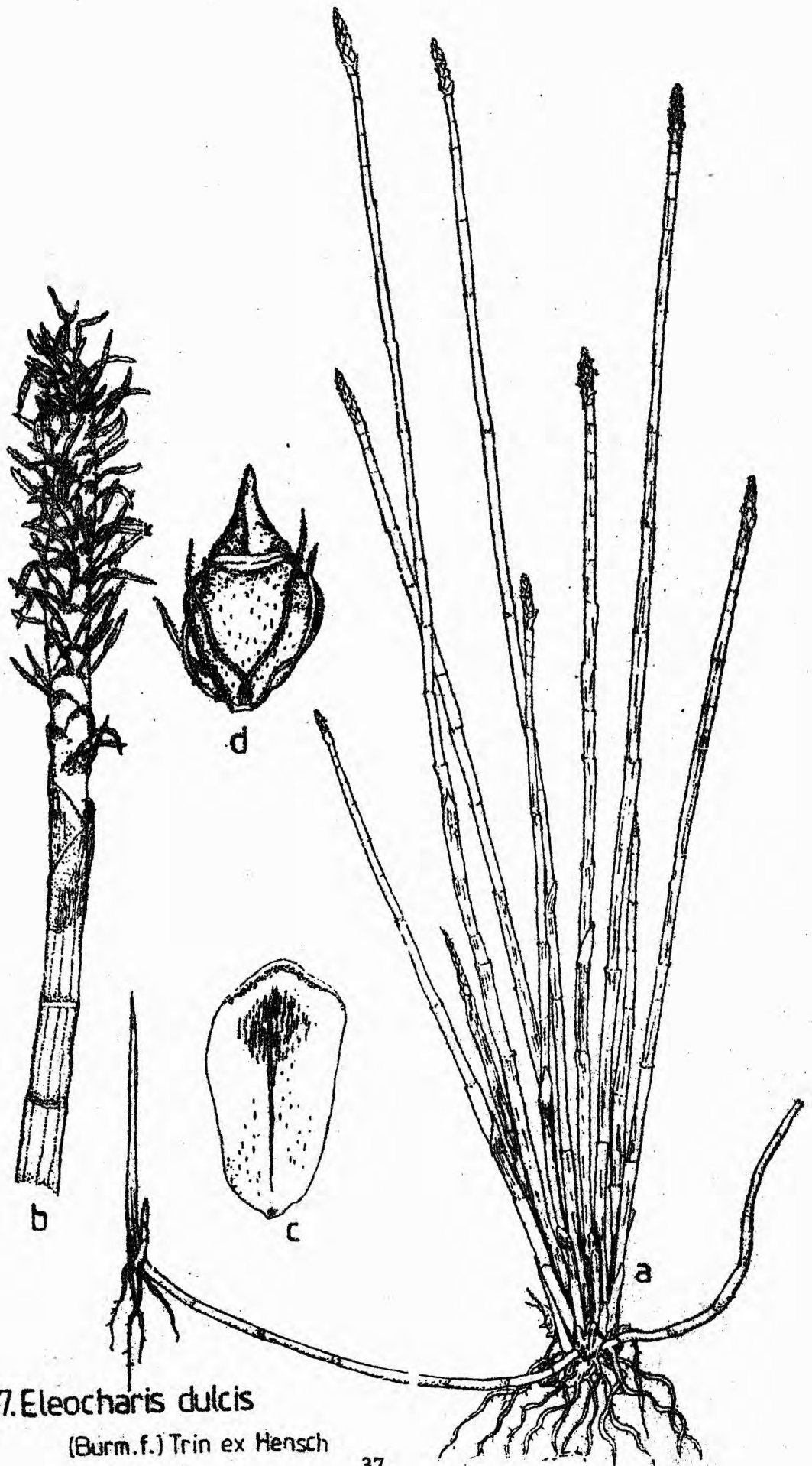


Fig.7. *Eleocharis dulcis*
(Burm.f.) Trin ex Hensch

8. FIMBRISTYLIS DICHOTOMA

Family: Cyperaceae

Botanical Name: Fimbristylis dichotoma (L.) Vahl

Synonyms: Sciirpus dichotomus L.;
Fimbristylis diphylla Vahl var. ovalis Nees
Fimbristylis diphylla (Retz.) Vahl

Description:

A species known to be very variable in habit, size of inflorescence. Annual or perennial, clump or tussock-forming, rhizome none or short, fibrous wiry roots; Culms erect, soft to rigid, ascending, slender to stout, 3-angled, compressed near inflorescence, 10-60 cm tall, up to 2 mm thick. Leaves at base, few to several, much shorter than stem, blades erect, narrowly linear 10-30 cm long, 1.5-5 mm wide, slightly incurved margins. Inflorescence terminal, simple or compound corymb, wide and lax or dense with few to numerous spikelets, up to 20 cm long. Involucral bracts 2-7, 1-25 cm long; rays 2-10, very unequal, 1-8 cm long, slender, terminated by 1-3 solitary spikelets or aggregates of spikelets. Spikelets ovoid-ellipsoid, 3-10 mm long, cylindrical, sub-sessile, densely-many flowered, reddish-brown; Glumes helically arranged, broadly ovate, bearing bisexual flowers; Stamens 1-3, Style with 2 stigmas. Achenes biconvex, obovate-obovoid, straw-coloured.

Propagation: propagated by seeds

Ecology: Open and waste places, among grass. Frequently in damp wet places at low altitude often becoming weedy in cultivated ground; common in irrigated or rainfed rice-fields and rice-field bunds.

Distribution: Cosmopolitan in temperate, sub-tropical and tropical regions of the world. Very widely distributed in the low-country Wet Zone of Sri Lanka up to about 800 m altitude.

Agricultural Importance: Although very common in occurrence and bothersome in grasslands, this species is generally not regarded as a serious weed of rice-fields.

Figure 8: a. Habit (x 1/2); b. ligule (x 20); c. cluster of spikelets (x 20); cl. spikelet (x 25); d. glume- dorsal view (x 40); e. flower (x 50); el. fruit with style and bristles; f. nut (x 40)

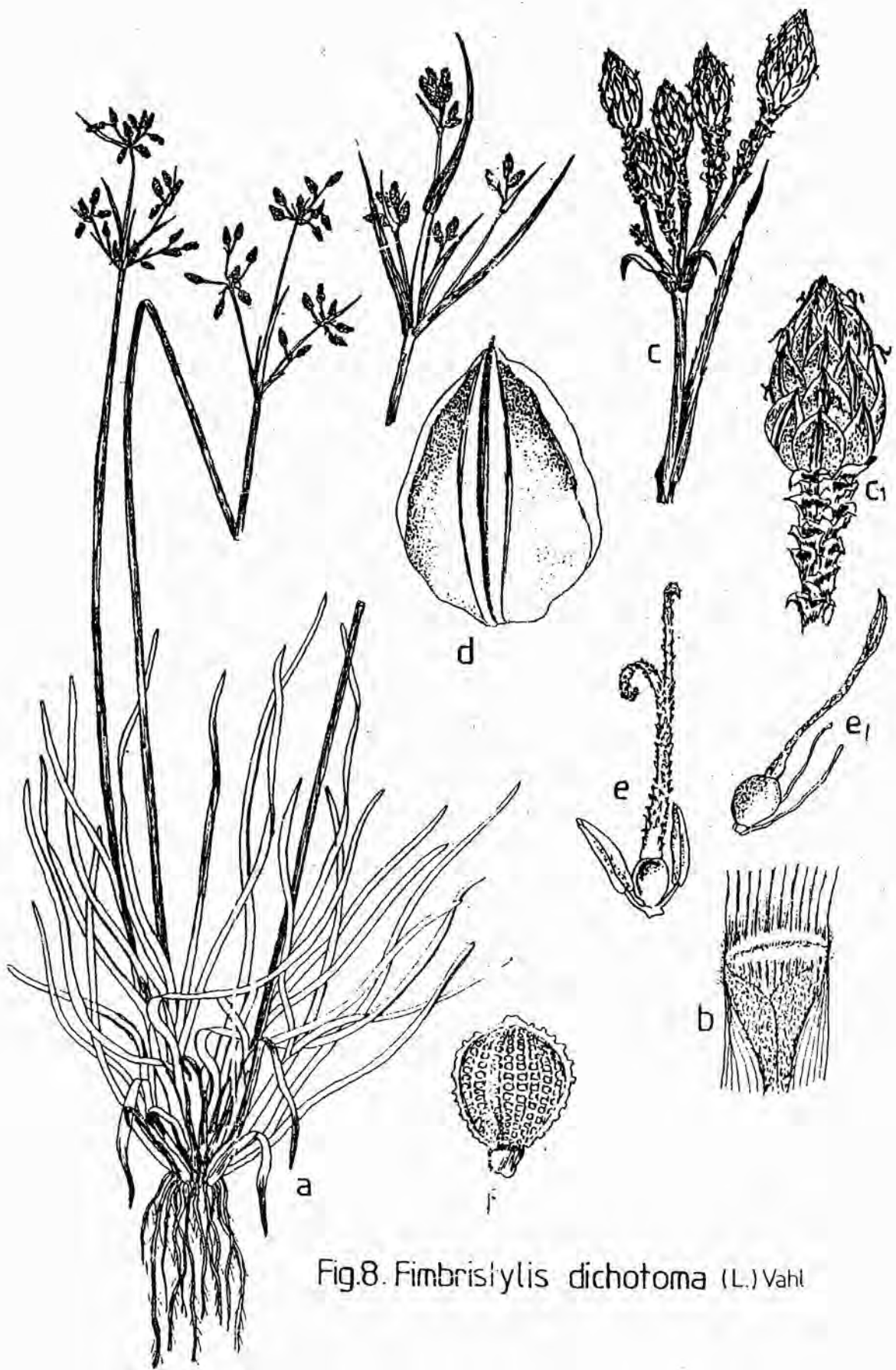


Fig.8. *Fimbristylis dichotoma* (L.) Vahl

9. FIMBRISTYLIS MILIACEA

Family: Cyperaceae

Botanical Name: Fimbristylis miliacea (L.) Vahl

Synonyms: Scirpus miliaceus L.
Fimbristylis littoralis Gaud.
Fimbristylis miliacea Vahl var. congesta Trimen

Vernacular Names: Mudu-halpan (S); Kudametta (S)

Description:

Annual, strongly tillering, tuft consisting of flowering culms and leafy shoots. Stems erect, compressed, laterally flattened with two sharp edges, 10-60 cm tall, 1-3 mm thick below, light green, covered with 2-3 bladeless basal sheaths which are also laterally flattened, 2-10 cm long. Basal leaves stiff, distichous, blades linear, 10-50 cm long, 1-3 mm wide. Inflorescence terminal, irregular, umbel-like corymb with numerous spikelets (6-50) up to 10 cm long. Involucral bracts 2-4, erect, much shorter than inflorescence; rays 3-7, unequal, 1-5 cm long. Spikelets solitary, globular, cylindrical, many flowered, reddish-brown; Glumes helically arranged, ovate, 1.5-2 mm long, bearing bisexual flowers; Stamens usually 1, rarely 2, Stigmas 3. Achenes obovate-obovoid, with marked ridges.

Propagation: propagated by seeds

Ecology: Damp wet places at low altitude; Very abundant in lowland irrigated or rainfed rice-fields and rice-field bunds; also along ditches, drains, irrigation channels and such perpetually moist, soggy locations.

Distribution: Pantropical. Very widely distributed in the low-country Wet Zone of Sri Lanka up to about 1000 m altitude.

Agricultural Importance: A most serious weed of rice-fields; seedlings emerge throughout rice-growing season, but most commonly coinciding with emergence of rice seedlings; a very strong competitor with rice.

Figure 9: a. Habit (x 1/2); a1. cross-section of culm (x 10); b. spikelet (x 40); c. rachilla bearing spikelets (x 20); d. flower with glume (x 40); e. glume- dorsal view (x 40); f. flower (x 50); g. fruit with style; h. nut (x 40)

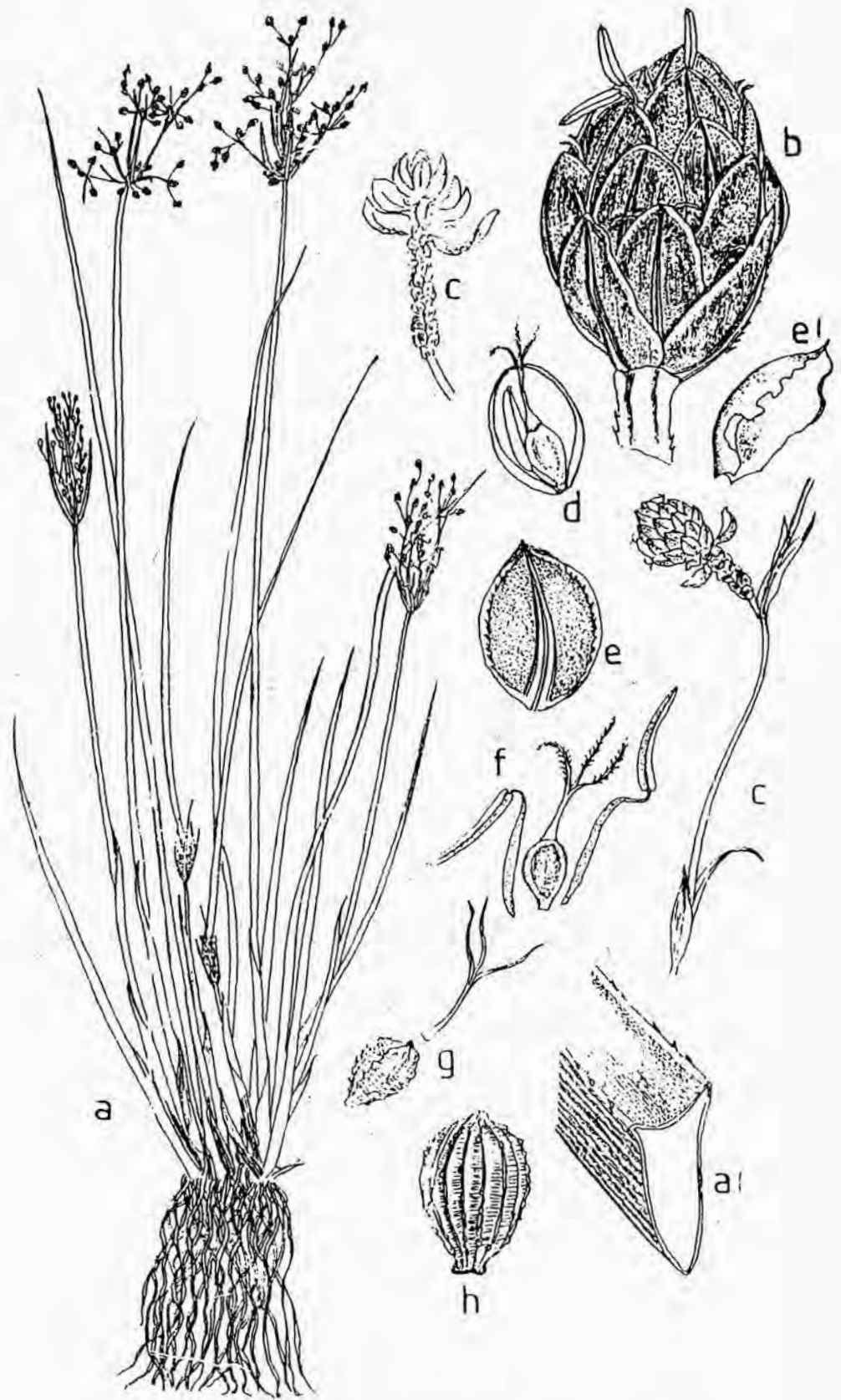


Fig.9. *Fimbristylis miliacea* (L.) Vaht

10. FIMBRISTYLIS SCHOENOIDES

Family: Cyperaceae

Botanical Name: Fimbristylis schoenoides (Retz.) Vahl

Synonym: Scirpus schoenoides Retz.

Description:

Annual or short-lived perennial, densely tufted with fibrous roots, without conspicuous rhizome. Culms erect, slender, trigonous, 5-50 cm tall, up to 0.5 mm thick below, leaved at base. Leaves few, blades 2-15 cm long, 0.5-1 mm wide, with inrolled margins. Inflorescence of 1 to 4 spikelets; rays 1-3 cm long each terminated by a single spikelet; bracts 1 or 2, usually shorter than the corymb. Spikelets ovoidal-ellipsoidal, acute at apex, sub-cylindrical, 5-10 mm long, 3-4 mm across, many-flowered, orange-brown in colour. Glumes tightly and helically arranged, ovate-orbicular, bearing bisexual flowers; Stamens 2(3), Stigmas 2. Achenes obovate-orbicular, 1-1.3 mm long, 1-1.2 mm wide, biconvex, yellow-white in colour when maturing.

Propagation: propagated by seeds

Ecology: Damp wet places at low altitude; common in lowland irrigated or rainfed rice-fields and rice-field bunds; also along ditches, drains, irrigation channels.

Distribution: Tropical Asia, South-East Asia. Widely distributed in the low-country Wet Zone of Sri Lanka.

Agricultural Importance: Although common, a weed of minor importance in rice-fields.

Figure 10: a. Habit (x 1/2); b. ligule (x 20); b1. cross-section of culm; c. cluster of spikelets (x 10); c1. spikelet (x 40); d. flower with glume (x 40); e. glume- dorsal view; f. flower (x 50); g. fruit with style; h. nut (x 40)

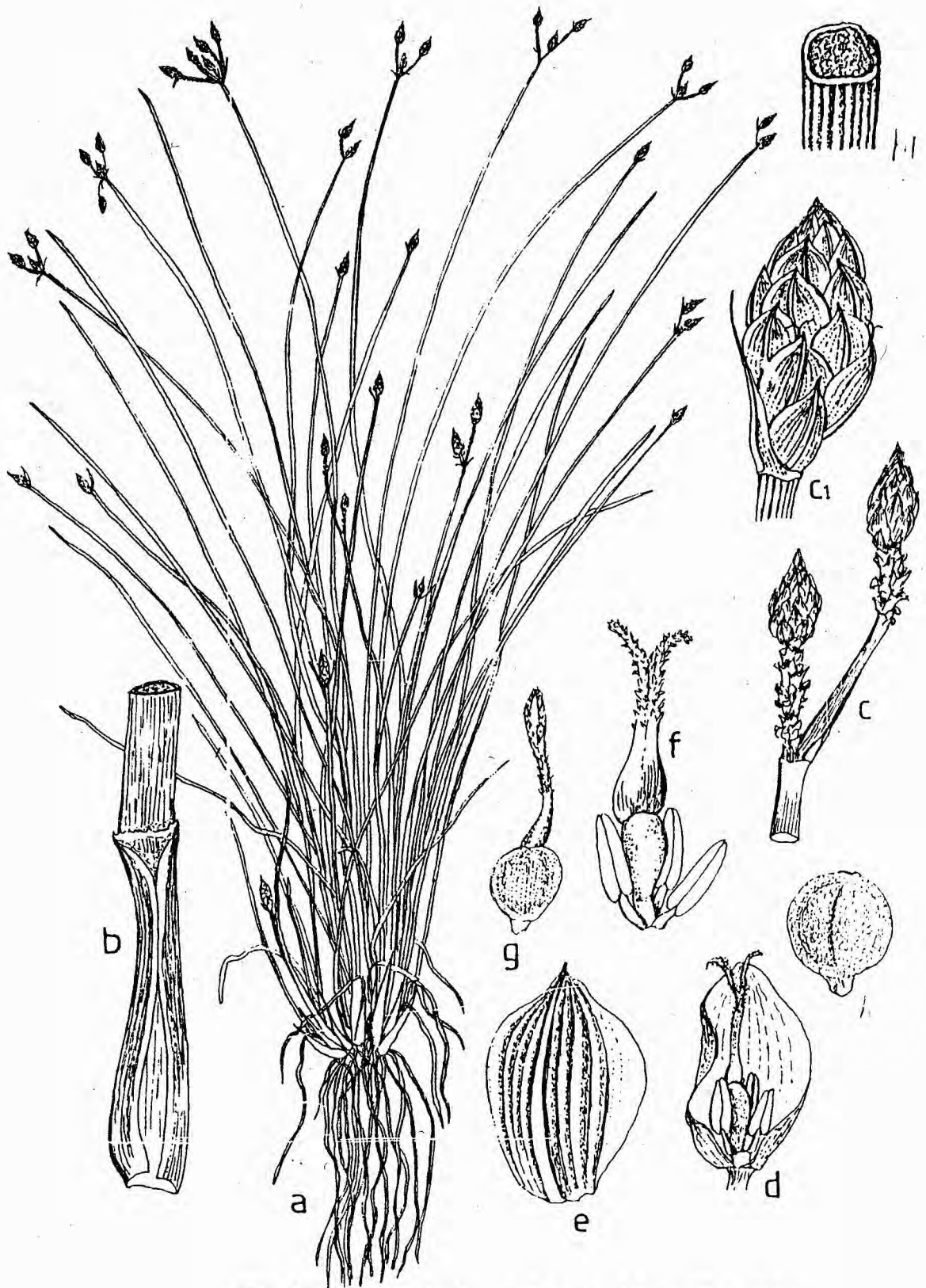


Fig.10. *Fimbristylis schoenoides* (Retz.) Vahl

11. FIMBRISTYLIS TETRAGONA

Family: Cyperaceae
Botanical Name: Fimbristylis tetragona R. Br.
Synonyms: Fimbristylis arnotii Thw.
Vernacular Names: Heen-kokmota (S)

Description:

A subaphyllous perennial sedge, densely tufted with very short rhizome. Culms erect, 10-60 cm tall, 1-1.5 mm thick, sharply 3-4 angled, glabrous, brownish-green, clothed at base with 2-4 bladeless sheaths which tightly surround the culms, 1-15 cm long, brownish in colour. Inflorescence a single, terminal spikelet, without a bract. Spikelet erect, ovoid-ellipsoidal, cylindrical, 5-12 mm long, 4-6 mm across, rounded at both ends, yellowish to dark brown, densely many flowered. Glumes tightly imbricated, oblong-elliptic, incurved, 3-5 mm long, 1-1.5 mm wide, often yellowish-brown in colour. Bisexual flowers; Stamens 1(2), Stigmas 2-3. Achenes oblong-cylindrical, biconvex.

Propagation: propagated by seeds

Ecology: Damp wet places at low altitude; common in lowland irrigated or rainfed rice-fields, borders of rice-fields, or edges of marshes.

Distribution: Pantropical. Widely distributed in the low-country Wet Zone of Sri Lanka up to medium altitudes.

Agricultural Importance: Probably not a major weed of rice-fields, but when present in large populations it can become a nuisance, as in neglected or under-cultivated rice-fields.

Figure 11: a. Habit (x 1/4); b. basal sheath (x 10); c. spikelet (x 10); d. glume- dorsal view (x 20); e. pistil (x 40); f. style (x 40); g. stamens (x 40); h. nut (x 40)

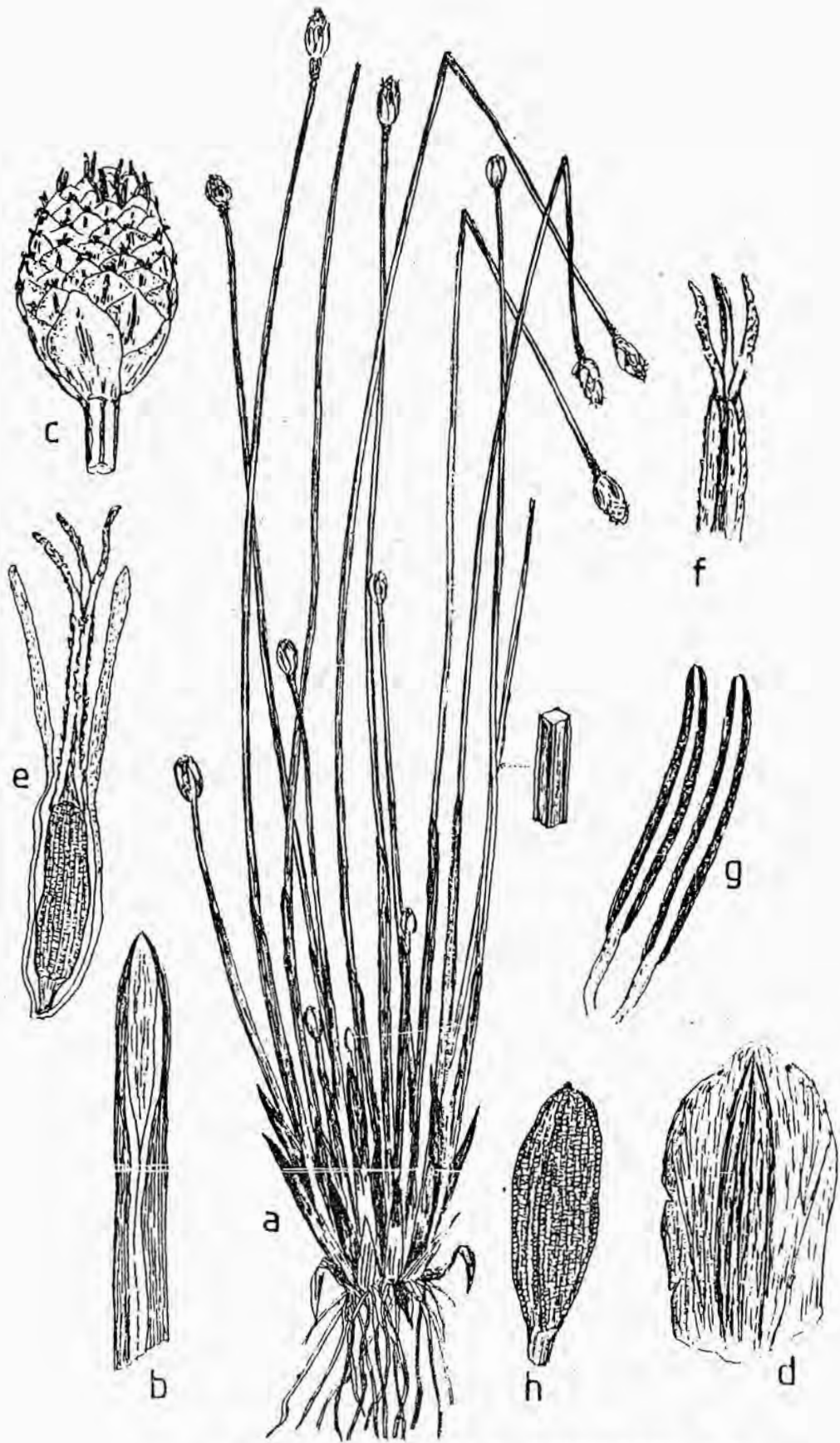


Fig.11. *Fimbristylis tetragona* R.Br.

12. FIMBRISTYLIS UMBELLARIS

Family: Cyperaceae

Botanical Name: Fimbristylis umbellaris (Lam.) Vahl

Synonyms: Scirpus umbellaris Lam.
Scirpus globulosus Retz.
Fimbristylis globulosa (Retz.) Kunth

Vernacular Names: Hal-pan (S)

Description:

A perennial species with short rhizomes covered with brown scales. Culms tufted, erect, soft to rigid, slender to stout, 3-angled, 20-70 cm tall, up to 2-3 mm thick. Base of culms covered with a few, bladeless cylindrical sheaths. Upper leaf sheaths 6-20 cm long, light green; Lower sheaths 2-4 cm long, brownish coloured. Inflorescence terminal, simple or compound corymb, wide and lax with few to numerous spikelets, up to 2-5 cm long, up to 4 cm wide; Involucral bracts 2-4, narrowly lanceolate, up to 1 cm long; rays 2-8, very unequal, 1-4 cm long, slender, terminated by solitary spikelets. Spikelets broadly ovate or elliptic, 3-6 mm long, 3-4 mm wide, rusty-brown, densely-many flowered; Glumes helically arranged, broadly ovate, bearing bisexual flowers; Stamens 3, Stigmas 3. Achenes biconvex, obovate-orbicular.

Propagation: propagated by seeds

Ecology: In marshy places. Frequently in damp wet places at low altitude; also in irrigated or rainfed rice-fields and rice-field bunds.

Distribution: Mostly in sub-tropical and tropical Asian and South-Asian region. Widely distributed in the low-country Wet and Intermediate Zones of Sri Lanka.

Agricultural Importance: Though common in occurrence, not considered a serious weed of rice-fields.

Figure 12: a. Habit (x 1/2); b. cluster of spikelets (x 10); b1. spikelet (x 40); c. glume- dorsal view (x 40); d. flower (x 50); e. fruit with style; f. nut (x 20)

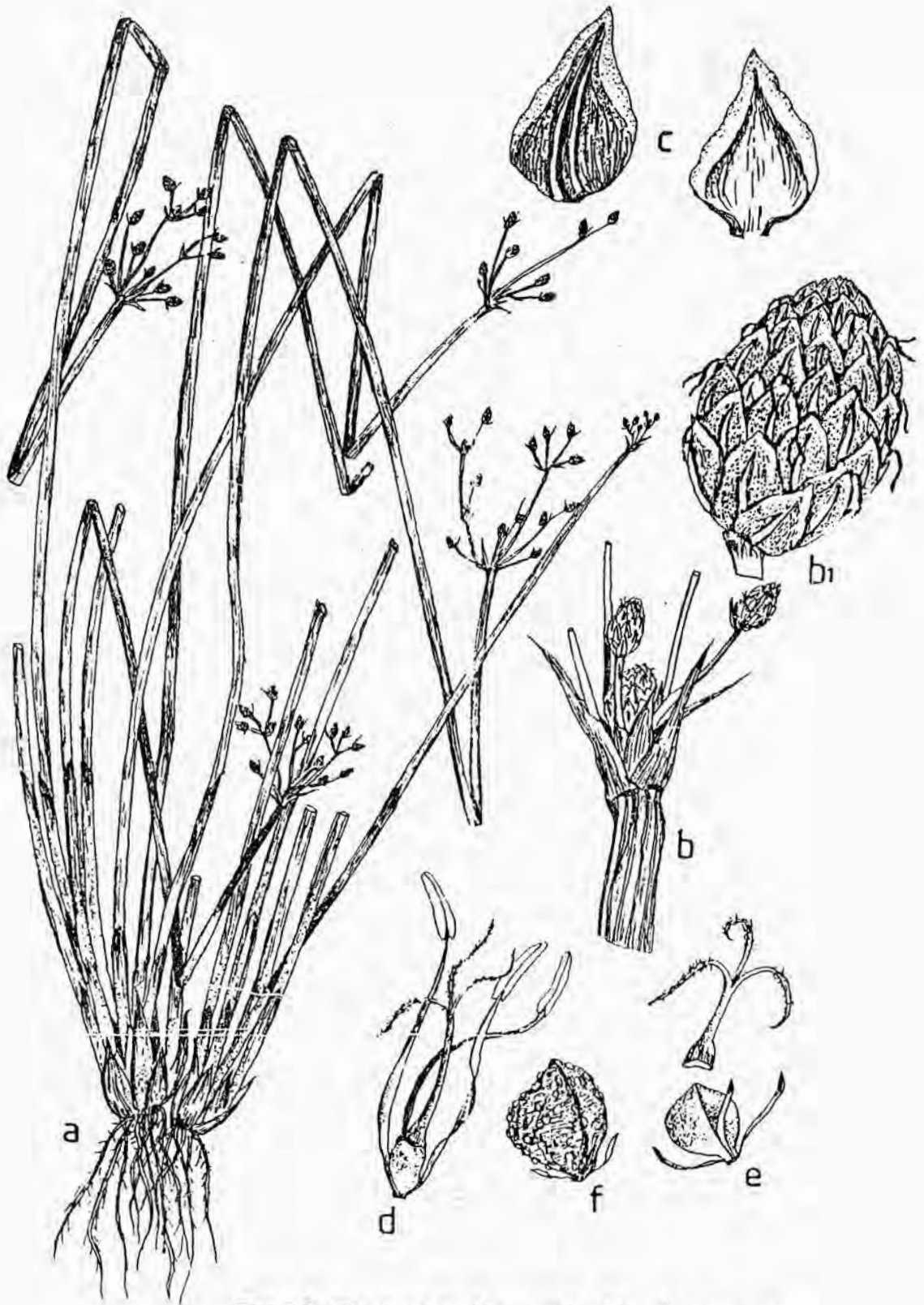


Fig.12. *Fimbristylis umbellaris* (Lam.) Vahl

13. FUIRENA CAPITATA

Family: Cyperaceae

Botanical Name: Fuirena capitata (Burm. f.) T. Koyama

Synonyms: Fuirena uncinnata (Willd.) Kunth
Scirpus capitatus Burm. f.
Scirpus uncinatus Willd.

Description:

Annual (or short-lived perennial under favourable conditions) culms tufted in small clumps with reddish-brown fibrous roots. Culms slender, noded, leafy, 5-30 cm tall, 1-2 mm wide below. Leaves mostly basal, linear-lanceolate, 2-14 cm long, 2-5 mm wide, pubescent on both sides, light-green, several prominent nerves. A few basal leaves reduced to membranous sheaths, brownish in colour. Inflorescence a loose panicle with hairy axes, bearing 3-4 glomerulous clusters of spikelets on short hairy peduncles; clusters 1-2 cm across, bearing 3 to 30 spikelets, mostly inclosed in a leaf-like bract-sheath; Spikelets ellipsoidal, 4-7 mm long, 3-4 mm wide, pubescent. Glumes numerous, helically imbricate, obovate or obovate-elliptic, shortly pubescent nearly all over, 3 strong veins prominent on glumes, glume apex drawn into a recurved ca. thorn-shaped 1-1.5 mm awn; Flowers bisexual, bearing 3 hypogynous scales which are also short-awned; Stamens 3, Stigmas 3. Achenes obovate to elliptic, 0.8 mm long, 0.5 mm wide, acute at both ends.

Propagation: Propagation by seed (nuts).

Ecology: Open wet places, swampy places such as wet grassy areas, river, stream banks or margins of ponds and rice-fields.

Distribution: Presently found only in Sri Lanka and South India. Throughout much of the low-country Wet Zone and Dry Zone in Sri Lanka, up to medium altitudes.

Agricultural Importance: An important weed in cultivated rice-fields.

Figure 13: a. Habit (x 1/3); b, b1. ventral and dorsal views of basal sheath (x 20); c. cluster of spikelets (x 20); d. spikelet (x 20); e. glume- lateral view (x 40); f. flower with glume (x 50); g. flower; h. Hypogynous scales and bristles at base of flower; h1. Hypogynous scale; i. nut (x 40)

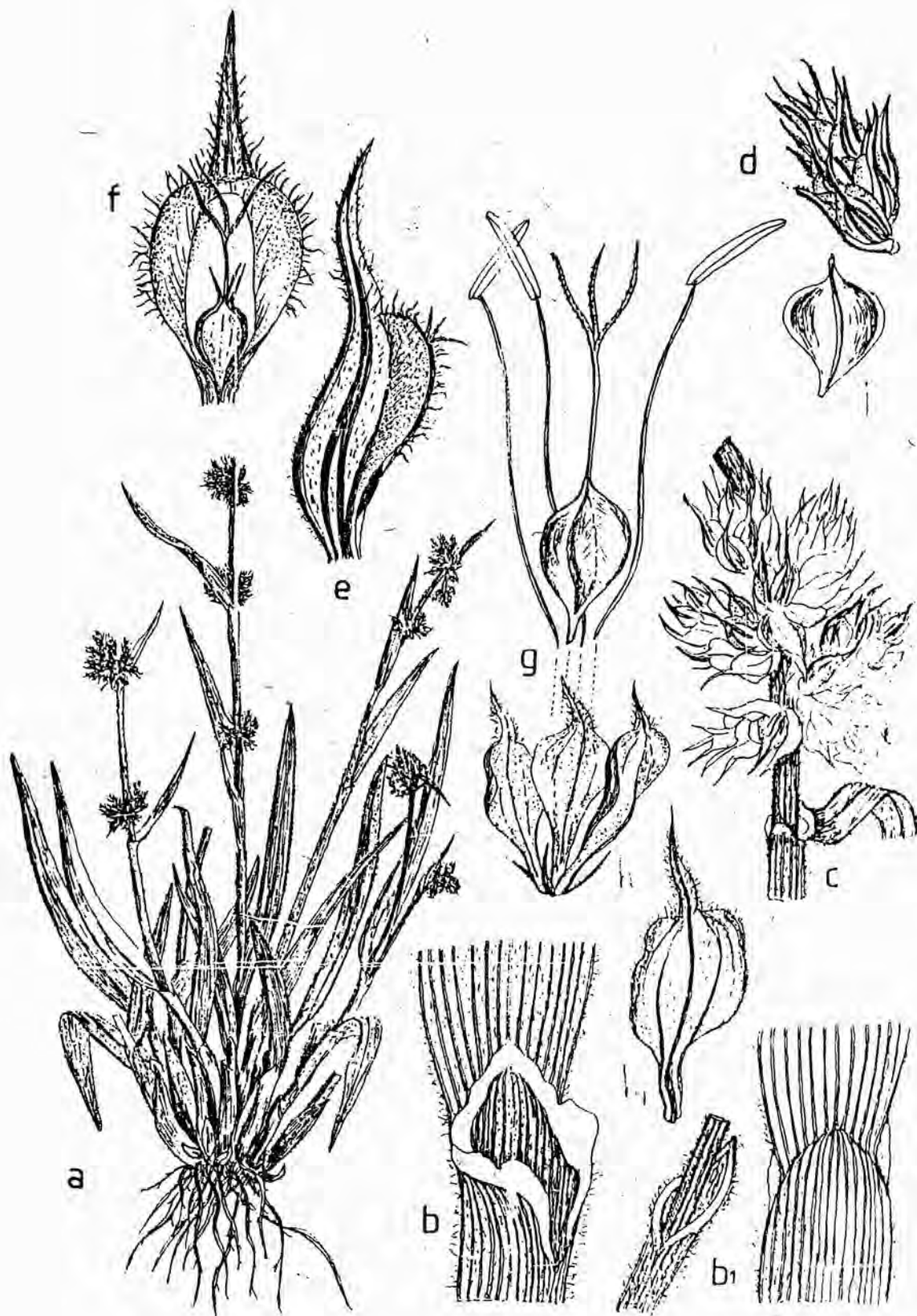


Fig.13. *Fuirena capitata* (Burm. f.) T. Koyama

14. FUIRENA CILIARIS

Family: Cyperaceae

Botanical Name: Fuirena ciliaris (L.) Roxb.

Synonyms: Fuirena glomerata Lamk.
Scirpus ciliaris L.
Scirpus pilosus Retz.

Description:

Annual, culms tufted in small clumps with fibrous roots. slender, noded, leafy stems, 20-80 cm tall, 1-3 mm wide. Basal leaves reduced to bladeless sheaths, bladed leaves on the culms 5-15 cm long, 3-8 mm wide linear, light-green 3-5 prominent nerves, soft-hairy. Inflorescence a loose panicle with hairy axes, 1-2 terminal clusters of spikelets on short hairy peduncles; clusters 1-2 cm across, bearing 3 to 10 spikelets, mostly inclosed in a leaf-like bract-sheath; Spikelets ovate or oblong-elliptic, 4-12 mm long, 3 mm wide, pubescent. Glumes numerous, helically imbricate, obovate, shortly pubescent nearly all over, 3-veined, often glume apex drawn into a recurved ca. 1 mm slender awn; Flowers bisexual, upper ones shrivelled, bearing 3 hypogynous bristles and scales; Stamens 2-3, Style with 3 stigmas. Achenes obovate to elliptic, 1 mm long, 0.5 mm wide.

Propagation: Propagation by seed (nuts).

Ecology: Open wet places, swampy places such as wet grassy areas, river, stream banks or margins of ponds and rice-fields.

Distribution: Pantropical. Throughout much of the low-country Wet Zone and Dry Zone in Sri Lanka, up to medium altitudes.

Agricultural Importance: An important weed in cultivated rice-fields.

