The Occurrence of *Ruppia maritima* L. (Ruppiaceae, Tracheophyta) in the Drainage Waters of Yazd Province (Yazd, Iran)

Bijan Mostafazadeh[1], Fereidun Mohebbi[1, 3*], Masoud Seidgar[1], Amir Parnian[2]

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Abstract

Aquatic ecosystems, characterized by their unique water and sediment characteristics, sustain a wide array of life forms, ranging from microscopic plankton to large macrophytes and fish, thereby offering vital essential ecosystem services to mankind. The aquatic plant species *Ruppia maritima* was collected in May 2024, in proximity to Turkan village, located in Harat County, Yazd province, within the central region of Iran . Morphological traits, including leaf color, shape, length, width, and phyllotaxy, were assessed to identify the species. The distribution of this plant is consistently quite low in the central region of Iran. This species is classified within the kingdom Plantae, phylum Tracheophyta, class Angiosperms, order Najadales, family Ruppiaceae and genus *Ruppia*. *R. maritima* is a thread-thin, grasslike annual or perennial herb that grows from a rhizome anchored shallowly in the wet substrate. It produces a long, narrow, straight, or loosely coiled inflorescence tipped with two tiny flowers. The plant frequently undergoes self-pollination; however, its flowers also release pollen that can travel to other plants, carried by bubbles. This species is cosmopolitan in nature, with a global distribution. It is commonly observed in tropical and semi-tropical areas, as well as seasand oceans. This species grows on clay and clay-sandy substrates texture with rhizome or plant's separated parts and is a primary producer in saline water bodies. Moreover, this plant provides suitable shelter for many aquatic life forms' nurseries. Saline municipal wastewater treatment is a challenging environmental issue in coastal cities, due to the discharge of saline water into the sewers. *R. maritima* is a potential species to be used as an organism to treat wastewater in population centers.

Keywords

Widgeon grass, *Ruppia maritima*, Central Iran, Yazd Province

Introduction

Inland waters, as noted by Revenga and Kura, encompass not only freshwater bodies but also brackish and saline environments. These ecosystems are home to a vast array

1-National Artemia Research Center, Iranian Fisheries Science Research Institute, Agricultural Research, Education and Extension Organization, Urmia, Iran
2-National Salinity Research Center (NSRC), Agricultural Research Education and Extension Organization (AREEO), Yazd, Iran.
3- West Azarbaijan Agricultural and Natural Resources Center, Iranian Forests and Rangelands Research Institute, Agricultural Research, Education and Extension Organization, Urmia, Iran
Corresponding author's email address: mohebbi44@gmail.com
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of biodiversity and various aquatic habitats. Regrettably, in recent decades, they have faced significant threats, disturbances, and damage due to human activities (Reis et al., 2017; Flitcroft et al., 2019). Indeed, we occasionally observe the destruction of significant wetlands or aquatic ecosystems before we have the opportunity to identify their inhabitants, which encompass various forms of flora, fauna and microbiota (Troia, 2023).

The aquatic vegetation of inland waters, particularly the plants that thrive in or on the water's surface, remains largely underexplored. This lack of knowledge can be attributed to the tendency of many traditional botanists to limit their studies to the boundary between land and water (Strayer and Dudgeon, 2010).The complexities of biodiversity in aquatic environments is essential for effective conservation and sustainable management practices (Behrenfeld et al., 2009; Marszelewski et al., 2017; Malea et al., 2021; Ji and Ma, 2022). Aquatic ecosystems, charecterized by water and sediment characteristics, support a vast diversity of life forms, ranging from microscopic plankton to macrophytes, crozoobenthos and fish. These ecosystems play crucial role in global biogeochemical cycles and providing essential ecosystem services to humankind (Staniszewski et al., 2024; Cheng et al., 2022; Messyasz et al., 2018; Cole et al., 2013).

Ruppia maritima is an aquatic plant species commonly widely recognized by various names, including beaked tassel weed, beaked ditch grass, ditch grass, tassel pondweed and widgeon grass. Despite its scientific name, it is not a marine plant; it accurately characterized as a salt-tolerant freshwater species. The genus name *Ruppia* was dedicated by Linnaeus to the German botanist *Heinrich Bernhard Ruppius* (1689–1719), while the specific epithet (maritima) means "of the sea" (Dinarvand, 2021; Dinarvand et al., 2022).

R. maritima is a thread-thin, grasslike herb that can be annual or perennial, originating from a rhizome that is shallowly embedded in a wet substrate (Kantrud, 1991). It features as an elongated, narrow in florescence that may be straight or loosely coiled, culminating in two tiny flowers. While the plant frequently self-pollinates, it also disperses pollen that reaches other plants as it carries by bubbles (Dinarvand et al., 2022).

