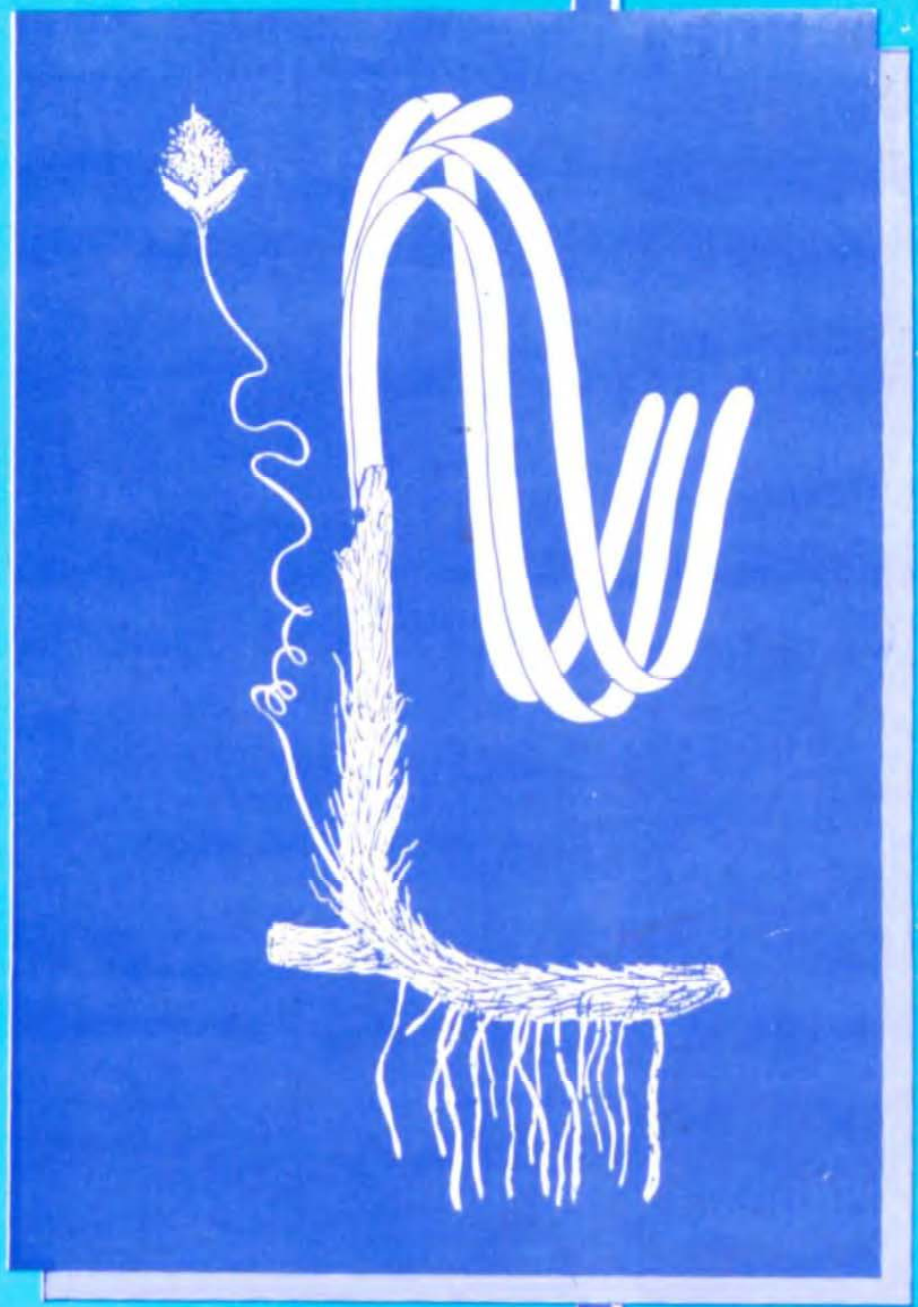
SEAGRASSES OF COROMANDEL COAST INDIA



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FOREWORD

Seagrasses are marine plants belonging to two monocotyledonous families, Hydrocharitaceae and Potamogetonaceae. Being the only submerged marine angiosperms to have very successfully adapted to survive in the saline environment, these form a very fascinating group of plants. They are distinct from the members of the grass family Poaceae and should not be confused with them.

Of the 52 species of seagrasses available in both tropical and temperate waters around the World, 14 species are found along the Coromandel Coast (eastern coast of Peninsular India) extending to a length of about 2000 km. In India very few works have been carried out on these special groups of plants eventhough we have around 6000 km long coastal belt, consisting of many bays, gulfs, lagoons, estuaries and backwaters, abounding in rich wealth of seagrasses. Therefore, it was felt to be worthwhile to make a detailed survey and study of the seagrasses of Coromandel Coast. The present work is the result of such an exhaustive study conducted for the first time in India and contains detailed original descriptions, illustrations, ecological notes of all the species involved.

I am sure that this contribution will considerably enhance the knowledge on this interesting group of plants, which would greatly help in its economic utilization and aspects of environmental conservation of coastal areas. I also hope that the authors would welcome any suggestions for the improvement of the book in future editions.

August 1991

B.D. SHARMA
DIRECTOR
Botanical Survey of India
Calcutta

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CONTENTS

1. INTRODUCTION

Seagrasses are angiospermous plants, specially adapted to grow in a complete marine environment. The name Seagrass is purely descriptive as is the name seaweed with respect to marine algae (Pettitt *et al.*, 1981). In no way seagrasses are related to the grass (Poaceae) family. They belong to two monocotyledonous families, *viz.* Hydrocharitaceae and Potamogetonaceae. As per our present knowledge there are 13 genera and about 52 species distributed throughout the world. Seagrasses account for only about 0.016% of the 300,000 species of angiosperms presently identified (Dawes 1987).

In tropical seas, genera such as *Cymodocea, Enhalus, Halodule, Halophila, Syringodium, Thalassia* and *Thalassodendron* are represented. However, some of the species of the above genera are confined to temperate regions, whereas *Amphibolis, Heterozostera, Phyllospadix, Posidonia, Pseudalthenia* and *Zostera* are usually restricted to temperate seas (Hartog, 1970, 1977; Hartog & Zong- Dai Yang 1988).

Seagrasses have always been fascinating; being the only angiosperms to become so successful in the subtidal marine environment. The increasing interest in seagrasses also reflects recognition of their unique ecological importance in the preservation of marine ecosystems. Arber (1920) and Hartog (1970) have put forth certain salient properties for a plant to adapt and withstand marine environment.

a. ability to grow in saline medium.
b. ability to grow when completely submerged.
c. must possess well developed anchoring below ground system.
d. ability to compete with other marine organisms.
e. completion of life cycle while completely submerged.
f. must have the capacity for hydrophilous pollination.

In general seagrasses inhabit the tidal and subtidal zones of shallow and sheltered localities of seas, gulfs, bays, backwaters, lagoons and estuaries. They usually prefer to grow on muddy, sandy, clayey and coral rubble bottoms but also on rocks and its crevices. They are found to grow either homogenously or heterogenously in mixed populations forming thick and dense meadows.

When compared with countries like Phillipines, Malaysia, Singapore, Japan, United States, Australia, Netherlands etc., only meagre studies have been carried out in India. Moore (1963) rightly pointed out that the seagrass beds are rarely visited by "land botanists". Collection of detailed distributional and taxonomical data on seagrasses of India is highly desirable and essential. However, only very few isolated pockets of Indian Coast have been studied by botanists and that too without giving primary importance to the distribution, taxonomy, illustrations and ecology of these restricted groups of plants.

2. PREVIOUS WORK

The literature scanned pertaining to seagrasses shows sporadic studies in India. Hooker (1889 & 1893) reported the occurrence of *Enhalus koenigii (=E. acoroides)* and *Halophila ovata* (Hydrocharideae) and *Cymodocea serrulata, C. australis (=Halodule uninervis)* and *C. isoetifolia (=Syringodium isoetifolium)* (Naiadaceae) from the Indian coasts. Fischer (1928 & 1931) included 4 genera

comprising 7 species from the East Indian Coast. Nayar (1959) listed *Halophila ovalis* and *Enhalus acoroides* from Kanniyakumari Coast. Rao *et al.* (1963 a) enumerated 5 species of seagrasses from the Gulf of Mannar and also (1963 b) enlisted 2 species from Rameswaram Island. Daniel Sundararaj & Nagarajan (1964) reported 2 species from Hare Island and Church Island of Tuticorin. Santapau & Henry (1973) enlisted 5 genera consisting of 7 species from India. Sastry & Rao (1973) collected *Halophila ovalis* from Pulicat Lake and later Rao *et al.* (1975) reported 6 species from Mandapam Coast. Untawale & Jagtap (1977) reported *Halophila beccarii* for the first time from India, based on Parija's collection from Chilka Lake of Orissa, deposited in Kew. Ramamurthy (1981) reported *Halophila beccarii* for the first time from Pichavaram in Tamil Nadu. Nair & Srinivasan (1981) enlisted 4 seagrasses from Mandapam Coast. Lakshmanan & Rajeswari (1981) reported the occurrence of 9 species in the Gulf of Mannar. Rajeswari & Lakshmanan (1981) enlisted 6 seagrasses from Krusadai Island and provided an artificial key based on vegetative characters. Raghavan & Deshpande (1982) discussed the availability of *Halophila beccarii* in India. Lakshmanan & Rajeswari (1982) reported *Thalassia hemprichii* for the first time from the main coast of India. Matthew (1983) enumerated *Halophila ovalis* and *H. beccarii* from Pichavaram lagoon. Almeida & Latto (1984) gave a note on *Halophila decipiens*, a rare pantropical species from Bombay Coast. Untawale & Jagtap (1984) reported 5 species from Minocoy Atoll of Lakshadweep.

Parthasarathy *et al.* (1988 a) described monoecious condition, floral biology and ecology of *Halophila beccarii*. Parthasarathy *et al.* (1988 b) and Lakshmanan *et al.* (1988) reported *Halophila decipiens* for the first time from the Coromandel Coast and the former described the floral biology and ecology. Velusamy & Kannan (1985) and Hartog & Zong-Dai Yang (1988) reported *Halodule pinifolia* for the first time in India. Ravikumar & Ganesan (1989) described a new subspecies of *Halophila ovalis* from the Eastern Coast of Peninsular India. Ravikumar *et al.* (1990) reported *Halodule wrightii* for the first time from India.

3. AREA OF STUDY

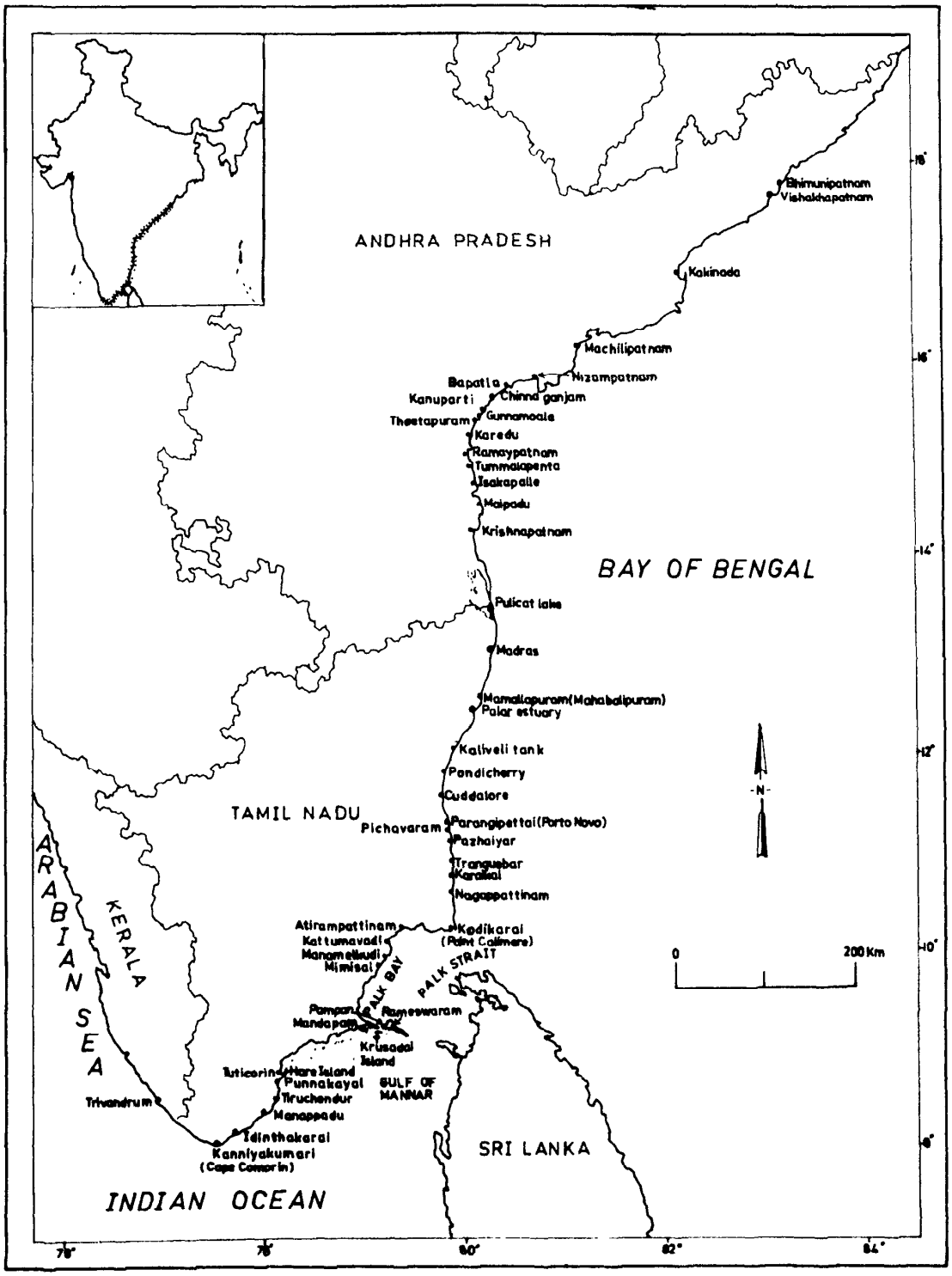
A. Study area:

The present study area starts from Srikakulam in the State of Andhra Pradesh and ends at Thiruvananthapuram in the State of Kerala. This area covers completely the coastal areas of Tamil Nadu and Andhra Pradesh.

Due to the large area to be covered, it was found to be far beyond the scope of the programme to concentrate on all the districts. Hence, based on richness, 7 districts in Andhra Pradesh,*viz.* Visakhapatnam, East Godavari, West Godavari, Krishna, Guntur, Prakasam and Nellore; 9 districts in Tamil Nadu, *viz.* Chengalpattu, Madras, South Arcot, Thanjavur, Pudhukkottai, Ramanathapuram, V.O. Chidhambaranar, Nellai Kattabomman and Kanniyakumari and Thiruvananthapuram district of Kerala were chosen and thoroughly explored. **(Map 1)**

B. Physiography:

India is having a vast coastal belt extending up to 6000 km. An area of 20,13,440 sq. km forms the Exclusive Economic Zone (EEZ) and the shelf area is



Map 1. Study area surveyed for **Seagrasses** along Coromandel Coast

4,52,060 sq. km (Khoshoo 1986). The Bay of Bengal occupies an area of about 4.087 x 10^6 sq. km between latitudes 0^0 and 23^0 N and longitudes 80^0 and 100^0 E (Qasim 1977).

The Coromandel Coast comprises of a major part of Bay of Bengal, the Palk Bay and the Gulf of Mannar of Indian Ocean and the southernmost coast of Arabian Sea. The Bay of Bengal Coast starting from south of West Bengal ends at north of Kodikarai of Tamil Nadu. Palk Bay Coast starts from south of Kodikarai of Tamil Nadu and covering a part of southern Thanjavur district and ends in northern part of Ramanathapuram district. The Gulf of Mannar starts from southern coast of Pamban in Ramanathapuram district and ends at Cape of Kanniyakumari where the Indian Ocean mixes with Bay of Bengal and Arabian Sea. The Thiruvananthapuram district of Kerala is at the southern end of West Coast on the Arabian Sea.

C. Principal rivers:

In Andhra Pradesh the major river systems are Gautami - Godavari in East Godavari district, Vashista-Godavari in part of East and West Godavari districts, Krishna in Krishna district and Pennar in Nellore district. Godavari estuarine system is the second largest in India, and the largest in the region adjoining Eastern Ghats. The river Krishna is as important as Godavari in Peninsular India. All these rivers originate from Western Ghats and cutting through Eastern Ghats, further branch into many tributaries and finally join the Bay of Bengal. They are all perennial (except Pennar) and the discharge into sea is substantial.

There are five major rivers in Tamil Nadu, namely Palar in Chengalpattu; South Pennar and Kollidam in South Arcot; Cauvery in Thanjavur and Thamiraparani in V.O. Chidhambaranar districts. The rivers Palar and South Pennar originate from Eastern Ghats and the rest from Western Ghats. All these rivers are seasonal and the discharge into sea is not large.

Most of the river mouths are accumulated with heavy silt deposits and these in turn provide an ideal place for the luxurious growth of mangrove plants. Along the mangrove creeks, seagrasses grow abundantly. The seasonal rivers play a major dynamic role in the seagrass growth along the river mouth.

The Coromandel Coast consists of bays, gulfs, straits, channels, lagoons, estuaries, salt water lakes, back waters, etc.

D. Bays:

Along Andhra Pradesh coast, Kakinada and Nizampatnam bays are deep and usually exhibit high waves. The Tamil Nadu Coast has only one major bay, the Palk Bay which is shallow and almost waveless.

E. Gulf of Mannar:

This is the first marine biosphere reserve in South-East Asia. This zone may be termed as a "Marine Province". There are 26 Islands in a string of which 16 are in Ramanathapuram district and the rest in V.O. Chidhambaranar district. Krusadai is one of the biggest islands which harbours 9 species of seagrasses. These islands are characterised by the presence of coral reefs. The substratum is with coral rubbles,

broken shells, calcareous deposits, sandstones and coarse to fine sands. This area is biogeographically important and rich in endemic and rare fauna and flora. The flow of water during tidal action from the Gulf of Mannar to Palk Bay is through the Pamban channel.

F. Estuaries, Lagoons, Backwaters, etc.:

They are formed by the widened mouths of rivers near the sea which may or may not have mangroves and they sometimes intrude far inland. Usually they form an extensive area with loose muddy, fine to coarse sandy bottoms.

The Andhra Pradesh Coast is fringed with many backwaters, estuaries and lagoons. The important backwaters and estuaries are near Bhimunipatnam, Coringa, Nizampatnam, Bapatla, Chinnaganjam, Tummalapenta, Gunnamola, Utukuru, Krishnapatnam etc. The Southern part of Andhra Pradesh including Guntur, Prakasam and Nellore districts and the northern part of Tamil Nadu including Chengalpattu and South Arcot districts were connected by Buckingham Canal, an inland network of water-way system running parallel to the Bay of Bengal and was used for transportation during the British rule. Now this canal system remains almost unused, heavily silted and harbours vast stretches of *Halophila* and *Halodule* meadows.

In Tamil Nadu the major lagoons are in Muthupettai of Thanjavur district and Pichavaram of South Arcot district. These lagoons are surrounded by thick mangrove forests with many lengthy water channels. The margins of mangrove creeks are dominated with seagrass populations like *Halophila ovalis, H. beccarii* and *Halodule pinifolia.*

Some of the important backwaters and estuaries in Tamil Nadu are in Ennore, Muttukadu, Palar of Chengalpattu district, Marakkanam (Kaliveli Tank), Vellar, Pazhaiyar of South Arcot district, Chunnambar in Pondicherry Union Territory, Punnakayal in V.O. Chidhambaranar district.

Pulicat is the second largest salt water lake along the Coromandel coast, where the major portion of the lake lies in Andhra Pradesh and the rest in Tamil Nadu. Generally, the gradation of salinity is more throughout the sea-ward side and gradually decreasing towards lee-ward side and sometimes, even becomes nil in distant areas of extensive lake system.The formation of sand bars near the mouth of rivers, backwaters and estuaries especially during summer season prevent entry of sea water which in turn affect the growth of faunal and floral populations which are completely dependent on salinity. The substratum of the above area are usually fine black muddy, clayey to fine sandy but also rarely with coarse sand.

4. METHODOLOGY

A. AREAS SURVEYED:

During the period 1987 to 1989, several field trips were conducted in different seasons to cover the entire Coromandel Coast. In total 99 localities along the entire Coromandel Coast were intensively explored for study of seagrasses, of which 82 localities are from Tamil Nadu and 17 are from Andhra Pradesh. A total

of 482 field numbers of seagrasses belonging to 14 taxa were collected during these trips. Apart from these, 194 field numbers of interesting, less known of rare coastal plants including psamophytes, halophytes and mangroves were also collected.

B. HERBARIUM:

i. Collection:

The black patches over the water bodies in shallow regions during high or medium-tides indicate the presence of submerged seagrass beds, which is an easy way to locate seagrasses. Fertile and healthy populations were selected and excavated from field by shovel or digger. Since, the flowering of seagrasses are rare and ephemeral, sufficient care was taken to collect all the developmental stages of male, female flowers and fruits. The specimens were dug off taking care to keep the rhizomatous system intact. Sand, sediments and animals were washed without causing damage to the leaf tips and tender reproductive parts. They were kept in polythene bags with field numbers and brought to the camp. Simultaneously, important field observations like habitat, nature of substratum, distribution, associated plants and animals, depth, abundance, colour of the flowers, etc., were noted in the field itself.

ii. Poisoning and Drying:

Healthy specimens with male, female flowers and fruits were selected. The poisoning for rough and robust materials *(Enhalus, Cymodocea, Thalassia,* and *Syringodium)* were done by the method suggested by Jain & Rao (1977). Whereas, the thin and fragile materials *(Halodule & Halophila)* were spread neatly on thick boards inside a tray containing water and the board was gradually lifted, allowing the excess water to drain off. The board with the specimen sticking to it was then kept in blotters for drying. The blotters were changed often till the plants were completely dry. Rectified spirit saturated with Mercuric Chloride was brushed on the plants and allowed to dry.

iii. Mounting and Labelling:

After the specimens are poisoned, pressed and dried, they were neatly pasted on mounting boards. Stitches were made wherever necessary to ensure the intactness of the specimens. The fragile and thin materials were kept in pockets and pasted on the mounting boards.

The labels pasted on the lower right hand corner of the mounting boards were filled with details like correct binomial, family, date, locality, collection number, habitat, local names, notes, collector, etc. After accession and filing, the herbarium sheets were deposited in the Madras Herbarium (MH), Coimbatore.

Fresh materials showing various developmental stages of flowers and fruits and important vegetative parts were fixed in 25% rectified spirit mixed with seawater. Later, they were dissected out for critical study and preparation of illustrations.

For easy reference appropriate keys (indented) are given for family, genus, species and subspecies. Hartog (1960 & 1970) stated that, since the occurrence of

flowers are very infrequent and ephemeral, vegetative characters are much relied upon to delimit the taxa. However, in addition to vegetative characters, flower and fruit characters are also used to differentiate the family, genera and species. Detailed family description, followed by key to the genera and their description and key to the species and their description are given in the usual taxonomic format. The species are arranged in alphabetical sequence. For nomenclature of the species, the correct names are given first, followed by the original citation of publication in the standard abbreviated form. This is followed by basionyms and synonyms, with their citations. Monographs, books and recent publications concerning the taxa and the study area were also cited. At the end of nomenclature of each species the figures are given in paranthesis. The local names are gathered from local fishermen of different areas for some species and are given in Tamil and Telugu. After detailed taxonomical descriptions, flowering and fruiting periods are given. Under ecology, field observations like habitat, distribution, substratum, abundance, association, etc. are discussed precisely. The details regarding the utility value of seagrasses, if any, is given following the Ecology.

Under the specimens examined, the earlier collections from the study area by various collectors deposited in the Madras Herbarium (MH), Coimbatore; Her biere Francaise Institut Pondicherry (HIFP), Pondicherry and Central National Herbarium (CAL), Howrah are referred in the text chronologically. Specimens from Tamil Nadu precedes Andhra Pradesh. Details regarding locality, nearest town, district, date, depth, nature of the plant, collector, collection number, name of the herbarium, etc. are given.

C. BIOMASS:

To study the biomass value and shoot density of 13 taxa, materials were collected in different localities of the study area in different seasons. It was determined in 5 randomly placed square quadrats of 25 cm^2. The substratum was excavated well so as to collect all underground parts. The materials were completely washed free of sediments in the field.

They were air dried in shade at camp, then carefully segregated into Below Ground Biomass (rhizomes & roots BGB), Above Ground Biomass (shoots & leaves AGB) and reproductive biomass (flowers & fruits RB).

The plants were then treated with 5-10% v/v Orthophosphoric acid to remove the epiphytes and calcareous substances. Then they were washed several times in water to remove the traces of acid. The materials were kept at 60^0 c in an oven for 48 hours and the biomass values were determined by weighing on a monopan balance. The shoot density and the biomass values were then converted for m^2.

5. SYSTEMATIC TREATMENT

Key to the Seagrass Families

1a. Leaves ligulate; male flowers without tepals; fruits indehiscent ..... **Potamogetonaceae**

1b. Leaves eligulate; male flowers with 3 to 6 tepals; fruits dehiscent (except *Halophila*) ..... **Hydrocharitaceae**

HYDROCHARITACEAE

Annuals or perennials, aquatics, submerged or partly emergent, sometimes free-floating; vessels present in roots. Leaves spirally arranged, opposite or whorled, often sheathing at base, sometimes with distinct lamina; nerves parallel, straight or curved, connected by cross-veins. Flowers regular, rarely slightly irregular, usually unisexual, solitary or in a few-flowered cymes, enclosed by spathes, sessile or stalked; perianth with 1 or 2 whorls of 3 tepals. Male flowers 1-many; stamens 3-many, arranged in 1 or many whorls; anthers basifixed, 2-4-celled, subsessile, dehiscing longitudinally; filaments absent or present, if present slender; pollen grains globose or ellipsoid, sometimes combined in moniliform chains. Female flowers solitary, enclosed by spathes; ovary inferior, globose, ovoid, ellipsoid or linear, sometimes with persistent hypanthium, 1-celled; placentae parietal, intruded or sometimes meeting; styles 2-15, often split into 2 stigmatic branches; ovules many erect or pendulous; fruits opening by decay of pericarp; pericarp fleshy or membranous; seeds many, ovoid, globose, ellipsoid, fusiform or conical; embryo straight.

Key to the genera

A. Key based on vegetative characters:

1a. Leaves differentiated into petioles and blades; lamina oblong, elliptic, linear, ovate, obovate or spathulate without tannin cells ..... **Halophila**

1b. Leaves not differentiated into petioles and blades; lamina linear with tannin cells :

2a. Rhizomes 10 to 20 mm thick, without scales; roots stout; leaves *ca* 100 cm by 17 mm ..... **Enhalus**

2b. Rhizomes 2 to 5 mm thick, with scales; roots thin; leaves *ca* 16 cm by 12 mm ..... **Thalassia**

B. Key based on reproductive characters:

1a. Perianth in 2 rows; male flowers numerous in spathes; pollen grains free; peduncles long, coiled in fruit ..... **Enhalus**

1b. Perianth in 1 row; male flowers single in spathes; pollen grains in moniliform tube; peduncles short, not coiled in fruit, or absent:

2a. Styles 6-8; fruits *ca* 20 by 18 mm across, echinate, dehiscent . . . . . **Thalassia**

2b. Styles 2-3; fruits *ca* 5 by 3 mm across, smooth, indehiscent . . . **Halophila**

ENHALUS RICH.

Dioecious. Rhizomes creeping, coarse, branched or unbranched; internodes short, with numerous remains of dacayed leaves; roots coarse, unbranched. Leaves distichously arranged, 1-6, ribbon-like, subamplexicaule, sheathing at base; nerves many, parallel; scales absent. Inflorescences axillary, pedunculate with 2 persistent spathes. Male flowers numerous, pedicellate, crowded on a central conical axis; sepals 3, concave, transparent; petals 3, concave, transparent; stamens 3, alternate to petals; anthers subsessile, 2-celled, dehiscing longitudinally; pollen grains large. Female inflorescences on long peduncles, 1-flowered, enclosed by 2 persistent spathes; sepals 3, erect, rigid, reddish-brown; petals 3, membranous, crested with numerous tannin cells; ovary unilocular, with 3 carpels; stylar branches 10-12; ovules many, embedded in mucilagenous fluid; fruits ovoid, acuminate at apex, with persistent stiff appendages; seeds obconical; embryo with suspensor cell.

Enhalus acoroides (L.f.) Royle, Illustr. 453. 1840; Fischer in Gamble, Fl. Pres. Madras 3: 1305. 1957 (repr. ed.); Subram., Aquatic Angiosperms 64. 1962; Hartog, Seagrasses World 215. 1970; Srinivasan in Henry *et al.*, Fl. Tamil Nadu I. 3: 1. 1989.

Stratiotes acoroides L.f., Suppl. Pl. 268. 1781.

Enhalus koenigii Rich. in Mem. Cl. Sci. Math. Inst. Natl. France 12(2): 64, 78. 1812; Hook. f., Fl. Brit. India 5: 663. 1888.

Local names: TAMIL: Alai vaari, Olai paasi, Kadal vaàri and Vaataalai.

Plants robust, up to 2 m long; rhizomes creeping, branched or unbranched, stout, up to 2 cm thick, densely covered with persistent fibrous strands of decayed leaves; roots *ca* 30 cm by 6 mm, numerous, cord-like, unbranched, spongy; white; shoots erect, branched or unbranched, bearing 4-5 leaves at each branch; sheaths obconical, 10-23 by 2-3 cm, convolute, white to pale brown; lamina linear, ribbon-like, obtuse or slightly emarginate at apex, 40-102 cm by 12-17 mm, entire and thickened along margins, sometimes serrulate in young leaves; nerves many, parallel, with parallel septate air channels. Male flowers numerous, enclosed by 2 spathes, arranged densely on conical central axis, white; peduncle of the male inflorescences up to 6 cm long and *ca* 5 mm broad, flattened, always submerged; spathes lanceolate, overlapping at base, acute at apex, 3-5.7 by 2-4 cm, subequal, wavy along margins and serrulate at the upper half, persistent, with numerous tannin cells, greenish-brown; midrib prominent with many irregular hairs; hairs up to 1.5 cm long, subulate, unbranched, stiff; the lateral 2 nerves obscure, which run half way from the base and end half way from the tip, with short hairs; hairs up to 5 mm long, subulate, unbranched, brown; male flowers globose, 3-6 mm long, white; pedicels 3-4.5 mm long, very thin, hyaline, white, breaking of at *ca* 0.5 mm below the flower; sepals 3, elliptic, *ca* 1.5 by 0.7 mm, entire along margins, concave, hyaline, white; petals 3, elliptic, subtruncate at base, obtuse at apex, *ca* 1.5 by 0.7 mm, entire along margins, concave, hyaline, white; both sepals and petals reflexed after anthesis; stamens 3, *ca* 1.2 by 0.5 mm, erect, minutely stalked; anthers elliptic, basifixed, 2-celled, with tuberculate outgrowths throughout, each cell contains 2 rows of pollen grains, dehiscing longitudinally; pollen grains globose, *ca* 12 in each row, white. Peduncle of the female inflorescences up to 142 cm long, up to 5 mm broad, flattened, dilated at apex, brownish, subtended by 2 equal spathes, after fertilization coiled and

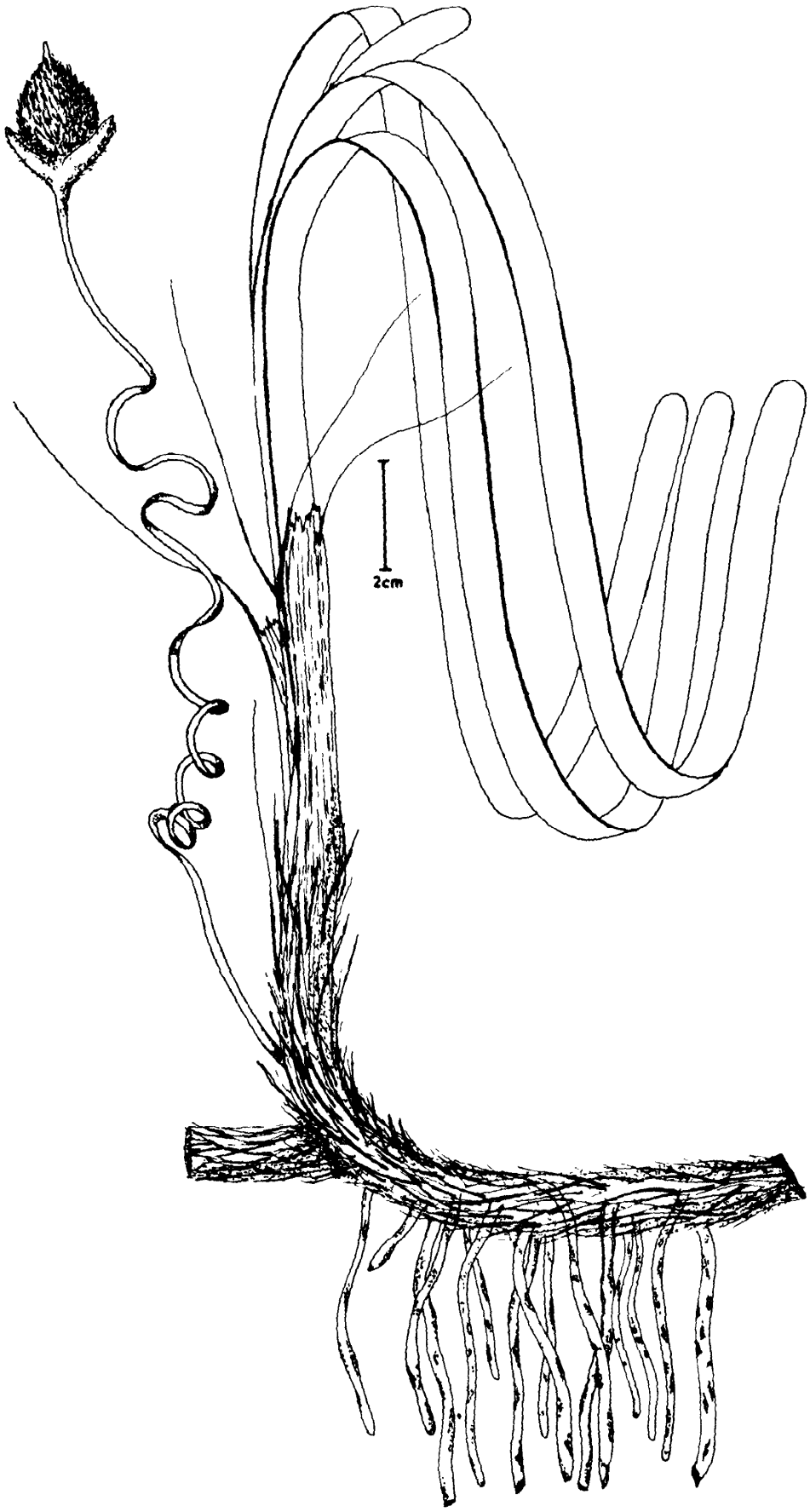


Fig.1. Enhalus acoroides (L.f.) Royle Habit with fruit.

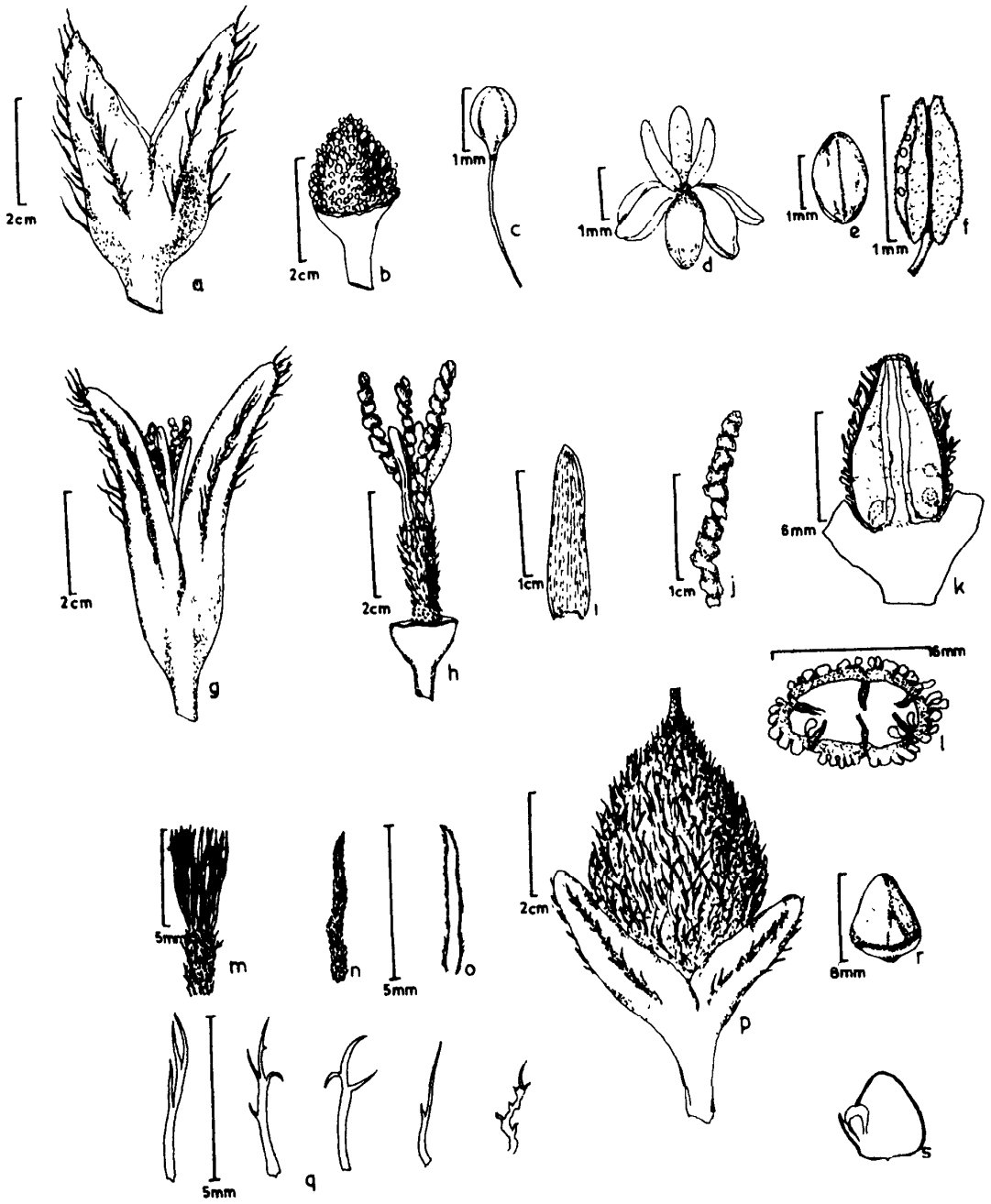


Fig.2. Enhalus acoroides (L.f.) Royle

a-f: Male flower; a. Inflorescence, b. Inflorescence spathes removed showing flowers, c. Single flower, d. Opened flower, e. Tepal, f. Stamen, g-s: Female flower; g. Inflorescence, h. Inflorescence - spathes removed showing ovary, sepals and petals, i. Sepal, j. Petal, k. L.S. of ovary, l. C.S. of ovary, m. Single flower, n & o. Stigmatic branch dorsal & ventral sides, p. Fruit, q. Different shapes of appendages on fruit, r. Seed, s. Embryo.

contracted below the water level; spathes linear-oblong, obtuse at apex, 2-5.7 by 1-2 cm, entire along margins below, serrulate above, persistent, with numerous tannin cells; midrib conspicuous, swollen dorsally, grooved ventrally, with irregular long slender hairs towards 1/3 of the apex, the lateral 2 nerves grooved ventrally with short irregular hairs towards 1/3 of the apex and 4-6 inconspicuous nerves in between; sepals 3, oblong, subtruncate at base, acute at apex, 10-15 by 4-5 mm, entire, recurved along margins, transparent, reddish-brown, with numerous tannin streaks; petals 3, linear-oblong, obtuse at apex, 13-20 by 3-5 mm, crumbled, membranous, with waxy coating and numerous reddish-brown tannin streaks; ovary ovoid, laterally compressed, *ca* 10 by 6 mm, with minute tuberculated projections at base, densely multibranched flattened appendages at apex, up to 6 mm long, with numerous tannin cells; ovary enlarged at base, the inner wall at base doom-shaped from where placental lamella arise which incompletely separate the cavity into 6 partitions; the placenta 2-layered, transparent; styles 6, each divided into 2 stigmatic branches; stigmatic branches 10-12, linear or subulate, acute at apex, *ca* 5 mm long, with numerous sticky projections on dorsal side and glabrous on ventral side; ovules many, ellipsoid, *ca* 1 mm long, minutely stalked, yellow, 1 or 2 attached parietally at each placenta, embedded in viscous fluid; fruits ovoid, acuminate at apex, 2.5-6 by 1.5-3.5 cm, green, densely clothed with numerous erect branched black appendages, with many indistinct longitudinal ribs, opening irregularly at apex; seeds 10-12, obconical to obovoid, 9-12 mm long, the conical part greenish, the stout basal part brownish; testa thin, easily ruptured; embryo ellipsoid, with conical hypocotyl; plumule lateral. **(Figs. 1 & 2; Photos 1 & 2)**

Flowering and fruiting: Periodical throughout the year.