Figure 14: a. Habit (x 1/3); b. leaf base and sheath (x 10); c. spikelets (x 10); d, dl. glume- dorsal and ventral views (x 40); e. Hypogynous scale; f. Hypogynous scales and bristles at base of flower (x 40); g. flower. h. fruit with style; i. nut (x 40)

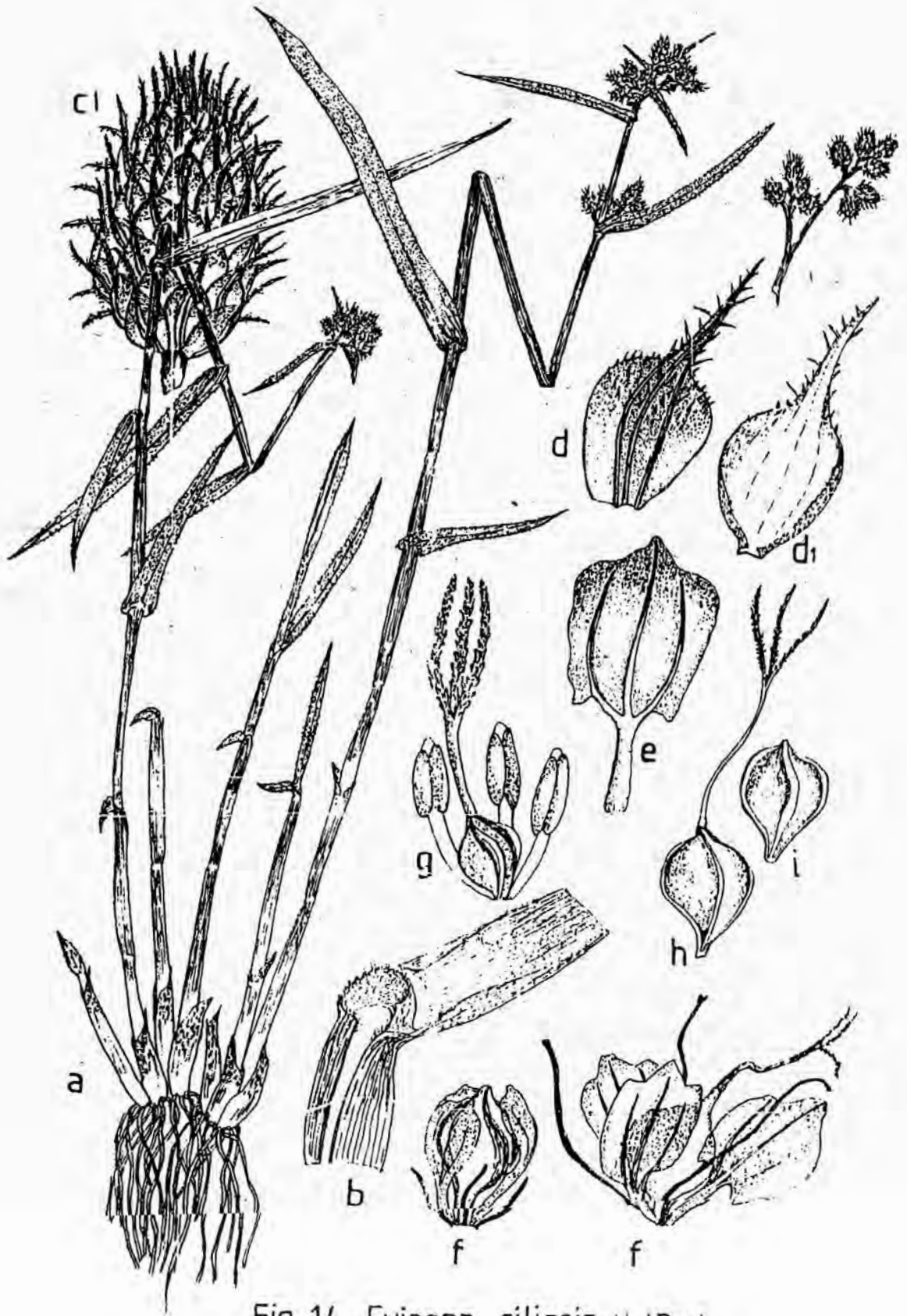


Fig. 14. *Fuirena ciliaris* (L.) Roxb.

15. KYLLINGA BREVIFOLIA

Family: Cyperaceae

Botanical Name: Kyllinga brevifolia Rottb.

Synonyms: Cyperus brevifolius (Rottb.) Hassk.

Description:

A relatively small perennial sedge with long, slender rhizomes, covered with brownish scales. Culms closely arranged in a single row along rhizomes, 7-30 cm tall, 1-1.5 mm thick, soft, slender, 3-angled. Basal leaves narrowly, linear, lanceolate, usually shorter than culms, 1-3 mm wide, flat. Inflorescence, a terminal, single globose head. Involucral bracts 3-4, foliaceous, very unequal, 3-10 50 cm long, slender, erect. Globose head densely bearing numerous spikelets. Spikelets lance-oblong to lance-elliptic, 3-3.5 mm long, 1 mm wide, usually 1-flowered; Glumes several, ovate-elliptic, folded with an acute keel, wings ciliate-serrate, 2-3 mm long, third glume containing the bisexual flower; Stamens 1-2, Style with 2 clefts. Nuts 1-1.5 mm long, 0.5 mm wide, obovate, brownish.

Propagation: Propagation by rhizomes and seed (nuts).

Ecology: Common in shady places, very wet rice-fields and on bunds of rice-fields. Frequently found growing among grass on the banks of ditches, drains and small irrigation channels.

Distribution: Pantropical; Widely distributed in Sri Lanka, mainly in the low-country Wet and Dry Zones up to medium altitudes.

Agricultural Importance: Although very common in rice-field habitats, probably a weed of minor importance.

Figure 15: a. Habit (x 1/2); b. part of culm showing leaf bases; c. L.S. of flower-head; d, d1. spikelet (x 20); e, e1. flower with glumes (x 40); f. nut (x 40)

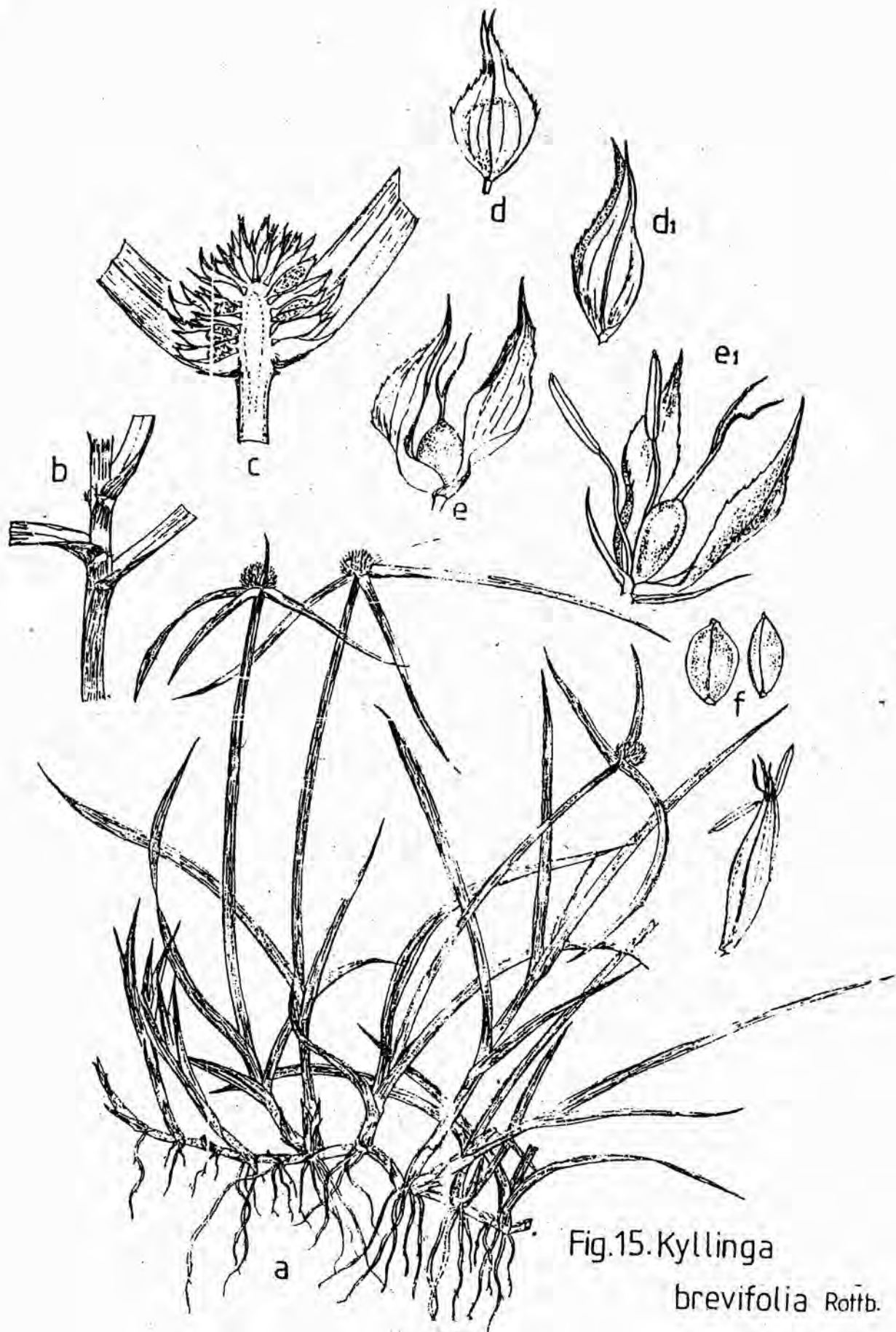


Fig.15. *Kyllinga*
brevifolia Rottb.

16. KYLLINGA NEMORALIS

Family: Cyperaceae

Botanical Name: Kyllinga nemoralis (J.R & G. Forst)
Dandy ex Hutch & Dalziel

Synonyms: Cyperus kyllingia Endl.
Kyllinga monocephala Rottb.
Kyllinga monocephalus (non Roxb.) F.v.M.

Vernacular Names: Mottu-tana (S)

Description:

A perennial sedge, loosely tufted with short, creeping, thick rhizomes, covered with lanceolate scales. Culms close together or spaced along rhizomes, erect, rather stiff, 10-50 cm tall, 1-1.5 mm thick, sharply 3-angled. Basal leaves few to many, usually shorter than to equalling the culm, linear, 2-5 mm wide, sheaths prominently brown to purple-brown. Inflorescence, a terminal, ovoid-globose head 5-10 mm long by 5-8 mm wide, with 1-3 smaller heads at its base, initially whitish, later rusty-brown in colour. Involucral bracts 3-4, foliaceous, very unequal, lowest up to 30 cm long. Globose heads densely bearing numerous, sessile, ovate-elliptic and strongly compressed, bisexual spikelets; spikelets 1- or 2-flowered, usually 1-fruited. Glumes usually 5, lower ones smaller, upper ones 2-3 mm long, boat-shaped, thinly membranous; Stamens 2 (3), Stigmas 2. Nuts oblong-ovate, brownish.

Propagation: Propagation by rhizomes and seed (nuts).

Ecology: Common in sunny or shady places which are not too dry; wastelands, roadsides, grasslands, gardens, rice-field bunds, also found growing on the banks of ditches, drains and small irrigation channels.

Distribution: Commonest in tropics and subtropics of Asia, less common in Africa and tropical America. Widely distributed in Sri Lanka, at low to medium altitudes.

Agricultural Importance: A rice-field weed of minor importance.

Figure 16: a. Habit (x 1/2); b. spikelet (x 40); c. flower (x 50); d. nut (x 40)

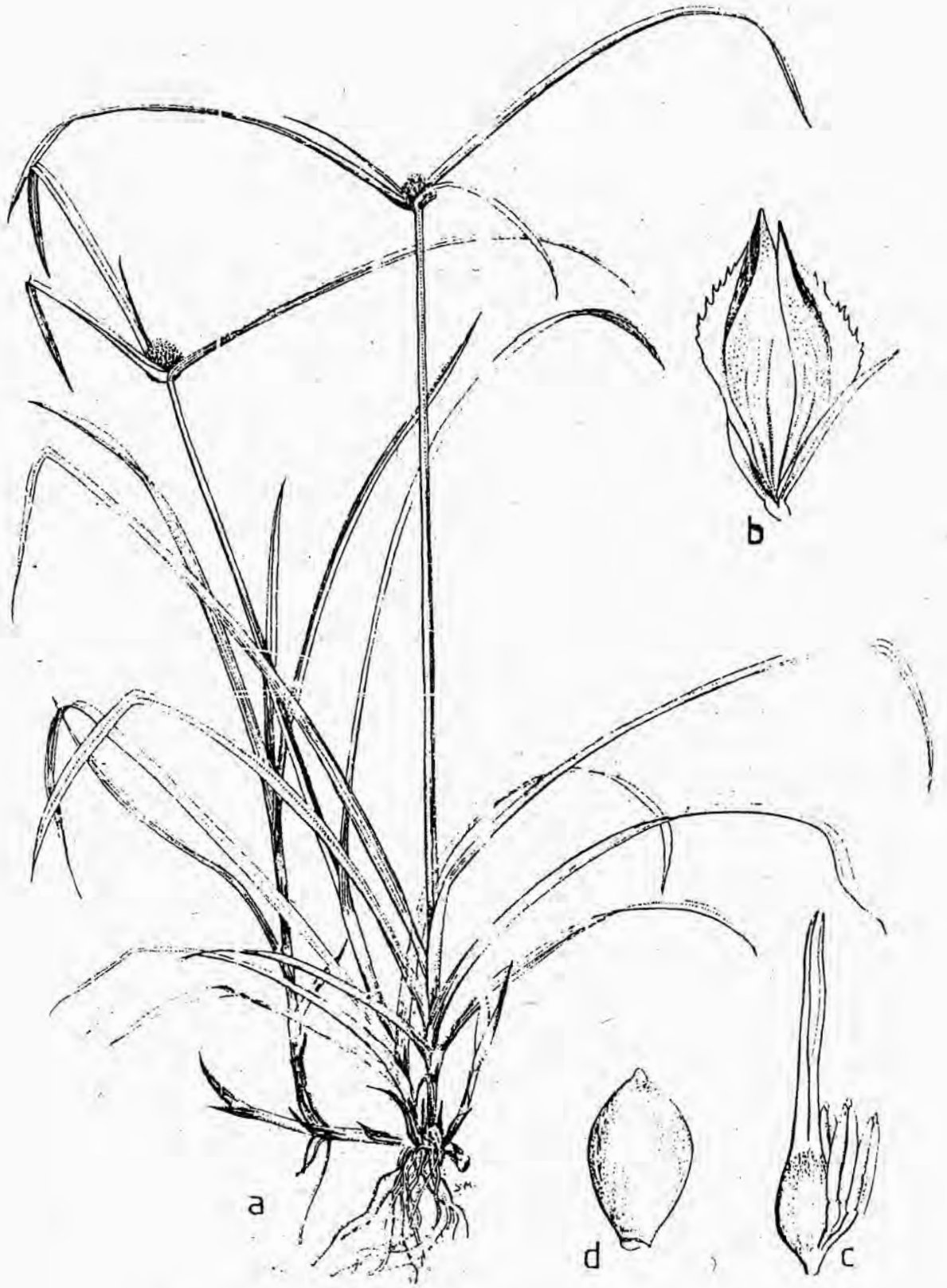


Fig.16. *Kyllinga nemoralis* (J.R.&G.Forst.)

Dandy ex Hutchinson & Dalziel

17. PYCREUS POLYSTACHYOS

Family: Cyperaceae

Botanical Name: Pycneus polystachyos (Rottb.) Beauv.

Synonyms: Cyperus polystachyos Rottb.
Cyperus paniculatus Rottb.
Cyperus polystachyos Rottb. var. laxiflorus Benth.
Pycneus polystachyos Beauv. var. laxiflorus
(Benth.) Clarke

Description:

Annual or short-lived perennial sedge, tillering, with masses of fibrous roots, sometimes with short, slender rhizomes. Culms rather rigidly erect, 10- 60 cm high, sharply 3-angled. Basal leaves weak, linear, flat, usually much shorter than culm, 1-2 mm wide. Inflorescence terminal, simple or compound umbellate, often strongly contracted, dense, sometimes as a head-like cluster of spikelets without rays, 2-15 cm across. Involucral bracts 3-7, foliaceous, spreading, unequal, lower ones exceeding the inflorescence with the longest up to 20 cm long. Primary rays 0-10, spreading, slender very short up to 10 cm bearing spikes; Spikes cm long, crowded with 2-15 spikelets, which are digitately disposed, linear-lanceolate, flattened. Each spikelet bearing 10-50 bisexual flowers; Glumes oblong-ovate, yellowish-brown; Stamens 2, Style long, Stigmas 2. Nut (Achene) oblong-ovate, 1-1.5 mm long.

Propagation: Reproduction is by seed (nuts).

Ecology: Common in wet places, grasslands, borders of water courses, roadsides, prominent on bunds of rice-fields.

Distribution: Pantropical; Widely distributed in Sri Lanka, mainly in the low-country Wet Zone.

Agricultural Importance: A rice-field weed of minor importance.

Figure 17: a. Habit (x 1/2); b. spikelet (x 40); c. glume- dorsal view (x 40); d. flower (x 50); e. nut (x 40)



Fig.17. *Pycneus polystachyos* (Rottb) Beauv.

18. RHYNOSPORA CORYMBOSA

- Family:** Cyperaceae
- Botanical Name:** Rhynchospora corymbosa (L.) Britt.
- Synonyms:** Scirpus corymbosus L.
Rhynchospora aurea Vahl

Description:

A perennial, erect, robust, large shrub, comprising of several tillers with short rhizomes, without stolons. Culms rather stiff, 1-2 m tall, 3-10 mm thick, sharply 3-sided. Leaves stiff, acute, with scabrid margins; blades linear, 30-70 cm long, 1-2 cm wide; sheaths of lower leaves generally split open. Inflorescence paniculate, with 2-5 main branches (antheas), 20-40 cm long, subtended by long leafy, 10-30 cm long, sheathing bract; antheas with many smaller unequal secondary branches, up to 12 cm long; tertiary branchlets up to 3 cm long; Spikelets numerous, in groups of 2-5; each spikelet acute, lanceolate, yellow-brown, peduncled, 6-10 mm long, 2 to 3-flowered; lower flowers bisexual, upper ones male; glumes 5-7, oblong-elliptic; flowers with 5-6 filiform bristles up to 5 mm long forming perianth, Stamens 3, Style long, very briefly 2-lobed. Nuts (achenes) obovate to oblong-obovate, wrinkled, brown, 3.5 mm long, 2 mm wide.

Propagation: Propagation by seed (nuts).

Ecology: In swampy or inundated places often forming large populations; often near ditches, pools, marshes or in abandoned rice-fields; occur on bunds of lowland rice-fields as well in the form of bothersome clumps.

Distribution: Throughout the Indo-Malaya region and Australia. Common in the low-country Wet Zone in Sri Lanka.

Agricultural Importance: Not a major weed in cultivated rice-fields; however, this species can be a considerable nuisance when neglected or fallowed fields become infested.

Figure 18: a. Habit (x 1/10); b. leaf base and sheath (x 1); c. spikelet (x 10); d. glume- dorsal view (x 40); e. flower (x 40); f. nut, fl. with its bristles (x 40)

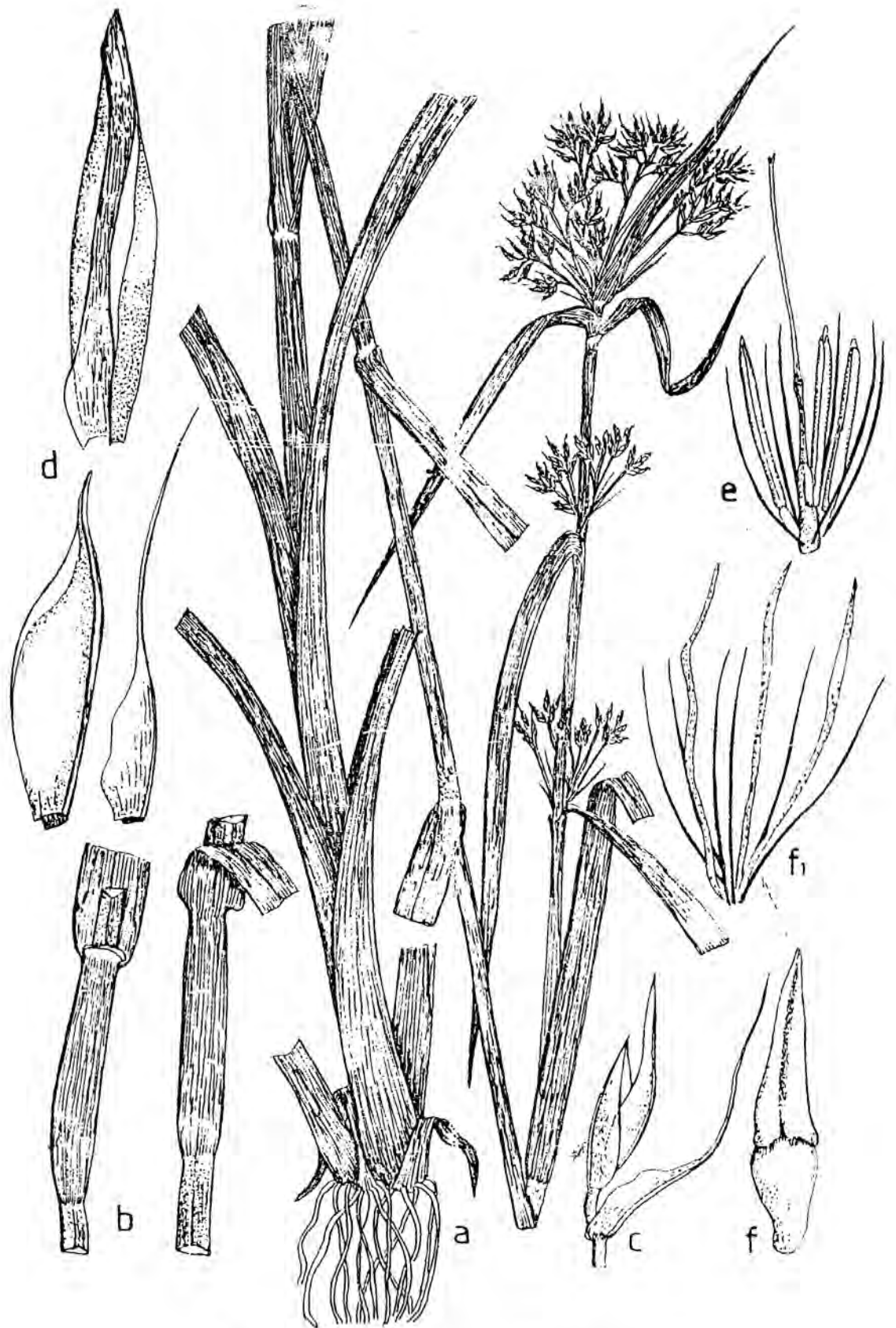


Fig. 18. *Rhynchospora corymbosa* (L.) Britton

19. SCHOENOPLECTUS GROSSUS

Family: Cyperaceae
Botanical Name: Schoenoplectus grossus (L. f.) Palla
Synonyms: Scirpus grossus L. f.
Vernacular Names: Thun-Hiriya Pān (S)

Description:

A perennial, erect, robust, large shrub, comprising of several tillers with long slender stolons, corm-like thickenings at base; Culms rather stiff, 1-2 m tall, 3-10 mm thick, sharply 3-sided, spongy, noded. Leaves few to a culm, with sheaths aggregated tightly surrounding base of culm; blades linear, 50-80 cm long or mostly equalling culms, 1-3 cm wide, green in colour, thickish, 1-ribbed. Inflorescence a terminal, irregularly compound umbel of corymbs with primary, secondary and tertiary branches; rather dense, 5-15 cm long and as broad; base with 3-4 unequal leafy bracts, exceeding the inflorescence, the longest up to 50 cm long; Spikelets numerous, solitary, sessile or peduncled, ovoid, to ovoid-ellipsoid, 6-10 mm long, 3-4 mm across, densely many-flowered; glumes densely helically imbricate, membranous, concave, broadly oval, rust-coloured or reddish brown, 3 x 2 mm; lower glumes often empty. Bisexual flowers with 5-6 filiform hypogynous bristles forming perianth. Stamens 3, Style 3 mm long with 3 stigmas; Nuts (achenes) obovoid, smooth, brown, 1.75 x 1 mm in size.

Propagation: Propagation by stolon fragments and seed (nuts).

Ecology: In swampy or inundated places often forming large populations (such as in the Bellanwila-Attidiya marsh); near ditches, pools, marshes or in abandoned rice-fields; frequently stepping into lowland-rice fields as well.

Distribution: Throughout the Indo-Malaya region and Australia. Common in the low-country Wet and Dry Zones in Sri Lanka.

Agricultural Importance: Not a major weed in cultivated rice-fields; however, this species can be a considerable nuisance when neglected or fallowed fields become overgrown.

Note: Culms of this species are extensively used for making mats and baskets etc.

Figure 19: a. Habit (x 1/10); b. spikelets (x 20); c. glume- dorsal view (x 40); d. flower (x 40); f. nut with bristles (x 40)

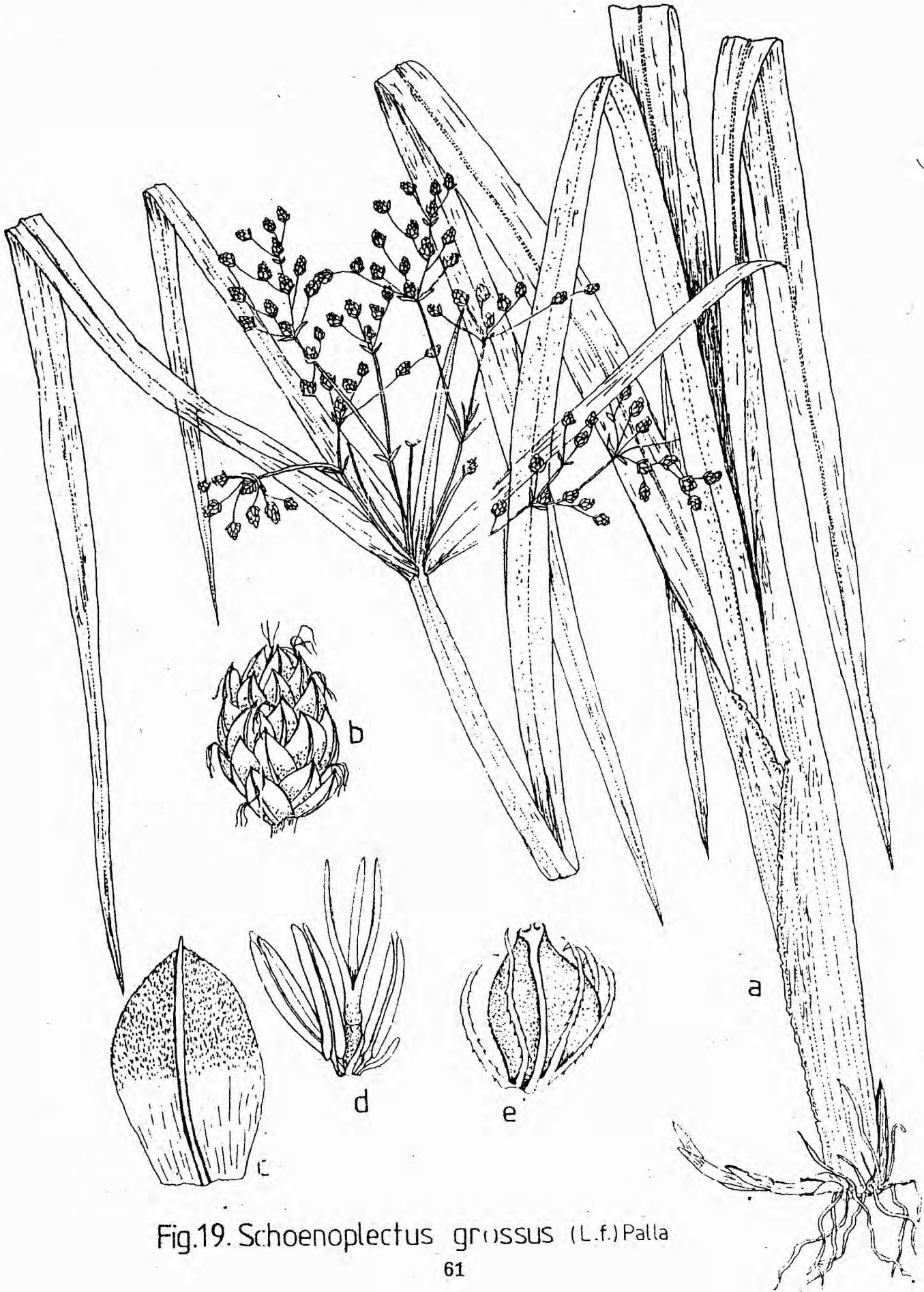


Fig.19. *Schoenoplectus grossus* (L.f.) Palla

20. SCHOENOPLECTUS JUNCOIDES

Family: Cyperaceae

Botanical Name: Schoenoplectus juncoides (Roxb.) Palla

Synonyms: Scirpus juncoides Roxb.
Scirpus erectus (non Poir.) Clarke.
Eleocharis juncoides (Roxb.) Schult.

Description:

An annual, relatively small, strongly tillering plant comprising of a tuft of culms, with a fibrous root mass, without conspicuous rhizomes. Culms rather stiff or slender, 20-80 cm tall, 1-4 mm thick, usually subcylindrical, light-green, clothed at base with few sheaths only. Leaves reduced to 2-3 membranous sheaths, lower ones scale-like, brownish, upper ones pale green, often with rudimentary, tongue-like blades. Inflorescence pseudolateral (because involucre bract forms a continuation of stem), head-like, consisting of 2-7 spikelets; bract 5-15 cm long, septate and chambered like stem, sub-acute at apex; 1-furrowed on ventral side. Spikelets sessile, ovoid to ovoid-oblong, 6-18 mm long, 3-6 mm wide, straw-coloured, apex rounded densely many-flowered. Glumes densely helically imbricate, oval shaped, 3-4 mm x 2-3 mm, membranous, concave, shortly mucronate tips, lower 1-3 empty, perianth consisting of 5-6 unequal hypogynous bristles, up to 2.5 mm, bisexual flowers, Stamens 2 or 3, Style 2 mm long with 2 (3) stigmas; Achenes broadly obovate, biconvex, glossy-black, shiny, 2 x 1.5 mm in size.

Propagation: by seed (nuts).

Ecology: Open wet places, brackish and fresh water, swamps, and often in lowland, wet rice-fields.

Distribution: India, South East Asia and Australia. Common in the low-country Wet Zone in Sri Lanka up to about 1000 m altitude.

Agricultural Importance: A major typical weed in cultivated rice-fields; although not often a very competitive species, it can be harmful at high population densities.

Figure 20: . a. Habit (x 1/3); b. cluster of spikelets (x 10); b1. spikelet (x 20); c. glume- dorsal view (x 40); d. flower with glume; e. stamen (x 50); f. fruit with bristles and style; g. nut (x 40)

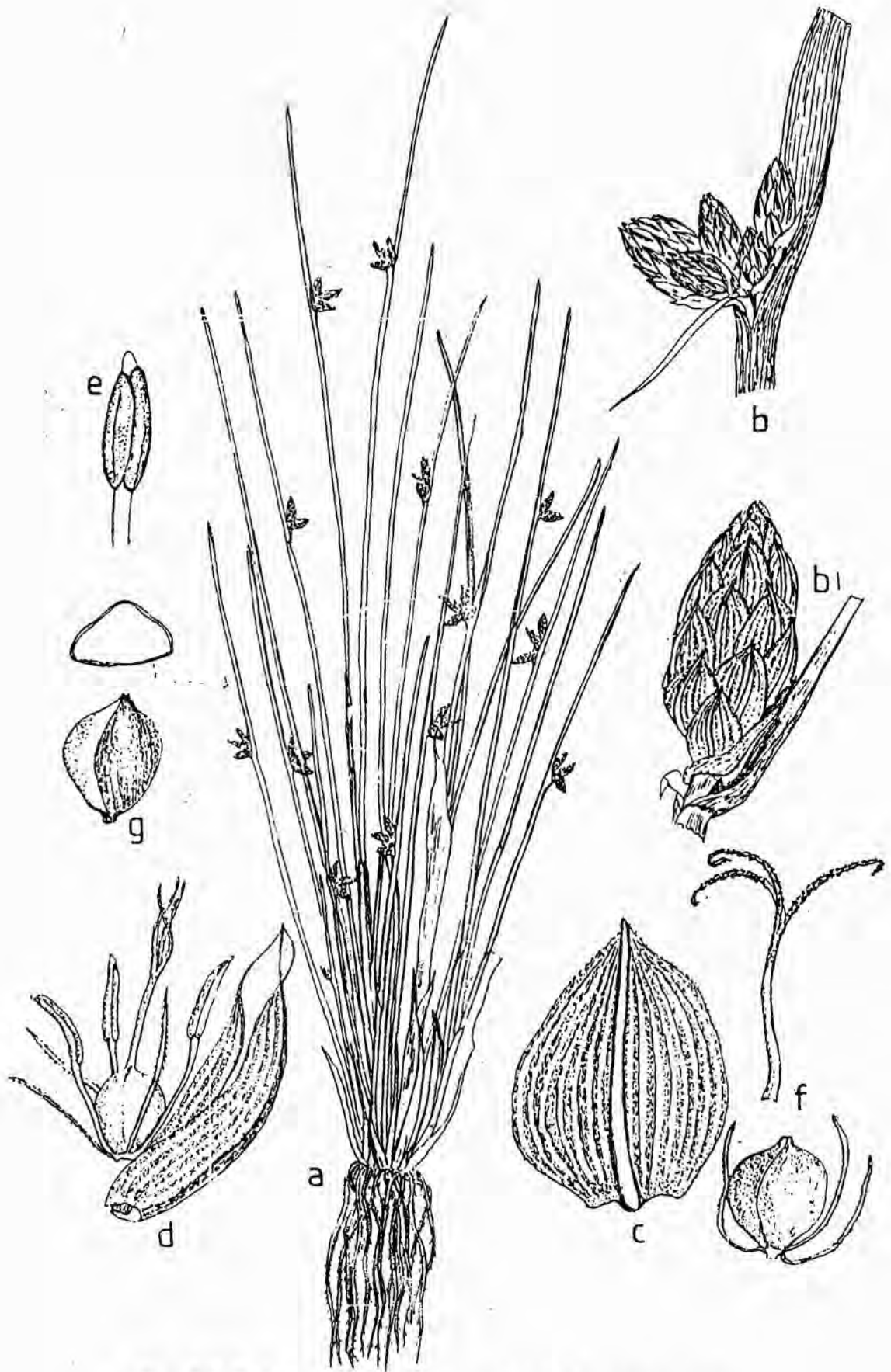


Fig. 20. *Schoenoplectus juncooides* (Roxb.) Palla

2.2 POACEAE WEEDS (Grass-Weeds)21. ALLOTEROPSIS CIMICINA

Family: Poaceae (Gramineae)
 Botanical Name: Alloteropsis camicina (L.) Stapf.
 Synonyms: Panicum camicina (L.) Retz.
Axonopus camicina (L.) Beauv.
Urochloa camicina (L.) Kunth

Description:

An annual grass, 25-50 cm tall, erect or decumbent at base, rooting at nodes, internodes 2.0- 6.0 cm, nodes hairy; Leaf sheaths somewhat compressed, blades ovate-lanceolate with broadly rounded or ovate base and acute tip, 2-8 cm by 6-16 mm, glabrous or hairy on both sides, margins ciliate with distant long stiff hairs; ligule of short hairs; Inflorescence composed of 3-8 umbellate spikes, on tip of slender pedicel, 5-14 cm long; rachis filiform, naked for lower 1/3 or 1/2. Spikelets 2-3 mm, erect, solitary, loosely imbricate, very shortly peduncled, ovoid, flattened; Spikelets consisting of only one bisexual floret; Caryopsis free, flat, oval, completely enclosed by hardened lemma and palea.

Propagation: stolons, caryopsis (seed)

Ecology: Both in everwet and dry areas, in sunny or shaded somewhat moist sites; common in grasslands, roadsides and on rice-field bunds and upland rice-fields.

Distribution: Pantropical. Also widely distributed in Sri Lanka in the low-country Wet or Dry Zones, up to medium altitudes.

Agricultural Importance: A weed frequently found on rice-field bunds, but not in the wetland fields.

Figure 21: a. Habit (x 1/2); b. ligule and leaf base (x 10); c. part of spike; cl. part of spike- enlarged (x 40); d. spikelet-opened; e. lower glume (G1) (x 40); f. palea; g. lemma with awn; h. upper glume (G2); i. flower; j. caryopsis (x 40)



Fig.21. *Alloteropsis*
cimicina (L.) Steud

22. AXONOPUS AFFINIS

Family: Poaceae (Gramineae)

Botanical Name: Axonopus affinis Chase

Vernacular Names: Carpet-grass (E)

Description:

Perennial, tufted grass with ability to produce stolons, often forming loose clumps rather than mats; stolons often long, branched, slender, rooting at nodes; roots fibrous. Culms laterally compressed, deeply grooved, glabrous, 20-50 cm long, very leafy. Leaf sheaths strongly compressed with winged-keeled back, blades linear-lanceolate with broadly rounded base, 2-35 cm by 6-10 mm. Inflorescence composed of a long slender peduncle, apically with two conjugate spikes; axis of spike slender 4-10 cm long, bearing subsessile spikelets in 2 alternate rows pressed against rachis; Spikelets of 2 florets, the lower one sterile, upper one fertile and bisexual; spikelets compressed; lower glume lacking. Caryopsis free, completely enclosed by hardened (upper) lemma and palea.

Propagation: caryopsis (seed), also by rooting nodes

Ecology: Both in everwet and dry areas, in sunny or slightly shaded somewhat moist sites; in lawns, grasslands, roadsides. A gregarious grass often found growing with A. compressus. Common on rice-field bunds and upland rice-fields.

Distribution: Pantropical. Widely distributed in Sri Lanka, mainly in the low-country Wet or Dry Zone, up to 1200 m altitude.

Agricultural Importance: A weed found abundantly on rice-field bunds, but not a major weed in wetland rice-field.

Figure 22: a. Habit (x 1); b. part of spikelet (x 20); c. spikelet (x 40); c1. spikelet- opened; e. upper lemma (L2); f. upper palea (P2); g. upper glume (G2); h. flower; i. caryopsis (x 20)

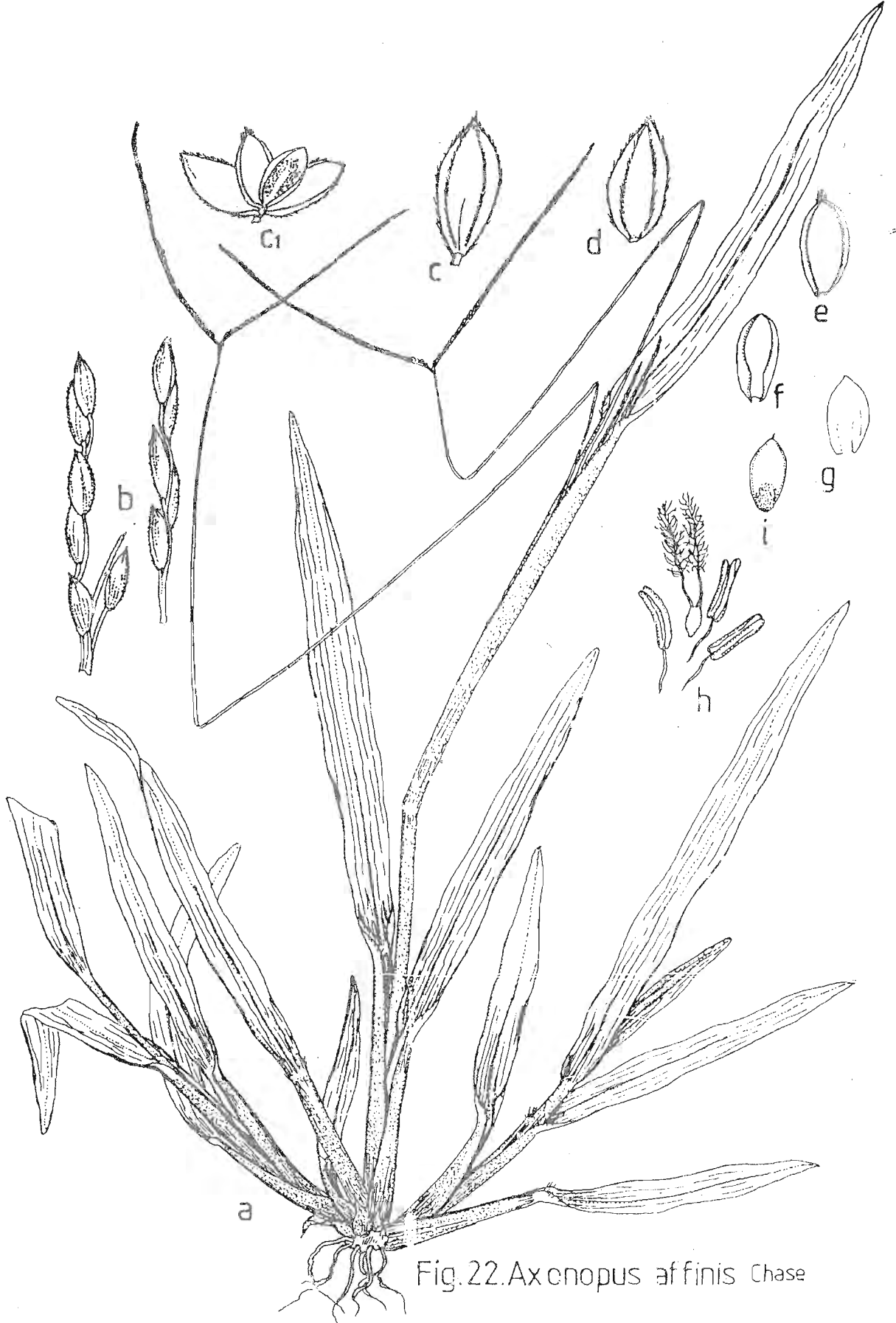


Fig. 22. *Axenopus affinis* Chase

23. AXONOPUS COMPRESSUS

Family: Poaceae (Gramineae)

Botanical Name: Axonopus compressus (Sw.) Beauv.

Vernacular Names: Carpet-grass (E), Blanket-grass (E)

Description:

Perennial, tufted, stoloniferous grass often forming loose mats; stolons often long, branched, slender, rooting at nodes; roots fibrous. Culms laterally compressed, deeply grooved, glabrous, 20-50 cm long. Leaf sheaths strongly compressed with winged-keeled back, blades linear-lanceolate with broadly rounded base, 2-35 cm by 6-16 mm. Inflorescence composed of a slender peduncle, apically with two conjugate spikes, lower down often with a third; axis of spike slender 3-10 cm long, bearing sessile spikelets in 2 alternate rows pressed against rachis; Spikelets of 2 florets, the lower one sterile, upper fertile and bisexual; lower glume lacking. Caryopsis free, completely enclosed by hardened (upper) lemma and palea.

