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A Taxonomic Revision on Aquatic Vascular Plants in Iran

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In The Name of God

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A Taxonomic Revision on Aquatic Vascular Plants in Iran

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Abstract

Iran covers an area of 1.65 m km^2 in the SW Asia. Based on climatic variation and geobotanical structure, Iran has the most variation and with about 7864 vascular plant species, is the second richest country after Turkey in SW Asia. Aquatic vascular plants with 23 families contain about 1% of Iran's flora. To prepare the aquatic Flora of Iran and review of its vegetation, as a national project of the Research Institute of Forest and Rangelands (Tehran, Iran), 20 aquatic plant families were studied by the authors. Sampling of specimens was carried out from 238 localities of the aquatic plants during 2008–20 from rivers, wetlands, and other aquatic ecosystems of Iran. In recent years including the present project, 14 taxa have been recorded or described from Iran by the authors and their colleagues. In this research, new identification keys to all aquatic taxa in Iran with descriptions of all species based on morphological studies following the APG IV classification system have been presented. Finally, 33 genera, 66 species, one subspecies, two varieties, and two hybrids belonging to 20 families of three classes including floating, submerged, and emerged plants are described from Iran.

Keywords: Floating plant, flora, herbarium, submerged plant, wetland

Introduction

Aquatic plants are the main elements of wetlands with wide range of ecological roles, make a substantial contribution to the structure, function, and service provision of aquatic ecosystems. There are about 183 vascular plant families in the flora of Iran (Zohdi 2022) among which 57 families embrace the aquatic species, while the species of only 21 families (about 37%) are totally true hydrophytes. To prepare the Flora of Iran and to review of its vegetation, as a national project of the Research Institute of Forests and Rangelands (Tehran, Iran), 20 aquatic vascular plant families were studied by the authors. This is noteworthy to mention that, two families of *Menyanthaceae* (with two species) and *Typhaceae* (with 12 species) have already been investigated in Iran (Khatamsaz 1995, Hamdi & Assadi 2003, Saeidi Mehrvarz & Ashouri Nodehi 2016). Since authors did not observe and investigate all plant specimens related to these families, therefore, they have just reffered to plant specimens; but instead, in the present article, the identification key to the genera of their related families are also prepared.

Based on 20 plant aquatic families studied in this research, the aquatic flora of the neighboring countries such as Pakistan (Aziz & Ali 1972, Aziz & Dawar 1972, Ghafoor & Ali 1972, Jafari 1972, Aziz 1974a,b, Ghafoor 1974, 1985, Aziz 1975, Aziz & Jafari 1975, Ghazanfar 1976–77, Ali 1993, Hashemi & Omer 1986–87) found quite similar to Iran, if Iran's wetlands had not been dried up as it is happening now a days, more species would have been expected to be found in the coutry. In the northern parts of Iran (Euro-Siberian region) due to the existence of different wetlands, local dams, and suitable seasonal rains, compared to other regions of the country, the conditions are better for aquatic species. There are many studies on aquatic vascular flora of some parts of Iran such as: 1. The study of the flora of the aquatic habitats in east and west of Mazandaran province by Tavakoli *et al*. (2013), 2. Flora, life forms and chorotypes of plants in Selkeh Lagoon by Zahed *et al.* (2014), 3. Life and growth form of helophytic, hygrophytic and euhydrohytic plants in east and west of Mazandaran by Tavakoli *et al*. (2014), 4. Introduction of a preliminary checklist of vascular aquatic plants of Iran by Yousefi & Toranj (2015), 5. A preliminary introduction to vascular plants of Zayandeh-Rood River by Mohaghegh Tabatabaei *et al*. (2021), and 6. Wetland flora study of Kermanshah province by Khanhasani *et al*. (2021). In addition, the aquatic plants of Iran were studied by Rechinger (1966, 1978, 1990), Casper (1969), Dandy (1971), Riedl (1969, 1976), Podlech (1971), and Schotsman (1976) in the framework of the Flora Iranica project, covering also Afghanistan, and adjacent parts of Pakistan, Iraq, Turkmenistan, and Azerbaijan.

Unfortunately, since numerous wetlands have been dried up, some of the species are landlocked to just a particular wetland (or may include a partial of it). For example, *Nuphar lutea* (L.) Sm. in Sarabe Nilofar of Kermanshah province, *Utricularia minor* L. in Gahar Lake of Lorestan province, and *Nymphaea alba* L. in Zarivar Lake of Kurdistan province (Dinarvand 2017) where they are at high risk of extinction. Aquatic plants contain about 1% of Iran's flora (Dinarvand 2017). Fourteen records including eight genera, one hybrid, and two varieties of aquatic plants as well as one hybrid were introduced for Iran recently, namely, *Ruppia cirrhosa* (Petagna) Grande from Hassanloo wetland of W Azerbaijan and Andica (Dinarvand 2008), *Potamogeton trichoides* Cham. & Schltdl. from Neor of Ardabil (Dinarvand 2008), *Stuchenia filiformis* (Pers.) Borner from Shadegan (Dinarvand 2008, Abbasi *et al*. 2017), *Najas gracillima* (A. Braun ex Engelmn.) Magnus from Abdolkhan of Khuzestan province (Dinarvand 2010), *Lemna perpusilla* Torr (Dinarvand 2010) fom Fars province, *Sparganium emersum* Rehmann and *S. natans* L. (Naqinezhad & Bidarlord 2015) from Ardabil province, *P. schweinfurthii* A. Benn. from Gahar of Lorestan province (Abbasi *et al*. 2017), *P. friesii* Rupr. from Hamid Abad River of Khuzestan province and some other parts of country (Abbasi *et al*. 2015), *Utricularia* × *ochroleuca* R.W.Hartm. from Chalus and *Utricularia australis* R. Br. from North of Iran (Dinarvand 2012), *Zannichellia palustris* L. var. *palustris* (Syn. of *Z. palustris* L.), and *Z. palustris* var. *pedicellata* (Wahlenb. & Rosén) (Syn. of *Z. palustris* subsp. *pedicellata*

(Wahlenb. & Rosén) Hook.f. (Abbasi *et al*. 2019, Abbasi *et al*. 2021), and *P.* × *khuzestanicus* Abbasi, Afsharzadeh & Dinarvand (Abbasi *et al*. 2017).

The purpose of this study was to prepare a new taxonomic account of the 20 aquatic families for Iran; also, the range of species distribution is introduced based on previous and recent comprehensive collections. In this research, a new identification keys to all taxa in Iran together with descriptions of all species based on morphological studies following the APG IV (2016) are also presented. Finally, 33 genera, 66 species, one subspecies, two varieties, and two hybrids belong to 20 families of three classes, *viz*. floating, submerged, and emerged plants are also described from Iran.

Materials and Methods

- Floristic survey

A sampling of specimens was carried out from 238 localities of the aquatic plants during of 2008–20 from Rivers, wetlands, and other aquatic ecosystems of Iran. Collected plants after washing were kept in the laboratory in two forms fixed in 6% formaldehyde and herbarium specimens. All plant samples were labeled precisely for Khuzestan Agricultural and Natural Resources Research and Education herbarium specimens. Specimens were then identified at species, subspecies and variety levels, following relevant floras, mainly "Flora Iranica" (Rechinger 1966, 1978, 1990, Casper 1969, Riedl 1969, 1976, Dandy 1971, Podlech 1971, and Schotsman 1976), "Flora of Iraq" (Critopoulos 1980, Carter 1985, Dandy 1985, Townsend & Evan 1985), "Flora of Turkey and the East Aegean Islands" (Chamberlain 1972, Davis *et al.* 1972, Davis *et al.* 1978, 1982, 1984, Uotila 1984a,b), "Flora Palestina" (Zohary 1966, 1972, 1978, 1986), "Flora Europaea" (Tutin 1964, 1968, Webb 1964, Cook 1968a,b, 1980, Taylor 1972, Schotsman 1972, Dandy 1980, Lawalree 1980, Webb 1980), "Flora of West Pakistan" (Ghafoor & Ali 1972, Aziz & Dawar 1972, Aziz & Ali 1972, Jafari 1972, Aziz 1974, 1975, Aziz & Jafari 1975, Ghazanfar 1976–77, Ghafoor 1974, 1985, Hashemi & Omer 1986–87, Ali 1993), "Flora de l´Iran" (Parsa 1950–51), "Flora of the U.S.S.R" (Kuzeneva 1935, Komarov 1937, Shteinberg 1955, Kuzeneva 1964, Fedchenk 1968, Yuzepchuk 1968), "Flora Orientalis" (Boissieri 1881), "Flora of the Kingdom of Saudi Arabia" (Chaudhary 2001), and "The genus *Utricularia*: a taxonomic monograph" (Taylor 1989).

In addition, specimens of the Center, and National Herbarium of Iran including Research Institute of Forests and Rangelands (TARI), Herbarium of the Ministerii Iranici Agriculturae (IRAN), Herbarium of The University of Tehran (TUH), Herbarium of the Khuzestan Agricultural and Natural Resources Research and Education, Herbarium of The University of Ferdowsi Mashhad (FUMH), Herbarium of the University of Shiraz, and Herbarium of the University of Mazandaran were also identified and reviewed. Species descriptions and keys were provided based on morphological observations and measurements.

- Study area

Based on vegetation condition, climatic variation, and geobotanical structure, Iran is the most diverse and interesting country in SW of Asia (Zohary 1963, Frey & Probest 1986). About 7834 vascular plant species (Akhani 2006, Govaerts 2001, Zohdi 2022) is in a 1.65 m km^2 surface area, so Iran is the second richest country after Turkey in SW Asia (Davis *et al.* 1994). Besides, Iran, despite being in the arid and semi-arid belt of the world has a variety of microclimates (Modarres *et al*. 2007). More than 85% of the total 1.6 m km^2 area of the country is dryland and steppe (Karandish & Mousavi 2018) with rainfall averages ~ 2000 mm/yr in the northern and western parts, and ~ 120 mm/yr in central and eastern areas. Temperature extremes can range from −20 to 50 °C in the Northwest to South, respectively (Eskandari Dameneh *et al.* 2021). Climatic diversity, Zagros and Elburz Mountain chains, the existence of two vast seas in the north

and south of the country, and wide expansion of geological formations of the third geological period, are often saline, causing different types of wetlands from Mangrove forests and coral reefs to mountaineous lakes and desert saline plains (Heshmati 2007). Out of 42 types of wetlands identified by the Ramsar Convention, except one type of wetland (Tundra), 41 types are found in Iran, which indicates a great variety of Iranian wetlands. The location and names of 22 Ramsar sites as well as 24 international wetlands that visited by the authors are shown in figures 1 & 2. In table 1, some of the main locations are introduced that recently have been visited by the authors. It should be noted that, some of these wetlands lacked aquatic plant samples.

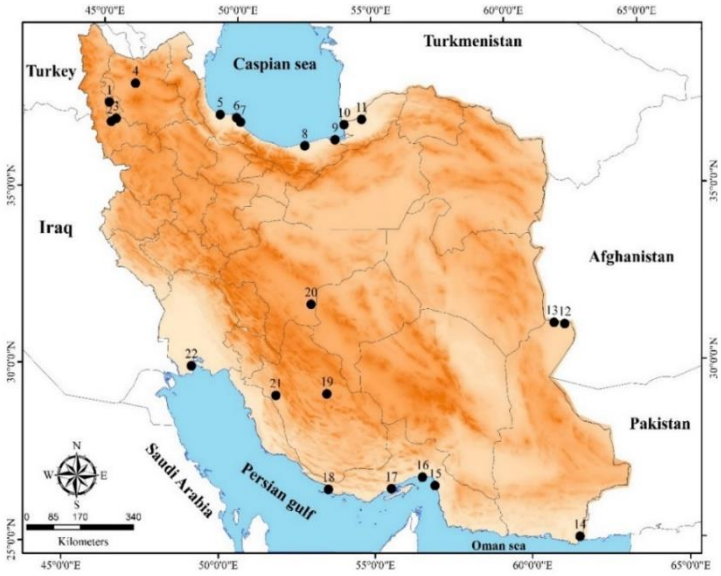

Fig. 1. Map of Iran in the Middle East, the points shows the position of wetland based on Ramsar Convention (1. Urmia, 2. Yadegarloo, 3. Ghopi, 4. Ghori Gol, 5. Anzali, 6. Kiashahr, 7. Amir Kalayeh, 8. Fereydon Kenar, 9. Miankaleh, 10. Gomishan, 11. Alagol, Ajigol, and Almagol, 12. Hamoon Posak, 13. Hamoon Saberi, 14. Govatr Gulf, 15. Gaz and Hara Rivers, 16. Shoor and Shirin River, Minab, 17. Khor Khoran, 18. Shidvar Island, 19. Nayriz and Komjan, 20. Gavkhooni, 21. Parishan & Arzhan, 22. Shadegan).

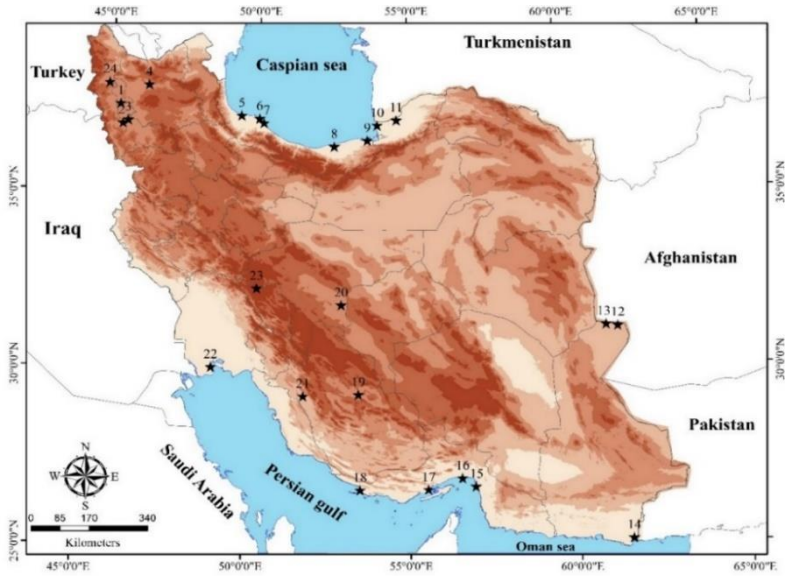

Fig. 2. Map of Iran in the Middle East, the points shows the position of international wetlands (1. Kanibrazan, 2. Yadegarloo, 3. Ghopi, 4. Ghoorigol, 5. Anzali, 6. Kiashahr, 7. Amir Kalayeh, 8. Fereydon Kenar, 9. Miankaleh, 10. Gomishan, 11. Alagol, Ajigol, and Almagol, 12. Hamoon Posak, 13. Hamoon Saberi, 14. Govatr Gulf, 15. Gaz and Hara Rivers, 16. Shoor River, Minab, 17. Khor Khoran, 18. Shidvar Island, 19. Nayriz and Komjan, 20. Gavkhooni, 21. Parishan and Arzhan, 22. Shadegan, 23. Choghakhor, 24. Urmia).

Table 1. List of some of wetlands from which plant samples were collected by the authors in Iran (Ramsar Con.: Ramsar Convention, W. Qua: water quality, Geo. of Iran: Geography position in Iran, F: Freshwater, S: Salty, M: Marine, B: Brackish)

Wetland	Ramsar Con.	W. qua	Province	Geo. of Iran
Abzalo		F	Khuzestan	Southwest
Alagol, Almagol, and Ajigol	*	S	Golestan	Northeast
Amir Kelayeh	*	F	Gilan	North
Anzali	*	F	Gilan	North
Avan Lake		F	Ghazvin	Center
Bakhtegan		S	Fars	Center
Bamdezh		F	Khuzestan	Southwest
Bandar Abbas Seaside		M	Hormozgan	South
Chabahar Gulf		M	Sistan va Balochestan	Southeast
Choghakhor	*	F	Chahar Mahal-o-Bakhtiari	Center
Ferydon Kenar	*	F	Mazandaran	North
Gahar Lake		F	Lorestan	Center
Gavkhooni	*	B	Esfahan	Center
Ghoorigol	*	F	E Azarbayjan	Northwest
Gomishan	*	S	Golestan	Northeast
Gorgan Gulf	*	S	Golestan	Northeast
Govatr Gulf	*	M	Sistan va Balochestan	Southeast
Hamoon	*	M	Sistan va Balochestan	Southeast
Hashilan		F	Kermanshah	West
Hassanloo		S	W Azarbayjan	Northwest
Havir Lake		F	Tehran	Center
Hele		M	Bushehr	South
Hoor Al Azim		B	Khuzestan	Southwest
Hormoz Island		M	Hormozgan	West
Kaftar		F	Fars	Center
Kanibrazan	*	S	W Azarbayjan	Northwest
Khor Mosa		M	Khuzestan	Southwest
Lefone wetland		F	Lorestan	Center
Miangaran		F	Khuzestan	Southwest
Miankaleh	*	S	Mazandaran	North
Minab (Korahi, Tiab)	*	M	Hormozgan	South
Neyriz	*	F	Fars	Center
Neour Lake		F	Ardebil	Northwest
Parishan	*	B	Fars	Center
Sarabe Nilofar		F	Kermanshah	West
Shadegan	*	B	Khuzestan	Southwest
Shirinsoo		F	Hamadan	Center
Siah Darvishan		F	Gilan	North
Siahkashim		F	Gilan	North
Soldoz		S	Khuzestan	Southwest
Stil		F	Gilan	North
Tar Lake		F	Tehran	Center
Tembi Lake		F	Khuzestan	Southwest
Valasht		F	Gilan	North
Yadegarloo	*	S	W Azarbayjan	Northwest
Zarivar	*	F	Kordestan	West

Results

To prepare the aquatic flora of Iran and review of its vegetation, as a national project of the Research Institute of Forest and Rangelands (Tehran, Iran), the total number of 66 species, one subspecies, two varieties, and two hybrids belonging to 33 genera and 20 plant families were identified. Submerged plants (45%) and emerged (16%) are the dominant life forms. Besides, 12% and 7% of the species are submerged-leaf floating and emerged or submerged-leaf floating, respectively (Fig. 3).

