

A note on *Ruppia* species (Ruppiaceae) from the abandoned saltpan in the Gulf of Kutch, India

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Ruppia bed measuring ~ 0.015 km² was observed from the shallow waters in the saltpan. The salinity and temperature of the overlying waters of the bed was 22.7 PSU and 30°C, respectively. Vegetative features, ecological and environmental characteristics, confirmed close resemblance of the genus with *Ruppia rostellata* Koch. However, pollen morphology is suggestive of an ecological adaptation or a new variety of *R. rostellata*. Vegetation remains for the short period (June-October) during monsoon. Annual occurrence of *R. rostellata* bed from the region could be attributed to the reduced salinity and temperature with the onset of monsoon. Epiphytic flora was mostly dominated by species of *Lyngbya* and *Navicula*.

[Keywords: *Ruppia*; Salt pan; Gulf of Kutch; Ecology; Taxonomy]

Introduction

The Gulf of Kutch, Gulf of Khambhat and Rann of Kutch form predominant features along the Northwest coast of India. The Gulf of Kutch (GoK) is characterized by scanty rainfall (414 mm yr⁻¹), and greater thermal (10°C) and tidal (>3.5 m) amplitudes. The intertidal regions are highly influenced with tidal waters having high (>39 PSU) salinity concentration with evaporation exceeding precipitation. In spite of such extreme climatic and ecological conditions, the GoK is recognized for its rich marine biodiversity¹, compared with the Gulf of Khambhat and Rann of Kutch. It is represented by multitiered ecosystem consisting of saltmarshes, mangroves, seagrasses and coral reefs². The plain topography and relatively greater tidal column and amplitude provide extensive stretches of tidally influenced low-lying area. The lower littoral swamps are dominated by mangrove *Avicennia marina* while mid littoral and upper littoral zones mainly harbor obligate halophytes such as *Salicornia brachiata*, *Sueda maritima*, *S. fruticososa*, *S. monoica*, *Sesuvium portulacastrum* and *Arthrocnemum indicum*²

Due to the rapid industrialization the region is constantly monitored by various research organizations in the country for alterations in marine habitats, since the last three decades. During routine environmental impact evaluation of marine

environment, a meadow of submerged angiosperm of *R. rostellata* was observed on 25th October 2005, in the abandoned saltpan from the supralittoral region of Bocha Creek at Mundra, in the GoK. The present investigation describes the taxonomic identification, and relative ecological and environmental characteristics of this species. *Ruppia rostellata* has been observed for the first time from the GoK, and possible reasons of its introduction in the region have discussed in the present document.

Methodology

Water, sediment and vegetative samples were collected on 25th October 2005 from the saltpan regions at Mundra (22° 46' 611" N and 69°42' 227" E), GoK (Fig. 1). Plant specimens were preserved by wet (4% seawater formalin) and dry (herbaria) method, and further investigated for taxonomic identification using relevant literature³⁻⁵. Specimen has been deposited in the Marine Biological Museum and Taxonomy Reference Centre, of National Institute of Oceanography (CSIR), at Goa, India (NIO/DOD/DIO-2680). Water samples were analyzed for salinity using standard techniques⁶ and sediments were dried at room (25°C ± 1°C) temperature and analyzed for granulometry⁷. Measurements of various vegetative features such as height and relevant vegetative and morphological characters, were carried

out on randomly selected plants ($n=20$). Saltpan area was calculated from measuring length and breadth, while vegetation cover was measured by estimating percentage frequency occurrence (%FO) by random ($n=30$) quadrant method⁸. The size of the quadrant used was 25 cm². The epiphytic flora was collected, identified and analyzed as described earlier⁸. The saltpan was also revisited during premonsoon (May, 2008) period to observe vegetation status.

Results and Discussion

Dense monospecific meadow of *R. rostellata* mixed with algae and diatom species existed in the shallow (0.5-1.5 m), sheltered and abandoned saltpan having connectivity to the regular tidal inundation (Plate I-a). The height of the vegetation ranged from 0.5-1 m and covered 70% (% FO=70) of saltpan area (~0.0105 km²). The salinity and temperature of the overlying waters on the bed were 22.7 PSU and 30°C, respectively, while the air temperature was 25°C, at the time of sampling. The substratum mainly composed of sand (45.82%) and gravel (38.75%), and low concentration of silt (11.87%) and clay (3.56%). The epiphytic flora was represented by four species of algae and three species of diatoms.