Propagation: stolons, caryopsis (seed)

Ecology: Both in everwet and dry areas, in sunny or shaded somewhat moist sites; in lawns, grasslands, roadsides. A gregarious grass forming a dense mat-like cover. Common on rice-field bunds and upland rice-fields.

Distribution: Pantropical. Also widely distributed in Sri Lanka in the low-country Wet or Dry Zones, up to medium altitudes.

Agricultural Importance: A major weed of rice-field bunds, but not of wetland fields. However, this grass can form dense infestations which are difficult to control in abandoned or neglected fields.

Figure 23: a. Habit (x 1); b. ligule (x 5); c. part of spike; d. spikelet- opened; e. lower lemma (L1); f. upper glume (G2); g. spikelet (x 40); h. upper lemma (L2); i. upper palea (P2); j. flower; k. caryopsis (x 40)



Fig. 23. *Axonopus compressus* (Sw.) Beauv.

24. CYNODON DACTYLON

Family: Poaceae (Gramineae)
Botanical Name: Cynodon dactylon (L.) Pers.
Vernacular Names: Bermudagrass (E)

Description:

Perennial with wiry, short or long rhizomes, stolons and prostrate stems rooting at nodes, often forming extensive mats. Culms often slender, somewhat compressed, flowering culms ascending, 10-40 cm tall. Leaves in 2 rows, leaf sheaths compressed, ligule very short; blade linear, acute, bluish-green, 2-15 cm by 2-17 mm, with long hairs at base near ligule. Inflorescence made up of 3-8 digitately-arranged, apical, spreading spikes, 1-10 cm long, purplish. Spikelets solitary, sessile, attached alternately on axis, compressed, elliptic-oblong, 2-2.5 mm long, not awned, green or purplish, each with one bisexual flower. Caryopsis ellipsoid, laterally compressed, 1.5 mm long.

Propagation: caryopsis (seed), also by fragments of plant, stolons, rhizome rooting at nodes.

Ecology: Both in wet and dry areas, in sunny or slightly shaded somewhat moist but not swampy sites; a major grass in lawns, grasslands, fallow land, roadsides. A grass common on rice-field bunds and upland rice-fields.

Distribution: Pantropical. Widely distributed in Sri Lanka, very common in the low-country Wet or Dry Zone, up to 1500 m altitude.

Agricultural Importance: A weed found abundantly on rice-field bunds, but not a major weed in wetland rice-field, may dominate abandoned or neglected fields surviving flooding or droughts, often forming massive infestations.

Figure 24: a. Habit (x 1/2); b. ligule (x 2); c. part of spike; c1. part of spike- enlarged (x 20); d. spikelet (x 20); e. lower glume (G2); f. upper glume (G1); g. lemma (L); h. palea (P) with rudimentary upper floret; i. flower; j. caryopsis (x 40)

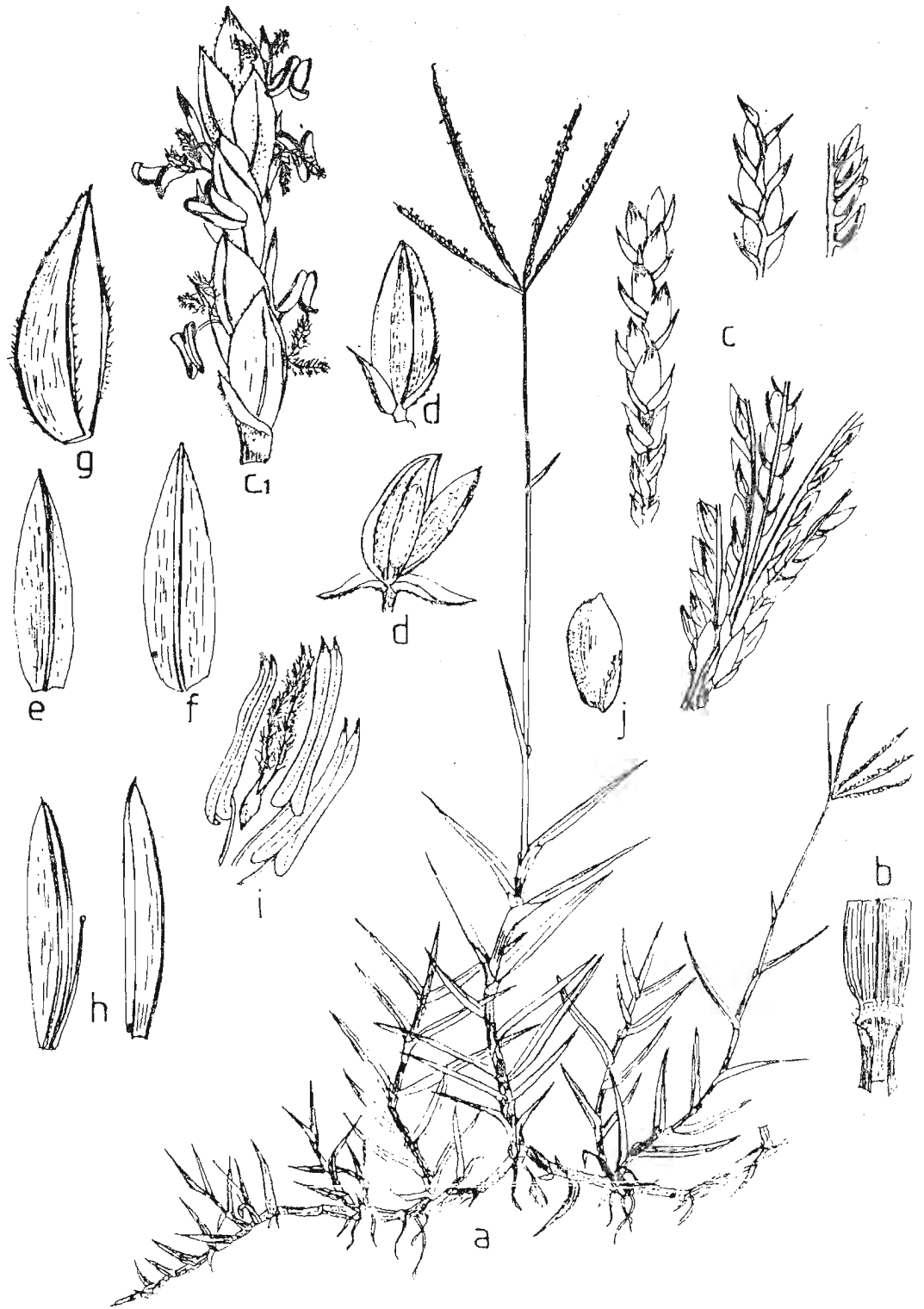


Fig. 24. *Cynodon dactylon* (L.) Pers

25. DACTYLOCTENIUM AEGYPTIUM

Family: Poaceae (Gramineae)

Botanical Name: Dactyloctenium aegyptium (L.) Richt.

Vernacular Names: Beach-wiregrass (E)

Description:

Annual (sometimes perennial) grass, with prostrate stems, rooting at nodes. Culms ascending, erect often forming a dichotomously branched radiate mass, 10-60 cm tall. Leaf sheaths compressed, ligule very short and membranous; blade linear, acute at apex, broad at base, 2-25 cm by 3-10 mm, upper part scabrously margined. Inflorescence terminal consisting of 2-8 digitately arranged initially erect, ultimately spreading spikes; Spikes 1-4 cm by 3-8 mm, on a short, straight or slightly curved hairy peduncle, axis with keeled back; Spikelets solitary, sessile, alternately on left and right on the ventral side of axis, dense, 3.5 mm long and wide, hairy at base, 3-12 flowered, with 5-15 persistent glumes, green or purplish, lower florets bisexual, upper florets rudimentary. A Glume forming 1-2 mm long bristly awn; Caryopsis obovoid, 1 mm long.

Propagation: caryopsis (seed), also by rooting nodes

Ecology: Both in moist and dry areas, prefers light, sandy soils, in sunny or slightly shaded sites; in lawns, grasslands, roadsides, waste places or arable lands. Common on rice-field bunds and upland rice-fields.

Distribution: Pantropical. Widely distributed in Sri Lanka, mainly in the low-country Wet or Dry Zone, up to 1200 m altitude.

Agricultural Importance: A weed found abundantly on rice-field bunds, but not a major weed in wetland rice-field.

Figure 25: a. Habit (x 1); b. ligule (x 10); c. part of spike-enlarged; d. spikelet (x 10); d1. spikelet-opened; e. lower glume (G1); f. upper glume (G2); g, g1. lemma (L)- two views; h, h1. palea (P)- two views; i. flower; j. caryopsis (x 40)

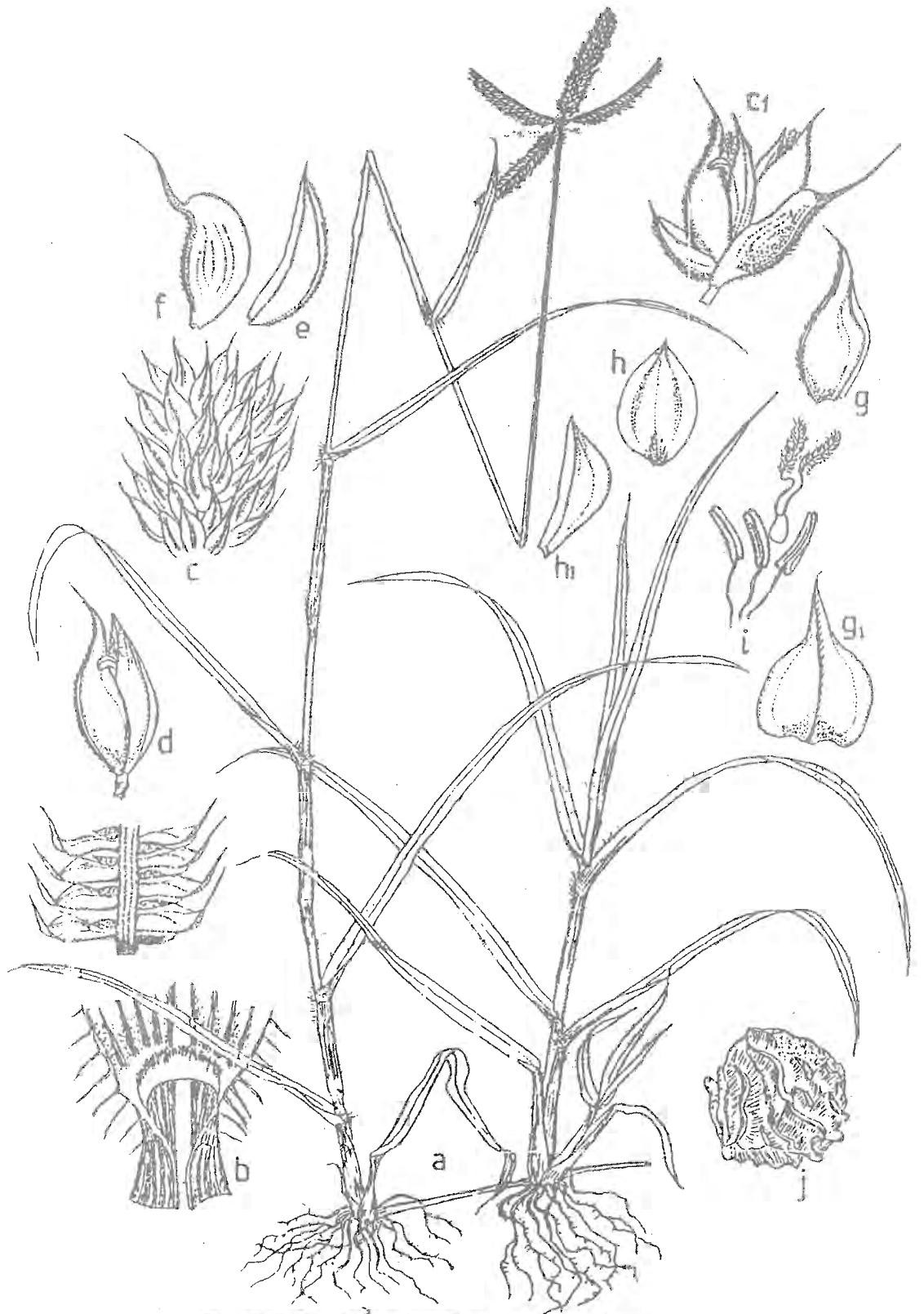


Fig. 25 *Dactyloctenium aegyptium*

26. ECHINOCHLOA COLONUM

Family: Poaceae (Gramineae)

Botanical Name: Echinochloa colonum (L.) Link

Synonyms: Echinochloa crus-galli (L.) Beauv. ssp. colonum Honda
Panicum colonum L.

Vernacular Names: Wel-Maruk (S); Wel-Marathu (S); Jungle-rice (E)

Description:

Annual grass often forming large tufts and extensive fibrous root system. Culms erect or often decumbent below with rooting at nodes, purplish, 10-60 cm tall. Leaf sheaths compressed, lacking a ligule; blade linear, broad or rounded at base, 3-20 cm by 3-15 mm. Inflorescence a terminal panicle of 4-10 racemosely arranged short, erect spikes; Spikes 1-3 cm long, solitary or 2-3 together, bearing alternately on each side of midrib pairs or three's of pedicillate spikelets in two rows (hence in 4-6 rows). Spikelet elliptic, 2-3.5 mm, not awned, green or purplish, 2-flowered, lower floret sterile or male, upper floret bisexual. Caryopsis covered by hardened palea and lemma, nearly subtriangular in T.S.

Propagation: caryopsis (seed), also by rooting nodes

Ecology: In sunny or lightly shaded moist places; prefers soggy, wet soils but not long-inundated soils; common along drains, ditches, irrigation channels, bunds of rice-fields; very common in all kinds of rice-fields.

Distribution: Pantropic and in some temperate countries, most common in Africa, Asia and S.E. Asia. Widely distributed in Sri Lanka in the Wet or Dry Zones, up to medium altitudes.

Agricultural Importance: Probably one of the worst rice-field weeds, it thrives as an annual weed in lowland or upland rice under moist conditions. Known to be a severe competitor of rice.

Figure 26: a. Habit (x 1); b. sheath-blade junction (x 4); c. part of spike; c1. part of spike- ventral view; d. spikelet; e. lower glume (G1); f. upper glume (G2); g. lower lemma (L1); h. lower palea (P1); i. upper palea (P2); j. upper lemma (L2); k. flower; l. caryopsis



Fig. 26. *Echinochloa colonum* (L.) Link.

27. ECHINOCHLOA CRUS-GALLI

Family: Poaceae (Gramineae)

Botanical Name: Echinochloa crus-galli (L.) Beauv.

Synonyms: Panicum crus-galli L.

Vernacular Names: Wel-Maruk (S); Wel-Marathu (S); Barnyardgrass (E)

Description:

Robust, strongly tufted, annual grass, erect or decumbent at base with rooting at nodes, and extensive fibrous root system. Culms 20-150 cm tall, cylindrical. Leaf sheaths lacking a ligule; blade linear, broad or rounded at base, 5- 60 cm by 5-20 mm. Inflorescence a terminal panicle of 5-40 racemosely arranged spikes; Spikes solitary or 2-4 together, initially erect, later often bent down, 5-20 cm long, crowded with alternating pairs of spikelets on each side; Spikelets pedicillate, paired or solitary, elliptic, 3.5-4.5 mm long, with a lemma drawn out to form a prominent bristly awn of variable length (0.25-4.5 cm), usually greenish or brownish, 2-flowered, upper floret bisexual, lower floret sterile. Caryopsis compressed, ovoid to obovoid, up to 2 mm long.

Propagation: caryopsis (seed), also by rooting nodes

Ecology: Prefers sunny or lightly shaded moist places along water edges, marsh or swampy areas. Generally restricted to soggy, wet soils but not long-inundated soils; bunds of rice-fields; very common in all kinds of rice-fields.

Distribution: Pantropic, Very common in Asia and S.E. Asia. Widely distributed in Sri Lanka in the low-country Wet or Dry Zones, up to medium altitudes.

Agricultural Importance: Probably the No. 1 ranking rice-field weed in the world; it thrives as an annual weed in lowland or upland rice under moist conditions. Known to be a severe competitor of rice, as well as a strong rice-mimic.

*Note: Echinochloa species are known to display polymorphism, resulting in a number of taxa which have been referred to as varieties; E. crus-galli, var. caudata, var. oryzicola, var. hispidula etc. are known to occur in tropical rice-growing areas of the world.

Figure 27: a. Habit (x 1/2); b. sheath-blade junction; c. spikelet- two views (x 5); d. lower glume (G1); e. upper glume (G2); f. lower lemma (L1); g. lower palea (P1); h. upper lemma (L2); i. upper palea (P2); j. caryopsis (x 20)

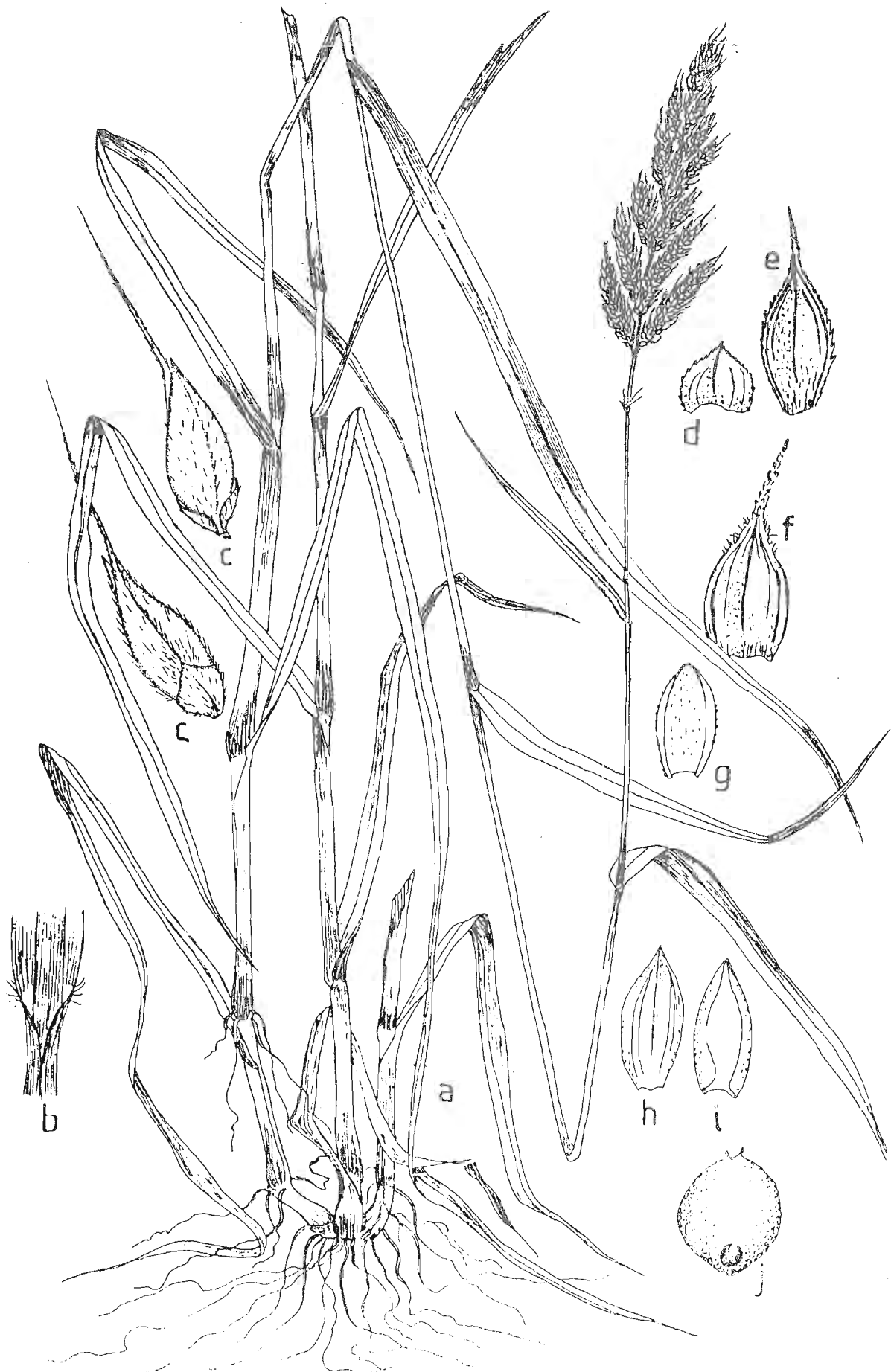


Fig. 27. *Echinochloa crus-galli* (L.) Beauv.

28. ELEUSINE INDICA

Family: Poaceae (Gramineae)

Botanical Name: Eleusine indica (L.) Gaertn.

Vernacular Names: Bela-thana (S), Goose-grass (E)

Description:

Annual, very strongly tufted with fibrous root masses, often tillering with erect or ascending culms showing rooting at nodes. Culms 50-60 cm tall, often flat on soil, strongly laterally compressed, glabrous, branched. Leaves distichous, leaf sheaths strongly compressed with winged-keeled back, short pubescent; blades linear-lanceolate with acuminate tips, 12-40 cm by 4-10 mm, green. Inflorescence composed of 2-12 erect, patent spikes, of which 2-7 are terminal and digitately arranged, the others lower down often solitary; spikes 3-17 cm long, axis straight, spikelets at the ventral side of spike axis, alternately left and right, solitary, sessile, strongly laterally compressed; Spikelets consisting of 3-7 bisexual flowers, 4-7 mm long, glumes without awns. Caryopsis ellipsoid, 1.5 mm long, brownish.

Propagation: by caryopsis (seed)

Ecology: In sunny or somewhat shaded moist sites; in lawns, grasslands, roadsides and arable lands. Very common on rice-field bunds and upland rice-fields.

Distribution: Pantropical. Also widely distributed in Sri Lanka in the low-country Wet or Dry Zones, up to 1500 m altitude.

Agricultural Importance: A major weed of rice-field bunds, but not of wetland fields.

Figure 28: a. Habit (x 1); b. ligule (x 5); c. part of spike (x 10); d. spikelet (x 15); e. lower (G1) and upper (G2) glumes; f. lemma (L); palea (P); h. flower; i. caryopsis



Fig. 28. *Eleusine indica* (L.) Gaertn.

29. ERAGROSTIS UNIOLOIDES

Family: Poaceae (Gramineae)
Botanical Name: Eragrostis unioloides (Retz.) Nees ex Steud.
Synonyms: Poa unioloides Retz.

Description:

Annual grass often forming large tufts and extensive fibrous root system. Culms erect, ascendent or often decumbent below with rooting at nodes, purplish, 10-60 cm tall. Leaf sheaths split, greenish often with purple striations, ligule a fringe of hairs; blade linear, broad or rounded at base, acute tip, 3-20 cm by 2-10 mm. Inflorescence a terminal loose, erect panicle 2-20 cm long with a thin rachis and many branches, lower branches up to 8 cm long; Spikelets on 1-1.5 mm long pedicels, strongly compressed, ovate-oblong, 2-10 mm long, many flowered, usually reddish or purplish, lower florets all fertile. Caryopsis brownish, ovoid in shape.

Propagation: by caryopsis (seed).

Ecology: Generally found in sunny or slightly shaded somewhat moist sites; along drains and irrigation canals; not found in lawns, grasslands, roadsides. A very common grass often found growing with other grasses on rice-field bunds and upland rice-fields.

Distribution: Pantropical. Widely distributed in Sri Lanka, mainly in the low-country Wet Zone, up to 1000 m altitude.

Agricultural Importance: One of the chief components of the weed-flora found on rice-field bunds, but not a major weed in the wetland field habitat.

Figure 29: a. Habit (x 1/2); b. ligule (x 10); c. spikelet (x 10); d. lower glume (G1); e. upper glume (G2); f. lemma (L); g. palea (P); h. flower; i. caryopsis (x 40)

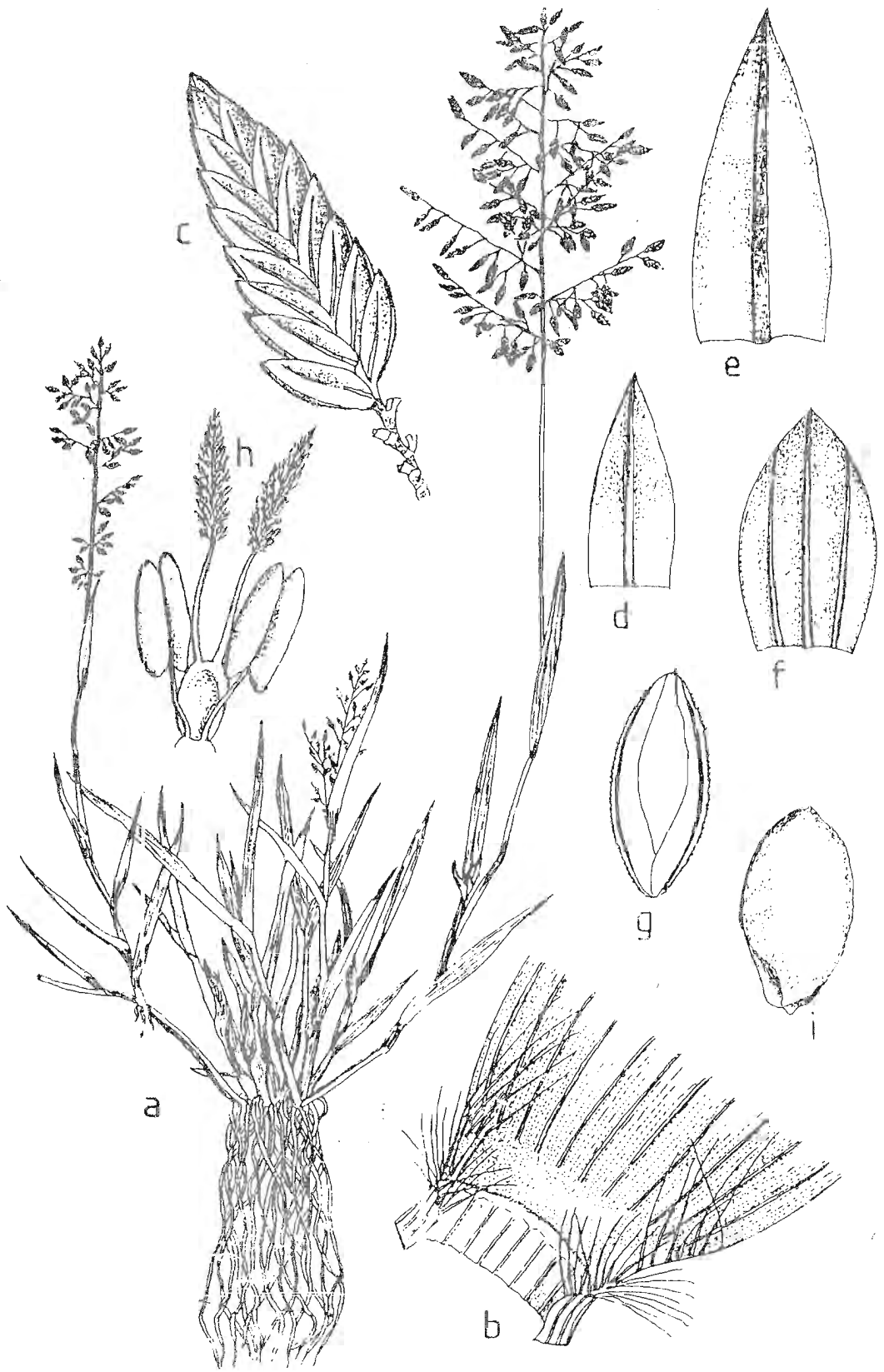


Fig. 29. *Eragrostis unioides* (Retz.) Nees ex Steud.

30. ISACHNE GLOBOSA

Family: Poaceae (Gramineae)
Botanical Name: Isachne globosa (Thunb.) O.Kuntze
Synonyms: Isachne australis R. Br.
Vernacular Names: Bata-della (S)

Description:

Tusfted perennial, creeping grass with lower part of culms stolon-like and rooting at nodes, producing erect (20-50 cm tall) or scrambling branches, which may be 80-100 cm long. Often forming mats or cushions. Culms leafy throughout, sheaths 2-3 cm long; ligule a row of white hairs; blade oblong-lanceolate, 2-10 cm by 3-10 mm; base broad rounded with acute tip, glaucous-green above or on both surfaces, glabrous or minutely pilose; main nerves usually visible on the lower surface. Inflorescence a terminal, erect, rather stiff, 4-15 cm long panicle with many spikelets; Spikelets globose, 2-3 mm long, not awned, yellow-greenish, 2-flowered, lower floret male or bisexual, the upper floret female or bisexual. Caryopsis flat-convex, covered by hardened glumes, 1-1.5 mm long.

Propagation: caryopsis (seed), also by fragments rooting at nodes.

Ecology: Widespread and very common in everwet, or slightly moist ground in open places, soggy or swampy areas, along drains and ditches or on borders of pools, in sunny or slightly shaded places. Very common in lowland, irrigated or rainfed-rice, also on rice-field bunds.

Distribution: South Asia. Widely distributed in Sri Lanka, mainly in the low-country Wet Zone, up to 1200 m altitude.

Agricultural Importance: A most serious weed of rice-fields in Sri Lanka; found abundantly on rice-field bunds, and stepping into the flooded fields whenever possible forming large cushions or mats of grass; may dominate abandoned or neglected fields often forming massive infestations.

Figure 30: a. Habit (x 1/2); b. ligule (x 10); c. part of inflorescence; c1. spikelet showing lower bisexual floret; d. spikelet- enlarged (x 20); d1. spikelet- dorsal view; e. lower glume (G1); f. upper glume (G2); g. lower lemma (L1); h. lower palea (P1); i. upper lemma (L2); j. upper palea (P2); k. lower male floret; l. caryopsis (x 10)

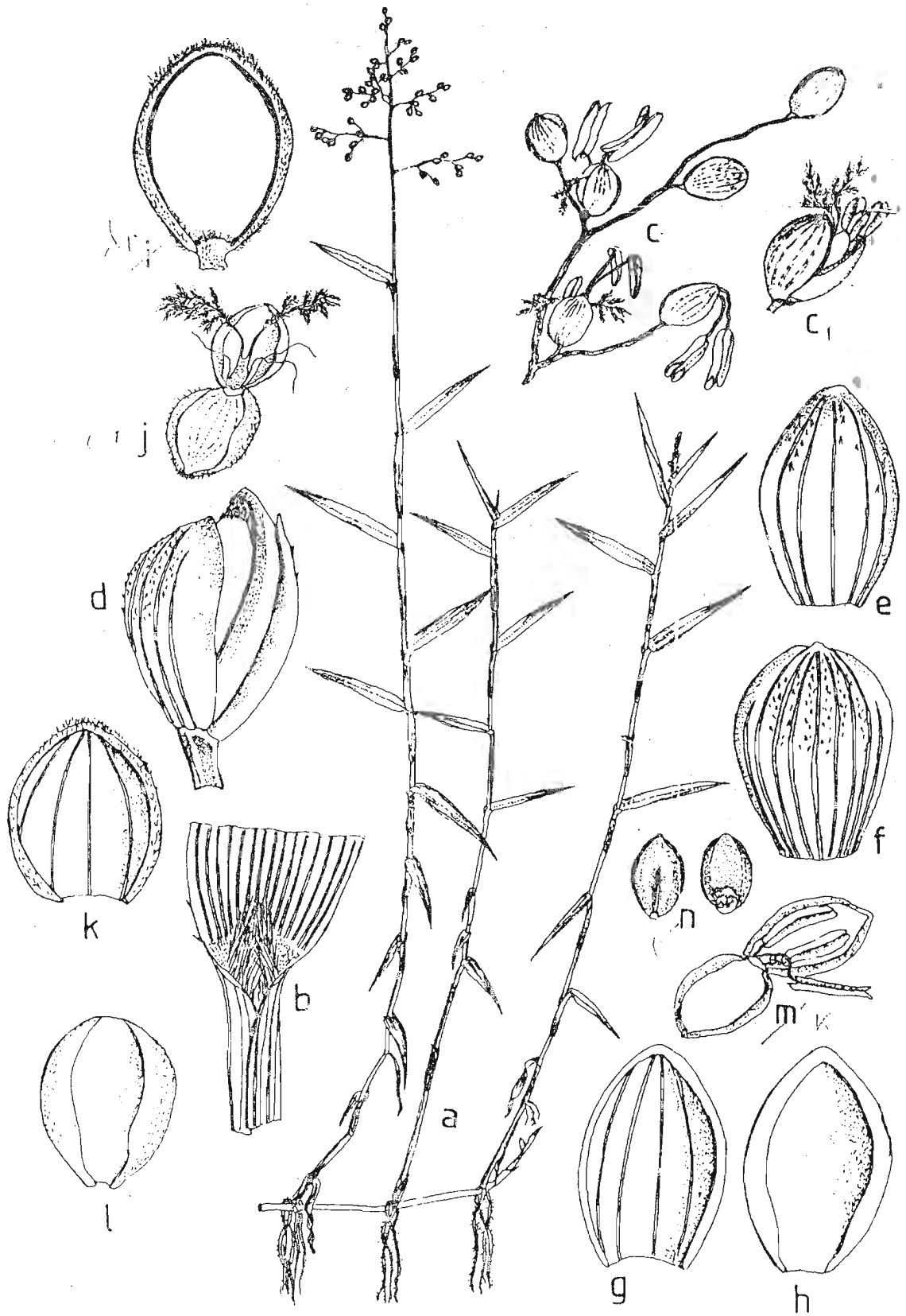


Fig.30. *Isachne globosa* (Thunb.) Kuntze

31. ISCHAEMUM RUGOSUM

Family: Poaceae (Gramineae)

Botanical Name: Ischaemum rugosum Salisb.

Vernacular Names: Lokkan-Nattan (S), Kudu-Kedu (S)

Description:

Perennial, but usually annual because of desiccation of site, with erect or ascendent strongly branched culms, 10-120 cm long. Culms solid, cylindrical-compressed. Leaf sheaths usually loose with long auricled top; ligule a brownish membrane; blades linear with a narrowed or somewhat rounded base, acute tips, 8-40 cm by 6-40 mm. Inflorescence composed of pair of terminal spikes, 2-12 cm long, often strongly pressed against one another, thus simulating a single spike; each axis nodes of spike bearing a sessile and a stalked spikelet. Sessile spikelet 5-6 mm long, 2-flowered, the lower flower male or sterile, the upper bisexual; Glumes very hard with prominent transverse ridges, Upper lemma with 12-20 mm long awn, Caryopsis ovoid, brown, 2 mm long. Pedicelled spikelet 2-5 cm long either well developed or having only glumes which are slightly awned, and with transverse ridges.

Propagation: by caryopsis (seed)

Ecology: Common in periodically wet or soggy sites, on innundated or fallow fields; often abundant in lowland irrigated, rainfed rice-fields.

Distribution: Tropical Asia, tropical America, West Africa and Pacific islands. Widely distributed in Sri Lanka in the low-country Wet or Dry Zones, up to medium altitudes.

Agricultural Importance: A very serious and major weed of rainfed or irrigated rice-fields of Sri Lanka. A mimic of rice in its seedling stage, thus evading early detection.

Figure 31: a. Habit (x 1); b. ligule (x 5); c. sessile and pedicelled spikelet pairs; d. sessile spikelet with glumes pulled out; d. spikelet- lateral view; e. lower lemma (L1) and lower palea; f. upper floret; g. upper lemma (L2); h. stamens (x 40); i. caryopsis (x 40)



Fig. 31. *Ischaemum rugosum* Salisb.

32. ISCHAEMUM TIMORENSE

Family: Poaceae (Gramineae)

Botanical Name: Ischaemum timorense Kunth

Synonyms: Ischaemum tenellum Roxb.
Andropogon timorensis Steud.
Andropogon blumii Nees ex Steud.

Description:

Annual, with ascending to erect habit, solid culms, 40-100 cm long, creeping stems with rooting at nodes and base; nodes with a whorl of long white hairs. Leaf sheaths pillose; Ligule short, membrane-like; blades linear to lanceolate with an obtuse base, acute tips, 2-10 cm by 2-15 mm, blades of uppermost leaves often very small. Inflorescence composed of pair of terminal spikes, 2-8 cm long, often strongly pressed against one another, thus simulating a single spike; each axis node of spike bearing a sessile and a stalked spikelet; spikelets green or tinged with purple. Sessile spikelet 5-6 mm long, 2-flowered, the lower flower male or sterile, the upper bisexual; Outer (lower) Glume broadly ovate with an acuminate tip divided into 2 teeth; Upper lemma with a 10-15 mm awn in the middle. Pedicelled spikelet with stalk 3 mm long, spikelet 5-8 mm long, 2-flowered, the lower male, upper bisexual; Upper lemma with 6-10 mm awn. Caryopsis ellipsoid, brown, 1 mm long.

Propagation: by caryopsis (seed)

Ecology: Common in periodically wet or soggy grasslands, on inundated or fallow fields; often abundant along ditches, irrigation canals, and on bund in lowland rice-fields.

Distribution: Tropical Asia. Widely distributed in Sri Lanka in the low-country Wet or Dry Zones, up to medium altitudes.

Agricultural Importance: A common weed of the bunds of rice-fields of Sri Lanka, but not a major weed in the field habitat.

Figure 32: a. Habit (x 1); b. ligule (x 5); c. part of spike (x 20);
c1. sessile and pedicelled spikelet pair; d. sessile spikelet-
opened; d1. flower; e. lower glume (G1); f. upper glume (G2);
g. upper lemma (L2) with awn; h. lower lemma (L1); i. upper
palea (P2); j. caryopsis- two views (x 20)

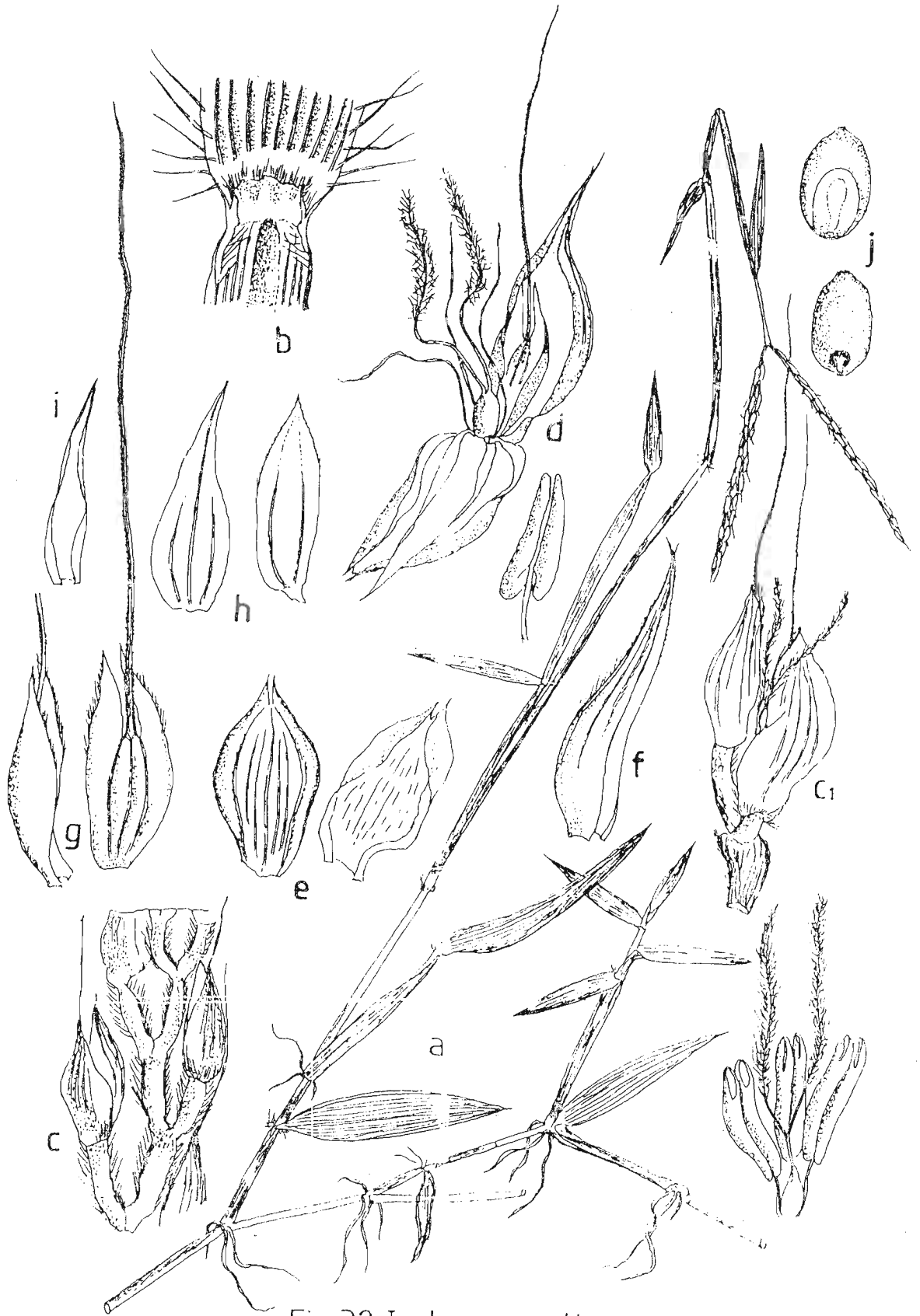


Fig.32. *Ischaemum timorense*

33. LEERSIA HEXANDRA

Family: Poaceae (Gramineae)

Botanical Name: Leersia hexandra Sw.