Ecology: The distribution of *Enhalus acoroides* along the Coromandal Coast is very much restricted in Pudhukkottai and Ramanathapuram districts of Tamil Nadu, whereas, washed ashore materials were collected in plenty from Chengal-pattu and Thanjavur districts. This species is totally absent along Andhra Pradesh coast.

This giant seagrass prefers sheltered marine environment of shallow water where the substratum is sandy to muddy with coral flats. It is strictly a pure marine form and do not occur in estuaries or backwaters. Normally, it is found to occur in tidal and subtidal zones.

The underground rhizomes are stout and branched which can penetrate up to 50 cm deep. The roots are also well developed, both of which provide a concrete anchoring system in order to withstand the water current and tidal action. It is found to occur from 2 m deep onwards. The plants growing in deeper zones (3 m) are healthier and form pure formations with lengthy leaves and peduncles. In contrast to this, the marginal populations are stunted and found associated with *Thalassia hemprichii, Cymodocea rotundata,C. serrulata* and rarely with *Syringodium isoetifolium, Halodule uninervis* (broad-leaved form) and *H. pinifolia.*

During low-tide, it is seen to be exposed fully or partially with leaves facing towards seaward direction. Since the surface of the leaf is wide, it harbours a wide range of dense micro-epiphytic flora and fauna. Macro-epiphytes are not found growing on the leaves. Moreover, these underwater meadows provide abode to various marine fauna like Sepia, Sea lotus, Dugong, Sea horse, Eel, Ray and Scorpion

fishes, Sea cucumber, Marine snakes, Molluscs, etc. Since, the leaves resemble sea snakes, the latter was found lying over the leaf for pseudo-copulation, as observed near Pamban and Krusadai Island in the Gulf of Mannar.

The availability of male plants is very rare, whereas, that of female plants is common. This is because, single male inflorescence contains hundreds of minute male flowers which would be sufficient to pollinate a considerable number of female plants. It is also observed that, numerous male inflorescences, as such, get detached from the plants and are found floating over the water surface. Among all the marine angiosperms, *E. acoroides* is the only species which shows aerial surface pollination.

U s e s: The seeds are edible and eaten by local people at Pamban and it tastes like groundnuts. The fibre from leaves are used for making fishing nets. The plants are used as manure in coconut and tobacco plantations (Wealth of India, 1952).

S p e c i m e n s e x a m i n e d: TAMIL NADU: Krusadai Island, Ramanathapuram district, 25-9-1944, female, *Parthasarathy & Daniel* 88139 (MH); *ibid.*, 26.9.1946, vegetative, *Gopal Rao 93045* (MH); Pamban, Ramanathapuram district, 14.2.1987, to a depth of + 2 m, fruiting, *Parthasarathy & Ravikumar 85130* (MH); Krusadai Island, Ramanathapuram district, 18.2.1987, to a depth of + 1.5 m, fruiting, *Parthasarathy & Ravikumar 85332* (MH); Mamallapuram, Chengalpattu district, 26.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85713* (MH); Poompuhar, Thanjavur district, 7.9.1987, materials washed ashore, vegetative, *Ravikumar 85789* (MH); Karaikal, Pondicherry Union Territory, 8.9.1987, materials washed ashore, vegetative, *Ravikumar* 85794 (MH); Kodikarai (Point Calimere), Thanjavur district, 11.9.1987, materials washed ashore, female, *Ravikumar 85809* (MH); *ibid.*, 12.9.1987, materials washed ashore, female, *Ravikumar 85816* (MH); Kattumavadi, Pudhukkottai district, 20.9.1987, to a depth of + 2 m, vegetative, *Ravikumar 85859* (MH); Krusadai Island, Ramanathapuram district, 25.9.1987, to a depth of + 1.5 m, female, *Ravikumar 85899* (MH); Pamban, Ramanathapuram district, 26.9.1987, to a depth of + 2 m, female, *Ravikumar 86815* (MH); Kovilvadi, Mandapam, Ramanathapuram district, 20.4.1988, to a depth of + 5 m, male and female, *Ravikumar & Ganesan 86823* (MH); Krusadai Island, Ramanathapuram district, 21.4.1988, to a depth of + 2 m, female, *Ravikumar & Ganesan 86831* (MH).

HALOPHILA THOUARS.

Monoecious or dioecious herbs; rhizomes creeping, rooting at nodes; roots solitary, unbranched, closely set with soft root hairs; scales 2, one embracing rhizome, other embracing shoot. Leaves in pairs, in pseudowhorls, or distichously arranged, petiolate or sessile, linear, lanceolate, oblong-elliptic, ovate, obliquely cuneate to attenuate at base, acute to obtuse at apex, entire or serrulate along margins, glabrous or hairy. Spathes 2, elliptic, obovate or suborbicular, truncate or acute at apex, entire, serrulate or ciliate along margins. Flowers unisexual, solitary, rarely male and female flowers occur in single spathe. Male flowers pedicellate; tepals 3, imbricate; stamens 3, alternate with tepals; anthers 2-4-celled, linear, oblong, sessile, dehiscing longitudinally. Female flowers sessile or minutely stalked; ovary ellipsoid or ovoid, single-celled, with persistent hypanthium; styles 2-5, filiform, papillose, smooth abaxially, grooved adaxially, with a row of reddish-brown glandular hairs on either side; fruits ovoid or globose, rostrate, with translucent pericarp; seeds many, globose to subglobose, floating in viscous fluid, attached to the ovary wall; embryo with well developed hypocotyl and spirally coiled cotyledon.

Key to the species

1a. Leaves 6-12 at each node; cross-veins absent ..... **H. beccarii**

1b. Leaves 2 at each node; cross-veins present:

2a. Lamina hairy, margins serrulate:

3a. Plants dioecious; leaves linear-oblong ..... **H. stipulacea**

3b. Plants monoecious; leaves oblong-elliptic ..... **H. decipiens**

2b. Lamina glabrous, margins entire:

4a. Seeds 6-12 ..... **H. ovalis subsp. ramamurthiana**

4b. Seeds 20 or more:

5a. Lamina 20-30 mm long; cross-veins 13-22 pairs .....**H. ovalis subsp. ovalis**

5b. Lamina 4-15 mm long; cross-veins 3-9 (-11) pairs ..... **H. ovata**

Halophila beccarii Asch. in Nuovo Giorn. Bot. Ital. 3: 302. 1871; Hartog, Seagrasses World 261. 1970; Untawale & Jagtap in Mahasagar Bull. Nat. Inst. Oceanogr. 10: 91. 1977; Raghavan & Deshpande in Bull. Bot. Surv. India. 24: 200. 1982; Matthew & Britto in Matthew, Fl. Tamil Nadu Carnatic 3: 1544. 1983; Parthasarathy *et al.* in Aquat. Bot. 31: 141. 1988; Srinivasan in Henry *et al.*, Fl. Tamil Nadu I. 3: 1. 1989.

Local names: TAMIL: Kadal paasi, Ilai paasi; TELUGU: Aaku naasi, Samuthra naasu.

Plants monoecious. Rhizomes creeping, branched or unbranched, slender, fleshy, transparent with single root at each node; roots up to 6.7 cm long, with soft root hairs; internodes 1.2-4.2 cm long, 0.5-1 mm thick; scales 2; the one embracing the rhizome obcordate, truncate to subtruncate at base, emarginate to subacute at apex, 2-3 by 1-2 mm, entire along margins, convolute, hyaline; the other embracing the shoot, elliptic, subtruncate at base, subacute to acute at apex, 4-5 by 2-3 mm, entire along margins, convolute, hyaline, with conspicuous midrib. Shoots erect, up to 2.4 cm long, rarely branched, with a pseudowhorl of 6-11 leaves at each node; petioles 3-15 mm long, sheathing; sheaths emarginate to retuse at apex, 2-4 mm long, scarious along margins, hyaline; lamina oblong-lanceolate, cuneate at base, acute at apex, 5-16 by 1-3 mm, entire or minutely spinulose along margins, glabrous; cross-veins absent; intramarginal nerves 2, joining at apex with conspicuous midrib. Flowers solitary, axillary, male and female flowers borne either in successive lateral branches or distantly, both subtended by spathes. Male flowers up to 1 cm long; spathes oblong, lanceolate, subtruncate at base, acute at apex, *ca* 4 by 2 mm, entire, convex, cleft apically when the flower protrudes at maturity; pedicels up to 8 mm long, slender, hyaline; tepals 3, oblong, subtruncate at base, obtuse at apex, *ca* 2.5 by 1.5 mm, entire, hyaline, convex, imbricate, pale brown; anthers 3, linear-oblong, *ca* 2 by 0.25 mm, sessile, 2-celled, pale brown, intact in bud, only hyaline connective tissue remains in opened flowers; pollen grains ellipsoid to oblongoid, contained in mucilagenous sheaths. Female flowers up to 1.7 cm long, projecting laterally at maturity; ovary oblongoid, 1-2 by 0.3-1 mm; hypanthium up to 2 mm long, curved upwardly; styles 2-3, 1-1.5 cm long, unequal, filiform, papillose. Fruits ellipsoid to ovoid, 4-5 by 1-2 mm; pericarp membranous, translucent; beak curved upwards; seeds 1-4, globose, *ca* 1.2 by 1 mm, reticulate, hard, reddish-brown; embryo subglobose, *ca* 1 by 0.5 mm, hard, white; cotyledon spirally coiled at the upper side. **(Fig. 3; Photos 3 & 4)**

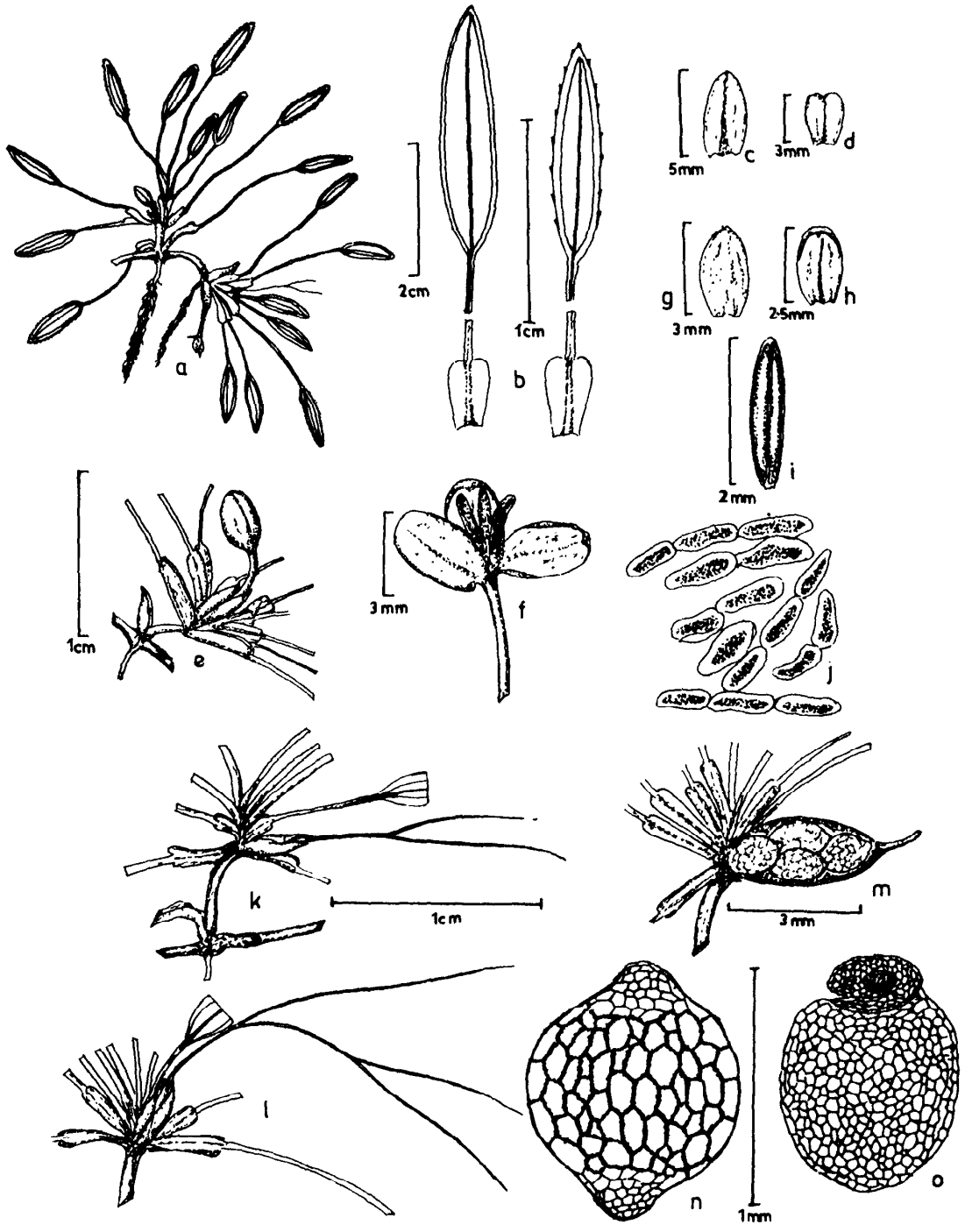


Fig.3. Halophila beccarii Asch.

a. Plant displaying monoecious condition, b. Entire and minutely spinulose leaves, c. Shoot scale, d. Rhizome scale, e-j: Male flower; e. Bud, f. Opened flower, g. Spathe, h. Tepal, i. Stamen, j. Pollen grains (X450), k-o: Female flower; k & l. Flower with 2 and 3 stylar branches, m. 4-seeded fruit, n. Seed, o. Embryo.

Flowering and fruiting: January-March & August-October.

Ecology: *Halophila beccarii* is distributed continuously along the Coromandel Coast and is most common in shallow, sheltered localities of bays, estuaries, back-waters and in the undergrowth of mangrove swamps, whereas absent in open sea and is found to a depth of 0.5 to 2 m. It inhabits coarse sand to fine, muddy and clayey substratum. In contrast to Hartog's (1970) observation it is found growing on pure sandy bottom at Cuddalore in Tamil Nadu and Kakinada port in Andhra Pradesh.

Unlike other seagrasses, *H. beccarii* has not been observed washed ashore, since, in most of the areas, almost 2/3 part of the plants get buried in soil. Decayed populations were also excavated from the mud in certain localities like Pichavaram in Tamil Nadu and Krishnapatnam harbour in Andhra Pradesh.

Generally, it occurs in pure formations and also found associated with other seagrasses like *Halophila ovata, H. ovalis, Halodule uninervis* and *H. pinifolia.* Microalgae and several marine fauna like molluscs and juvenile crabs inhabit the beds of *Halophila beccarii.*

Specimens examined: TAMIL NADU: Porto Novo (Parangipettai), South Arcot district, 30.9.1978, vegetative, *Ramamurthy 58146* (CAL, MH); *ibid.*, 10.2.1979, vegetative, *Ramamurthy 58167* (MH); Pichavaram, South Arcot district, 11.2.1979, male, female flowers and fruits, *Ramamurthy 58196* (MH); Tuticorin, V.O. Chidhambaranar district, 24.2.1987, to a depth of ± 1.5 m, fruits, *Parthasarathy & Ravikumar* 85394 (MH); Cuddalore O.T. Port, South Arcot district, 18.3.1987, to a depth of ± 1.5 m, female flowers and fruits, *Parthasarathy & Ravikumar 85403* (MH); Vellar Estuary, Porto Novo (Parangipettai), South Arcot district, 23.3.1987, to a depth of ± 1.5 m, *Parthasarathy & Ravikumar 85432* (MH); Annankoil, Porto Novo (Parangipettai), 23.3.1987, to a depth of ± 2.5 m, male, female and fruits, *Parthasarathy & Ravikumar 85436* (MH); Pichavaram, South Arcot district, 28.3.1987, to a depth of ± 3 m, fruits, *Parthasarathy & Ravikumar 85860* (MH); Punnakayal, Thiruchendur, V.O. Chidhambaranar district, 17.7.1987, to a depth of ± 2.5 m, flowers and fruits, *Ravikumar 85731* (MH); Tuticorin, V.O. Chidhambaranar district, 2.9.1988, to a depth of ± 1.5 m, vegetative,*Ravikumar & Ganesan 86896* (MH).

ANDHRA PRADESH: Chinnaganjam, Prakasam district, 25.6.88, to a depth of ± 2 m, in fruits, *Ravikumar & Ganesan 88128* (MH); Tummalapenta, Nellore district, 1.7.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 88257* (MH); Karedu, Prakasam district, 3.7.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 88175* (MH); Isakapalle, Nellore district, 5.7.1988, to a depth of ± 2.5 m, vegetative, *Ravikumar & Ganesan 88185* (MH); Utukuru, Nellore district, 6.7.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 88193* (MH); Bhimunipatnam, Visakhapatnam district, 8.9.1988, to a depth of ± 0.5 m, vegetative, *Ramamurthy 88825 & 88826* (MH); Kakinada port, East Godavari district, 11.9.1988, to a depth of ± 1 m, male, female and fruits, *Ramamurthy 88835* (MH); Krishnapatnam, Nellore district, 16.9.1988, to a depth of ± 2 m, female flowers and fruits, *Ramamurthy 88873 & 88875* (MH).

Halophila decipiens Ostenf. in Bot. Tidsskr. 24: 260. 1920; Hartog, Seagrasses World 254. 1970; Almeida & Lattoo in Bull.Bot.Surv.India 26:215-216.1984; Lakshmanan *et al.* in Curr. Sci. 57: 199. 1988; Parthasarathy *et al.* in Aquat. Bot. 32: 179. 1988; Srinivasan in Henry *et al.*, Fl. Tamil Nadu I. 3: 1. 1989.

Halophila decipiens Ostenf. var. *pubescens* Hartog in Steenis, Fl. Males. Ser. 1. 5: 410. t. 18. 1957.

Local names: TAMIL: Kadal paasi, Neer pasalai.

Plants monoecious. Rhizomes creeping, branched, slender, fragile, translucent; roots solitary, unbranched, up to 4.5 cm long; internodes 1.5-3.5 cm by 0.5-1 mm; scales 2, obovate, amplexicaul to subtruncate at base, incised or mucronate at apex, 3-5 by 2-3 mm, keeled, entire or serrulate along margins and midribs.

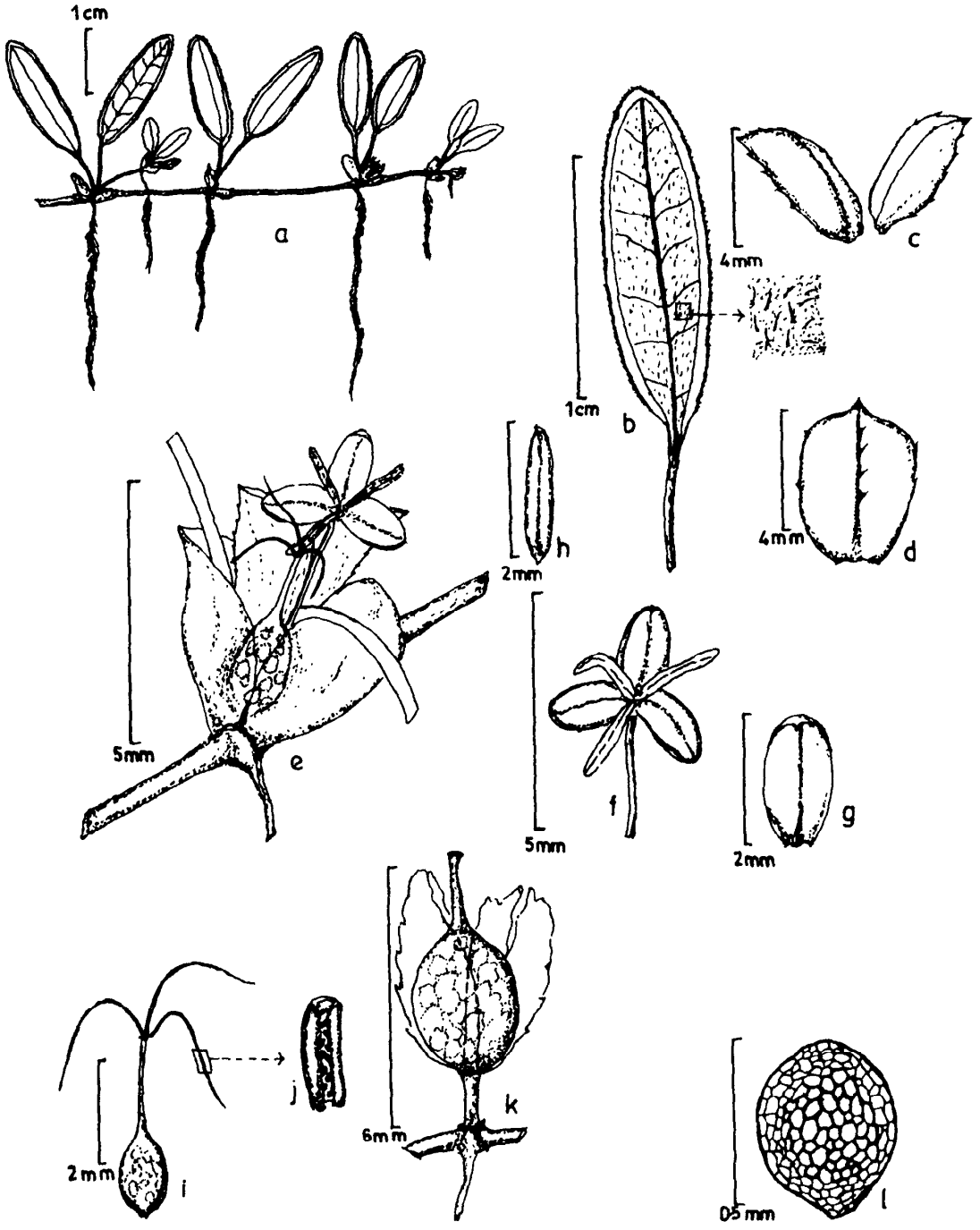


Fig.4. Halophila decipiens Ostenf.

a. Habit, b. Leaf, with a portion enlarged, c. Spathes, d. Scale, e. Plant exhibiting male and female flower in spathes, f-h: Male flower, f. Opened flower, g. Tepal, h. Stamen, i-l: Female flower; i. Female flower, j. A portion of style enlarged (x 100), k. Fruit, l. Seed.

Shoots up to 3.5 cm long, branched or unbranched, with 2 leaves at each node; petioles faintly triquetrous, up to 10 mm long, hyaline; lamina oblong-elliptic, cuneate at base, obtuse to acute at apex, 10-25 by 3-6 mm, serrulate along margins, hairy on both surfaces; cross-veins 5-9 pairs, joining the intramarginal nerves which run at a distance of *ca* 0.5 mm from the margins; midrib united at the apex with the intramarginal nerves. Spathes ovate, acuminate to mucronate at apex, 3-4 by 2-3 mm, entire or serrulate along margins, with or without stiff hairs abaxially, keeled, scarious, hyaline, enclosing 1 male and 1 female flower, splitting at the top when fruits mature. Male flowers occur at the base of the subsessile female flowers, pale green; pedicels up to 3 mm long, slender; tepals 3, ovate to elliptic, subtruncate at base, obtuse to hooded at apex, *ca* 2 by 1 mm, entire along margins, concave, hyaline; anthers 3, linear-oblong, 1.5-2 mm long, only connective tissue remains after anthesis, brown; pollen grains ellipsoid, adhere to the dorsal side of the tepals. Female flowers subsessile, up to 6 mm long; ovary oblongoid to ovoid, *ca* 1.5 mm long; hypanthium 1-2 mm long, erect, crowned by 3 reduced tepals; styles 3, 1.5-2 mm long, radiating, papillose adaxially, smooth abaxially; fruits globose, *ca* 4 by 3 mm across, with persistent hypanthium; pericarp translucent, scarious; seeds globose, *ca* 0.5 mm across, bluntly beaked at both ends, about 26 in number; testa reticulate, pale white. **(Fig. 4; Photo 5)**

Flowering and fruiting: January-March.

Ecology: *Halophila decipiens* is a marine form and its global distribution is pantropic, whereas it is restricted to Tuticorin coast of Tamil Nadu along the Coromandel Coast. It was collected from soft muddy sand to fine coarse sand, to a depth of ± 5 m. It strongly exhibits protogyny. No other seagrasses were found associated with this, but algae like *Caulerpa scalpelliformis* R.Br. and *Ulva reticulata* Forssk. grow abundantly along with it. The foliage is clothed with microepiphytes. Lakshmanan *et al.* (1988) reported its association with *H. beccarii* in Alankarathattu, near Tuticorin. Thirespuram coastal area of Tuticorin, is highly polluted with domestic sewage, oil spills and industrial effluents. As a result, most of the plants often get uprooted and washed ashore along the coasts near Thirespuram and harbour of Tuticorin in Tamil Nadu.

Specimens examined: TAMIL NADU: Thirespuram, Tuticorin, V.O. Chidhambaranar district, 22.1.1987, to a depth of ± 2 m, flowers and fruits, *Parthasarathy & Ravikumar 85383 & ibid.*, 23.1.1987, *Parthasarathy & Ravikumar 85384* (MH); Tuticorin harbour, 30.4.1988, to a depth of ± 5 m, vegetative, *Ravikumar & Ganesan 88106* (MH).

Halophila ovalis (R. Br.) Hook. f., Fl. Tasman. 2: 45. 1858, subsp. **ovalis**; Fischer in Gamble, Fl. Pres. Madras 3: 1304. 1957 (repr. ed.); Subram., Aquatic Angiosperms 62. 1962; Hartog, Seagrasses World 240. 1970; Matthew & Britto in Matthew, Fl. Tamil Nadu Carnatic 3: 1544. 1983; Srinivasan in Henry *et al.*, Fl. Tamil Nadu I. 3: 1. 1989.

Caulinia ovalis R. Br., Prodr. 1: 339. 1810.

Halophila ovata auct. non. Gaud. 1827; Hook. f., Fl. Brit. India 5: 663. 1888; Fischer in Gamble, Fl. Pres. Madras 3: 979. 1957 p.p. (repr. ed.).

Local names: TAMIL: Aathu korai, Aathu ponnanganni, Alai vaari, Chinna ponnanganni, Elai passi, Kadal paasi, Kuthippu paasi, Murungai paasi, Neer pasalai, Poduthalai paasi, Vaataalai. TELUGU: Aaaku naasi, Dheghu naasi, Elai paasi, Naasi, Samuthra naasi.

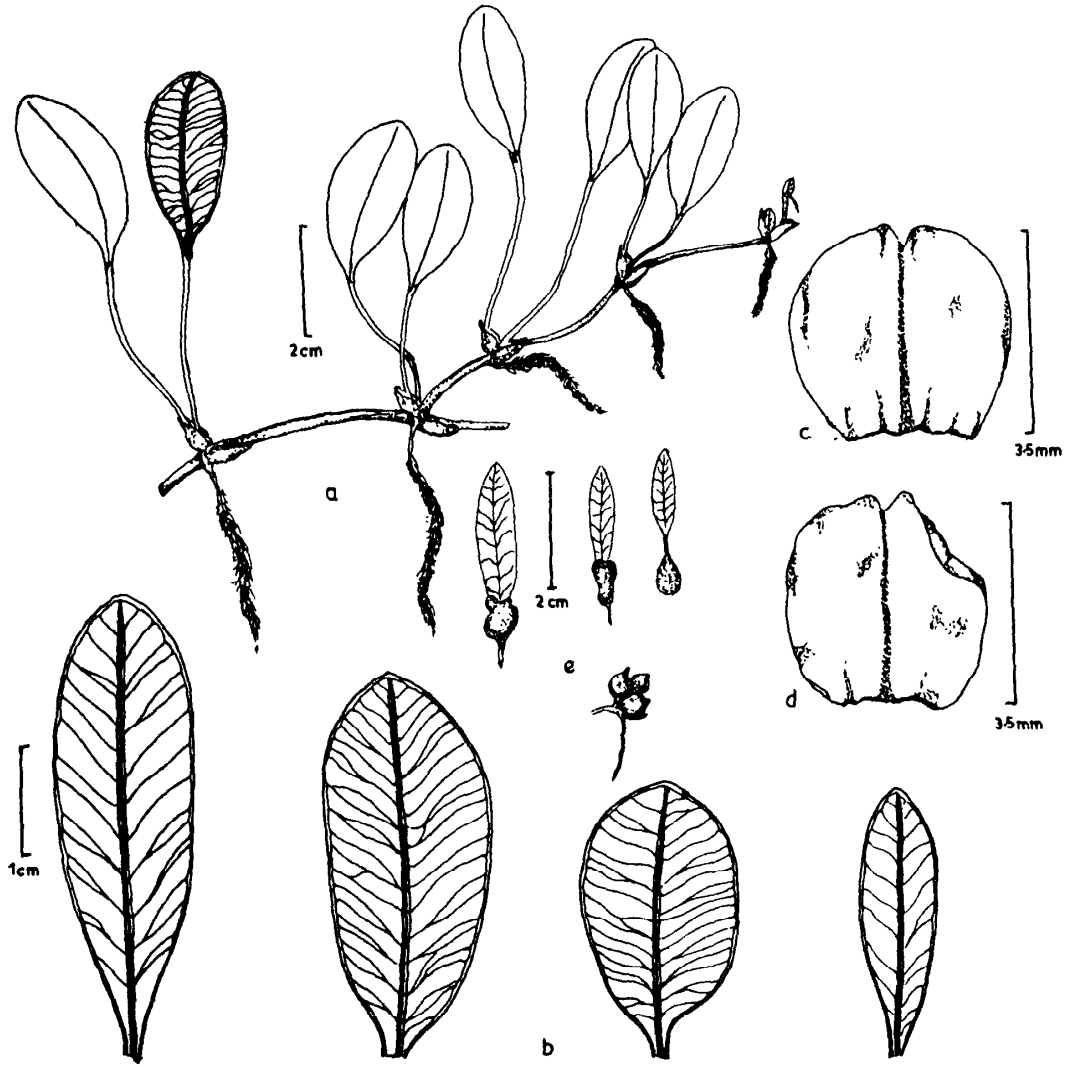


Fig.5. Halophila ovalis (R.Br.) Hook. f. subsp. ovalis

a. Habit, b. Leaf variations, c. Rhizome scale, d. Leaf scale, e. Leaf, petiole and bud galls.

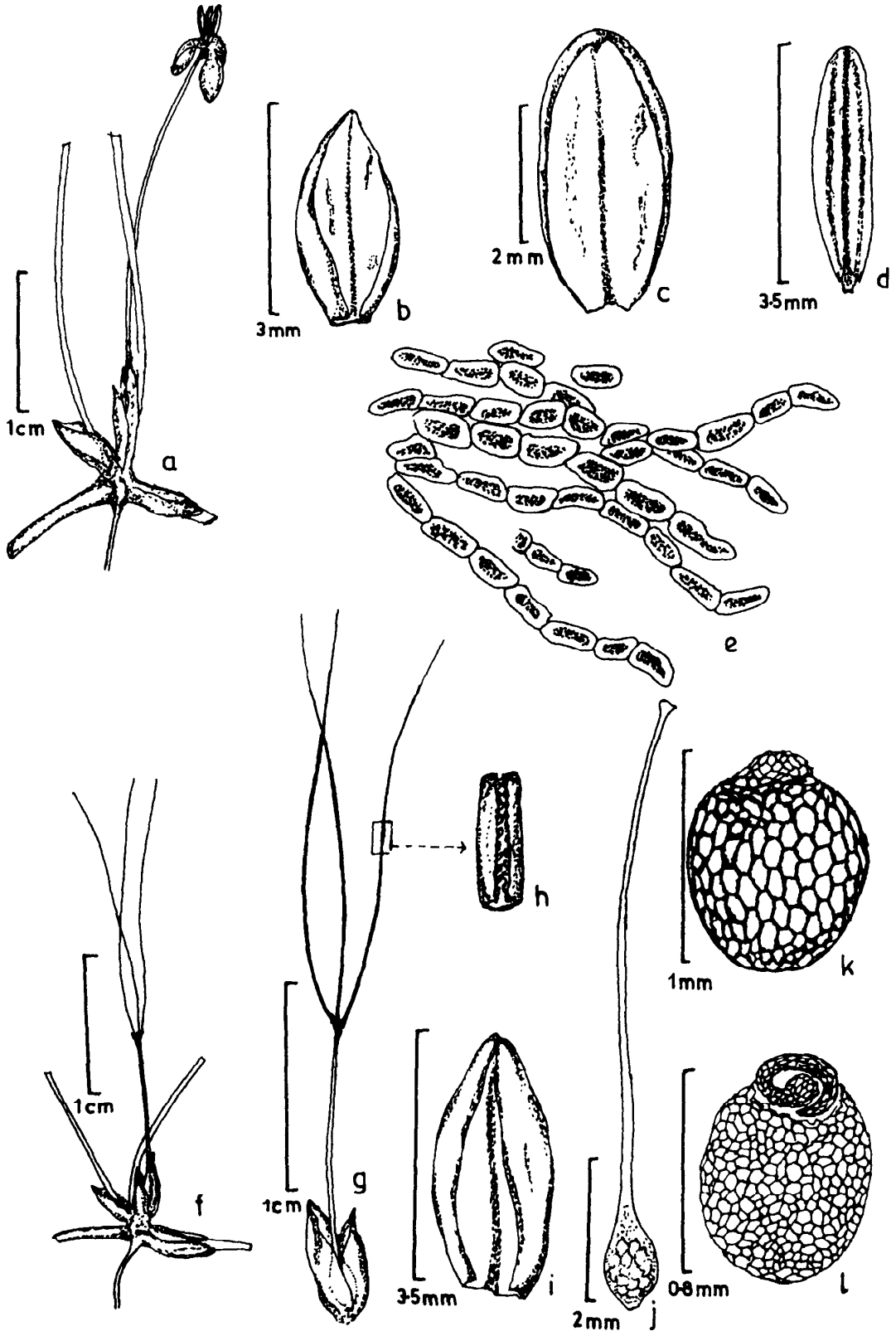


Fig.6. Halophila ovalis (R.Br.) Hook. f. subsp. **ovalis**

a-e: Male flower; a. Single flower, b. Sheath, c. Tepal, d. Stamen, e. Pollen grains (x 450), f-l: Female flower; f. Single flower, g. Single flower, h. A portion of style enlarged (x 100), i. Sheath, j. Fruit with persistent hypanthium, k. Seed, l. Embryo.

Plants dioecious. Rhizomes creeping, branched, slender, fleshy, brittle, semitransparent; roots *ca* 11 cm by 1 mm, solitary at each node with soft root hairs; internodes up to 5.5(-9) cm long, up to 2.5 mm thick; scales 2, one embracing the base of the petioles and the other embracing the rhizomes; each suborbicular, subtruncate at base, retuse to emarginate at apex, 4-9 by 3-8 mm, entire along margins, convolute, transparent, with thick white midrib. Leaves 4-12.6 cm long, paired at nodes, glabrous; petioles 1-8.2 cm long, subterete, fleshy, transparent; lamina oblong-elliptic, oblanceolate, linear-elliptic, linear-oblong, cuneate to slightly oblique at base, rarely subtruncate, obtuse to acute at apex, entire or rarely undulate along margins, pale to dark green; cross-veins 13-20 (-22) pairs, alternate, subopposite or opposite, forked or unforked; intramarginal nerves never merging at the margins; midribs never extend above the intramarginal nerves at apex. Flowers solitary, axillary, subtended by 2 subequal spathes; spathes elliptic to lanceolate, truncate at base, hooded or acuminate at apex, 6-10 by 2-5 mm, entire along margins, convolute, transparent. Male flowers up to 4 cm long; stalks up to 3.5 cm long, terete, slender, fleshy, hyaline; tepals 3, broad elliptic, truncate at base, hooded or obtuse at apex, 3-5 by 1.5-3 mm, concave, convolute, brownish without, whitish within; stamens 3, brownish; filaments minute or absent; anthers oblongoid, *ca* 3.4 by 1.5 mm, connective tissue yellow, remains erect even after shedding the pollens; pollen grains oblong, contained in a mucilage sheath forming chains. Female flowers 2-5.3 cm long, subsessile; spathes ovate, oblong or lanceolate, subtruncate at base, obtuse to acuminate at apex, 4-11 by 3-8 mm, entire along margins, concave, convolute, transparent; ovary ellipsoid, *ca* 1 mm long, white to pale yellow; styles 3, 1.5-3 cm long, equal, all inserted at the same point, papillose adaxially, smooth abaxially; fruits ovoid to ellipsoid, 2-5 by 1.4-4 mm, white to pale yellow; hypanthium 5-17 mm long, terete, straight or curved with dilated apex, semitransparent, persistent; pericarp translucent, scarious, white; seeds globose to ellipsoid, *ca* 0.5 by 0.4 mm across, bluntly beaked at both ends, 18-27 in number, with a few aborted ovules; testa reticulate, thin, white when young, brown when mature; embryo globose, *ca* 0.5 by 0.4 mm, white; cotyledon spirally coiled on the anterior side, with a pinkish dot at the centre. **(Figs. 5 &6; Photos 7 & 8)**

Flowering and fruiting: Throughout the year.