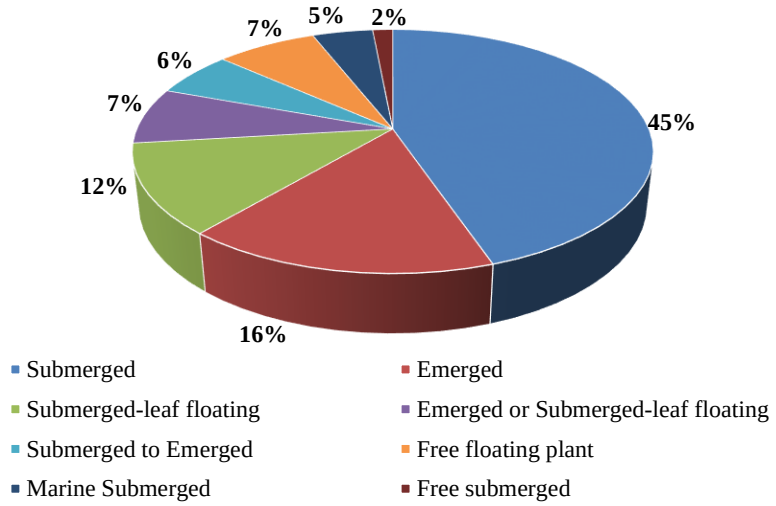

Fig. 3. The life-form spectrum of the flora of 21 families in Iran.

- Taxonomic treatment

Key to the aquatic genera in Iran

1. Plant with large body……. 4
1. Plant in millimeter size and plate form…….. 2
2. Plant without roots and less than 1 mm diam. (fresh water)……. *Wolffia*
2. Rooted plant and more than 1 mm in diam……. 3
3. Frond obovate or pear-shaped, with numerous roots (fresh water)…….. *Spirodela*
3. Frond with different shape but not obovate or pear-shaped, with single root……. *Lemna*
4. Leaves rosulate……. 5
4. Leaves cauline or verticillate…... 11
5. Leaves sheathless, lamina reniform or cordate (fresh water)…... *Hydrocharis*
5. Leaves sheathed. Lamina with different shape……. 6
6. Lamina trifoliolate (fresh water)……. *Menyanthes*
6. Lamina simple……. 7
7. Flowers unisexual, male and female flowers on separate pedicel (fresh water)…... *Vallisneria*
7. Flowers bisexual. Inflorescence raceme or umbellate..…….. 8
8. Inflorescence umbellate (fresh water)……. *Butomus*
8. Inflorescence raceme……. 9
9. Leaves rush-like, linear-subulate (fresh water)……. *Triglochin*
9. Leaves flat, not rush-like nor linear-subulate……. 10
10. Leaves sagitatte (fresh water)…….. *Sagittaria*
10. Leaves ovate, elliptic or lanceolate……. 12
11. Fruits schizocarp, carpels elliptic (fresh water)…….. *Alsma*
11. Fruits multi-carpel, stellate (fresh water)…….. *Damasonium*
12. Plant stemless...…….. 13
12. Plant with obvious stem..…….. 19
13. Leaves alternate, rosulate. Rhizome abscent (fresh water)…... *Trapa*

13. Leaves basal, arising from rhizome…… 14
14. Leaves elliptic. Rhizome white and transparent (marine)…… *Halophila*
14. Leaves rounded, peltate or cordate. Rhizome brown or black…… 15
15. Inflorescence raceme (fresh water)…… *Monochoria*
15. Flowers solitary...…… 16
16. Leaves peltate. Corolla pink (fresh water)…… *Nelumbo*
16. Leaves cordate. Corolla white or yellow…… 17
17. Stamens 5 (fresh water)…… *Nymphoides*
17. Stamens many...…… 18
18. Flower floating. Leaves suborbicular or cordate. Corolla white (fresh water)…… *Nymphaea*
18. Flower submerged. Leaves elliptic. Corolla yellow (fresh water)…… *Nuphar*
19. Leaves diplostichous; with imbricated sheaths…… 20
19. Leaves alternate or verticillate...…… 23
20. Plant more than 50 cm hight. Stem cylindrical…… 21
20. Plant less than 30 cm hight. Stem articulated.…… 22
21. Inflorescence a simple globose head (fresh water)…… *Sparganium*
21. Inflorescence cylindric (fresh water)…… *Typha*
22. Leaves 7-8 mm wide, denticulate; apex rounded and ciliated. Rhizome woody (marine)…… *Thalassodendron*
22. Leaves less than 1 mm wide, entire; apex dentate. Rhizome herbal (marine)…… *Halodule*
23. Leaves verticillate…… 24
23. Leaves opposite or alternate…… 27
24. Leaves simple, linear or lanceolate...…… 25
24. Leaves pinnatifid or dichotomously divided.…… 26
25. Leaves in whorls of 3-5; denticulate and ciliated (fresh water)…… *Hydrilla*
25. Leaves in whorls of 9; entire, rounded at tip...…… *Hippuris*
26. Flowers solitary; perianths with 14 segments. Leaves dichotomously divided (fresh water)..... *Ceratophyllum*
26. Inflorescence verticillate spike; perianths with 4 segments. Leaves pinnatisect with capillary segments (fresh water)…… *Myriophyllum*
27. Leaves opposite...…… 28
27. Leaves alternate…… 32
28. Leaves entire at margin…… 29
28. Leaves denticulate at margin.…… 30
29. Fruits schizocarps. Leaves linear (less than 3 cm long) or obovate (fresh water)…… *Callitriche*
29. Fruits serrated nut of sickle shape. Leaves linear (3-8 cm long) (fresh and brackish water)…… *Zannichellia*
30. Inflorescence spike. Leaves crispate at margin (fresh water)…… *Groenlandia*
30. Flowers solitary or verticillate whorls. Leaves smooth at margin.…… 31
31. Flowers bisexual. Stamens 8-10. Leaves without sheath (fresh water)…… *Bergia*
31. Flowers unisexual. Stamen solitary. Leaves with obvious sheath…… *Najas*
32. Fruits capsule (fresh water)…… 33
32. Fruits drupaceous or achenial.…… 34
33. Plant insecticide. Leaves bearing small bladders. Inflorescence raceme (fresh water)…… *Utricularia*
33. Plant not insecticide. Inflorescence spike (fresh water)…… *Sphenoclea*
34. Fruits with a long pedicel. Seed conical (fresh and brackish water)…… *Ruppia*
34. Fruits without pedicel. Seed spherical (fresh and brackish water)…… 35
35. Submerged leaves with stipules free from leaf base (fresh and brackish water).…… *Potamogeton*
35. Submerged leaves with stipules adnate to leaf base for at least 2/3 of length of stipule (fresh and brackish water)…… *Stuckenia*

Potamogetonaceae

Key to the genera in Iran

1. Leaves opposite. Inflorescence mostly axillary. Fruits nut...…… 2
1. Leaves alternate. Inflorescence terminal. Fruits drupaceous…… 3
2. Leaves linear or filiform, 0.3-1 mm wide. Fruits serrated nut of sickle shape…… *Zannichellia*
2. Leaves lanceolate or ovate, 4-10 mm wide. Fruits elliptic nut, not serrated…… *Groenlandia*
3. Submerged leaves with stipules free from leaf base…… *Potamogeton*
3. Submerged leaves with stipules adnate to leaf base for at least 2/3 of length of stipule…… *Stuckenia*

Potamogeton L. (Dinarvand 2017)

Key to the species in Iran

1. Leaves monomorphic, all submerged..... 2
1. Leaves dimorphic, submerged and floating..... 8
2. Submerged leaves linear..... 3
2. Submerged leaves broadly oblong, lanceolate, ovate-oblong or elliptical..... 6
3. Stipules open at base, convolute. Nodes with two obvious nodal glands..... 4
3. Stipules connate at base. Nodes without obvious nodal glands..... 5
4. Carpels 4. Leaves 3-veined; with a broad row of lacunae cells along the midrib, leaf apex acuminate..... *P. berchtoldii*
4. Carpels 1. Leaves (1-)3-veined; without a row of cells along the midrib, leaf apex acute..... *P. trichoides*
5. Leaves green, 1 mm wide; 3-veined..... *P. pusillus*
5. Leaves brownish to reddish, 2.5-3.5 mm wide; (3-)5(-7)-veined..... *P. friesii*
6. Leaves serrate and crispate at margin..... *P. crispus*
6. Leaves entire or minutely denticulate at margin..... 7
7. Leaves clasping the stem; sessile, ovate or ovate-oblong..... *P. perfoliatus*
7. Leaves not clasping the stem; shortly petiolate, lanceolate to oblong-lanceolate..... *P. lucens*
8. Floating leaves with a flexible joint and distinct angle at the top of the petiole..... *P. natans*
8. Floating leaves without joint..... 9
9. Submerged leaves with long petiolate..... *P. nodosus*
9. Submerged leaves sessile..... 10
10. Submerged leaves denticulate. Stem repeatedly branched..... *P. gramineus*
10. Submerged leaves entier. Stem unbranched..... *P. schweinfurthii*

Description of species

P. natans L.

Submerged plant with floating leaves. Rhizome and stem robust. Leaves dimorphic, submerged leaves phyllodial, 100-600 mm long, 0.5-3.5 mm wide, acute at apex, straight at base, 1-3 veined, floating leaves with a flexible joint and distinct angle at the top of the petiole, lamina oblong-lanceolate to elliptic, 50-90 mm long, 15-40 mm wide, obtuse at apex, rounded or subcordate at base, petiole 4-10 cm long, with a flexible discolored joint and a distinct angle at the top, stipules free, linear-lanceolate, 5-8 cm long, membranous, persistent. Spike 2.5-3.5 cm long, peduncle 7-8.5 cm long. Tepals 4, 1-2 mm long. Anthers 1 mm long. Carpels fruits obovoid, 3-4 mm long, indistinctly keeled.

Flowering time: Spring to summer.

World distribution: W Asia (Iran, Afghanistan, Pakistan, Turkey), temperate and arctic regions of Europe, Africa and N. America.

Distribution in Iran: North, West.

Specimens examined: Iran: Golestan province: Northwest of national park of Golestan, Sologoli Lake, 1349 m, Akhani 17050 (TUH!); Lorestan province: Gahar Lake: 2350 m, Dinarvand & Mohammadi 8761 (Khuzestan Herbarium!).

P. nodosus Poir. (Fig. 4a)

Submerged plant with floating leaves, rhizomatous. Stem branched. Leaves dimorphic, submerged leaves laceolate to elliptic, petiole 2.5-10 cm, lamina 9-20 cm long, 2-4 cm wide, obtuse at apex, cuneate at base, 7-veined, floating leaves 12-55 cm long, 1.5-4 cm wide, 20-veined, obtuse to acute at apex, petiole 7-20 cm long, stipules free, lanceolate, 3-7.5 cm long, membranacous. Spike 1.5-5.5 cm long, peduncle 4.5-10.5 cm long. Tepals 4, 1 mm long, anthers 1 mm long. Carpels 4, fruits elliptic, 2.5-4 mm long.

Flowering time: Winter to autumn.

Worldwide distribution: Subcosmopolitan, W Asia (Iran, Afghanistan, Pakistan, Iraq), temperate and tropical Asia, Europe, Africa, Australia, Pacific islands, North America, N and C South America.

Distribution in Iran: North, Northwest, West, Center, Northeast, South.

Specimens examined: Iran: Mazandaran province: Road of Chalos to Nowshahr, 8 m, Dinarvand & Mohammadi 8772 (Khuzestan Herbarium!), Ghaemshahr, Shahpour bridge, before Shirgah, 160 m, Dinarvand & Mohammadi 8813 (Khuzestan Herbarium!); Gilan province: Astaneh, Sefid-Rood River, Dinarvand 8813 (Khuzestan Herbarium!), Anzali wetland, Mozaffarian & Maassoumi 65262 (TARI!); W Azerbayjan province: South of Urmia Lake, Zarineh-Rood River, 1300 m, Assadi & Akhani 61338 (TARI!); Kurdistan province: 78 km from Pveh to Kermanshah, between Cheshme Kaboud and Kor, 1380 m, Runemark & Mozaffarian 27469 (TARI!), Palangan, 1800-2100 m, Iranshahr & Terme, s.n. (IRAN!); Kermanshah province: Gilan Gharb, Behboudi 33920 (IRAN!); Ilam province: Islam Abad road, Seymareh River, Dinarvand & Mohammadi 8285 (Khuzestan Herbarium!); Lorestan province: Pole Dokhtar, Lefone wetland Dinarvand & Mohammadi 8710 (Khuzestan Herbarium!); Kohgiloye and Boyer-Ahmad province: Yasouj, Morgah to Dashte Eoom, 2120 m, Dinarvand & Mohammadi 8658 (Khuzestan Herbarium!); Fars province: Beyza to Banesh, Kamfirooz, 1660 m, Dinarvand & Mohammadi 8673 (Khuzestan Herbarium!); Khuzestan province: Shushtar, Gotvand to Aghili, Mandli, Dinarvand 8129 (Khuzestan Herbarium!), Ahvaz to Shushtar, after Arab Asad village, Karoon River, Dinarvand 8143 (Khuzestan Herbarium!), Karoon River, Dinarvand & Mohammadi 8264 (Khuzestan Herbarium!), Dezful, Hamid Abad, Dez River Dinarvand 8341 (Khuzestan Herbarium!); Kerman province: Jiroft, Mohammad Abad, Abe Garm, 2300 m, Iranshahr & Terme, s.n. (IRAN!); Sistan va Baluchestan province: 130 km from Iranshar to Rask, 680 m, Assadi & Sardabi, 22545 (TARI!).

P. lucens L.

Submerged plant. Rhizomatous. Stem branched. Leaves monomorphic, laceolate to elliptic, translucent, dentate at margin, subsessile to shortly petiolate, lamina 5-18 cm long, 2-2.5 cm wide, acuminate at apex, 9-11-veined, stipules free, lanceolate, 3.5-8 cm long, membranacous. Spike 2-7 cm long, peduncle 6-14 cm long, considerably thickened at the top. Tepals 4, 1-2 mm long, anthers 1 mm long. Carpels 4, fruits elliptic, 2.5-3 mm long.

Flowering time: Spring to summer.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Iraq, Palestine), Central Asia, Siberia, Europe, N Africa.

Distribution in Iran: North, West, Center, South, Southeast.

Specimens examined: Iran: Mazandaran province: Feridonkenar, Azbaran village, 5 m, Dinarvand & Mohammadi 8792 (Khuzestan Herbarium!), Nowshahr, Iranshah 33917 (IRAN!); Gilan province: Anzali wetland, Mozaffarian & Maassoumi 6914 (TARI!); Kermanshah province: Paveh to Kermanshah, Between Cheshme Kabood and Kor, 1380 m, Runemark & Mozaffarian 27465 (TARI!), Ravansar, Hashillan wetland,1320 m, Dinarvand & Mohammadi 8286 (Khuzestan Herbarium!); Lorestan province: Dorood, Gahar Lake, 2350 m, Dinarvand & Mohammadi 8756 (Khuzestan Herbarium!); Khuzestan province: Andica, Abzalo wetland, Dinarvand & Mohammadi 8548 (Khuzestan Herbarium!), Hor-Al Azim, Howeizeh 4512 (Khuzestan Herbarium!); Sistan va Baluchestan province: Hamon Lake, Sharif 33915 (IRAN!); Tehran province: Havir Lake, Dinarvand & Mohammadi 8811 (Khuzestan Herbarium!); Ghazvin province: Dictin village, Avan Lake, 1820 m, Dinarvand & Mohammadi 8818 (Khuzestan Herbarium!).