Synonyms: Leersia abyssinica A. Rich.
Leersia ciliata Roxb.

Vernacular Names: Levu (S) (=Layoo); swamp-ricegrass (E)

Description:

Tall, Perennial, tufted, aquatic swampy grass with creeping rhizomes. Culms rooting in mud, often with floating branches, erect, ascending, 25-120 cm high, slender, hollow. Leaf sheaths markedly thickened with cuff-like base (sheath-node) which is densely pilose; ligule 4-9 mm long; leaf blades linear with narrowed base, tapering acute apex, bluish-green, 3-30 cm by 2-10 mm wide. Inflorescence composed of a slender terminal panicle, 5-12 cm long, laxly-branched or contracted, bearing pedicillate, laterally-compressed spikelets. Spikelets consisting of only one bisexual floret. Caryopsis free, completely enclosed by hardened lemma and palea.

Propagation: stolons, rhizomes, caryopsis (seed)

Ecology: Mainly in permanently wet sites, swamps, soggy grasslands, often on the banks of ditches, drains or irrigation canals. Common on borders of wetland rice-fields and bunds and upland rice-fields.

Distribution: Pantropical. Also widely distributed in Sri Lanka in the low-country Wet or Dry Zones, up to medium altitudes.

Agricultural Importance: A less serious weed of the rice-field habitat in Sri Lanka, although it is known to be a serious weed of rice in other rice-growing countries, which can often grow in drains impeding the flow of water.

Figure 33: a. Habit (x 1/2); b. ligule (x 10); c. node; d. part of panicle; e. spikelet (x 40); f. lemma (L); g. palea (P); h. flower

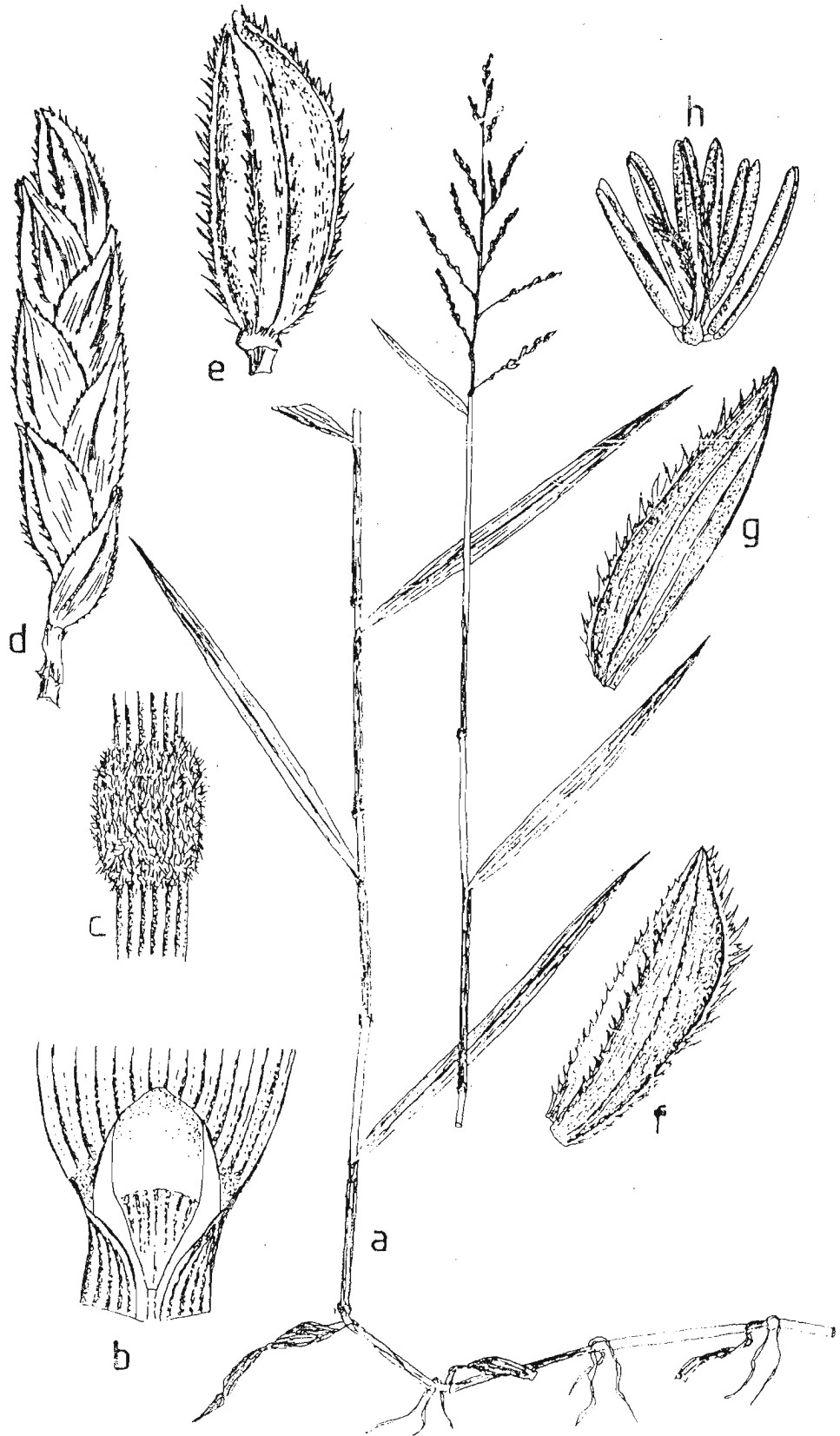


Fig.33. *Leersia hexandra* Sw.

34. LEPTOCHLOA CHINENSIS

Family: Poaceae (Gramineae)

Botanical Name: Leptochloa chinensis (L.) Nees

Vernacular Names: Red-sprangletop (E)

Description:

Tufted, slender annual (or perennial) grass. Culms 50-120 cm tall, erect, with culm bases often reclining and rooting at nodes, culms glabrous, hollow and leafy. Leaf sheaths loose, 4-8 cm long; ligule membranous, 2 mm long; blades linear, flat 5-25 cm by 4-8 mm, with minute bristles on upper acute margin. Inflorescence a 10-40 cm long, terminal loose panicle with many branches (spikes) which are up to 10 cm long; main axis thin; spikes often solitaru or 2-4 together; spikes shortly pedicelled, bearing subsessile double row of spikelets; Spikelets consisting of 4-5 bisexual florets, purplish, glumes persistent ovate-oblong, minutely bristly. Caryopsis brown, ellipsoid, 0.8 mm long.

Propagation: stolons, caryopsis (seed)

Ecology: Common in everwet and swampy or innundated sites, in sunny or shaded places; in and along soogy grasslands, drains and ditches. Common in rice-fields irrigated or rain-fed.

Distribution: In South and South-East Asia. Distributed in Sri Lanka in the low-country Wet Zone, up to medium altitudes.

Agricultural Importance: Not a major weed of rice-fields, but it can grow profusely on waterlogged fields and bunds, and in soggy neglected fields.

Figure 34: a. Habit (x 1); b. ligule; c. part of spike-like raceme; d. lower glume (G1); e. upper glume (G2); f. lemma (L); g. palea (P); h. flower; i. caryopsis (x 5)



Fig. 34. *Leptochloa chinensis* (L.) Nees

35. ORYZA RUFIPOGON

Family: Poaceae (Gramineae)

Botanical Name: Oryza rufipogon Griff.

Synonyms: Oryza sativa L. forma spontanea Back
Oryza fatua Koen. ex Trin.

Vernacular Names: Uru-Wee (S); Red-rice (E)

Description:

A Perennial, tufted, creeping grass with lower stems floating in shallow water and rooting at nodes, upper stems erect to sub-erect, 15-150 cm tall, leafy. Leaf sheaths loose, cylindrical, glabrous with distinct auricles at junction with blade; ligule membranous, leaf-like with pointed tip; blades linear, apex acute, scabrid on margins and main nerves, 15-75 cm long by 10-25 mm. Inflorescence terminal, panicle, up to 20 cm long, well-exserted, initially concealed in spathe-like sheath of uppermost leaf, later emerging fully; main axis, slender, compressed laterally, branches angular; Spikelets many, always awned, each on a 2 mm long pedicel, containing one bisexual flower; Glumes lanceolate, straw-coloured, lemma boat-shaped, 7 mm long, awn (up to 7 cm long) formed by lemma, both lemma and palea bristly; Caryopsis broadly elliptic, enclosed by stiff lemma and palea.

Propagation: By caryopsis (seed).

Ecology: Around pools, ditches, drains, irrigation canals and other sites with stagnant or slow-running water; occasionally found in the rice-fields close to border with bunds, mainly in lowland irrigated rice.

Distribution: Pantropical. Also widely distributed in Sri Lanka in the low-country Wet Zone.

Agricultural Importance: A minor weed of the rice-field habitat, not known to cause much concern to farmers in Sri Lanka. However, in America, it is considered a serious weed, because it crosses in nature with improved rice cultivars.

Figure 35: a. Habit (x 1/4); b. ligule with auricles; c. spikelet- two views; d. lower glume (G1); e. upper glume (G2); f. lemma (L) (without awn); g. palea (P); h. flower

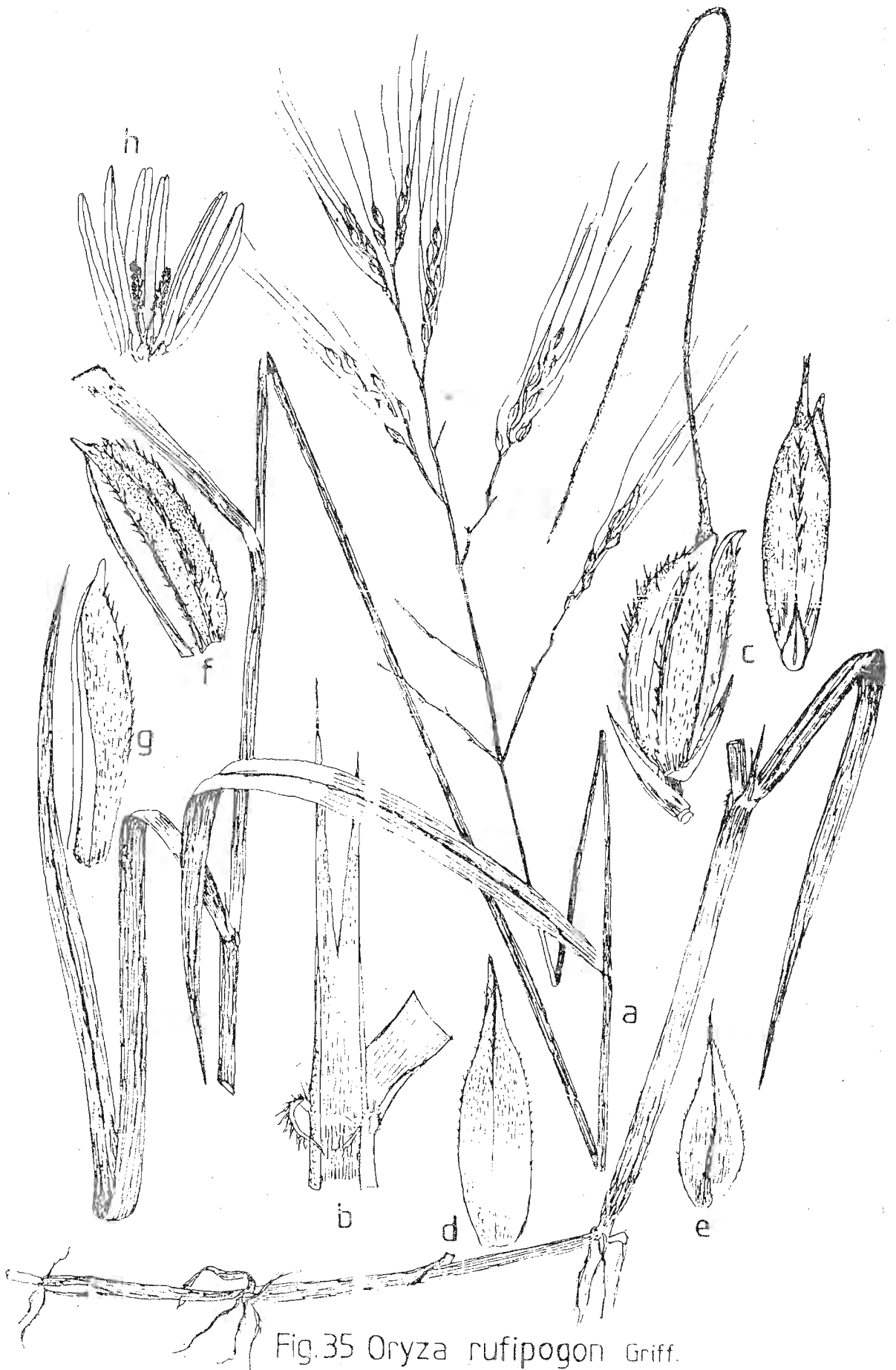


Fig.35 *Oryza rufipogon* Griff.

36. PANICUM REPENS

Family: Poaceae (Gramineae)

Botanical Name: Panicum repens L.

Vernacular Names: E-tora (S), Couch-grass (E), Torpedo-grass (E)

Description:

Perennial, rhizomatous grass with 30-100 cm tall culms arising from strong, white, deeply buried rhizomes; rhizomes often forming an extensive subterranean system with many branches, irregularly thickened parts, and torpedo-like sharply pointed rhizome apices; Culms leafy, decumbent, rooting at base, hollow. Leaf sheaths with long-ciliate margins; ligule 0.5 mm, membranous; blades linear-lanceolate (rolling when dry) with rounded base, apex acute, pilose above, glabrous on underside, 5-25 cm long by 3-15 mm, midrib prominent. Inflorescence an open panicle, 5-20 cm long, with ascending primary, secondary and even tertiary branches, lower ones 2-20 cm long; Spikelets solitary, pedicelled, oblong-acute, up to 3.5 mm long, pale-green, often with purple tinge, consisting of 2 florets, lower floret male, upper floret bisexual. Caryopsis is almost sterile.

Propagation: By rhizome fragments.

Ecology: In everwet or slightly wet or periodically moist areas, in sunny or shaded places; prefers sandy loose soils, but can grow in heavy upland soils as well; in lawns, wastelands, grasslands, roadsides, cropping-fields, plantations, playing-fields. A gregarious grass. Common in the rice-field habitat, mainly on the bunds and in upland rice-fields.

Distribution: Pantropical. Also widely distributed in Sri Lanka in the Wet Zone and in up-country, from 0-1500 m altitude.

Agricultural Importance: A major weed of rice-field bunds, and occasionally in wetland fields. This grass can form dense infestations which are difficult to control in abandoned or neglected fields, around tanks, ponds or stream banks, affecting access to water and water distribution. A very serious weed in upland terrestrial conditions as well, such as in tea and coconut plantations in Sri Lanka.

Note: Although the plant produces very conspicuous panicles, seeds are usually not set.

Figure 36: a. Habit (x 1/4); b. ligule (x 10); c. part of panicle, d. spikelet- opened; d1. upper (G2) and lower glume (G1); e. upper lemma (L2); f. lower palea (P1) and lemma (L1); g. upper bisexual flower; h. flower; i. lower male flower

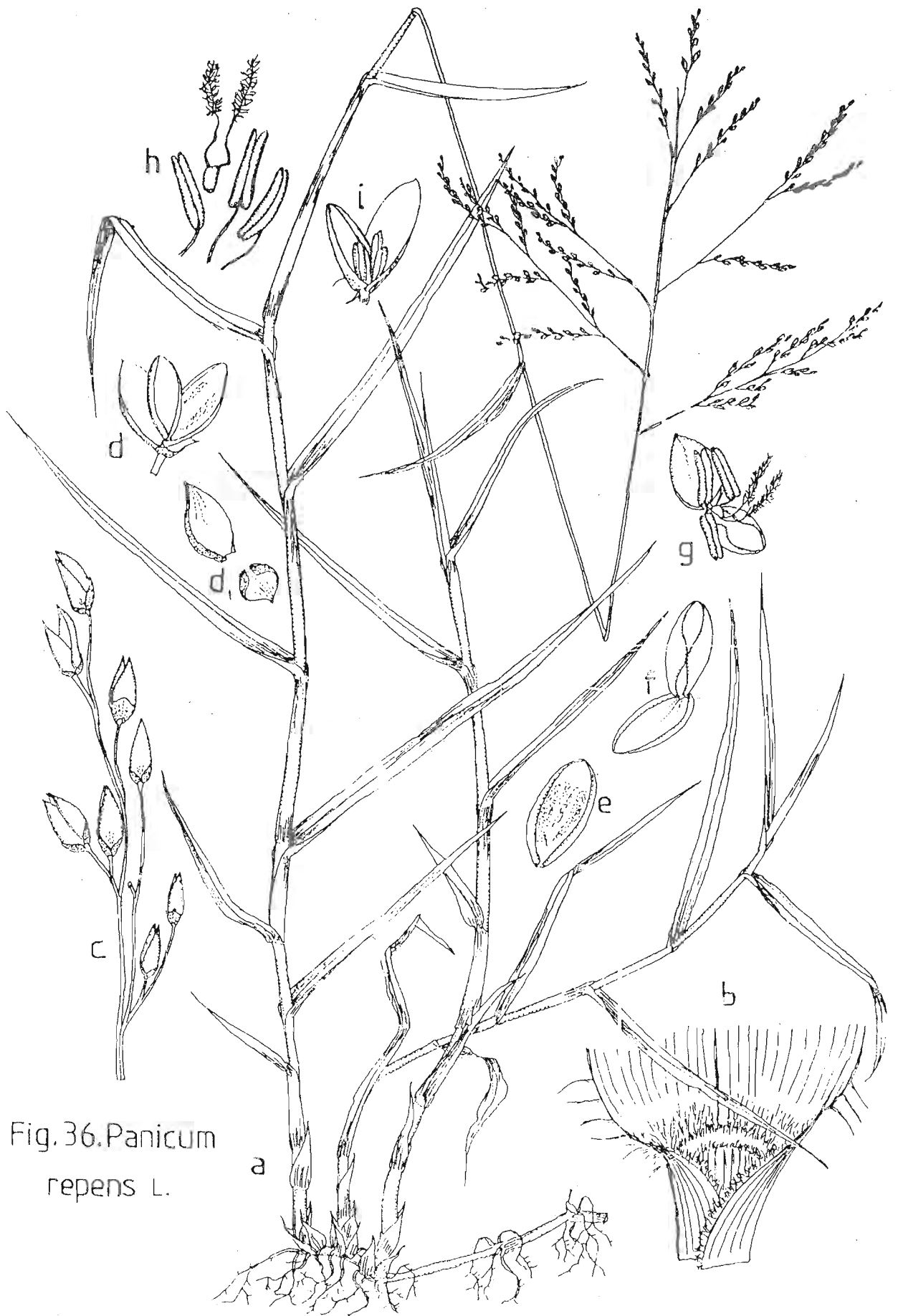


Fig. 36. *Panicum repens* L.

37. PASPALUM COMMERSONII

Family: Poaceae (Gramineae)

Botanical Name: Paspalum commersonii Lamk.

Synonyms: Paspalum scrobiculatum L.
var. commersonii (Lamk.) Stapf

Description:

Perennial, loosely tufted, erect or decumbent culms, rooting at nodes, never long-creeping; Culms 20-80 cm tall, hollow, glabrous, strongly compressed, leafy. Leaf sheaths up to 5 cm, with hairs; ligule 0.5-3 mm long, membranous; junction of sheaths and blades hairy; blades linear, narrow (2-15 mm wide), 15-30 cm long, with somewhat broad base, tapering to an acute apex, glabrous except near sheath junction. Inflorescence terminal, consisting of 2-12 raceme-like spikes, 1-9 cm long; Spikelets elliptic to spherical, 2-2.5 mm long, flattened, dark brown in colour, situated in 2 closely set rows, pedicelled, bearing 2 florets, lower floret male, upper floret bisexual. Caryopsis is orbicular.

Propagation: caryopsis (seed)

Ecology: In everwet or slightly wet or periodically moist areas; Common in the rice-field habitat, mainly on the bunds and on the boundaries of wetland fields.

Distribution: Pantropical. Also widely distributed in Sri Lanka in the low-country Wet Zone up to medium altitudes.

Agricultural Importance: A common weed of rice-field bunds, but not of wetland fields, rarely if ever becoming a nuisance.

Figure 37: a. Habit (x 1/2); b. ligule (x 10); c, cl. part of spike-like raceme; d. spikelet- opened; e. upper glume (G2); f. lower glume (G1); g. lower lemma (L1); h. lower palea (P1); i. upper lemma (L2); j. upper palea (P2); k. flower; l. caryopsis (x 10)

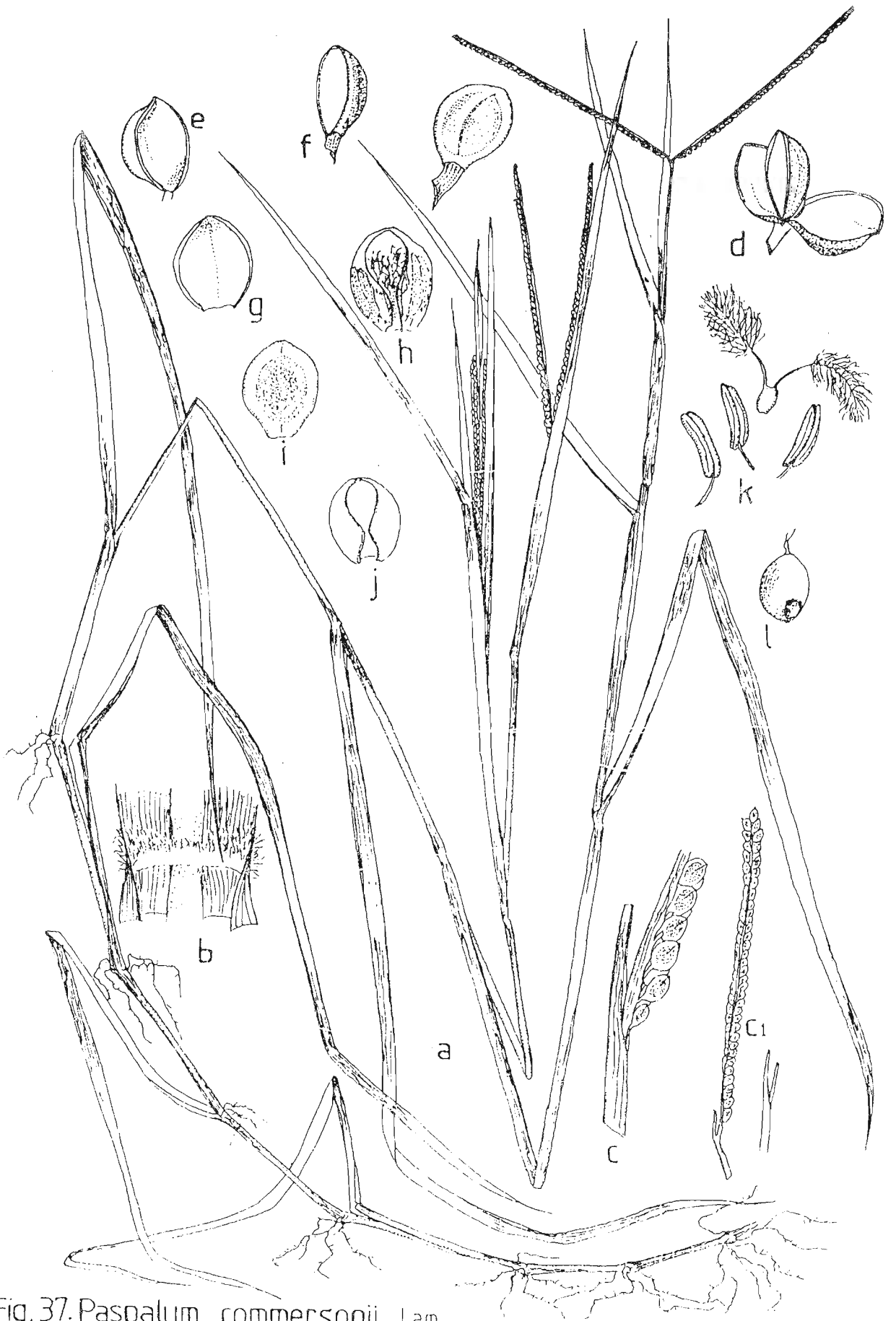


Fig. 37. *Paspalum commersonii* Lam.

38. PASPALUM CONJUGATUM

Family: Poaceae (Gramineae)

Botanical Name: Paspalum conjugatum Berg.

Vernacular Names: Buffalo-grass (E)

Description:

Perennial, tufted, creeping grass with long stolons, rooting at hairy nodes from which culms arise. Culms erect or scrambling, compressed, 30-80 cm tall, glabrous, leafy. Leaf sheaths keeled-compressed, green or purplish, 3-5 cm long, mostly glabrous; ligule 0.5 mm, membranous; blades linear-lanceolate with attenuate base, apex acute, glabrous or sparingly hairy above, glabrous on underside, 5-25 cm long by 5-15 mm. Inflorescence terminal, consisting of 2 subopposite initially erect, later patent, 3-15 cm long racemes; Spikelets solitary, pedicelled, broadly elliptic, imbricate in one row, compressed, 2 x 1.5 mm long, with one bisexual floret. Caryopsis broadly ellipsoid, yellowish-brown.

Propagation: By caryopsis (seed) and stolon fragments.

Ecology: On not too dry, wet or slightly wet or periodically moist areas, in sunny or shaded places; in lawns, wastelands, grasslands, roadsides, cropping-fields, plantations, often forming dense masses. Common on rice-field bunds and in upland rice-fields.

Distribution: Pantropical. Also widely distributed in Sri Lanka in the low-country Wet Zone and in up-country, from 0 up to 1500 m altitude.

Agricultural Importance: A major weed of rice-field bunds, but not of wetland fields. However, this grass can form dense infestations which are difficult to control in other cropping-fields and plantations, such as rubber and coconut.

Figure 38: a. Habit (x 1/2); b. ligule (x 10); c. cl. part of spike-like raceme; d. spikelet; e. lower glume (G1); f. upper glume (G2); g. lower lemma (L1); h. lower palea (P1); i. upper lemma (L2); j. upper palea (P2); k. flower; l. caryopsis (x 10)



Fig.38. Paspalum conjugatum Berg.

39. SACCIOLEPIS INDICA

Family: Poaceae (Gramineae)
Botanical Name: Sacciolepis indica (L.) Chase
Synonyms: Hymenachne indica (L.) Buese.

Description:

Annual, more or less creeping grass with few tillers (if any), basal stem areas reclining and rooting at nodes, from which erect or ascendent stem arises. Culms cylindrical, hollow, glabrous, 20-50 cm tall. Leaf sheaths, mostly glabrous, shorter than internodes; ligule very short, 0.5 mm, membranous; blades linear-lanceolate with obtuse base, acute apex, glabrous or sparingly hairy, 5-25 cm long by 3-8 mm. Inflorescence terminal, spike, cylindrical, branched on all sides, compact and dense, 1-15 cm x 5 mm, each branch with a double row of closely packed, pedicelled spikelets; Spikelets broadly elliptic, compressed, 2-4 mm long, each containing two florets, upper one bisexual, lower one male or sterile. Caryopsis free and compressed.

Propagation: By caryopsis (seed).

Ecology: On not too dry, wet or slightly wet or periodically moist areas, in sunny or shaded places; in moist grasslands, fallow lands, along the banks of ditches, drains and irrigation canals. Common on rice-field bunds.

Distribution: Mostly Asia and Africa. Throughout Sri Lanka, mainly in the low-country Wet Zone and in up-country, from 0 up to 1000 m altitude.

Agricultural Importance: A weed of minor importance, although very common on rice-field bunds.

Figure 39: a. Habit (x 1); b. ligule (x 10); c. part of inflorescence; d. spikelet (x 20); e. spikelet- opened showing flower; f. lower glume (G1); g. upper glume (G2); h. lower lemma (L1); i. upper lemma (L2); j. upper palea (P2); k. caryopsis (x 20)

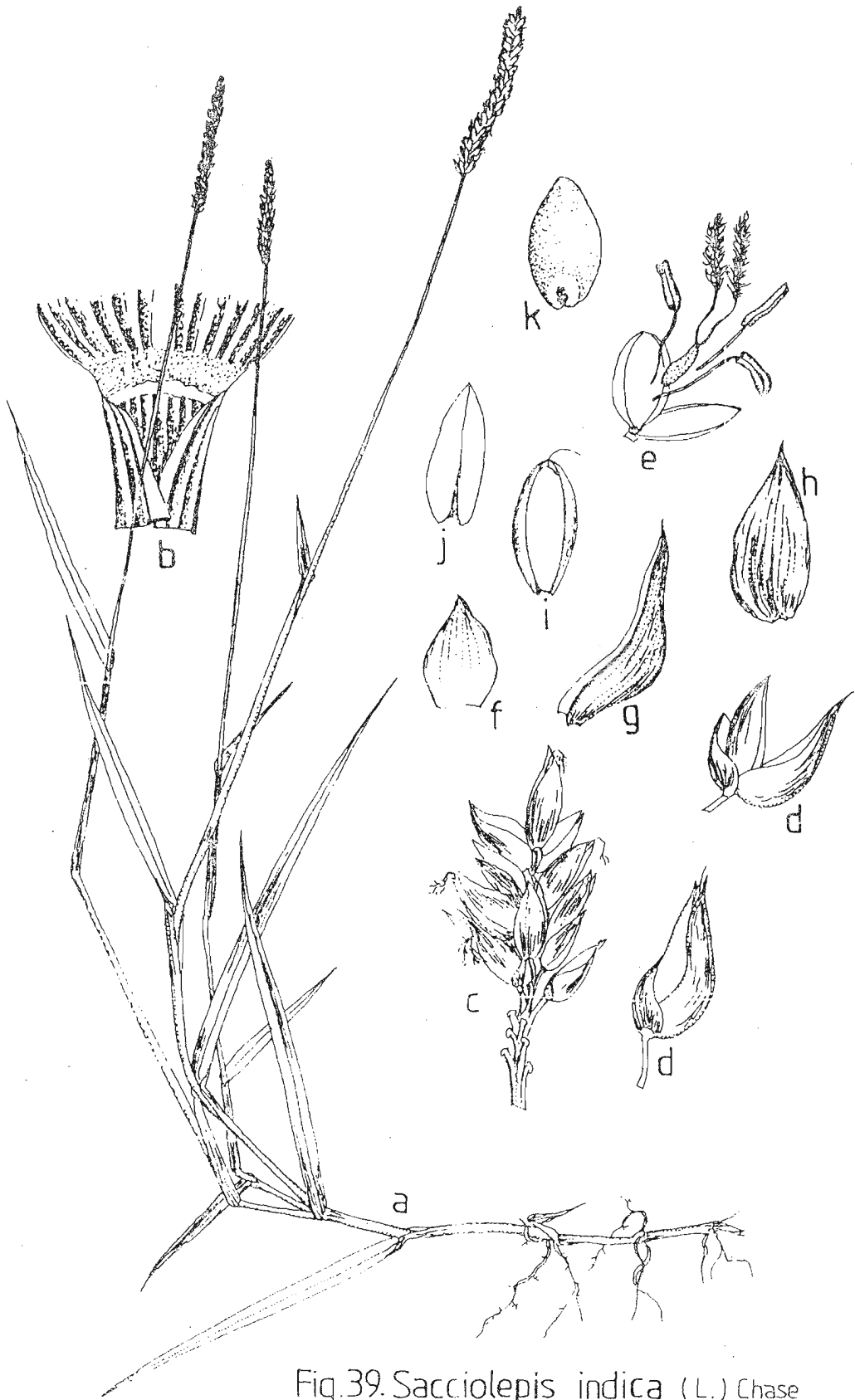


Fig.39. *Sacciolepis indica* (L.) Chase

40. SACCIOLEPIS INTERRUPTA

Family: Poaceae (Gramineae)
 Botanical Name: Sacciolepis interrupta (Willd.) Stapf
 Synonyms: Panicum interruptum Willd.
Hymenachne interrupta (Willd.) Buese

Description:

Perennial, creeping or floating grass with long stolons, rooting at nodes from which culms may arise. Tips of culms always erect, 50-120 cm tall, hollow, base swollen, often purplish-red, 10-15 mm diameter, glabrous, leafy. Leaf sheaths greenish-yellow or purplish, 5-6 cm long, mostly glabrous; ligule 1.5-3 mm, membranous; blades linear-lanceolate with broad base, apex acute, glabrous, 15-40 cm long by 7-20 mm. Inflorescence terminal, a very slender panicle, forming a pseudo-spike, 15-40 cm long with short, thin, branches which are adnate and decurrent with main axis; Spikelets 2 or more together, 3- 3.5 mm long, with one bisexual flower, elliptic or ovate. Caryopsis broadly elliptic, free between not hardened lemma and palea, compressed, 2 mm long.

Propagation: By caryopsis (seed) and stolon fragments.

Ecology: On wet or slightly wet or periodically moist areas, in swamps, stagnant water-pools, along ditches and drains; often gregarious. Common in lowland rice-fields and bunds.

Distribution: From West Africa to South East Asia and China. Also widely distributed in Sri Lanka in the low-country Wet Zone up to medium altitudes.

Agricultural Importance: An important weed of rice-fields and their bunds.

Figure 40: a. Habit (x 1/2); b. ligule (x 5); c. part of inflorescence; d. spikelet- several views (x 20); d1. spikelet- opened; e. lower glume (G1); f. upper glume (G2); g. lower lemma (L1); h. lower palea (P1); i. upper lemma (L2); j. upper palea (P2); k. caryopsis (x 10)



Fig. 40. *Sacciolepis interrupta* (Willd.) Stapf

41. AESCHYNOMENE INDICA

Family: Fabaceae
Botanical Name: Aeschynomene indica L.
Synonym: Aeschynomene aspera (non L.) Hassk.
Vernacular Name: Vel-Siyambala (S); jointvetch (E)

Description:

Annual or Perennial, erect, strongly branched plant, often woody at base, 50-200 cm. Stems more or less cylindrical and warty. Leaves paripinnate, 3-10 cm long; petiole up to 2 cm long; rachis of compound leaf up to 14 cm long; leaflets in 15-45 pairs, partly-opposite or scattered, linear-oblong, 2.5-10 x 1-4 mm with one median vein, apex obtuse and slightly mucronate, glabrous. Stipules nearly triangular, acute, 8-12 mm long, at base petioles. Flowers papilionate, bisexual, in axillary, 1-4 flowered racemes. Peduncles 3-8 cm long; bracts ovate-oblong, 1.5-4 mm long; pedicel 1.5-5 mm long, apically with oblong sharply serrate, 2-3 mm long bracteoles; calyx 4-5 mm long, bifid, 2 lobed, 3-toothed; petals yellow, standard petal 7-9 mm long, obovate, apex rounded; wing petals obtuse, subequal to keel petal. Stamens 10, in two equal bundles of 5 each. Ovary superior, borne on a 1-3 mm long stalk. Pods oblong, 5 x 50 mm in size, straight or slightly curved, compressed on a 5-10 mm long stalk; composed of 8-10 seeds. Seeds kidney-shaped, brown to black, 2.5 x 3.5 mm.

Propagation: by seeds

Ecology: On moist sunny or shady sites along borders of ditches and drains, near pools or in wet cultivated lands; in wetland rice-fields among rice.

Distribution: Pantropical. Throughout the Wet Zone of Sri Lanka up to medium altitudes.

Agricultural Importance: Although common, a weed of minor importance in Sri Lanka's rice-fields.

Figure 41: a. Habit (x 1); a1. leaflet (x 5); b. stipules (x 5), c. staminal tube with pistil (x 5); d. part of flower; e. flower-ventral view (x 5); f. keel petal; g. wing petal; h. pistil (x 5); i. pod (x 10); j. seed (x 10)

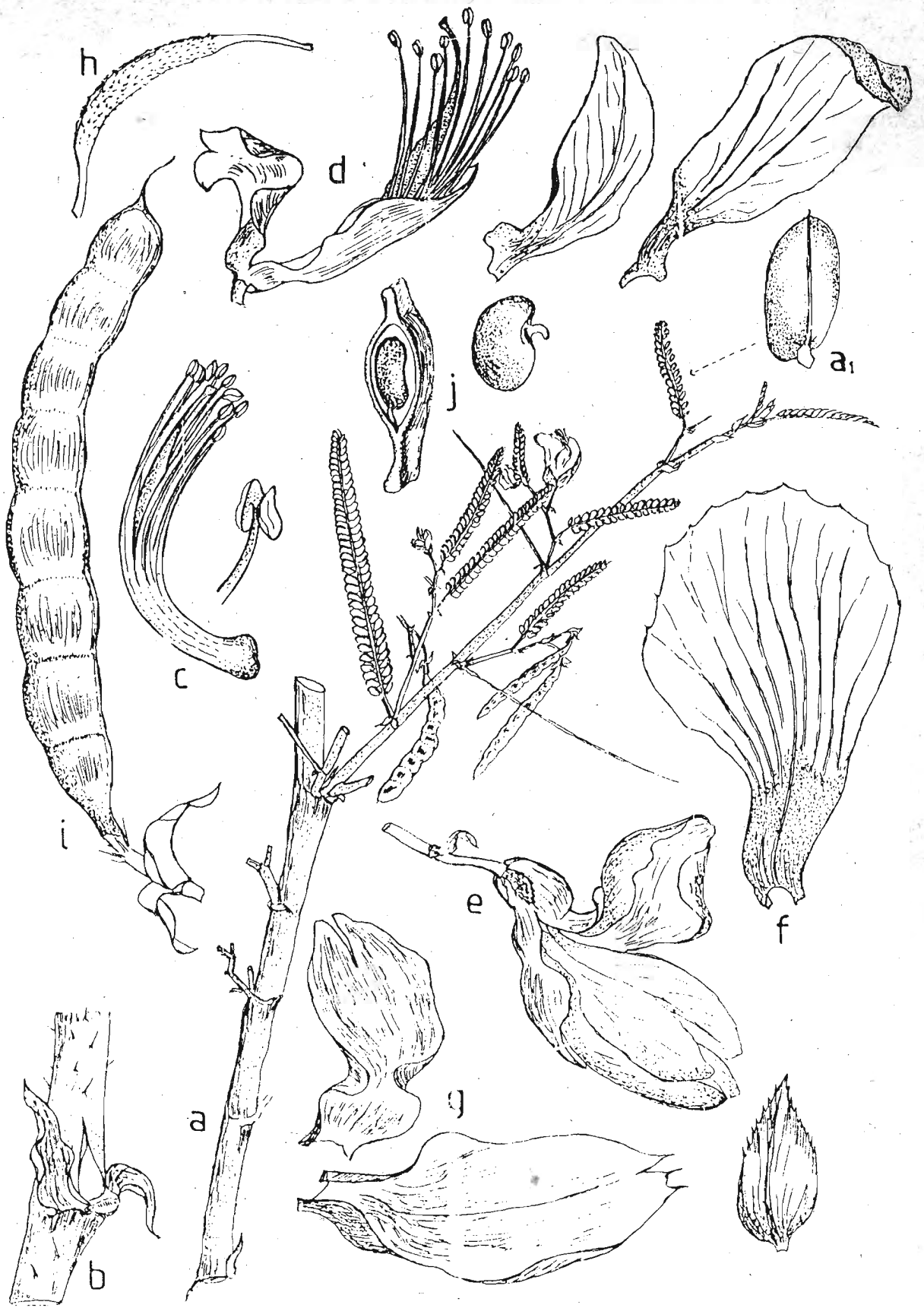


Fig.41. *Aeschynomene indica* L.

42. AGERATUM CONYZOIDES

Family: Asteraceae

Botanical Name: Ageratum conyzoides L.

Vernacular Name: Hulan-thala (S); Goat-weed (E)

Description:

Annual, often strongly branched herb, often decumbent with ascending or erect branches, 30-120 cm tall, with a strong taproot and fibrous roots at base. Stems cylindrical, often green or purplish, densely covered with appressed or patent white hairs. Leaves simple, opposite, ovate to rhomboid-ovate, subcordate or rounded at base, apex acute or obtuse, with serrate or crenate margins, densely pubescent on both sides, 2-12 x 3-6 cm; petiole 1-5 cm long, pilose. Inflorescence a terminal corymb with 4-18 flower heads each 5-7 mm in diam. on erect hairy, peduncles (5-17 mm long); homogamous, containing bisexual disc flowers only; involucre bell-shaped; bracts many, green with a purple or reddish tip, 2-3 seriate, lanceolate with prominent nerves; hypanthium white to purple or bluish-purple; flowers (disc), numerous, dense, inner ones longest, corolla tubular 1- 1.5 mm long, 5 lobed. Achenes brown or dirty-white, 2 mm long, elongated; with short, white hairs at top, pappus comprising of 5 basally connate, lanceolate, long stiff bristles with serrate margins, 3 mm long.

Propagation: by seeds (achenes)

Ecology: On moist or dry areas, sunny or shady sites along borders of ditches and drains, roads, cultivated lands, wastelands; often gregarious forming large masses; in wetland or upland rice-fields mainly on bunds.

Distribution: Pantropical. Throughout the Wet Zone of Sri Lanka up to about 1500 m altitude.

Agricultural Importance: A weed of minor importance in rice-fields, but one of the most troublesome weeds in plantation crops or upland crops after grasses have been suppressed.