Ecology: *Halophila ovalis* is the most common seagrass found abundantly along the entire Coromandel Coast. Since, this species grows in varied environments, it shows a wide range of morphological variability, among which two distinct forms of *H. ovalis* are collected, the one growing in pure marine environment and the other along backwaters.

The marine form occurs in tidal and subtidal zones generally growing on coarse to fine sand, coral debris and muddy substratum. The leaves are ovate to obovate, rarely oblong, truncate to subtruncate at base, obtuse at apex, transparent, pale green. They are often found associated with almost all seagrasses except *Enhalus acoroides* and*Thalassia hemprichii*, but rarely form isolated pure stands. The epiphytic invasion is less or almost absent.

The other form inhabit along the margins of estuaries, backwaters and mangrove creeks. In backwater lakes, it forms extensive dense meadows of either monospecific or mixed populations. The substratum ranges between loose black muddy, clay and coarse to fine sandy soil. The leaves are oblong, elliptic-oblong,

oblong-lanceolate, cuneate to attenuate at base, acute at apex, dark green, often densely clothed with micro and macro epiphytic algae. The submerged meadows form an ideal abode and provide a good breeding site for various marine fauna such as Prawns, Eel fishes, Crabs etc. In some shallow backwater lakes it forms an extensive pure monospecific, continuous to discontinuous formation, but also found associated with *Halodule pinifolia, H. uninervis, Halophila beccarii, H. ovata* and *H. stipulacea*. Galls were observed in all the vegetative parts of pure marine and backwater forms.

The decaying older populations, successively add organic matter in addition to the trapped particulate matter suspended in the water, leading to considerable raise in the bottom level of estuaries and backwater lakes. Detached plant parts get washed ashore in plenty.

U s e s: Leaf paste mixed with turmeric is applied to cure various skin diseases, burns, boils, etc., by local fishermen in Cuddalore O.T. Port of South Arcot district. (This information is reported here for the first time). Occasionally plants are used as manure in coconut and other plantations (Wealth of India, 1959).

S p e c i m e n s e x a m i n e d: TAMIL NADU: South of Sathurangapatnam (Sadras), Chengalpattu district, Jan. 1884, vegetative, *without collector, s.n.*, (CAL & MH); Sandy Point, Krusadai Island, Ramanathapuram district, 24.2.1959, male, *Krishnamurthy 7946* (CAL & MH); Krusadai Island, 18.1.1977, vegetative, *Thanikaimoni GT 1273* (HIFP); Pichavaram lagoon, South Arcot district, 11.2.1979, male and female flowers, *Ramamurthy 58197* (MH); Nalla vadu, Pondicherry, 27.7.1981, vegetative, *Krishnamurthy & Bheema Rao, s.n.*, (HIFP); Pichavaram, South Arcot district, 12.8.1982, *Thanikaimoni GT 1756* (HIFP); Ramatheertham, Rameswaram, Ramanathapuram district, 13.2.1987, to a depth of ± 2 m, female, *Parthasarathy & Ravikumar 85305* (MH); Near Fisheries Godown, Tuticorin, V.O. Chidhambaranar district, 20.2.1987, to a depth of ± 3 m, male, *Parthasarathy & Ravikumar 85359* (MH); & *ibid.*, female, 85360 (MH); Near SPIC Unit, Tuticorin, 21.2.1987, to a depth of ± 1.5 m, male, *Parthasarathy & Ravikumar 85367* (MH); Hare Island, Tuticorin, 21.2.1987, to a depth of ± 1.5 m, female, *Parthasarathy & Ravikumar 85368* (MH); Thirespuram, Tuticorin, 22.2.1987, to a depth of ± 1 m, vegetative, *Parthasarathy & Ravikumar 85381* (MH); Near Madura Coats, Tuticorin, 23.2.1987, to a depth of ± 1.5 m, vegetative, *Parthasarathy & Ravikumar 85385* (MH); Near Thermal Station, Tuticorin, 24.2.1987, to a depth of ± 1 m, vegetative, *Parthasarathy & Ravikumar 85391* (MH); Uppanar estuary, Cuddalore O.T, South Arcot district, 19.3.1987, to a depth of ± 1 m, female, *Parthasarathy & Ravikumar 85406* (MH); Chunnambar Estuary, Thavalakuppam, Pondicherry, 21.3.1987, to a depth of ± 1m, female, *Parthasarathy & Ravikumar 85411, 85415, 85416 & 85418* (MH); *ibid.*, to a depth of ± 3.5 m, male, *Parthasarathy & Ravikumar 85414* (MH); Vellar estuary, Porto Novo, South Arcot district, 23.3.1987, to a depth of ± 4 m, vegetative, *Parthasarathy & Ravikumar 85434* (MH); Thenpakkam bridge, Marakkanam, 24.3.1987, to a depth of ± 2 m, male and female, *Parthasarathy & Ravikumar 85439* (MH); Killaiyar, Pichavaram lagoon, 26.3.1987, to a depth of ± 5 m, male, *Parthasarathy & Ravikumar 85444* (MH); *ibid.*, to a depth of ± 1.5 m, female, *Parthasarathy & Ravikumar 85452* (MH) & male and female, 85454 (MH); Pazhaiyar estuary, Kollidam, 27.3.1987, to a depth of ± 2 m, male, *Parthasarathy & Ravikumar 85456* (MH); Ennore, Chengalpattu district, 16.5.1987, to a depth of ± 1.5 m, vegetative, *Parthasarathy & Ravikumar 85467* (MH); Pulicat Lake, Chengalpattu district, 18.5.1987, to a depth of ± 4 m, male, *Parthasarathy & Ravikumar 85473* (MH); & female, *85475* (MH); *ibid*, 19.5.1987, male, *Parthasarathy & Ravikumar 85476* (MH); & female, *85477* (MH); Muttukkadu backwater, Chengalpattu district, 22.5.1987, to a depth of ± 2 m, male, *Parthasarathy & Ravikumar 85492* (MH); & female, *85493* (MH); *ibid.*, 23.5.1987, female, *Parthasarathy & Ravikumar 85703* (MH); Perumalcherry, Sathurangapatnam (Sadras), Chengalpattu district, 24.5.1987, vegetative, to a depth of ± 3 m, *Parthasarathy & Ravikumar 85710* (MH); Thiruchendur, V.O. Chidhambaranar district, 16.7.1987, to a depth of ± 2.5 m, vegetative, *Ravikumar 86722* (MH); & female, *85723* (MH); *ibid.*, 17.7.1987, vegetative, *Ravikumar 85727* (MH); Kayalpattinam, V.O. Chidhambaranar district, 18.7.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85738* (MH); Manappadu, V.O. Chidhambaranar district, 19.7.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85748* (MH); Nadar Uvari, Nellai Kattabomman district, 20.7.1987, to a depth of ± 3 m, male, *Ravikumar 85754* (MH); Idinthakarai, 23.7.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85766 & 85767* (MH); Nagapattinam, Thanjavur district, 6.9.1987, materials washed ashore, vegetative, *Ravikumar 85780* (MH); Akkaraipettai, Nagapattinam, 6.9.1987, materials washed ashore, vegeta-

tive, *Ravikumar 85784* (MH); Kuvatti, Kodikarai (Point Calimere), 11.9.1987, materials washed ashore, vegetative, *Ravikumar 85807* (MH); Kodikarai Port, 12.9.1987, materials washed ashore, vegetative, *Ravikumar 85818* (MH); Adhirampattinam, Thanjavur district, 15.9.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85825* (MH); Mallipattinam, Thanjavur district, 16.9.1987, to a depth of ± 2 m, female and fruits, *Ravikumar 85836* (MH); Manora, Thanjavur district, 17.9.1987, to a depth of ± 1.5 m, female flowers and fruits, *Ravikumar 85850* (MH); & *ibid.*, male, *Ravikumar 85851* (MH); Manamelkudi, Pudhukkottai district, 21.9.1987, to a depth of ± 1.5 m, male, *Ravikumar 85869* (MH); & female, *85870* (MH); Mimisal, Pudhukkottai district, 22.9.1987, to a depth of ± 1 m, male, *Ravikumar 85879* (MH); Jagathapattinam, Pudhukkottai, district, 22.9.1987, to a depth of ± 3 m, male, *Ravikumar 85887* (MH); Mandapam, Ramanathapuram district, 24.9.1987, to a depth of ± 3 m, vegetative, *Ravikumar 85896* (MH); Krusadai Island, 25.9.1987, to a depth of ± 2 m, vegetative, *Ravikumar 86804* (MH); Pamban, 26.9.1987, to a depth of ± 3 m, vegetative, *Ravikumar 86810* (MH); Thonithurai, Mandapam, 20.4.1988, to a depth of ± 2.5 m, vegetative, *Ravikumar & Ganesan 86827* (MH); Krusadai Island, 21.4.1988, to a depth of ± 4 m, vegetative, *Ravikumar & Ganesan 86835* (MH); Ramatheertham, Rameswaram, 24.4.1988, to a depth of ± 1.5 m, male, *Ravikumar & Ganesan 86850* (MH); *ibid.*, female, *86851* (MH); & *ibid.*, vegetative, *86860* (MH); Alankarathattu, Tuticorin, V.O. Chidhambaranar district, 27.4.1988, materials washed ashore, vegetative, *Ravikumar & Ganesan 86868* (MH); Near SPIC Unit, Tuticorin, 28.4.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 86882* (MH); Tuticorin Harbour, 30.4.1988, to a depth of ± 3.5 m, vegetative, *Ravikumar & Ganesan 88105* (MH); Near Fisheries College, Tuticorin, 1.5.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 88110* & *ibid.*, vegetative, *88116* (MH); Kadalur-Chinnakuppam, Palar estuary, Chengalpattu district, 3.9.1988, to a depth of ± 2.5 m, vegetative, *Ramamurthy 88197* (MH) & male, *88198* (MH).

ANDHRA PRADESH: West Tauvinapatnam, Nellore district, July 1883, male and female, *Gamble 12220 A* (MH); Chinnaganjam brackish water, Kistna district, Feb. 1890, vegetative, *Gamble 21736* (MH); Nizampatnam Kalva, Bapatla, Guntur district, 22.6.1988, to a depth of ± 1.5 m, male, *Ravikumar & Ganesan 88117* (MH); Nizampatnam Harbour, Guntur district, 23.6.1988, to a depth of ± 3.5 m, vegetative, *Ravikumar & Ganesan 88118* (MH); Pedhapallipalem, Chinnaganjam, Prakasam district, 25.6.1988, to a depth of ± 2 m, female, *Ravikumar & Ganesan 88131* (MH); & *ibid.*, male, *88132* (MH); Salt Peta, Kanuparti, 27.6.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 88137* (MH); Gunnamola, Kothapatnam, 28.6.1988, to a depth of ± 2 m, female, *Ravikumar & Ganesan 88140* (MH); *ibid.*, male, *88142* (MH); *ibid.*, vegetative, *88144* (MH); *ibid.*, vegetative, *88145* (MH); *ibid.*, female, *88146* (MH); & *ibid.*, vegetative, *88147* (MH); Madanoor, Theetapuram, Ethamukkalu, 29.6.1988, to a depth of + 1 m, female, *Ravikumar & Ganesan 88151* (MH); *ibid.*, vegetative, *88152* (MH); *ibid.*, male, *88154* (MH); Ramayeepatnam, Kavali, 2.7.1988, to a depth of + 1 m, vegetative, *Ravikumar & Ganesan 88170* (MH); & *ibid.*, vegetative, *88171* (MH); Karedu, Kavali, 3.7.1988, to a depth of + 2.5 m, vegetative, *Ravikumar & Ganesan 88183* (MH); Utukuru, Nellore district, 6.7.1988, to a depth of + 2 m, female, *Ravikumar & Ganesan 88189* (MH); & *ibid.*, male, *88188* (MH); Buckingham Canal, Maipadu, Nellore district, 7.7.1988, to a depth of + 1 m, vegetative, *Ravikumar & Ganesan 88192* (MH); Mahalakshmipuram, Nellore district, 9.7.1988, to a depth of + 1 m, female, *Ravikumar & Ganesan 88196* (MH); Bhimunipatnam, Visakhapatnam district, 8.9.1988, to a depth of + 1 m, vegetative, *Ramamurthy 88826* (MH); Madanoor, Theetapuram, Ethamukkalu, Prakasam district, 15.9.1988, to a depth of + 2 m, male, *Ramamurthy 88859* (MH); & *ibid.*, female, *88860* (MH); Krishnapatnam Port, Nellore district, 16.9.1988, to a depth of + 2.5 m, vegetative, *Ramamurthy 88871* (MH); & *ibid.*, vegetative, *88874* (MH).

Halophila ovalis (R. Br.) Hook. f. subsp. **ramamurthiana** Ravikumar & Ganesan in Aquat. Bot. 36: 351-358. 1990.

Local names: TAMIL: Elai paasi; TELUGU: Aaku naasi.

Plants dioecious. Rhizomes slender, fleshy, transparent; internodes up to 2.6 cm long, 0.5-1.5 mm thick; roots up to 9.6 cm long, solitary at each node with soft root hairs; scales 2, the scale covering the base of the petioles ovate to oblong, subtruncate at base, retuse at apex, 5.5-7 by 3-5 mm, convolute, entire along margins, transparent; the scale embracing the rhizomes oblong, truncate at base, retuse at apex, *ca* 7 by 4 mm, convolute, entire along margins, hyaline. Leaves 1.2-7.5 cm long, glabrous, paired at each node; petioles 0.3-6.5 cm long, fleshy, transparent, each pair subequal; lamina oblong, rarely elliptic, cuneate to attenuate and asymmetrical at base, acute at apex, up to 3.5 by 0.7 cm, entire along margins; cross-veins

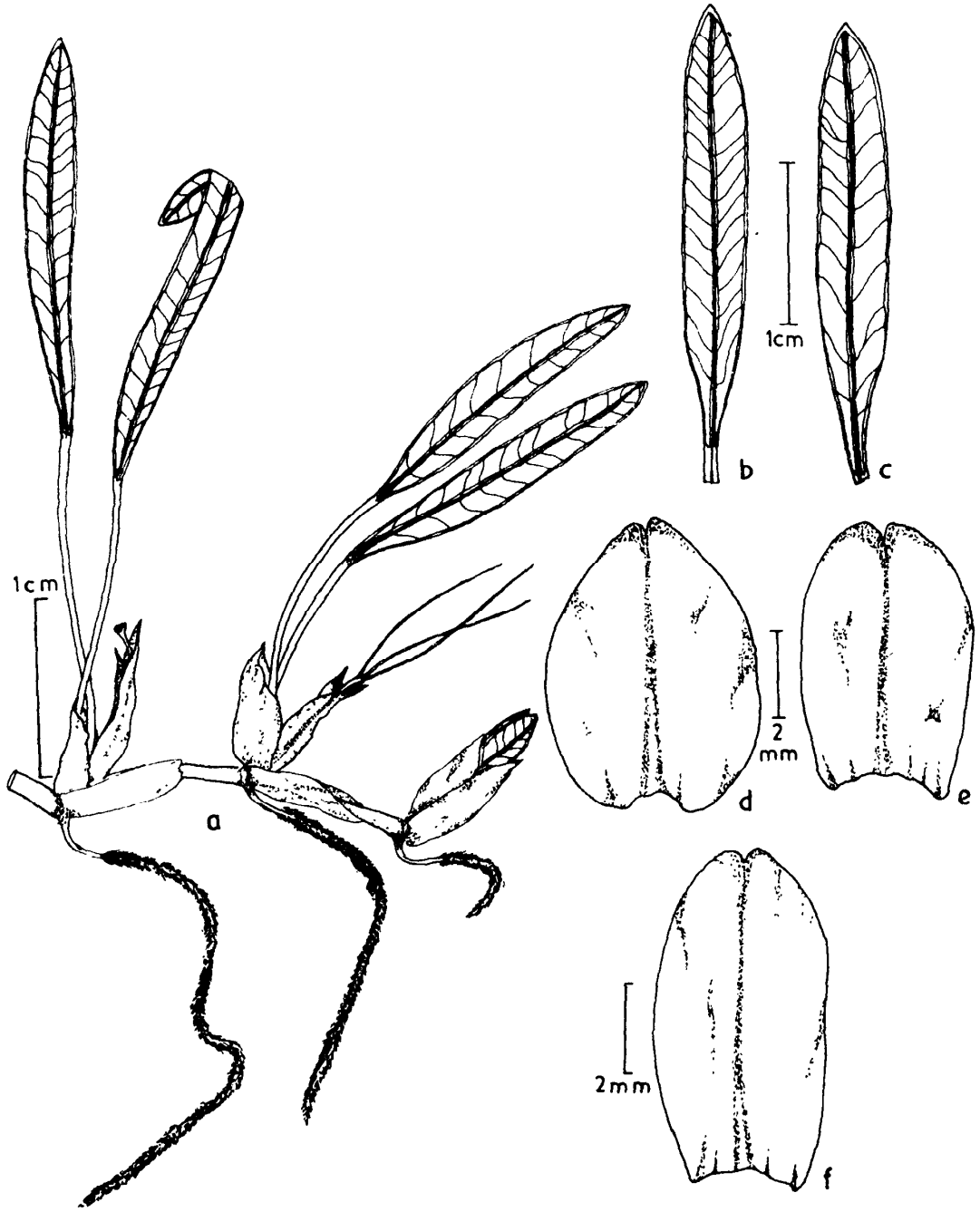


Fig.7. Halophila ovalis (R.Br.) Hook. f. **subsp. ramamurthiana** Ravikumar & Ganesan

a. Habit with female flower and fruit, b & c. Leaf with unforked and forked cross-veins, d & e. Leaf scales, f. Rhizome scale.

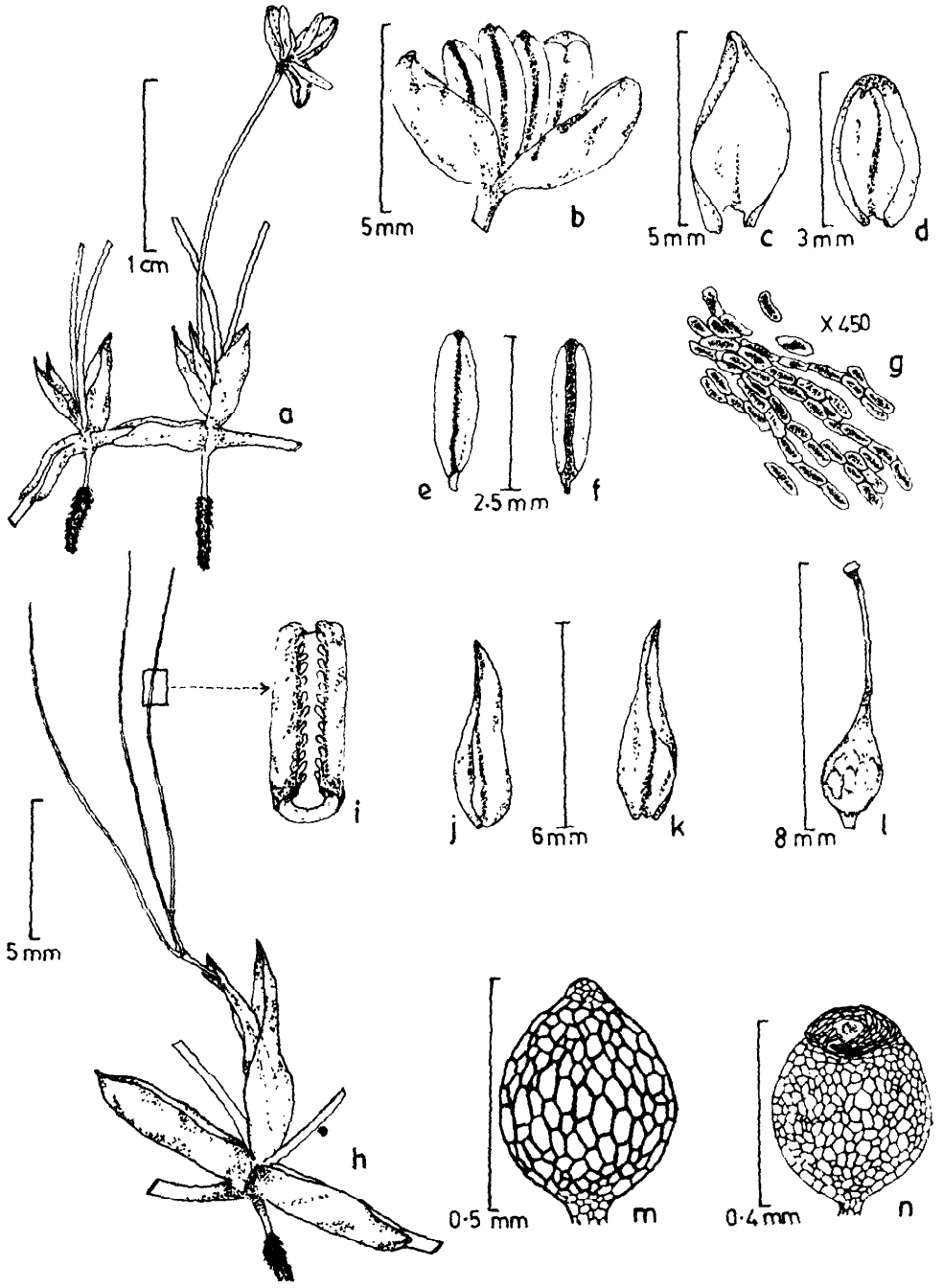


Fig.8. Halophila ovalis (R.Br.) Hook. f. **subsp. ramamurthiana** Ravikumar & Ganesan

a-g: Male flower; a. Single flower, b. Single flower enlarged, c. Spathe, d. Tepal, e & f. Stamen dorsal & ventral view, g. Pollen grains (x 450), h-n: Female flower; h. Single flower, i. A portion of style enlarged (x 100), j & k. Spathes, l. Fruit with persistent hypanthium, m. Seed, n. Embryo.

7-16 pairs, subopposite to alternate, rarely opposite or forked; intramarginal nerves rarely merging with the margins; midrib never extending beyond the intramarginal nerve at apex. Flowers solitary, axillary, dioecious, subtended by 2 subequal spathes; Male flowers *ca* 3 cm long, spathes ovate-lanceolate, acuminate at apex, *ca* 5 by 3 mm, convolute, hyaline; tepals 3, ovate-oblong, mucronate at apex, 2.5-3 by 2-2.5 mm, concave, convolute, entire, brownish without, whitish within; stamens 3, *ca* 3 mm long, brownish; filaments minute; anther lobes oblongoid, *ca* 3 by 0.5 mm, connective tissue thick, brown; pollen grains variable in shape, mostly elliptic, contained in a mucilage sheath. Female flowers 1.7-3 cm long, subsessile or sessile; spathes lanceolate, truncate at base, acuminate at apex, 6-8 by 3-4.5 mm, convolute, entire along margins; ovary ellipsoid to ovoid, *ca* 2.75 by 1 mm, whitish; styles 3, 13-23 mm long, unequal, all inserted at the same point at a distance of *ca* 7 mm from the tip of the ovary, papillose adaxially, smooth abaxially; fruits ovoid, 2.5-4 by 1-2 mm; hypanthium 4-5 mm long, persistent; pericarp translucent, scarious; seeds globose, *ca* 0.5 by 0.4 mm, in viscous fluid, normally 6-12 (-18) in number, bluntly beaked at both ends; testa reticulate, greyish white; embryo globose, *ca* 0.4 by 0.3 mm, white; cotyledon spirally coiled on the upper side. **(Figs. 7 & 8)**

Flowering and fruiting: Almost throughout the year.

Ecology: This subspecies is apparently restricted to the Coromandel Coast. It is locally abundant and forms several isolated patches of pure stands in the backwaters of Marakkanam, whereas in Theetapuram it is also associated with typical subspecies of *H. ovalis*. During low-tide a vast stretch of seagrass beds is exposed partially, up to a distance of about 1 km in Marakkanam, where this subspecies is found growing in monospecific patches or along with mixed populations of *Halophila ovalis* subsp. *ovalis*, *Halodule uninervis* and *H. pinifolia*. It is also noticed from this area that the detached seagrasses are washed ashore in plenty, forming a thick mat due to bleaching and drying.

In both areas the backwater system is directly connected with the sea throughout the year and is always influenced by tidal rhythms. The substratum is of loose, soft, black mud full of decayed plants. Epiphytic invasion is small. The male and female populations of this species are found growing in separate patches. This subspecies was collected only from the backwaters and is not found in open sea. In general, the habitat of this seagrass is not affected by pollution from any of the domestic or industrial effluents which are found nearby.

Types: *Holotype: Parthasarathy & Ravikumar 85440* (CAL) and *Isotypes: Parthasarathy & Ravikumar 85440* (MH) were collected at Marakkanam (Kaliveli Tank), South Arcot district, Tamil Nadu State on 29 March 1987, to a depth of ± 2 m. *Paratypes: Ravikumar & Ganesan 88153* (MH), male plants; *Ravikumar & Ganesan 88155* (MH), female plants were collected at Theetapuram, Prakasam district, Andhra Pradesh State on 29 June 1988, to a depth of ± 1 m; *Ramamurthy 88861* (MH),, female plants were collected at Theetapuram, Prakasam district, Andhra Pradesh State, on 15 September 1988, to a depth of ± 2 m.

This subspecies is closely related to the typical subspecies, but differs distinctly in having oblong or rarely elliptic leaves with cuneate base and acute apex, 7-16 paired cross-veins and fruits with 6-12 (-18) seeds.

This subspecies is closely related to the typical subspecies of *H. ovalis*. In some characters it is also allied to *Halophila stipulacea* (Forsk.) Aschers. However it can easily be distinguished by the characters given in Table 1.

H. ovalis subsp. *ramamurthiana*	*H. ovalis* subsp. *ovalis*	*H. stipulacea*
Lamina oblong, rarely elliptic, asymmetrically cuneate to attenuate at base, acute at apex, 1-3.5 cm by 1-7 mm, entire along margins, glabrous, bright green	Lamina obovate, spathulate, oblong-elliptic, rarely-linear, rounded, obtuse, truncate or cuneate, mostly symmetrical at base, rounded at apex, 1-4(-7) by 1.5-2 cm, entire along margins, glabrous, pale green	Lamina linear to oblong or elliptic, cuneate at base, obtuse at apex, 3-6 cm by 2.5-8 mm, serrulate along margins, glabrous, papillose or slightly hairy, sometimes bullate, pale green
Cross-veins 7-16 paired, ascending at angles of 55°-65° ; rarely forked	Cross-veins 10-25 paired, ascending at angles of 45°-65° ; often forked	Cross-veins 4-11 paired, ascending at angles of 45°-65° ; often forked
Petioles not sheathing	Petioles not sheathing	Petioles sheathing lopsidedly
Spathal bracts mucronate to acuminate at apex, glabrous	Spathal bracts acute at apex, glabrous	Spathal bracts acute at apex, hairy, glabrous on one side, ciliate on other side
Seeds 6-12 (-18), also recorded two seeds and eight aborted ovules in a fruit	Seeds 20-30	Seeds 30-40

Halophila ovata Gaud. in Bot. Voy. Uranie t. 40. f. 1. 1827; Fischer in Gamble, Fl. Pres. Madras 3: 978. 1957 p.p. (repr. ed.). Hartog, Seagrasses World 251. 1970; Srinivasan in Henry *et al.*, Fl. Tamil Nadu I. 3: 2. 1989.

H. minor (Zoll.) Hartog in Steenis, Fl. Males. Ser. 1. 5: 410. & 17b. 1957; Sachet & Fosberg in Taxon 22: 441. 1973.

Lemnopsis minor Zoll., Syst. Verz. Ind. Archip. 1: 75. 1854.

Local names: TAMIL: Elai paasi, Kadal paasi, Murungai paasi, Neer pasalai, Paasi, Poduthalai paasi. TELUGU: Aaku naasi, Naasu, Samuthra naasu.

Plants dioecious. Rhizomes slender, terete, fleshy, unbranched, rarely branched, semi-transparent; roots up to 6 cm long, solitary, unbranched with soft minute root hairs; internodes up to 4.2 cm long, *ca* 1 mm thick; scales 2, the one embracing the base of petioles obovate, oblong-elliptic, truncate to subtruncate at base, retuse at apex, 1.5-4 by 1-3 mm, entire along margins, convolute, transparent; the other embracing rhizome obovate, subtruncate at base, retuse at apex, 1.7-5 by 1-3 mm, entire along margins, convolute, transparent, with thick white tissue in the middle. Leaves 1.1-3.7 cm long, paired at each node, glabrous; petioles 4-24 mm long, subterete, fleshy, transparent; lamina oblong, oblong-elliptic, linear-oblong or oblanceolate, cuneate to attenuate or rarely slightly oblique at base, acute to obtuse at apex, 4-15 by 1-6 mm, entire along margins; cross-veins 3-9 (-11) pairs, suboppposite, alternate, rarely opposite and forked; intramarginal nerves rarely merging with the margins; midrib never extends above the intramarginal nerve at apex. Flowers axillary, solitary, subtended by spathes. Male flowers up to 3 cm long; spathes elliptic-lanceolate, subtruncate at base, hooded or shortly acuminate at apex, 4-5 by 2-2.5 mm, entire along margins, convolute, transparent; pedicels 7-30 mm long, slender, terete, fleshy, semitransparent; tepals 3, elliptic, subtruncate at base, hooded or obtuse at apex, 3-4 by 1.5-2 mm, entire along margins, concave, transparent, pale brown without, white within; stamens 3, oblong, pale yellow; filaments minute or sessile; anthers oblongoid, *ca* 2.5 by 0.5 mm; connective tissues thick, brown, stand erect even after shedding pollens; pollen grains oblong, forming a chain, contained in a mucilage sheath, brown. Female flowers 1.2-2.8 cm long, subsessile, subtended by 2 subequal spathes; spathes lanceolate, subtruncate at base, acuminate at apex, 3-5 by 2-3 mm, entire along margins, convolute, hyaline; ovary ellipsoid, *ca* 1 mm long, white to pale yellow; styles 3, 8-22 mm long, equal, all inserted at the same point, papillose adaxially, smooth abaxially; fruits ovoid to ellipsoid, 1-3 by 0.5-2 mm, white to pale yellow; hypanthium 3-6 mm long, terete, straight or curved, with dilated tip, persistent; pericarp translucent, scarious; seeds globose to ellipsoid, *ca* 0.8 by 0.4 mm across, bluntly beaked at both ends, white to pale brown, *ca* 20 in number, with a few aborted ovules; testa thin, reticulate, white when young, brown when mature; embryo globose, *ca* 0.7 by 4 mm, white; cotyledon spirally coiled at the anterior side, with a pinkish dot at the centre. **(Fig. 9; Photos 9 & 10)**

Flowering and fruiting: Throughout the year.

Ecology: *Halophila ovata* inhabits sheltered localities, waveless open seas, estuaries and backwaters. It grows on fine to coarse sandy, soft muddy bottoms and also on coral rubbles. Generally, its population is dense along the marginal area, which is often exposed during low-tide. Eventhough it forms pure and isolated formations, it sometimes grows along with other seagrasses like *Halodule pinifolia*,

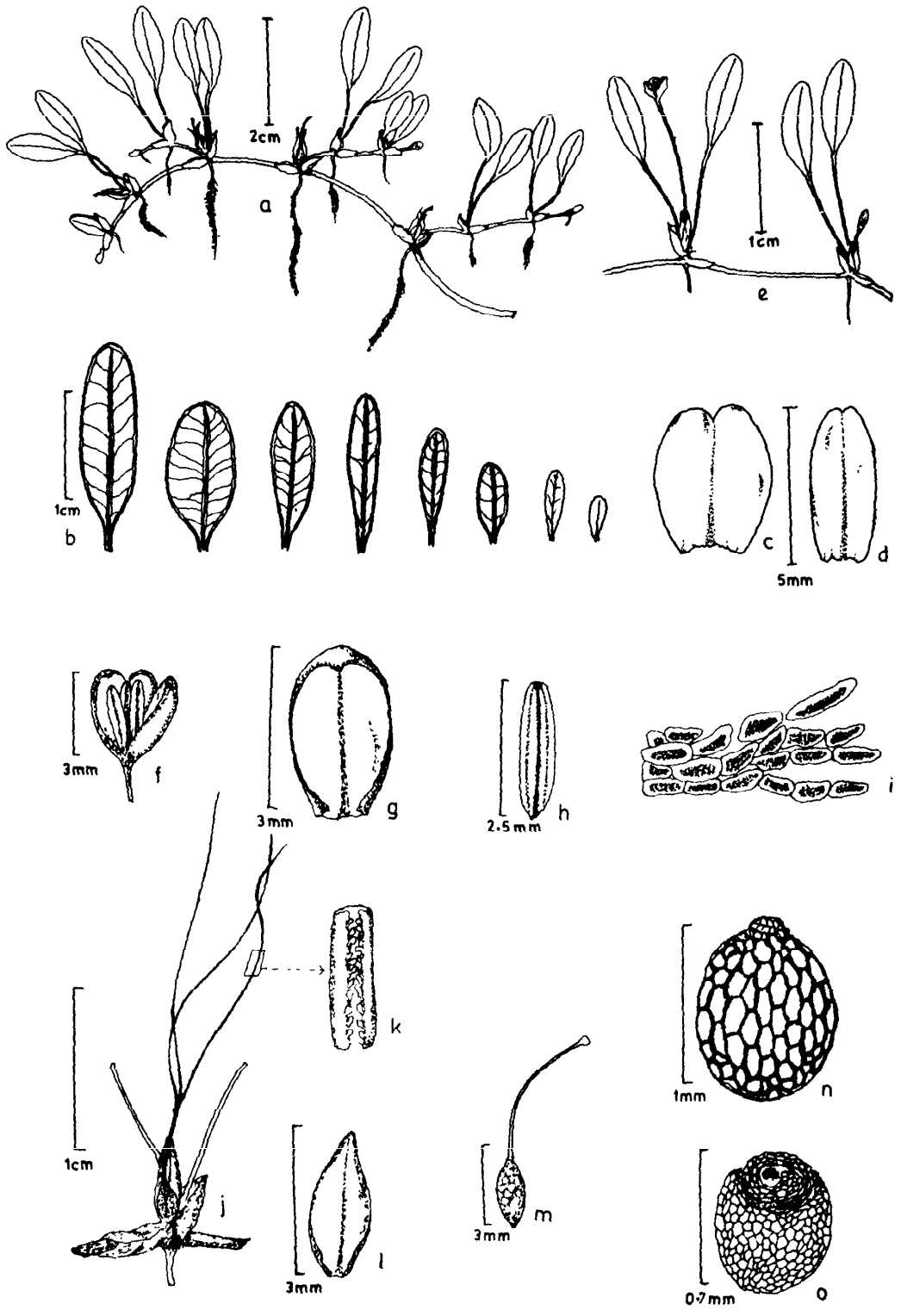


Fig.9. Halophila ovata Gaud.

a. Habit with fruits, b. Leaf variations, c. Rhizome scale, d. Leaf scale, e-i: Male flower; e. Male plant, f. Opened flower, g. Tepal, h. Stamen, i. Pollen grains (x 450), j-o: Female flower; j. Single flower, k. A portion of style enlarged (x 100), l. Spathe, m. Fruit, n. Seed, o. Embryo.

H. uninervis (narrow leaved form), *Halophila beccarii*, *H. ovalis* and rarely with *Cymodocea rotundata* and *Thalassia hemprichii*. In Krusadai Island, decaying population with matured fruits were noticed and thus ascertaining it as an annual. The plants growing in Thonithurai near Mandapam in Palk Bay are comparatively smaller and the leaves sometimes without cross-veins. It is distributed almost throughout the Coromandel Coast. The epiphytic invasion is less, since, most part of the leaves get burried in the bottom.

Specimens examined: TAMIL NADU: Rameswaram, Ramanathapuram district, 13.2.1987, to a depth of ± 2 m, vegetative, *Parthasarathy & Ravikumar 85301, 85306 & 85307* (MH); Mandapam, Ramanathapuram district, 16.2.1987, to a depth of ± 1.5 m, vegetative, *Parthasarathy & Ravikumar 85326* (MH); Rameswaram, Ramanathapuram district, 17.2.1987, to a depth of ± 2 m, vegetative, *Parthasarathy & Ravikumar 85329* (MH); Hare Island, Tuticorin, V.O. Chidhambaranar district, 21.2.1987, to a depth of ± 2 m, vegetative, *Parthasarathy & Ravikumar 85372 & 85378* (MH); Salt office, Cuddalore O.T., South Arcot district, 18.3.1987, to a depth of ± 2 m, vegetative, *Parthasarathy & Ravikumar 85402* (MH); Gori, Cuddalore O.T., 19.3.1987, to a depth of ± 1.5 m, vegetative, *Parthasarathy & Ravikumar 85408* (MH); Pulicat, Chengalpattu district, 19.5.1987, to a depth of ± 3.5 m, vegetative, *Parthasarathy & Ravikumar 85479* (MH); Muttukkadu, Chengalpattu district, 23.5.1987, to a depth of ± 3 m, vegetative, *Parthasarathy & Ravikumar 85704* (MH); Sathurangapatriam (Sadras), Chengalpattu district, 24.5.1987, to a depth of ± 3 m, vegetative, *Parthasarathy & Ravikumar 85709* (MH); Punnakayal, Thiruchendur, V.O. Chidhambaranar district, 17.7.1987, to a depth of ± 2 m, vegetative, *Ravikumar 85733* (MH); Manora, Thanjavur district, 17.9.1987, to a depth of ± 2 m, vegetative, *Ravikumar 85885* (MH); Kattumaavadi, Pudhukkottai district, 20.9.1987, to a depth of ± 1.5 m, vegetative, *Ravikumar 85866* (MH); Mimisal, Pudhukkottai district, 22.9.1987, to a depth of ± 3 m, vegetative, *Ravikumar 85866* (MH); Krusadai Island, Ramanathapuram district, 25.9.1987, to a depth of ± 1 m, vegetative, *Ravikumar 86804* (MH); Pamban, Ramanathapuram district, 26.9.1987, to a depth of ± 1 m, male, female and fruits, *Ravikumar 86814* (MH); Thonithurai, Mandapam, Ramanathapuram district, 20.4.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 86826* (MH); Krusadai Island, Ramanathapuram district, 21.4.1988, to a depth of ± 1 m, female and fruits, *Ravikumar & Ganesan 86836* (MH); Akkalmadam, Ramanathapuram district, 22.4.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 86840* (MH); Pamban, Ramanathapuram district, 23.4.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 86845* (MH); Ramatheertham, Rameswaram, 24.4.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 86852* (MH); Sangumal, Rameswaram, 24.4.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 86858* (MH); Near SPIC Unit, Tuticorin, V.O. Chidhambaranar district, 28.4.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 86883* (MH); Near Fisheries College, Tuticorin, 1.5.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 88108 & 88109* (MH).