The fruits consist of drupelets, which are dispersed in water and subsequently sink into the digestive systems of fish and waterfowl that consume them. Additionally, the plant can reproduce vegetatively by sprouting from its rhizome, leading to the formation of colonies. *R. maritima* grows in soft sediments in sheltered shallow coastal waters, from full salinity to nearly freshwater but mainly in brackish waters of lagoonal habitats, lochs, estuaries, creeks, and pools in salt marshes, wetlands, ditches, and lakes (Kantrud, 1991).

Materials and methods

Study area

The sampling was conducted in the drainage waters of pistachio orchards situated 20 kilometers from Turkan village, within Harat city, Khatam county, Yazd province, Iran (latitude: 30.188759°,

longitude: 54.309733°). Harat is the center of Khatam County, located in southern most region of Yazd Province between Fars and Kerman Provinces along the Mehriz to Neiriz highway (Fig. 1).

Yazd Province is characterized by a dry and arid climate with an average annual precipitation of approximately 50 mm, predominantly occurring during winter months. The region is marked by high evaporation rates and low humidity, which are defining characteristics of its climate. The highest temperatures are typically recorded in the spring, while the lowest levels of precipitation are reported in autumn. This climate conditins pose significant challenges for water resource management and agriculture practices in Yazd.

Iranian pistachio farmers managed these fields, and some ditches were employed to drain the excessive sub-surface saline water for agricultural purposes (Fig. 2). The ditches vegetation includes *R. maritime* and *Tamarix* sp. The local soil moisture regime is xeric with thermic temperature regime and ochre soil surface horizon (Xerept in USDA soil taxonomy system). In addition, the surface soil had white and brown spots specifically of saline and sodic soils. The salinity of drainage waters was 30 ppt and the temperature was 28.5 °C. The water flow rate was 20-30 l/s with a 30 cm depth. The air temperature was 35 °C.

In May 2024, a shovel was utilized to collect a sample from the plant, which was subsequently placed in a 2-liter sampling plastic bottle and preserved with a 4% formalin solution (4% water based

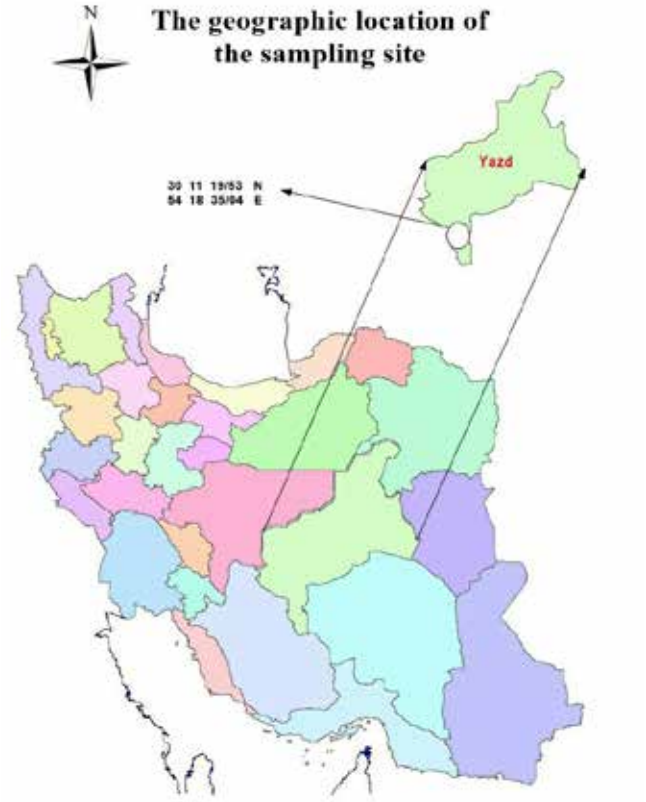

Fig. 1. The geographical location of the sampling site of *R. marritima* in Yazd province (central Iran)

formaldehyde, CH_2O). This sample was then transferred to the West Azarbaijan Agricultural and Natural Resources Research Center Herbarium (WESTA), Urmia, Iran, for examination using an Olympus SZ-CTV stereoscope (Japan). The identification of the plant was conducted according to Flora of Iran (vol. 115), edited by Dinarvand (2017). Morphologic characteristics, including leaf color, shape, length, width and phylotaxis, were measured to determine the species. The voucher specimen for this species is maintained at the WESTA herbarium under the designation number 11070.