Figure 42: a. Habit (x 1); b. flower head (x 10); c. involucral bract (x 15); d. flower (x 15); e. achene with pappus (x 20)



Fig.42. *Ageratum conyzoides* L.

43. BACOPA MONNIERI

Family: Scrophulariaceae

Botanical Name: Bacopa monnieri (L.) Pennell

Vernacular Name: Lunuwila (S)

Description:

Annual creeping much-branched fleshy herb, with erect, ascending branches, 5-50 cm long. Stems solid, glabrous, green, almost cylindrical, with air cavities. Leaves entire, opposite, fleshy, obovate, 10-25 x 4-10 mm, apex rounded, remote or close together. Flowers bisexual, zygomorphic, solitary, axillary; pedicels 5-20 mm long, slender; 2 bracteoles appressed to calyx, ovate-lanceolate; calyx 4-8 mm long glabrous, 5-lobed; corolla white or very pale purple, bilabiate, 10-12 mm long; tube 5-9 mm long; capsule ovoid-oblong, 3-4 mm long, enclosed in calyx. Seeds numerous, ovoid-oblong, 0.6 mm long.

Propagation: by seeds

Ecology: On moist or soggy sunny or shady sites along borders of ditches and drains, banks of ponds, or in soggy grasslands; in wetland rice-fields, both on bunds and in field habitat.

Distribution: In tropical and subtropical Asia. Throughout the Wet Zone of Sri Lanka mainly at low altitudes.

Agricultural Importance: Although common, a weed of minor importance in Sri Lanka's rice-fields.

Note: Known to have medicinal value; also edible

Figure 43: a. Habit (x 1/2); b. flower-lateral view (x 10); c. flower-ventral view (x 10); d. corolla-opened (x 10); e. pistil (x 10); f. capsule (x 15); g. seed (x 40)

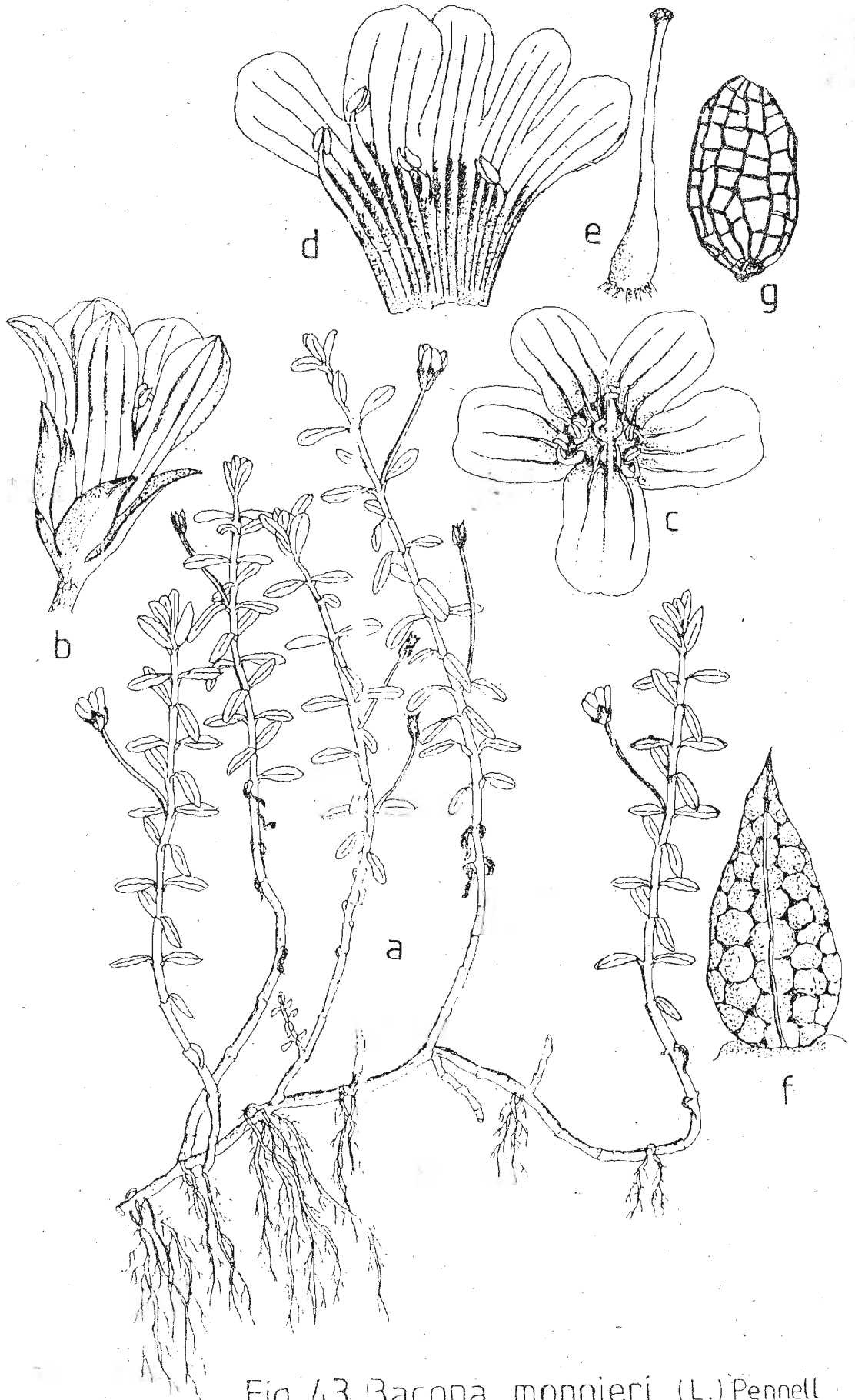


Fig. 43. *Bacopa monnieri* (L.) Pennell

44. DOPATRIUM JUNCEUM

Family: Scrophulariaceae
Botanical Name: Dopatrium junceum (Roxb.) Buch.-Ham. ex Benth.
Synonym: Gratiola juncea Roxb.
Vernacular Name: Bin-savan (S)

Description:

Annual, slender, erect herb, stems with a few erect branches up to 30 cm high, rather thick and spongy towards base, gradually tapering towards apex; Leaves oblong or oblong-oval, entire, opposite, mostly crowded close together at base, 5-14 x 2-4 mm, upper ones distant on the erect branches, much smaller, all parallel-nerved. Flowers bisexual, zygomorphic, solitary, in axils of middle and upper leaves; pedicels 5-10 mm long, very slender; calyx tube 1-1.5 mm long with oval-lanceolate lobes, 5-lobed; corolla purple-blue, bilabiate, tube up to 4 mm long. Perfect stamens 2, staminodes 2. Capsule ellipsoid, 3-4 mm long. Seeds numerous, oblong, 0.5 mm long, longitudinally ribbed, blackish-brown.

Propagation: by seeds

Ecology: On moist or soggy, marshy sites on banks of ponds and tanks, in soggy grasslands; in wetland rice-fields, among rice in the field habitat.

Distribution: In tropical and subtropical Asia. Throughout the Wet Zone of Sri Lanka mainly at low altitudes up to 550 m.

Agricultural Importance: Although common, a weed of minor importance in Sri Lanka's rice-fields.

Figure 44: a. Habit (x 1/4); b. flower-lateral view (x 15); c. flower-ventral view (x 15); d. pistil (x 10); e. capsule (x 15); f. seed- three views (x 40)

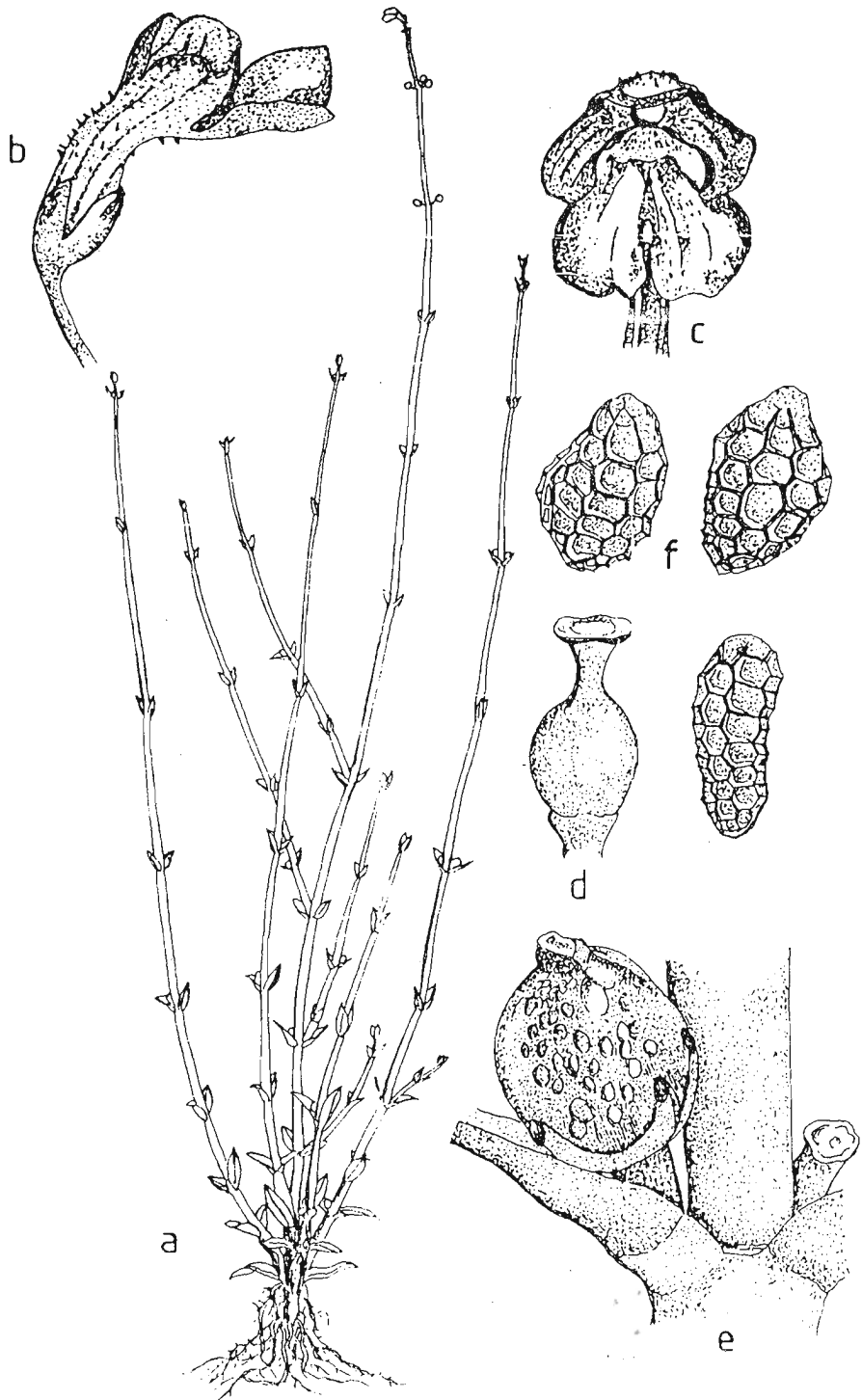


Fig. 4-4. *Dopatrium junceum* (Roxb.) Buch-Ham. ex Benth.

45. ECLIPTA PROSTRATA

Family: Asteraceae
Botanical Name: Eclipta prostrata (L.) L.
Synonym: Eclipta alba (L.) Hassk.
Eclipta erecta L. var. prostrata
Vernacular Name: Ki-Kirindiya (S)

Description:

Annual or short-lived perennial, strongly branched plant, often variable with prostrate or erect branches, 10-60 cm tall, rooting at basal nodes, with taproot. Stems cylindrical, green, purplish or brownish, densely covered with appressed or patent white hairs. Leaves simple, opposite, sessile, lanceolate, elliptic or ovate-oblong, slightly serrate or entire, rather densely pilose, 2-15 x 1-4 cm. Inflorescence, axillary or terminal head, subglobose, 0.5-1 cm in diameter; peduncles 2-8 cm long, pilose; involucre bell-shaped, later widened at base, bracts 5-6, green, biseriate, pilose with white short hairs; elliptic or ovate-oblong; hypanthium convex, light green after fruit drop, covered with numerous filiform 3-4 mm paleas. Ray flowers (marginal) numerous, female or neutral, corolla white, 2-3 mm long. Disc flowers bisexual, numerous, corolla white, 1.5-2 mm long with short tube. Achenes brown or black, compressed, 2-3 mm long, elongated; with short, white hairs at top, pappus hairs absent; achenes of ray flowers smaller, triangular and often sterile.

Propagation: by seeds (achenes)

Ecology: On moist poorly drained wet areas, sunny or shady sites along borders of ditches and drains, in wet cultivated lands; in wetland rice-fields on bunds as well as among rice.

Distribution: Pantropical. Throughout the Wet Zone of Sri Lanka up to about 1500 m altitude.

Agricultural Importance: A weed of considerable importance in Sri Lanka's low-country rice-fields, particularly in the bund-habitats.

Figure 45: a. Habit (x 1); b. leaf (x 5); c. flower head (x 5); d. involucreal bract (x 10); e. ray flower (x 20); f. disk flower (x 20); g. syngenicious anthers; h. palea (x 40); i. corolla of disk flower-opened (x 20); j. achene (x 40)

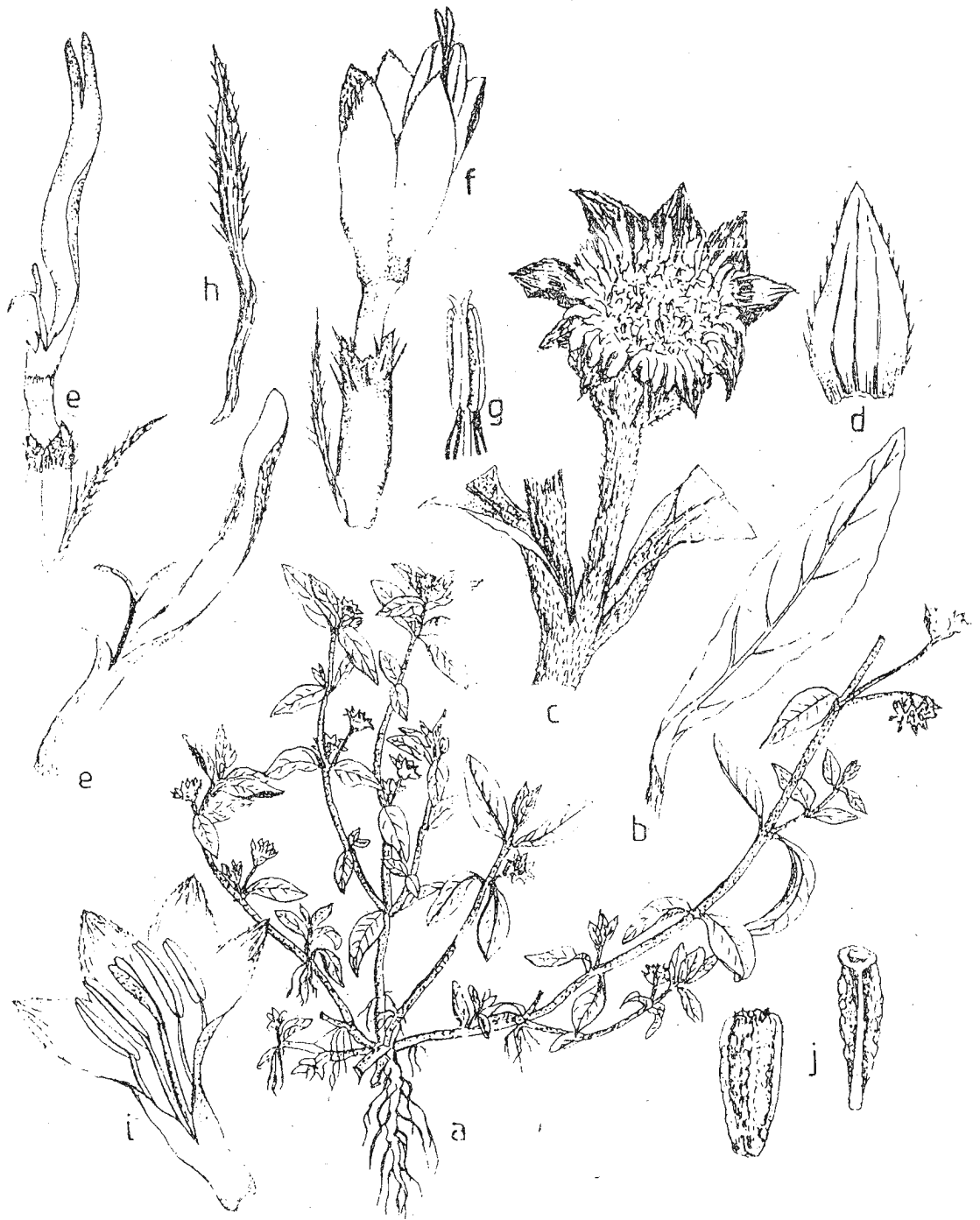


Fig.45. *Eclipta prostrata* (L.) L.

46. HEDYOTIS CORYMBOSA

Family: Rubiaceae
Botanical Name: Hedyotis corymbosa (L.) Lam.
Synonym: Oldenlandia corymbosa L.
Vernacular Name: Wal-pathpadagam (S)

Description:

Annual creeping much-branched small herb, with erect, ascending branches, 5-50 cm long, with strong tap root. Stems, glabrous, green, almost 4-angled; with minute interpetiolar stipules adnate to the petioles. Leaves simple, entire, opposite, on short petioles, narrowly lanceolate, acute at both ends, 10-35 x 2-8 mm. Flowers bisexual, actinomorphic, in peduncled, axillary, 2-8 flowered cymes or as axillary solitary flowers, peduncles often 4-8 mm long; pedicels of flowers slender, 2-5 mm long; flowers 4 (or 5)-merous; calyx lobes minute, acute; corolla white or pale purple, tube ca. 2 mm long, with a ring of hairs which close the tube. Ovary inferior, 2-celled, cells many-ovuled. Capsule crowned by calyx lobes, loculicidally dehiscent; Seeds numerous, ellipsoid, 0.3 mm long.

Propagation: by seeds

Ecology: On moist, sunny or shady sites along borders of ditches and drains, on roadsides, gardens, lawns, fallow fields, in wetland rice-fields mainly on bunds.

Distribution: In tropical and subtropical Asia. Throughout the Wet Zone of Sri Lanka mainly at low altitudes.

Agricultural Importance: Although common, a weed of minor importance in the rice-field habitat.

Figure 46: a. Habit (x 1); b. node with leaves (x 10); c. flower (x 10); d. corolla-opened; e. petal; f. calyx (x 15); g. pistil and stamens (x 15); h, h1. L.S. & T.S. of ovary (x 20); i. cluster of fruits (x 15); j. capsule (x 20)



Fig. 46. *Hedyotis corymbosa* (L.) Lam.

47. LEUCAS ZEYLANICA

Family: Lamiaceae

Botanical Name: Leucas zeylanica (L.) R.Br.

Vernacular Name: Geta-Thumba (S)

Description:

Annual, much-branched somewhat aromatic herb, with erect, ascending branches, 30-60 cm long. Stems solid, green, acutely 4-angled. Leaves entire, opposite, linear-lanceolate, 30-50 x 5-15 mm, apex acute or subacute, margin entire or distantly serrate, petioles 1-4 mm long. Flowers bisexual, zygomorphic, in axillary cymes, combined into verticils, 2-3 verticils combined into a terminal head. Floral leaves present, longer than normal leaves. Pedicels minute. Calyx tube 7-8 toothed, 5 mm long, 10-11 nerved, hairy. Corolla white, bilabiate, upper lip hooded, 15-17 mm long, tube 9 mm long; Fruit of four 1-seeded nutlets enclosed within a persistent calyx; nutlets, oblong, 3 mm long, black, shining.

Propagation: by seeds

Ecology: On moist or soggy sunny or shady sites along borders of ditches and drains, by roadsides, in waste places, in wetland or upland rice-fields common on bunds.

Distribution: In tropical and subtropical Asia. Throughout the Wet Zone of Sri Lanka up to 1500 m. altitudes.

Agricultural Importance: Although common, a weed of minor importance in the rice-field habitat.

Note: Leaves are eaten as a vegetable; also a plant well-known for medicinal value

Figure 47: a. Habit (x 1); b. flower- lateral views (x 10); b1. flower-ventral view (x 20); c. d. stamens; e. pistil; f. capsule (x 15); g. seeds (x 20)

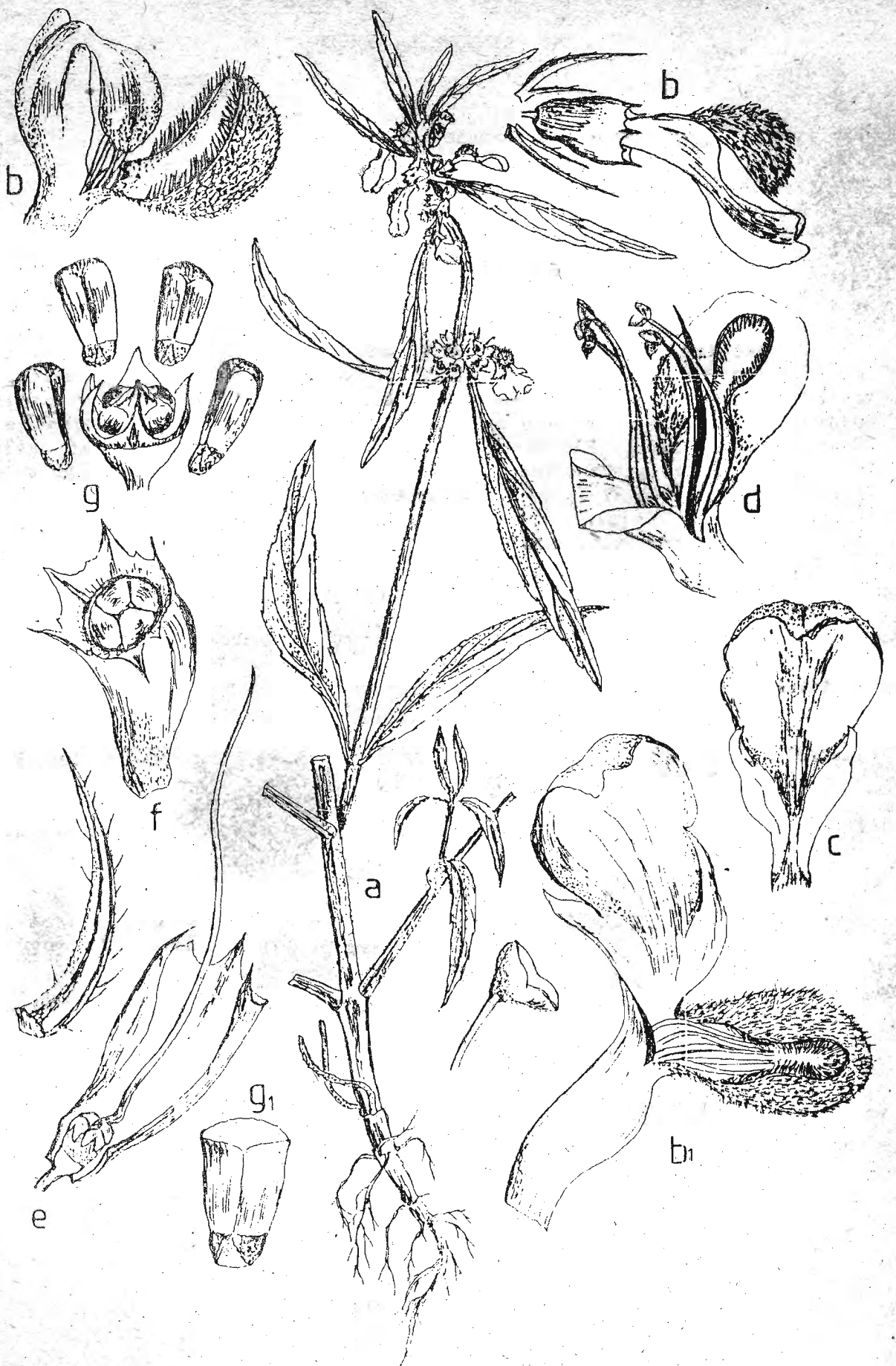


Fig.47. *Leucas zeylanica* (L.) R.Br.

48. LIMNOPHILA REPENS

Family: Scrophulariaceae
Botanical Name: Limnophila repens (Benth.) Benth.
Synonyms: Limnophila serrata Thw.
Limnophila conferta Benth.

Description:

Annual creeping much-branched fleshy, spongy aromatic herb, with erect, ascending branches, up to 30 cm long. Stems solid, glabrous, green, almost cylindrical. Leaves opposite, fleshy, rhomboid-oblong to ovate-elliptic, 5-20 x 4-10 mm, apex subacute, serrate at margins, penninerved, sessile. Flowers bisexual, zygomorphic, solitary, in axils of leaves, sessile; bracteoles linear-spathulate, 3 x 0.5 mm. Calyx tube 1.25 mm long, subequal lobes, linear-lanceolate. Corolla pinkish-purple, bilabiate, tube 6-8 mm long; perfect stamens 4. Capsule ellipsoid, 3-4 mm long. Seeds numerous, small, 0.75 mm long.

Propagation: by seeds

Ecology: Widespread in paddy fields and marshy places in wet lowlands; frequently found on moist places along borders of ditches and drains, in wet grasslands as well; in rice-fields both on bunds and in field habitat.

Distribution: In tropical and subtropical Asia. Throughout the Wet Zone of Sri Lanka mainly at low altitudes.

Agricultural Importance: Although common, a weed of minor importance in Sri Lanka's rice-fields.

Figure 48: a. Habit (x 1); a1. leaves (x 2); b. flower buds (x 5); c. flower (x 10); d. corolla- opened (x 12); e. pistil (x 10); f. stamen (x 15); g. node with immature fruits; h.i.j. views of capsule (x 10); k. T.S. fruit; l. seed (x 40)

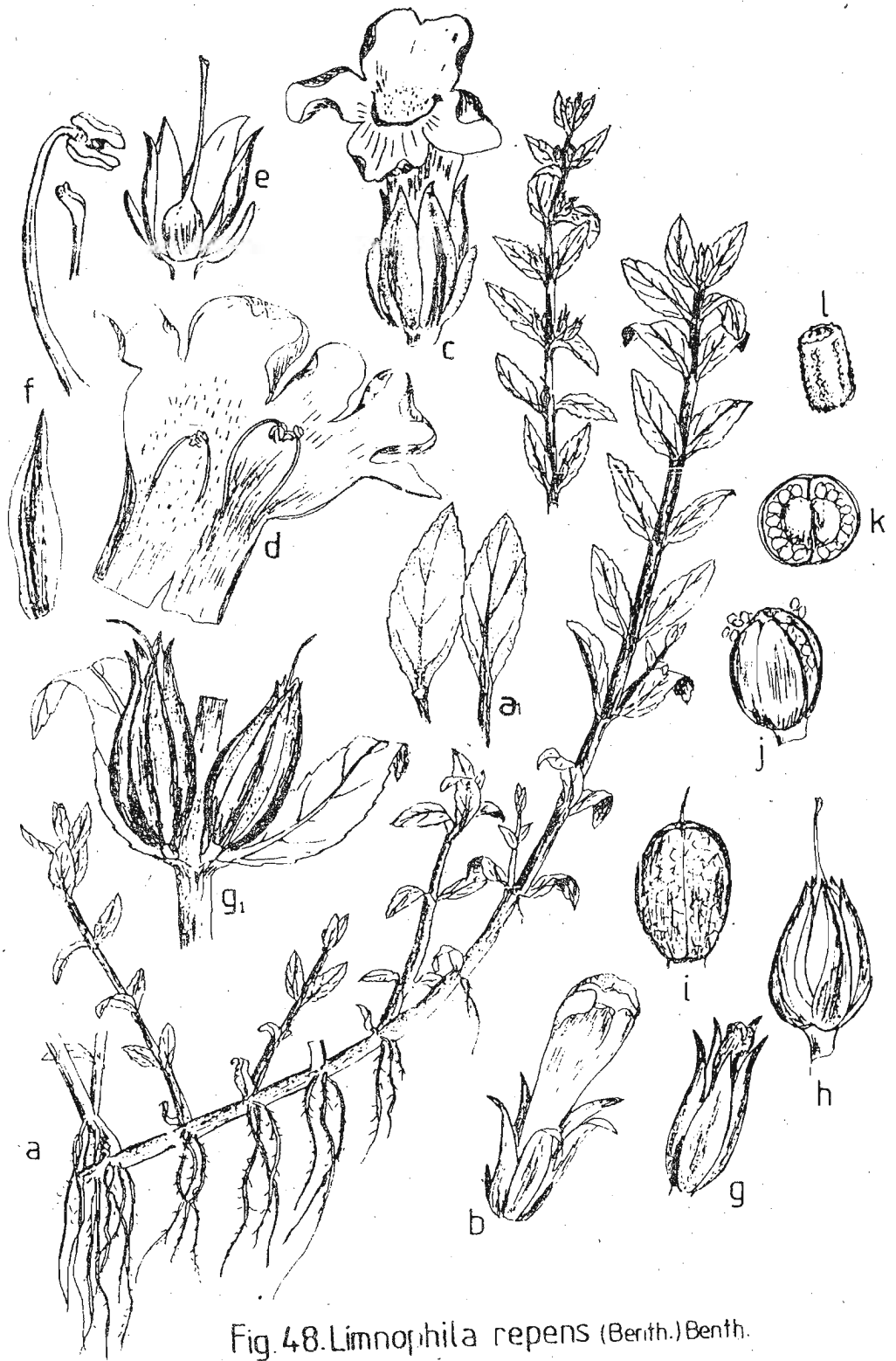


Fig. 48. *Limnophila repens* (Benth.) Benth.

49. LINDERNIA ANAGALLIS

Family: Scrophulariaceae

Botanical Name: Lindernia anagallis (Burm.f.) Pennell

Synonyms: Lindernia cordifolia (Colsm.) Don.
Ruellia anagallis Burm. f.

Description:

Annual herb, strongly branched from base, branches mostly prostrate, some ascending up to 30 cm. Stems very slender, sub-cylindrical to quadrangular, often rooting at basal nodes. Leaves opposite, sub-sessile or with short (1-3 mm) petioles, remote, oblong-lanceolate, subobovate to ovate, subentire or shallowly serrate, glabrous, sub-acute tip, 10-25 x 10-15 mm, penninerved. Flowers zygomorphic, mostly solitary or a few together, axillary on leaves, borne on 0.5-1 cm long pedicels which elongate to 1-2.5 cm in fruit. Calyx deeply 5-lobed, subequal, 1-4 mm long, linear-lanceolate. Corolla bilabiate, 5-10 mm long tube, pale bluish-purple above the yellowish base or almost white, lower lip 3-lobed, lobes orbicular, mid-lobe larger; 4 didynamous fertile stamens with anthers pairwise coherent; filaments 1-1.5 mm long. Superior ovary. Capsule ellipsoid, 1 cm long, yellow-greenish. Seeds ellipsoid, yellow, reticulately ridged.

Propagation: by seeds.

Ecology: On moist poorly drained wet areas, marshy sites, swamps, sunny or shady sites along borders of ditches and drains; very common in lowland rice-fields particularly on bunds, rarely among rice; in abandoned or harvested rice-fields which remain wet.

Distribution: Tropical Asia. Throughout the Wet Zone of Sri Lanka up to about 1000 m altitude.

Agricultural Importance: A weed of minor importance in rice-fields, although very common.

Figure 49: a. habit (x 1); a1. leaf (x 10); b. flower (x 10); c. corolla- opened showing stamens; d. pistil (x 12); e1. L.S. ovary (x 20); e2. T.S. ovary (x 40); f. capsule (x 20); g. seed (x 40)

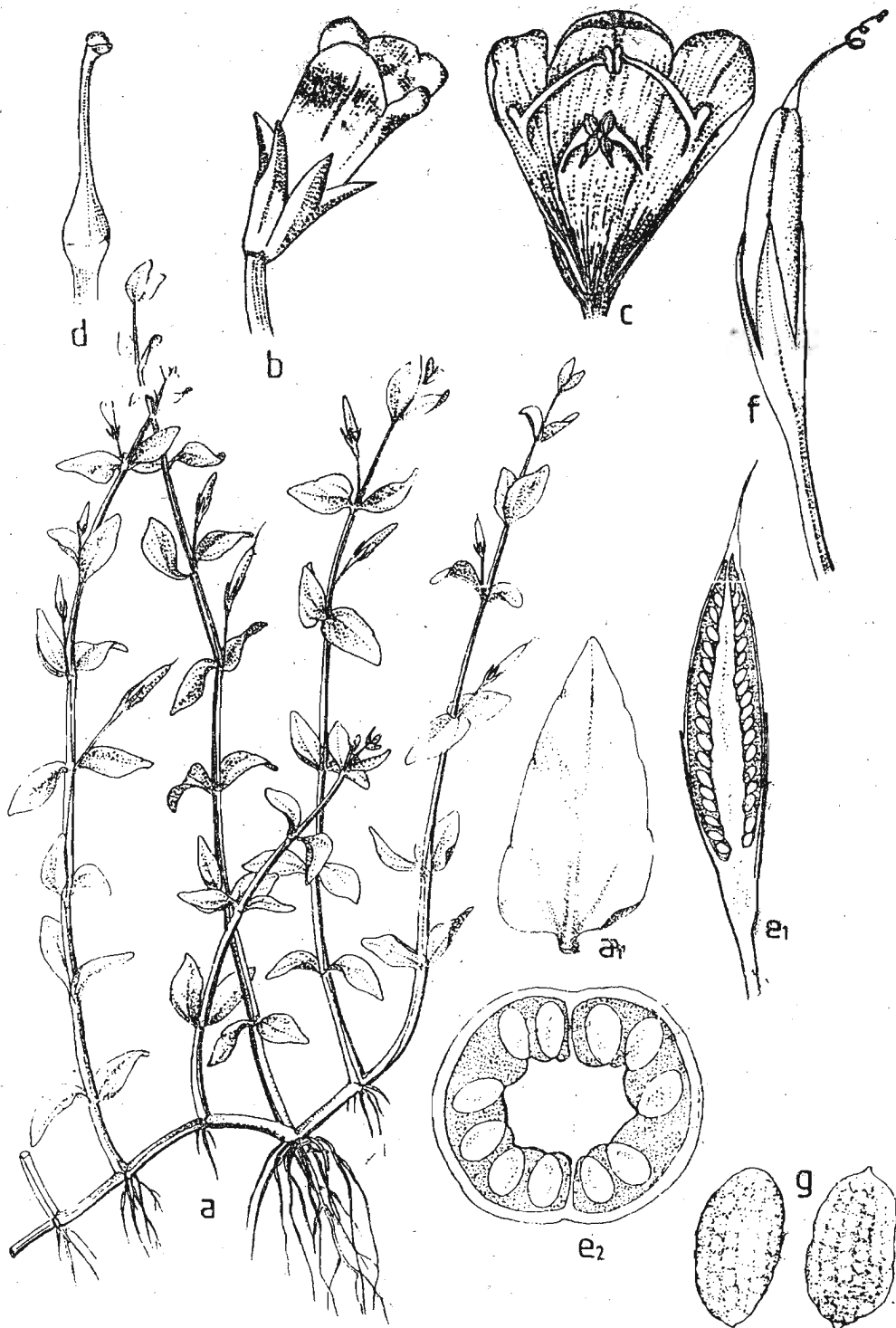


Fig. 49. *Lindernia anagallis* (Burm. f.) Pennell

50. LINDERNIA ANTIPODA

Family: Scrophulariaceae
Botanical Name: Lindernia antipoda (L.) Alston
Synonyms: Ilysanthus antipoda (non L.) Merr.
Ruellia antipoda L.

Description:

Generally, annual creeping herb, with short erect stems up to 30 cm tall, somewhat variable in habit, leaves, inflorescence size, and flower colour. Stems usually very slender, sub-cylindrical to quadrangular, often with a few branches, rooting at basal nodes. Leaves opposite, sessile to subsessile, remote, oblong-ovate to oblong-lanceolate, glabrous, sub-acute tip, shallowly or coarsely serrate, 7-45 x 3-15 mm, penninerved. Flowers solitary on axils of lower leaves, or on loose racemes (1-12 cm long) on axils of upper leaves. Bracts oblong-lanceolate. Pedicels 0.5-1 cm, later elongating to 1.5 cm; Calyx deeply 5-lobed, 1-4 mm long, lanceolate. Corolla bilabiate, tube 3-7 mm long widening upwards, pale violet, blue to white with yellowish base; upper lip erect, obtuse to emarginate with recurved margins, 6-9 mm long; lower lip much broader than upper-lip, 3-lobed, lobes obtuse, central one with white hairy spot at base; Stamens didynamous, 2 fertile stamens; 2 staminodes; filaments 2-2.5 mm long. Superior ovary. Capsule linear-lanceolate, 1-2 cm long. Seeds very small, ellipsoid, reticulately ridged.

Propagation: by seeds.

Ecology: On moist poorly drained wet swampy, marshy areas, sunny or shady sites along borders of ditches and drains; very common in wetland rice-fields particularly on bunds, rarely among rice; in abandoned and harvested rice-fields which remain wet.

Distribution: Tropical Asia. Throughout the Wet Zone of Sri Lanka up to about 1000 m altitude.

Agricultural Importance: A weed of minor importance in rice-fields, although very common.

Figure 50: a. Habit (x 1); a1. leaf (x 10); b. flower (x 15); c. corolla- opened showing stamens and staminodes (x 10); d. pistil (x 15); e1. L.S. ovary (x 20); e2. T.S. ovary (x 40); f. capsule (x 20); g. seed (x 40)

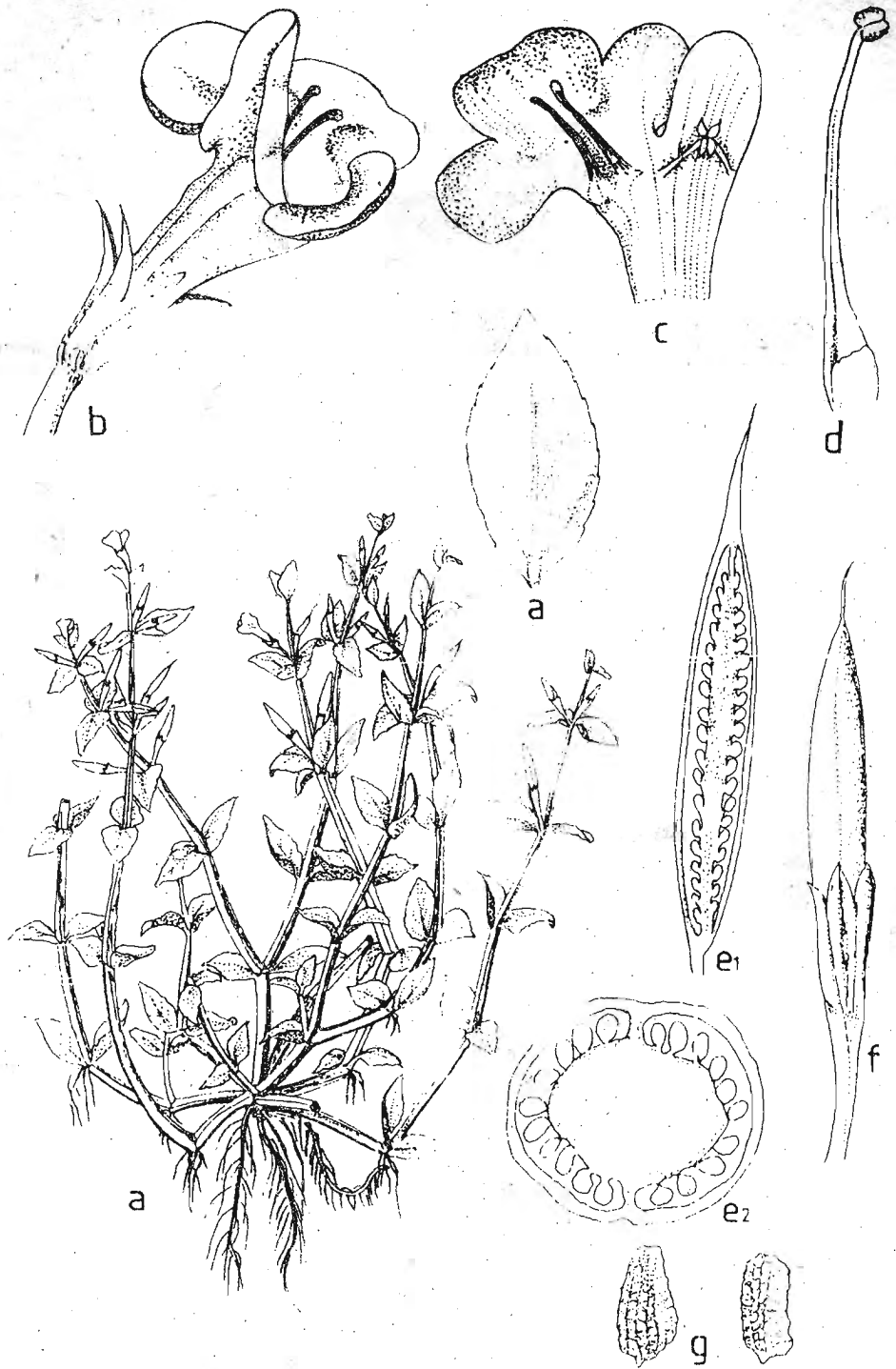


Fig. 50. *Linderria antipoda* (L.) Alston

51. LINDERNIA HYSSOPIOIDES

Family: Scrophulariaceae
Botanical Name: Lindernia hyssopioides (L.) Haines
Synonyms: Bonnaya hyssopioides (L.) Benth
Gratiola hyssopioides L.
Ilysanthes hyssopioides (L.) Benth

Description:

Annual herb, up to 30 cm tall. Stems very slender, sub-cylindrical to angular, generally erect and often with a few branches, rooting at basal nodes and with tap root. Leaves opposite, sessile, remote, linear or oblong-lanceolate, almost entire, glabrous, sub-acute tip, 7-15 x 1-5 mm, 3-nerved. Flowers solitary, mostly axillary on upper leaves, borne on 1-3 cm long pedicels. Bracts lanceolate. Calyx deeply 5-lobed, 1-3 mm long, linear-lanceolate. Corolla zygomorphic, 5-10 mm long, pale mauve or blue, upper lip erect, lower lip 3-lobed, midlobe broader than lateral ones; 2 fertile stamens; 2 staminodes; filaments 1-1.5 mm long. Superior ovary. Capsule ovoid-ellipsoid, 4-5 mm long, almost twice as long as calyx, greenish. Seeds oblong, yellow, longitudinally ridged, 0.4 mm long.