ANDHRA PRADESH: West Tanvinapatnam, Nellore district, July 1883, vegetative, *Gamble 12230* (CAL); Pedhapallipalem, Chinnaganjam, Prakasam district, 25.6.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 88129* (MH); Salt Pettah, Kanuparti, Ongole, Prakasam district, 27.6.1988, to a depth of ± 1 m, vegetative. *Ravikumar & Ganesan 88138* (MH); Venkateshpuram, Tummalapenta, Nellore district, 1.7.1988, to a depth ± 1 m, vegetative, *Ravikumar & Ganesan 88161* (MH); Reddypalem, Ramayeepatnam, Prakasam district, 2.7.1988, to a depth of ± 1/2 m, vegetative, *Ravikumar & Ganesan 88167* (MH).

Halophila stipulacea (Forsk.) Asch. in Bot. Zeitung (Berlin) 25: 95. 1867; Hartog, Seagrasses World 258. 1970; Srinivasan in Henry *et al.*, Fl. Tamil Nadu I. 3: 2. 1989.

Zostera stipulacea Forsk., Fl. Aeg.-Arab. 158. 1775.

Halophila balfourii Soler. in Beih. Bot. Centralbl. 30(1): 47. 1913; Fischer in Gamble, Fl. Pres. Madras 33: 1305. 1957 (repr. ed.).

H. ovata auct. non Gaud. 1827; Fischer in Gamble, Fl. Pres. Madras 3: 979. 1957 p.p. (repr. ed.).

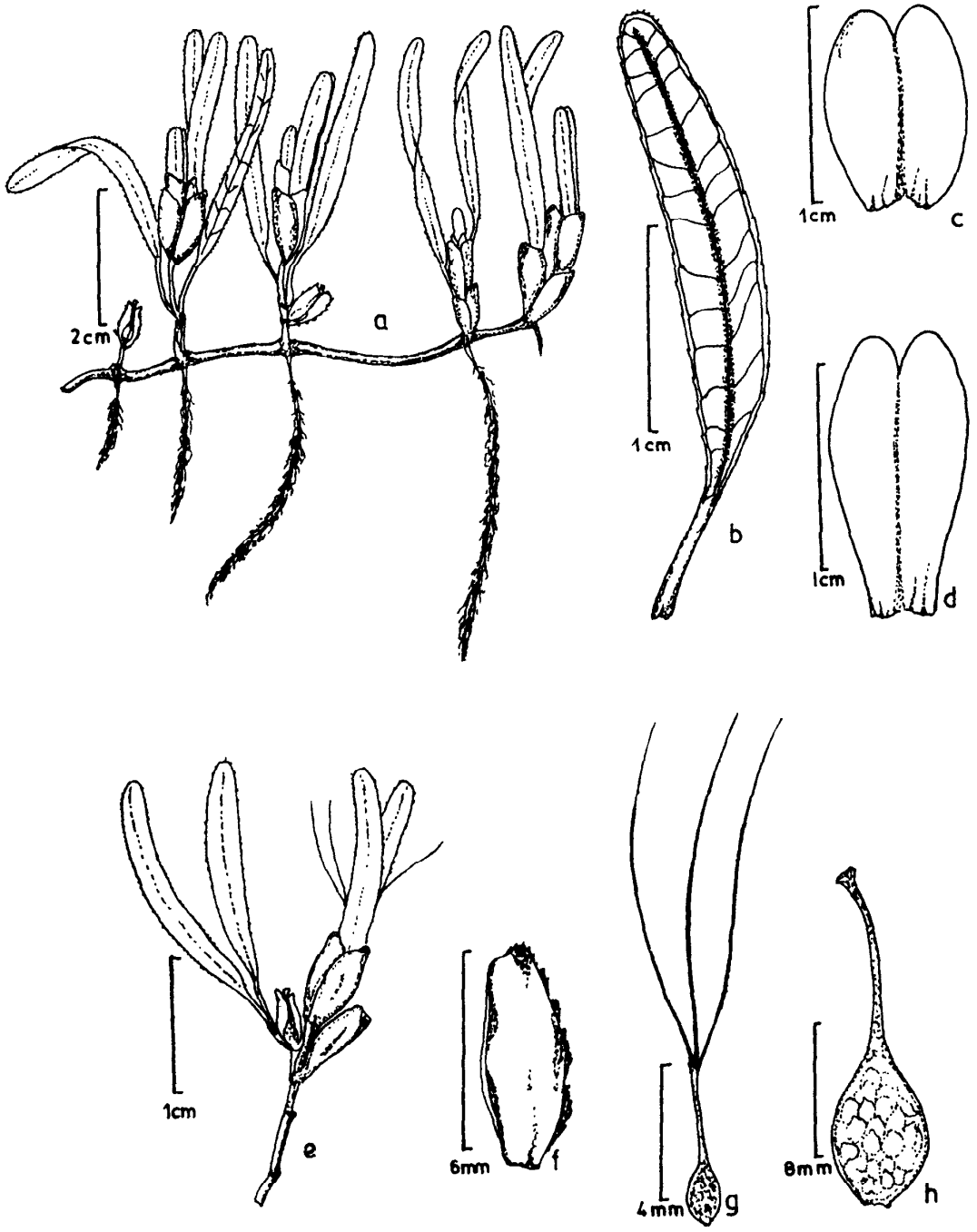


Fig.10. Halophila stipulacea (Forsk.) Asch.

a. Habit with fruits, b. A leaf enlarged, c. Leaf scale, d. Rhizome scale, e. Female plant, f. Spathe, g. Female flower, h. Fruit with persistent hypanthium.

Local names: TAMIL Elai paasi, Kadal paasi.

Plants dioecious. Rhizomes creeping, terete, branched, fleshy, semitransparent; roots up to 7.5 cm long, *ca* 1.5 mm thick, solitary, unbranched; with dense soft root hairs; internodes up to 4.2 cm long; scales 2, the one embracing petioles broadly elliptic, subtruncate to subcordate at base, retuse at apex, 4-12 by 3-8 mm, entire along margins, convolute, transparent; the other embracing rhizomes broadly elliptic to obovate, subtruncate at base, retuse at apex, 7-12 by 4-8 mm, entire along margins, convolute, transparent. Shoots up to 7.5 cm long, erect, rarely branched, with 2 leaves at each node; petioles up to 12 mm long, flat, sheathing at base; lamina linear-oblong, cuneate to gradually decurrent at base, obtuse at apex, 1-3.5 cm by 1.5-5 mm, serrulate along margins, hairy on both surfaces, pale green; cross-veins 4-14 pairs; intramarginal nerves not merging with the margins; midrib never extends beyond the intramarginal nerve at apex. Flowers solitary, axillary, subtended by spathes. Male flowers not seen. Female flowers solitary, axillary, up to 17 mm long; spathes oblong-elliptic to ovate, truncate at base, obtuse at apex, 4-6 by 2-4 mm, keeled, entire along margins, ciliate at midrib; ovary ellipsoid, *ca* 1 by 1 mm across, pale green; hypanthium up to 4 mm long, terete, slender, semitransparent, persistent; styles 3, 8-12 mm long, slender, papillose adaxially, smooth abaxially; fruits ovoid to subglobose, *ca* 3 mm across; pericarp membranous; seeds globose, *ca* 27 in number, abruptly beaked at both ends. **(Fig. 10; Photo 6)**

Flowering and fruiting: Male flowers not seen, probably the appearence of male flowers is for a very short period and is ephemeral. Female flowers and fruits in February to April.

Ecology: *Halophila stipulacea is* restricted in distribution and is found in Thanjavur, Pudhukkottai and Ramanathapuram districts of Tamil Nadu. It is a marine form and not available in backwaters. It grows in sheltered localities as isolated patches either as pure formations or mixed with *Halophila ovalis, H. ovata, Cymodocea rotundata, Halodule pinifolia* and *H. uninervis* (broad & narrow leaved forms). It is locally abundant on muddy bottoms and on coral rubbles. Epiphytic invasion is less or absent.

Specimens examined: TAMIL NADU: Krusadai Island, Ramanathapuram district, 18.2.1987, to a depth of ± 3 m, female and fruits, *Parthasarathy & Ravikumar 85336* (MH); Adhirampattinam, Thanjavur district, 15.9.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85826* (MH); Mallipattinam, Thanjavur district, 16.9.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85840* (MH); Manora, Thanjavur district, 17.9.1987, to a depth of ± 2 m, vegetative, *Ravikumar 85853* (MH); Manamelkudi, Pudhukkottai district, 21.9.1987, to a depth of ± 2 m, vegetative, *Ravikumar 85874* (MH); Mimisal, Pudhukkottai district, 22.9.1987 to a depth of ± 5m, vegetative, *Ravikumar 85881* (MH); Krusadai Island, Ramanathapuram district, 21.4.1988, to a depth of ± 4 m, female, *Ravikumar & Ganesan 86837* (MH).

THALASSIA BANKS ex KONIG

Plants dioecious. Rhizomes creeping, terete, branched, often interwoven, rooting at nodes; scales on juvenile plants membranous, caducous. Shoots erect with 2-6 distichously arranged leaves; leaves linear, often falcate, differentiated into sheath and lamina, ligules absent; nerves parallel, joining at apex. Inflorescences pedunculate, single flowered, subtended by 2 connate spathes; spathes connate at one side in male flowers and connate at both sides in female flowers. Male flowers shortly pedicelled; tepals 3, elliptic; stamens 3-12, sessile; anthers oblong, erect,

subsessile, 2-4-celled, dehiscing longitudinally; pollen grains globose, forming moniliferous chain. Female flowers subsessile; tepals 3; ovary muricate, uni to imperfectly trilocular; hypanthium partly persistent; styles 6-8, each one further divided into 2 stigmata; fruits globose, warted, beaked; pericarp fleshy, splitting into irregular valves; seeds few, conical, thickened at base, embryo with a large hypocotyl and a cotyledon.

Thalassia hemprichii (Ehrenb.) Asch. in Petermanns Geogr. Mitt. 17: 242. 1871; Hartog, Seagrasses World 232. 1970; Lakshmanan & Rajeswari in Curr. Sci. 51: 373. 1982; Srinivasan in Henry *et al.*, Fl. Tamil Nadu I. 3: 2. 1989.

Schizotheca hemprichii Ehrenb. in Abh. Berl. Akad. Wiss. 1832 (1): 429. 1834.

Local names: TAMIL Alai vaari, Kadal thazhai, Karumbu paasi, Kattai korai, Korai paasi, Neer pasalai, Olai paasi.

Rhizomes creeping, branched, brittle, brown to white; roots single at each node, up to 19 cm long, with a tuft of soft root hairs; internodes 2-5 by 2-5 mm, with persistent, oblique, circular, rhizome scale scars; scales ovate, truncate, obtuse at apex, 5-8 by 5-6 mm, entire along margins, hyaline, convolute, brown, crowded and overlapping near the tip with numerous reddish-brown tannin streaks. Shoots up to 30 cm long, erect, sometimes branched, bearing 3-7 leaves at each branch; stems up to 9 cm long, erect, brownish-black; internodes short, many; sheaths obconical, slightly narrow to subtruncate at base, truncate at apex, *ca* 10.5 by 1.5 cm; margins convolute, hyaline, with decayed persistent older sheaths forming a thick mass; lamina linear, falcate, slightly narrow at base, obtuse, rarely emarginate or oblique and serrulate at apex, *ca* 15.5 by 1.2 cm, entire or rarely serrulate along margins, dark green, giving an appearance of spongy texture with numerous tannin streaks; transition between sheath and lamina is well marked by oblique, curved or straight lines; nerves 7-13, parallel, joining with the intramarginal nerves at apex; air channels many, longitudinal, parallel with the nerves. Flowers uniflorous, subtended by spathes; spathes oblong to lanceolate, acute, obtuse or entire, rarely serrulate at apex, 1.75-2.5 cm long, *ca* 5 mm broad, persistent, connate, with many short, brown, tannin dashes. Peduncle of the male inflorescences *ca* 3 cm long; pedicel of the male flowers 2-3 mm long; tepals 3, elliptic; stamens 3-12, mostly 6-9; anthers oblong, 7-11 by 1-1.25 mm, occasionally forked; pollen grains globose, yellow, when forming tubes 20-33 mm long. Peduncle of the female inflorescences 1-1.5 cm long, after anthesis elongating to 2-4 cm long; female flowers subsessile, after anthesis very shortly pedicellate; tepals 3, elliptic, 7-8 mm long, *ca* 3 mm broad: margins revolute during anthesis, smooth at inner side, longitudinally ribbed at outer side, hyaline or pale brown, with numerous tannin cells; ovary conical, *ca* 1 mm long; hypanthium 2-3 mm long; styles 6, 5-7 mm long; stigmata 10-15 mm long, pale brown, after flowering recurved and subsequently caducous; stalks of fruits 7-15 by 3-4 mm, erect, flattened; fruits globose, 1.4-2 by 1.4-1.8 cm, roughly warty, distinctly 3-ridged, with many inconspicuous longitudinal ridges, bursting into 8-13 irregular valves; beaks prominent, 1-2 mm long; seeds 3-9, obconical to obovoid, 6-8 mm by 5-6 mm, conical part greenish, basal part stout, dark brown; embryo ellipsoid, white. **(Fig. 11; Photos 11 & 12)**

Flowering and fruiting: The flowering plants are not seen. (The floral descriptions adapted from Hartog, *l.c.*). Fruits in March and April.

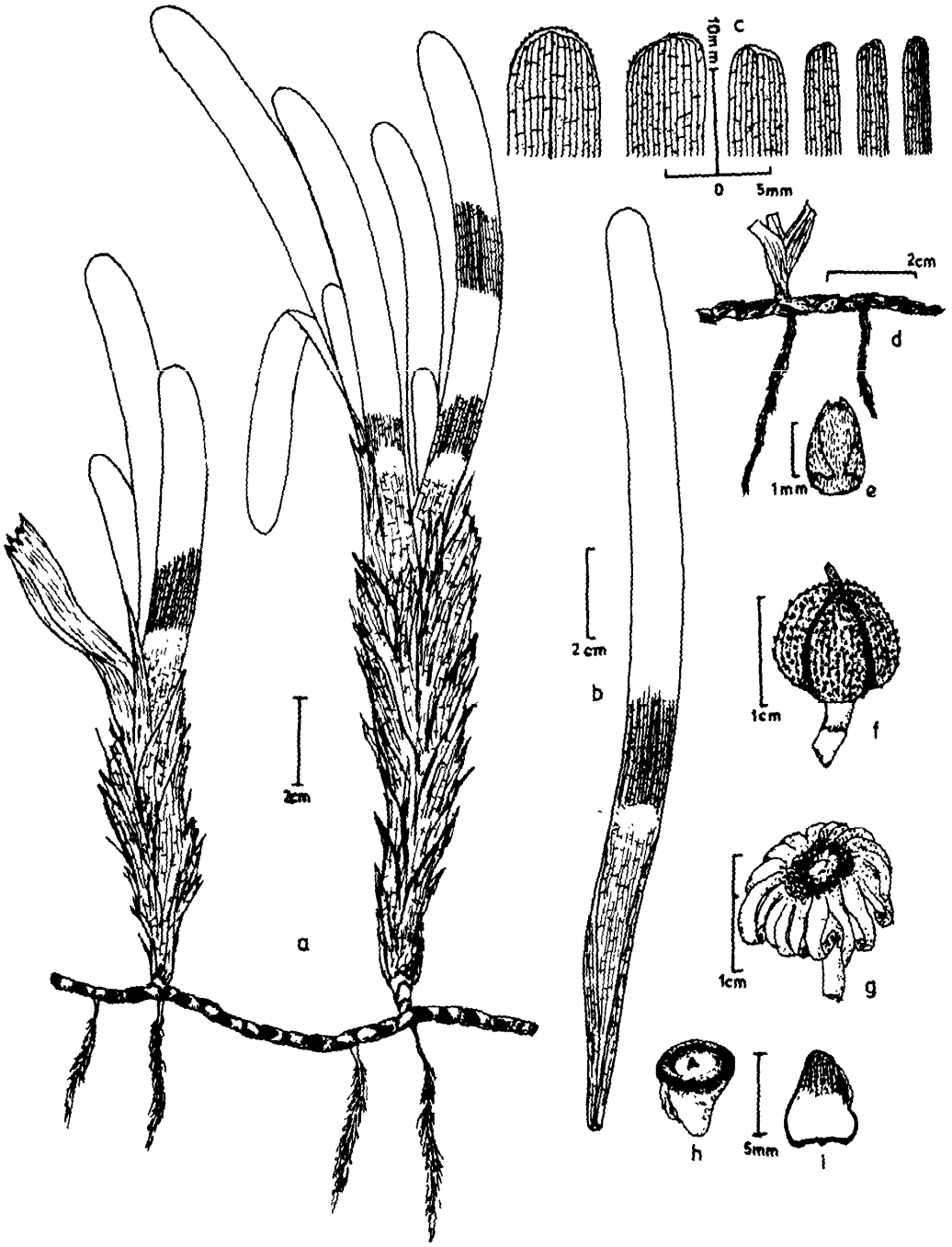


Fig.11. Thalassia hemprichii (Ehrenb.) Asch.

a. Habit, b. Leaf showing lamina and sheath, c. Variation in the leaf tips, d. Portion of young plant displaying rhizome scales, e. Scale, f. Fruit, g. Dehisced fruit, h. Seed, i. Embryo.

Ecology: The distribution of *Thalassia hemprichii* in Tamil Nadu Coast is almost continuous in all districts except South Arcot and Kanniyakumari. Fresh materials were collected from southern parts of Thanjavur, Ramanathapuram and V.O. Chidhambaranar districts, whereas, in Madras, Chengalpattu, northern coasts of Thanjavur, V.O. Chidhambaranar and Nellai Kattabomman districts the materials were washed ashore freshly. In the entire Andhra Pradesh Coast, this species is completely absent and not even washed ashore specimens were noted.

In general the habitat of this species is very distinct, which are found on black muddy, loose sandy and coral rubbles. It occurs in sheltered localities of tidal and subtidal zones. It is purely a marine form and is not seen in backwaters or estuaries.

The underground rhizomatous system is tightly interwoven and forms half feet thickness in muddy and coral bottoms. This underground system helps as a good soil binder and also collects suspended organic matter thus enriching the substratum and in turn the marine environment.

They usually form pure and distinct populations but are also found with *Cymodocea rotundata, C. serrulata, Enhalus acoroides* and rarely associated with *Syringodium isoetifolium, Halodule uninervis* (narrow and broad-leaved forms) and *H. pinifolia*. The leaves are generally falcate so as to enable them to withstand the tidal actions, however, rarely straight leaves are also observed. Along the marginal regions of Pamban Coast, stunted forms are noted and this may be due to total exposure during low-tide and high water temperature. The epiphytic invasion is only micro-fauna and flora. Like *Enhalus*, the matured fruits often get detached and washed ashore.

Specimens examined: TAMIL NADU: Tuticorin, Tinnevely district, 2.10.1916, vegetative; *collector unknown 13725 B (acc. no. 52968* MH); Foreshore Estate, Madras district, 15.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85465 A* (MH); Thiruvottiyur, Chengalpattu district, 17.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85471 B* (MH); Foreshore Estate, Madras district, 20.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85490* (MH); Enjampakkam, Chengalpattu district, 23.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85499* (MH); Mamallapuram (Mahabalipuram), Chengalpattu district, 25.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85712* (MH); *ibid.*, 26.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85716* (MH); Poompuhar, Thanjavur district, 7.9.1987, materials washed ashore, vegetative, *Ravikumar 85792* (MH); Karaikal, Pondicherry Union Territory, 8.9.1987, materials washed ashore, vegetative, *Ravikumar 85796* (MH); Nagoor, Thanjavur district, materials washed ashore, 9.9.1987, vegetative, *Ravikumar 85801* (MH); Kodikarai (Point Calimere), Thanjavur district, 11.9.1987, materials washed ashore, vegetative, *Ravikumar 85812* (MH); *ibid.*, 12.9.1987, materials washed ashore, vegetative, *Ravikumar 85821* (MH); Mandapam, Ramanathapuram district, 24.9.1987, materials washed ashore, vegetative, *Ravikumar 85893* (MH); Krusadai Island, Ramanathapuram district, 25.9.1987, to a depth of ± 3 m, vegetative, *Ravikumar 85898* (MH); Thalaipalem, Pamban, Ramanathapuram district, 26.9.1987, to a depth of ± 2 m, vegetative, *Ravikumar 86812* (MH); Mandapam, Gulf of Mannar, Ramanathapuram district, 20.4.1988, to a depth of ± 4 m, fruits, *Ravikumar & Ganesan 86819* (MH); Krusadai Island, Ramanathapuram district, 21.4.1988, to a depth of ± 3 m, vegetative, *Ravikumar & Ganesan 86829* (MH); Pamban, Ramanathapuram district, 23.4.1988, to a depth of ± 3 m, vegetative, long leaved form, *Ravikumar & Ganesan 86841* (MH); *ibid.*, 23.4.1987, to a depth of ± 1.5 m, vegetative, stunted form, *Ravikumar & Ganesan 86842* (MH); Sangumal, Rameswaram, Ramanathapuram district, 24.4.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 86855* (MH); Alankarathattu, Tuticorin, V.O. Chidhambaranar district, 27.4.1988, materials washed ashore, vegetative, *Ravikumar & Ganesan 86869* (MH); Near SPIC Unit, Tuticorin, 28.4.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 86881* (MH); Hare Island, Tuticorin, 28.4.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 86893* (MH); Tuticorin Harbour, 30.4.1988, to a depth of ± 3 m, vegetative, *Ravikumar & Ganesan 88103* (MH).

POTAMOGETONACEAE

Dioecious, annual or perennial aquatic plants. Rhizomes creeping, herbaceous or lignified; rooting at nodes or internodes; vessels absent. Shoots erect, branched or unbranched. Leaves submerged or floating, distichously arranged, alternate or opposite, linear, lanceolate, elliptic or ovate, petiolate, sessile or sheathed; stipules axillary or lateral; nerves parallel, connected by perpendicular cross-veins. Flowers simple, actinomorphic, unisexual or bisexual, sessile, solitary or in pairs or in compound cymes; perianth absent, if present, consisting of 3-4 bracts. Stamens without filaments; anthers 1-2- locular, dehiscing extrorsely, sometimes 2 stamens dorsally connate, connective either broad or extremely reduced; pollen grains globoid or confervoid. Ovaries 2, free, superior, ellipsoid or ovoid; styles with 1-3 filiform stigmata; stigma discoid; fruits indehiscent; pericarp stony, fleshy or membranous; ovules pendulous, orthotropus or campylotropus, straight or curved; hypocotyl well developed; endosperm absent.

Key to the genera

A. Key based on vegetative characters:

1a. Leaves terete, fleshy, grooved along adaxial side for a short distance; nerves absent . . . . . **Syringodium**

1b. Leaves flat, not fleshy, without grooves; nerves present :

2a. Rhizomes usually moniliferous, with scales; nerves 3; lamina 0.25-4 mm broad . . . . . **Halodule**

2b. Rhizomes not moniliferous, without scales; nerves 7-22; lamina 4-10 mm broad . . . . . **Cymodocea**

B. Key based on reproductive characters:

1a. Flowers in dichasial cymes . . . . . **Syringodium**

1b. Flowers solitary or in pairs :

2a. Anthers attached at equal levels, with apical appendages; styles divided into 2 stigmata; fruits angular . . . . . **Cymodocea**

2a. Anthers attached at unequal levels, without apical appendages; styles undivided ; fruits globose . . . . . **Halodule**

CYMODOCEA KONIG

Submerged, dioecious, marine herbs. Rhizomes monopodial, creeping, branched, jointed, fibrous, rigid; roots solitary, branched; scales absent; Shoots erect, branched, sometimes crowded, bearing 2-5 leaves at each branch; stems with opened or closed leaf scars; leaf sheaths linear-oblong to obconical, truncate to obtuse at apex, transparent with short acute ligules, persisting longer than the leaf blades, with longitudinal discontinous, tannin streaks; lamina linear, often falcate, narrow at base, obtuse, emarginate, oblique, entire to serrulate at apex, entire to serrulate along margins with vertical tannin dashes; nerves 9-22; midrib conspicuous; lateral nerves vertical, merging or not merging with the intramarginal nerves, rarely merging into the apex. Flowers solitary, axillary, arising from the reduced leaves; reduced leaves appearing as spathes. Male flowers stalked; perianth absent;

anthers 2, dorsally connate, attached at equal level, with subulate appendages at apex; pollen grains forming a thread. Female flowers sessile or minutely stalked; ovaries 2; styles prominent; stigma 2, subulate; drupelets 2, obovoid, laterally compressed, angular with persistent beak; pericarp stony.

Key to the species

1a. Leaf scars forming closed rings; sheaths persistent; lamina 3-6 mm broad, rarely serrulate at apex; nerves 9-14 . . . . . **C. rotundata**

1b. Leaf scars forming opened rings; sheaths not persistent; lamina 4-10 mm broad, serrulate at apex; nerves 12-22 . . . . **C. serrulata**

Cymodocea rotundata Ehrenb. & Hempr. ex Asch. in Sitz. Ges. Naturf. Freunde Berlin 1870: 84. 1870; Fischer in Gamble, Fl. Pres. Madras 3: 1117. 1957 (repr. ed.); Subram., Aquatic Angiosperms 98. 1962; Hartog, Seagrasses World 166. 1970; Bhargavan in Henry *et al.*, Fl. Tamil Nadu I. 3: 61. 1989.

Local names: TAMIL: Alai vaari, Kadal karumbu, Kadal korai, Kadal paasi, Kadal thazhai paasi, Karumbu paasi, Kattai korai, Korai paasi, Neer pasalai, Thazhai paasi, Vaataalai, Vellai kadal korai paasi.

Plants dioecious. Rhizomes creeping, branched, flexible, fibrous, jointed, white to pale brown; roots single at each node, branched; internodes up to 4 cm long, 2-4 mm thick. Shoots erect, up to 31 cm long, rarely many branches crowded at tip, each bearing 3-4 leaves; stems erect, up to 6 cm long; internodes 2-8 mm long with persistent closed circular leaf scars; leaf sheaths obconical, gradually cuneate at base, truncate at apex, 1.5-8 cm by 2.5-7 mm, transparent, entire along margins and folded inwardly, older sheaths forming a scarious mass; ligules triangular, acute at apex, *ca* 1 mm high; lamina linear, usually falcate, narrowed at base, obtuse, emarginate, oblique, rarely faintly serrulate at apex, 2.7-18.5 cm by 3-6 mm, entire along margins; nerves 9-14, rarely reaching the apex. Male flowers stalked; anthers *ca* 11 mm long. Female flowers sessile, axillary; ovary very small, gradually passing into the style, *ca* 5 mm long; stigma at least 30 mm long, spirally coiled; fruits 1 or 2 together, sessile, semicircular in outline, laterally compressed, *ca* 10 mm long, *ca* 6 mm wide and *ca* 1.5 mm thick with 3 dorsal, parallel ridges of which the median one is set with 6-8 conspicuous acute teeth and one ventral ridge bearing 3-4 teeth; exocarp sclerenchymatous, covered with numerous longitudinal tannin cells; beak apical, *ca* 2 mm long, suboblique, persistent. **(Fig. 12; Photo 13)**

Flowering and fruiting: The plants are seen in vegetative condition only. (The descriptions of flowers and fruits are adapted from Hartog, *l.c.*)

Ecology: *Cymodocea rotundata* is a pure marine form, distributed in almost all districts of Tamil Nadu Coast except South Arcot and Kanniyakumari districts. In Madras, Chengalpattu, Thanjavur and Nellai Kattabomman districts plenty of drifted materials were collected, whereas in Pudhukkottai, Ramanathapuram and V.O. Chidhambaranar districts, fresh materials have been collected. This species is not collected from Andhra Pradesh Coast, where it seems to be absent.

Like other marine forms, it grows in sheltered and shallow regions of tidal and subtidal zones. The substratum is of fine sand to coarse sand, muddy and with

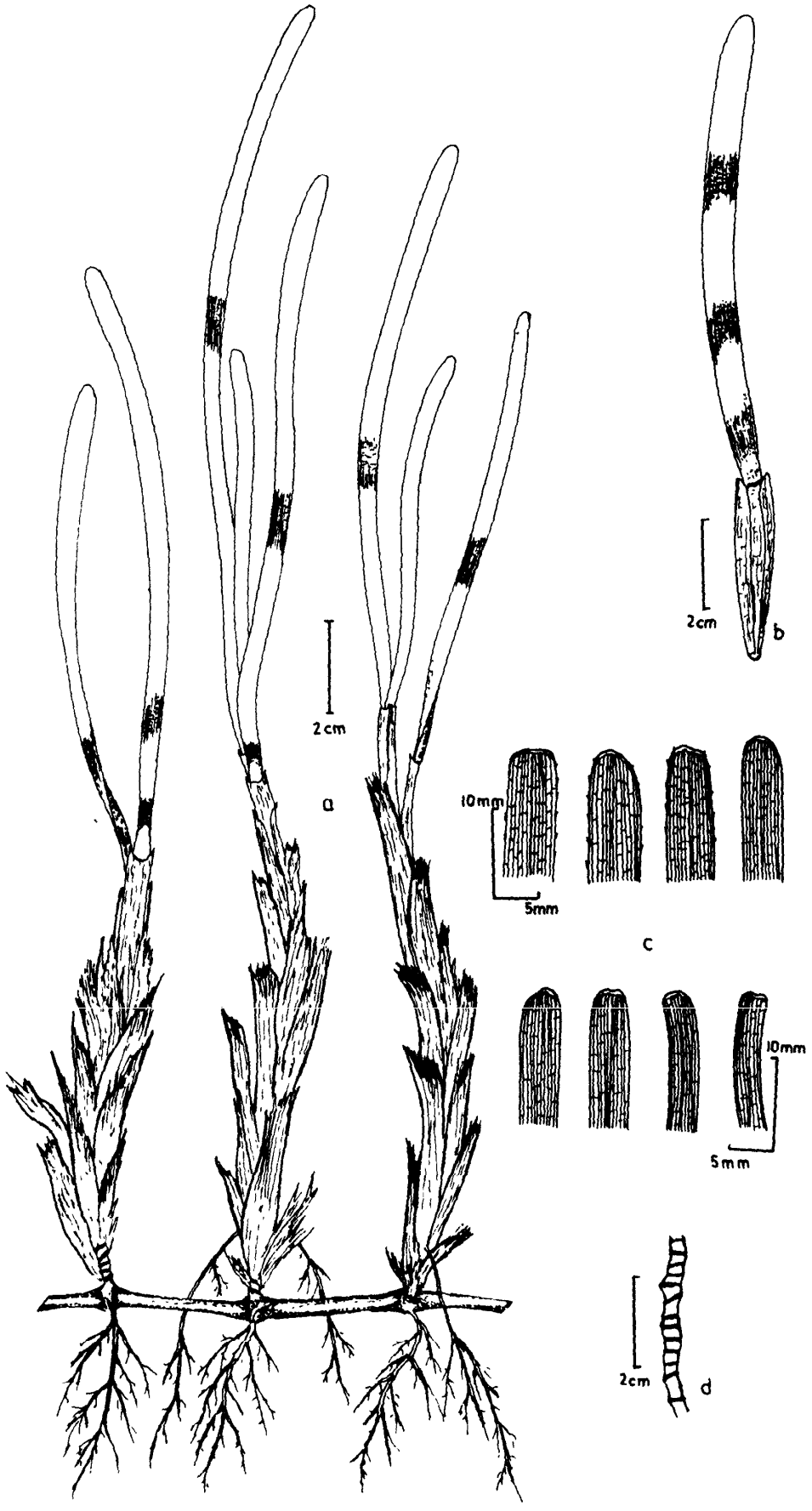


Fig.12. Cymodocea rotundata Ehrenb. & Hempr. ex Asch.

a. Habit, b. A leaf enlarged to show lamina and sheath, c. Variations in the leaf tips, d. Stem with closed leaf scars.

coral rubbles. It seldom grows as isolated patches of pure and discontinuous populations but are often found growing with *Cymodocea serrulata, Enhalus acoroides, Halophila stipulacea, Halodule uninervis* (narrow-leaved form), *H. pinifolia* and *Thalassia hemprichii.* Also recorded, though rarely, with *Halophila ovata* and *Syringodium isoetifolium.*

The populations which often get exposed during low-tides are in stunted nature with thick micro and macro epiphytes on the leaves, on the other hand, the deep zone populations have lengthier vegetative parts with less epiphytes. Generally, this species is found to occur from 1 m deep onwards and forms an extensive submerged thick meadow with other seagrasses in which many marine fauna also live.

Specimens examined: TAMIL NADU: Tuticorin, Tinnevely district, 2.10.1916, vegetative, *without collector, 13725 (acc. no. 73320, MH); ibid.*, vegetative, *without collector, 13725 A (acc. no. 52968,* MH); *ibid.*, vegetative, *without collector, 13725 B (acc. no. 52970,* MH); Krusadai Island, Ramanathapuram district, 24.9.1944, vegetative, *Parthasarathy & Daniel, s.n., (acc. no. 88137,* MH); Rameswaram, Ramanathapuram district, 13.2.1987, to a depth of ± 1.5 m, vegetative, *Parthasarathy & Ravikumar 85303* (MH); Mandapam, Ramanathapuram district, 16.2.1987, to a depth of ± 4 m, vegetative, *Parthasarathy & Ravikumar 85325* (MH); Hare Island, Tuticorin, V.O. Chidhambaranar district, 21.2.1987, to a depth of ± 2 m, vegetative, *Parthasarathy & Ravikumar 85377* (MH); Foreshore Estate, Madras, 15.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85465 B* (MH); Thiruvottiyur, Chengalpattu district, 17.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85471 A* (MH); Kalpakkam, Chengalpattu district, 24.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85706* (MH); Sathurangapatnam (Sadras), Chengalpattu district, 24.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85708* (MH); Mamallapuram, Chengalpattu district, 26.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85714* (MH); Nadar Uvari, Nellai Kattabomman district, 20.7.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85790* (MH); Karaikal, Pondicherry Union Territory, 8.9.1987, materials washed ashore, vegetative, *Ravikumar 85799* (MH); Velanganni, Thanjavur district, 9.9.1987, materials washed ashore, vegetative, *Ravikumar 85805* (MH); Kodikarai, Thanjavur district, 11.9.1987, materials washed ashore, vegetative, *Ravikumar 85810* (MH); Kattumavadi, Pudhukkottai district, 20.9.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85860* (MH); Mandapam, Gulf of Mannar, Ramanathapuram district, 24.9.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85894* (MH); Krusadai Island, Ramanathapuram district, 25.9.1987, to a depth of ± 2 m, vegetative, *Ravikumar 86807* (MH); Pamban, Gulf of Mannar, 26.9.1987, to a depth of ± 1.5 m, vegetative, *Ravikumar 86811* (MH); Mandapam, Gulf of Mannar, 20.4.1988, to a depth of ± 3 m, vegetative, *Ravikumar & Ganesan 86820* (MH); Thonithurai, Mandapam, Palk Bay, 20.4.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 86824* (MH); Krusadai Island, 21.4.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 86836* (MH); Pamban, Gulf of Mannar, 23.4.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 86844* (MH); Ramatheertham, Rameswaram, Ramanathapuram district, 24.4.1988, to a depth of ± 2.5 m, vegetative, *Ravikumar & Ganesan 86849* (MH); Sangumal, Rameswaram, 24.4.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 86854* (MH); Alankarathattu, Tuticorin, V.O. Chidhambaranar district, 27.4.1988, to a depth of ± 4 m, vegetative, *Ravikumar & Ganesan 86867* (MH); Near SPIC Unit, Tuticorin, 28.4.1988, to a depth of ± 2.5 m, vegetative, *Ravikumar & Ganesan 86878* (MH); Tuticorin Harbour, 30.4.1988, to a depth of ± 2.5 m, vegetative, *Ravikumar & Ganesan 88104* (MH).

Cymodocea serrulata (R.Br.) Asch. & Magnus in Sitz. Ges. Naturf. Freunde Berlin 1870: 84. 1870; Hook. f., Fl. Brit. India 6: 570. 1893; Fischer in Gamble, Fl. Pres. Madras 3: 1117. 1957 (repr. ed.); Subram., Aquatic Angiosperms 98. 1962; Hartog, Seagrasses World 171. 1960; Bhargavan in Henry *et al.*, Fl. Tamil Nadu I. 3: 62. 1989.

Caulinia serrulata R. Br., Prodr. 339. 1810.

Local names: TAMIL: Alai vaari, Kadal karumbu, Kadal karappu korai, Kadal korai, Kadal korai paasi, Kadal paasi, Kadal pullu, Kadal thazhai, Karambu, Kattai korai, Korai, Neer pasalai, Olai paasi, Peria korai paasi, Thazai paasi, Vaataalai.