P. gramineus L.

Submerged plant with floating leaves. Rhizomatous, stem slender, repeatedly branched. Leaves dimorphic, submerged leaves elliptic or elliptic-oblong to oblanceolate-oblong, translucent, minutely denticulate at margin, acute or acuminate, lamina 35-90 mm long, 2-5 mm wide, sessile, acute at apex, cuneate at base, minutely denticulate at margin, 3-7 veined, floating leaves elliptic or ovate-elliptic, lamina 5 cm long, 2 cm wide, 7-12 veined, Petiole 7-20 mm long, stipules free, 6 mm long. Spike 2.5-3.5 mm long, peduncle 2-3 cm long, strongly thickened. Carpels 4, fruits 2.5 mm long
Flowering time: Summer.
Worldwide distribution: W Asia (Iran, Turkey, Pakistan), Temperate and arctic regions of Europe, N. America.
Distribution in Iran: Southwest.
Specimens examined: Iran: Khuzestan province: Andica, Shimbar wetland, 850 m, Afsharzadeh 20215 (HUI!).

P. schweinfurthii A. Benn.

Submerged plant with floating leaves. Rhizome slender. Stem slender to robust, unbranched or sparingly branched. Leaves dimorphic, submerged leaves membranous, sessile, lamina narrowly lanceolate, 70-120 mm long, 5-7 mm wide, acute to mucronate at apex, generally 7(-9) veined, floating leaves petiolate, often absent, oblong to elliptical or ovate, 43-130 mm long, 10-20 mm wide, 2-6 times as long as wide, yellow-green or dark green, with a reddish tinge, 11-21-veined, cuneate to rounded at base, obtuse to acute at apex, petiole 4-7 cm long. Spike 2.5-3.5 cm long, peduncle 2.5-3.5 cm long. Tepals 1 mm, anthers 0.8-0.9 mm long. Carpels 4, fruits 3 mm long.
Flowering time: Summer.
Worldwide distribution: W Asia (Iran), S Europe, the Azores, Africa, Madagascar, Mascarene Islands, Mediterranean**.**
Distribution in Iran: West.
Specimens examined: Iran: Ardabil province: Ardabil to Khalkhal, Neour Lake, 1450 m, Zehzad, Jamzad, Izadpanah & Taheri 70524 (TARI!); Lorestan province: Dorood, Gahar Lake, 2350 m, Dinarvand & Mohammadi 8760 (Khuzestan Herbarium!).

P. perfoliatus L.

Submerged plant. Rhizome and Stem slender. Leaves monomorphic, lamina ovate or elliptic, sessile, cordate at base, clasping the stem, minutely denticulate at margin, at least in juvenile state, 15-45 mm long, 9-20 mm wide, 7-15 veined, obtuse to retuse at apex, stipules free, lanceolate, 6-7 mm long, membranacous. Spike 5-15 mm long, peduncle 1-4.5 cm long. Tepals 4, 1-2 mm long, anthers 1 mm long, carpels 4, fruits elliptic, 2.5-3 mm long.
Flowering time: Spring to autumn.
Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Iraq, Palestine), Siberia, Europe, Africa, America.
Distribution in Iran: North, Center, Northeast, South, Southeast.
Specimens examined: Iran: Mazandaran province: Sari, Tajan River, 50 m, Dinarvand & Mohammadi 8282 (Khuzestan Herbarium!), 20 km to Chalos, Valasht Lake, Dinarvand & Mohammadi 8769 (Khuzestan Herbarium!); W Azerbayjan province: South of Urmia Lake, Somleh River, 1300 m, Assadi & Akhani 61339 (TARI!); Chahar Mahale Bakhtiari province : Shahre Kord, Esfandiari 33925 (IRAN!); Fars province: Dashte Arzhan wetland, 1800 m, Zehzad & Taheri 67053 (TARI!); Khuzestan province: Ahvaz, Karoon River, 4 m, Dinarvand & Mohammadi 8263 (Khuzestan Herbarium!), Dezful, Hamid Abad village, Dez River, Dinarvand 8337 (Khuzestan Herbarium!), Shush, Haft Tapeh, Dinarvand 8085 (Khuzestan Herbarium!), Bostan to Chazabe, Dinarvand 8271 (Khuzestan Herbarium!), Andimeshk,

Pole Naderi, Karkhe River, Dinarvand 8106 (Khuzestan Herbarium!); Sistan va Baluchestan province: Hamon wetland, Sharif 33927 (IRAN!); Khorasan province: Khavaf, Band Salami, 1250 m, Joharchi & Zangoee 21136 (FUMH!).

P. pusillus L. (Fig. 4b)

Submerged plant. Rhizome and stem filiforme. Leaves monomorphic, sessile, green, linear, 20-30 mm long, 1 mm wide, 3-veined, entire, acute to acuminate at apex, Stipules connate at base, membranacous, lanceolate, 4-5 mm long. Spike 4-5 mm long, peduncle 4-5 mm long. Tepals spathulate, 0.8-1 mm long, anthers 0.5 mm long, Carpels 4, 0.8-1 mm long, fruits 2 mm long.

Flowering time: Spring to autumn.

Worldwide distribution: W Asia (Iran, Afghanistan, Pakistan, Iraq), C Asia, Siberia, Europe, Africa and South America.

Distribution in Iran: North, West, South and Southeast.

Specimens examined: Iran: Gillan province: Rasht to Foman, 50 m, Runemark & Assdi 22146 (TARI!); E Azerbayjan province: Tabriz to Bostan Abad, Ghori Gol Lake, 1920 m, Dinarvand & Mohammadi 8313 (Khuzestan Herbarium!), Road of Sarab, 60 km to Sarab, Shahinsara village, Dinarvand & Mohammadi 8318 (Khuzestan Herbarium!); Hamadan province: Zanjan to Hamadan, Shirinso wetland, 120 m, Dinarvand & Mohammadi 8325 (Khuzestan Herbarium!); Khuzestan province: Andica, Abzalo wetland, 730 m, Dinarvand & Mohammadi 8554 (Khuzestan Herbarium!), Ahvaz, Karoon River, Dinarvand & Mohammadi 8261 (Khuzestan Herbarium!), Khoramshahr, Arvand River, Dinarvand 8064 (Khuzestan Herbarium!), Shushtar, Arab Hassan village, Dinarvand 8137 (Khuzestan Herbarium!), Dezdul, Hamid Abad village, Dez River, Dinarvand 8334 (Khuzestan Herbarium!), Andimeshk, Pole Naderi, Karkhe River, Dinarvand 8063 (Khuzestan Herbarium!); Sistan va Baluchestan province: Hamon wetland, Sharif 33929 (IRAN!).

P. friesii Rupr.

Submerged plant. Rhizome and stem filiforme. Leaves monomorphic, sessile, green, linear, 30-50 mm long, 1-2.5 mm wide, (3-)5-7-veined, entire, acuminate at apex, stipules connate at base, membranacous, 7-9 mm long, fibrous, splitting into two parts when mature. Spike 7-9 mm long, peduncle 15-20 mm long. Tepals 1 mm long, anthers 0.8-0.9 mm long, carpels 4, fruits 2 mm long.

Flowering time: Spring to autumn.

Worldwide distribution: W Asia (Iran), Siberia, Europe.

Distribution in Iran: West, Center.

Specimens examined: Iran: Gilan province: Astara, Plasi village, Dinarvand 8230 (Khuzestan Herbarium!); Isfahan province: Deemeh spring, 2133 m, Afsharzadeh & Abassi 19635 (HUI!); Chahar Mahale Bakhtiari province: Gandoman wetland, 2253 m Afsharzadeh & Abassi 19637 (HUI!); Khuzestan province: Dezdul, Hamid Abad village, Dez River, Dinarvand 8332 (Khuzestan Herbarium!).

P. berchtoldii Fieber

Submerged plant. Rhizome and stem filiforme, nodes with two obvious nodal glands. Leaves monomorphic, sessile, green, linear, 30-45 mm long, 1.5-2 mm wide, entire, 3-veined with at least 2 rows of lacunar cells along the shiny yellow midrib, acuminate at apex, stipules open at base, convolute at base, 5-9 mm long, membranous. Spike 4-5 mm long, peduncle less than 1cm long, tepals 2 mm long, anthers 0.5 mm long, carpels 4, fruits 2 mm long.

Flowering time: Spring to autumn.

Worldwide distribution: W Asia (Iran, Turkey, Iraq, Palestine), Europe.

Distribution in Iran: North, West, South.

Specimens examined: Iran: Gilan province: Astaneh, under Sefidrood bridge, Dinarvand 8156 (Khuzestan Herbarium!); Kurdistan province: 48 km from Paveh to Kermanshah, Ravansar, 1430 m, Runemark & Mozaffarian 27447 (TARI!); Lorestan province: Pole Dokhtar, Lefone wetland Dinarvand & Mohammadi 8713 (Khuzestan Herbarium!), Dorood, Gahar Lake, Dinarvand & Mohammadi 8755 (Khuzestan Herbarium!); Fars province: Tange Boragh dam, 1230 m, Dinarvand & Mohammadi 8667 (Khuzestan Herbarium!); Khuzestan Province: Khoramshahr, Arvand River, Dinarvand 8059 (Khuzestan Herbarium!).

P. crispus L. (Fig. 4c)

Submerged plant. Rhizome and stem slender. Leaves monomorphic, sessile, translucent, broadly linear to oblong, 25-95 mm long, 3-10 mm wide, serrate and crispate at margin, 3-5-veined, acute to retuse at apex, stipules free, lanceolate, 6-7 mm long, membranacous. Spike 1-1.5 cm long, peduncle 3-4.5 cm long. Tepals 1-1.5 mm long, anthers 1 mm long, carpels 4, fruits 5 mm long, with prominent beak.

Flowering time: Spring and summer.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Palestine), C Asia, Siberia, Europe, Africa, America and Australia.

Distribution in Iran: North, West, Northeast, South.

Specimens examined: Iran: Mazandaran province: Sari, Tajan River, 50 m, Dinarvand & Mohammadi 8784 (Khuzestan Herbarium!), Ghaemshahr, Shahpour bridge, 160 m, Dinarvand & Mohammadi 8715 (Khuzestan Herbarium!), Ghaemshahr, Siah-Rood River, 28 m, Dinarvand & Mohammadi 8790 (Khuzestan Herbarium!), Freidonkenar, Azbaran village, Dinarvand & Mohammadi 8794 (Khuzestan Herbarium!); Gillan province: Astaneh, Estil wetland, Dinarvand 8235 (Khuzestan Herbarium!), Anzali wetland, Dinarvand 8198 (Khuzestan Herbarium!), Astane, Sefid-Rood River, Dinarvand 8191 (Khuzestan Herbarium!), Siah Keshim wetland, 5 m, Dinarvand 8955 (Khuzestan Herbarium!); E Azerbayjan province: Bostan Abad to Sarab, 60 km to Sarab, Dinarvand & Mohammadi 8319 (Khuzestan Herbarium!); W Azerbayjan province: Naghadeh, Kanibrazan wetland, Dinarvand & Mohammadi 8306 (Khuzestan Herbarium!); Kurdistan province: Marivan, Zarivar Lake, 1300 m, Dinarvand & Mohammadi 8299 (Khuzestan Herbarium!); Kermanshah province: Ravansar, Sarabe Nilofar wetland, 1510 m, Attar, Mirtajedini & Shakholeslami 19886 (TUH!); Fars province: Haft Barm wetland, 2180 m, Dinarvand & Mohammadi 8689 (Khuzestan Herbarium!); Khuzestan province: Ahvaz, Karoon River, Dinarvand & Mohammadi 8258 (Khuzestan Herbarium!), Dezful, Hamid Abad village, Dez River, Dinarvand 8340 (Khuzestan Herbarium!), Abadan, Mino Island, Dinarvand 8274 (Khuzestan Herbarium!), Khoramshahr, Arvand River, Dinarvand 8028 (Khuzestan Herbarium!), Andimeshk, Naderi bridge, Karkhe River, Dinarvand 8104 (Khuzestan Herbarium!); Khorasan province: Khovaf, Bande Salami, 1150 m, Joharchi & Zangoee 21137 (FUMH!); Tehran province: Ghazvin, Dikten village, Avan Lake, 1820 m, Dinarvand & Mohammadi 8299 (Khuzestan Herbarium!).

P. trichoides Cham. & Schltdl.

Submerged plant. Rhizome and stem filiforme, nodes with two obvious nodal glands. Leaves monomorphic, sessile, green, linear, 35-85 mm long, less than 15 mm wide, entire, 1(-3)-veined with one prominent midrib, side veins

ending far before apex, acute apex, stipules 3 mm long, membranacous. Spike 1-3 mm long, peduncle 7-9 mm long, tepals 1 mm long, anthers 1 mm long, carpels 1, fruits 2 mm long.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Turkey, Palestine), C Asia, Siberia, Europe and Africa.

Distribution in Iran: Northwest.

Specimens examined: Iran: Ardabil province: Ardabil to Khalkhal, 22 km SE of Budalalou, Neor Lake, 1450 m, Zehzad, Taheri & Izadpanah 70520 (TARI!).

Stuckenia Borner (Abbasi *et al*. 2017)

Key to the species in Iran

1. Leaf sheaths convolute, leaf apex acute to acuminate. Stem repeatedly branched…..…… *S. pectinata*
1. Leaf sheaths connate, leaf apex rounded. Stem less branched……..…….....…… 2
2. Leaves mostly filiform, apex obtuse or bifurcate. Fruits 1.9-2.6 mm…….....…..……. *S. filiformis*
2. Leaves narrowly linear, apex obtuse or rounded. Fruits 2.9-3.3 mm…….....…….. *S. amblyophylla*

S. amblyophylla (C.A.Mey.) Holub (Fig. 4d)

Submerged plant. Rhizome filiforme, stem slender to filiform. Leaves monomorphic, sessile, green, linear, 50-70 mm long, 0.5-1 mm wide, 3-veined, entire, obtuse or rounded at apex, stipules membranacous, adnate to leaf base, 20-80 mm long. Spike 2-4 mm long, peduncle 4-7 cm long, tepals 1.5 mm long, anthers 1 mm long, carpels 4, fruits 2.9-3.3 mm long.

Flowering time: Spring and summer.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan) and C Asia.

Distribution in Iran: North, West, Center, South.

Specimens examined: Iran: Gilan province: Kiashahr to Dastak, Dinarvand 8151 (Khuzestan Herbarium!), Astane, Sefid-Rood River, Dinarvand 8152 (Khuzestan Herbarium!), Rasht to Some Sara, Tolam Shahr, Dinarvand 8227 (Khuzestan Herbarium!), Anzali wetland, Dinarvand 8169 (Khuzestan Herbarium!), W Azerbayjan: Soldoz wetland, Dinarvand & Mohammadi 8310 (Khuzestan Herbarium!); Lorestan province: Dorood, Gahar Lake, 2350 m, Dinarvand & Mohammadi 8759 (Khuzestan Herbarium!); Fars province: Bande Amir, 1400 m, Zehzad & Taheri 66939 (TARI!), Sivand, 1580 m, Zehzad & Taheri 66919 (TARI!); Bushehr province: Hele River, 24 m, Dinarvand & Mohammadi 8691 (Khuzestan Herbarium!); Khuzestan province: Andica, Abzalo wetland, 730 m, Dinarvand & Mohammadi 8552 (Khuzestan Herbarium!), Ahvaz, Karoon River, Dinarvand & Mohammadi 8262 (Khuzestan Herbarium!), Shushtar, Aghili, Dinarvand 8130 (Khuzestan Herbarium!), Andimeshk, Naderi bridge, Karkhe River, Dinarvand 8034 (Khuzestan Herbarium!).

S. filiformis (Pers.) Borner (Fig. 4e)

Submerged plant. Rhizome filiforme, stem slender to filiform. Leaves monomorphic, sessile, green, filiform, 40-60 mm long, 0.5 mm wide, 3-veined, entire, obtuse or or bifurcate at apex, stipules membranacous, adnate to leaf base, 8-10 mm long. Spike 1-3 mm long, peduncle often more than 10 cm long, tepals 1 mm long, anthers 1 mm long, carpels 4, fruits 1.9-2.6 mm long.

Flowering time: Spring to autumn.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Palestine), Europe, Siberia, and America.

Distribution in Iran: Southwest and Southeast.

Specimens examined: Iran: Khuzestan province: 17 km from Ahvaz to Shadegan, Shadegan wetland, Dinarvand 8043 (Khuzestan Herbarium!), Old road of Ahvaz to Khoramshahr, 90 km to Khoramshahr, Dinarvand 8090 (Khuzestan Herbarium!); Sistan va Baluchestan province: Hamon wetland, Sharif 33922 (IRAN!).

S. pectinata (L.) Borner (Fig. 4f)

Submerged plant. Rhizome and stem slender to filiform, stem repeatedly branched. Leaves monomorphic, sessile, green, linear, 60-90 mm long, 0.5-1 mm wide, 3-veined, entire, acute to acuminate at apex, leaf sheaths convolute, stipules membranacous, adnate to leaf base, 10-70 mm long. Spike 1-3 mm long, peduncle 3-5 cm long, tepals 2 mm long, anthers 1 mm long, carpels 4, fruits 4 mm long.