Propagation: by seeds.

Ecology: Very common in rice-fields of wet lowlands, particularly towards harvest time and afterwards, on bunds as well as in the wet field habitat; also on moist poorly drained wet areas, along borders of ditches and drains and ponds.

Distribution: Tropical Asia. Throughout the Wet Zone of Sri Lanka up to about 500 m altitude.

Agricultural Importance: A weed of minor importance in rice-fields, although very common.

Figure 52: a. Habit (x 1); b. flower (x 10); c. corolla- opened showing stamens and staminodes; d1. L.S. ovary (x 10); d2. T.S. ovary (x 20); e. capsule (x 10); f seeds (x 40)

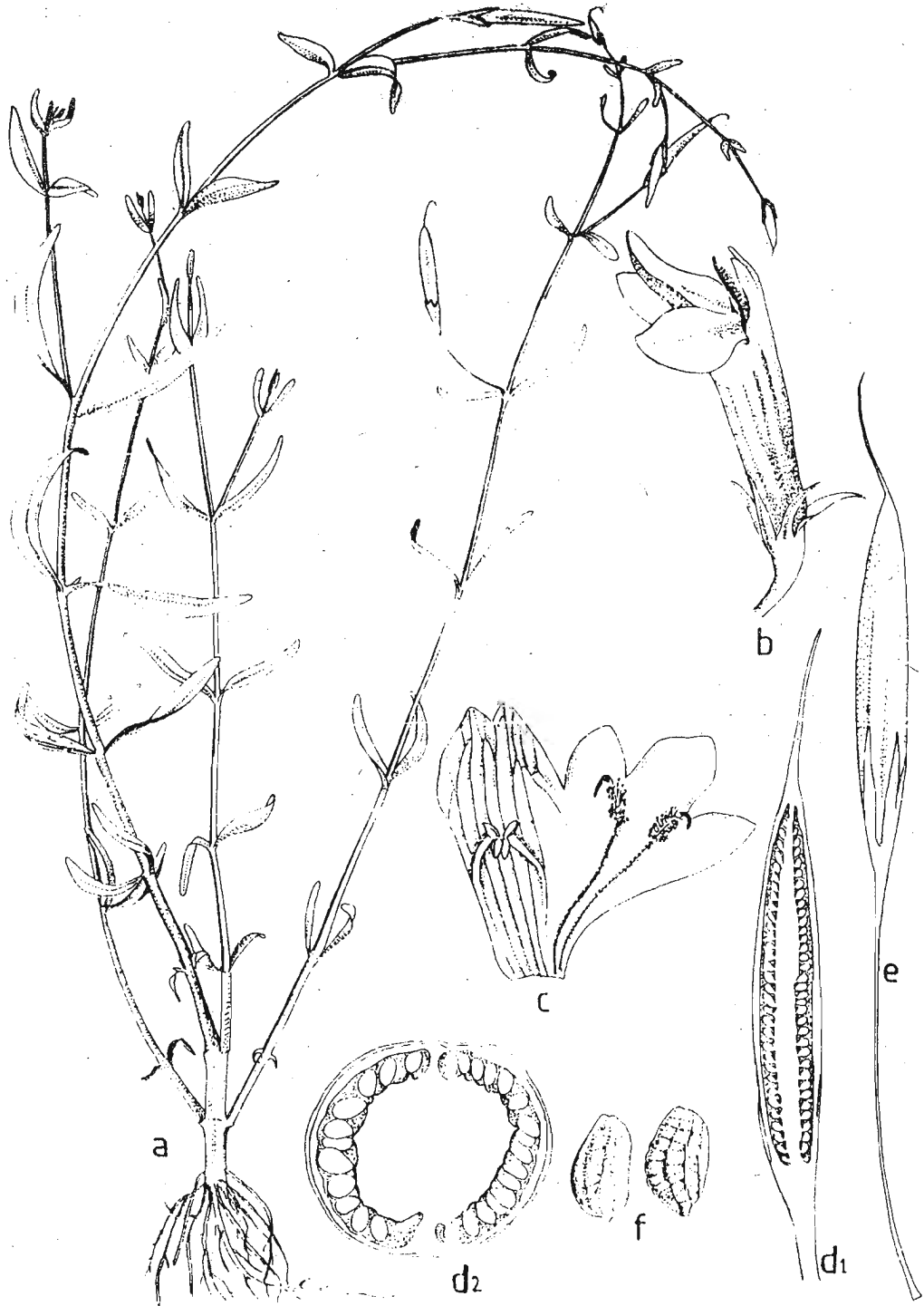


Fig. 51. *Lindernia hyssopifolia* (L.) Haines

52. LINDERNIA ROTUNDIFOLIA

Family: Scrophulariaceae
Botanical Name: Lindernia rotundifolia (L.) Alston
Synonyms: Gratiola rotundifolia L.
Ilysanthes rotundifolia Benth.

Description:

Annual herb, with creeping or decumbent stems with branches which may ascend up to 20 cm. Stems very slender, sub-cylindrical to angular, rooting at basal nodes. Leaves opposite, sessile, remote, broadly ovate to orbicular, obtuse at apex, 5-12 x 4-12 mm, distantly serrate towards apex, 4-5 nerved, glabrous. Flowers solitary, mostly axillary on upper leaves, borne on 1-1.5 cm long slender pedicels. Calyx deeply 5-lobed, 2.5 x 1 mm, more or less equal, lanceolate. Corolla zygomorphic, 10-13 mm long, bluish-white, tube 9-10 mm long, upper lip broadly pyramidal, 2-lobed at apex, lower lip 3-lobed, lobes orbicular, midlobe slightly broader than lateral ones; 2 fertile stamens; 2 staminodes; filaments 1-1.5 mm long. Superior ovary. Capsule ovoid-globose, 3-3.5 mm long, equal or slightly shorter than calyx. Seeds oblong, brown, 0.4 mm long.

Propagation: by seeds.

Ecology: Very common in rice-fields of lowlands, on bunds as well as in field habitat, particularly after harvesting; also on moist poorly drained wet areas, along borders of ditches and drains.

Distribution: Tropical Asia. Throughout the Wet Zone of Sri Lanka up to about 500 m altitude.

Agricultural Importance: A weed of minor importance in rice-fields, although very common.

Figure 52: a. Habit (x 1); a1. leaf (x 20); b. flower (x 15); c. corolla- opened showing stamens and staminodes; d1. L.S. ovary (x 20); d2. T.S. ovary (x 20); e. capsule (x 20); f. seed (x 40)



Fig. 52. *Lindernia rotundifolia* (L.) Alston

53. LUDWIGIA DECURRENS

Family: Onagraceae

Botanical Name: Ludwigia decurrens Walt.

Synonyms: Jussiaea decurrens (Walt.) DC.

Vernacular Name: Wel-Karabu (S); winged water-primrose (E)

Description:

Erect herb, with much branching, 25-150 cm in height; Stems sharply 4-angled with 4-wings (1-2 mm wide) formed by decurrent leaf bases, glabrous or minutely hairy in younger parts. Leaves simple, entire, almost sessile, or very shortly petioled (10-20 mm), narrowly linear-lanceolate, 3-10 x 0.2-3 cm, apex strongly acute, base acute to obtuse, both surfaces generally glabrous, sub-marginal vein prominent. Flowers bisexual, actinomorphic, solitary, axillary on upper leaf axils, on short pedicels 5-10 mm long; Calyx tube 8-12 mm long, 4-lobed, 8-10 mm long, elliptic-lanceolate with acuminate apex; Petals 4, broadly-ovate, 10-13 x 7-10 mm, bright yellow; Stamens 8, in two whorls, outer epipetalous whorl shorter; Ovary inferior 4-celled with numerous ovules in each cell, with 2 minute bracteoles at base. Capsule 4-angled, obconical, 10-20 mm long, 5-8 mm wide at summit, on a short pedicel (10 mm), irregularly loculicidal. Seeds numerous, elliptic, with very narrow raphe.

Propagation: by seeds

Ecology: On moist or soggy sunny or shady sites along borders of ditches, drains and pools; in wetland rice-fields, both on bunds and in field habitat.

Distribution: In tropical and subtropical Asia and America. Throughout the Wet Zone of Sri Lanka mainly at low altitudes.

Agricultural Importance: This is probably a weed introduced relatively recently to Sri Lanka, and which has spread rapidly in the Wet Zone rice-fields. A weed already regarded as troublesome by farmers.

Figure 53: a. Habit (x 1/2); b. leaf (x 1); b1. bracteole (x 2); c. part of stem showing winged nature and decurrent leaf bases; d. flower- lateral view (x 2); d1. flower- ventral view; d1. petal; d2. calyx lobe; e. L.S. flower showing gynoecium and stamens; f. T.S. ovary (x 5); g. stamens (x 5); h. seed (x 40)

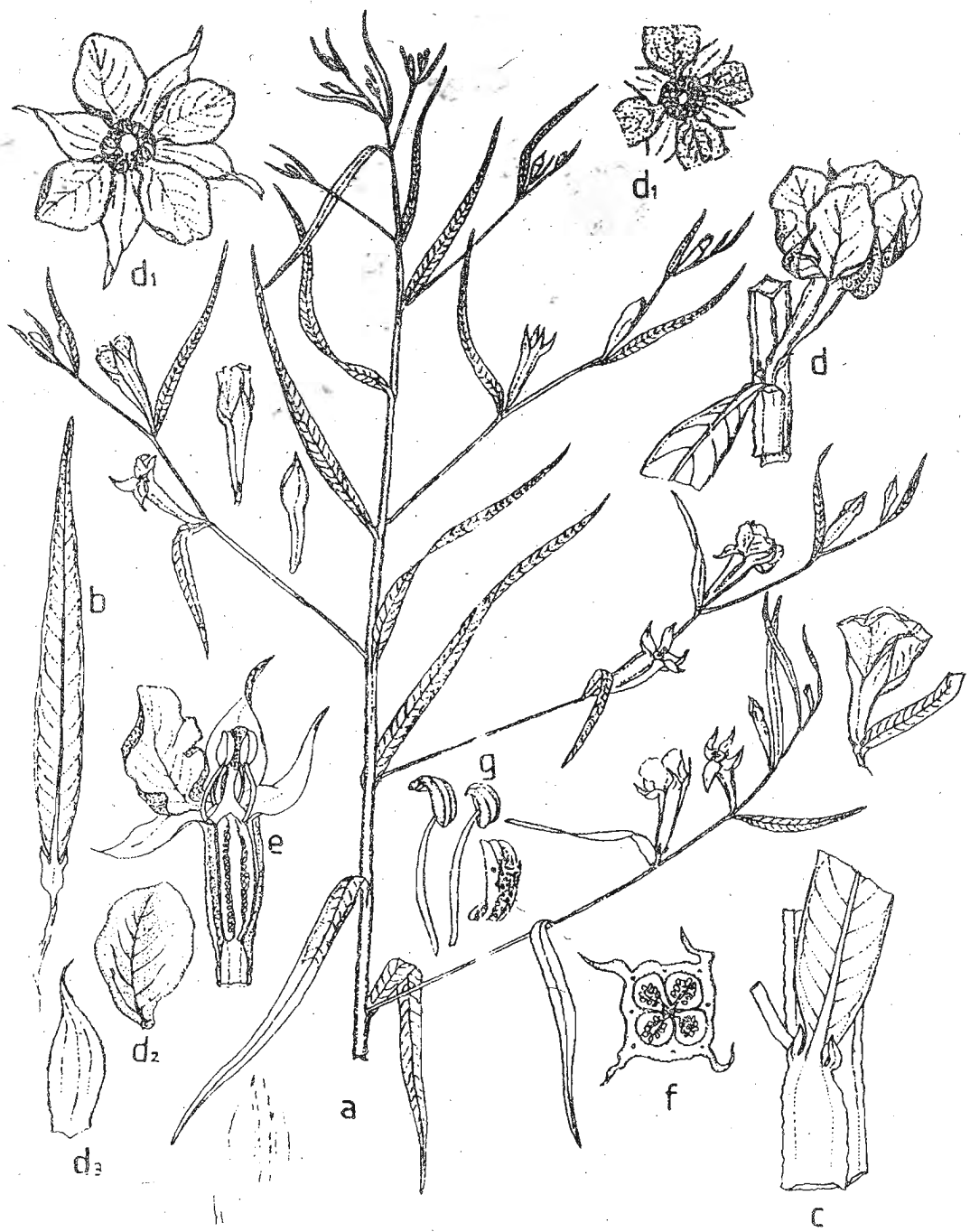


Fig. 53. *Ludwigia decurrens* Walt.

54. LUDWIGIA HYSSOPIFOLIA

Family: Onagraceae

Botanical Name: Ludwigia hyssopifolia (G. Don) Exell

Synonyms: Jussiaea linifolia Vahl
Jussiaea hyssopifolia G. Don
Ludwigia micrantha (Kunze) Hara

Vernacular Name: Wel-karabu (S)

Description:

A profusely branched, erect highly variable herb, 10-150 cm in height; Stems angular, green or often reddish, glabrous or minutely hairy in younger parts. Leaves simple, entire, almost sessile, or very shortly petioled (10-30 mm), linear-lanceolate or elliptic, 1-10 x 0.2-3.5 cm, apex and base both strongly acute, both surfaces generally glabrous. Flowers bisexual, actinomorphic, solitary, axillary on upper leaf axils, on short pedicels 5-10 mm long, open only one day; Calyx tube 6-11 mm long, 4-lobed which are 3-4 mm long, oblong-lanceolate with acuminate apex; Petals 4, ovate to ovate-elliptic, 2-5 x 1-2 mm, bright yellow; Stamens 8, in two whorls, outer epipetalous whorl slightly shorter; Ovary inferior 4-celled, with numerous ovules in each cell in the upper 2/3, one ovule in each cell in the lower 1/3. Capsule subcylindrical to 4-angled, 1.75- 2.5 cm long, upper 2/3 slightly broader with pluriseriate, free seeds, falling apart loculicidally, lower 1/3 narrower with uniseriate seeds firmly embedded in endocarp, dividing into corky discs. Seeds oblong, with very narrow raphe.

Propagation: by seeds

Ecology: On moist, or ever wet regions and in those with drier seasons, or soggy sunny or shady sites along borders of ditches and drains, pools; in wetland rice-fields, both on bunds and in field habitat.

Distribution: Pantropical. Throughout the Wet and Intermediate Zone of Sri Lanka mainly at low altitudes.

Agricultural Importance: This is probably the most prevalent broad-leaf weed causing problems to rice in Sri Lanka. Heavy to massive infestations are common.

Figure 54: a. Habit (x 1/2); b. leaf (x 2); c. flower (x 20); c1. bracteole (x 40); d. parts of gynoecium and androecium (x 25); e. stamens; f. T.S. ovary; f1. L.S. ovary (x 25); g. capsule (x 5); h. capsule- ventral view; i. L.S. capsule showing dimorphic seeds (x 10); i1. T.S. of upper part of capsule; i2. T.S. of lower part of capsule; j. seed (x 40)

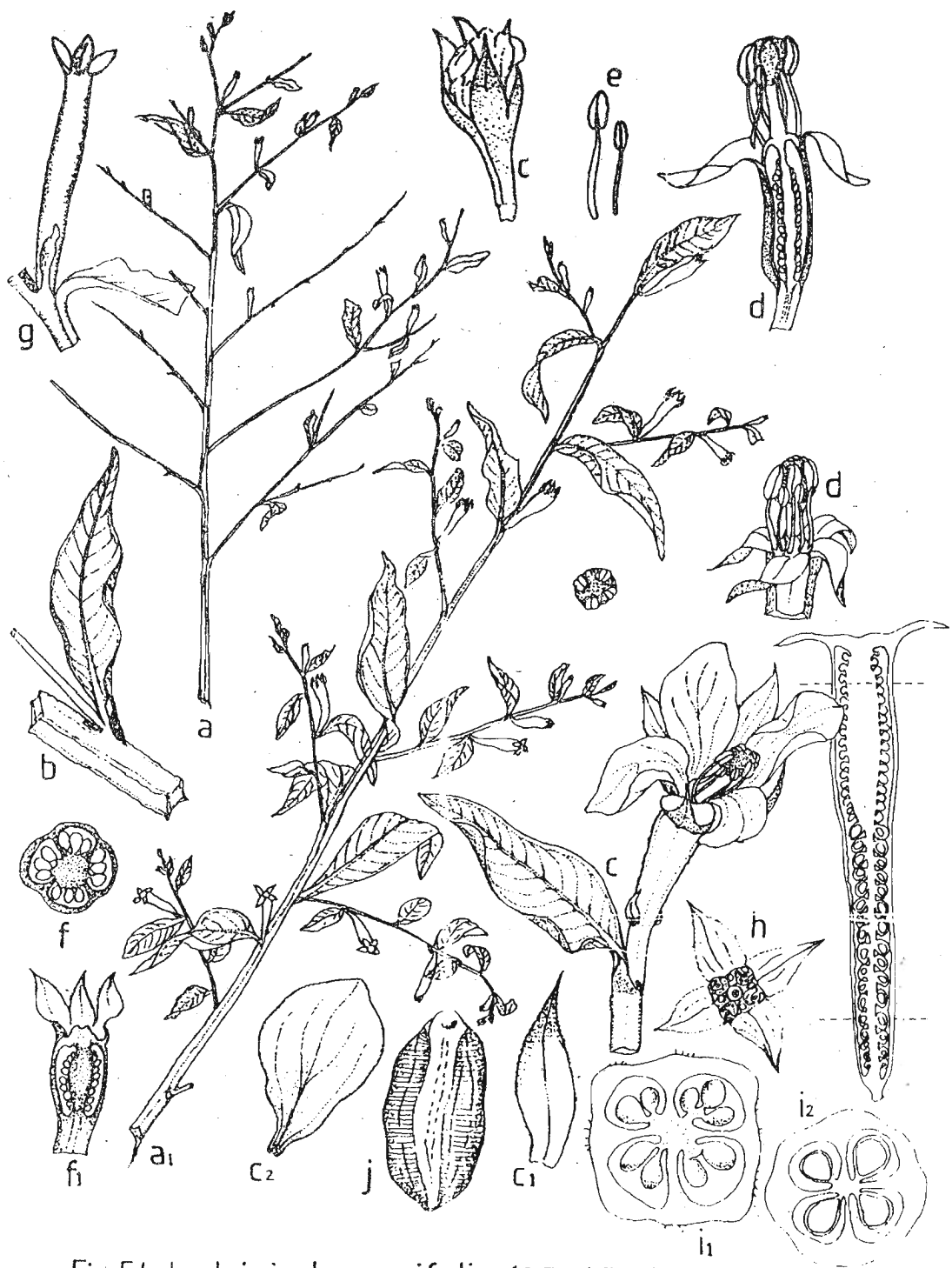


Fig.54. *Ludwigia hyssopifolia* (G. Don) Exell

55. LUDWIGIA PERENNIS

Family: Onagraceae

Botanical Name: Ludwigia perennis L.

Synonyms: Ludwigia parviflora Roxb.
Ludwigia gracilis Miq.
Ludwigia lythroides Bl.

Vernacular Name: Wel-karabu (S)

Description:

Small erect highly variable herb, with much branching, 10-75 cm in height; Stems angular, often strongly reddish-purple, glabrous or minutely hairy in younger parts. Leaves simple, entire, almost sessile, or very shortly petioled (10-20 mm), linear-lanceolate or elliptic, 1-10 x 0.2-3 cm, apex acute or obtuse, base very acute, both surfaces generally glabrous. Flowers bisexual, actinomorphic, solitary, axillary on upper leaf axils, on short pedicels 5-10 mm long; Calyx tube 4-6 mm long, short-hairy, 4-lobed, each lobe 1-3 mm long, ovate-lanceolate with acuminate apex, purple-red in colour; Petals 4, ovate to oblong, 2-5 x 1-2 mm, bright yellow; Stamens 4, free; ovary inferior 4-celled with numerous ovules in each cell, with 2 minute bracteoles at base. Capsule subcylindrical to 4-angled, slightly hairy, 7-20 mm x 2-3 mm, irregularly loculicidal. Seeds numerous, oblong to elliptic, with very narrow raphe.

Propagation: by seeds

Ecology: On moist or soggy sunny or shady sites along borders of ditches and drains, particularly in areas with pronounced dry seasons; in wetland rice-fields, both on bunds and in field habitat.

Distribution: In tropical and subtropical Asia. Throughout the Wet Zone of Sri Lanka mainly at low altitudes; in drier areas of the Wet Zone and in the Intermediate Zone.

Agricultural Importance: Although common, this weed cannot be regarded as important as L. hyssopifolia as it usually does not occur in heavy infestation scale. Often mistaken for the former.

Figure 55: a. Habit (x 1); b. leaf (x 5); c. flower- ventral view (x 10); cl. flower- dorsal view; d. stamens (4) and pistil (x 15); e. capsule (x 20); fl. L.S. capsule (x 20); fl. T.S. capsule; g. seed (x 50)

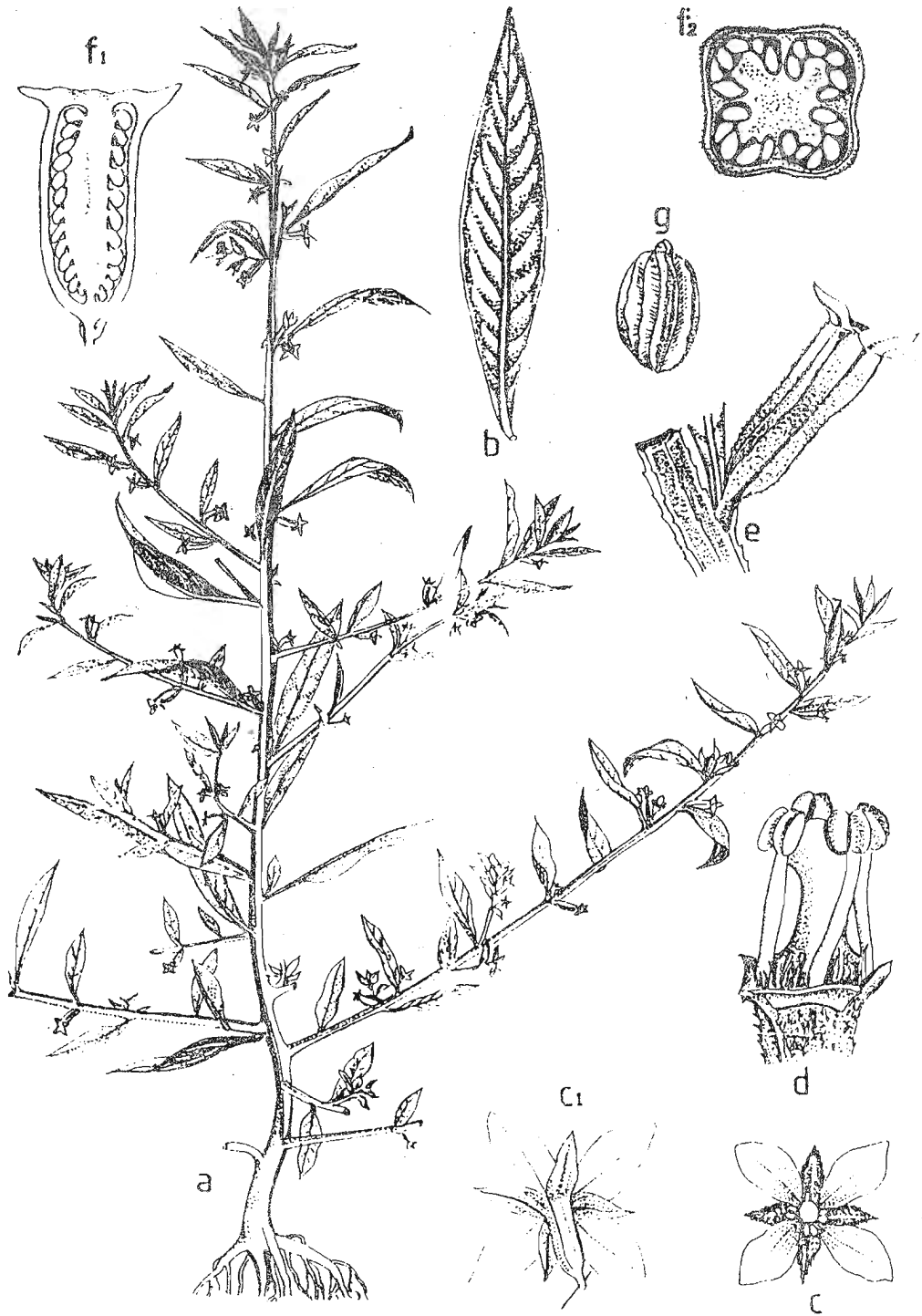


Fig. 55. *Ludwigia perennis* L.

56. LUDWIGIA PERUVIANA

Family: Onagraceae

Botanical Name: Ludwigia peruviana (L.) Hara

Synonyms: Jussiaea peruviana L.
Jussiaea speciosa Ridley
Jussiaea hirta (L.) Sw.
Jussiaea suffuticosa sensu Trimen (non L.)

Description:

Perennial shrub or robust herb, reaching up to 1-3 m in height, with much branching; Stems solid, apical areas sharply angular. Densely pubescent all over. Leaves simple, entire, almost sessile, broadly oblong-lanceolate or elliptic, 5-15 x 2-4 cm, apex acute, base attenuate or decurrent, both surfaces densely pilose, lateral nerves numerous, prominent below. Flowers bisexual, actinomorphic, solitary, axillary on upper leaf axils, on pedicels 5-25 mm long; 2 bracteoles appressed to calyx, ovate-lanceolate, 8-12 mm long; calyx tube 10-15 mm long, pilose, 4-lobed, each lobe 10-15 mm long lanceolate with acuminate apex; petals 4, very broadly oval or ovate, 15-25 x 15-23 mm, emarginate, bright yellow; Stamens 8, in two whorls, outer epipetalous whorl slightly shorter; ovary inferior 4-celled with numerous ovules in each cell. Capsule obconical, sharply angular, hairy, 25-30 mm long, irregularly loculicidal. Seeds numerous, oblong, 0.8 mm long with prominent raphe.

Propagation: by seeds

Ecology: On moist or soggy sunny or shady sites along borders of ditches and drains, in soggy lands near pools often forming the dominant vegetation; in wetland rice-fields, mainly on bunds, rarely in fields.

Distribution: In tropical and subtropical Asia. Throughout the Wet Zone of Sri Lanka mainly at low altitudes.

Agricultural Importance: Although common, a weed of minor importance in Sri Lanka's rice-fields.

Figure 56: a. Habit (x 1/2); al. T.S. stem; b. leaf (x 1); c. flower bud on leaf axil with bracteole at base; d. flower (x 2); e. flower with corolla removed; f. stamens (x 10); g. T.S. ovary (x 10); gl. L.S. Ovary (x 10); h. capsule (x 5); i seed (x 40)



Fig.56. *Ludwigia peruviana* (L.) Hara

57. MITRACARPUS VILLOSUS

Family: Rubiaceae

Botanical Name: Mitracarpus villosus (Sw.) DC.

Synonyms: Mitracarpus scaber Zucc.

Description:

Annual much-branched, sturdy herb, with erect, ascending branches, 30-50 cm long. Stems solid, cylindrical below, 4-angled higher up, villous, green. Leaves simple, entire, opposite, oblong- obovate, 20-35 x 5-20 mm, apex obtuse to acute, base rounded. Interpetiolar stipules short, adnate to base of leaves forming a sheath with bristles. Flowers bisexual, in axillary or terminal dense heads, sessile; calyx bristly, with 4-limbs, 2 much longer than the other 2; corolla white, tube funnel-shaped, lobes 4, tops of lobes ciliate. Capsule dehiscent at the middle. Seeds marked with a cross.

Propagation: by seeds

Ecology: On moist or sunny sites along borders of ditches and drains, on roadsides; on wetland rice-field habitats, mainly on bunds.

Distribution: In tropical and subtropical Asia and Africa. Throughout the Wet Zone of Sri Lanka up to medium altitudes.

Agricultural Importance: Although common, a weed of minor importance in Sri Lanka's rice-fields.

Figure 57: a. Habit (x 1/2); b. flower (x 20); c. flower with corolla removed showing pistil; d. corolla tube- opened showing stamens (x 15); e. fruit; f seed- two views (x 40)



Fig.57. *Mitracarpus villosus* (Sw.) DC.

58. PHYLLANTHUS DEBILIS

Family: Euphorbiaceae
Botanical Name: Phyllanthus debilis Klein ex Willd.
Synonym: Phyllanthus niruri Auct. non L.
Vernacular Name: pitawakka (S)

Description:

Annual erect herb, with ascending branches resembling a pinnate leaf, 5-80 cm tall. Stems angular, glabrous, green. Leaves entire, helically arranged, those on lateral branches closely set in two rows, oblong-oval, base obtuse, apex acute to obtuse, 5-20 x 3-6 mm, on very short petioles, triangular stipules at base. Flowers without petals, axillary on lateral branches, turned downward; male flowers 2-3 together in lower axils; female flowers usually solitary or with a few male ones in higher axils. Male flowers on very short pedicels, sepals 6, 3 stamens; Female flowers on slightly longer pedicels, sepals 6, globose, 3-celled, each cell with 2 ovules. Fruit globose 2-2.5 mm in diameter, dehiscent into 3, two-valved, 2-seeded capsules.

Propagation: by seeds

Ecology: On moist or soggy sunny or shady sites along borders of ditches and drains, in home gardens, roadsides, plantations and grasslands; in wetland rice-fields, mainly on bunds.

Distribution: In tropical and subtropical Asia. Throughout the Wet Zone of Sri Lanka mainly at low altitudes.

Agricultural Importance: Although common, a weed of minor importance in Sri Lanka's rice-fields.

Figure 58: a. Habit (x 1); a1. lateral branch with leaves (x 2); a2. leaf (x 10); b. female flower (x 20); c. male flower (x 20); d. immature fruit (x 20); d1. mature fruit; e. 2-seeded capsules (x 40)



Fig. 58. *Phyllanthus debilis* Klein ex Willd.

59. POLYGONUM BARBATUM

Family: Polygonaceae

Botanical Name: - Polygonum barbatum L.

Vernacular Name: Kimbul-wenna (S); Smartweed (E)

Description:

Perennial herb with creeping, tillering, much-branched habit, with erect, ascending branches, 40-70 cm tall. Stems hollow, glabrous, green to purplish, almost cylindrical, with thickening at nodes, tubular stipules at nodes, stipule membranous, up to 2 cm long tight around the stems, often torn. Leaves entire, helically arranged, with short petioles, oblong to lanceolate, with acute apex and obtuse base, 10-25 x 4-10 mm, apex rounded, remote or close together. Inflorescence 2-8 spikes, lower spikes peduncled, upper ones sessile; Flowers bisexual, actinomorphic, 3-5 in a funnel-shaped bract, bract 3 mm long, with deep apical clefts; Perianth whitish 5-lobed, oval. Stamens 6-7. Ovary superior with one cell, 1-ovulate. Fruit indehiscent, trigonous, ovoid, 2 mm long, black. Seed trigonous, 1.5 mm long.

Propagation: by seeds

Ecology: On moist or soggy sunny or shady sites along borders of ditches and drains, in soggy grasslands or near pools; in wetland rice-fields, both on bunds and in field habitat.

Distribution: In tropical and subtropical Asia. Throughout the Wet Zone of Sri Lanka mainly at low altitudes.

Agricultural Importance: Although common, a weed of minor importance in rice-fields. Could become major problems if fallow-fields are heavily infested.

Figure 59: a. Habit (x 1/2); b, b1. membranous stipule at node (x 5); c. spike; c1. portion of spike- enlarged to show bracts and flowers (x 5); d. flower (x 10); e. perianth-opened; f. fruit without perianth; g, g1. seed and its cross section (x 40)



Fig. 59. *Polygonum barbatum* L.

60. ROTALA INDICA

Family: Lythraceae

Botanical Name: Rotala indica (Willd.) Koehne

Description:

Annual, strongly branched herb, often with ascendent or creeping stems, 10-40 cm tall, with rooting at nodes. Stems quadrangular, fleshy, greenish to purple-pink in colour. Leaves simple, entire, opposite, sessile with narrowed base, oblong to obovate, acute tip sometimes blunt, 4-15 x 1-8 mm. Flowers bisexual, actinomorphic, small, commonly borne in large numbers on 2-4 cm long spikes with leafy bracteoles; calyx 2-3 mm long, tubular, obconical with 4 lobes which are triangular; petals also 4, very small, 0.75-1.0 mm long, oblong to obovate, white. Stamens 2-6 attached deep down in calyx tube. Ovary superior, ellipsoid. Capsule narrowly oblong, 2-valved, loculicidally dehiscent. Seeds numerous, minute.

Propagation: by seeds (achenes) and fragments of plant.

Ecology: On moist poorly drained wet areas, in rainfed or irrigated wetland rice-fields mainly in the field among rice; also in abandoned wet fields.

Distribution: Pantropical. Throughout the Wet Zone of Sri Lanka up to about 1000 m altitude.

Agricultural Importance: Although very common, a weed of minor importance in rice-fields.

Figure 60: a. Habit (x 1); b. leaf (x 5); c. part of stem enlarged (x 10); d. cluster of spikes (x 2); e. portion of spike- enlarged to show leafy bracteoles (x 15); f. flower (x 15); g. calyx tube- opened showing petals and attachment of stamens; h. pistil; i. T.S. immature capsule showing numerous seeds; ii. capsule (x 15); j. seed (x 40)

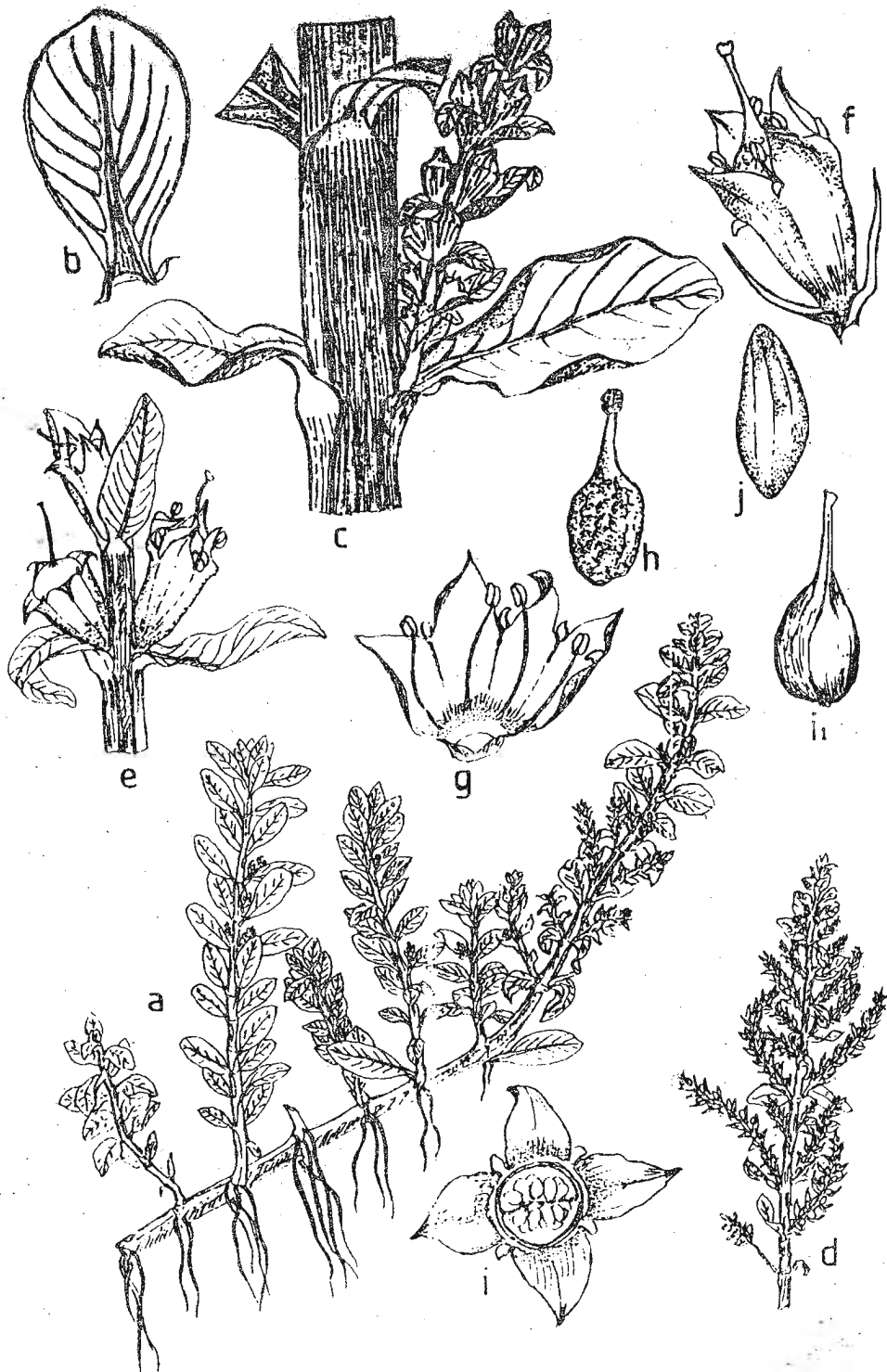


Fig. 60. *Rotala indica* (Willd.) Koehne

61. SCOPARIA DULCIS

Family: Scrophulariaceae

Botanical Name: Scoparia dulcis L.

Description:

Annual, strongly branched herb, often with many stiff, erect branches, 10-70 cm tall, with taproot. Stems sub-cylindrical or angularly-ribbed, slender to stiff, green, glabrous. Leaves simple, entire, in whorls of 3, oblong, oblong-ovate or ovate-oblong, with acute base and acute tip, strongly serrate-crenate margins, glabrous, penninerved with strong midrib, 10-30 x 3-12 mm; petiole 2-8 mm long. Flowers borne in large numbers, small, bisexual, actinomorphic, solitary or few together, on axils of upper leaves, on short pedicels (5-7 mm long); calyx deeply 4-lobed, lobes ovate-oblong, 2 mm long. green; corolla also 4-lobed, lobes unequal, obovate or rounded, very pale purple or white, 6-7 mm in diameter, with numerous white hairs in the throat. Stamens 4, subequal. Ovary, superior, 2-celled, many ovulate. Capsule ovoid, 2-3 mm long, yellow-brown, 4-valved, loculicidally dehiscent, calyx and style persistent. Seeds many globose to obovoid, brown, up to 0.5 mm long.

Propagation: by seeds (achenes)

Ecology: On moist poorly drained wet areas, sunny or shady sites along borders of ditches and drains; on roadsides, old walls; in wetland rice-fields mainly on bunds, rarely among rice.

Distribution: Tropical Asia. Throughout the Wet Zone of Sri Lanka up to about 1000 m altitude.

Agricultural Importance: Very common on bunds, yet a weed of minor importance in rice-fields.

Figure 61: a. Habit (x 1); b. flower-bud (x 5); c. lateral view (x 10); d. flower-without corolla, ventral view; e. L.S. flower; f. stamens (x 20); g. capsule with calyx (x 5); h. L.S. and T.S. ovary; i. seed (x 40)



Fig.61. *Scoparia dulcis* L.

62. SPERMACOCE LATIFOLIA

Family: Rubiaceae
Botanical Name: Spermacoce latifolia Aubl.
Synonyms: Borreria alata (Aubl.) DC.
B. latifolia (Aubl.) K. Schum.

Description:

Annual, or short-lived perennial herb, with prostrate, strongly branched habit, often with many, erect or ascending branches, 10-70 cm tall; with taproot and rooting at nodes. Stems fleshy and quadrangular with 4 distinct wings, green, and densely pubescent with short hairs. Interpetiolar stipules small, adnate to leaves, forming a thin sheath. Leaves simple, entire, thick, opposite, sessile, elliptic to ovate-elliptic, with acute to obtuse base and tip, penninerved with strong midrib, 20-70 x 12-14 mm. Flowers bisexual, actinomorphic, small, borne in axillary clusters; calyx tube funnel-shaped, deeply 4-lobed, lobes ovate-elliptic, hairy, 1-2 mm long; corolla purplish or rarely white, 3-6 mm long, funnel-shaped, also 4-lobed, lobes orbicular, with a ring of hairs inside. Stamens 4; Superior, 2-celled ovary, cells 1-ovulate; Capsule 2-4 mm long, hairy, loculicidally dehiscent, splitting into 2 valves. Seeds ellipsoid.