Rhizomes creeping, branched, flexible, fibrous, reddish brown to white; roots up to 10 cm long, solitary at each node, branched; internodes up to 1.5 cm long, 2-3 mm thick, often swollen at nodes. Shoots up to 70 cm long, erect, unbranched, rarely branched, bearing 2-5 leaves at each branch; stems up to 42 cm long; internodes up to 2.6 cm long with persistent open leaf scars; leaf sheaths broadly triangular or obconical, 1.5-4 by 0.7-2 cm, transparent, margins entire and folded inwards, clasping the stem, pink to pale brown; ligules triangular, acute at apex,*ca* 2 mm high; lamina linear, often falcate, narrowed at base, obtuse, emarginate or oblique and serrulate at apex, up to 23 cm long, 6-10 mm broad, entire or serrulate along margins; nerves 12-22 with many vertical tannin streaks; marginal nerves not merging at apex; midrib conspicuous, not projecting. Male flowers solitary, terminal at first and pushed laterally by the successive lateral shoots, borne on the tip of two different adjecent nodes giving the appearence of 2 flowers in the same node; one flower *ca* 4.3 cm long; stalks *ca* 3.5 cm long, flattened, rigid, erect, brown with dehisced anthers; another flower enclosed in reduced leaves and spathes; spathes 1 or 2, obconical, subtruncate at base, truncate to obtuse at apex, 11-17 by 5-8 mm, convolute, entire along margins, transparent with many vertical tannin dashes, distinctly 3-nerved, all nerves merging together at *ca* 3 mm from the margin; anthers 2, linear-elliptic with slightly bent subular appendages at base and straight at apex, 6-8 by 1.5-4 mm, dorsally connate and equally attached to the stalks with numerous reddish-brown tannin dashes, dehiscing longitudinally. Female flowers in pairs, sessile or minutely stalked, up to 3.4 cm long, brown; ovaries subglobose, *ca* 1.5 by 0.5 mm; style 1, forked, up to 14 mm long, slender, laterally compressed, brown; stigmata 12-26 mm long, equal or subequal, bent downward, brown; fruits 2, ellipsoid, 4-angular, sessile or minutely stalked, 7-9 by 2-4 mm and *ca* 2 mm thick, ridged, green when young, brown when mature, rarely 1 undeveloped fruit seen adjacent to 1 matured fruit; beak apical, 1-4 mm long, slightly bent, rarely with remnants of styles; exocarp sclerenchymatous, brown; seeds oblongoid, *ca* 4.5 by 2.2 mm, white to yellow; radicle red or with orange tinge.

(Figs. 13 & 14; Photos 14, 15 & 16)

Flowering and fruiting: March-April and September-October.

Ecology: *Cymodocea serrulata* is widely distributed along the Coast of Tamil Nadu and totally absent in Andhra Pradesh Coast. Fresh materials were collected from Thanjavur, Pudhukkottai, Ramanathapuram, V.O. Chidhambaranar and Nellai Kattabomman districts, whereas plenty of drifted materials were collected from the rest of the districts. It is a pure marine form and is not found in backwaters or estuaries.

It generally inhabits sheltered localities of tidal and subtidal zones. It is found from 1 m deep of shallow water areas. It generally grows on fine to coarse sand, in muddy and with rubbles of coral substratum. It has also been found growing on rocks in Thiruchendur, Manappadu, Uvari and Idinthakarai Coastal regions of Tamil Nadu. In some sheltered localities it forms pure, continuous or discountinuous submerged, dense meadows. It was also found associated with *Enhalus acoroides, Syringodium isoetifolium, Cymodocea rotundata, Halophila ovalis, Halodule pinifolia*

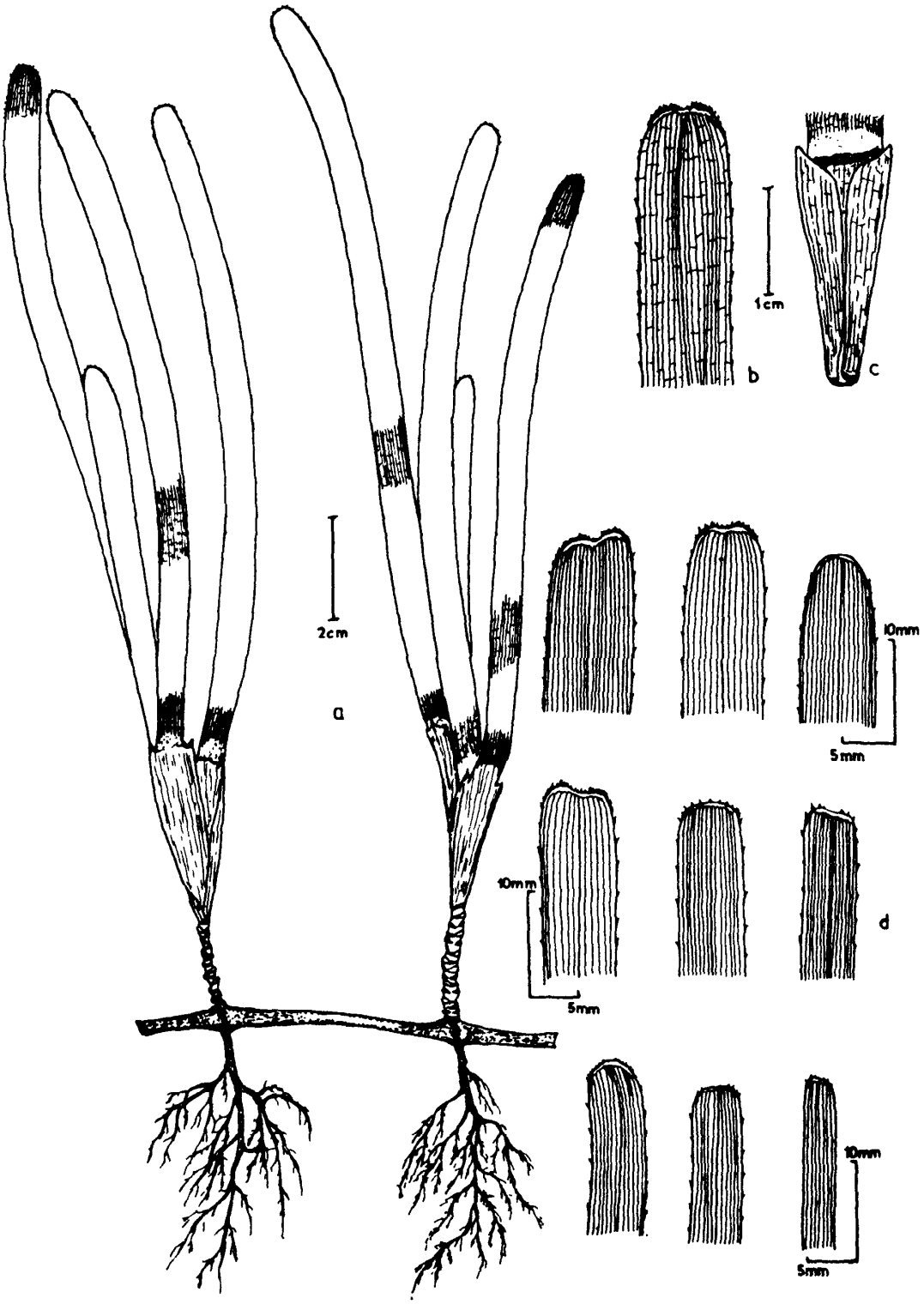


Fig.13. Cymodocea serrulata (R.Br.) Asch. & Magnus

a. Habit, b. A portion of leaf tip enlarged, c. Sheath, d. Variations in the leaf tips.

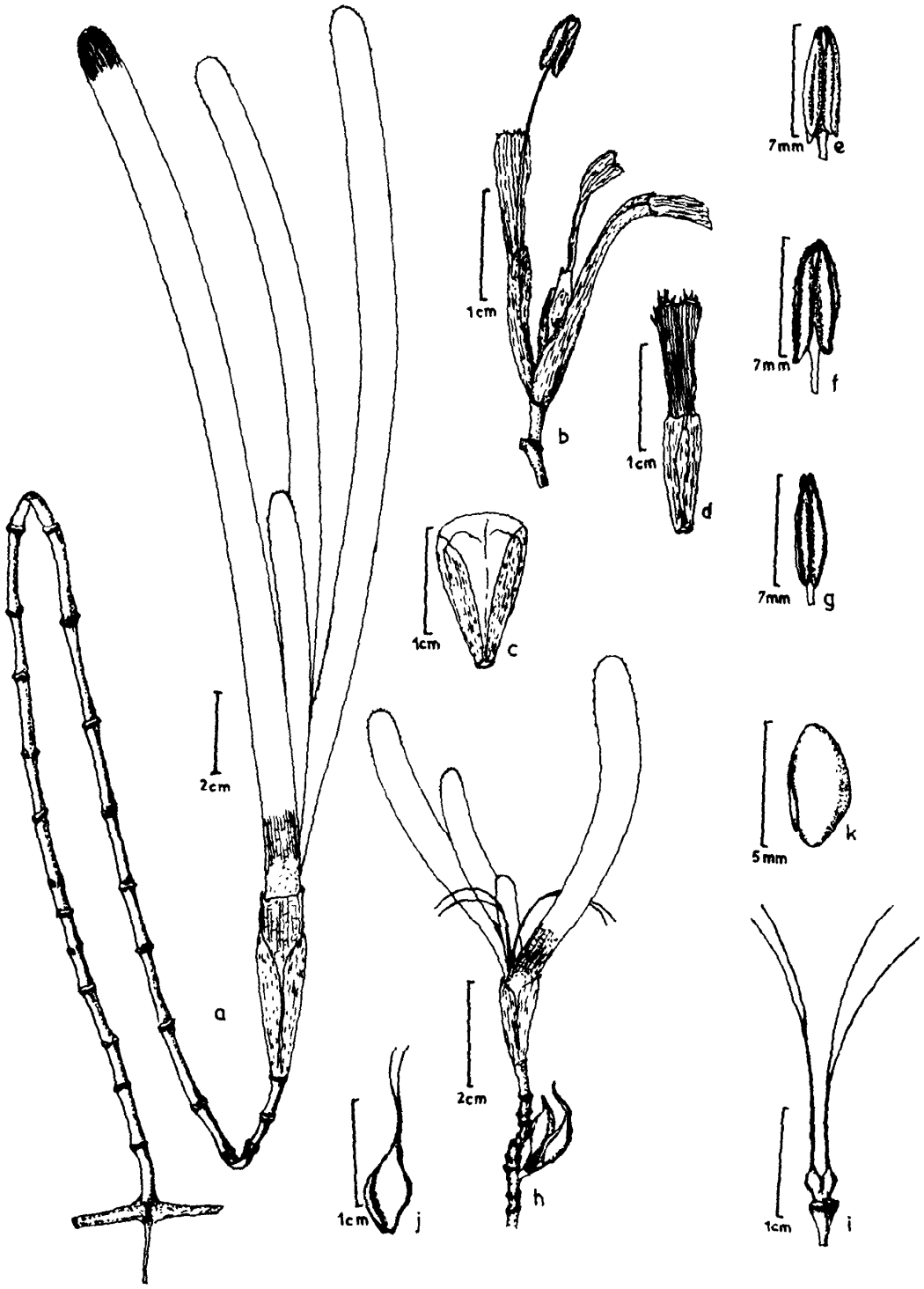


Fig.14. Cymodocea serrulata (R.Br.) Asch. & Magnus

a. Habit showing long stem, b-g: Male flower; b. Male plant, c. Scale, d. Reduced leaf, e. Stamen dorsal view, f. Mature stamen showing dehiscence, g. Stamen ventral view, h-k: Female flower; h. Female plant, i. Ovaries, j. Fruit, k. Embryo.

and *H. uninervis* (broad-leaved form). The deeper zone plants are with longer stems and leaves, whereas the shallow zone plants are with stunted vegetative parts.

The falcate leaves are thickly encrusted with microflora and fauna. Rarely the stems and leaves are clothed with macro-epiphytic algae. In the Gulf of Mannar, these vast submerged beds provide shelter for a number of marine fauna. It is interesting to note that usually the reproductive parts are borne on stunted branches.

Specimens examined: TAMIL NADU: Tuticorin, Tinnevely district, 2.10.1916, vegetative, *without collector, 13725 A (acc. no. 52970,* MH); *ibid.*, vegetative, *without collector, 13725 B (acc. no. 52972,* MH); *ibid.*, vegetative, *without collector, 13725 B (acc. no. 52974,* MH); *ibid.*, vegetative, *without collector, 13725 A & 13725 B (acc. no. 52975,* MH); *ibid.*, vegetative, *13725 (acc. nos. 73319, 52969, 52971* MH); *ibid.*, vegetative, *2414* (MH); Krusadai Island, Ramanathapuram district, 24.9.1944, vegetative, *Parthasarathy & Daniel, s.n., (acc. no. 88138,* MH); *ibid.*, 26.9.1946, vegetative, *Gopal Rao, s.n., (acc. no. 93047,* MH); Rameswaram, Ramanathapuram district, 3.5.1972, materials washed ashore, vegetative,*Sastry 9233* (CAL); Ramatheertham, Rameswaram, 13.2.1987, to a depth of ± 2.5 m, vegetative, *Parthasarathy & Ravikumar 85304* (MH); Pamban Channel, Ramanathapuram district, 14.2.1987, to a depth of ± 4 m, vegetative, *Parthasarathy & Ravikumar 85309* (MH); Krusadai Island, Ramanathapuram district, 18.2.1987, to a depth of ± 2 m, vegetative, *Parthasarathy & Ravikumar 85345* (MH); Near Fisheries Godown, Tuticorin, V.O. Chidhambaranar district, 20.2.1987, to a depth of ± 3 m, fruits, *Parthasarathy & Ravikumar 85355* (MH); *& ibid., 85356* (MH); Near Thermal Station, Tuticorin, 24.2.1987, to a depth of ± 3 m, male, *Parthasarathy & Ravikumar 85390* (MH); Foreshore Estate, Madras district, 15.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85463* (MH); Besent Nagar, Madras district, 15.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85464* (MH); Ennore, Chengalpattu district, 16.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85468* (MH); Thiruvottiyur, Chengalpattu district, 17.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85470* (MH); Coovum river mouth, Marina beach, Madras district, 17.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85472* (MH); Foreshore Estate, Madras district, 20.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85489* (MH); Enjampakkam, Chengalpattu district, 23.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85498* (MH); Kalpakkam, Chengalpattu district, 24.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85705* (MH); Sathurangapatnam (Sadras), Chengalpattu district, 24.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85707* (MH); Mamallapuram, Chengalpattu district, 25.5.1987, materials washed ashore, vegetative, *Parthasarathy & Ravikumar 85711* (MH) *& ibid.*, 26.5.1987, *Parthsarathy & Ravikumar 85712* (MH); Thiruchendur, V.O. Chidhambaranar district, 16.7.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85720* (MH); Kayalpattinam, V.O. Chidhambaranar district, 18.7.1987, to a depth of ± 5 m, vegetative, *Ravikumar 85737 & 85740* (MH); Manappadu, V.O. Chidhambaranar district, 19.7.1987, to a depth of ± 5 m, vegetative, *Ravikumar 85746* (MH); Nadar Uvari, Nellai Kattabomman district, 20.7.1987, to a depth of ± 2.5 m, vegetative, *Ravikumar 85753* (MH); Nagapattinam, Thanjavur district, 6.9.1987, to a depth of ± 7 m, vegetative, *Ravikumar 85779* (MH); Poompuhar, Thanjavur district, 7.9.1987, materials washed ashore, vegetative, *Ravikumar 85788* (MH); Tranquebar (Tharangambadi), Thanjavur district, 8.9.1987, materials washed ashore, vegetative, *Ravikumar 85793* (MH); Karaikal, Pondicherry Union Territory, 8.9.1987, materials washed ashore, vegetative, *Ravikumar 85795* (MH); Nagoor, Thanjavur district, 9.9.1987, materials washed ashore, vegetative, *Ravikumar 85802* (MH); Velanganni, Thanjavur district, 9.9.1987, materials washed ashore, vegetative, *Ravikumar 85804* (MH); Kodikarai, Thanjavur district, 11.9.1987, materials washed ashore, vegetative, *Ravikumar 85813* (MH); *ibid.*, 12.9.1987, *Ravikumar 85817* (MH) *& 85822* (MH); Vedharanyam, Thanjavur district, 13.9.1987, materials washed ashore, vegetative, *Ravikumar 85824* (MH); Adhirampattinam, Thanjavur district, 15.9.1987, to a depth of ± 6 m, male, *Ravikumar 85827* (MH) *& ibid.*, fruits,*85828* (MH); Mallipattinam, Thanjavur district, 16.9.1987, to a depth of ± 7 m, fruits, *Ravikumar 85834* (MH) *& ibid.*, male, *85835* (MH); Pudhupattinam, Thanjavur district, 16.9.1987, to a depth of ± 5 m, fruits, *Ravikumar 85842* (MH) *& ibid.*, vegetative, *85843* (MH); Manora, Thanjavur district, 17.9.1987, to a depth of ± 7 m, female, *Ravikumar 85848* (MH) *& ibid.*, male, *85849* (MH); Kattumavadi, Pudhukkottai district, 20.9.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85861* (MH) *& ibid.*, fruits, 85862 (MH); Manamelkudi, Pudhukkottai district, 21.9.1987, to a depth of ± 4 m, male, *Ravikumar 85867* (MH) *& ibid.*, female, *85868* (MH); Mimisal, Pudhukkottai district, 22.9.1987, to a depth of ± 7 m, female, *Ravikumar 85875* (MH) *& ibid.*, male, *85876* (MH); Jagathapattinum, Pudhukkottai district, 22.9.1987, to a depth of ± 5 m, male, *Ravikumar 85882* (MH) *& ibid.*, female, *85883* (MH); Kottaipattinam, Pudhukkottai district, 22.9.1987, to a depth of ± 5 m, female, *Ravikumar 85888* (MH) *& ibid.*, male,

85889 (MH); Mandapam, Ramanathapuram district, 24.9.1987, to a depth of ± 5 m, female, *Ravikumar 85900* (MH); Pamban Channel, Ramanathapuram district, 26.9.1987, to a depth of ± 3 m, vegetative, *Ravikumar 86809* (MH); Mandapam, Gulf of Mannar, Ramanathapuram district, 20.4.1988, to a depth of ± 3 m, vegetative, *Ravikumar & Ganesan 86821* (MH); Thonithurai, Mandapam, Palk Bay, Ramanathapuram district, 20.4.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 86825* (MH); Krusadai Island, Ramanathapuram district, 21.4.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 85830* (MH); Pamban, Ramanathapuram district, 23.4.1988, to a depth of ± 3 m, vegetative, *Ravikumar & Ganesan 85843* (MH); Ramatheertham, Rameswaram, Ramanathapuram district, 24.4.1988, to a depth of ± 3m, vegetative, *Ravikumar & Ganesan 85848* (MH); Sangumal, Rameswaram, 24.4.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 86857* (MH); Near Madura Coats, Tuticorin, V.O. Chidhambaranar district, 27.4.1988, materials washed ashore, male, *Ravikumar & Ganesan 86861* (MH); Near SPIC Unit, Tuticorin, 28.4.1988, to a depth of ± 3 m, male, *Ravikumar & Ganesan 86877* (MH); Hare Island, Tuticorin, 29.4.1988, to a depth of ± 2 m, female, *Ravikumar & Ganesan 86886* (MH); Near SPIC Unit, Tuticorin, female, *Ravikumar & Ganesan 86895* (MH); Tuticorin Harbour, 30.4.1988, vegetative, *Ravikumar & Ganesan 88102* (MH).

HALODULE ENDL.

Plants dioecious. Rhizomes creeping, herbaceous, branched or unbranched, often moniliferous; roots 1 or more, branched or unbranched. Shoots erect, bearing 1-4 leaves at each branch; scales oblong, hyaline, caducous in older plants; leaf sheaths persisting longer than leaf blades, leaving circular scars on shedding; lamina linear, narrowed at base, tridentate or serrulate or obtuse at apex, entire along margins; nerves 3; lateral nerves intramarginal, inconspicuous, both ending into lateral teeth; lateral teeth well developed or poorly developed or absent; midrib conspicuous, widened or furcate at apex. Flowers solitary, axillary or terminal. Male flowers stalked; anthers 2, attached subequally, dehiscing longitudinally. Female flowers sessile or subsessile; ovaries 2, free; styles 1, long; fruits 1 or 2, globose; pericarp stony with numerous tannin cells; seed single; beak short, lateral or terminal.

Key to the species

1a. Leaf tips obtuse, serrulate; lateral teeth poorly developed or absent ..... **H. pinifolia**

1b. Leaf tips not obtuse, not serrulate; lateral teeth well developed:

2a. Leaf tips tridentate; median tooth present; lamina 0.7-5 mm wide ..... **H. uninervis**

2b. Leaf tips bidentate; median tooth absent; lamina 0.5-1 mm wide ..... **H. wrightii**

Halodule pinifolia (Miki) Hartog in Blumea 12: 309. f. 10. 1964; Hartog, Seagrasses World 158. 1970; Hartog & Zong-Dai Yang in Curr. Sci. 57. 1988; Bhargavan in Henry *et al.*, Fl. Tamil Nadu I. 3: 62. 1989; Ravikumar *et.al.*, in J.Econ.Tax. Bot.14 (3): 711 714. 1990.

Diplanthera pinifolia Miki in Bot. Mag. Tokyo 46: 787. f. 9. 1932.

Local names: TAMIL: Kadal karumbu, Kadal korai, Kadal paasi, Korai, Korai paasi, Nedung korai, Neettu korai. TELUGU: Ghaddu naasu, Ghar naasu, Thungha.

Plants dioecious. Rhizomes creeping, branched, often moniliferous, flexible, white to pale brown; roots 1-7 at each node, up to 12 cm long, slender, unbranched, white to pale brown; internodes up to 5 cm long, 1-12 mm thick. Shoots up to 40 cm long, erect, branched or unbranched, bearing 2-3 leaves at each branch; stems up to 2 cm long, with short internodes; scales linear-oblong, subtruncate at base, acute to obtuse or rarely oblique at apex, 6-17 by 1-3 mm, scarious, convolute, entire

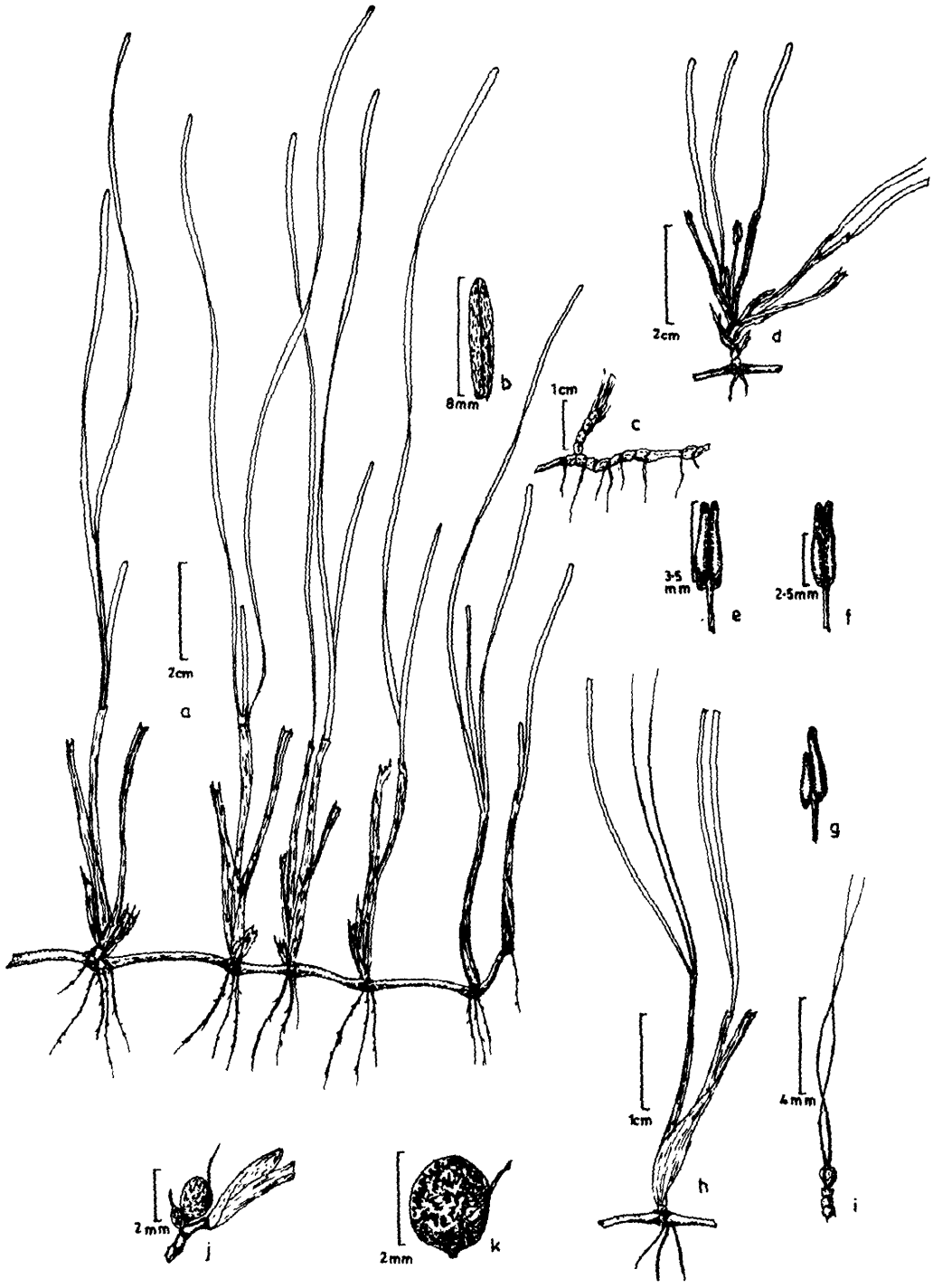


Fig.15. Halodule pinifolia (Miki) Hartog

a. Habit, b. Scale, c. Moniliferous rhizome internodes, d-j: Male flower; d. Male plant, e, f & g. Stamen ventral, dorsal and lateral views, h-k: Female flower; h. Female plant, i. Ovaries, j. Fruit with an aborted ovule, k. Fruit with persistent style.

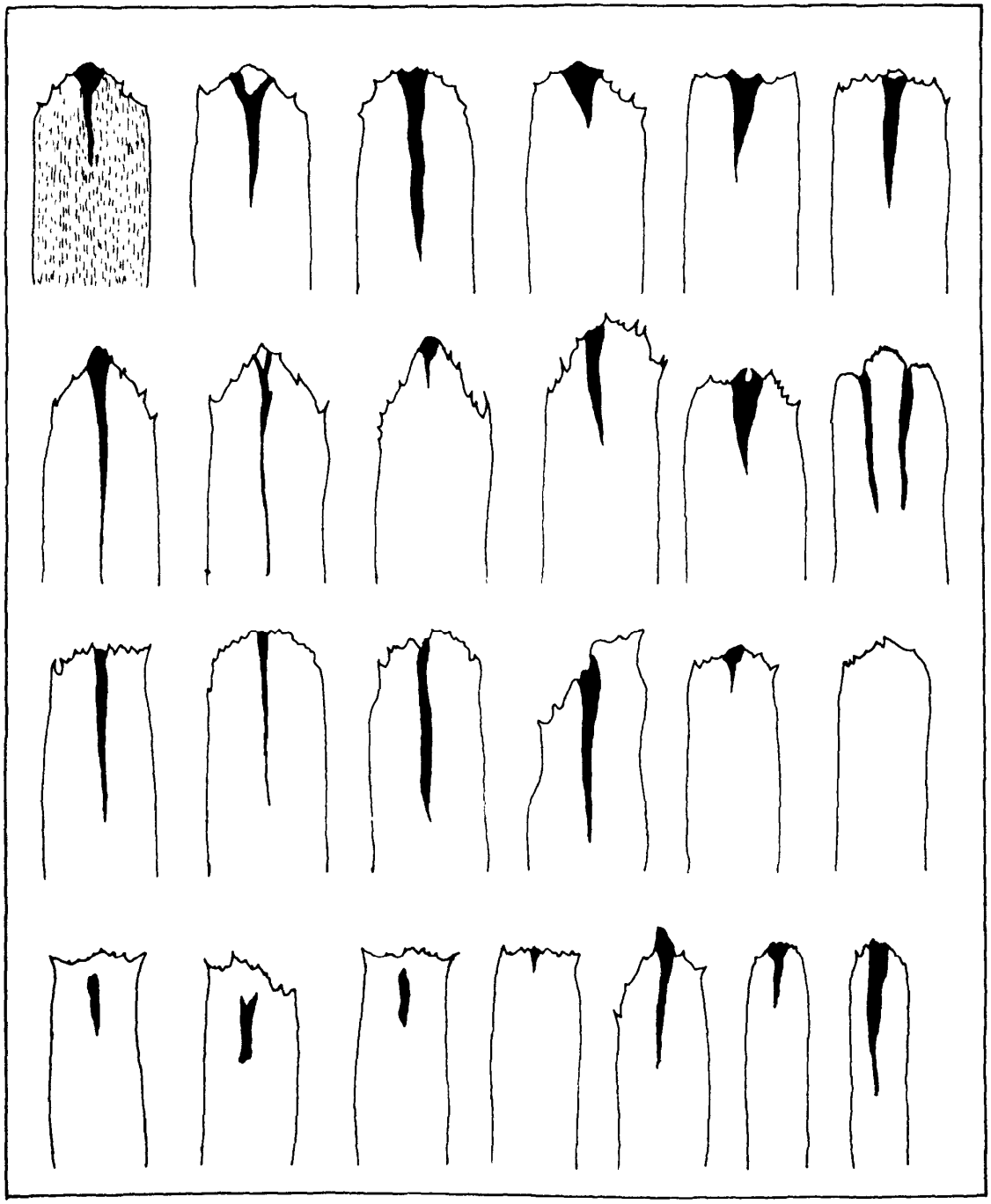


Fig.16. Halodule pinifolia (Miki) Hartog

Leaf tips Morphological variations.

along margins, with many vertical, discontinuous tannin dashes; leaf sheaths linear, 1-6 cm by 1-5 mm, convolute, entire along margins, transparent, with numerous reddish-brown tannin streaks, persisting longer than leaf-blades; ligules *ca* 1 mm high; lamina linear, narrowed at base, 10-29 cm long, 0.75-1.5 mm broad, entire along margins; nerves 3, midrib prominent, widened or divided at apex; lateral nerves intramarginal, inconspicuous, ending in lateral teeth; lateral teeth minute, poorly developed or absent; leaf-tips obtuse, rarely oblique, retuse or subtruncate, with irregular few to many serrations. Male flowers 2, subequal, dorsally connate at the apex of stalks; stalks up to 2 cm long, terete, slender, white; anthers oblongoid, 3-5 mm long, 0.5-1 mm broad; upper anther 3-4.5 mm long; lower anther 2-3 mm long, with numerous reddish-brown vertical tannin dashes, dehiscing longitudinally. Female flowers sessile, enclosed by leaf sheaths; ovaries ovoid, *ca* 0.75 by 0.5 mm; styles 1-1.5 cm long, terete, filiform, terminal, pushed subterminal or lateral in fruits; fruits *ca* 2 mm across, globose to subglobose or ovoid, mostly in pairs, rarely with an aborted ovary with persistent, lateral styles; testa hard, stony, smooth with ornamentations. **(Figs. 16 & 17; Photos 17 & 18)**

Flowering and fruiting: February July.

Ecology: *Halodule pinifolia* is the most common seagrass distributed along the entire Coromandel Coast and found to occur in tidal and subtidal zones. It generally grows on fine sandy to muddy bottoms. Further it has been found growing along creeks of mangrove swamps, on rocks and on coral platforms. This species is found luxuriently in backwaters, estuaries, bays and gulfs in sheltered localities.

Like *H. uninervis*, this species also has 2 forms, the short-leaved form found along the marginal and subtidal zones and the long-leaved form dominating the deeper zones. In both the forms, the breadth of the leaf is narrow and ranging from 0.75 to 1.5 mm. The moniliferous nature of the rhizomes is commonly observed. Like *H. uninervis*, this species also forms up to 20 cm thick underground sediment layer on muddy bottoms.This observation is in contrast to Hartog's (1970) in Queensland, where he did not find this sediment-layer built up by the growth of *H. pinifolia*.

This species forms continuous or isolated patches of pure populations but are also found associated with *Halodule uninervis* (narrow-leaved forms), *Halophila ovalis, H. ovata, H. beccarii* on muddy bottoms. On Coral flats, it is found growing with *Thalassia hemprichii, Cymodocea rotundata, C. serrulata* and *Syringodium isoetifolium*. Very rarely it is seen with *Enhalus acoroides* in Krusadai Island.

The epiphytic algal and faunal invasion is high in backwater and estuarine populations, whereas, it is comparitively less in pure marine forms. In the submerged beds numerous marine fauna take shelter and food.

Specimens examined: TAMIL NADU: Tuticorin, Tinnevely district, 2.10.1916, vegetative, *without collector, 13728 B* (MH); Krusadai Island, Ramanathapuram district, 11.5.1949, vegetative, *without collector, 93755* (MH); Rameswaram, Ramanathapuram district, 13.2.1987, to a depth of ± 2 m, vegetative, *Parthasarathy & Ravikumar 85302* (MH); Krusadai Island, Ramanathapuram district, 18.2.1987, to a depth of ± 2 m, vegetative, *Parthasarathy & Ravikumar 85334* (MH); Near SPIC Unit, Tuticorin, V.O. Chidhambaranar district, 21.2.1987, to a depth of ± 1.5 m, female, *Parthasarathy & Ravikumar 85370* (MH); Hare Island, Tuticorin, 21.2.1987, to a depth of ± 1.5 m, vegetative, *Parthasarathy & Ravikumar 85373* (MH); Cuddalore O.T, South Arcot district, 18.3.1987, to a depth of ± 2 m, vegetative, *Parthasarathy & Ravikumar 85401* (MH); Chunnambar, Thavalakuppam, Pondi-

cherry, 21.3.1987, to a depth of ± 3 m, vegetative, *Parthasarathy & Ravikumar 85419* (MH); Vellar Estuary, Porto Novo (Parangipettai), South Arcot district, 23.3.1987, to a depth of ± 3 m, flowers and fruits, *Parthasarathy & Ravikumar 85433* (MH); Kaliveli Tank, Marakkanam, South Arcot district, 24.3.1987, to a depth of ± 3 m, vegetative, *Parthasarathy & Ravikumar 85442* (MH); Pazhaiyar, Chidhambaram, South Arcot district, 27.3.1987, to a depth of ± 4 m, vegetative, *Parthasarathy & Ravikumar 85458 & 85459* (MH); Pulicat, Chengalpattu district, 18.5.1987, to a depth of ± 3 m, vegetative, *Parthasarathy & Ravikumar 85474* (MH); *ibid.*, 19.5.1987, vegetative, *85478 & 85480* (MH); Muttukkadu, Chengalpattu district, 22.5.1987, to a depth of ± 2 m, vegetative, *Parthasarathy & Ravikumar 85497* (MH); Thiruchendur, V.O. Chidhambaranar district, 17.7.1987, to a depth of ± 3 m, vegetative, *Ravikumar 85726* (MH); Punnakayal, Thiruchendur, 17.7.1987, to a depth of ± 1/2 m, vegetative, *Ravikumar 85732* (MH); Kayalpattinam, V.O. Chidhambaranar district, 18.7.1987, to a depth of ± 3 m, vegetative, *Ravikumar 85739* (MH); Nadar Uvari, Nellai Kattabomman district, 20.7.1987, to a depth of ± 2 m, vegetative, *Ravikumar 85756* (MH); Keezha Uvari, *ibid.*, female, *85757* (MH); Kanniyakumari, Kanniyakumari district, 22.7.1987, to a depth of ± 1 m, vegetative, *Ravikumar 85763* (MH); Idinthakarai, Nellai Kattabomman district, 23.7.1987, to a depth of ± 4 m, vegetative, *Ravikumar* 85764 (MH); Kanniyakumari, Kanniyakumari district, 25.7.1987, to a depth of ± 1/2 m, vegetative, *Ravikumar 85775* (MH); Mallipattinam, Thanjavur district, 16.9.1987, to a depth of ± 1 m, vegetative, *Ravikumar 85837* (MH); Manora, Thanjavur district, 17.9.1987, to a depth of ± 1.5 m, vegetative, *Ravikumar 85852* (MH); Kattumavadi, Pudhukkottai district, 20.9.1987, to a depth of ± 2 m, vegetative, *Ravikumar 85865* (MH); Manamelkudi, Pudhukkottai district, 21.9.1987, to a depth of ± 3 m, vegetative, *Ravikumar 85871* (MH); Krusadai Island, Ramanathapuram district, 25.9.1987, to a depth of ± 1 m, vegetative, *Ravikumar 86803* (MH); Pamban, Ramanathapuram district, 26.9.1987, to a depth of ± 1.5 m, vegetative, *Ravikumar 86813* (MH); *ibid.*, 20.4.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 86822* (MH); Thonithurai, Mandapam, Palk Bay, 20.4.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 86828* (MH); Krusadai Island, Ramanathapuram district, 21.4.1988, to a depth of ± 1/2 m, vegetative, *Ravikumar & Ganesan 86834* (MH); Akkalmadam, Rameswaram, Ramanathapuram district, 22.4.1988, to a depth of ± 2 m, female and fruits, *Ravikumar & Ganesan 86839* (MH); Pamban, Gulf of Mannar, Ramanathapuram district, 23.4.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 86846* (MH); *& ibid.*, female, *86847* (MH); Ramatheertham, Rameswaram, Ramanathapuram district, 24.4.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 86854* (MH); Near Madura Coats, Tuticorin, V.O. Chidhambaranar district, 27.4.1988, materials washed ashore, vegetative, *Ravikumar & Ganesan 86862* (MH); Near SPIC Unit, Tuticorin, 28.4.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 86880* (MH); Hare Island, Tuticorin, 28.4.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 86887* (MH); Near Korapallam bridge, Tuticorin, 29.4.1988, vegetative, *Ravikumar & Ganesan 86898* (MH); Tuticorin Harbour, 30.4.1988, to a depth of ± 4 m, vegetative, *Ravikumar & Ganesan 86899* (MH); Near Fisheries College, Tuticorin, 1.5.1988, to a depth of ± 2.5 m, vegetative, *Ravikumar & Ganesan 88111* (MH); Palar Estuary, Chengalpattu district, 3.9.1988, to a depth of ± 2.5 m, vegetative, *Ramamurthy 88199* (MH).

ANDHRA PRADESH: Chinnaganjam, Prakasam district, 25.6.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 88125* (MH); *ibid.*, female, *88127* (MH) *& ibid.*, male, *88133* (MH); Salt Pettah, Kanuparti, Prakasam district, 27.6.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 88134* (MH) *& ibid.*, female, *88136* (MH); Gunnamola, Kothapatnam, Prakasam district, 28.6.1988, to a depth of ± 1.5 m, male, *Ravikumar & Ganesan 88141* (MH); Theetapuram, Ethamukkalu, Prakasam district, 1.7.1988, to a depth of ± 1.5 m, male, *Ravikumar & Ganesan 88156* (MH) *& ibid.*, male, *88162* (MH); *ibid.*, vegetative, *88164 & 88165* (MH); Ramayeepatnam, Kavali, Prakasam district, 2.7.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 88166* (MH); Karedu, Kavali, Prakasam district, 3.7.1988, to a depth of ± 2.5 m, vegetative, *Ravikumar & Ganesan 88177* (MH); Isakkapalle, Nellore district, 5.7.1988, to a depth of ± 2.5 m, male, *Ravikumar & Ganesan 88179* (MH); *ibid.*, vegetative, *88180 & 88184* (MH); Utukuru, Nellore district, 6.7.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 88186 & 88189* (MH); Krishnapatnam, Nellore district, 8.7.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 88194 & 88195* (MH); Ramayeepatnam, Prakasam district, 16.9.1988, to a depth of ± 2 m, vegetative, *Ramamurthy 88868* (MH); Krishnapatnam, Nellore district, 16.9.1988, to a depth of ± 3 m, vegetative, *Ramamurthy 88872* (MH).