Ecological and vegetative features (Table 1) confirmed the species belonging to genus *Ruppia*. Though it showed close resemblance with *R. maritima*, the comparative taxonomic accounts (Table 1) mainly fruit, peduncle, achenes and seeds (Plate I-b to h) further confirmed its very close resemblance with *R. rostellata*. However, typical pollen morphology with bulging (Plate I-e) on convex surface of form under investigation, is suggestive of an ecological adaptation or an ecotype or a new variety of *R. rostellata*. However, such morphological characteristic of pollen grain was not reported earlier⁵ in *R. rostellata*, occurring in Rann of Kutch (highly saline) or in *R. maritima* from India. Therefore, the present form calls for further investigations to confirm identification of *R. rostellata* to the variety level. *Ruppia rostellata* is considered⁹ a synonym for *R. maritima*. McCann too identified it as *R. maritima* and later confirmed⁵ the same to be *R. rostellata*. There is a great confusion over taxonomy and synonyms of *Ruppia* sp., because of morphological variations in different geographical regions, and invites for taxonomic study of the genus at global scale using molecular techniques.

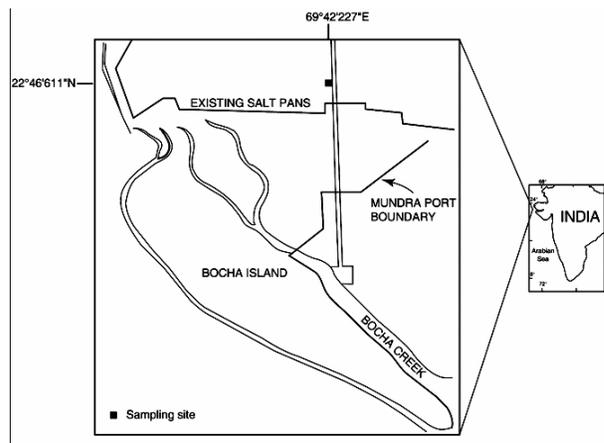


Fig. 1—Map showing the location of the study area in Gulf of Kutch.

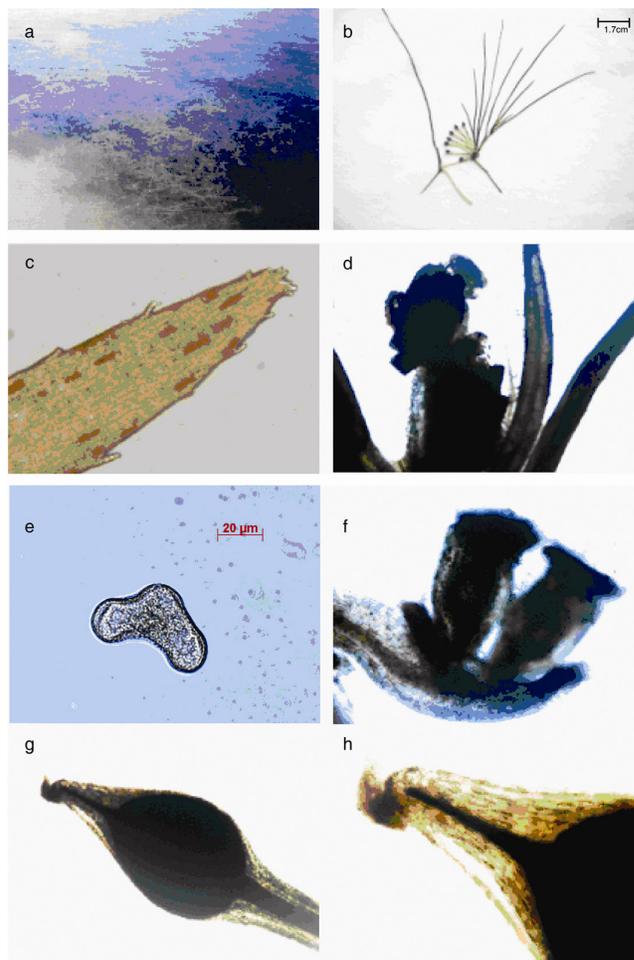


Plate I—Vegetative features of *Ruppia rostellata* Koch: (a) Habit-Submerged bed from saltpan; (b) Portion of the plant showing peduncle and inflorescence; (c) Apical portion of leaf-spiny margins (10 \times); (d) Male inflorescence (4 \times); (e) Pollen grains with bulging; (f) Female florets (10 \times); (g) Fruit (4 \times) and (h) Beak of the fruit (10 \times).

Table 1—Comparative account of vegetative characters of *Ruppia maritima* L. and *R. rostellata* Koch. from India.