Flowering time: Spring to autumn.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Palestine), C Asia, Siberia, Saudi Arabia.

Distribution in Iran: North, Northeast, Center, Southeast and Southwest.

Specimens examined: Iran: Mazandaran province: Nowshahr, Nezam Abad, Iranshahr 33921 (IRAN!); Gillan province: Some Sara, Siah Kashim wetland, 5 m, Dinarvand 8956 (Khuzestan Herbarium!), Anzali wetland, Mozaffarian 65230 (TARI!); W Azerbayjan province: Kanibrazan wetland, Dinarvand & Mohammadi 8305 (Khuzestan Herbarium!), Road of Miandoab to Urmia, 100 km to Urmia, 1280 m, Dinarvand & Mohammadi 8327 (Khuzestan Herbarium!), 3 km from Moana to Silvaneh, Sharchay River, 1400 m, Izad Panah & Taheri 68282 (TARI!); E Azerbayjan province: Tabriz to Bostan Abad, Ghori Gol Lake, 1920 m, Dinarvand & Mohammadi 8314 (Khuzestan Herbarium!); Kermanshah province: Ravansar, Hashilan wetland, 1320 m, Dinarvand & Mohammadi 8288 (Khuzestan Herbarium!); Ilam province: Seymare River, 920 m, Dinarvand & Mohammadi 8282 (Khuzestan Herbarium!); Lorestan province: Pole Dokhtar, Lefone wetland, 730 m, Dinarvand & Mohammadi 8709 (Khuzestan Herbarium!), Dorood, Gahar Lake, 2350 m, Dinarvand & Mohammadi 8755 (Khuzestan Herbarium!); Isfahan province: Zayandeh-Rood River, 1320 m, Zehzad & Taheri 66862 (TARI!), Kohgiloye and Boyer-Ahmad province: Yasuj, Kakan, Barme Zard spring, 2220 m, Dinarvand & Mohammadi (Khuzestan Herbarium!); Fars province: Haft Barm wetland, 2150 m, Dinarvand & Mohammadi 8696 (Khuzestan Herbarium!), Road of Tange Boragh dam, 1230 m, Dinarvand & Mohammadi 8668 (Khuzestan Herbarium!); Khuzestan province: Andica, Abzalo wetland, 730 m, Dinarvand & Mohammadi 8551 (Khuzestan Herbarium!), Shadegan wetland, Dinarvand 8057 (Khuzestan Herbarium!), Dezful, Safi Abad, Dinarvand 8347 (Khuzestan Herbarium!), Shushtar to Gotvand, Dinarvand 8135 (Khuzestan Herbarium!), Sistan va Baluchestan: Hamon wetland, Sharif 33929 (IRAN!); Khorasan province: Bazangan Lake, 800 m, Akhani & Zangoee 24577 (FUMH!), Tehran province: Doabe Arak, Ghahreman & Sheikhol Eslami 8987 (TUH!).

Potamogeton* × *khuzestanicus (*P. crispus* × *P. pusillus*) Abbasi, Afsharzadeh & Dinarvand (Fig. 4g)

Submerged plant. Rhizome and stem slender to filiform, stem branched. Leaves monomorphic, sessile, reddish or brownish, lanceolate, 3-5 cm long, 2.5-3.5 mm wide, 3-veined, entire, obtuse or rounded at apex, stipules membranacous, 7-9 mm long. Spike with 2-4 floweres, 5-8 mm long, peduncle 2-3 cm long, tepals 1 mm long, anthers 1 mm long, carpels 4, fruits 3 mm long.

Flowering time: Spring and summer.

Type: Iran: Khuzestan province, Dezful: Hamidabad River, Dinarvand 8332 (Khuzestan Herbarium!).

Groenlandia J.Gay (Dinarvand 2017)

G. densa (L.) Fourr.

Submerged plant. Rhizomatous, stem slender to filiform. Leaves monomorphic, opposite, sessile, clasping at base, ovate to laceolate, 10-25 mm long, 4-10 mm wide, 3-7 veined, crispate at margin**,** minutely serrate especially at apex, stipules membranacous, 3 mm long. Spike elongated, peduncles with low number of flowers, 1-1.5 cm long, tepals brown and membranaceous, 1.5 mm long, carpels 4, fruits drupaceous, 3-4 mm long, beak 2 mm long.

Flowering time: Spring to summer.

Worldwide distribution: W Asia (Iran, Turkey) and Europe.

Distribution in Iran: Northwest.

Specimens examined: W Azerbayjan province: 3 km from Movana to Silvaneh, Shahrechay River, Izad Panah & Taheri 68290 (TARI!), Road of Tala Tapeh to Urmia, Yugon Abad, 1190 m, Izad Panah & Taheri 68330 (TARI!).

Zannichellia palustris L. (Fig. 4h)

Submerged plant. Rhizome filiforme, stem articulated, slender to filiform. Leaves opposite, lamina linear or filiform, 25-80 mm long, 0.3-1 mm wide, entire, acute at apex, stipules free, membranacous. Male and female flowers subsessile on the base of leaves. Anthers 0.5 mm. Carple asymmetric and jar shape, 1-1.3 mm long, fruits 4 achenes, curved and dentate on back, with a long beak.

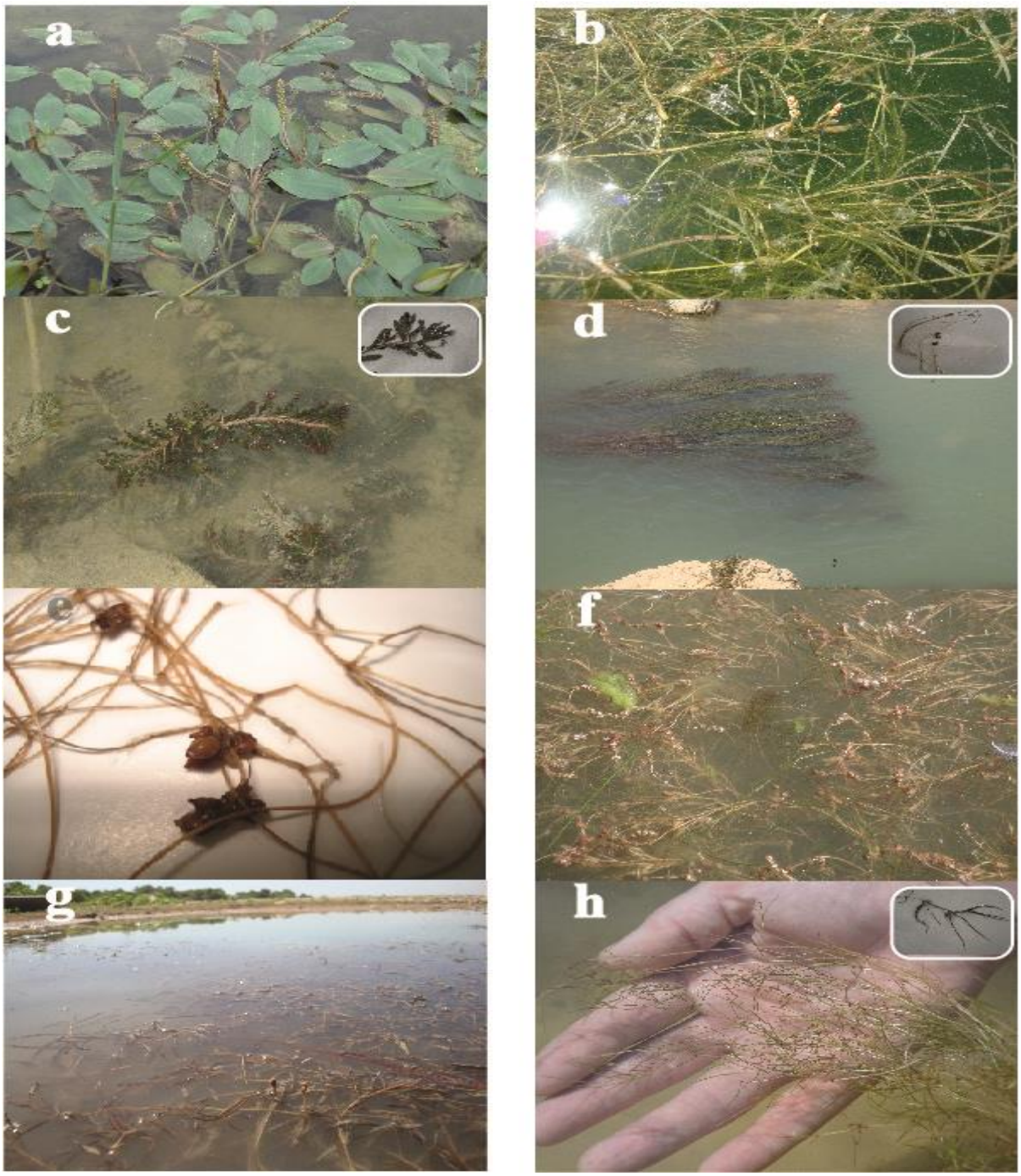

Fig. 4. Selected several aquatic plants of Iran in their habitats: a. *Potamogeton nodosus*, b. *P. pusillus*, c. *P. crispus*, d. *Stuckenia amblyophylla*, e. *S. filiformis* (recorded as new species by author), f. *S. pectinata*, g. *P.* × *khuzestanicus* (recorded as new species by author and other collegues), h. *Zannichellia palustris* (Photos by M. Dinarvand).

Key to the varieties

1. Fruits without pedicel or rarely pedicel size less than1 mm. Leaves 1-2 mm wide..... *Z. palustris* var. *palustris*
1. Fruits with obvious pedicel, 2.5 mm long. Leaves less than 1 mm wide……..…. *Z. palustris* var. *pedicellata*

Z. palustris var. ***palustris*** (Syn. of *Z. palustris* L.) (Abbasi *et al*. 2019)

Flowering time: Winter.

Worldwide distribution: Asia, Europe, Australia and Africa.

Distribution in Iran: North, Northwest, Center, Southwest and Southest.

Specimens examined: Iran: Gilan province: Astaneh, under Sefid-Rood River bridge, 94 m, Dinarvand 8155 (Khuzestan Herbarium!), Anzali wetland, -20 m, Dinarvand 8175 (Khuzestan Herbarium!); E Azerbayjan province: Tabriz to Bostanabad, Ghoorigol Lake, 1400 m, Dinarvand & Mohammadi 8316 (Khuzestan Herbarium!), Bostanabad to Sarab, 60 km to Sarab, Saghinsara village, Dinarvand & Mohammadi 8320 (Khuzestan Herbarium!), Sarab to Ardabil, 1 km after Mijmir village, Dinarvand & Mohammadi 8321 (Khuzestan Herbarium!); Ardabil province: Neor Lake, 2494 m, Dinarvand & Mohammadi 8331 (Khuzestan Herbarium!); Kurdistan province: Marivan to Chenareh, Garan Dam, 1400 m, Dinarvand & Mohammadi 8304 (Khuzestan Herbarium!); Hamadan province: Zanjan to Hamadan, after Khodabandeh, 120 km to Hamadan, Shirinsoo wetland, 1838 m, Dinarvand & Mohammadi 8629 (Khuzestan Herbarium!); Chahar Mahale Bakhtiari province: 80 km to Shahrekord, Dehno village, Dinarvand & Mohammadi 8241 (Khuzestan Herbarium!); Fars province: Haftbarm wetland, 2180 m, Dinarvand & Mohammadi 8687 (Khuzestan Herbarium!); Khuzestan province: Dezful, Hamidabad village, Dez River, 80 m, Dinarvand & Mohammadi 8603 (Khuzestan Herbarium!), Hamidieh, Dinarvand & Mohammadi 8070 (Khuzestan Herbarium!), 25 km to Bostan, 838 m, Dinarvand 8054 (Khuzestan Herbarium!); Sistan va Baluchestan province: 40 km to Zahedan, 90 m, Valizadeh & Maassoumi 1074 (TARI!), Hamoon, 450 m, Ghahreman & Aghostin, s.n. (TUH!); Tehran province: Damavand, 1800 m, Mozaffarian 66200 (TARI!).

Z. palustris var. ***pedicellata*** (Wahlenb. & Rosén) (Syn. of *Z. palustris* subsp. *pedicellata* (Wahlenb. & Rosén) Hook.f. (Abbasi *et al*. 2019)

Flowering time: Winter.

Worldwide distribution: Asia.

Distribution in Iran: Center and Southwest.

Specimens examined: Iran: Kohgiluyeh and Boyer-Ahmad province: Yasouj, 15 km to Yasouj, 2120 Dinarvand & Mohammadi 8661 (Khuzestan Herbarium!); Fars province: Dashte Arzhan, Ghareaj River, 1990 m, Dinarvand & Mohammadi 8697 (Khuzestan Herbarium!); Khuzestan province: Shush, Shahor station, Dinarvand & Mohammadi 8433 (Khuzestan Herbarium!), Shush, Alhaei, 80 m, Dinarvand & Mohammadi 8840 (Khuzestan Herbarium!), Ahvaz, Karoon River, 80 m, Dinarvand & Mohammadi 8355 (Khuzestan Herbarium!), Andica, ghalekhaje, Abzaloo wetland, 838 m, Dinarvand & Mohammadi 8549 (Khuzestan Herbarium!).

Elatinaceae

Bergia capensis L.

Emerged plant, 20-30 cm tall. Rhizomatous. Stem erect or prostrate and rooting in lower part. Leaves opposite, lamina lanceolate, 25-65 mm long, 5-15 mm wide, minutely serrulate at margin, apex acute or obtuse. Flowers bisexual, arranged into small axillary cymes or verticillate whorls, subsessile or with short pedicel 1-5 mm. Sepals ovate, 1-1.5 mm long. Petals subspatulate, 2 mm long. Stamen 8-10, 1 mm long. Ovary subglobose, 0.5-1 mm long. Capsule subglobose, ca. 1.8 mm in diam.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Afghanistan, Pakistan, Iraq), Siberia, India, N Africa.

Distribution in Iran: North and West.

Specimens examined: Iran: Mazandaran province: Sari, Gohar Baran road, 60 m, Aghabeigi & Karavar 17539 (TUH!); Lorestan province: Khoram Abad, Chame Divan, 1000 m, Vaisekarami (TUH!).

Haloragaceae

Myriophyllum L. (Dinarvand 2017)

Key to the species in Iran

1. Leaves in 5 whorls. Verticillate spike along of stems. Bracts pinnatifid……..……. *M. verticillatum*
1. Leaves in 4 whorls. Spike on top of stems. Bracts entire, obovate…….……. *M. spicatum*

M. verticillatum L. (Fig. 5a)

Submerged to emerged plant. Rhizome filiforme. Stem thick, green. Leaves in 5 whorls, lamina pinnatifid, 10-25 mm long, 5-10 mm wide, segments linear or filiform. Bracts pinnatifid. Spike along of stems, verticillate, flowers sessile, 1-2 mm long, the upper male, the lower female with a few bisexual ones in between. Male flower with a calyx tube, 1 mm long, stamens 8. Female flower without petals, ovary subglobose 2 mm long. Fruits schizocarp. Seeds elongated, 1.5 mm long, smooth.

Flowering time: Spring to summer.

Worldwide distribution: Asia, Europe, N Africa and, America.

Distribution in Iran: Centr.

Specimens examined: Iran: Kohgiloye and Boyer-Ahmad province: Yasuj to Morgan, Kakan, Barme Zard spring, 2220 m, Dinarvand & Mohammadi 8655 (Khuzestan Herbarium!); Chahar Mahale Bakhtiari province: Choghakhor wetland, 2300 m, Zehzad 862836 (TARI!); Fars province: Tange Boragh, Mola Sadra dam to Kamfiroz, 2000 m, Dinarvand & Mohammadi 8680 (Khuzestan Herbarium!).

M. spicatum L. (Fig. 5b)

Submerged plant. Rhizome filiforme. Stem thick, green or brown. Leaves in whorls of 4, lamina pinnatifid, 10-25 mm long, 5-13 mm wide, segments linear or filiform. Bracts entire, obovate. Spike on top of stems, 70-95 mm long, flowers in whorls of 4, the upper flowers male, the lower female. Male flower 1-2 mm long, sepals 0.5-1.5 mm long, triangular, obtuse, petals 2 mm long, oblong, Stamens 8. Female flower 2 mm long, ovary 1-1.5 mm long, subglobose. Fruits 2 mm long, long elliptic to subglobose, 2 mm long.

Flowering time: Spring to summer.

Worldwide distribution: Asia, Europe, N Africa and, America.

Distribution in Iran: North, Northeast, West, Center and South.