Halodule uninervis (Forsk.) Asch. in Boiss., Fl. Orient. 5: 24. 1882; Hartog, Seagrasses World 147. 1970; Bhargavan in Henry *et al.*, Fl. Tamil Nadu I. 3: 63. 1989; Ravikumar *et al.* in J.Econ.Tax.Bot. 14 (3): 711-714. 1990.

Zostera uninervis Forsk., Fl. Aeg.-Arab. 157. 1775.

Diplanthera uninervis (Forsk.) Asch. in Engler & Prantl, Pflanzenf. 1: 37. 1897; Fischer in Gamble, Fl. Pres. Madras 3: 1117. 1957 (repr. ed.); Subram., Aquatic Angiosperms 98. 1962.

Cymodocea australis Trimen, Cat. Pl. Ceylon 99. 1885; Hook. f., Fl. Brit. India 6: 570. 1893.

Halodule tridendata F.v.Muell. in Census Austr. Pl. 121. 1882; Hartog in Blumea 12: 301. f. 4. 1964.

Local names: TAMIL: Kadal karambu, Kadal korai, Kadal paasi, Korai, Korai paasi, Nedung korai, Neettu korai. TELUGU: Ghaddu naasu, Ghar naasi, Thungha.

Plants dioecious. Rhizomes creeping, branched, flexible, fibrous, often monoliferous, white to pale brown; roots 1-6 at each node, up to 8.5 cm long, unbranched, slender, white to pale yellow; internodes up to 4.2 cm long, *ca* 2 mm thick. Shoots up to 30 cm long, erect, branched or unbranched, bearing 2-4 leaves at each branch; stems up to 19 cm long; internodes up to 2.4 cm long; scales linear-oblong, subtruncate at base, acute to obtuse or rarely oblique at apex, 7-12 by 2-6 mm, hyaline, convolute, entire along margins, with many vertical tannin dashes; leaf sheaths linear, 1.4-4.8 cm by 3-8 mm, transparent, entire and folded along margins, with numerous reddish-brown tannin streaks, persisting longer than leaf blades; ligules *ca* 3 mm high; lamina linear, narrowed at base, 6-24 cm by 0.7-5 mm, entire along margins; nerves 3, midrib conspicuous, widened or furcate at apex; lateral nerves inconspicuous, ending in well developed lateral teeth. Male flowers 2, subequal, dorsally connate at the tip of stalks; stalks up to 2 cm long, terete, slender, white; anthers oblongoid, 3-4.5 mm long, 0.5-1 mm broad with many reddish-brown tannin dashes, dehiscing longitudinally. Female flowers sessile, enclosed in leaf sheaths; ovaries ovoid, *ca* 1 mm long; styles 2-3.8 cm long, slender, terete, smooth, terminal; fruits *ca* 2 mm across, subglobose to ovoid, usually in pairs, with persistent subterminal or lateral styles; testa hard, stony, smooth with ornamentations.

(Figs. 17 & 18; Photos 19 & 20)

Flowering and fruiting: June July.

Ecology: A common seagrass distributed along the entire Coromandel Coast. It is found to occur in open seas, sheltered localities of bays, gulfs, backwaters, estuaries and the margins of mangrove creeks. Generally, this species is predominent in tidal and subtidal zones. The substratum is mostly fine sand to coarse sand, black mud, rock and coral rubbles.

Two distinct forms of *Halodule uninervis* were observed. The broad-leaved form, whose leaf breadth ranges from 2 to 5 mm, is seen in pure marine environment and totally absent in backwaters, estuaries, etc.The other, narrow-leaved form, whose leaf breadth is up to 1 mm, is found both in marine and backwater regions. The latter has short-leaved populations which are often restricted to the marginal zones and is always subjected to tidal influences, whereas the long-leaved ones are usually seen inhabiting the deeper zones.

The rhizomes are often infected with the fungus, *Plasmodiophora diplantherae*, and as a result, the internodes become constricted, swollen and appear like

Fig.17. Halodule uninervis (Forsk.) Asch.

a. Habit with male flower, b. Leaf with sheath, c. Scale, d, e & f. Stamen lateral, dorsal and ventral views, g. Female plant, h. Ovaries, i. Fruit.

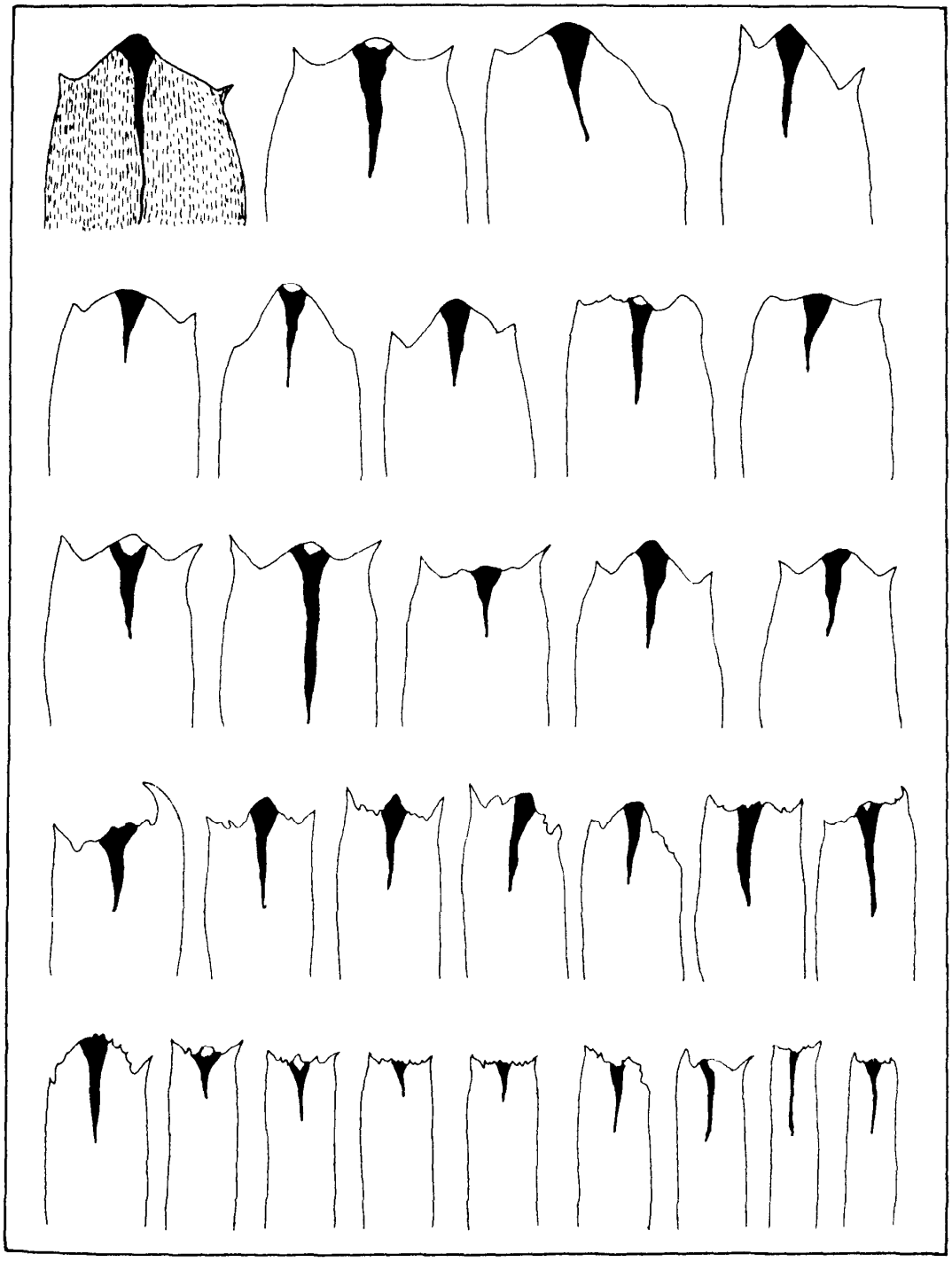


Fig.18. Halodule uninervis (Forsk.) Asch.

Leaf tips Morphological variations.

beads in a string. The dense underground system plays a vital role in sediment accumulation. In muddy bottoms, the above system forms up to 30 cm thickness along with older rhizomes.

This species generally forms a vast stretch of submerged meadows of monospecific, continuous formations. In sheltered localities and backwaters, it is commonly interspersed with *Halodule pinifolia, Halophila ovalis, H. ovata, H. beccarii* but sometimes as separate patches adjacently. It has been also found associated with *Cymodocea rotundata, C. serrulata, Syringodium isoetifolium, Thalassia hemprichii* in Krusadai Island, Rameswaram and Tuticorin regions of Gulf of Mannar.

The leaves are often encrusted with micro-epiphytes and rarely macro-algae. Various marine fauna such as Eel fish, Prawn, Crab, etc. live in these submerged beds for breeding and shelter.

Specimens examined: TAMIL NADU: Tuticorin, Tinnevely district, 2.10.1916, vegetative, *without collector, 13726* (MH); Mandapam, Ramanathapuram district, 4.5.1972, vegetative, *Sastry 9237* (CAL); Near Thermal Station, Tuticorin, V.O. Chidhambaranar district, 24.2.1987, to a depth of ± 1.5 m, vegetative, *Parthasarathy & Ravikumar 85393* (MH); Chunnambar bridge, Thavalakuppam, Pondicherry Union Territory, 21.3.1987, to a depth of ± 1.5 m, vegetative, *Parthasarathy & Ravikumar 85417* (MH); Kaliveli Tank, Marakkanam, South Arcot district, 23.3.1987, to a depth of ± 2.5 m, vegetative, *Parthasarathy & Ravikumar 85441* (MH); Thiruchendur, V.O. Chidhambaranar district, 16.7.1987, to a depth of ± 3 m, flowers and fruits, *Ravikumar 85721* (MH); Punnakayal, Thiruchendur, 17.7.1987, to a depth of ± 1.5 m, vegetative, *Ravikumar 85734* (MH); Manappadu, Thiruchendur, 19.7.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85751* (MH); Nagapattinam, Thanjavur district, 6.9.1987, materials washed ashore, vegetative, *Ravikumar 85785* (MH); Karaikal, Pondicherry Union Territory, 8.9.1987, materials washed ashore, vegetative, *Ravikumar 85797* (MH); Kodikarai, Thanjavur district, 11.9.1987, materials washed ashore, vegetative, *Ravikumar 85808* (MH); *ibid.*, 12.9.1987, *85819 & 85820* (MH); Adhirampattinam, Thanjavur district, 15.9.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85829 & 85830* (MH); Mallipattinam, Thanjavur district, 16.9.1987, to a depth of ± 5 m, vegetative, *Ravikumar 85841* (MH); Manora, Thanjavur district, 17.9.1987, to a depth of ± 2 m, vegetative, *Ravikumar 85854 & 85855* (MH); Mimisal, Pudhukkottai district, 22.9.1987, to a depth of ± 2 m, vegetative, *Ravikumar 85880* (MH); Jagathapattinam, Pudhukkottai district, 22.9.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85856* (MH); Mandapam, Ramanathapuram district, 24.9.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85895* (MH); Krusadai Island, Ramanathapuram district, 25.9.1987, to a depth of ± 1.5 m, vegetative, *Ravikumar 86802* (MH); *ibid.*, 21.4.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 86833* (MH); Sangumal, Rameswaram, Ramanathapuram district, 24.4.1988, to a depth of ± 3 m, vegetative, *Ravikumar & Ganesan 86859* (MH); Alankarathattu, Tuticorin, V.O. Chidhambaranar district, 27.4.1988, materials washed ashore, vegetative, *Ravikumar & Ganesan 86865* (MH); near SPIC Unit, Tuticorin, 28.4.1988, to a depth of ± 3 m, vegetative, *Ravikumar & Ganesan 86879* (MH); Hare Island, Tuticorin, to a depth of ± 4 m, vegetative, *Ravikumar & Ganesan 86888* (MH); Tuticorin Harbour, 30.4.1988, materials washed ashore, vegetative, *Ravikumar & Ganesan 86900* (MH).

ANDHRA PRADESH: Chinnaganjam, Prakasam district, 25.6.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 88126* (MH); Salt Pettah, Kanuparti, Prakasam district, 27.6.1988, to a depth of ± 1 m, female, *Ravikumar & Ganesan 88135* (MH); Gunnamola, Kothapatnam, Prakasam district, 28.6.1988, to a depth of ± 1.5 m, male, *Ravikumar & Ganesan 88143* (MH) & *ibid.*, female, 88148 (MH); Venkateshpuram, Tummalapenta, Nellore district, 1.7.1988, to a depth of ± 1.5 m, male, *Ravikumar & Ganesan 88158* (MH); *ibid.*, female, 88160 (MH) & *ibid.*, vegetative, 88163 (MH); Ramayeepatnam, Kavali, Prakasam district, 2.7.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 88169* (MH); Karedu, Kavali, Prakasam district, 3.7.1988, to a depth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 88176* (MH); Krishnapatnam, Nellore district, 8.7.1988, to a dpeth of ± 1.5 m, vegetative, *Ravikumar & Ganesan 88195* (MH).

Halodule wrightii Asch., Sitz. Ber. Ges. Naturf. Freunde Berlin 19, 24. 1868; Hartog in Blumea 12: 304-308, f. 6-8 (map) 1964; Hartog, Seagrasses World 154. 1970; Ravikumar *et al.*, in J.Econ.Tax. Bot.14 (3): 711-714.1990.

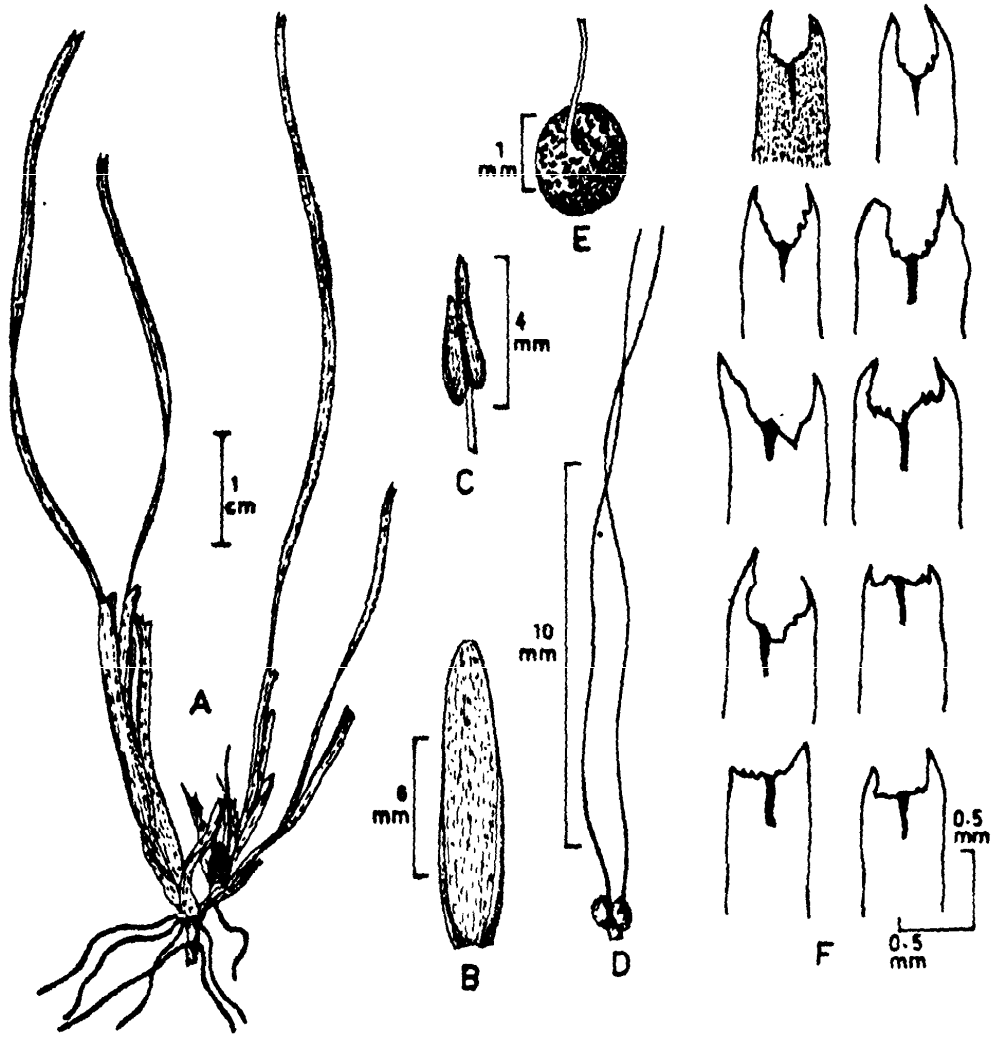


Fig.19. Halodule wrightii Asch.

a. Habit, b. Scale, c. Stamen, d. Ovary, e. Fruit with persistent style, f. Leaf tips variations.

Diplanthera wrightii Asch. in Engler & Prantl, Pflanzenf. 1: 37: 1897.

Local names: TAMIL: Korai paasi. TELUGU: Ghadda naasi, Ghar naasi, Paasi.

Plants dioecious. Rhizomes creeping, branched, often moniliferous, flexible, white to pale brown; internodes up to 2.6 cm long, less than 0.5 mm thick; roots 1-7 at each node, up to 13 cm long, slender, unbranched, white. Shoots up to 15 cm long, erect, branched or unbranched, bearing 2-3 leaves at each branch; stems up to 4.2 cm long with 1-7 mm long internodes; scales linear-oblong, subtruncate at base, acute to obtuse or rarely oblique at apex, 7-13 by 1-3 mm, scarious, convolute, entire along margins, with many vertical discontinuous tannin dashes; leaf sheaths linear, 1.2-3.5 cm by 1-2 mm, convolute, transparent with numerous reddish tannin streaks, persisting longer than leaf blades; ligules *ca* 1 mm high; lamina linear, narrowed at base, 5-12 cm long, 0.5-1 mm broad, entire along margins; nerves 3, midrib prominent, lateral nerves intramarginal, inconspicuous, ending in lateral teeth; leaf tips bicuspidate with two well-developed lateral teeth, median tooth absent and concave at apex; lateral teeth acute. Male flowers 2, subequal, dorsally connate at stalk-apices; stalks up to 2.6 cm long, slender, terete, white; anthers oblongoid, 3-5 mm long, 0.5-1 mm broad, white when young, brown when mature; upper anther *ca* 4 mm long, lower anther *ca* 3 mm long with numerous vertical reddish-brown tannin dashes, dehiscing longitudinally. Female flowers sessile, enclosed by leafy sheaths; ovaries ovoid, *ca* 0.75 by 0.5 mm; styles up to 2.8 cm long, terete, unequal, filiform, terminal or subterminal, lateral in fruits; fruits *ca* 2 mm across, globose to subglobose or ovoid, mostly in pairs, rarely with an aborted ovary with persistent lateral styles; testa hard, stony, smooth with tannin mosaics. **(Fig. 19)**

Flowering and fruiting: March July.

Ecology: *H. wrightii* is now known from the Coromandel Coast of Peninsular India along the backwaters which usually form lakes near the mouth of the sea. It has also been, but rarely, found in open sea near Akkalmadam (near Rameswaram) of Palk Bay, and along mangrove creeks. They generally grow from 25 cm to 2 m deep, sometimes exposed during low-tides.

The substratum ranges from fine sand to black mud and coral platforms. Generally it is found growing as mixed populations with *H. uninervis* (narrow-leaved form) and *H. pinifolia*. Rarely it is seen growing as overlapping populations with *Halophila ovalis*, *H. ovata* and *H. beccarii*. The rhizomes are poorly affected by fungus unlike *H. pinifolia* and *H. uninervis*. The extent of epiphytic algal invasion is less or little. Eventhough its abundance is less common, it is continuously distributed along the entire coast.

Since the patches of *Halodule wrightii* are mostly found growing with *H. pinifolia* and *H. uninervis* (narrow-leaved form), the earlier collectors could have overlooked it, as the differentiating character of the above species is mainly based on the leaf tips.

Specimens examined: TAMIL NADU: South Arcot district, Pazhaiyar estuary, 27.3.1987, to a depth of ± 0.5 m, female and fruits, *Parthasarathy & Ravikumar 85459 A* (MH); Ramanathapuram district, Akkalmadam, Palk Bay, Rameswaram, 22.4.1988, to a depth of ± 2 m, female, *Ravikumar & Ganesan 86839 A* (MH).

ANDHRA PRADESH: Prakasam district, Chinnaganjam, Pedhapallipalem backwaters, 25.6.1988, to a depth of ± 2 m, female, *Ravikumar & Ganesan 88127 A* (MH); *ibid.*, male, *Ravikumar & Ganesan 88133* (MH); Gunnamola-Kothapatnam backwaters, 28.6.1988, to a depth of ± 1.5 m, male, *Ravikumar & Ganesan 88141 A* (MH); *ibid.*, female, *Ravikumar & Ganesan 88148* (MH); Reddypalem-Buckingham Canal, Ramayeepatnam, 2.7.1988, to a depth of 0.5 m, vegetative, *Ravikumar & Ganesan 88169* (MH); Nellore district, Venkateshpuram - Tummalapenta backwaters, 1.7.1988, to a depth of ± 1.5 m, female, *Ravikumar & Ganesan 88160* (MH); *ibid.*, vegetative, *Ravikumar & Ganesan 88163* (MH); Pattapalem-Isakkapalle backwaters, 5.7.1988, to a depth of ± 1.5 m, male, *Ravikumar & Ganesan 88179* (MH); *ibid.*, female, *Ravikumar & Ganesan 88184* (MH); Krishnapatnam Harbour, 8.7.1988, to a depth of ± 1 m, vegetative, *Ravikumar & Ganesan 88195* (MH).

SYRINGODIUM KUTZING

Plants dioecious. Rhizomes creeping, herbaceous, branched, with 1 or more unbranched roots. Shoots erect, branched bearing 2-3 leaves at each branch; scales oblong, scarious; leaf sheaths slightly tubular, persisting longer than leaf blades, leaving open circular scars when shed, ligulate, biauriculate; leaf blades terete, subulate, narrowed at base, fleshy, in cross section showing 1 central vascular bundle and 2-15 pericentral vascular bundles. Flowers in terminal cymes enclosed or subtended by reduced leaves and scales. Male flowers stalked; anthers 2, dorsally connate, without apical appendages. Female flowers sessile; ovaries 2, free; styles 2; stigmata 4, flattened; fruits 2, obliquely ellipsoid, ridged; pericarp stony; rostrum short, bifid.

Syringodium isoetifolium (Asch.) Dandy in J. Bot. 77: 166. 1939; Hartog, Seagrasses World 177. 1970; Bhargavan in Henry *et al.*, Fl. Tamil Nadu I. 3: 62. 1989.

Cymodocea isoetifolia Asch. in Sitz. Ges. Naturf. Freunde Berlin 1867: 3. 1867; Hook. f., Fl. Brit. India 6: 570. 1893; Fischer in Gamble, Fl. Pres. Madras 3: 1117. 1957 (repr. ed.); Subram., Aquatic Angiosperms 98. 1962.

Local names: TAMIL: Kadal korai, Kadal paasi, Kadal thazhai, Karumbu paasi, Korai paasi.

Rhizomes creeping, herbaceous, branched, slender, fleshy, white to pale yellow; roots 1-5 at each node, up to 8 cm long, sparsely to well branched; root hairs soft, minute, many; internodes up to 2.7 cm long, 1-2.5 mm thick, swollen at nodes; scales linear-oblong, subtruncate at base, acute to obtuse at apex, 14-22 by 1.5-2.5 mm, hyaline, convolute, entire along margins, with numerous longitudinal, discontinuous tannin dashes. Shoots up to 60 cm long, erect, branched or unbranched, bearing 2-3 leaves at each branch; internodes up to 7.5 cm long, 1-2 mm thick; leaf sheaths tubular, narrowed at base, retuse at apex, 1.1-6.3 cm by 4-7 mm, persisting longer than blades, with numerous vertical, tannin dashes, greenish brown; lamina terete, narrowed at base, up to 40 cm long, *ca* 1.5 mm thick, fleshy, brittle, green, in cross-section showing 1 central vascular bundle surrounded by 7-8 pericentral vascular bundles. Inflorescences up to 29 cm long; flowers in terminal cymes, the lower branches dichasial, the upper branches monochasial, enclosed or subtended by reduced leaf sheaths and scales; floral sheaths oblong, subtruncate at base, obtuse at apex, 0.7-3.2 cm by 4-8 mm, convolute, hyaline, entire along margins with many tannin streaks; floral lamina 3-32 mm long, towards tips of inflorescence the lamina gradually decreases or disappears; scales linear-oblong, subtruncate at base, acute to obtuse at apex, 4-7 by 1-1.5 mm, hyaline,

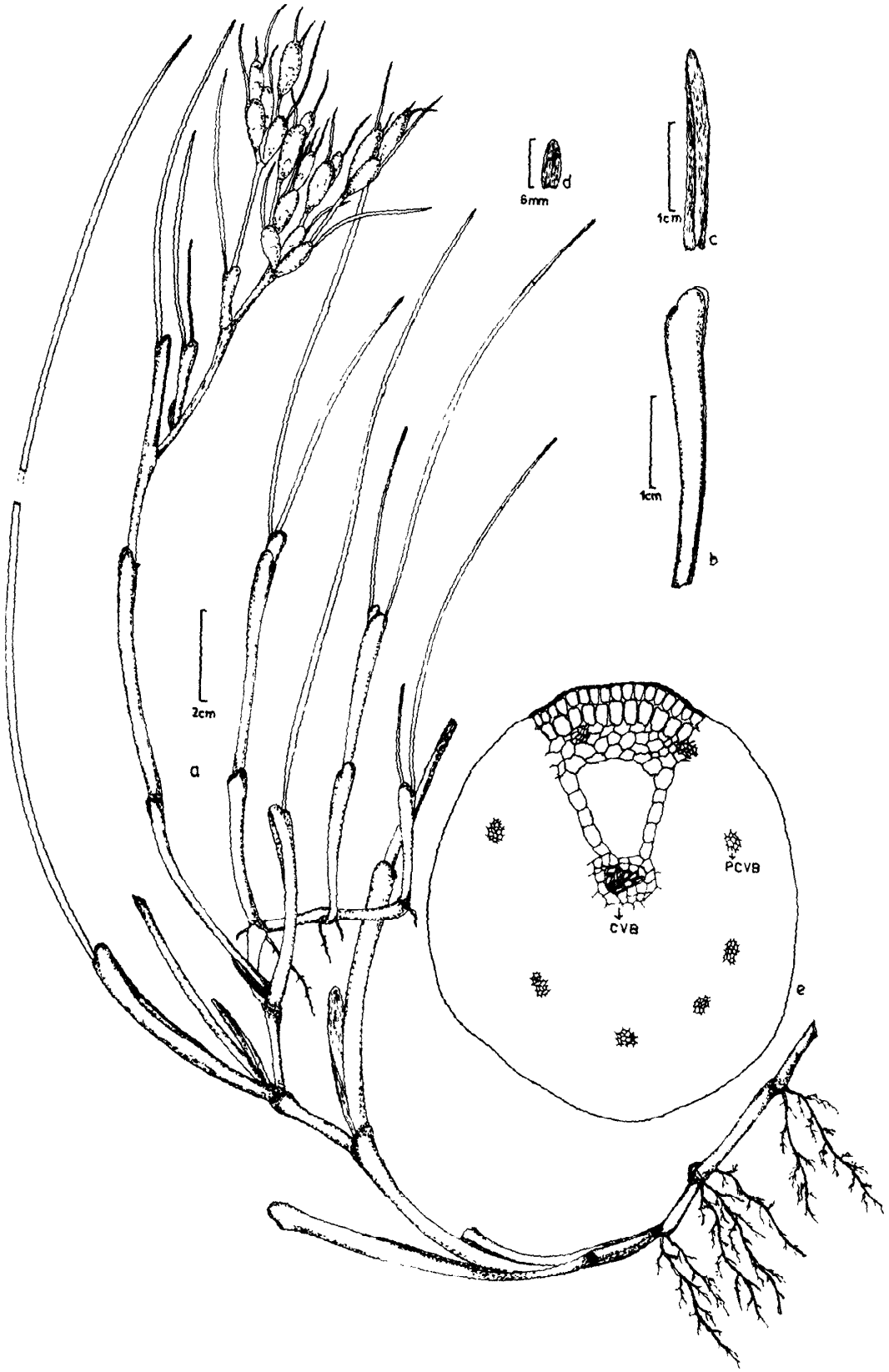


Fig.20 Syringodium isoetifolium (Asch.) Dandy

a. Habit with male flowers, b. Leaf sheath, c. Vegetative scale, d. Floral scale, e. C.S. of lamina showing Central Vascular Bundle (CVB) and Peri Central Vascular Bundles (PCVB).

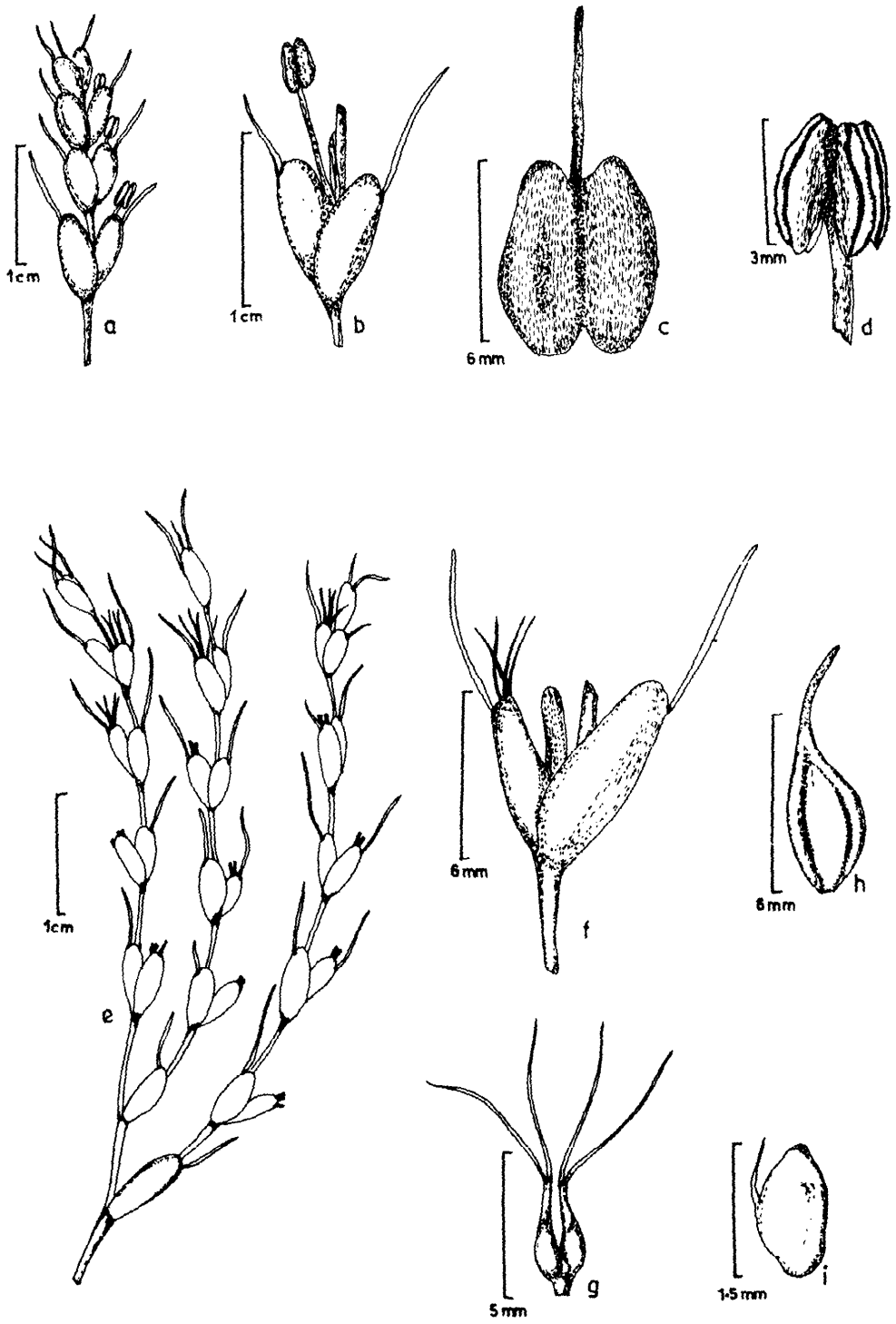


Fig.21. Syringodium isoetifolium (Asch.) Dandy

a. A portion of male inflorescence, b. Male flower enlarged, c. Reduced leaf, d. Dehisced stamens, e. A Branch of female inflorescence, f. Female flower, g. Ovaries, h. Fruit, i. Embryo.

convolute, entire along margins with tannin cells. Male flowers up to 1.4 cm long, erect; stalks 6-10 mm long, terete, erect, stiff, brownish, persistent; anthers 2, oblongoid, 2.5-3.5 by 1-1.5 mm, dorsally connate, equal, dehiscing by vertical slits; pollen grains oblongoid, contained in a mucilagenous sheath forming threads. Female flowers 5-9 mm long, sessile; ovaries 2, ovoid, *ca* 1 by 0.5 mm, sessile, brown; styles 1, 1-7 mm long, terete; stigmata bifid, 3.5-5 mm long, subulate, recurved, brown; fruits obliquely ellipsoid, angular, 4-6 by 1-2 mm; pericarp stony; beak *ca* 2 mm long, bifid; embryo ellipsoid, *ca* 1.5 by 1 mm.

(Figs. 20 & 21; Photos 21 & 22)

Flowering and fruiting: Throughout the year.

Ecology: The distribution of *Syringodium isoetifolium* is restricted to Palk Strait, Palk Bay and Gulf of Mannar. Rarely some drifted materials were seen washed ashore along the coasts of Madras and Chengalpattu districts. It is a pure marine form and is not seen in backwaters, estuaries, etc. Along the entire Andhra Pradesh Coast not even materials washed ashore were seen.

This species generally prefers coral flats but also occurs on rocky, sandy to muddy bottoms. In deeper zones, it forms continuous, isolated patches of pure formation, whereas in subtidal zones it is always found associated with *Cymodocea serrulata, Thalassia hemprichii, Enhalus acoroides, Halophila ovalis, Halodule pinifolia* and *H. uninervis* (broad-leaved form). Usually it is found to occur from 1 m deep onwards. The leaves are often clothed with dense micro and macro epiphytes.

Specimens examined: TAMIL NADU: Tuticorin, Tinnevelly district, *s.d.*, vegetative, *Wight, s.n., (acc. no. 551338,* CAL); *ibid.*, 2.10.1916, male, female and fruits, *without collector, 13726* (MH); *ibid.*, 2.10.1916, male and female, *without collector, 13728 A* (MH); *ibid., s.d.*, vegetative, *without collector, 2413* (MH); Krusadai Island, Ramanathapuram district, 25.9.1944, vegetative, *Parthasarathy & Daniel, s.n. (acc. no. 88148,* MH); *ibid.*, 26.9.1946, female, *Gopal Rao, s.n. (acc. no. 93046,* MH); Mandapam, Ramanathapuram district, materials washed ashore, vegetative, 4.5.1972, *Sastry 9240* (CAL); Krusadai Island, Ramanathapuram district, 18.2.1987, to a depth of ± 1.5 m, vegetative, *Parthasarathy & Ravikumar 85333* (MH); Near Thermal Station, Tuticorin, V.O. Chidhambaranar district, 20.2.1987, to a depth of ± 2.5 m, male, *Parthasarathy & Ravikumar 85357* (MH); Near Fisheries Godown, Tuticorin, to a depth of ± 3 m, 20.2.1987, vegetative, *Parthasarathy & Ravikumar 85358* (MH); Near SPIC Unit, Tuticorin, 21.2.1987, to a depth of ± 3.5 m, male, *Parthasarathy & Ravikumar 85371* (MH); Hare Island, Tuticorin, 21.2.1987, to a depth of ± 2 m, male, *Parthasarathy & Ravikumar 85374* (MH); Thirespuram, Tuticorin, 22.2.1987, to a depth of ± 3.5 m, female, *Parthasarathy & Ravikumar 85380* (MH); Near Thermal Station, Tuticorin, 24.2.1987, to a depth of ± 3 m, female, *Parthasarathy & Ravikumar 85389* (MH); Thiruchendur, V.O. Chidhambaranar district, 17.7.1987, to a depth of ± 3 m, male, *Ravikumar 85724* (MH) *& ibid.*, female, *85725* (MH); Manappadu, V.O. Chidhambaranar district, 19.7.1987, to a depth of ± 4 m, female, *Ravikumar 85747* (MH); Idinthakarai, Nellai Kattabomman district, 23.7.1987, to a depth of ± 4 m, vegetative, *Ravikumar 85765* (MH); Nambiyar Nagar, Nagapattinam, Thanjavur district, 6.9.1987, materials washed ashore, vegetative, *Ravikumar 85782* (MH); Akkaraipettai, Nagapattinam, 6.9.1987, materials washed ashore, vegetative, *Ravikumar 85783 & 85786* (MH); Poompuhar, Thanjavur district, 7.9.1987, materials washed ashore, vegetative, *Ravikumar 85791* (MH); Kodikarai, Thanjavur district, 11.9.1987, materials washed ashore, vegetative, *Ravikumar 85811* (MH); *ibid.*, 12.9.1987, materials washed ashore, vegetative, *Ravikumar 85823* (MH); Adhirampattinam, Thanjavur district, 15.9.1987, to a depth of ± 5 m, male, *Ravikumar 85831* (MH) *& ibid.*, female, *85832* (MH); Mallipattinam, Thanjavur district, 16.9.1987, to a depth of ± 6 m, male, *Ravikumar 85838* (MH) *& ibid.*, female, *85839* (MH); Manora, Thanjavur district, 17.9..1987, to a depth of ± 4 m, female, *Ravikumar 85856* (MH) *& ibid.*, male, *85857* (MH); Kattumavadi, Pudhukkottai district, 20.9.1987, to a depth of ± 3 m, male, *Ravikumar 85863* (MH) *& ibid.*, female,*85864* (MH); Manamelkudi, Pudhukkottai district, 21.9.1987, to a depth of ± 5 m, male, *Ravikumar 85872* (MH) *& ibid.*, female, *85873* (MH); Mimisal, Pudhukkottai district, 22.9.1987, to a depth of ± 5 m, male, *Ravikumar 85877* (MH) *& ibid.*, female, *85878* (MH); Jagathapattinam, Pudhukkottai district,

22.9.1987, to a depth of ± 5 m, female, *Ravikumar 85885* (MH) *& ibid.*, male, *85886* (MH); Kottaipattinam, Pudhukkottai district, 22.9.1987, to a depth of ± 5 m, male, *Ravikumar 85890* (MH) *& ibid.*, female, *85891* (MH); Krusadai Island, Ramanathapuram district, 25.9.1987, to a depth of ± 1.5 m, vegetative, *Ravikumar 86801* (MH) *& ibid.*, 21.4.1988, vegetative, *Ravikumar & Ganesan 86832* (MH); Ramatheertham, Rameswaram, Ramanathapuram district, 24.4.1988, to a depth of ± 2 m, vegetative, *Ravikumar & Ganesan 86853* (MH); Alankarathattu, Tuticorin, V.O. Chidhambaranar district, 27.4.1988, materials washed ashore, female, *Ravikumar & Ganesan 86865* (MH); Near SPIC Unit, Tuticorin, 28.4.1988, to a depth of ± 3 m, male, *Ravikumar & Ganesan 86884* (MH) *& ibid.*, female, *86885* (MH); Hare Island, Tuticorin, 28.4.1988, to a depth of ± 3 m, male, *Ravikumar & Ganesan 86890* (MH) *& ibid.*, female, *86891* (MH); Tuticorin Harbour, 30.4.1988, to a depth of ± 4.5 m, male, *Ravikumar & Ganesan 88101* (MH) *& ibid.*, female, *88107* (MH).