Propagation: by seeds (achenes)

Ecology: On moist poorly drained wet areas, sunny or shady sites along borders of ditches and drains; on plantations, roadsides, waste, fallowed lands; in wetland rice-fields mainly on bunds.

Distribution: Tropical Asia. Throughout the Wet Zone of Sri Lanka up to about 1000 m altitude.

Agricultural Importance: A weed of minor importance in rice-fields, although very common and dominant in other agricultural fields, particularly plantation crops.

Figure 62: a. Habit (x 1/2); b. T.S. Stem showing winged nature (x 10); c. axillary cluster of flowers (x 10); d. flower (x 20); e. corolla- opened; f. dehisced capsule (x 20); g, gl. seed- two views (x 40)

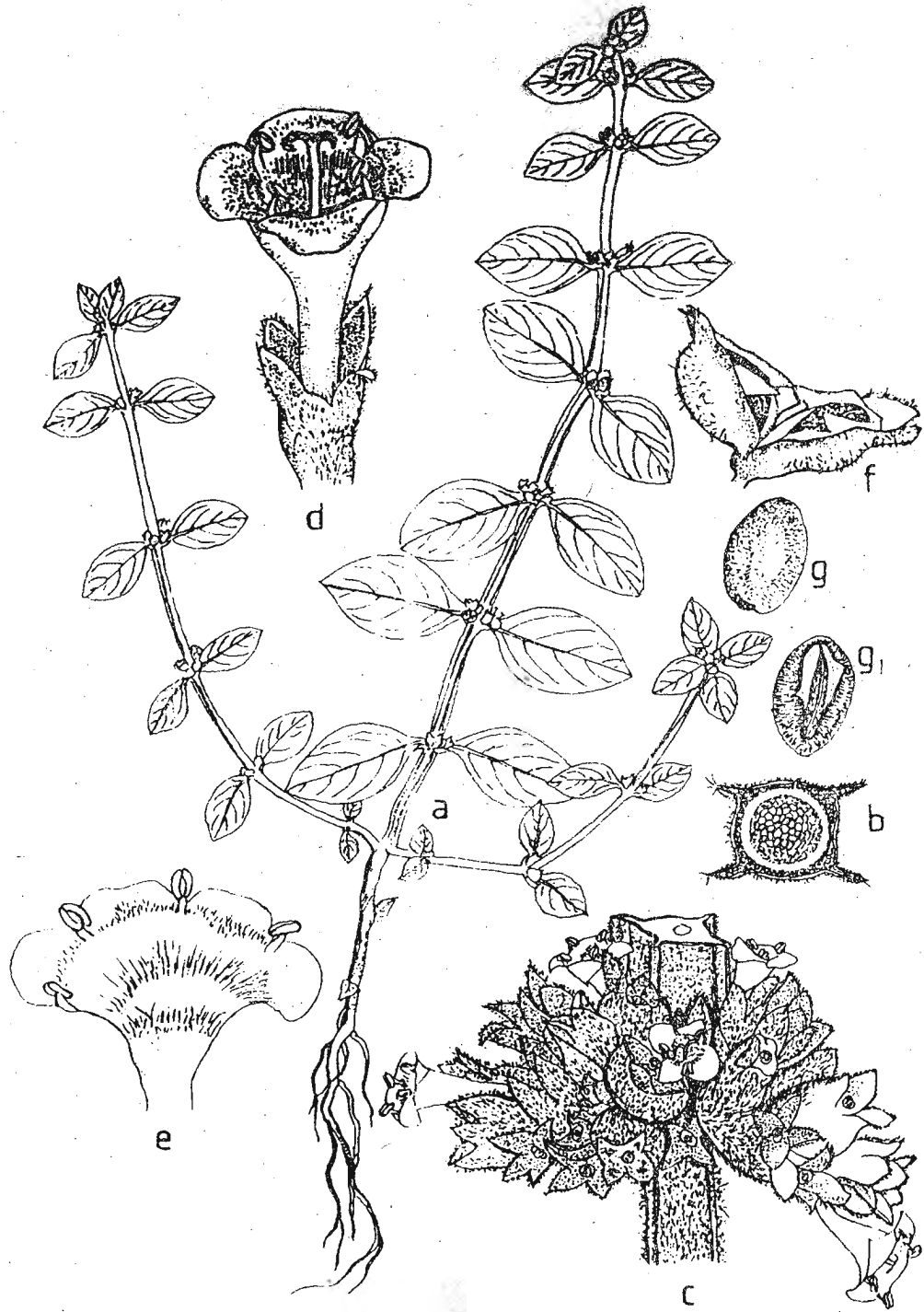


Fig. 62. *Spermacoce latifolia* Aubl.

63. SPHAERANTHUS INDICUS

Family: Asteraceae
Botanical Name: Sphaeranthus indicus L.
Synonym: Sphaeranthus hirtus Willd.
Vernacular Name: Mudu-mahana (S)

Description:

Annual herb, with a strong tap root, well-branched from base, 20-100 cm tall, strongly aromatic and usually sticky. Stems cylindrical, with broad, coarsely-toothed wavy stem wings continuous with leaves which are also with toothed-margins. Leaves sessile, helically arranged, decurrent with broad wings, oblong-obovate, 2-11 cm long, 1-4 cm wide, nerves prominent on underside, bearing short glandular hairs. Inflorescence, globose-ellipsoidal heads, initially terminal in position, later opposite leaves, borne on winged peduncles which are 2-4 cm long; flower heads 10-15 mm in diameter, purple coloured, dense with many flowers. Involucral bracts about 20, with purple tips, hairy. Ray flowers (marginal) 10-12, female, corolla white, 1.5 mm long, 2-3 toothed. Disc flowers 1-4, bisexual, 2-3 mm long with short tube, 4-5 lobed; anthers connate, style thick. Achenes without pappus, 1 mm long, with short, erect hairs.

Propagation: by seeds (achenes)

Ecology: On moist poorly drained wet areas, sunny or shady sites along borders of ditches and drains; in wetland rice-fields on bunds as well as occasionally among rice.

Distribution: Tropical Asia. Throughout the Wet Zone of Sri Lanka up to about 1000 m altitude.

Agricultural Importance: Although quite common, a weed of minor importance in rice-fields.

Figure 63: a. Habit (x 1); b. leaf with decurrent bases; c. flower-head (x 4); c1. cluster of flower heads; d. flower-head enlarged (x 20); e. involucral bract (x 20); f. ray flower (female) (x 20); g. disc flower (bisexual) (x 20); g1, g2. disc flower opened; h. achene of ray flower



Fig. 63. *Sphaeranthus indicus* L.

64. TRIDAX PROCUMBENS

Family: Asteraceae

Botanical Name: Tridax procumbens L.

Description:

Annual or short-lived perennial, strongly branched plant, often with ascending or erect branches arising from a creeping base, 20-50 cm tall, with a strong taproot. Stems cylindrical, often green or purplish, densely covered with appressed or patent white hairs. Leaves simple, opposite, ovate-lanceolate, or oblong-ovate, strongly irregularly serrate to pinnatilobed, somewhat succulent, densely white-pubescent, 2-6 x 2-4 cm, midrib prominent on underside; petiole concave, 1-2.5 cm long, pilose. Inflorescence a head, mostly terminal on erect peduncles, 2 cm in diameter; peduncles 10-40 cm long, hirsute; involucre bell-shaped; bracts many, triseriate, outer bracts smallest, foliaceous, green, ovate-oblong; inner ones membranous; hypanthium convex, light green after fruit drop. Ray flowers (marginal) 5-6, female, corolla pale yellow or white, with greenish-yellow limb, 3-4 lobed, 8 mm long. Disc flowers bisexual, numerous, dense, inner ones longest, corolla bright yellow, 6-7 mm long with tube. Achenes brown or black, 2-2.5 mm long, elongated; with short, white hairs at top, pappus comprising of 15-20 long stiff bristles, 3-5 mm long.

Propagation: by seeds (achenes)

Ecology: On moist or dry areas, sunny or shady sites along borders of ditches and drains, roads, cultivated lands, wastelands; often gregarious forming large masses; in wetland or upland rice-fields mainly on bunds.

Distribution: South and South-East Asia. Throughout the Wet Zone of Sri Lanka up to about 1500 m altitude.

Agricultural Importance: A weed of minor importance in rice-fields.

Figure 64: a. Habit (x 1/2); b. flower-head (x 20); c. leaf; d. unopened head; e1, e2, e3. ray flower (female) with palea (x 20); f1, f2, f3. disc flower with palea (x 20); g. achene with pappus (x 20); h. achene; i. mature seed-head (x 4)

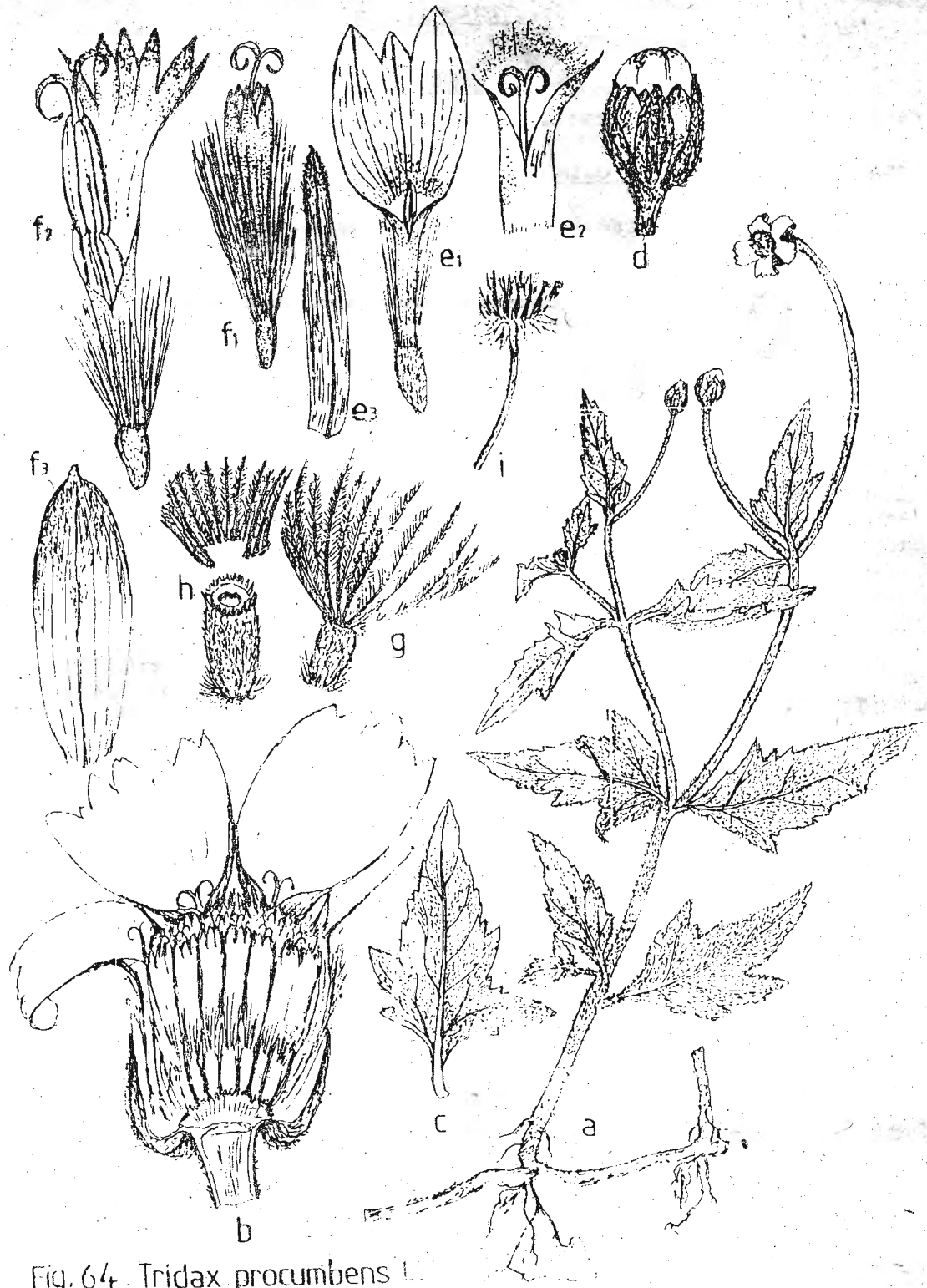


Fig. 64. *Tridax procumbens* L.

65. VERNONIA CINEREA

Family: Asteraceae

Botanical Name: Vernonia cinerea (L.) Less.

Synonym: Vernonia laxiflora Less.
Vernonia abbreviata DC.

Vernacular Name: Monara-kudumbiya (S); little-ironweed (E)

Description:

Annual, highly variable, erect herb usually with branches from base, 10-100 cm tall, with strong tap root. Stems stiff, cylindrical and ribbed, greenish or purplish, with fine hairs. Leaves simple, helically arranged, lower ones petioled, very variable, obovate, ovate-oblong with decurrent base; upper leaves very small, sessile, oblong or lanceolate, margins somewhat superficially crenate, finely hairy on both sides. Flower heads numerous, 5-8 mm long, 20-30-flowered, composed only of disc flowers; Involucral bracts 4-seriate, green or purplish, elongate-linear, finely pilose with white short hairs. Disc flowers bisexual, much longer than involucre, actinomorphic, 3-4 mm long, lobes 5, purple, pink or white. Achenes brown or black, compressed, 1-2 mm long, elongated; with short, white hairs at top, pappus hairs biseriate, white, dentate, 0.2-5 mm long.

Propagation: by seeds (achenes)

Ecology: On moist poorly drained wet areas, sunny or shady sites along borders of ditches and drains, in cultivated lands, plantations, along roadsides; in rice-fields on bunds.

Distribution: Pantropical. Throughout the Wet Zone of Sri Lanka up to about 1500 m altitude.

Agricultural Importance: A weed of considerable importance in Sri Lanka's low-country rice-fields.

Figure 65: a. Habit (x 1/2); b. leaf (x 1); c. immature flower head (x 10); d. mature head; e. very young head; f. disc flower (x 20); g. corolla tube- opened to show pistil; h. syngeneicious anthers (x 40); i. achene with pappus and (older) without pappus; j. receptacle after release of achenes.

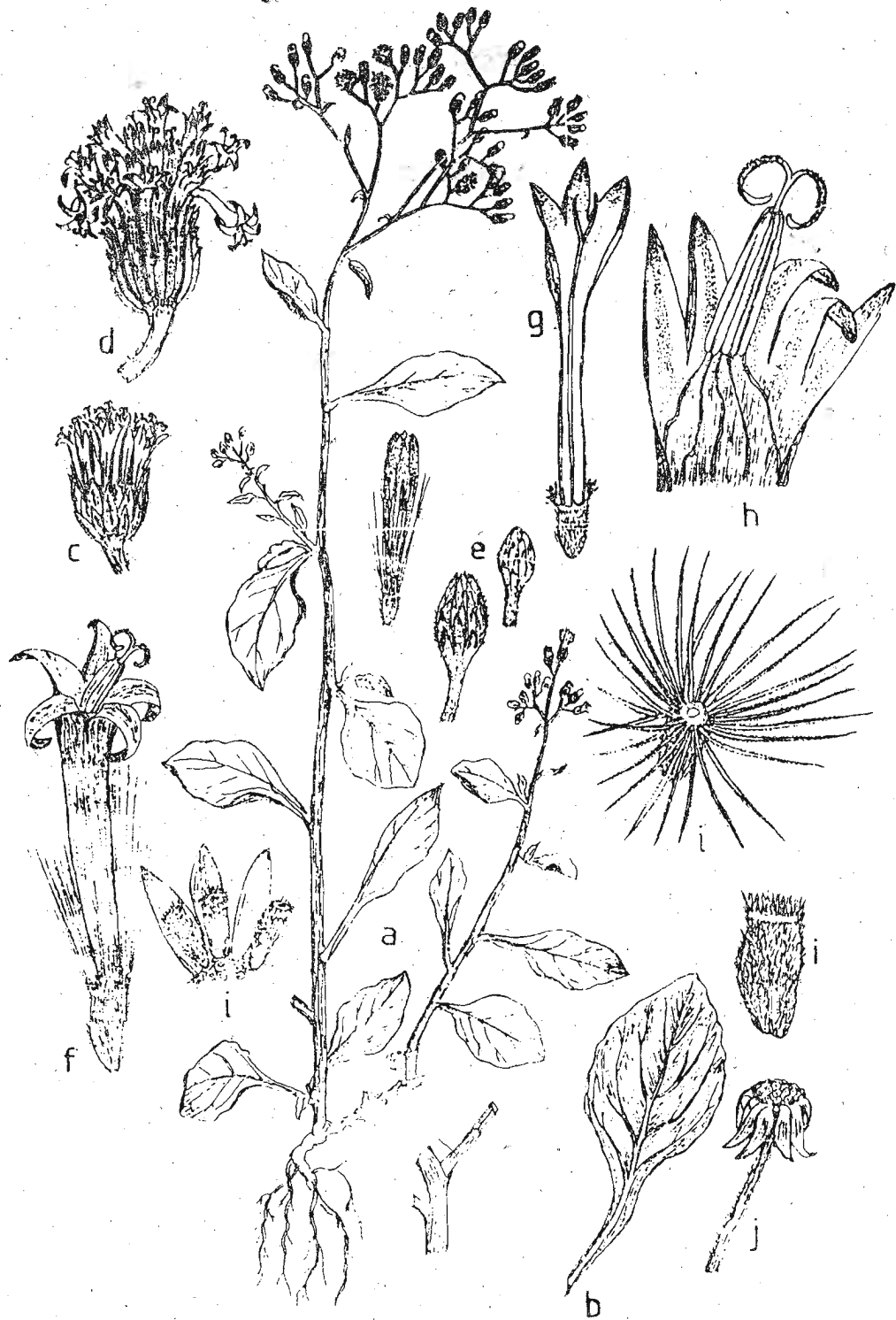


Fig. 65. *Vernonia cinerea* (L.) Less.

2.4 OTHER MONOCOTYLEDONOUS WEEDS

66. COMMELINA DIFFUSA

Family: Commelinaceae

Botanical Name: Commelina diffusa Burm.f.

Synonym: Commelina nudiflora *** (non L.)

Vernacular Names: Gira-pala (S)

Description:

Ascendent or prostrate, dichotomously branched fleshy annual or perennial herb. Stems cylindrical, 20-100 cm long, much rooted, hairy. Leaves simple, helically arranged, parallel veined, distinctly petioled, ovate-oblong or ovate-lanceolate, 2.5-8 x 1-2.5 cm; base obtuse or acute, sheathing with cylindrical sheaths. Inflorescences terminal and axillary, solitary or 2-4 together, peduncled; Inflorescence inside a large folded bract (spathe). posterior peduncle 10-25 mm long, much exserted, with 1-3 male flowers; anterior peduncle 5-10 mm long with 2-5 bisexual flowers; Flowers zygomorphic, 3-merous; sepals membranous, 3-4 mm long, the two posterior ones connate at base; petals clear blue, the two posterior ones (with claws) 5-10 mm long, anterior one smaller (3-5 mm). Fertile stamens 3, Stamines usually 2. Ovary 3-locular, glabrous, styles blue. Fruit a capsule, oblong, acute up to 6-7 mm long, 3-5 seeded. Seeds reticulate-ribbed, ridged on one side, grey-black.

Propagation: by seeds and stolon fragments.

Ecology: In places continuously damp for much of the year, sunny or lightly shaded waste places, roadsides, or among grass; along ditches, drains, irrigation canal banks; Common on bunds of rice-fields both in lowland-irrigated or rain-fed fields.

Distribution: Pantropical. Throughout the Wet Zone in Sri Lanka, up to medium altitudes.

Agricultural Importance: A weed of considerable importance in cultivated rice-fields and bunds. It is known to become a noxious weed by overgrowing in neglected fields.

Figure 66: a. Habit (x 1/2); b. inflorescence (x 4); c. flower (x 4); d. stamen (x 10); e. staminodes (x 10); f. pistil (x 10); g. maturing fruit (x 10); h. seed- two views (x 20)

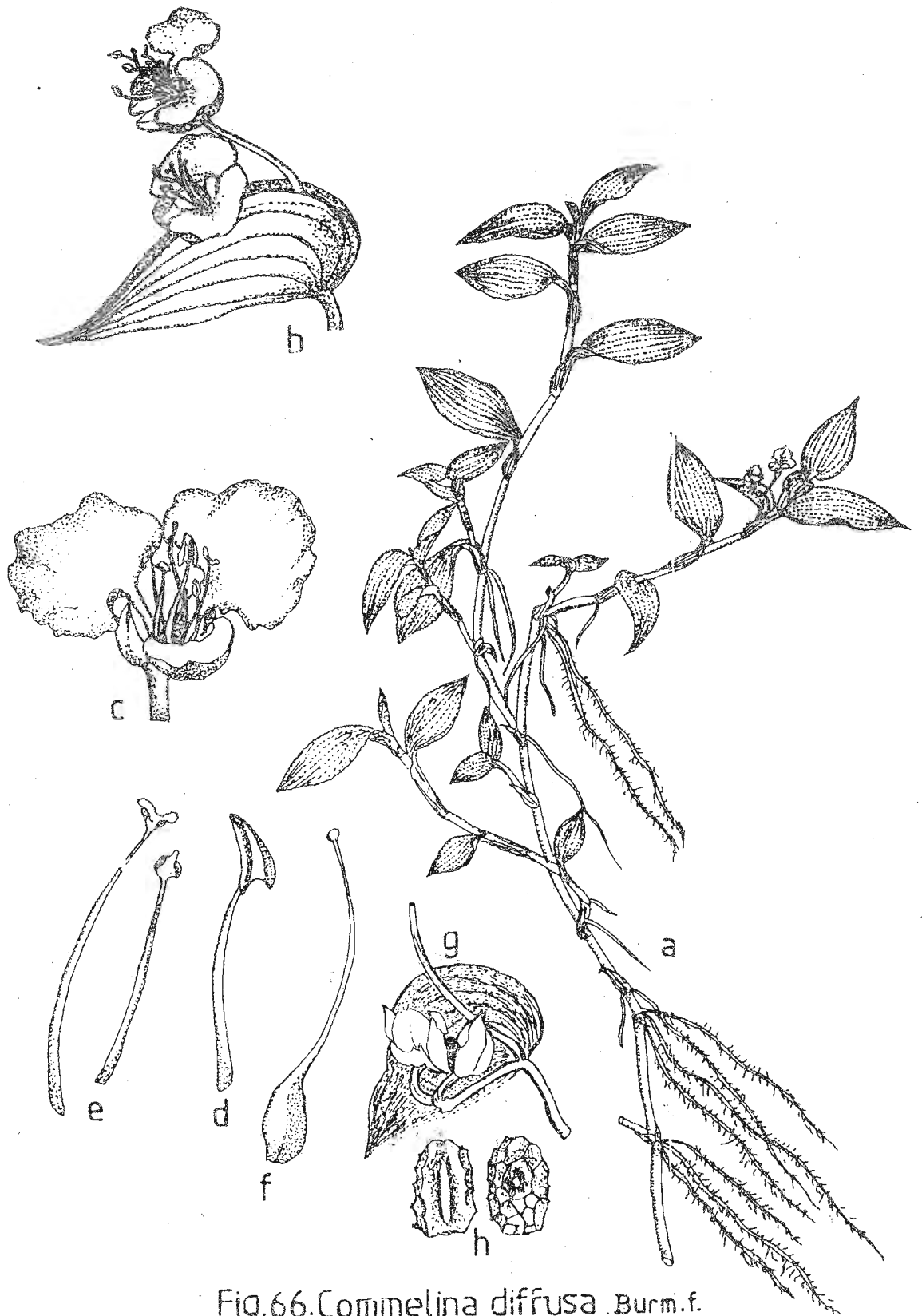


Fig.66. *Commelina diffusa* Burm.f.

67. EICHHORNIA CRASSIPES

Family: Pontederiaceae

Botanical Name: Eichhornia crassipes (Mart.) Solms

Vernacular Names: Water-hyacinth (E) ; Japan-jabara (S)

Description:

Floating or in shallow water rooting perennial plant with axillary stolons, forming easily detachable new plants at the ends. Stems densely covered with petiole bases and roots and numerous rootlets. Leaves in rosettes, thick, glossy green, broadly ovate, with subcordate or rounded base and obtuse apex, 7-25 cm in diameter, glabrous; petiole spongy, up to 30 cm in adult leaves, gradually narrowed upwards. Flowers zygomorphic, bisexual, in long-stalked, erect spikes, up to 50 cm long, bearing 18-35 flowers, bending downward after flowering; peduncles with 2 bracts (spathes), tubular; perianth also tubular; tube 15-18 mm long, base green, top pale green; lobes 6, mauve in colour, the anterior one 3-4 cm long. Stamens 6, attached to perianth tube, the 3 anterior ones small, other 3 much longer. Ovary superior, 3-celled, multi-ovulate, axile placentation; style long, slender; stigma hairy with 3 lobes; Capsule membranous, 3-valved, surrounded by persistent perianth. Seeds many, minute, ribbed, obovoid.

Propagation: by seeds and plant fragments.

Ecology: In stagnant or slow-moving shallow or deep freshwater pools, watercourses, rivers, ponds, reservoirs, lakes, ditches, canals; on water-saturated soils; often forming dense large mat-like masses; Often gregarious. Common in irrigation canals supplying rice-fields and associated habitats.

Distribution: Pantropical. Throughout the Wet Zone in Sri Lanka, up to medium altitudes.

Agricultural Importance: One of the World's worst aquatic weeds, infesting canals, watercourses and reservoirs. A weed of minor importance in cultivated rice-fields. However, it is known to become a major noxious weed by overgrowing in any water body associated with the fields.

Figure 67: a. Habit (x 1/4); b. flower (x 2); c. flower- opened; d. stamen (x 10); e. pistil (x 10); f. T.S. ovary; g. maturing capsule; h. capsule with persistent calyx (x 10); i1, i2. L.S. and T.S. capsule (x 20); j. seed (x 40)



Fig. 67. *Eichhornia crassipes* (Mart.) Solms

68. ERIOCAULON QUINQUANGULARE

Family: Eriocaulaceae

Botanical Name: Eriocaulon quinquangulare L.

Description:

Tufted herb, 5-20 cm tall, with a very large mass of fibrous roots. Leaves linear-lanceolate with a broader base and acute tip, 4-12 x 1-1.5 cm. Flower heads globose or hemispherical, 0.5-1.5 cm in diameter; peduncles glabrous, 10-20 cm long; sheath at the base of peduncle loosely appressed; involucre bracts ovate-oblong, 2-3 mm long; floral bracts triangular, acute with short-hairy top, 2-3 mm long. Male flower: sepals 3, petals 3, stamens 6; Female flowers: sepals 3, hairy, petals 3, hairy, ovary 3-celled each with one ovule, style 3-fid; capsule loculicidally dehiscent; seeds brownish.

Propagation: by seeds.

Ecology: In soggy grasslands, borders of water bodies, in canals, ditches and drains with slow-moving shallow water; often forming dense infestations in rice-fields.

Distribution: Pantropical. Throughout the Wet Zone in Sri Lanka, up to medium altitudes.

Agricultural Importance: A very common weed infesting rice-fields, and therefore, probably of some importance.

Figure 68: a. Habit (x 1/4); b. sheath of peduncles; c. flower head (x 10); d. involucre bract (x 20); e. floral bract (x 20); f. female flower; g. male flower; h. capsule; i. seed (x 40)

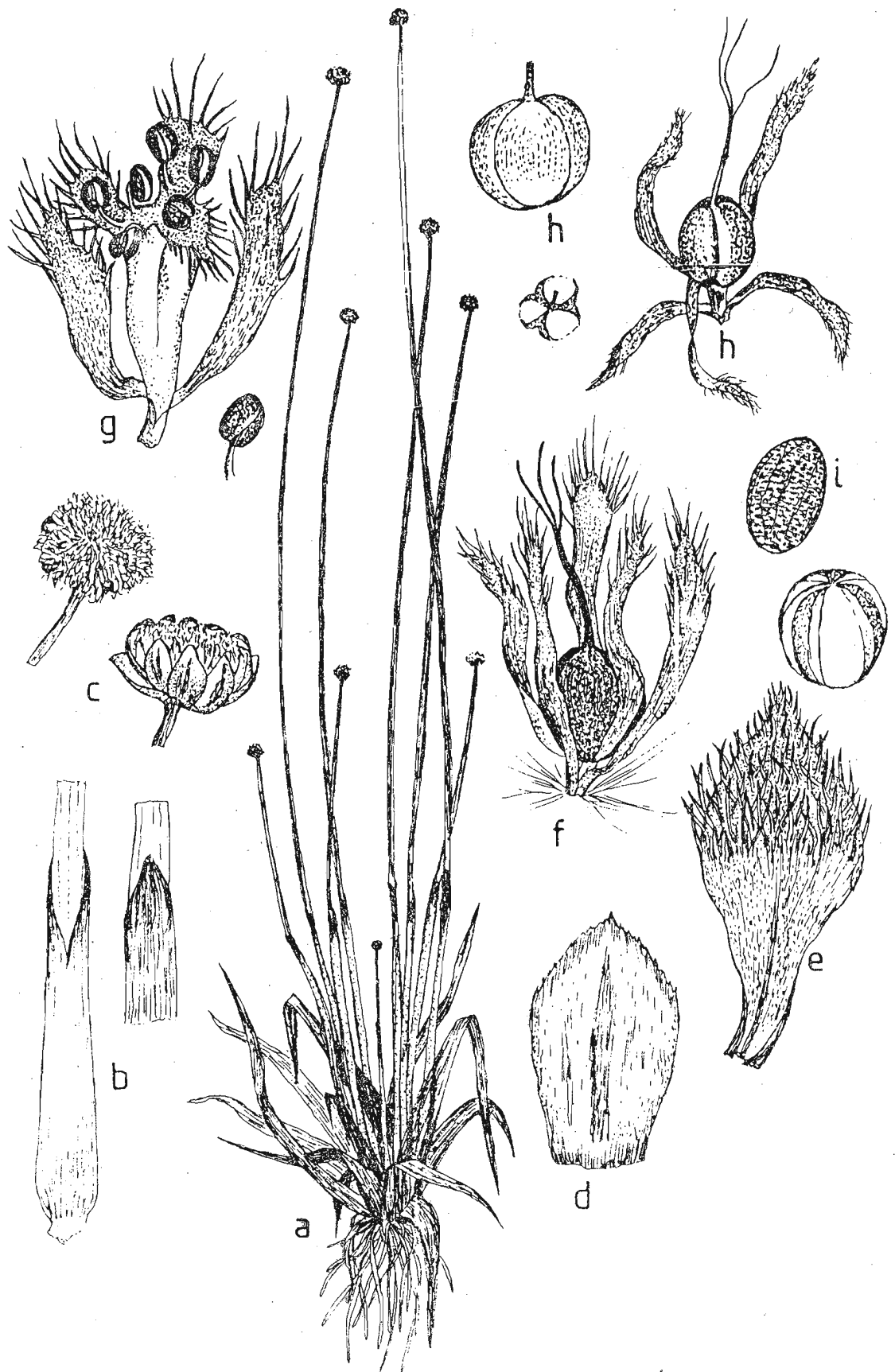


Fig.68. Eriocaulon quinquangulare L.

69. ERIOCAULON THWAITSII

Family: Eriocaulaceae

Botanical Name: Eriocaulon thwaitsii Koern.

Description:

Tufted small herb of marshy sites, 5-12 cm tall, with a very large mass of fibrous roots. Leaves entire, arranged in a rosette, linear-lanceolate with a broader base and acute tip, 2-6 x 0.5-1 cm. Flower heads globose or hemispherical, 0.25-0.5 cm in diameter; peduncles glabrous, 5-12 cm long; sheath at the base of peduncle loosely appressed, toothed; involucre bracts ovate-oblong, 1-2 mm long; floral bracts oblong-triangular, 1-1.5 mm long. Male flower: sepals 3, connate into a laterally split sheath, petals minute, stamens 6; Female flowers: sepals 3, petals lacking, ovary 3-celled each with one ovule, style 3-lobed; capsule loculicidally dehiscent; seeds brownish.

Propagation: by seeds.

Ecology: Attached to mud in borders of water bodies, in canals, ditches and drains with slow-moving shallow water; often forming dense infestations in rice-fields, with or without standing water.

Distribution: Pantropical. Throughout the Wet Zone in Sri Lanka, up to medium altitudes.

Agricultural Importance: One of the commonest monocotyledonous weeds in the low-country Wet Zone rice-fields, mostly at the early part of growing season. Probably a weed probably of some importance, because of its high occurrence.

Figure 69: a. Habit (x 1); b. sheath of peduncles; c. flower head (x 10); d. involucre bract (x 20); e. floral bract (x 20); f. female flower; g. male flower; h. capsule; i. seed (x 40)

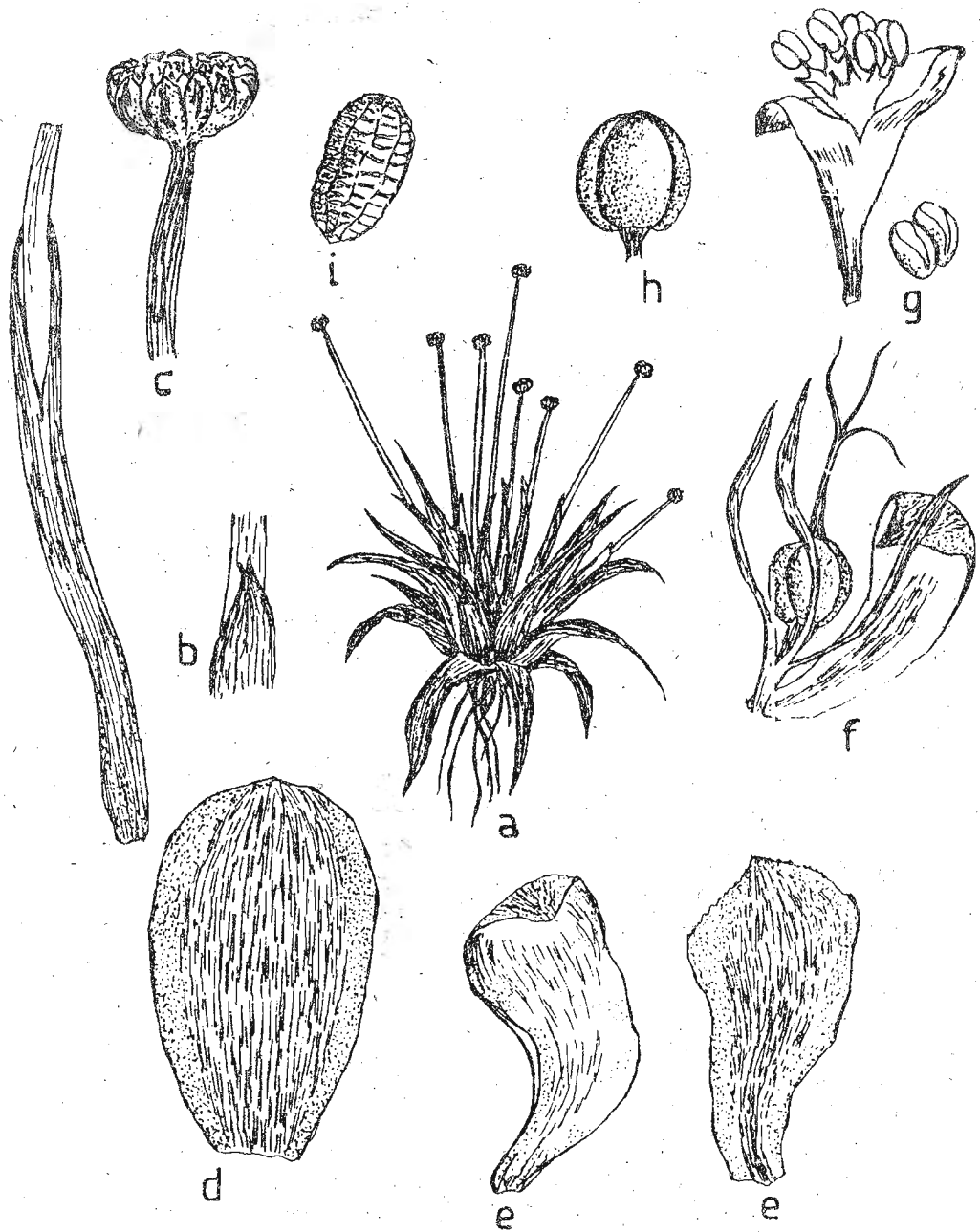


Fig. 69. *Eriocaulon thwaitzii* Koern.

70. LIMNOCHARIS FLAVA

Family: Butomaceae

Botanical Name: Limnocharis flava (L.) Buchenau

Vernacular Names: Yellow water-lettuce (E); Diya-Gowa (S)

Description:

Perennial plant which behaves like an annual because of desiccation of the site. Robust, erect, laticiferous marsh-herb, 20-100 cm tall, rooting in mud, strongly tillering. Leaves basal, glabrous, long-petioled, orbicular or ovate, 5-30 x 4-25 cm, entire, yellowish green, curvined, transversed lattice-veined, leaf apex with a water pore; petiole acutely trigonous, thick, sheathing at base, 5-75 cm long. Inflorescence axillary, long-peduncled, umbelliform, 5-15 flowered, erect, recurved after fruiting until it reaches the water or mud; peduncles 10-90 cm long. Flowers rather large, in axils of membranous bracts; pedicels 3-7 cm long; sepals 3, yellow-green, ovate-elliptic; petals 3, pale yellow, obovate 1.5-3 x 0.6-2 cm; stamens more than 15, surrounded by a whorl of staminodes. Ovaries superior, numerous in one whorl, laterally compressed simulating a single, deeply-incised ovary. Compound fruit, 1.5-2 cm in diameter, enclosed by sepals. Seeds numerous, horse-shoe shaped, dark brown, 1-1.5 mm long, testa spongy with transverse ridges.

Propagation: by seeds.

Ecology: In freshwater pools, ditches, swampy marshes in the wetter regions. Often gregarious. Common in neglected rice-fields which are periodically flooded. In lowland-irrigated or rain-fed fields.

Distribution: South East Asia, India. Throughout the Wet Zone in Sri Lanka, up to medium altitudes.

Agricultural Importance: A weed of minor importance in cultivated rice-fields. However, it is known to become a noxious weed by overgrowing in neglected fields.

Figure 70: a. Habit (x 1/5); b. young flower buds; c. flower- ventral and lateral views (x 1); d. L.S. flower- showing attachment of stamen and ovary; e. stamens (x 10); e1. staminodes; f. mature ovary; g. compound fruit of many fruitlets (follicles) (x 10); h. T.S. and L.S. of fruit showing fruitlets; i. single fruitlet; j. seed (x 20)

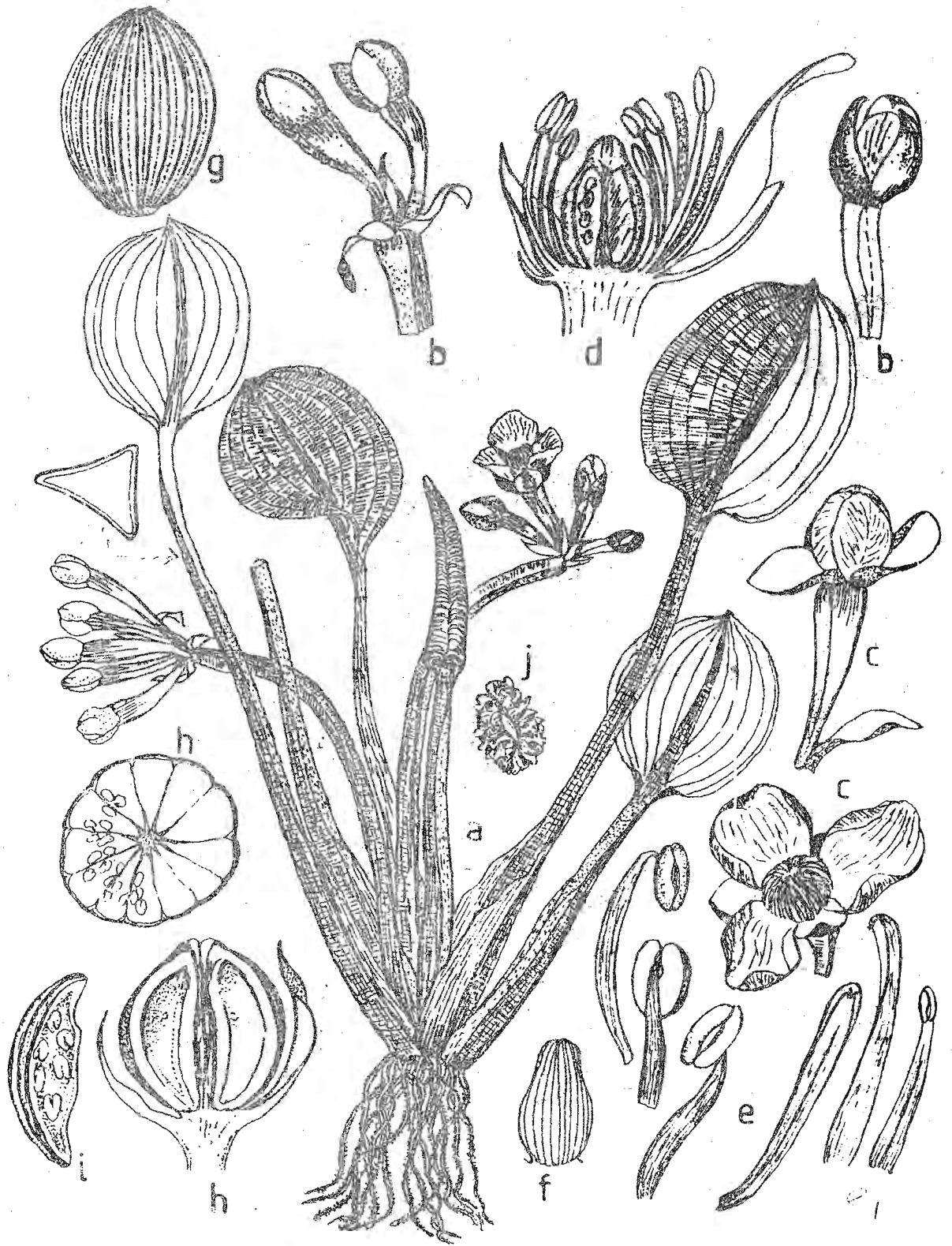


Fig.70. *Limnocharis flava* (L.) Buchen.