Specimens examined: Iran: Golestan province: Gomishan wetland, Dinarvand & Mohammadi 8807 (Khuzestan Herbarium!); Mazandaran province: Feridonkenar, Azbaran village, Dinarvand & Mohammadi 8795 (Khuzestan Herbarium!), Zaghmorad village, Lopo wetland, Dinarvand & Mohammadi 8780 (Khuzestan Herbarium!), Nowshahr, Nezam Abad, Iranshahr 22170 (IRAN!); Gillan province: 2 km from Ghazian to Khomam, Taleb Abad, Zehzad, Pakravan & Taheri 67291 (TARI!), Somesara, Siah Kashim wetland, Dinarvand 8954 (Khuzestan Herbarium!); W Azerbayjan province: Urmia, Soldoz wetland, Dinarvand & Mohammadi 8311 (Khuzestan Herbarium!); E Azerbayjan province: Sarab to Ardabil, Mig village, Dinarvand & Mohammadi 8322 (Khuzestan Herbarium!), Bostan Abad, Ghori Gol Lake, Assadi, Taheri & Izad Panah 68436 (TARI!); Kurdistan province: Marivan, Zarivar Lake, 1300 m, Dinarvand & Mohammadi 8300 (Khuzestan Herbarium!), Ravansar, Sarabe Nilofar, Dinarvand & Mohammadi 8290 (Khuzestan

Herbarium!), Ravansar, Hashilan wetland, 1320 m, Dinarvand & Mohammadi 8287 (Khuzestan Herbarium!); Ilam province: Seymare River, 920 m, Dinarvand & Mohammadi 8280 (Khuzestan Herbarium!); Lorestan province: Dorood, Gahar Lake, 2350 m, Dinarvand & Mohammadi 88762 (Khuzestan Herbarium!); Chahar Mahale Bakhtiari province: Choghakhor wetland, 2300 m, Dinarvand 8249 (Khuzestan Herbarium!); Khuzestan province: Shushtar to Gotvand, Mandeli, Dinarvand 8140 (Khuzestan Herbarium!), Bostan, Chazabe, Dinarvand 8270 (Khuzestan Herbarium!), Andimeshk, Naderi bridge, Karkhe River, Dinarvand & Adel 8606 (Khuzestan Herbarium!), Dezful, Hamid Abad village, Dez River Dinarvand 8336 (Khuzestan Herbarium!); Sistan va Baluchestan province: Moladari village, Hamon wetland, Zare, s.n. (TUH!).

Ceratophyllaceae

Ceratophyllum L. (Dinarvand 2017)

Key to the species in Iran

1. Leaves once or twice dichotomously divided; segments linear. Fruit with 2 spines at base and one on top.....*C. demersum*
1. Leaves dichotomously divided 3-4; segments filiform. Fruit without spines at base……..……. *C. submersum*

C. demersum L. (Fig. 5c)

Submerged plant. Stem slender, much branched. Leaves whorls of 1-4, one or twice dichotomously divided, 1-3 cm long, segments linear, 0.2-1 mm wide, with toothed at irregular intervals, often terminated by 1 or 2 sharp bristles. Flowers sessile, unisexual, axillary. Male and female flowers at different nodes. Male flowers 1 mm long, with 8-30 stamens. Female flower 1 mm long, stigma 1 mm long, 0.5 mm wide. Style elongating in fruit forming the apical spine. Achene elliptic, 3.5-5 mm long, 2.5 mm wide, with one apical and 2-lateral spines, apical spine 8-13 mm long, laterals 3-10 mm long.

Flowering time: Winter to spring.

Worldwide distribution: Asia and Europe.

Distribution in Iran: North, Northeast, West, Center and South.

Specimens examined: Iran: Mazandaran province: Ferydon Kenar, Azbaran village, Dinarvand & Mohammadi 8793 (Khuzestan Herbarium!), Ghaemshahr, Siah-Rood River, Dinarvand & Mohammadi 8788 (Khuzestan Herbarium!), Gilan: Anzali wetland, Dinarvand 88206 (Khuzestan Herbarium!), Astane, Sefid-Rood River, Dinarvand 8145 (Khuzestan Herbarium!), Somesara, Siahkashim wetland, Dinarvand 8953 (Khuzestan Herbarium!), Talesh to Astane, 150 km to Astane, Dinarvand 8221 (Khuzestan Herbarium!), 2 km from Ghazian to Khomam, Taleb Abad, Zehzad, Pakravan & Taheri 67288 (TARI!); W Azerbayjan province: Miandoab to Urmia, 100 km to Urmia, Dinarvand & Mohammadi 8328 (Khuzestan Herbarium!), South of Urmia, Zarineh-Rood River, 1300 m, Assadi & Akhani 61341 (TARI!), Naghade, Kanibrazan wetland, Dinarvand & Mohammadi 8307 (Khuzestan Herbarium!), Mahabad, Mahabad Lake, 1230 m, Izad Panah & Taheri 68349 (TARI!), Marivan to Kamyaran, 5 km to Kamyaran, 1350 m, Dinarvand & Mohammadi 8293 (Khuzestan Herbarium!); Kurdistan province: Marivan, Zarivar Lake, 1300 m, Dinarvand & Mohammadi 8302 (Khuzestan Herbarium!), Ilam: Seymare River, 920 m, Dinarvand & Mohammadi 8276 (Khuzestan Herbarium!); Lorestan province: Pole Dokhtar, Lefone wetland, Dinarvand & Mohammadi 8711 (Khuzestan Herbarium!); Isfahan province: Azheh, Zayandeh-Rood River, Zehzad & Taheri 66863 (TARI!); Chahar Mahale Bakhtiari province: Choghakhor wetland, Dinarvand 8250 (Khuzestan Herbarium!); Fars province: Kharame to Bakhtegan, 1400 m, Zehzad & Taheri 66983 (TARI!), Sivand, Sivand River, Zehzad & Taheri 66917 (TARI!), Parishah

Lake, Khaje spring, 700 m, Zehzad & Taheri 66993 (TARI!), Shiraz, Babahaji, 1500 m, Iranshahr & Terme 5726 (IRAN!); Khuzestan province: Andica, Abzalo wetland, 730 m, Dinarvand & Mohammadi 8554 (Khuzestan Herbarium!), Ahvaz, Karoon River, Dinarvand & Mohammadi 8359 (Khuzestan Herbarium!), Shushtar to Gotvand, Mandeli, Dinarvand 8139 (Khuzestan Herbarium!), Dezful, Safi Abad, Dinarvand 8348 (Khuzestan Herbarium!), Shush to Dezful, Hamid Abad village, Dez River, Dinarvand 8335 (Khuzestan Herbarium!), Hamidieh Dinarvand 8266 (Khuzestan Herbarium!), Hore Rofegh, 20 m, Salehi & Hasonizadeh 3539 (Khuzestan Herbarium!), Shush, Abdolkhan village, Dinarvand & Adel 8601 (Khuzestan Herbarium!), Andimeshk, Naderi bridge, Karkhe River, 120 m, Dinarvand & Adel (Khuzestan Herbarium!), Ahvaz to Shush, Between Al Baji and Ple Shavor, 80 m, Mozaffarian 72236 (TARI!), Shush, Sadat, Hore Bamzezh, Dinarvand & Mohammadi 8764 (Khuzestan Herbarium!), 60 km from Ahvaz to Shush, Assadi & Angoshti 67395 (TARI!), Ahvaz, Nahre Maleh, Dinarvand & Hassanzadeh 8372 (Khuzestan Herbarium!), Ahvaz to Behbahan, 60 km to Behbahan, Dinarvand & Hanoor 3706 (Khuzestan Herbarium!), Ahvaz to Khoramshahr, 150 km to Khoramshahr, Dinarvand 8269 (Khuzestan Herbarium!).

C. submersum L. (Fig. 5d)

Submerged plant. Stem slender, much branched. Leaves whorls of 1-4, dichotomously divided 3-4, 1-3 cm long, segments filiform, 0.1-0.3 mm wide, with toothed at irregular intervals, often terminated by 1 or 2 sharp bristles. Flowers sessile, unisexual, axillary. Male and female flowers at different nodes. Male flowers 1 mm long, with 8-30 stamens. Female flower 1 mm long, stigma 1 mm long, 0.5 mm wide. Style elongating in fruit forming the apical spine. Achene elliptic, 3.5-5 mm long, 2.5 mm wide, without spines at base.

Flowering time: Spring to summer.

Worldwide distribution: Asia, Europe and Africa.

Distribution in Iran: Northwest.

Specimens examined: Iran: E Azerbayjan province: Tabriz to Bostan Abad, Ghori Gol Lake, Dinarvand & Mohammadi 8315 (Khuzestan Herbarium!).

Hippuridaceaea

Hippuris vulgaris L.

Emerged plant, 25-50 cm tall. Rhizome creeping. Stem erect or prostrate. Leaves whorls, up to 9, sessile, entire, lanceolate to linear, 10-20 mm long, 2 mm wide, submerged leaves longer than emergent leaves. Flowers in whorls of the axils of emergent leaves. Stamen 1-1.5 mm long, anther bilobed. Ovary 1 mm. Achene obovoid-ellipsoid, 2-2.5 mm long.

Flowering time: Summer.

Worldwide distribution: Asia, Europe and America.

Distribution in Iran: Northwest.

Specimens examined: Iran: Mazandaran province: Lar valley, 2420 m, Wendelbo & Assadi 13307 (TARI!); Ardabil province: 42 km West of Nhor, Lisar protected area, 2450 m, Foroughi & Assadi 13774 (TARI!), Fars: Dashte Arzhan wetland, 1800 m, Zehzad & Taheri 67054 (TARI!).

Nymphaeaceae

Key to the genera in Iran

1. Flower floating, Leaves suborbicular or cordate. Corolla white……. *Nymphaea*
1. Flower emergent, Leaves elliptic. Corolla yellow……. *Nuphar*

Nymphaea alba L. (Fig. 5e)

Submerged-leaf floating plant. Rhizome creeping. Leaves floating, suborbicular or cordate, 6.5-24 cm in diam., with obvious sinus reaching up to middle of blade, Petiole 18-50 cm long. Flower solitary, floating, sepals lanceolate, 6-7 cm long, 3 cm wide, petals white, oblong, 5-7 cm longe, 2-3.5 cm wide. Stamens many in 3 rows, filaments of the inner stamens are usually as broad as anthers. Fruits berry-like, 2-4 cm in diam. Seeds many, ellipsoid, 2-3 mm.

Flowering time: Spring to summer.

Worldwide distribution: Asia, Europe and Mediterranean area.

Distribution in Iran: North and West.

Specimens examined: Iran: Mazandaran province: Nowshahr, Iranshahr 31006 (IRAN!); Gilan province: West of Rasht, 50 m, Wendeldo & Assadi 18638 (TARI!), Anzali wetland, Mozaffarian & Maassoumi 7076 (TARI!); Kurdistan province: Marivan, Zarivar Lake, Dinarvand & Mohammadi 8297 (Khuzestan Herbarium!); Khuzestan province: Shush, Bamdezh wetland, 50 m, Mozaffarian 83596 (TARI!).

Nuphar luteum (L.) Sm. (Fig. 5f)

Submerged-leaf floating plant. Rhizome creeping. Leaves floating or submerged, elliptic, 18-23 cm long, 10-15.5 cm wide, entire, cordate at base, Petiole 10-50 cm long. Flower solitary, emergent, sepal oblong to obovate, 2-3 cm long, 1-2 cm wide, petals yellow, elliptic, 1-1.5 cm longe, 0.5-1 cm wide. Stamens many, inserted at base of ovary, filament strap-like, 7 mm long. Ovary superior. Fruit urceolate, 4 cm long, 3 cm wide.

Flowering time: Spring to summer.

Worldwide distribution: Asia, Europe and Mediterranean area.

Distribution in Iran: Center and West.

Specimens examined: Iran: Kermanshah province: Ravansar, Sarabe Nilofar, Dinarvand & Mohammadi 8292 (Khuzestan Herbarium!), Fars province: Shiraz, Babahaji, 1500 m, Iranshahr & Terme 31000 (IRAN!).

Nelumbonaceae

Nelumbo nucifera Gaertn. (Fig. 5g, h)

Submerged-leaf floating plant. Rhizome creeping. Leaves floating or submerged, lamina entire, peltate, 25-45 cm in diam., petiole 50-150 cm long. Flower solitary, emergent, tepal pink, ovate to elliptic, 1.5-7 cm long, with obvious parallel veined. Stamens many, 7 mm long, filament 1-1.5 mm long. Carpels several, borne singly in the cavities of the broad, turbinate, spongy receptacle. Fruits nutlike, obconic, 3 cm long.

Flowering time: Summer.

Worldwide distribution: Asia, Europe, Mediterranean area and Australia.

Distribution in Iran: North.

Specimens examined: Iran: Mazandaran province: Babolsar to Mahmod Abad, Fereydon Kenar, Sute wetland, *Zehzad* 90129 (TARI!); Gilan province: Anzali wetland, Dinarvand 8144 (Khuzestan Herbarium!), Amir Kalayeh wetland, Dinarvand 8187 (Khuzestan Herbarium!), Somesara, Siah Kasim wetland, 5 m, Dinarvand 8951 (Khuzestan Herbarium!).

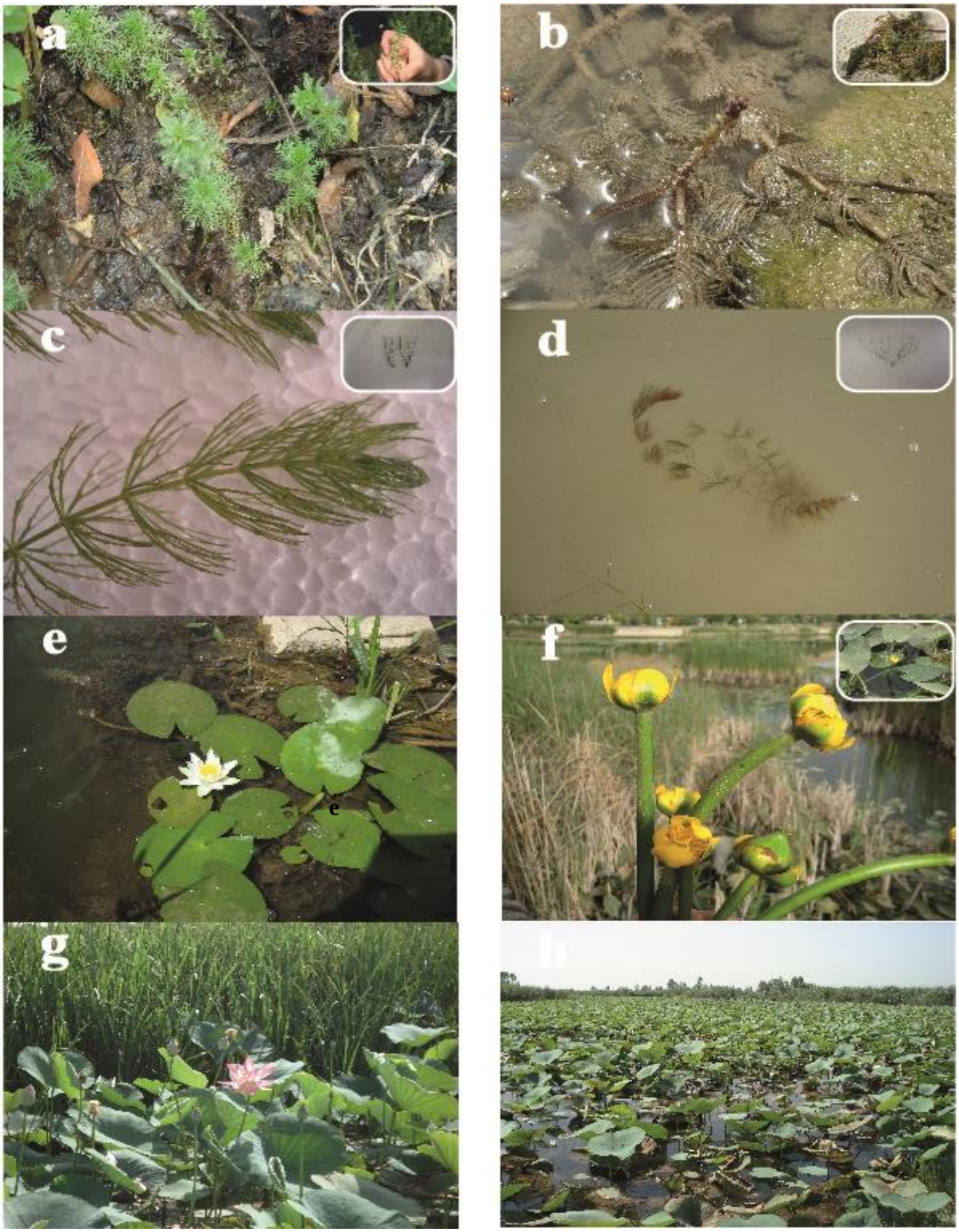

Fig. 5. Selected several aquatic plants of Iran in their habitats: a. *Myriophyllum verticillatum*, b. *M. spicatum*, c. *Ceratophyllum demersum*, d. *C. submersum*, e. *Nymphaea alba*, f. *Nuphar luteum*, g. *Nelumbo nucifera*, h. A community of *N. nucifera* (Photos by M. Dinarvand).