Results

Plant morphological characteristics

The leaves are bright green, measuring <1 mm in width, and ranging from 20 to 115 mm in length. They possess an elliptical cross-section with pointed tips that are slightly serrated. Each leaf is supported by membranous sheaths that vary in length from 5 to 22 mm at their base. The plant is anchored in the substrate by a network of fine, slender rhizomes and delicate roots. Flowers and fruits develop on a distinctive coiled stalk known as a peduncle), which can position the flowers either at the water surface or submerged. However, the growth form of the plants highly variable, with some exhibiting long and tall structures in deeper waters, others are characterized by tightly branched, shorter forms in shallow, clear waters. Dwarf varieties have also been observed (Figure 3).

This species was initially reported in the shrimp culture ponds of Gomishan, located along the beaches of the Caspian Sea in Golestan Province, Iran (Gharanjik,2016). Other known habitats of this species in Iran are listed in Table 1.

This species does not have a direct economic application; however, it serves as a habitat for benthic organisms and fish larvae in natural environments. In aquaculture, it frequently behaves as an invasive plant species, necessitating its removal from these ecosystems. The treatment of saline municipal wastewater treatment presents a significant environmental challenge in coastal cities, primarily due to the discharge of saline water into the sewage systems. In the Khuzestan province of Iran, multiple

Fig. 2. Sampling location, Harat County, Yazd province, Iran, May 2024 (photographed by A. Parnian)

phytoremediation attempts utilizing *R. maritima* have been conducted to address both high saline municipal wastewater and boron-contaminated agricultural drainage water. these initiatives not only targeted the specific contaminants but also led to a notable decrease in the salinity of the growth medium (Ahmadi et al., 2017; Parnian et al., 2017 and 2022).

Conclusion

Numerous studies have been conducted on the aquatic plants found in the inland waters of the country (Dinarvand, 2021). However, research on seagrass has been limited. This research represents the first report of *R. maritima* in the aquatic environments of desert ecosystems located in central Iran. Previous studies have already shown its distribution in Pakistan in the east and Khoozestan in the west. Notably, climate change plays a significant role in the species' expansion in Yazd Province by facilitating increased evaporation rates.

Research on seaweeds was notably conducted in the early nineteen century (Gharanjik, 2017). These studies were mostly concentrated on the effects of seaweeds on ecosystems and aquatic animals. The rhizomes extended horizontally through mud and sandy substrates, emerging at intervals to generate new foliage. Seaweed

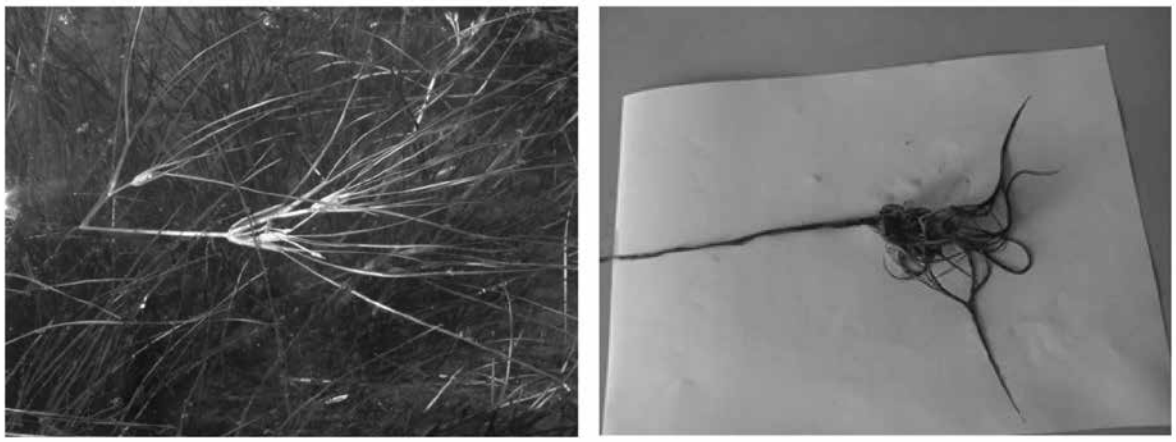

Fig. 3. *R. maritima* in its natural habitat (captured by Parnian and Mohebbi)

Table 1. Additional reported habitat of *R. maritima* in Iran

Province	Collection site
Gorgan	Aji Gol wetland
Zanjan to Hamedan road	120 km to Hamedan
Shiraz	Fasa bridge, Neiriz wetland
Booshehr	Rig Mohammadi to Bido Road, Shoor River, and Persian Gulf intersection
Khuzestan	Ahvaz to Khoramshahr road, 90 km to Khoramshahr, Shadegan Wetland and Hoorolazim Wetland
Razavi Khorasan	Sarakhs, the northern part of Bazangan Lake

plays a crucial role in stabilizing beach soils and sediment deposits (Gharanjik, 2016).

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