Vegetative characters	<i>R. maritima</i> *	<i>R. rostellata</i> **
Fruit	Symmetrical	Asymmetrical
Male floret	2-8	4
Anthers	4, sausage shaped	4, subglobose, not encircling peduncle
Peduncle	Spirally coiling to maturity 90-100 mm long	Short, straight, 7-9 mm long
Stigma	Semi hemispheric	Peltate
Achenes	Obliquely pointed drupe	Beaked
Pollens	Sausage shaped	Sausage shaped bulged on convex surface

Source
*Mc Cann 1978
**Present study

Genus *Ruppia*, commonly known as 'Widgeongrass' or "Ditch grass", is cosmopolitan in distribution. The genus is represented by 28 submerged species (including varieties) in the brackish and alkaline fresh waters^{3,9-14}. It occurs between 69° N to 55° S, and distributed from the sea level to the altitude of 3800 m above sea level. It has wide tolerance for salinity and hence its species are highly variable in their forms (annuals and perennials) depending upon environmental and ecological conditions¹⁵. These meadows serve as excellent feeding grounds for aquatic birds, invertebrates, fishes, turtles, manatee and muskrats^{14,16-19}. Besides sustaining food web, *Ruppia* meadows help in sand binding and minimizing the effect of erosion.

Ruppia maritima L. was commonly reported^{3,4,9} in the late and early periods of eighteenth and nineteenth centuries, respectively, from the tidal marshes around salt works from India. However, patchy distribution of the same was reported to very few localities²⁰ because of habitat loss from various anthropogenic developments. Though found in the marine and estuarine habitats, *R. maritima* is considered to be a fresh water form with wider tolerance for salinity¹⁴. *Ruppia rostellata* Koch. was reported from the central west (Mumbai-Maharashtra coast) and northwest coasts (Gulf of Khambhat and Rann of Kutch) of India^{3,4,9}. It was reported^{5,9} to be perennial and germinate with the onset of the monsoon and continue to grow during the rainy season (June-September).

However, there is no record of *R. rostellata* from the GoK, inspite of intensive studies on flora during recent years^{2,8,20} may be because these observations were mainly confined to the mid and lower littoral zones during pre-monsoon (February-May) and post-monsoon (October-January) periods. *Ruppia maritima* as well as *R. rostellata* are considered to be the most threatened species in the world²¹ mainly due to the habitat loss. *Ruppia rostellata*, appears to be totally vanished from the Indian coast as there were no reports on this particular species during the recent past except from Rann of Kutch⁵. Salt industries in GoK are operational in >400 ha of supra tidal zones. Extreme climate and scanty rainfall cause excessive evaporation favoring the salt production. The salt rich supralittoral zones, particularly, saltpans along the Indian coast commonly harbor *Enteromorpha* sp. (Jagtap, unpublished data). However, standing stock of *Ruppia* during present observations was heavily infested with algal species of *Lyngbya*, *Enteromorpha*, *Rhizoclonium*, and *Aphanocapsa*, and diatoms (*Navicula*, *Triceratium* and *Nitzschia*). *Lyngbya* sp. was the most dominant (%FO=100), while among the diatoms *Navicula* sp. was the most dominant (%FO=100). Maximum rainfall occurred during June to August, marginally reducing the salinity from the saltpans possibly favoring growth of other plants. The most favourable growth²² and development in *Ruppia* occur at temperature range of 20°C-25°C and water salinity of 25 PSU or less^{21,23}. *Ruppia* spp., mostly prefer undisturbed areas having fine textured sediments rich in nutrients and organic matter. Therefore, annual occurrence of *R. rostellata* beds from the region could be attributed to the reduced salinity and temperature from the abandoned saltpans with onset of monsoon. The vegetation remains for the short period (June-October) during monsoon, and the substratum rich in sand and gravel (contributed from anthropogenic activities) favoured the growth. The same saltpan was totally devoid of *Ruppia* vegetation during premonsoon period (May, 2008), further strengthening its germination and growth during monsoon.

The geographical distribution of *Ruppia* is governed by dispersal of fruits, seeds and rhizomes by currents and wind²²⁻²⁵. The Gulf of Kutch is of international importance for conservation of waterfowl²⁶ and other migratory birds (during November-February) from Arctic and Sub Arctic, South Africa, Northwest and South India. Seeds of

R. rostellata might be continuously getting introduced in the region through excreta of migratory birds those that feed on *Ruppia* in their native localities. Hence, salt pans could form potential reserves for *Ruppia* seeds, which have been reported²² to remain dormant upto three years. They could germinate with lowering salinity²⁵ and temperature during the period of monsoon and reaching peak growth during October, as observed during the present study. The absence of *Ruppia* in operational salt pans in the vicinity may be attributed to unfavorable conditions such as higher salinity, the nature of substratum, disturbance, lack of tidal influence and poor water retention capacity.

Ruppia spp., from the Indian coast could be considered as threatened as in other part of the world, mainly due to reduction or total loss of their habitats for extensive urbanization, aquaculture and industrial developments. Therefore, introduction or invasion of salt pans by *R. rostellata* in the GoK is a good sign from the germplasm preservation point of view, and further encourages relevant biological and ecological investigations.

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