Lentibulariaceae

Utricularia L. (Dinarvand 2017)

Key to the species in Iran

1. Stems dimorphic. Leaves polymorphic……2
1. Stems and leaves monomorphic……3
2. Leaves indistinctly denticulate or not denticulate; all segments dichotomously divided…… *U. minor*
2. Leaves distinctly denticulate; segments dichotomously and pinnatly divided…… *U* × *ochroleuca*
3. Leaves multipinnatipartite. Internod 1-1.5 cm. Pedicels 1-1.5 cm. Lower lip of corolla flat and spreading..... *U. australis*
3. Leaves pinnate. Internod 4-8 mm. Pedicels 0.5-1 cm. Lower lip of corolla flat and deflexed…….. *U. vulgaris*

U. minor L. (Fig. 6a)

Submerged plant. Stems filiform, dimorphic, green and colourless internod 4-7 mm. Leaves alternate, polymorphic, with 2 primary segments from the base, 2-10 mm long, semiorbicular in outline, secondary segments dichotomously divided into 2-5 segments, narrowly linear, 0.2-0.3 mm wide, entire or sparsely denticulate, apex acute. Traps on leaf segments, with short stalk, 0.2 mm, oblique ovate, 1.5-2 wide and 0.9-1 mm long. Antennae on mouth of traps much branched, 2 mm long.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan), SE Asia, Siberia, Europe and America.

Distribution in Iran: West.

Specimens examined: Iran: Lorestan province: Dorood, Gahar Lake, 2350 m, Dinarvand & Mohammadi 8757 (Khuzestan Herbarium!).

Utricularia* × *ochroleuca R. W.Hartm. (Fig. 6b)

Submerged plant. Stems filiform, dimorphic, Internod 4-7 mm. green and colourless. Leaves alternate, polymorphic, with 2 primary segments from the base, 3-10 mm long, oblong, ovate or semiorbicular in outline, secondary segments dichotomously and pinnatly divided, into 3-9 segments, narrowly linear, 0.1-0.6 mm wide, denticulate at margin, obviously with bristle on each tooth, apex acute. Traps on leafsegments or on stems without leaf, with shortly stalk, 0.1-0.2 mm, oblique ovate, 1-2.5 wide and 1.5-2 mm long. Antennae on mouth of traps much branched, 2 mm long.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Afghanistan), Europe.

Distribution in Iran: North.

Specimens examined: Iran: Mazandaran province: Beginning road of Chalos to Nowshahr, under bridge, 8 m, Dinarvand & Mohammadi 8787 (Khuzestan Herbarium!).

U. vulgaris L. (Fig. 6c)

Submerged plant. Stems filiform, monomorphic, all green, Internod 4-8 mm. Leaves alternate, monomorphic, with 2 primary segments from the base, 1-2.5 cm long, oblong to ovate in outline, Secondary segments filiform, 5-7, pinnately divided, denticulate at margin, obviously with bristle on each tooth, rounded to ovate in outline. Traps on leaf segments, with shortly stalk, 0.1-0.2 mm, oblique ovate, 2.5 mm wide and 3 mm long. Antennae on mouth of traps much branched,

2-3 mm long. Inflorescent raceme, peduncle emerged, erect, 6-10 cm. Bracts amplexicaul, rounded at apex, 3 mm long. Flowers yellow, 5-6 mm long, pedicels 0.5-1 cm. Calyx 2 dimorphic lobes, connate at base, the upper with rounded and lower emarginated apex, 3 mm long. Corolla bilabiate with spure, lower lip flat and deflexed. Stamen 2, filament curved, 2 mm. Capsule globose, 2 mm long.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Afghanistan, Pakistan), Siberia, Europe, Africa, America.

Distribution in Iran: West.

Specimens examined: Iran: Kurdistan province: Marivan, Zarivar Lake, 1300 m, Dinarvand & Mohammadi 8312 (Khuzestan Herbarium!).

U. australis R. Br. (Fig. 6d)

Submerged plant. Stems filiform, monomorphic, all green, internod 1-1.5 cm. Leaves alternate, monomorphic, with 2 primary segments from the base, 1-1.5 cm wide and 2.5-3.5 cm long, oblong to ovate in outline, secondary segments filiform, more than 10, multipinnately divided, denticulate at margin, obviously with bristle on each tooth, oblong to ovate in outline. Traps on leaf segments, with shortly stalk, 0.2-0.4 mm, oblique ovate, 1.5 mm wide and 1.5-2 mm long. Antennae on mouth of traps much branched, 2-3 mm long. Inflorescent raceme, peduncle emerged, erect, 10-20 cm. Bracts amplexicaul, rounded at apex, 2-4 mm long. Flowers yellow, 5-7 mm long, pedicels 1-1.5 cm. corolla bilabiate with spure, lower lip flat and spreading. Calyx 2 dimorphic lobes, connate at base, the upper with rounded and lower emarginated apex, 3.5 mm long. Capsule globose, 2-5 mm long.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan), SE Asia, Palestine, Europe, Africa, Australia, America.

Distribution in Iran: North.

Specimens examined: Iran: Mazandaran province: Fereydon Kenar, Azbaran village, -5 m, Dinarvand & Mohamadi 8797 (Khuzestan Herbarium!); Gilan province: Anzali wetland, Mobayen (TUH!), Lahijan, 2 km S. Khazar, Amir Kalayeh wetland, Moradi 1529 (Gilan Agricultural and Natural Resources Research and Education Center!).

***Typhaceae* (*Sparganiaceae*)**

Key to the species in Iran

1. Stem erect. Leaves 1-1.5 cm wide. Female capitules 1-1.5 cm……2
1. Stem often floating or slightly prostrate. Leaves less than 7 mm wide. Female capitules up to 1 cm……3
2. Seed elliptic, light brown…….. *S. erectum* (subsp. *neglectum*)
2. Seed pyramid form, dark brown……. *S. erectum*
3. Leaves triangular in transverse section. Style 3-4 mm long. Seed elliptic…… *S. emersum*
3. Leaves flat, translucent. Style 1 mm long. Seed fusiform……. *S. natans*

Sparganium L. (Dinarvand 2017)

S. erectum L. (Fig. 6e)

Emerged plant, 50-100 cm tall. Rhizomatous. Stem erect. Leaves linear, 10-15 mm wide. Racemes crowded in a simple globose head, much branched. Male capitula 3-5 mm in diam. Stamens 3, anther 1 mm long. Female capitula with a short or long pedicel, always on leaf axils, 1-1.5 cm, stigmas, linear, 3-6 mm long. Seed elliptic or pyramid form, light to dark brown.

Flowering time: Spring to summer.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Iraq, Palestine), and Europe.

Distribution in Iran: Northwest and Center.

Specimens examined: Iran: Kurdistan province: Marivand, Zarivar Lake, 1300 m, Dinarvand & Mohamadi 8303 (Khuzestan Herbarium!); Chahar Mahale Bakhtiari province: Shahre Kurd, Mordabe Shams Abad, 2600 m, Mozaffarian 58178 (TARI!); Fars province: Bayza to Banesh, Kamfiroz, 1660 m, Dinarvand & Mohamadi 8679 (Khuzestan Herbarium!), 57 km from Shiraz to Dashte Arzhan, Salman spring, 1800 m, Zehzad & Taheri 67017 (TARI!).

S. erectum* s**ubsp. ***neglectum (Beeby) K. Richt.

Distribution in Iran: North.

Specimens examined: Iran: Mazandaran province: Fereydon Kenar, Azbaran village, Dinarvand & Mohamadi 8776 (Khuzestan Herbarium!); Gilan: Anzali wetland, Siah Darvishan, Wendelbo & Assadi 18326 (TARI!), Rasht to Astane, 11 km to Astane, Dinarvand 8185 (Khuzestan Herbarium!).

S. natans L.

Emerged or submerged-leaf floating plant, 30-40 cm tall. Rhizomatous. Stem slender, often floating or slightly prostrate. Leaves floating, flat, linear, 3-6 mm wide, often translucent. Racemes crowded in a simple globose head. Male capitula solitary, stamens 3, anther less than 1 mm long. Female capitula 2-3, sessile or with a short pedicel, always on leaf axils, up to 1 cm, style 1 mm long. Seed fusiform, 4-5 mm long.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Turkey), E Asia and Europe.

Distribution in Iran: Northwest.

Specimens examined: Iran: Ardabil province: 43 km from Ardabil to Khalkhal, Neor Lake to Karevansar Abbasi, 2620 m, Naghinezhad & Bidarlar 5002 (Herbarium of the University of Mazandaran).

S. emersum Rehmann

Emerged or submerged-leaf floating plant, 20-70 cm tall. Rhizomatous. Stem slender, often floating or slightly prostrate. Leaves floating, triangular in transverse section, linear, 4-7 mm wide. Racemes crowded in a simple globose head. Male capitula 3-6, stamens 3, anther 1-1.5 mm long. Female capitula 2-4, sessile or with a short pedicel, up to 1 cm, style 3-4 mm long. Seed elliptic, 4-5 mm.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Turkey), E Asia, Siberia and Europe.

Distribution in Iran: Northwest.

Specimens examined: Iran: Ardabil province: 43 km from Ardabil to Khalkhal, Neor Lake to Karevansar Abbasi, 2553 m, Naghinezhad & Bidarlar 3003 (Herbarium University of Mazandaran).

Alismataceae

Key to the genera in Iran

1. Flowers unisexual. Leaves sagitatte……..…… *Sagittaria*
1. Flowers bisexual. Leaves ovate, elliptic or lanceolate…….....……..……..2

2. Fruits schizocarp; carpels elliptic……. *Alisma*
2. Fruits multi carpel, stellate form……. *Damasonium*

Sagittaria trifolia L.

Emerged or submerged plant, 40-50 cm tall. Stoloniferous, stolons bearing tubers at tip. Leaves sagitatte, 5-35 cm long, 0.5-13 cm wide, acute, petiole 34-70 cm long. Inflorescences racemose, in 2-6 whorls of 2-3 flowers each, unisexual, white. Male flowers with pedicels 0.5-1.5 cm, stamens many, c. 20, filaments lanceolate, 1.5-2 mm long, anther elliptic, 1.5 mm long. Female flowers with pedicels 0.5-1.5 cm, sepals 3-4 mm long, petals broadly elliptic-suborbicular, 12-15 mm long. Achenes obovate, 1-1.5 mm long, winged, with an erect, apical beak.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Afghanistan, Pakistan), C Asia, SE Asia, Siberia and Europe.

Distribution in Iran: North.

Specimens examined: Iran: Mazandaran province: Road of Tonekabon to Ramsar, Ghahreman & Aghostin 5035 (TUH!); Gilan province: Kiashahr to Dastak, lale Vachsar, Dinarvand 8148 (Khuzestan Herbarium!), 12 km from Chaf to Leskoklaye, Zehzad, Norian, Pakravan, & Taheri 67228 (TARI!), N of Anzali wetland, Zehzad, Pakravan, & Taheri 67296 (TARI!), 1 km from Havigh to Hashtpar, 20m, Zehzad, Pakravan, & Taheri 67278 (TARI!).

Alisma L. (Dinarvand 2017)

Key to the species in Iran

1. Anthers suborbicular. Style recurved, shorter than the ovaries. Petiole 3.5-10 cm long……. *A. gramineum*
1. Anthers elliptic-oblong. Style erect, loner than the ovaries. Petiole more than 10 cm long……. 2
2. Leaves broadly lanceolate, gradually narrowed at the base into petiole. Petals acute……. *A. lanceolatum*
2. Leaves broadly elliptic or ovate rarly lanceolate, cordate at the base. Petals obtuse……. *A. plantago-aquatica*

A. plantago-aquatica L. (Fig. 6f)

Emerged or submerged plant, 35-120 cm tall. Rhizomatous. Leaves broadly elliptic to ovate rarly lanceolate, 6-16.5 cm long, 3-12 cm wide, apex acute, cordate at the base, petiole 5-45 cm long. Inflorescences racemose, in 3-8 whorls, flowers bisexual, sepals 3, 2-3 mm long, petals 3, 2-3 mm long, white or purplish white, obtuse. Stamens 6, anthers elliptic, less than 1 mm long, style erect, loner than the ovaries. Fruits schizocarp, 4-5 mm in diam., achenes elliptic or suboblong, 2 mm long.

Flowering time: Spring to summer.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Palestine, Iraq), C Asia, Siberia, Europe, India and Africa.

Distribution in Iran: North, Northwest, West and South.

Specimens examined: Iran: Mazandaran province: Chalos to Nowshahr, 8 m, Dinarvand & Mohamadi 8773 (Khuzestan Herbarium!), Sari, Tajan River, 50 m, Dinarvand & Mohamadi 8783 (Khuzestan Herbarium!); Gilan province: Kiasar to Dastak, Lale Vachesar, Dinarvand 8146 (Khuzestan Herbarium!), Amirkalaye wetland, Dinarvand 8203 (Khuzestan Herbarium!), Astara to Talesh, Dinarvand 8216 (Khuzestan Herbarium!), N of Anzali wetland, Zehzad, Pakravan & Taheri 67297 (TARI!), Anzali, Kaporchal, Abkenar, Ghahreman 5029 (TUH!), Siah Darvishan wetland, Wendelbo & Assadi 18336, 12 km from Chaf to Leskoklaye, Zehzad, Norian, Pakravan & Taheri 67233 (TARI!), 1 km from Havigh to Hashtpar, 20 m, Zehzad, Pakravan & Taheri 67277 (TARI!), 4 km from Asalem to Khalkhal, 200 m, Zehzad, Pakravan & Taheri 67322 (TARI!); Ardabil province: Ardabil to Khalkhal, 22 km SE of Bodalalo, 1465 m, Zehzad, Jamzad, Taheri

& Izadpanah 70586 (TARI!); Zanjan province: Zanjan to Mianeh, 89 km to Miane, Ghezel Ozan River, 1430 m, Zehzad, Jamzad, & Taheri 70469 (TARI!); Kermanshah province: Ravansar, 1350 m, Mozaffarian 83795 (TARI!); Kermanshah province: Kermanshah to Ravansar, Atar, Mirtajedini & Shakhol Eslami 19935 (TUH!); Fars province: Road of Tange boragh, to Ab Mahi, Near Mola Sadra dam, Dinarvand & Mohamadi 8676 (Khuzestan Herbarium!); Khuzestan province: Bostan, Mozaffarian 64375 (TARI!).

A. lanceolatum With.

Emerged plant, 60-75 cm tall. Rhizomatous. Stem erect. Leaves broadly lanceolate, 13-23 cm long, 2-5 cm wide, attenuate at the base, apex acuminate, petiole 30-32 cm long. Inflorescences racemose, in 3-6 whorls, flowers bisexual, sepals 3, 2-3 mm long, with membranous margins, petals 3, less than 2 mm long, white or purplish white, acute. Stamens 6, anthers elliptic, 1-1.2 mm long, style erect, loner than the ovaries. Fruits schizocarp, 5 mm in diam., achenes elliptic, 1.5 mm long.

Flowering time: Spring to summer.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Palestine, Iraq), C Asia, Siberia, Europe and Africa.

Distribution in Iran: North, Northwest, West, Center and South.

Specimens examined: Iran: Mazandaran province: Tiryash, Sharif 197.2 (IRAN!); Gilan province: Asiabar, Sile Dashte Bon, Pahlavani & Eskandari 51649 (IRAN!), E Azerbayjan province: Tasoj to Shabestar, 1220 m, Taheri & Izadpanah 68158 (TARI!), W Azerbayjan province: 4 km from Tomatar to Urmia, 1170 m, Izadpanah & Taheri 68248 (TARI!); Kurdistan province: Mahabad Lake, 1230 m, Izadpanah & Taheri 68347 (TARI!), Marivan, Zarivar Lake, 1300 m, Dinarvand & Mohamadi 8298 (Khuzestan Herbarium!), 78 km from Paveh to Kermanshah, between Cheshme Kabod and Kor,1380 m, Mozaffarian 27458 (TARI!); Fars province: Zerghan to Marvdasht, Esfandiari 198.3 (IRAN!), Khuzestan: Bostan, 20 m, Rohipour 1461(Khuzestan Herbarium!), 30 km from Mahshar to Hendijan, 3 m, Salehi 2995 (Khuzestan Herbarium!); Sistan va Baluchestan province: Zabol, Hamon Lake, 450 m, Ghahraman & Aghostin 5948 (TUH!), W of Zabol, Ghaem Abad, 450 m, Ghahraman 5948 (TUH!); Khorasan province: NW Kalat, Soltan Abad, 650 m, Joharchi & Zangoee 15672 (FUMH!).

A. gramineum Lej. (Fig. 6g)

Emerged plant, 35-45 cm tall. Rhizomatous. Stem erect. Leaves linear-lanceolate or ellipic, 4-6.5 cm long, 1.3-2 cm wide, attenuate at the base, apex obtuse, petiole 35-100 mm long. Inflorescences racemose, in 3-6 whorls, flowers bisexual, sepals 3, 2-3 mm long, with membranous margins, petals 3, 2-3 mm long, white or purplish white, obtuse. Stamens 6, anthers suborbicular, 1 mm in diam., style recurved, shorter than the ovaries. Fruits schizocarp, 5-8 mm in diam., achenes obovate, 3 mm long.