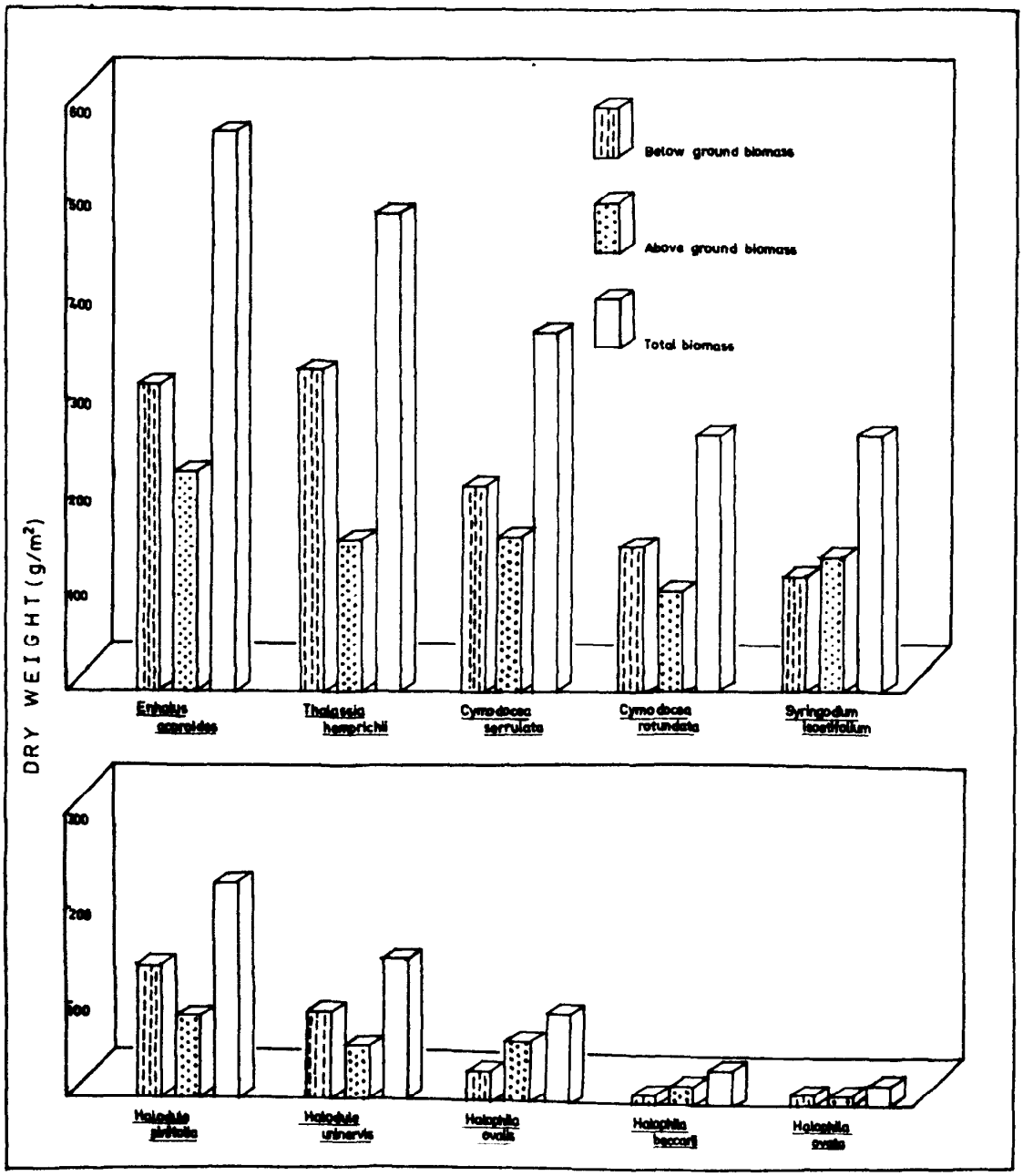
6. BIOMASS STUDIES

Biomass refers to the weight of all living plant material including roots and rhizomes and is expressed in terms of mass/unit (Zieman & Wetzel 1980). Seagrass meadows are the richest and ecologically the most important among the coastal habitats. In tropical and subtropical seagrass beds, the biomass and the productivity rates are very high, although they appear to be poorly known. In fact, seagrass productivity per unit area apparently can exceed that of some cultivated crops (McRoy & McMillan 1977) with an average production of 500-1000 g/C/m^2 (Fenchel 1977). In addition to its own biomass, the productivity and biomass of the epiphytes may equal or even surpass that of seagrasses (Hefferman & Gibbon 1983).

Seagrasses occur in a wide range of species composition and in vast high density meadows. Relatively homogenous seagrass beds cover thousands of hectares. These marine plants harvest the solar energy which are further transferred by herbivores to the next trophic. Most of the energy reaches to the next trophic level through the detritus food web.

The biomass value for 13 taxa collected from various localities of the Coromandel Coast, in different seasons are given family wise (**vide table**) and species wise (**Fig. 22**)

Fig.22- Biomass values for Seagrasses-species wise



POPULATION DENSITY AND BIOMASS OF SEAGRASSES AT DIFFERENT LOCALITIES IN THE COROMANDEL COAST

Seagrass species	Locality	Period of sampling	Population Density Shoot No./m²	B.G.B* g/m²	A.G.B** g/m²	Total Biomass g/m
(1)	(2)	(3)	(4)	(5)	(6)	(7)
HYDROCHARITACEAE						
Enhalus acoroides	Pamban (Gulf of Mannar)	Feb. 87	96	287.4	174.2 (R.B. 57.0)	518.6
,,	Kattumavadi (Palk Bay)	Sep. 87	155	523.9	137.7	661.6
,,	Thonithurai, Mandapam	Apr. 88	80	244.0	181.6 (R.B. 126.1)	551.7
Halophila beccarii	Tuticorin (Gulf of Mannar)	Feb. 87	3,632	1.9	4.3	6.2
,,	Cuddalore Port	Mar. 87	5,872	5.6	19.9	25.5
,,	Vellar estuary, Porto Novo (Parangipettai)	Mar. 87	6,153	7.4	13.1	20.5
,,	Pichavaram lagoon	Mar. 87	3,952	8.6	11.2	19.8
,,	Chinnaganjam	June 88	15,168	23.7	16.3	46.0
,,	Karedu	July 88	14,312	15.7	25.7	41.4
,,	Tummalapenta	July 88	11,209	7.0	15.4	22.5
,,	Utukuru	July 88	12,412	6.6	28.0	34.6
,,	Bhimunipatnam	Sep. 88	13,602	16.1	26.6	42.7
,,	Kakinada	Sep. 88	15,647	22.3	52.8	75.1
,,	Krishnapatnam	Sep. 88	14,784	29.9	13.0	73.0

Seagrass species	Locality	Period of sampling	Population Density Shoot No./m²	B.G.B* g/m²	A.G.B** g/m²	Total Biomass g/m
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Halophila decipiens	Tuticorin (Gulf of Mannar)	Feb. 87	5,296	4.6	3.8 (R.B. 1.0)	9.4
Halophila ovalis subsp. *ovalis*	Mandapam (Gulf of Mannar)	Feb. 87	2,352	18.5	23.8	42.3
"	Tuticorin (Gulf of Mannar)	Feb. 87	5,536	14.1	38.1	52.2
"	Chunnambar Estuary, Pondicherry	Mar. 87	5,930	14.6	35.6	50.2
"	Vellar Estuary, Porto Novo	Mar.87	6,154	9.9	18.4	28.4
"	Pichavaram Lagoon	Mar. 87	12,522	22.3	57.8	80.2
"	Pazhaiyar, Kollidam	"	9,898	31.4	31.8	63.2
"	Ennore, Madras	May 87	9,322	32.0	84.9	116.9
"	Pulicat	"	10,788	28.5	98.3	126.8
"	Kovalam, Muttukadu	"	13,242	21.4	75.7	97.1
"	Sathurangapatnam (Sadras)	"	6,528	17.1	55.3	72.3
"	Mallipattinam	Sep. 87	5,216	19.4	51.6	70.9
"	Mimisal (Palk Bay)	"	3,573	18.3	80.6	98.9
"	Krusadai Island (Gulf of Mannar)	"	2,869	45.4	29.1	74.5

Seagrass species	Locality	Period of sampling	Population Density Shoot No./m²	B.G.B* g/m²	A.G.B** g/m²	Total Biomass g/m
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Holophila ovalis subsp.*ovalis*	Pamban (Gulf of Mannar)	Sep. 87	3,621	39.6	71.2	110.8
,,	Bapatla	June 88	11,664	86.0	99.0	185.0
,,	Chinnaganjam	,,	9,632	46.2	102.4	148.6
,,	Kanuparti	,,	10,672	84.0	57.6	141.6
,,	Gunnamola	,,	7,109	63.3	54.0	117.3
,,	,,	,,	7,658	49.8	70.1 (R.B. 0.4)	120.3
,,	Theetapuram	June 88	11,096	47.0	53.8	100.9
,,	,,	,,	7,136	38.8	48.6	87.4
,,	Karedu	,,	7,496	24.0	88.1	112.1
,,	Utukuru	July 88	9,968	26.9	36.0	62.9
,,	Ramayeepatnam	,,	9,728	67.4	70.2	137.7
,,	Maipadu	,,	6,520	17.4	39.0	56.5
,,	Mahalakshmipuram	,,	8,544	25.4	73.5	98.9
,,	Bhimunipatnam	Sep. 88	7,832	19.8	46.2	66.1
H. ovalis subsp. *ramamurthiana*	Theetapuram	June 88	7,232	79.7	37.1	116.8
Halophila ovalis Complex	Thenpakkam, Marakkanam	Mar. 87	14,032	41.8	20.2	62.0
,,	Punnakayal, Thiruchendur	July 87	1,365	4.1	6.3	10.3

Seagrass species	Locality	Period of sampling	Population Density Shoot No./m²	B.G.B* g/m²	A.G.B** g/m²	Total Biomass g/m
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Halophila ovalis Complex	Chinnaganjam	June 88	14,568	22.5	26.3	48.8
,,	Kanuparti	,,	19,280	30.4	28.2	58.6
,,	Isakkapalli	July 88	15,576	37.8	36.8	77.6
,,	Tummalapenta	,,	11,552	15.7	15.8	31.5
Halophila ovata	Hare Island, Tuticorin	Feb. 87	6,128	29.4	15.4	44.8
,,	Cuddalore	Mar. 87	2,640	2.4	3.7	6.1
,,	Pulicat lake	May 87	4,316	3.7	5.9	9.6
,,	Manora (Palk Bay)	Sep. 87	3,584	6.7	5.9	12.6
,,	Thonithurai, Mandapam	Apr. 88	5,989	4.5	2.8	7.4
,,	Tummalapenta	July 88	9,127	11.5	18.2	29.8
Halophila stipulacea	Krusadai Island, (Gulf of Mannar)	Feb. 87	1,704	11.5	10.1	21.6
,,	Manamelkudi (Palk Bay)	Sep. 87	3,904	18.6	15.4	34.0
Thalassia hemprichii	Krusadai Island, (Gulf of Mannar)	Sep. 87	724	228.1	111.1	339.2
,,	Pamban (Gulf of Mannar)	,,	864	272.5	167.8	440.3
,,	Rameswaram	Apr. 88	1,512	348.3	197.8	546.1
,,	Hare Island, Tuticorin	Apr. 88	2,373	486.5	146.5	633.0

Seagrass species	Locality	Period of sampling	Population Density Shoot No./m²	B.G.B* g/m²	A.G.B** g/m²	Total Biomass g/m
(1)	(2)	(3)	(4)	(5)	(6)	(7)
POTAMOGETONACEAE						
Cymodocea rotundata	Kattumavadi (Palk Bay)	Sep. 87	2,089	142.8	114.5	257.3
,,	Pamban (Gulf od Mannar)	Sep. 87	2,256	152.9	135.2	228.1
,,	Krusadai Island (Gulf of Mannar)	Apr. 88	1,104	69.9	112.4	182.3
,,	Kovilvadi, Mandapam	Apr. 88	1,766	105.1	82.4	187.5
,,	Tuticorin	Apr. 88	3,208	290.4	135.7	426.1
Cymodocea serrulata	Pamban (Gulf of Mannar)	Feb. 87	1,200	221.2	148.0	369.2
,,	Krusadai Island (Gulf of Mannar)	Feb. 87	624	249.4	88.8	338.2
,,	Nadar Uvari	July 87	1,381	140.6	67.0	207.6
,,	Adirampattinam (Palk Bay)	Sep. 87	1,658	115.6	224.3	339.9
,,	Mallipattinam (Palk Bay)	Sep. 87	1,205	211.6	221.2	432.8
,,	Rameswaram	Apr. 88	3,400	351.7	376.8	728.5
,,	Tuticorin	Apr. 88	2,024	295.2	110.9	406.1
,,	Kovilvadi, Mandapam	Apr. 88	1,600	98.4	101.3	199.7
Halodule pinifolia	Rameswaram (Gulf of Mannar)	Feb. 87	7,184	11.6	47.3	58.9

Seagrass species	Locality	Period of sampling	Population Density Shoot No./m²	B.G.B* g/m²	A.G.B** g/m²	Total Biomass g/m
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Halodule pinifolia	Hare Island, Tuticorin	Feb. 87	9,584	68.6	70.1	138.8
,,	Cuddalore	Mar. 87	8,848	14.4	12.9	27.4
,,	Pulicat	May 87	3,397	44.6	40.8	85.4
,,	Kovalam, Muttukkadu	May 87	10,682	46.0	24.8	70.8
,,	Punnakayal	July 87	3,728	50.1	25.6	75.7
,,	Nadar Uvari	July 87	2,874	84.0	64.0	148.0
,,	Idinthakarai	July 87	3,653	193.4	84.3	277.7
,,	Kanniyakumari	July 87	3,600	448.8	73.9	522.7
,,	,,	July 87	4,352	228.3	97.5	385.9
,,	Manora (Palk Bay)	Sep. 87	8,304	48.6	16.9	65.5
,,	Mallipattinam (Palk Bay)	Sep. 87	7,477	49.3	193.1	242.4
,,	Manamelkudi (Palk Bay)	Sep. 87	9,882	382.5	341.2	723.7
,,	Mandapam	Apr. 88	12,016	285.3	61.3	346.6
,,	Akkalmadam	Apr. 88	11,368	297.6	138.0	435.6
,,	Rameswaram	Apr. 88	6,816	15.4	41.0	56.3
,,	Tuticorin	Apr. 88	16,816	73.1	76.8	149.9
,,	Chinnaganjam	June 88	7,732	151.5	240.6	392.2
,,	Kanuparti	June 88	9,349	97.4	76.2	173.5

Seagrass species	Locality	Period of sampling	Population Density Shoot No./m²	B.G.B* g/m²	A.G.B** g/m²	Total Biomass g/m
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Holodule pinifolia	Kanuparti	June 88	6,534	122.2	77.1	199.4
,,	Gunnamola	June 88	8,065	228.1	161.8	390.0
,,	Ramayeepatnam	July 88	6,719	126.7	176.2	303.0
,,	Karedu	July 88	5,636	78.1	49.0	127.0
,,	Isakkapalli	July 88	5,963	173.0	188.5	361.5
,,	,,	July 88	7,346	130.6	78.9	209.5
,,	Utukuru	July 88	8,463	158.6	223.1	381.8
,,	Krishnapatnam	July 88	6,216	301.9	148.6	450.6
Halodule uninervis	Mandapm (Gulf of Mannar)	Feb. 87	10,480	102.3	58.5	160.8
,,	Chunnambar, Pondicherry	Mar. 87	10,394	26.7	30.8	57.5
,,	Thenpakkam, Marakkanam	Mar. 87	5,397	11.8	8.1	19.9
,,	Thiruchendur	July 87	3,701	233.8	78.9	312.4
,,	Chinnaganjam	June 88	6,366	172.3	137.8	310.1
,,	Kanuparti	June 88	6,713	63.4	72.3	135.7
,,	Gunnamola	June 88	9,616	96.3	79.6	175.9
,,	Tummalapenta	July 88	6,315	133.7	101.6	235.3
,,	Karedu	July 88	5,918	30.4	12.6	42.6

Seagrass species	Locality	Period of sampling	Population Density Shoot No./m²	B.G.B* g/m²	A.G.B** g/m²	Total Biomass g/m
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Syringodium isoetifolium	Tuticorin (Gulf of Mannar)	Feb. 87	1,816	74.9	195.5	270.5
,,	Hare Island, Tuticorin	Feb. 87	1,264	44.9	74.2	119.1
,,	Thiruchendur	July 87	3,392	143.6	97.5	243.1
,,	Keela Uvari	July 87	3,141	138.5	146.8 (R.B.-18.6)	303.9
,,	Kanniyakumari	July 87	4,713	116.1	78.6	194.7
,,	Idinthakarai	July 87	3,002	80.5	103.3	183.8
,,	Rameswaram	July 87	4,896	130.5	172.8	303.3
,,	Hare Island, Tuticorin	July 87	8,336	227.0	202.4 (R.B.-85.4)	514.9

BGB* Below Ground Biomass
AGB** Above Ground Biomass
R.B. Reproductive Biomass

Results: Since, *Enhalus acoroides* is the gaint seagrass, its biomass value is maximum than the rest. The total average biomass value is 577.2 g/m^2, of which the Below Ground Biomass (BGB) is higher than the Above Ground Biomass (AGB) without epiphytes. *Thalassia hemprichii*, the another robust seagrass having the total biomass value of 489.61 g/m^2, of which 68% is constituted by BGB. In *Cymodocea serrulata* and *Cymodocea rotundata* 60% of the dry weight is locked in the BG system.

It has been observed from the study that the robust seagrass species like *Enhalus acoroides*, *Thalassia hemprichii*, *Cymodocea rotundata* and *C. serrulata* are contributing the maximum biomass values. This is due to the morphological nature of these plants where the rhizomatous system is well developed and highly branched in order to withstand the tidal and water currents prevailing in their habitat and the substratum ranging from fine sand to loose mud. Among all the seagrasses collected from Coromandel Coast, *Enhalus acoroides* and *Thalassia hemprichii* have well developed root and rhizomatous system, nearly one foot in thickness which are tough to excavate.

The results of the above discussed observations are coinciding with the results of other workers on biomass studies. Zieman (1987) reported that for the larger seagrass species, eventhough the AGB is quite significant most biomass is in the BG system. For *Thalassia testudinum*, Bittaker and Iverson (1976) reported that 52.6% of biomass is fixed in the rhizomatous and root system. The ratio between AGB & BGB found by Burkholder *et al.* (1959) shows that 2 fold increase of BGB is in the coarser sediments, whereas less in fine mud sediment habitat.

An entirely different tendency is found from the average AGB & BGB values for *Syringodium isoetifolium*. The AGB value constitutes the 55% of the total biomass value. Zieman (1982) reported the same observation in *Syringodium filiforme* which is a temperate seagrass.

For *Halodule pinifolia* and *Halodule uninervis* the biomass value is more in the BG system, since they are having highly branched intricate network of rhizomatous system. Moreover the life span of the leaves is short compared to other seagrasses and the sheaths also wither along with the leaves. The number of leaves per shoot are generally 2-3 with narrow lamina of less surface area compared to other linear-leaved seagrasses, which ultimately results in the production of less AGB. Eleuterius (1987) stated that, since *Halodule* grows faster than other seagrasses, consequently it has a greater leaf turn-over rate.

Invariably, for all the species of *Halophila* the AGB is more than the BGB, but in certain localities for the aged populations the values are reverse. The BG system is always occupying superficially and their substratum do not form an intricate network, which in turn results into the less BGB value.

The present work on biomass studies reveals that in the marine environment the higher biomass is contributed by *Enhalus acoroides*, *Thalassia hemprichii*, *Cymodocea rotundata*, *C. serrulata* and *Syringodium isoetifolium*. In the Gulf of Mannar and Palk Bay these plants add heavy biomass to their environment by forming vast continuous submerged meadows. The shallow and calm backwater environment is enriched with the biomass from *Halophila* spp. and *Halodule* spp.

However, the average biomass added to their environment by *Halophila* spp.is always small as stated by Burkholder *et al.* (1959). As concluded by Zieman (1987) in general, the seagrass biomass value vary widely depending upon the species composition, epiphytes, local condition, water clarity, circulation, sediment depth and nutrient content.

The population density determination for *Cymodocea rotundata, C. serrulata, Enhalus acoroides, Syringodium isoetifolium and Thalassia hemprichii* shows an inversely proportionate tendency to the total biomass value. The increase in shoot number shows gradual decrease in total biomass value. Shoot density for individual species varies with the season, substratum, habitat, etc. In *Halophila* spp. and *Halodule* spp. population density is more in sheltered localities of marine environment and in backwaters.

7. DISCUSSIONS AND CONCLUSIONS

Eventhough India is having a vast coastal line of approximately 6000 km, only a part of it, the Coromandel Coast ranging to a distance of about 1900 km has been satisfactorily explored. Till today an elaborate ecological and taxonomical research on seagrasses have not been carried out.

Hartog & Zong-Dai Yang (1988) stated that 20 species are available from the tropical Indian Ocean to West Pacific area. *Halodule pinifolia* was recorded from Pichavaram lagoon (Velusamy & Kannan 1985) and Mandapam Coast (Hartog & Zong-Dai Yang 1988) based on material deposited at Chinese herbaria. The record of *Halophila decipiens*, a new subspecies of *H. ovalis* and the new report of *Halodule wrightii* from the present study increase the number of seagrasses available in Coromandel Coast from 11 to 14, and these have been enlisted under two families, below:

HYDROCHARITACEAE

Enhalus acoroides (L.f.) Royle

Halophila beccarii Asch.

Halophila decipiens Ostenf.

Halophila ovalis (R. Br.) Hook. f. subsp. *ovalis*

Halophila ovalis (R.Br.) Hook. f. subsp. *ramamurthiana* Ravikumar & Ganesan

Halophila ovata Gaud.

Halophila stipulacea (Forsk.) Asch.

Thalassia hemprichii (Ehrenb.) Asch.

POTAMOGETONACEAE

Cymodocea rotundata Ehren. & Hempr. ex Asch.

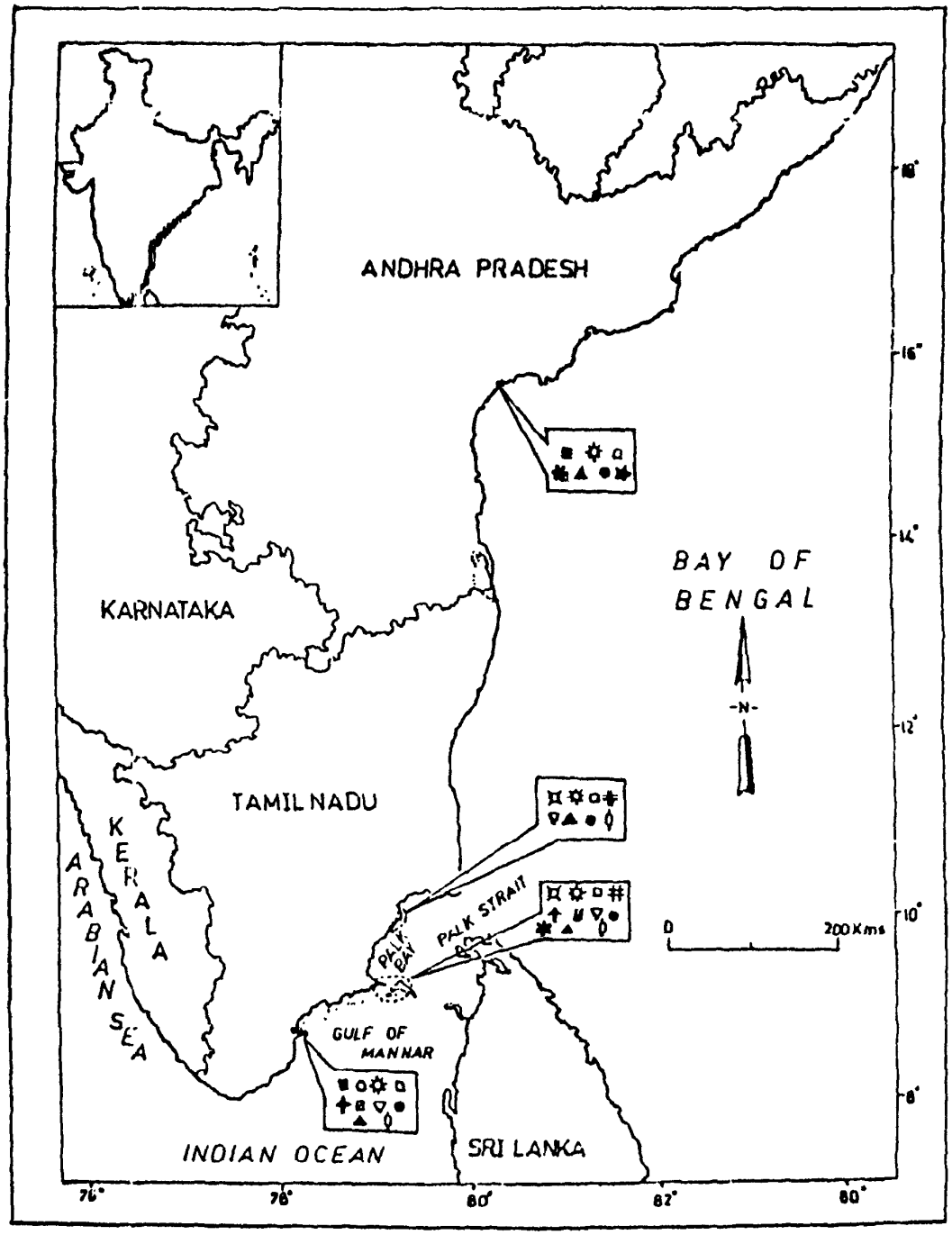
Cymodocea serrulata (R.Br.) Asch. & Magnus

Halodule pinifolia (Miki) Hartog

Halodule uninervis (Forsk.) Asch.

Halodule wrightii Asch.

Syringodium isoetifolium (Asch.) Dandy



Map 2. Species diversity of seagrasses along Coromandel Coast

Enhalus acoroides	⌑	Thalassia hemprichii	↑
Halophila beccarii	■	Cymodocea rotundata	◪
Halophila decipiens	○	Cymodocea serrulata	▽
Halophila ovalis subsp. ovalis	☼	Halodule pinifolia	▲
Halophila ovalis subsp. ramamurthiana	✸	Halodule uninervis	●
Halophila ovata	□	Halodule wrightii	✻
Halophila stipulacea	⌗	Syringodium isoetifolium	▯

A. Species diversity of Seagrasses (Map 2)

Gulf of Mannar : In the Coromondel Coast, Gulf of Mannar comprising Rameswaram, Pamban, Mandapam and Krusadai Island is an important area harbouring the maximum number of seagrass species. This area is the first marine biosphere reserve of South East Asia, harbouring 12 species of seagrasses namely *Cymodocea rotundata, C. serrulata, Enhalus acoroides, Halodule pinifolia, H. uninervis* (broad & narrow-leaved forms), *Halophila beccarii, H. decipiens, H. ovalis, H. ovata, H. stipulacea, Thalassia hemprichii* and *Syringodium isoetifolium.*

The Gulf of Mannar is having varied substratum. The island groups of this gulf are predominantly surrounded by coral rubbles, coral reefs, sand-stones mixed with sand and mud, which forms an ideal and congenial substratum for the luxurious growth of the species of *Cymodocea, Enhalus, Halodule, Thalassia* and *Syringodium.* In muddy and fine sandy bottoms species of *Halodule* and *Halophila* are commonly seen. However, in Thiruchendur, Idinthakarai and Kanniyakumari areas *Cymodocea serrulata, Halodule pinifolia* and *Syringodium isoetifolium* are found growing abundantly on rocks and its crevices.

The predominant species in this area are *Cymodocea rotundata, C. serrulata, Halodule pinifolia, Halophila ovalis, Syringodium isoetifolium* and *Thalassia hemprichii. Enhalus acoroides* is restricted to Pamban, Krusadai Island and Mandapam. The less predominent species are *Halodule uninervis* and *Halophila ovata. Halophila beccarii* is available only in sheltered localities of Tuticorin and Punnakayal backwaters. *Halophila decipiens* and *H. stipulacea* are restricted to Tuticorin and Krusadai Island and Tuticorin respectively.

Palk Bay: This is another important area showing diversified species composition of 10 species namely, *Cymodocea rotundata, C. serrulata, Enhalus acoroides, Halodule pinifolia, H. uninervis* (broad & narrow-leaved forms), *Halophila ovalis, H. ovata, H. stipulacea, Syringodium isoetifolium* and *Thalassia hemprichii*

The substratum is uniformly loose black muddy and fine to coarse sandy. Generally, the habitat is shallow with less waves. Two distinct zones are recognised based on the availability of seagrasses. The marginal zone is dominated with *Halodule* spp. and *Halophila* spp. whereas in the deeper zones, approximately 0.5 km. off from the shore, species of *Cymodocea, Enhalus* and *Syringodium* are seen.

In Palk Bay, *Cymodocea serrulata, Halodule pinifolia, Halophila ovalis* and *Syringodium isoetifolium* are predominent. Species like *Halodule uninervis, Halophila ovata* and *H. stipulacea* are less predominent. *Enhalus acoroides* is restricted to Kattumavadi and found growing as isolated patches. *Halodule wrightii* is restricted to Akkalmadam in Rameswaram Island towards the noth-east side of Pamban Channel and is found growing mixed with *H. pinifolia* and *H. uninervis.*

Back waters: The back water systems near the mouth of rivers harbour extensive beds of *Halodule* spp. and *Halophila* spp. There is not much species diversity in these habitats, compared to the communities found in Gulf of Mannar and Palk Bay. The substrata of the mangrove creeks, backwaters, estuaries, etc. are usually clayey to black muddy and fine to coarse sandy.

Compared to Tamil Nadu coast, Andhra Pradesh coast is poor in species diversity. The Chinnaganjam backwater contributing a maximum number of 6 species, viz. *Halodule pinifolia, H. uninervis, H. wrightii, Halophila beccarii, H. ovalis* and *H. ovata.* In all the backwaters, estuaries and mangrove swamps, *Halodule and Halophila* spp. grow abundantly.

No seagrasses were found in the open wavy sea, from north of Palk Bay in Tamil Nadu to the entire Andhra Pradesh coast. However, drifted materials of *Cymodocea rotundata, C. serrulata, Enhalus acoroides, Syringodium isoetifolium* and *Thalassia hemprichii* were found washed ashore from north of Palk Bay up to Chengalpattu district coast, whereas not even a bit of these materials were seen in the entire Andhra Pradesh coast. The probable primary factors responsible for the absence of seagrasses in these areas, might be due to the unstable sandy substratum, deep sea, violent tidal action and water current.

The present study reveals the fact that *Halodule pinifolia, H.uninervis, Halophila beccarii, H. ovalis* and *H. ovata* are distributed throughout the Coromandel Coast.

Hartog (1970) mentioned that *Halophila ovalis* is abundant in the mouth of Adyar river near Madras based on Cleghorn's collection in 1856, but presently a through search of this species in the same area went futile. This is due to the extreme level of water pollution in that river which might have completely devastated the entire population of this species. Nayar (1959) reported species of *Enhalus* and *Halophila* from Kanniyakumari coast and these species are also not found now.

Phenology: Of the few sheets of seagrasses deposited at MH, CAL and HIFP most are without flowers and fruits. So far, no consolidated account on the phenology of seagrasses in India has been worked out. However,Lakshmanan & Rajeswari (1985) tablulated the phenological data for 9 seagrasses available in Gulf of Mannar.

During this study flowering and fruiting materials were collected throughout the period for *Enhalus acoroides, Halodule pinifolia, Halophila ovalis* and *Syringodium isoetifolium.*

In *Halophila beccarii* the reproductive stages were observed during January to March and August to October. Though Ascherson (1871) observed monoecious condition in *H. beccarii,* the subsequent workers have not observed this. Recently, Parthasarathy *et al.* (1988 a) observed monoecism and protogyny in this species and also stated that the staminate and pistillate flowers are borne in different spathes of the same or different branches.

The phenophase for *H. decipiens* is from January to March. The phenological studies carried out by Parthasarathy *et al.* (1988 b) revealed protogynous nature in this species. Unlike *H. beccarii,* in *H. decipiens* the male and female flowers are borne within a single spathe.

Open staminate flowers found by Lipkin (1975) is the only report available for *H. stipulacea,* whereas, pistillate flowers and fruits were collected in plenty during February and March from Palk Bay and Gulf of Mannar. Even in culture studies McMillan (1980 a) could not observe staminate flowers, but fruit development was noted and hence suggested that the development of ovule is due to apomixis.

The flowering and fruiting materials of *Thalassia hemprichii* were observed during February to June and August to September (Lakshmanan & Rajeshwari, 1985).

The appearance of flowers in stunted branches and their absence in longer shoots is a noteworthy observation found among the species of *Cymodocea, Halodule* and *Syringodium* of Potamogetonaceae. Kirkman (1975) and McMillan (1980 b) observed the male flowers only from the stunted shoots in *Cymodocea serrulata*, both in nature and in culture condition.

Lakshmanan & Rajeswari (1985) reported that reproductive phase in *Halodule uninervis* is restricted to narrow-leaved forms as observed from Krusadai Island. During the present study, the staminate and pistillate flowers were observed in broad-leaved forms also in Thiruchendur in the Gulf of Mannar. Hartog (1967) and McMillan (1978 & 1979) stated that both broad and narrow-leaved forms are capable of bearing flowers and fruits.

Flowers and fruits in *Cymodocea rotundata* were so far not seen and appear to be highly infrequent. Hartog (1970) observed flowers once during 1967 in Queensland and McMillan (1979) reported flowers in field and also under controlled conditions.

As stated by Hartog (1970) there was no report on male flowers of *Cymodocea serrulata* till Kirkman's (1975) findings from Queensland. McMillan (1980) found male flowers under controlled condition. So far there is no detailed description available for male flowers and this is dealt in taxonomic part with illustration.

Recently Parthasarathy *et al.* (1991) discussed the distribution of 12 species of seagrasses in 38 stations in Tamil Nadu, Southern India and also gave an account on the types of substrata, flowering and fruiting, local uses and stresses on these beds.

The male and female populations of all dioecious seagrasses are found to occur as separate patches adjacent to one another or distantly and rarely found overlapping on margins. Because of inconspicuous and ephemeral nature of flowers and also since they last only for a very short period, it appears as if the flowering in seagrasses is infrequent as referred by various early workers. But, careful and intensive study in the field reveals that flowering is frequent, eventhough they last only for a short time. However, day length, temperature, salinity, tidal rhythm, *etc.* play major roles in the flowering physiology of seagrasses.

Importance and conservation: The true importance of seagrass meadows to estuarine and coastal marine ecosystem is generally underestimated. Until recently the need for elaborate ecological researches was not recognised. Thayer *et al.* (1975) summarised the importance of seagrass beds, which are as follows.

1. Seagrass has a high growth rate, producing on an average about 300-600 g dry weight/m^2/year, not including root production.

2. The leaves support a large number of epiphytic organisms, with a total biomass, perhaps approaching that of the grass itself.

3. Although a few organisms may feed directly on the seagrass and several may graze on the epiphytes, the major food chains are based on seagrass detritus and its resident microbes.

4. The organic matter in the detritus and in decaying roots initiates sulphate reduction and maintains an active sulphur cycle.

5. The roots bind the sediments together and with the production afforded by the leaves, surface erosion is reduced, thereby preserving the microbial flora of the sediment and the sediment-water interface.

6. The leaves retard currents and increase sedimentation of organic and inorganic materials around the plants.

7. Seagrass absorbs phosphorus both through the leaves and the roots; it may be that the phosphorus absorbed through the roots is released through the leaves, thereby returning phosphate from sediments to the water column. Nitrogen also is taken up by the roots and transferred to the leaves and into the medium.

Since, seagrass beds are the rich productive zone in any marine ecosystem, for effective and wise exploitation a thorough knowledge on various aspects, *viz.* abiotic factors like light, temperature, salinity, nutrient cycling, substratum, water current and tidal rhythm, freshwater discharge and pollutants and biotic factors like community structure, faunal and floral relationships, food complexity and finally anthropological stress on seagrass habitats should be elucidated.

After completely analysing the factors interlinked in the operation of the dynamic seagrass ecosystem of Indian coast, we may step down effectively to put forward suggestions for commercial exploitation and restoration of seagrass beds by evolving indigenous conservation methods.

Forest clearing, channeling and diversion of streams, excessive soil erosion, dam construction, siltation, etc. have their impact on the seagrass habitats. From the very past, seagrass beds and the associated animals and plants have co-evolved and are presently in a state of well balanced co-existence. Since, the seagrass beds provide unique niches to innumerable macro and micro fauna and algae, any threat to that habitat may ultimately put an end to those marine lives. The recent increasing anthropogenic influences on the marine habitats are worst, rapid and disastrous than any known natural calamities. Mushrooming of industries and settlements which are dumping their wastes into the sea, directly affect the marine ecosystem and indirectly human life through many ways. It is learnt from the fisherfolk, that these beds provide ideal shelter and nutrition for fishes, prawns, crabs, etc. and hence, fish yield is more in those areas.