71. MONOCHORIA VAGINALIS

Family: Pontederiaceae

Botanical Name: Monochoria vaginalis (Burm.f.) Presl

Synonyms: Monochoria plantaginea Kunth
Pontederia vaginalis Burm.f.

Vernacular Names:

Description:

Annual or perennial, glabrous and fleshy strongly-tillering, erect, marsh-herb, 5-50 cm tall, rooting in mud, forming large clumps. Leaves basal, in rosettes, very variable, glabrous, lamina of mature ones ovate-orbicular, 2-12 x 1-10 cm, base cordate, apex acuminate; younger leaves may be linear, lanceolate or ovate-oblong. Inflorescence axillary, initially inside the sheath of apical leaf, later short-peduncled, 5-25 flowered racemes, recurved after fruiting until it reaches the water or mud. Flowers bisexual, actinomorphic, pedicelled (pedicel 5-25 mm long), bluish-purple perianth. Stamens 6, attached to base of perianth, unequal. Ovary superior, 3-locular, multi-ovulate. Capsule loculicid, ellipsoid, 1 cm long, 3-valved. Seeds 1 mm long, with thin longitudinal ribs.

Propagation: by seeds.

Ecology: In swampy marshes or innundated sites in the wetter regions; in and along ditches and canals; in all types of rice-fields and in neglected rice-fields which are periodically flooded.

Distribution: South East Asia, India. Throughout the Wet Zone in Sri Lanka, up to medium altitudes.

Agricultural Importance: A major weed of lowland rice being one of the most common monocotyledonous weeds found in cultivated rice-fields. It is known to die when fields are dry, but develop again from seed.

Figure 71: a. Habit (x 1/4); b. flower (x 2); c. L.S. young inflorescence within apical leaf; d. L.S. through young flower buds; e. flower- dorsal view; f. stamens and pistil (x 4); g. flower after anthesis; h. capsule (x 10); i. mature capsule; j. T.S. capsule showing seeds; k. seed (x 40)



Fig. 71. *Monochoria vaginalis* (Burm.f.) Kunth

72. XYRIS INDICA

Family: Xyridaceae

Botanical Name: Xyris indica L.

Vernacular Names: Kok-Mota (S)

Description:

Perennial, erect, robust grass-like marsh-herb, 10-100 cm tall, rooting in mud, strongly tillering. Leaves distichous, basal, 5-60 x 0.5-1 cm, linear, obtuse to acute tip; sheaths 5-30 cm long, sharply keeled, with slime inside. Inflorescence a terminal globose to ellipsoid head, 0.5-3.5 x 0.5-1.5 cm, with strongly imbricate persistent bracts; hollow-peduncled. Bracts thin, obovate, 5-8 x 5-7 mm, dark brown, base broad, apex obtuse; lower bracts empty; only 1-3 flowers opening simultaneously. Sepals 3, unequal; Petals 3 clawed, yellow, obovate, 8-10 mm long. Stamens 3, shorter than corolla; Staminodes 3. Ovary superior, with numerous ovules showing parietal placentation. Capsules 3-valved, 3-4 mm high. Seeds ellipsoid, ribbed, brownish.

Propagation: by seeds.

Ecology: In swampy marshes or innundated fields in the wetter regions. Common in neglected rice-fields and in lowland-irrigated or rain-fed fields.

Distribution: South East Asia, India and Australia. Throughout the low-country Wet Zone in Sri Lanka, up to about 700 m altitude.

Agricultural Importance: A weed of minor importance in cultivated rice-fields. However, it may become a noxious and very troublesome weed by overgrowing in neglected fields.

Figure 72: a. Habit (x 1/4); b. bract (x 5); c. flower (x 5); d. corolla- opened; e. stamen (x 10); f. staminode (x 10); g. pistil (x 10); h. capsule (x 10); i. seed (x 25)

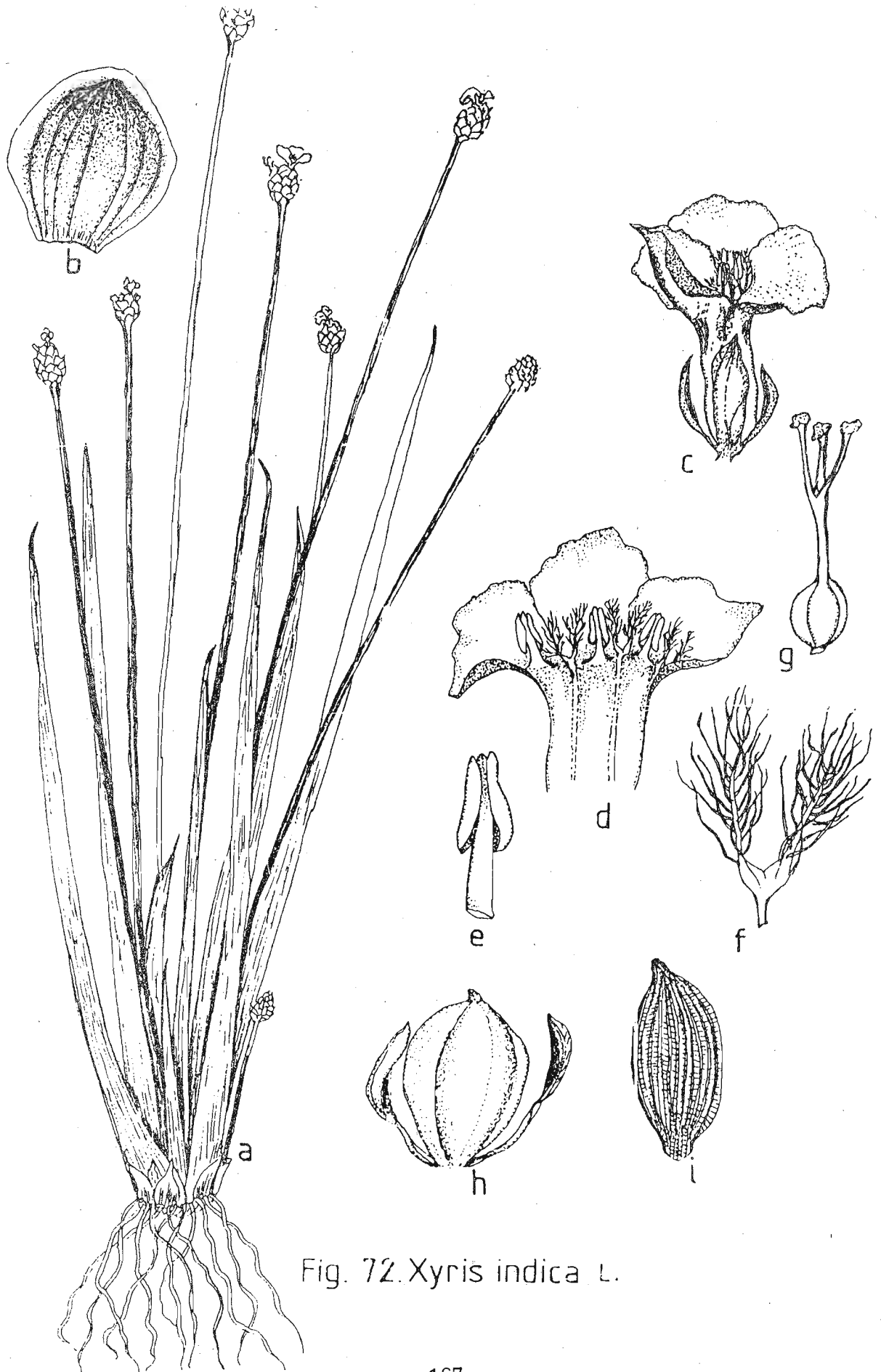


Fig. 72. *Xyris indica* L.

2.5 FERNS & ALLIES

73. MARSILEA QUADRIFOLIA

Family: Marsiliaceae

Botanical Name: Marsilea quadrifolia L.

Description:

Perennial, aquatic fern common on marshy sites. With creeping rhizomes/runners, bearing 4-folioled leaves on 2-30 cm long petioles, remote, erect and often emergent or floating; each leaflet obovate with rounded top, 3-30 x 2-20 mm in size, somewhat fan-shaped; veins repeatedly bifurcating; young leaves circinate. Sporocarps near base of petioles, usually 2-6 together on 3-5 mm long peduncles, hairy on outside.

Propagation: by sporocarps.

Ecology: In swampy marshes or inundated fields in the wetter regions. Common in lowland-irrigated or rain-fed fields.

Distribution: Pantropical. Throughout the low-country Wet Zone in Sri Lanka.

Agricultural Importance: A weed of minor importance in cultivated rice-fields.

Figure 73: a. Habit (x 1/2); b. single leaflet (x 4); c. sporocarp (x 10)

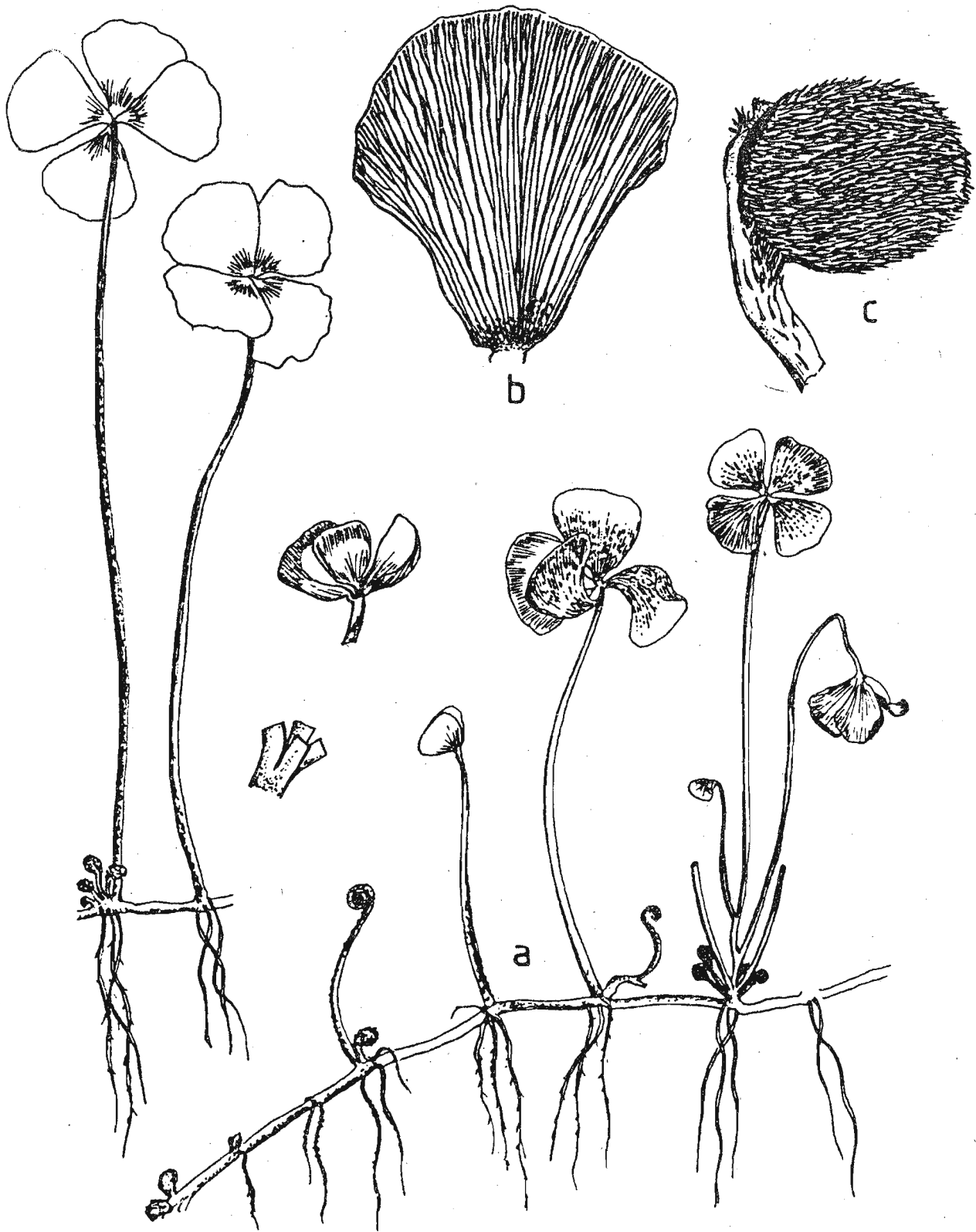


Fig. 73. Marsilea quadrifolia L.

74. SALVINIA MOLESTA

Family: Salvinaceae
Botanical Name: Salvinia molesta D. S. Mitchell
Vernacular Names: Salvinia (S, E); Kariba-weed (E)

Description:

Annual or Perennial, free-floating aquatic fern; rapid-growing, branched and forming thick mats which float on water; restricted to freshwater, brackish, polluted. Each plant may grow up to 30 cm with slender stolons, without roots, made up only of leaves in alternating whorls of three; 2 are green and floating, the third one finely dissected into numerous root-like filaments, which function as absorbing structures. Floating leaves with short stalks, ovate-oblong, up to 35 x 25 mm with cordate base, emarginate apex, bearing numerous compound hairs on upper side, each hair consisting of 4 uniseriate hairs distally united to form a cage-like structure; lower surface mostly glabrous except for simple hairs near mid-vein. Submerged root-like leaf up to 5 cm long, central filaments (fertile ones) bearing globose, shortly pillose sporocarps; basal, smaller ones with megasporangia, each producing one megaspore; distal, more numerous male sporocarps, containing numerous microsporangia and microspores.

Propagation: mainly by fragments.

Ecology: Mostly on stagnant or slow-moving fresh-water, shallow or deep; ponds, lakes, irrigation canals, watercourses, in swampy marshes or inundated rice-fields in the wetter regions. Often very abundant covering whole water surfaces.

Distribution: Pantropic. Throughout the low-country Wet Zone in Sri Lanka, up to about 800 m altitude.

Agricultural Importance: A weed of minor importance in cultivated rice-fields. However, it may become a noxious weed by overgrowing in irrigation canals, fresh-water 'tanks' which supply water for fields, or by infesting neglected fields and other low-lying areas, often causing abandonment of such areas.

Figure 74: a. young plant growing under uncrowded conditions (x 1); b. old plant under crowded condition (x 1); c. node with two floating leaves and one 'rooting' leaf with a chain of sporocarps; d. a chain of sporocarps (x 10); e1, e2, e3. papillae on leaf surface

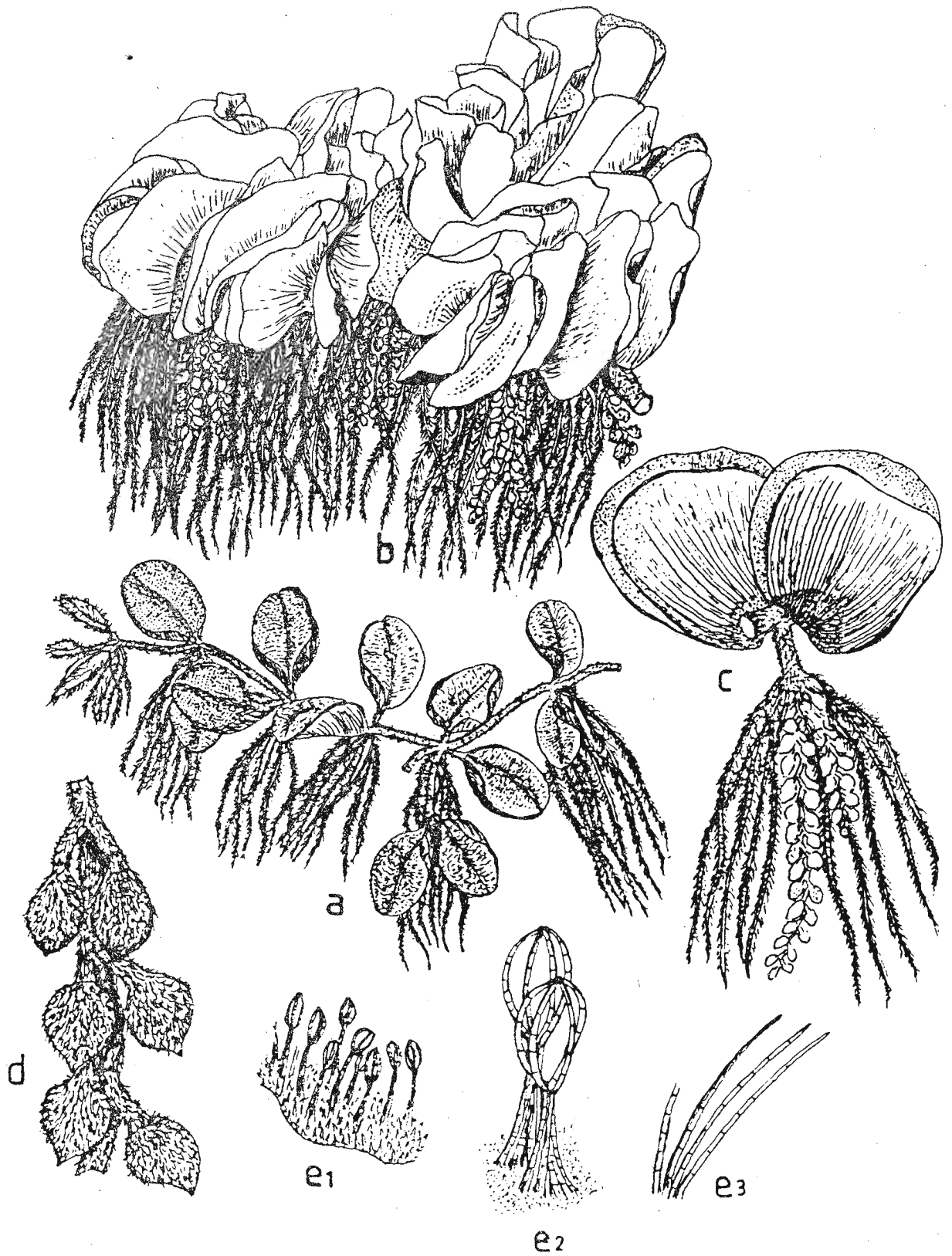


Fig. 74. *Salvinia molesta* D.S. Mitchell

SECTION 3GLOSSARY

- Abaxial.** Facing turned away from the axis.
- Achene.** A small, dry, hard, one-seeded, indehiscent fruit especially Asteraceae (Compositae).
- Actinomorphic.** Having flowers with radial symmetry.
- Acuminate.** Tapering to a slender point; drawn out into a long slender point.
- Acute.** With top distinctly and sharply pointed, but not drawn out.
- Adaxial.** Next to the axis; facing the axis.
- Adnate.** Designating the union of unlike parts; designating the condition of being grown together.
- Adventitious.** Originating from other than usual place; for example, roots arising from stem. **buds.** Those produced abnormally, as from the stem instead of the axis of the leaf. **roots.** Those which do not arise from the radicle or its subdivisions, but from another part.
- Aerenchyma.** Loose tissue containing air; tissue of thin-walled cells with large air spaces.
- Alternate.** Placed singly on the parent axis, resulting in zigzag arrangement; occurring on opposite sides of the stem at successive nodes.
- Angular.** With angles. **Obtusangular.** With obtuse angles. **Sharply angular** With acute angles. **Multangular.** With 3,4, etc., many angles.
- Annual.** A plant completing its life cycle in less than one year.
- Anther.** The part of the stamen which produce pollen.
- Anthesis.** The period of flowering; the time of the expansion of a flower; the time when fertilization takes place.
- Anthocarp.** A fruit formed by the union of floral organs, or part of them, with the fruit itself.
- Apex.** Top. **Apical.** On top.
- Apiculate.** Having a short and sharp, but not stiff, point.
- Appressed.** Lying close to; pressed closed to; flat against something.
- Archegonium.** The structure containing the female sex cells.
- Aril.** An expansion of the funiculus which arises from the placenta and envelops the seed.
- Articulate.** Joined; separating easily at certain points.
- Ascending.** Directed upwards, as the stem.
- Asymmetrical.** With dissimilar sides.
- Attenuate** Tapering slenderly; narrowed.
- Awn.** A bristle-like appendage.
- Axillary.** Situated in, growing from, or pertaining to an axil.
- Axis.** The main stem of a plant or an inflorescence.
- Basifixed.** Attached or fixed by the base.
- Beak.** A pointed projection at the tip of a fruit or a seed.
- Berry.** A simple fruit having a pulpy or fleshy ovary wall.
- Biconvex.** Convex on both sides.
- Bipinnate.** Twice pinnate.
- Bisexual.** Having both sexes.
- Blade (lamina).** The expanded portion of a leaf.
- Bract.** A modified leaf just below an inflorescence of flower.
- Bracteate.** With bracts.
- Bracteole.** A secondary bract; a bractlet; a small bract.

Branchlet. Small branch; ultimate division of a branch.
Bristle(seta). Thick stiff hair.
Bud. An undeveloped shoot or stem. **Apical.** Bud on top of an axis, not an axil. **scale.** Scale on a bud
Caducous. Falling early.
Callose. Hard and thick in structure.
Calyx. The outer ring of flower structures, made up of separate or joined sepals.
Campanulate. Bell shaped.
Canaliculate. Channeled; with a longitudinal groove.
Capillary. Hairlike; very slender.
Capitate. Gathered into a mass at apex; having a globose head; head-shaped.
Capsule. A dry dehiscent fruit composed of more than one carpel, having many seeds, and usually opening at maturity by valves or teeth.
Carpel. One of the innermost ring of flower structures, containing an ovary and later, seeds.
Caryopsis. The grain or fruit of grasses; a small, one-celled, one-seeded, dry, indehiscent fruit with a thin pericarp united to the seed.
Caudate. With a tail or any tail-like appendage.
Cauline. Produced by the stem; belonging to the stem.
Ciliate. Fringed on the margins with short, usually stiff, hairs.
Clavate. Club-shaped.
Claw. The narrow, basal part of a petal.
Composite. The type of flower found in Compositae. The apparent flower consists of a number of small flowers aggregated into a head and surrounded by one or more rows of bracts.
Compound (of leaves). Leaves divided into separate blades. **Doubly, twice, repeated.** 2 or more compound.
Concave. With surface rounded or bent inwards.
Conduplicate. Folded together lengthwise. **Induplicate.** The blade folded lengthwise along the midrib so that the halves of the upper surface lie together. **Reduplicate.** The blade folded lengthwise along the midrib so that the halves of the lower surface lie together.
Conical. Having the form of a cone.
Connate. United (similar organs).
Connective. The portion of a stamen, distinct from the filament, which connects the two lobes of an anther.
Constricted. Suddenly drawn together; contracted, narrower than surroundings. **Constriction.** Place where drawn together, where contracted.
Contiguous. Adjoining, touching cells each other at the ends of the edges.
Contorted Twisted or bent.
Convex. With surface rounded or bent inwards, as if swollen.
Convolute. Rolled so that one part is covered by another.
Cordate. Heart-shaped; with notched base. **Semi.** Cordate but with one-sided notched base.
Coriaceous. Leathery.
Corolla. The petals of a flower; the inner perianth.
Corolla tube. The tube formed by the joined bases of the petals.
Corona. An appendage above a corolla (sometimes incorporating parts of the stamens).
Corrugated. Rugose; wrinkled.
Corymb. An inflorescence in which the upper pedicels are shorter than the lower so that all the flowers are at approximately the same level.
Costa. Main nerve; midrib.

Costate. With one or more primary longitudinal nerves.
 Cotyledon. Leaf of an embryo.
 Creeping. Running along the ground, rooting at intervals.
 Crenate. With blunt protrusions and sharp incisions.
 Cuculate. Hooded or hood-shaped.
 Culm. The stem of a grass or sedge.
 Cunnate. Wedge-shaped with the narrow part below; triangular with the acute end at the point of attachment.
 Cusp. Sharp rigid point. **Cuspidate.** Tipped with a cusp.
 Cyme. A usually broad and more or less flat-topped determinate inflorescence, the central or terminal flowers opening first.
 Deciduous. Falling at certain seasons or stages of growth.
 Decomound. Several times divided or compound.
 Decumbent. Reclining, with the apical part ascending.
 Decurrent. Prolonged on another organ beyond insertion: extending down the stem below the point of insertion.
 Dehiscent. Bursting open; splitting apart along definite lines, as a capsule or another may do; discharging its contents, usually at maturity.
 Dentate. Toothed with acute protrusions and blunt incisions.
 Denticulate. Minutely toothed.
 Didynamous. Having four stamens in pairs, two long, two short.
 Digitate. Spreading like the fingers of a hand; compound, with the members arising from together from a common point.
 Dimorphic. Occurring in two forms or states.
 Disc-floret. One of a central florets of a composite flower.
 Desciform. Disk-shaped, with the shape of a disk.
 Dissected. Deeply divided or cut into many segments.
 Distichous. In 2 opposite rows.
 Divaricate. Widely divergent.
 Divided. Characterized by a lobing or segmentation which extends to the base.
 Drupe. A fleshy, pulpy or fibrous fruit with a hard endocarp (the stone) enclosing a single seed.
 Echinate. With patent prickles.
 Elliptic. Regular oval; with the outline of an ellipse, about twice as long as wide.
 Emarginate. Bluntly incised (not noched), usually at extremity.
 Emersed. Raised about and out of the water.
 Entire. With even margin without toothing or incisions.
 Epicotyl. First internode of the stem above the cotyledons.
 Epigynous. Borne on the ovary; said of floral parts in which the ovary is inferior.
 Epipetalous. Borne on or adnate to the petals.
 Erect. upright. **Erect-patent.** Between spreading and erect.
 Even-pinnate. Having a pinnately compound leaf which has no terminal leaflet.
 Expanded. Spread out.
 Exserted. Protruding beyond some enclosing organ or part.
 Exstipulate. Without stipules.
 Falcate. Sickle- or scythe-shaped.
 Fascicle. Bundle. **Fascicled.** In bundles.
 Felted. Matted with intertwined hairs.
 Female flower. A flower with functional ovaries but no stamens.
 Fertile (of flowers). Capable of producing viable seeds.

Filament. The part of a stamen that supports the anther.
Filiform. Thread-shaped.
Fimbriate. With margin divided into fringe.
Flaccid. Limp or flabby.
Fleshy (succulent). Thick, not flexible. **Thick.** Very thick and massive.
Flexuous. Repeatedly curved.
Floret. A small flower, usually one of a cluster, as found in members of the Asteraceae or in grasses.
Flower head. A group of flowers clustered into a head.
Foliaceous. Leaf-like, flat and broad; having the texture or shape of a leaf.
Foliar. Relating to a leaf. **Foliary axil.** Angle between stem and upper side of a leaf.
Foliate. Denoting the number of leaves.
Fronnd. The leaf of ferns which bears spore-producing structures.
Funiculus. The cord or thread which sometimes connects the ovules or seeds to the placenta.
Fusiform. Spindle-shaped.
Gamopetalous. Having flower petals that are fused to each other, either at the base only or throughout their length.
Geniculate. Abruptly bent so as to resemble the knee joint.
Glabrous. Without hairs. **Glabrescent.** Becoming glabrous or slightly so.
Gland. Secreting structure; warty swelling. **Stipitate.** Gland on stalk.
Glandular. With glands. **hair.** Hair with gland on top.
Glaucous. Bluish or greyish green, usually because of waxy coat.
Globose. Almost spherical. **Semi.** Half-globose.
Glomerule. An inflorescence with flowers crowded in small compact clusters.
Glume. One of the two empty, chaffy bracts at the base of the spikelet in grasses.
Gynobasic. Applies to a style which arises from the base of the ovary.
Hairiness (Pubescence). Type and quantity of hairs. **Hairy.** With hairs.
Hastate. Arrowhead-shaped (triangular), with the basal lobes spreading at nearly right angles.
Head. A dense inflorescence of sessile or subsessile flowers.
Herb. A plant generally lacking definite woody structure.
Heterophyllous. With leaves of more than of one shape.
Heterostylic. Having unlike or different style lengths.
Hilum. The scar or mark on a seed at the point of attachment to the placenta.
Hispid. Coarsely and stiffly hairy.
Hyaline. Colourless or translucent.
Hypanthium. Cup-like receptacle derived usually from the adnation of floral parts and on which are seemingly borne sepals, petals and stamens.
Hypocotyl. Stem below the cotyledons.
Hypogynous. Free from, but inserted beneath the ovary.
Imbricate. Overlapping as the tiles on a roof.
Imparipinnate (Odd-pinnate). Pinnate with one terminal leaflet.
Incised. Cut into; cut sharply into margin. **Incision.** Indentation in margin of foliar organ.
Indehiscent. Not opening.
Indigenous. Native.
Inferior ovary. An ovary that is below the insertion of the other floral parts.

Inflorescence. The arrangement of flowers on a plant; a flower cluster.

Inserted. Placed, attached. **Insertion.** Place where borne.

Internode. Stem between nodes.

Interpetiolar. Between petioles; enclosed by expanded base of a petiole; applied to connate stipules which have coalesced from two opposite leaves.

Interrupted. Not continuous.

Involucre. A whorl of rosette of bracts, often resembling an ordinary calyx, subtending or supporting a flower cluster or fruit.

Involute. With edges rolled inwards.

Keel. The two partially joined petals of papilionaceous flowers which form a sharp edge resembling the keel of a boat; any sharp edge which runs longitudinally.

Kidney-shaped. Reniform.

Laciferous (laticiferous). With latex.

Lamina (blade). Uppermost part of a leaf or leaflet, usually flat and spread out.

Lanceolate. Shaped like the head of a lance, several times longer than wide, broadest near the base and tapering at both ends.

Lateral. Borne from the side of an organ. **bud.** Bud on stem or branch, not on top of it. **lobe.** Lobe on the side of an organ. **nerve.** Nerve borne by main nerve. **root.** Branch of main root.

Laterally compressed. Cylindrical but flattened on two opposite longitudinal sides.

Latex. Milky juice.

Lax. Loose.

Leaflet. A single division of a compound leaf.

Leaf scar. The scar left on a stem after a leaf has fallen.

Lemma. In the grasses, the lower of the usually two bracts immediately enclosing the flower.

Lens-shaped (lenticular). Doubly convex.

Ligulate. Strap-shaped or strap like.

Ligule. A strap-shaped body; the limb of the corolla in a ray flower (Compositae); small appendage at the base of a leaf blade in grasses.

Linear. Lone, narrow and more or less parallel-edged.

Lip. One of the lobes of a fused corolla which is partially split into segments as in many Labiatae.

Lobed (of leaves). Partially divided but not deeply enough to form separate leaflets.

Locule (loculus). compartment of ovary or anther.

Loculicidal. Said of capsules that are dehiscent along the loculus or back of the carpels.

Lodicule. Small delicate scale at the base of the ovary in a grass flower (usually 2 in number).

Longitudinal, Longitudinally. Lengthwise, in the direction of the length of an organ.

Male flower. A flower with functional stamens but no ovary.

Margin. Edge. **Marginal.** On the near edge. **nerve.** Nerve along edge.

Marginate. With a margin of distinct character.

Membranous. Like a membrane, thin and usually transparent.

Merous (2-, 3-merous, etc.) Having the parts in twos or threes, etc., or in multiples of two or three, etc.

Mesophyll. Interior parenchyma of a leaf, the part between the nerves.

Midrib. Main nerve, costa.

Monadelphous. With stamens united in one bundle by their filaments.

Monoecious. Having unisexual flowers with both sexes borne on the same plant.

Monomorphous. Of one form only.

Mucro. Sharp, straight terminal point on nerve, midrib or rachis, protruding from the leaf. **Mucronate.** With a mucro.

Multi- Many. **foliate.** With many leaflets.

Narrowed (attenuate). Gradually growing more narrow.

Node. The point on a main stem or branch where leaves or buds arise.

Nut. A dry, indehiscent, 1-locular, 1-seeded fruit with a bony, leathery or paper wall.

Oblique. With unequal sides; slanting.

Oblong (of leaves). Longer than broad with roughly parallel sides.

Obovoid. 3-dimensional, in the shape of an egg, broadest above centre.

Obtuse. Blunt or rounded at the tip.

Operculate. With a lid.

Orbicular. Flat with a circular outline.

Ovary. The lower part of the carpel which contains the ovules and eventually forms the fruit.

Ovate. Egg-shaped, with the broadest end downward.

Ovoid. Solid like an egg in form and attached at the large end.

Ovule. That which becomes a seed after fertilization.

Palea (in a grass spikelet). The upper of the two glumes enclosing a flower.

Palmate (of leaves). Divided into lobes or leaflets like the palm of a hand.

Panicle. A compound or branched inflorescence.

Papilla. A small elongated projection.

Papillose. Covered with a papillae.

Pappus. The bristle-like or hair-like structure at the junction of the achenes and the petal tube in the Asteraceae, often appearing terminally on the ripe fruit.

Parietal. Borne on or belonging to a wall.

Paripinnate (abruptly pinnate, even-pinnate). Pinnate ending in a pair of leaflets.

Patent. Spreading.

Pedicel. Stalk of flower or spikelet.

Peduncle. The common stalk of a group of flowers.

Pellucid. Wholly or partially transparent.

Peltate. Shield-shaped, as a leaf attached by its lower surface to a stalk instead of by its margin.

Pendulous. Hanging downwards.

Perennial. A plant living for two or more years.

Perianth. The floral envelope, consisting of one or two whorls of sterile elements (petals, sepals, tepals).

Pericarp. The ripened wall of the ovary when it becomes a fruit.

Perigone. Perianth.

Persistent. Remaining attached; not falling off.

Petal. One of the inner, usually showy, perianth segments.

Petiolate. With a petiole.

Petiole. The leaf stalk.

Pilose. Pubescent with long soft hair.

Pinna. One of the primary divisions of a pinnate leaf. The pinnae may themselves be pinnate.

Pinnate. With the leaflets arranged on opposite sides of a common stalk.

Pistil. The female part of a flower, usually consisting of ovary, style and stigma.

Prickle. Sharp hard outgrowth from rind or bark. **Prickly.** With prickles.

Procumbent. Lying along the ground.

Prominent. Standing out.

Propagule. The structure or organ by which plants are propagated; for example, seeds, cuttings, etc.

Prostrate. Lying flat on the ground.

Pubescence. Hairiness. **Pubescent.** With soft hairs.

Raceme. A simple interminate inflorescence of pedicelled flowers on a common, more or less elongated axis.

Rachilla. A small or secondary rachis; in grasses and sedges, applies especially to the floral axis of a spikelet as opposed to that of a spike.

Rachis. An axis bearing flowers or leaflets.

Radicle. Root of an embryo.

Ray. Inflorescence branch in Cyperaceae.

Ray floret. One of the outer florets of a composite flower when distinct from the disc florets.

Receptacle. The flattened or rounded terminal portion of the stem bearing various parts of the flower or florets.

Recurved. Curved downwards or backwards.

Reflexed. Bent sharply backwards.

Remote. Far from one another.

Reniform. Kidney-shaped.

Reticulate. Being in the form of a network; net-veined.

Retrose. Turned backwards.

Rhizome. The rootstock or flattened stem having rootlike appearance; prostrate or underground, sending off rootlets, the apex progressively sending up stems or leaves.

Rosette. A cluster of closely crowded radiating leaves that appears to arise from the ground.

Rounded. Broad-obtuse.

Rugose. Wrinkled. **Rugulose.** Slightly wrinkled.

Runner. An elongated stem growing horizontally above the ground and rooting at the nodes to form new plants.

Sagittate (sagittiform). Arrow-shaped, enlarged at notched base which has 2 acute straight lobes.

Scabrid. Rough to the touch.

Scabrous. Rough to the touch.

Scalariform. With ladderlike margins.

Scale. A thin dry structure, not green; often a reduced leaf.

Scarious. Dry, thin and membranous.

Scrobiculate. Having many small depressions; furrowed or pitted.

Sepal. One of the units of the calyx.

Serrate. Toothed with the sharp teeth pointing forward on the margin.

Sessile. Lacking a stalk; rising directly from the stem.

Seta. bristle or bristle-shaped body.

Setaceous. Having the form or nature of a bristle.

Sheath. A long, more or less tubular envelope, as the tubular basal portion of a leaf of a grass or sedge which encloses the culm.

Silky. With soft, appressed shining hairs.

Simple. (of leaves). Not divided into leaflets or lobes.

Smooth. Without ribs, furrows, warts, wings, scales; not angular, not rough.

Solitary. Single, only one from the same place.

Sorus. (plural sori). A group of sporangia.

Sparse. Few and distant.

Spathe. A leaflike, usually more or less concave bract, sometimes coloured; a pair of bracts enclosing the inflorescence (spadix), as in aroids, palms.

Spathulate. Of a leaf, widest near the apex; obtuse at apex, tapering into the stalk.

Spike. As inflorescence consisting of a central stalk bearing a number of sessile or subsessile flowers.

Spikelet. A small spike of one or more flowers surrounded by bracts. As applied to grasses, the term refers to groups of one or more reduced florets subtended by a pair of bracts known as glumes.

Spindle-shaped. Terete but tapering towards each end.

Spine. A sharp pointed hardened stiff structure. Spiniform. Thornlike.

Spinous. Spiny; with spines.

Spirally arranged. Placed one by one on nodes, subsequent leaves alternating on 3 or more sides.

Split. Incised to half length or half of half breadth.

Spore. A small, unicellular reproductive body produced in large numbers by ferns and other non-flowering plants.

Sporophyte. Spore-producing phase in the life history of a plant.

Spreading (patent). Having an outward direction, approximately at right angles to the bearing organ.

Spur. A tubular or saclike projection from a blossom, as of a petal or sepal.

Stamen. The pollen bearing organ of the flower, the male organ in the flowering plants consisting of filament, connective and anthers.

Staminate. Bearing stamens (usually with the implication that the pistil is lacking).

Staminode. Sterile, non-functional and often antherless stamens present in some flowers as accessory structures.

Standard. The fifth or posterior petal of a papilionaceous corolla.

Stellate. Star-shaped, radiating like the points of a star.

Sterile (of flowers). Not capable of producing viable seed; non flowering.

Stigma. The part of the pistil that is adapted to receive pollen.

Stipe. A short stalk.

Stipitate. Stalked.

Stipule. Leaf- or scale like structure arising from the junction of leaf stalk and stem.

Stolon. A creeping stem of short duration produced by a plant which has a central rosette or erect stem.

Strap-shaped. Liguliform.

Striate. With fine lengthwise parallel lines, grooves or ridges.

Style. The upper part of the ovary terminating in the stigma.

Subopposite. Nearly opposite.

Suborbicular. Nearly circular.

Subsessile. Almost sessile.

Succulent. Fleshy.

Sucker. A shoot arising from the roots of a woody plant, often some distance away from the main stem.

Superior ovary. An ovary that is above the insertion of the outer floral parts.

Suture. A line of dehiscence in dry fruits or a line of junction or of cleavage of two united organs.

Tapering. Regularly diminishing in diameter in one direction.

Taproot. An unbranched, vertically descending root.

Tepals. Term used for the segments of the floral envelope (sepals and petals) when these cannot be differentiated.

Terete. Cylindrical; circular in transverse section.

Testa. Seed coat.

Thread-shaped. Filiform.

Tomentose. Covered with densely matted hairs.

Toothed. (of the margin). With sharp teeth pointing outward.

Torus. The receptacle of a flower.

Trichome. Any hair-like outgrowth of the epidermis.

Trifoliate (of leaves). Made up of three leaflets.

Trigonous. Having three angles and three convex faces, three-cornered, three-angled with plane faces.

Triquetrous. Three-edged.

Truncate. Abruptly cut-off.

Tube. The lower part of a fused calyx or corolla.

Tuber. A short thickened portion of underground stem bearing dormant buds.

Umbel. An indeterminate inflorescence consisting of several stalked flowers having a common point of attachment.

Undulate. Having a wavy margin.

Uni. One. lateral. at one side. nerved. with one primary nerve from the base without clearly observable lateral nerves.

Unisexual. Flowers bearing either functional stamens or ovaries, but not both.

United. With like parts congenitally grown together.

Valvate. With the parts edge-to-edge (i.e. not over-lapping).

Valve. One of the sections of a capsule which has split open.

Vegetative. Concerned with the growth of the plant, not with flowers and fruits.

Vein. An elongated conducting structure visible on leaves.

Ventral. Relating to front (or belly); the surface towards the axis.

Villous. With long weak hairs.

Whorl. The arrangement of leaves or flowers or other organs in a circle; verticil.

Wing. Membranous or leaf-like expansion of an organ.

Zygomorphic. Capable of division only along one plane of symmetry.

SECTION 4

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