Flowering time: Spring to summer.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan), Europe and Africa.

Distribution in Iran: Northwest, West, Center and South.

Specimens examined: Iran: Zanjan province: Zanjan to Miane, 89 km to Miane, Ghezel Ozan River, 1430 m, Zehzad, Jamzad, & Taheri 70471 (TARI!); E Azerbayjan province: Ghori Gol Lake, 2050 m, 1430 m, Zehzad, Jamzad, Taheri & Izadpanah 70327 (TARI!); Fars province: Haft Barm wetland, 2180 m, Dinarvand & Mohamadi 8685 (Khuzestan Herbarium!); Khuzestan province: Shush, Sadat village, Bamdezh wetland, 100 m, Dinarvand & Mohamadi 8768

(Khuzestan Herbarium!), 30 km from Mahshar to Hendijan, 30 m, Salehi 2995 (Khuzestan Herbarium!); Khorasan province: Beshroyeh, Fath Abad dam, 1300 m, Faghihnia & Zangoee 17975 (FUMH!).

Damasonium alisma Mill.

Emerged plant, 35-40 cm tall. Rhizomatous. Stem erect. Leaves ovate or elliptic, 4.5-6.5 cm long, 2-3 cm wide, cordate at the base, apex obtuse or acute, petiole 15-17 cm long. Inflorescences racemose, in 1-9 whorls, flowers bisexual, sepals 3, 2 mm long, petals 3, 2 mm long, white. Stamens 6. Fruits multi carpel, stellate form, 10-12 mm in diam., carpel often 6, 5-7 mm long.

Flowering time: Spring.

Worldwide distribution: W Asia (Iran, Turkey, Palestine, Iraq, Syria), C Asia, Siberia, Europe and Africa.

Distribution in Iran: South.

Specimens examined: Iran: Khuzestan province: Masjed Solyman to Andica, 600 m, Mozaffarian 63030 (TARI!).

Butomaceae

Butomus umbellatus L. (Fig. 6h)

Emerged plant, 80-100 cm tall. Rhizomatous. Stemless. Scapes erect. Leaves all radical, linear, 65-80 cm long, 5-10 mm wide. Inflorescence umbellate, flowers numerous, bracts lanceolate to ovate, 15-25 mm long, pedicels 5.5-7.5 cm. Tepals 6, biseriate, elliptic to ovate, 7 mm long, pinkish white. Stamens 9, 6 mm long. Fruits 6-beaked follicle, obovate, 4 mm long.

Flowering time: Spring.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Palestine, Iraq), C Asia, Siberia and Europe.

Distribution in Iran: North, Northwest, West, Center and South.

Specimens examined: Iran: Mazandaran province: Chalos to Nowshahr, 8 m, Dinarvand & Mohamadi 8774 (Khuzestan Herbarium!), 5 km from Babolsar to Babol, Dinarvand & Mohamadi 8799 (Khuzestan Herbarium!), Tirtash, Sharif 3345 (IRAN!); Gilan province: Anzali, Siah Darvishan wetland, Wendelbo & Assadi 18338 (TARI!), Amir Kalayeh wetland, Ghahreman & Aghostin 5478 (TUH!), Anzali wetland, Mozaffarian & Maassoumi 6958 (TARI!); W Azerbayjan province: 30 km N of Khoy Lake, Ghezel Farja village, 2300 m, Assadi & Olfat 68744 (TARI!), Marand to Mako, 35 km to Mako, 1900 m, Assadi & Mozaffarian 30078 (TARI!), Salmas to Ghoshchi, Khan Takhti, 1400 m, Atar & Dadjo 18036 (TUH!), S of Urmia Lake, Somele River, 1300 m, Assadi & Akhani 61340 (TARI!), 10 km from Urmia to Mahabad, Ardeshahi village, 1280 m, Hamze & Asri 70945 (TARI!), Norozlo to Miandoab, 1 km after sogoli Tape, 1220 m, Izadpanah & Taheri 68385 (TARI!); Ardabil province: Ardabil to Khalkhal, 22 km SE of Bodalalo, Neor Lake, 1450 m, Zehzad, Jamzad, Taheri & Izadpanah 70528 (TARI!); Kurdistan province: 78 km from Paveh to Kermanshah, between Cheshme Kabod and Kur, 1380 m, Mozaffarian 27461 (TARI!); Hamadan province: Hamadan to Ghorveh, Gosh Tapeh, 1850 m, Mozaffarian 65016 (TARI!); Kermanshah province: Ravansar, Sarabe Nilofar, Ghahreman 5477 (TUH!), 15 km from Hamadan to Kermanshah, Atar & Mirtajediny 19855 (TUH!); Chahar Mahale Bakhtiari province: Shahrekord to Naghan, 2100 m, Mozaffarian 54857 (TARI!), Boldaji, Choghakhor wetland, 2100 m, Iranshahr & Mosavi 3342.1 (IRAN!); Fars province: Tange Boragh, Mola Sadra dam to Kamfiroz, 1890 m, Dinarvand & Mohammadi 8677 (Khuzestan Herbarium!), Eghlid, Dashte Bokan, Chahar Donge, 2000 m, Mozaffarian 71303 (TARI!); Khuzestan province: Andica, Shimbar wetland, 900 m, Dinarvand, s.n. (Khuzestan Herbarium!).

Fig. 6. Selected several aquatic plants of Iran in their habitats: a. *Utricularia minor*, b. *U.* × *ochroleuca* (recorded as new species by author), c. *U. vulgaris*, d. *U. australis*, (recorded as new species by author), e. *Sparganium erectum*, f. *Alisma plantago-aquatica*, g. *A. gramineum*, h. *Butomus umbellatus* (Photos by M. Dinarvand).

Hydrocharitaceae

Key to the genera in Iran

1. Leaves sessile……2
1. Leaves with obvious petiole……3
2. Perianth 2-lipped. Fruit an elliptic-oblong achene…… *Najas*
2. Perianth segments free. Fruit a fleshy and berrylike capsule……4
3. Freshwater. Lamina reniform or cordate…….. *Hydrocharis*
3. Marine herbs. Lamina elliptic…… *Halophila*
4. Stem short. Leaves all radical, linear and ribbonlike …….. *Vallisneria*
4. Stem elongated. Leaves cauline, whorled, lanceolate……. *Hydrilla*

Hydrocharis morsus-ranae L.

Emerged or submerged-leaf floating plant, erect stem absent, with obvious stolon. Leaves floating or emergent, lamina entire, cordate to reniform or suborbicular, 3-4 cm in diam., stipules 10-20 mm long, petiole 6-10 cm long. Flowers unisexual. Male flowers 1-4, on 3-5 mm long pedicles, sepals oblong, 4-8 mm long, 2-5 mm wide, brownish mottled, petals 8-18 mm long, 6-9 mm wide, white with yellow claw, stamens 6-12. Female flower without pedicles, ovary oblong-elliptic, 5-6 mm long. Fruits 5-10 mm long, 4-8 mm in diam. Seeds with mucilaginous hairs, broadly ellipsoidal, 1-1.5 mm long.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Turkey, Palestine), C Asia Europe, Africa and America.

Distribution in Iran: North.

Specimens examined: Iran: Gillan province: 2 km from Ghazian to Khomam, Taleb Abad, Zehzad, Pakravan & Taheri 67290 (TARI!), Anzali wetlan, Assadi & Akhani 61664 (TARI!).

Hydrilla verticillata (L f.) Royle (Fig. 7a)

Submerged plant. Stems elongated, branched, green. Leaves cauline, in whorls of 3-5, lanceolate, 13-17 mm long, 2-3 mm wide, apex acute. Obviouusly denticulate and cilliate at margin. Flowers unisexual. Male flowers with a green spathe, sepals 1.5-3 mm long, petals linear to spathulate, equalling the sepals, stamens 3. Female spathe green, ovary oblong, 3.5 mm long. Fruits 5-7 mm long. Seeds 2.5 mm long.

Flowering time: Autumn to winter.

Worldwide distribution: W Asia (Iran, Iraq, Afghanistan, Pakistan), India, Europe and Africa.

Distribution in Iran: North.

Specimens examined: Iran: Gilan province: Anzali wetland, Wendelbo & Assadi 18359 (TARI!), 2 km from Ghazian to Khomam, Taleb Abad, Zehzad, Pakravan & Taheri 67292 (TARI!), 10 km to Talesh, Khalesara village, Dinarvand 8231 (Khuzestan Herbarium!).

Vallisneria spiralis L. (Fig. 7b)

Submerged plant, with obvious stolon. Stem short. Leaves all radical, linear and ribbonlike, 10-35 cm long, 3-8 mm wide, margins faintly denticulate and cilliate to entire, apex obtuse. Flowers unisexual. Male peduncles 3-7 cm long, spathe 6 mm long, stamen solitary, anthers 6 mm long. Female spathe 1-2 cm long, bifid, Peduncle filiform, spirally, longer to nearly as long as leaves, sepals ovate 2 mm long. Fruits up to 20 cm long. Seeds fusiform to cylindrical, 1.5-3 mm long.

Flowering time: Spring to summer.

Worldwide distribution: W Asia (Iran, Afghanistan, Pakistan, Palestin, Iraq), C Asia and Europe.

Distribution in Iran: North, Southwest, Southest.

Specimens examined: Iran: Gilan province: Anzali wetland, Ghahreman 473261 (TUH!); Ilam province: Seymare River, 920 m, Dinarvand & Mohamadi 8284 (Khuzestan Herbarium!); Khuzestan province: Andimeshk, Pole Naderi, Karkhe River, Dinarvand 8087 (Khuzestan Herbarium!), Shush, Shavoor River, Dinarvand 8083 (Khuzestan Herbarium!), Shush, Radadeh village, Shavoor River, Dinarvand 8344 (Khuzestan Herbarium!), Shush, Abdolkhan village, Dinarvand & Adel 8602 (Khuzestan Herbarium!), Shadegan wetland, Dinarvand & Assadi 8363 (Khuzestan Herbarium!), Ahvaz, Alhaee village, Dinarvand 8437 (Khuzestan Herbarium!), Bostan to Chazabe, Soble River, Dinarvand 8272 (Khuzestan Herbarium!), Ahvaz, Karoon River, Dinarvand 8360 (Khuzestan Herbarium!), Dezful, Hamid Abad village, Dez River, Dinarvand 8079 (Khuzestan Herbarium!); Sistan va Baluchestan province: Zabol, Khaje, Hamon wetland, Mozaffarian 63470 (TARI!).

Halophila ovalis (R.Br.) Hook.f. (Fig. 7c)

Marine submerged plant. Stem creeping, internodes 1.5-3 cm, nodal scabby suborbicular to obovate, 3-4 mm long, membranous, transparent, faintly keeled. Leaves 1-paired at each node, lamina elliptic, 16-18 mm long, 5-6 mm wide, entire, apex obtuse, petiole 10-13 mm, membranous, transparent. Flowers unisexual. Male spathes broadly lanceolate, 3.5 mm long, perianth segments elliptic, 3.5 mm long, stamens 3. Female spathes broadly lanceolate, with a neck at apex, stigmas and styles 3. Fruits ellipsoid-globose, 3-4 mm in diam., beak 4-5 mm. Seeds numerous, 1 mm long.

Flowering time: Autumn to winter.

Worldwide distribution: W Asia (Iran, Pakistan, Palestine), Saudi Arabia, E Asia and Australia.

Distribution in Iran: South.

Specimens examined: Iran: Hormozgan province: Hormoz Island, Emamzadeh Khazr, tidal line, Dinarvand 8352 (Khuzestan Herbarium!).

Najas L. (Dinarvand 2017)

Key to the species in Iran

1. Stem spiny. Leaves more than 2 mm wide, with conspicuously deltoid spines; sheath entire……. *N. marina*
1. Stem not spiny. Leaves less than 1 mm wide, with minute spines on marginal teeth. Sheath auriculate…….2
2. Fruits slightly recurved at aex……..…….. *N. minor*
2. Fruits no recurved……..…….3
3. Auricle lanceolate. Leaves 0.5-0.8 mm wide, linear, with more than 5.0 minute sp.ines on margin teeth….. *N. graminea*
3. Auricle truncate. Leaves 0.2 mm wide, filiform, with 6-12 minute spines on margin teeth……. *N. gracillima*

N. marina L. (Fig.7d)

Submerged plant. Stem fleshy, armed with spines. Leaves fleshy, lamina oblong-linear, 10-25 mm long, 2-5 mm wide, with conspicuously deltoid spines, sheath rounded, 3-4 mm long, entire. Flowers unisexual. Male flowers 4-5 mm long, enclosed in spathe, stamen 1, anther 3-4 mm long. Female flowers without spathe, solitary or binary, 4-5 mm long, stigmas 3 lobed, 2-3 mm long. Fruits elliptic to oblong achene, 4-6 mm long, 2 mm wide.

Flowering time: Spring to summer.

Worldwide distribution: W Asia (Iran, Turkey, Pakistan, Iraq), Saudi Arabia, SE Asia, Europe, Africa and Australia.

Distribution in Iran: North, West, South.

Specimens examined: Iran: Gilan province: Amirkalaye wetland, Moradi 80493 (Gillan Agricultural and Natural Resources Research and Education Center!); Kermanshah province: Ravansar, Sarabe Nilofar wetland, 1320 m, Dinarvand & Mohammadi 8279 (Khuzestan Herbarium!); Lorestan province: Pole Dokhtar, Lefone wetland, Dinarvand & Mohammadi 8708 (Khuzestan Herbarium!); Fars province: Parishan wetland, 700 m, Zehzad & Taher 66996 (TARI!); Khuzestan province: Shadegan wetland, Sarabehe village, Dinarvand & Assadi 8365 (Khuzestan Herbarium!), Hor-al Azim, 5 m, Mozaffarian 66278 (TARI!); Kerman province: Sirjan, Barown 30974 (IRAN!).

N. minor All.

Submerged plant. Stems branched in upper part. Leaves linear, usually recurved, 25-30 mm long, less than 1 mm wide, minute spines on margin teeth, apex acute with 1-2 teeth, sheath auriculat, auricle rounded or truncate, 1-2.5 mm long, 2-3 mm wide, with obvious teeth on each side. Flowers unisexual. Male flowers enclosed in a spathe, 1 mm long, stamen 1, anther 1-thecous. Female flowers, solitary or binary, 3 mm long, ovary elliptic, stigmas 2-3 lobed. Fruit slightly recurved at aex. 2-3.5 mm long.

Flowering time: Spring.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Palestine, Iraq), Saudi Arabia, C Asia, SE Asia, Europe and Africa.

Distribution in Iran: North, West, Southwest, Southest.

Specimens examined: Iran: Mazandaran province: Ghaemshahr, Siah-Rood River, 28 m, Dinarvand & Mohammadi 8789 (Khuzestan Herbarium!), Ghaemshahr, Shahpour bridge, before Shirgah, 160 m, Dinarvand & Mohammadi 8814 (Khuzestan Herbarium!), Freydon Kenar, Azbaran village, Dinarvand & Mohammadi 8803 (Khuzestan Herbarium!), Sari, Tajan River, 50 m, Dinarvand & Mohammadi 8781 (Khuzestan Herbarium!); Gilan province: Talesh to Astara, 15 km to Astara, Dinarvand 8225 (Khuzestan Herbarium!), Ilam: Seymare River, 920 m, Dinarvand & Mohammadi 8283 (Khuzestan Herbarium!); Lorestan province: Poledokhtar, Lefone wetland, Dinarvand & Mohammadi 8712 (Khuzestan Herbarium!); Khuzestan province: Dezful, Hamid Abad village, Dez River, 80 m, Dinarvand & Adel 8604 (Khuzestan Herbarium!), Shushtar to Gotvand, Mandeli, Dinarvand 8141 (Khuzestan Herbarium!), Ahvaz to Shush, Elhaee village, Dinarvand 8435 (Khuzestan Herbarium!); Sistan va Baluchestan province: Hamon wetland, Sharif 30975 (IRAN!).

N. graminea Delile

Submerged plant. Stems branched in upper part. Leaves linear, 10-12 cm long, 0.5-0.8 mm wide, with more than 50 minute spines on margin teeth, apex acute, sheath auriculate, auricle lanceolate, 2 mm long, serrulate with several teeth on each side. Flowers unisexual, solitary, or sometimes 2 or 3 together. Male flowers enclosed in a spathe, 1 mm long, stamen 1, anther 4-thecous. Female flowers, solitary or binary, 2 mm long, ovary elliptic, stigmas 2-lobed. Fruit oblong-ellipsoid, 3-3.5 mm long.

Flowering time: Spring.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Iraq), Saudi Arabia, C Asia, SE Asia, Europe and Africa.