Biotechnological methods could be developed in order to select competent and suitable biotype to the local environment for the practical and profitable mariculture. Symposia and seminars should be organised to evolve constructive ideas on marine resources utilization and conservation.

Various facets of seagrass community studies can be undertaken by various research institutions on their respective fields at national level and the results obtained could be amalgamated to formulate policies and principles on resource exploitation integrated with conservation.

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INDEX

The seagrass species mentioned in the Systematic Treatment are listed alphabatically. Species mentioned in the Introduction, Classification, Ecology, *etc.* are excluded. Correct names are printed in bold letters. Basionyms and synonyms are in italics.

Photo 1 : A dense population of *Enhalus acoroides* .(L.f.) Royle, partially exposed near Krusadai Island, Gulf of Mannar, Tamil Nadu.

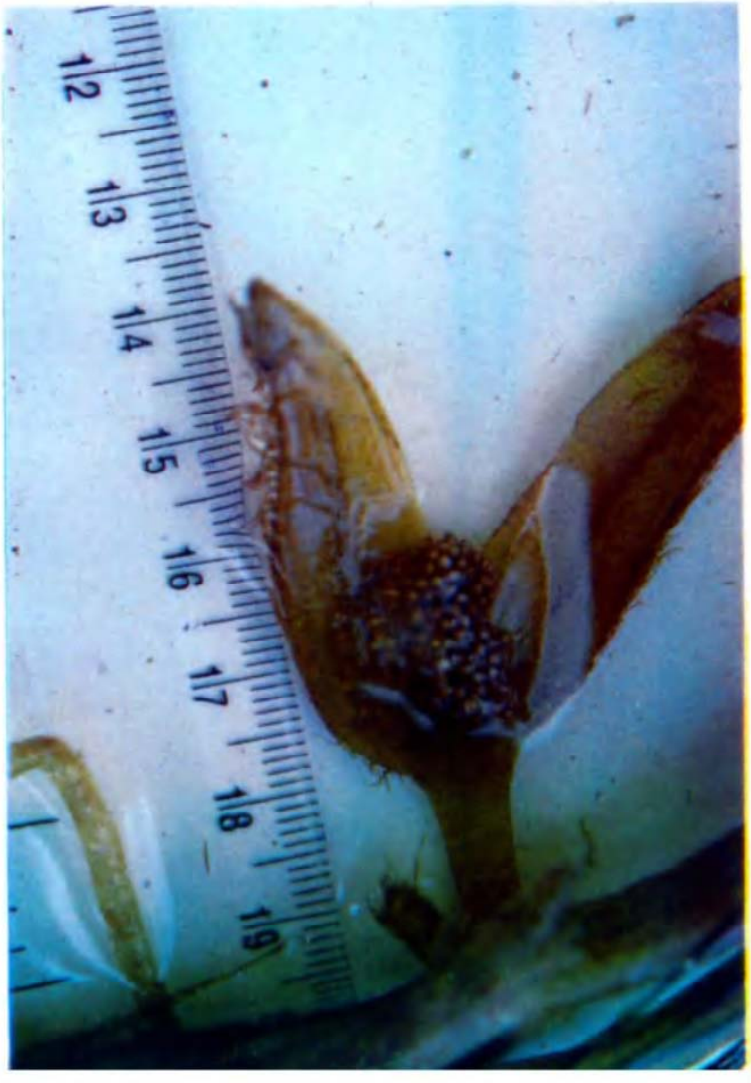

Photo 2 : Close up of male inflorescence of *Enhalus acoroides* (L.f.) Royle

Photo 3 : A patch of *Halophila beccarii* Asch., fully exposed during low-tide near Kakinada port in Andhra Pradesh.

Photo 4 : Monoecious condition in *Halophila beccarii* Asch., a rare phenomenon.

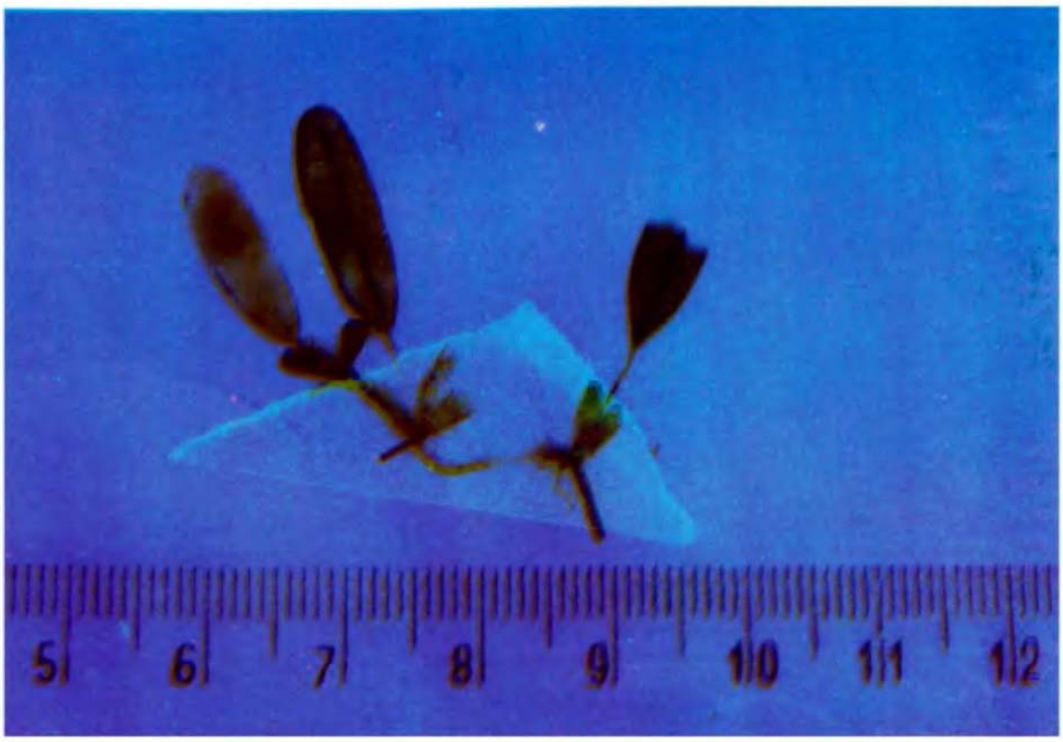

Photo 5 : ***Halophila decipiens*** **Ostenf., male and female flowers, a new report from coromandel coast.**

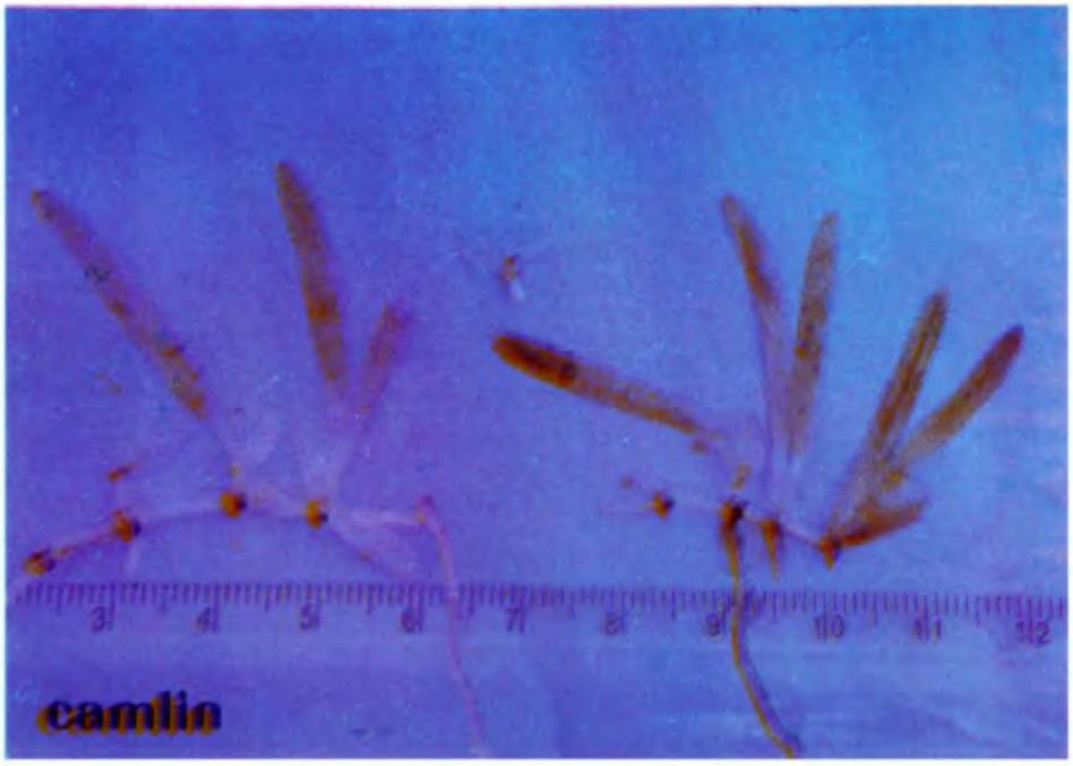

Photo 6 : ***Halophila stipulacea*** **(Forsk.) Asch., (fruits) collected from Krusadai Island, Gulf of Mannar, Tamil Nadu.**

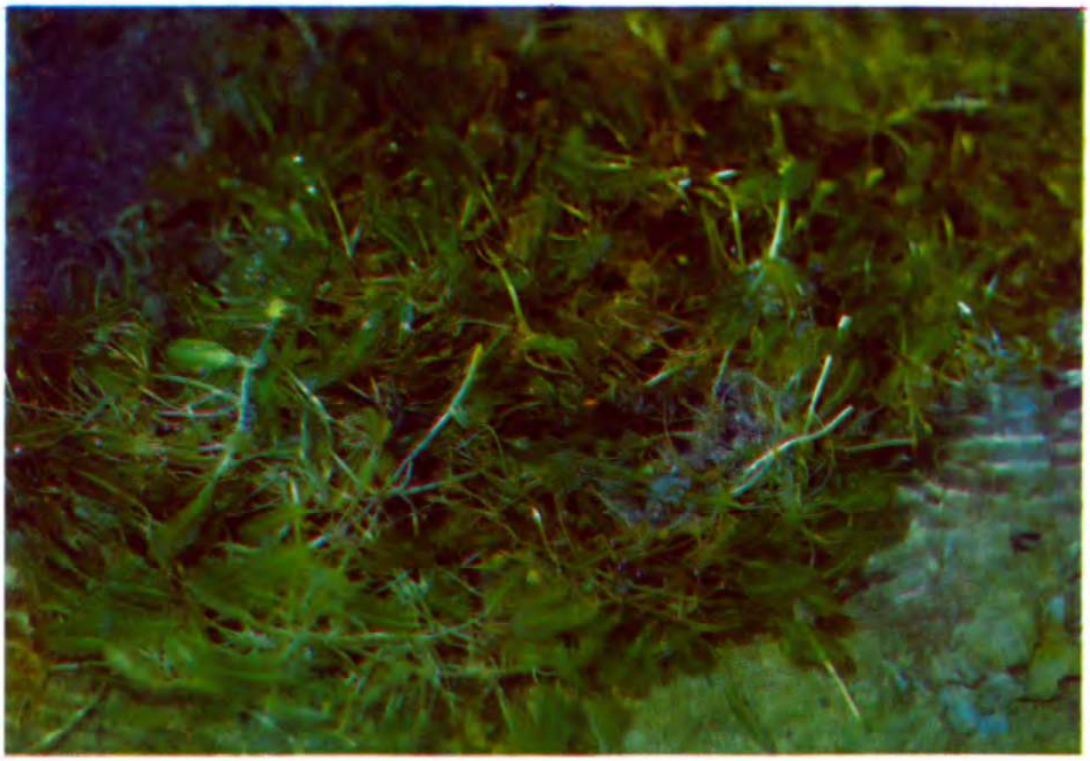

Photo 7 : A population of *Halophila ovalis* (R.Br.) Hook.f., near Pamban.

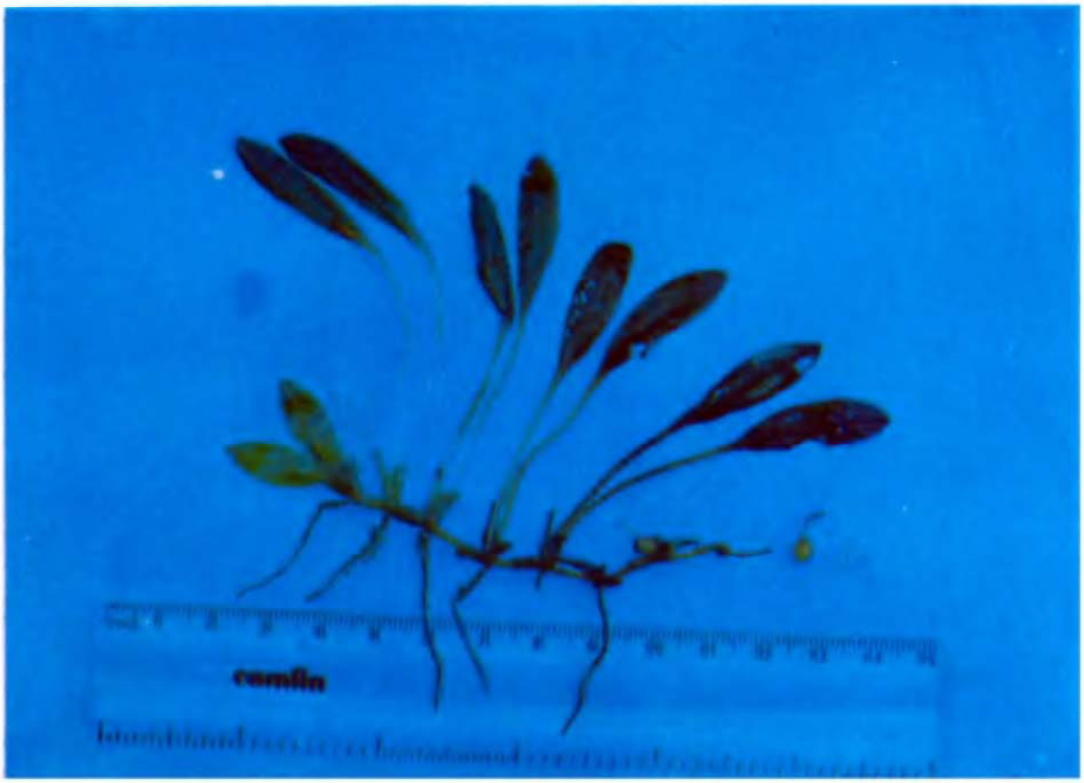

Photo 8 : Fruits in *Halophila ovalis* (R.Br.) Hook.f.

Photo 9 : *Halophila ovata* Gaud. population near Rameswaram, Gulf of Mannar, Tamil Nadu.

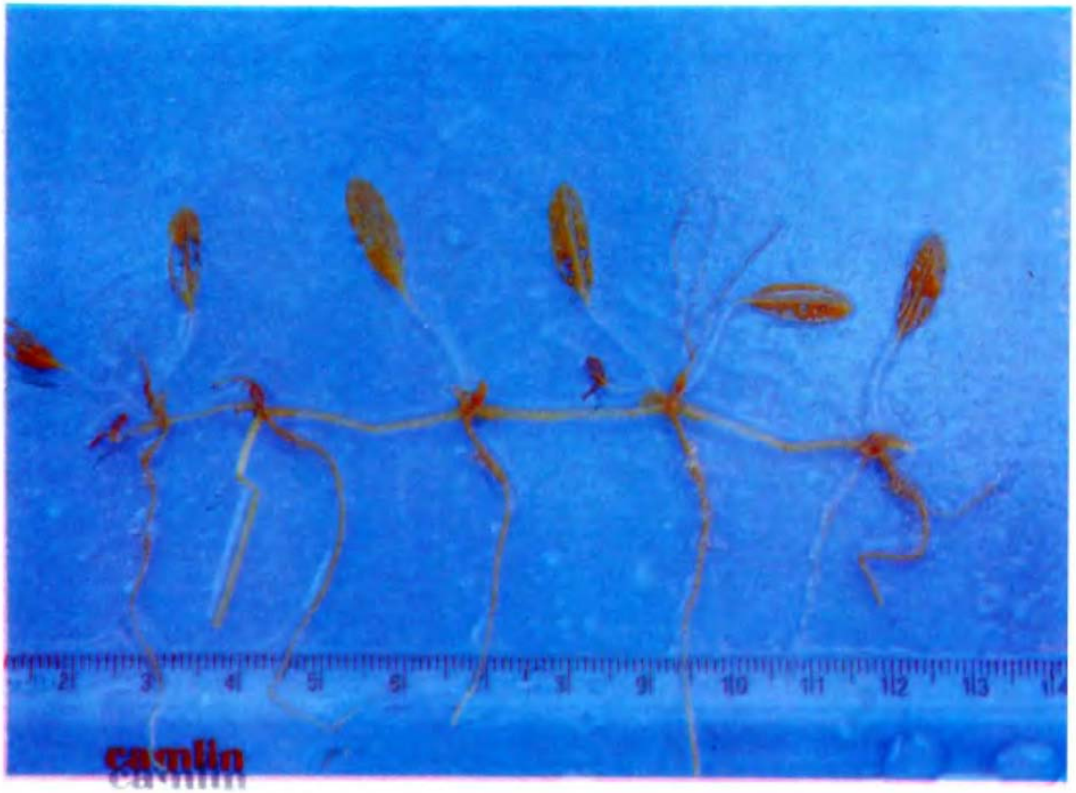

Photo 10 : Developmental stages of female flowers in *Halophila ovata* Gaud.

Photo 11 : Exposed dense population of *Thalassia hemprichii* (Ehrenb.) Asch., near Pamban, Gulf of Mannar, Tamil Nadu.

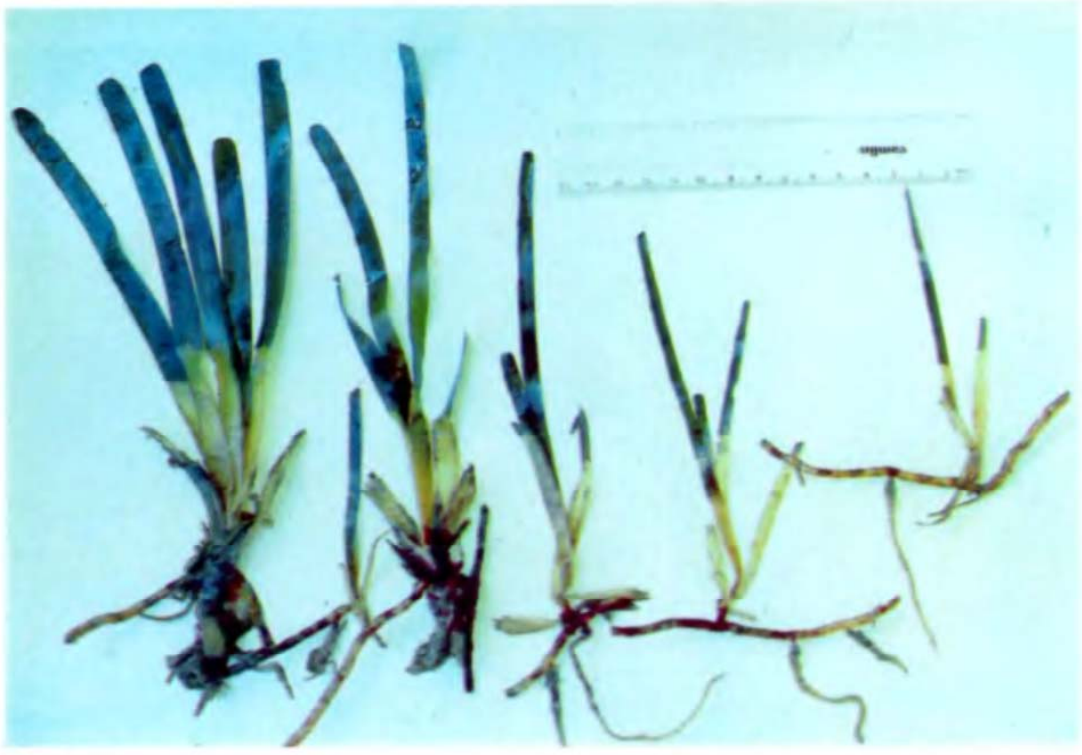

Photo 12 : Leaf variations in *Thalassia hemprichii* (Ehrenb.) Asch.

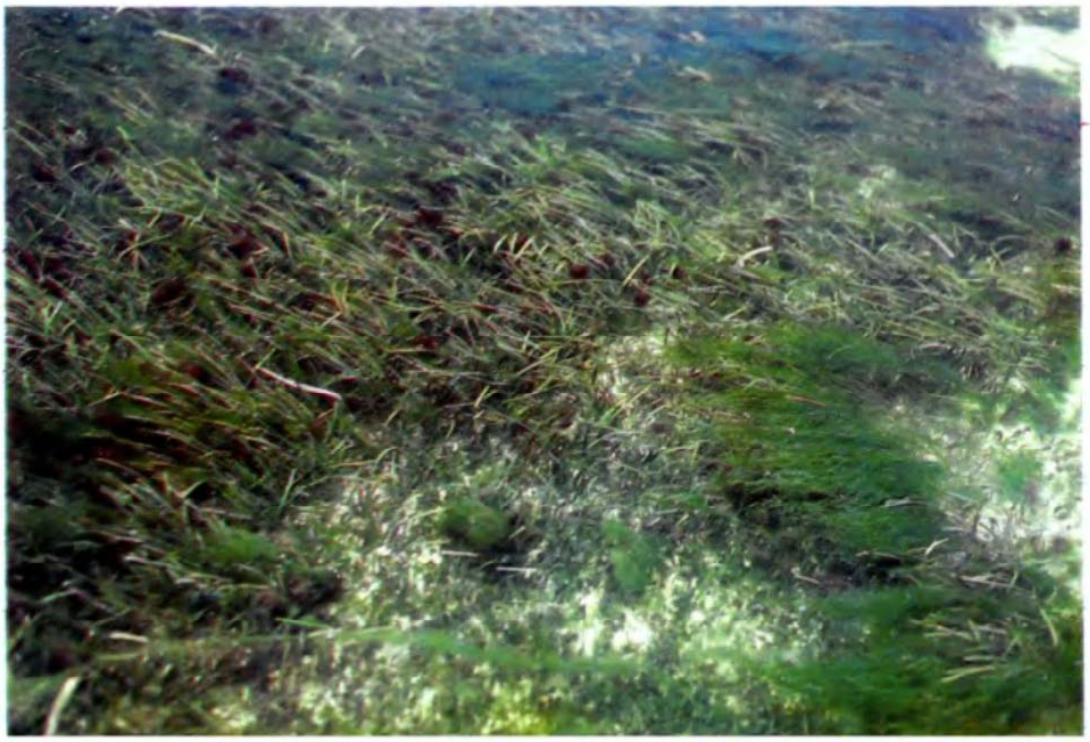

Photo 13 : A dense patch of *Cymodocea rotundata* Ehrenb. & Hempr. ex Asch., thickly encrusted with macro marine algae in Rameswaram, Tamil Nadu.

Photo 14 : Dense population of *Cymodocea serrulata* (R.Br.) Asch. & Magnus, near Hare Island, Tuticorin, Gulf of Mannar, Tamil Nadu.

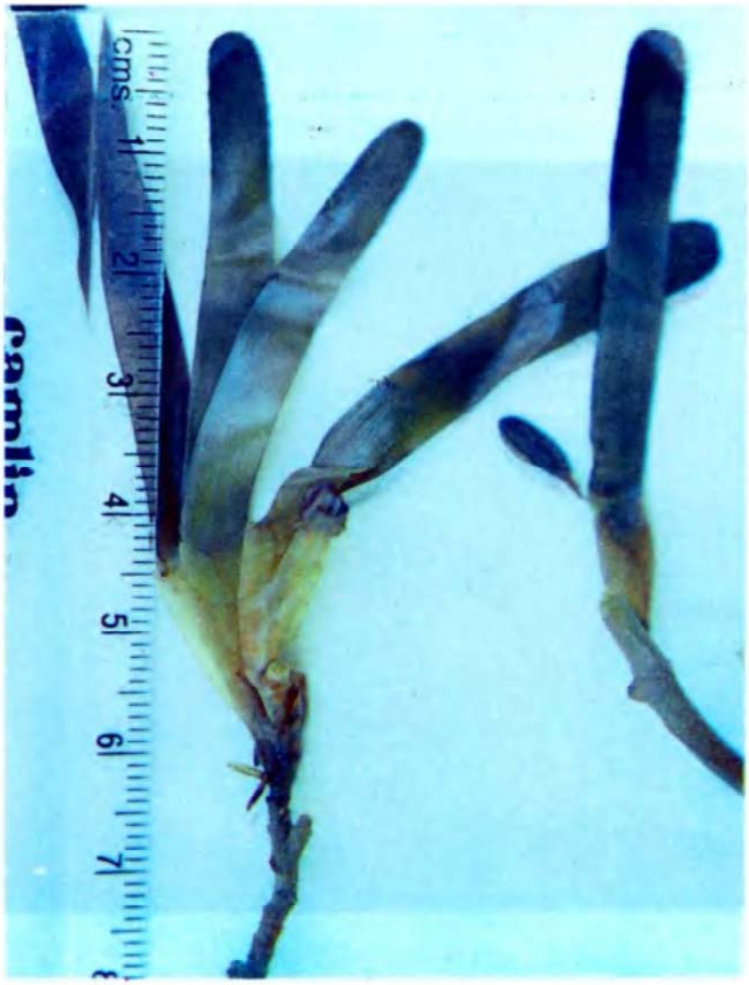

Photo 15 : Male flower in *Cymodocea serrulata* (R.Br.) Asch. & Magnus

Photo 16 : Female flowers and fruits in *Cymodocea serrulata* (R.Br.) Asch. & Magnus

Photo 17 : A population of *Halodule pinifolia* (Miki) den Hartog, near Kanniyakumari, Tamil Nadu.

Photo 18 : Close up view of *Halodule pinifolia* (Miki) den Hartog

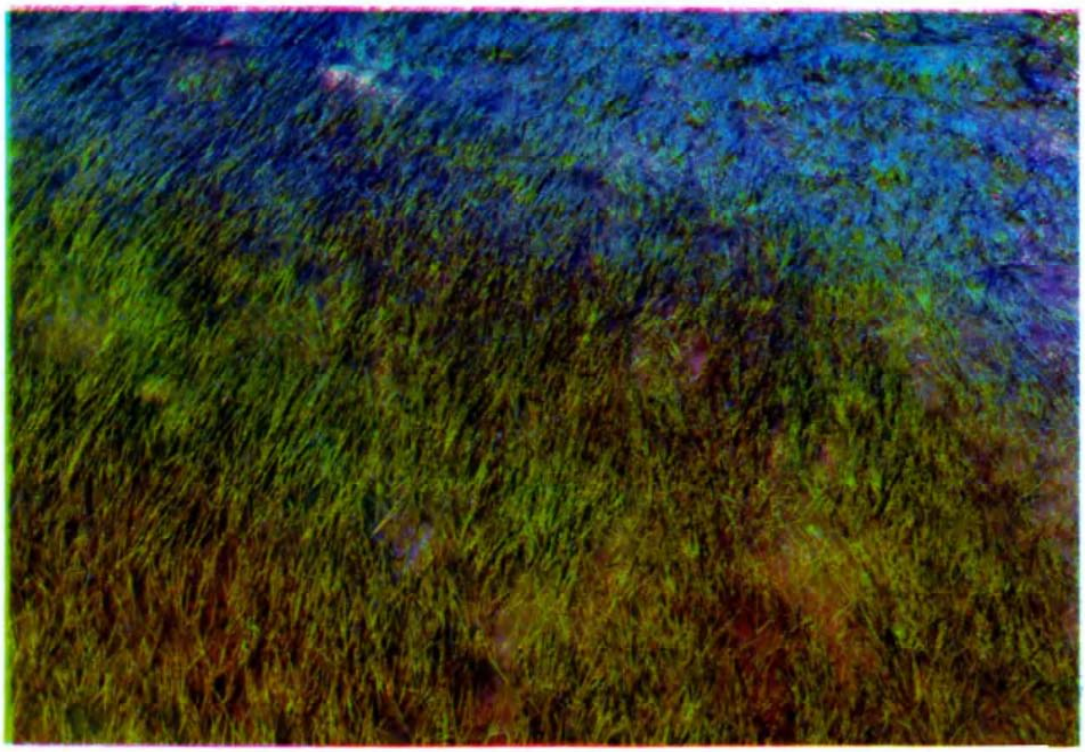

Photo 19 : Submerged meadow of *Halodule uninervis* (Forsk.) Asch., near Porto Novo, Tamil Nadu.

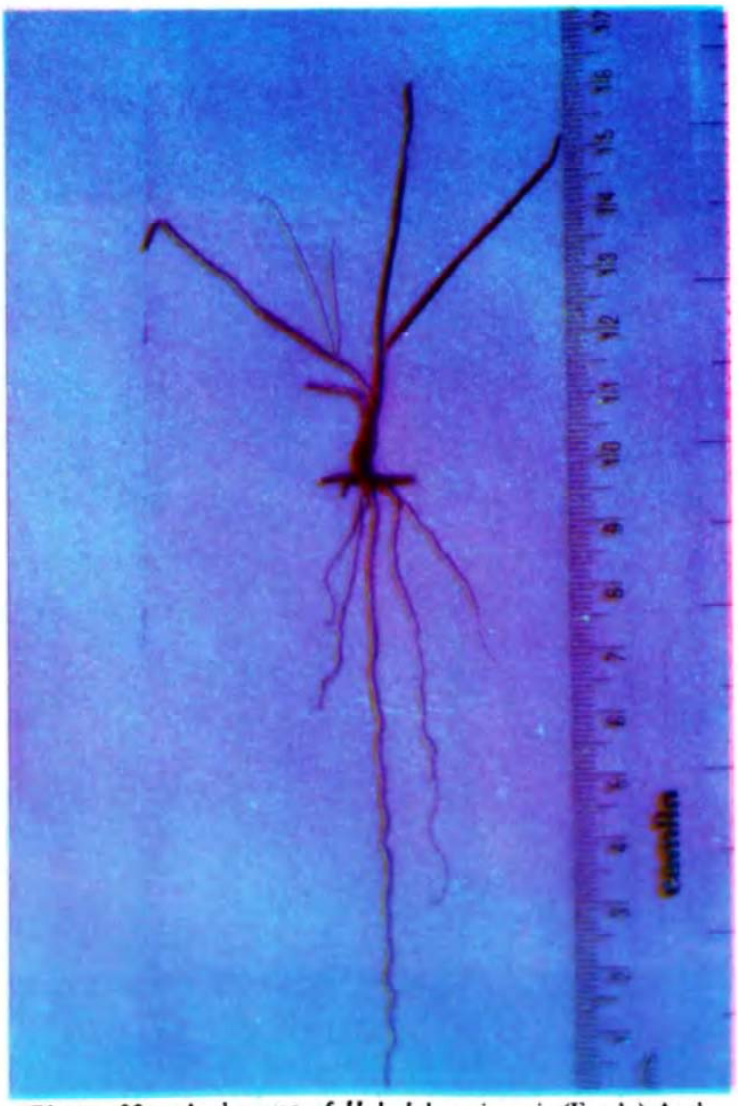

Photo 20 : A close up of *Halodule uninervis* (Forsk.) Asch., showing female flower with 2 stylar branches.

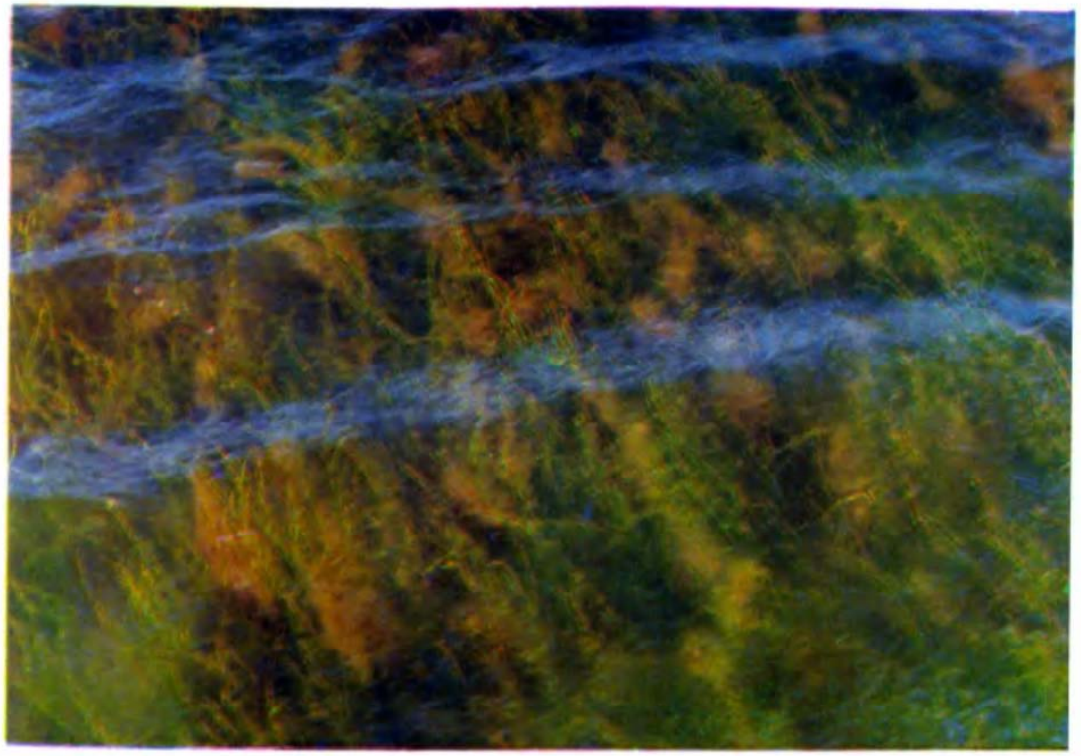

Photo 21 : *Syringodium isoetifolium* (Asch.) Dandy, with epiphytic algae submerged in high-tide near Hare Island, Gulf of mannar, Tuticorin, Tamil Nadu.

Photo 22 : Close up of *Syringodium isoetifolium* (Asch.) Dandy, with female flowers.

Photo 23 : Open sea near Nadar Uvari, Gulf of Mannar, where seagrasses form dense luxurious meadows.

Photo 24 : A view of Krusadai Island, Gulf of Mannar, Tamil Nadu

Photo 25 : Backwaters forming an extensive lake near mouth of river Thamiraparani, Punnakayal, Thiruchendur Coast.

Photo 26 : A view of mangrove forest in Pichavaram lagoon, near Chidambaram, Tamil Nadu.

Photo 27 : Vast stretches of seagrasses fully exposed during low-tide near Thenpakkam backwater in Marakkanam, Tamil Nadu.

Photo 28 : Unique coral substratum near Rameswaram Island : black patches on water surface indicate the presence of seagrasses.

Photo 29 : Rocky substratum near Kanniyakumari Coast, where seagrasses are abundant.

Photo 30 : Sea urchin abiding *Cymodocea serrulata* bed near Pamban, Gulf of Mannar.

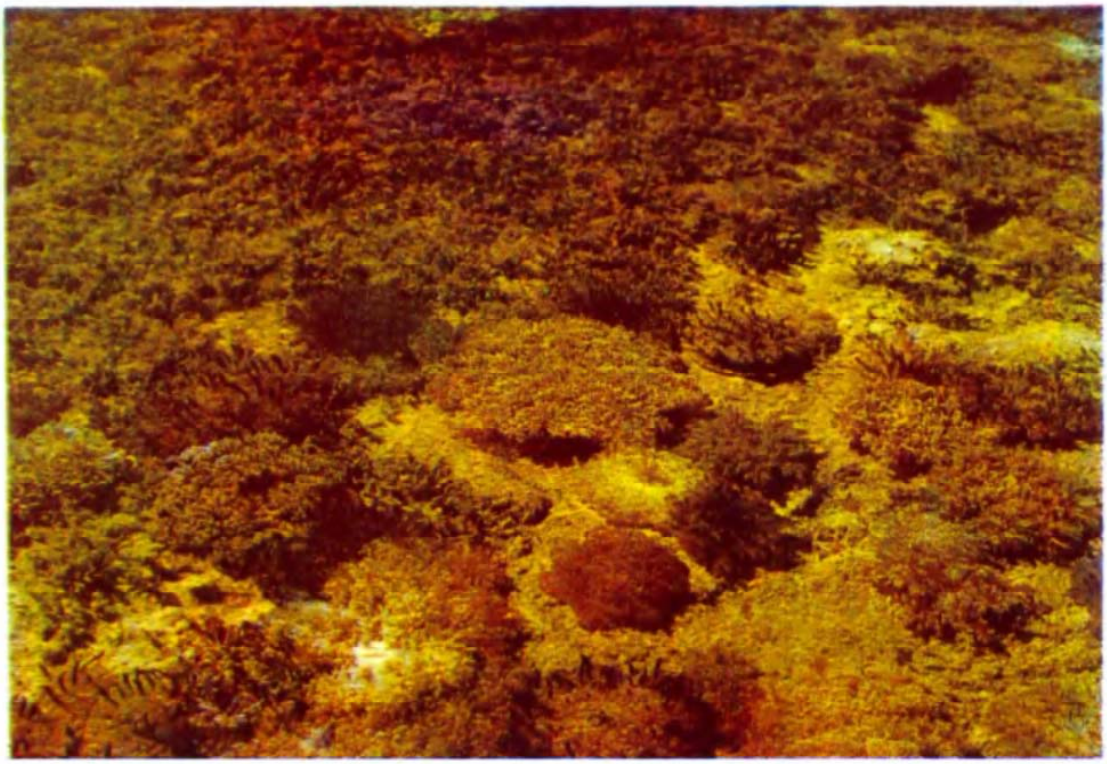

Photo 31 : Sea anemones camouflaged with *Halophila ovata* beds near Hare Island, Tuticorin, Gulf of Mannar.

Photo 32 : Photo showing the domestic and industrial sewage mixing with sea near Tuticorin, posing a serious threat to the habitat of *Halophila decipiens*, a rare species in coromandel coast.

Photo 33 : Seagrasses washed ashore along Tuticorin Coast due to oil spills, industrial wastes and domestic sewages dumped into sea.

Photo 34 : Fishermen spreading fishing nets on seagrass beds near Tuticorin, Gulf of Mannar, Tamil Nadu.