Distribution in Iran: North and Southwest.

Specimens examined: Iran: Gilan province: Lahijan, Hasan Bekandeh, Amir Kalayeh wetland, Naqinezhad 21428 (TUH!); Khuzestan province: Andica, Abzalo wetland, Dinarvand & Mohammadi 9088 (Khuzestan Herbarium!).

N. gracillima (A. Braun ex Engelm) Magnus

Submerged plant. Stems filiform, branched in upper part. Leaves linear to filiform, 10-12 mm long, 0.2 mm wide, with 6-12 minute spines on margin teeth, apex acute, sheath auricular, auricle truncate, 2 mm long, serrulate with 2-4 teeth on each side. Flowers unisexual. Male flowers elliptic, 1-1.5 mm, stamen 1, anther 1-thecous. Female flowers 2-3 mm, stigmas 2-lobed. Fruit linear-ellipsoid, 2-3 mm long.

Flowering time: Spring.

Worldwide distribution: Asia, Europe and America.

Distribution in Iran: Southwest.

Specimens examined: Iran: Khuzestan province: Ahvaz to Shush, Elhaee village, Dinarvand 8040 (Khuzestan Herbarium!).

Juncaginaceae

Triglochin L. (Dinarvand 2017)

Key to the species in Iran

1. Fruits 6 elliptic mericarps. Carple trigonal, 2-3 mm wide…….....…..…….. *T. maritima*
1. Fruits 3 linear mericarps. Carple cylindrical, less than 1 mm wide……..…….....…….. *T. palustris*

T. maritima L. (Fig. 7e)

Emerged plant, 30-55 cm tall. Rhizomatous. Stemless. Scapes erect. Leaves rush-like, linear-subulate, fleshy, 5-35 cm long, 3-4 mm wide. Raceme 20-22 cm long, Flowers 3 mm long, pedicel 1-2 mm long, perianth segments 1-3 mm long, white to greenish, stamens 6, carpels 6, trigonal, 2-3 mm wide. Fruit 6 elliptic mericarps, 2-3 mm long, 2-3 mm wide, slightly grooved on the back.

Flowering time: Spring.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan), C Asia, SE Asia, Europe and India.

Distribution in Iran: North, Northwest and Northeast.

Specimens examined: Iran: Ardabil province: 57 km from Khalkhal to Asalem, 1950 m, Maassoumi 80098 (TARI!), 45 km W of Neor, Lisar protected area, 2450 m, Froughi & Assadi 13773 (TARI!), Arasbaran, W of Makidi, 1500 m, Assadi & Maassoumi 20200 (TARI!), 22 km SE of Bodalalo, Neor Lake, Zehzad, Jamzad, Taheri & Izadpanah 70572 (TARI!), Sarab to Ardabil, 1 km after mijmir village, Dinarvand & Mohammadi 8323 (Khuzestan Herbarium!); E Azerbayjan province: 30 km NE of Marand, Koh Kamar village, 2000 m, Assadi & Shahsavari 65612 (TARI!), Sahand, between Lighvan and Esperkhan, 2200 m, Assadi & Mozaffarian 30619 (TARI!); W Azerbayjan province: Khoy to Mako, Kelisa Kendi, 1930 m, Assadi & Mozaffarian 30246 (TARI!), Urmia, Khosha Koh, 1800 m, Maassoumi & Nikchehreh 80247 (TARI!); Kurdistan province: 25 km from Divandareh to Sanandaj, Ebrahim Abad village, Maassoumi & Safavi 86015 (TARI!); Khorasan province: Mashhad to Torbate Heydarieh, Between Robat Sefid and Assad Abad, Alang Mohammad Mirza, 1900 m, Joharchi & Zangoee 17215 (FUMH!), Mashhad, Fariman, Kate Gosh, Faghihnia & Zangoee 20433 (FUMH!); Semnan province: Shahrood, Mojen, Sangbon, Shahkoh, 2450 m, Termeh, Mosavi & Tehrani 22547.3 (IRAN!), 30 km W of Shahrood, between Tash and Chahar Bagh, 2400 m, Assadi & Maassoumi 21175 (TARI!); Tehran province: 22 km from Firozkoh to Semnan, 2200 m, Assadi & Mozaffarian 35323 (TARI!); Ghazvin province: Abgarm, Asiab to Ederjin, 1700 m, Maassoumi & Mirhosseini 59422 (TARI!).

T. palustris L.

Emerged plant, 35-50 cm tall. Rhizomatous. Stemless. Scapes erect. Leaves rush-like, linear-subulate, fleshy, 5-25 cm long, 1.5-2 mm wide. Raceme 15-25 cm long, Flowers 1 mm long, pedicel 2-3 mm long, perianth segments 1-1.5 mm long, white to greenish, stamens 6, Carpels 6, cylindrical, less than 1 mm wide. Fruit 3 linear mericarps, 4 mm long, 1 mm wide, slightly grooved on the back.

Flowering time: Spring.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Iraq), C Asia, SE Asia, Europe and India.

Distribution in Iran: North, Northwest and Northeast.

Specimens examined: Iran: Ardabil province: 42 km W of Neor, Lisar protected area, 2450 m, Froughi & Assadi 13752 (TARI!), Bostan Abad to Ardabil, 1600 m, Assadi, Taheri & Izadpanah 69113 (TARI!), 30 km NW of Marand, Koh Kamar village, 2600 m, Assadi & Shahsavari 65617 (TARI!); E Azerbayjan province: Sofian to Marand, 1450 m, Assadi, Taheri & Izadpanah 68498 (TARI!), Palasht to Aras Lake, 730 m, Taheri & Izadpanah 68419 (TARI!), 50 km W of Khoy Lake, Pilesavar village, 2350 m, Assadi & Olfat 68855 (TARI!), Yazd: Shirkoh, Dehbala, Lajerd valley, 2400 m, Mozaffarian 77658 (TARI!); Chahar Mahale Bakhtiari province: Boldaji to Gandoman, Nasir Abad, 2200 m, Mozaffarian 57340 (TARI!); Fars province: Abadeh to Oghlid, Azadegan wetland, Terme & Izadyar 22550.1 (IRAN!); Khorasan province: N of Kashmar, 1 km after chlpo, 1857 m, Memariani & Zangoee 38925 (FUMH!), Torbate Heidarye, Yarfazli valley, near River, 2100 m, Faghihnea & Zangoee 22305 (FUMH!), NE Birjand, Noghand, 1950 m, Zangoee & Hosseinzadeh 24204 (FUMH!), Daregaz, S of Allah Akbar mountain, 1400m, Joharchi 18975 (FUMH!); Semnan province: 30 km NW Shahrood, between Tash and Chaharbagh, 2300 m, Assadi & Maassoumi 21137 (TARI!); Tehran province: Firozkoh, Lezor, Mishine Marg mountain, 3400 m, Mozaffarian 54228 (TARI!).

Ruppiaceae

Ruppia L. (Dinarvand 2017)

Key to the species in Iran

1. Peduncle more than 7 cm and spirally twisted in fruit. Nutlets 3-4 mm long. Leaves 0.5 mm wide…..... *R. cirrhosa*
1. Peduncle less than 3 cm and not spirally twisted. Nutlets 2-2.5 mm long. Leaves 0.1-0.2 mm wide……... *R. maritima*

R. maritima L. (Fig. 7f)

Submerged plant, with long white stems. Leaves alternate, linear filiform, more than 5 cm long, 0.1-0.2 mm wide, sheating at base, 10-12 mm long. Inflorescent spike with 2 flowers, axillary, raising from opposite leaves, peduncle less than 3 cm and not spirally twisted. Periant lacking. Stamens around of carpels, anthers sessile. Carpels numerous usually 4-6, free, at first sessile and then with 8-10 mm stipes. Nutlets oblique conical, 2-2.5 mm long, dark brown or black.

Flowering time: Spring.

Worldwide distribution: W Asia (Iran, Turkey, Pakistan, Iraq, Palestine), C Asia, Europe, Saudi Arabia, India and America.

Distribution in Iran: North, West, South and Northeast.

Specimens examined: Iran: Golestan province: Aji Gol wetland, Tangoli village, 19 m, Dinarvand & Mohammadi 8805 (Khuzestan Herbarium!); Hamadan province: Zanjan to Hamadan, after Khodabandeh, Shirinso wetland, 1838 m, Dinarvand & Mohammadi 8324 (Khuzestan Herbarium!); Fars province: E of Bakhtegan wetland, W of Kharame, 1400 m, Zehzad & Taheri 66982 (TARI!); Bushehr province: Righ Mohammadi to Bido, Shour River, 5 m, Dinarvand & Mohammadi 8699 (Khuzestan Herbarium!); Khuzestan province: Shushtar, Arab Hassan village, 100 m, Dinarvand 8148

(Khuzestan Herbarium!), Ahvaz to Shush, Alhaee village, 100 m, Dinarvand 8052 (Khuzestan Herbarium!), Ahvaz to Khoramshahr, 90 km to Khoramshahr, Dinarvand 8100 (Khuzestan Herbarium!), Shadegan wetland, Dinarvand 8092 (Khuzestan Herbarium!), Ahvaz to Bostan, 20 km to Bostan, Dinarvand 8088 (Khuzestan Herbarium!), Hor Al azim wetland, Dinarvand, Hassanzadeh, Howizeh & Mohammadi 8429 (Khuzestan Herbarium!); Khorasan province: Sarakhs, N of Bazangan Lake, 860 m, Gholami 34347 (FUMH!).

R. cirrhosa (Petagna) Grande (Fig. 7g)

Submerged plant, with long white stems. Leaves alternate, linear filiform, more than 5 cm long, 0.5 mm wide, sheating at base, 10-12 mm long. Inflorescent spike with 2 flowers, axillary, raising from opposite leaves, peduncle more than 7 cm and spirally in fruit. Periant lacking. Stamens around of carpels, anthers sessile. Carpels numerous usually 4-6, free, at first sessile and then with 8-10 mm stipes. Nutlets oblique conical, 3-4 mm long, dark brown or black.

Flowering time: Spring.

Worldwide distribution: W Asia (Iran, Turkey, Palestine), Siberia, Europe, Africa and America.

Distribution in Iran: North, West and South.

Specimens examined: Iran: Golestan province: Gorgan, S of Miankaleh wetland, Dinarvand & Mohammadi 8786 (Khuzestan Herbarium!), Gorgan Gulf, Dinarvand & Mohammadi 8809 (Khuzestan Herbarium!), Gomishan wetland, Dinarvand & Mohammadi 8808 (Khuzestan Herbarium!); W Azerbayjan province: Urmia to Naghadeh, Shore Gol wetland, 1300 m, Dinarvand & Mohammadi 8309 (Khuzestan Herbarium!); Khuzestan province: Andica, after Masjed Solyman dam, Dinarvand & Adel 8250 (Khuzestan Herbarium!).

Cymodoceaceae

Key to the genera in Iran

1. Rhizome woody. Leaves 7-8 mm wide, denticulate; apex rounded and ciliated……..……. *Thalassodendron*
1. Rhizome herbal. Leaves less than 1 mm wide, entire; apex dentate……..……..……. *Halodule*

Thalassodendron ciliatum (Forssk.) Hartog (Fig. 7h)

Marine submerged plant. Rhizome woody, robust and creeping, 3-5 mm in diam., nodal scabby perfoliate, lanceolate, 10 mm long. Stem erect, borne on node of rhizome, articulate, 9-15 cm long. Leaves curved linear, 10-13 cm long, 7-8 mm wide, denticulate, apex rounded and ciliated, sheath 2-3 cm long. Flowers unisexual. Male flower solitary, stamens 2. Female flower binary, with 2 free ovaries, stigmas bifid, filiform. Fruit sometime viviparous, consisting of 2 free ovaries and a fleshy innermost bract.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Palestine), SE Asia, Saudi Arabia, Africa and Australia.

Distribution in Iran: South.

Specimens examined: Iran: Sistan and Baluchestan province: Chabahar Gulf, tidal line, Dinarvand & Sharaki 8424 (Khuzestan Herbarium!).

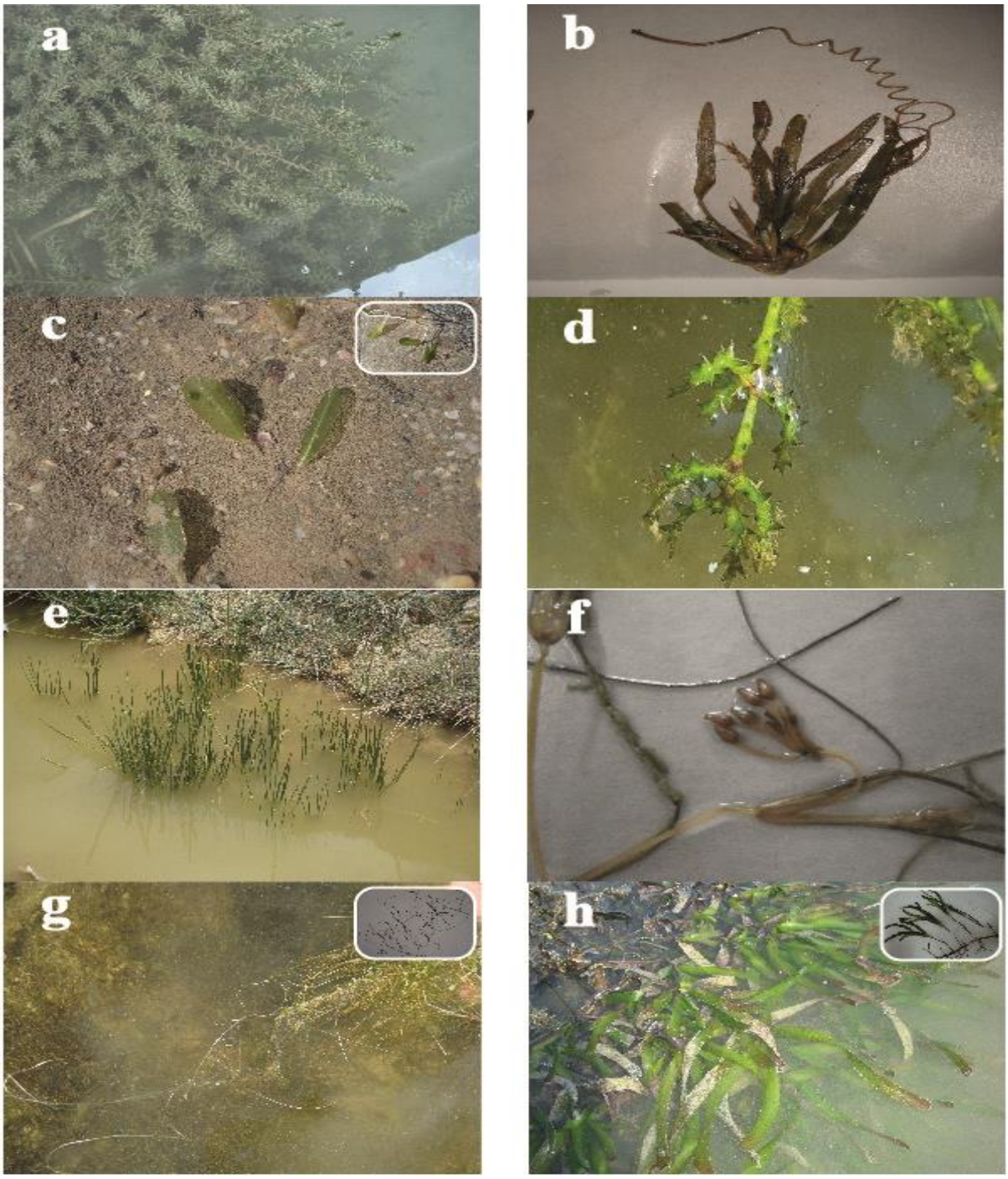

Fig. 7. Selected several aquatic plants of Iran in their habitats: a. *Hydrilla verticillata*, b. *Vallisneria spiralis*, c. *Halophila ovalis*, d. *Najas marina*, e. *Triglochin maritima*, f. *Ruppia maritima*, g. *R. cirrhosa* (recorded as new species by author), h. *Thalassodendron ciliatum* (Photos by M. Dinarvand).

Halodule wrightii Asch. (Fig. 8a)

Marine submerged plant. Rhizome herbal, creeping, 0.8-1 mm in diam., nodal scabby elliptic or ovate. Stem erect, borne on node of rhizome, articulate, 5-10 cm long. Leaves linear, 7-15 cm long, less than 1 mm wide, entire, apex dentate. Sheath 3-5 cm long. Flowers unisexual. Male flower stalked, peduncle 10-25 mm, stamens 2. Female flower subsessile, with 2 free ovaries. Fruits ovoid to subglobose, consisting of 2 free ovaries.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Palestine), Saudi Arabia, Africa, America and Australia.

Distribution in Iran: South.

Specimens examined: Iran: Hormozgan province: Bandar Abas, tidal line, near airport, Dinarvand 8350 (Khuzestan Herbarium!), Hormoz island, Khazre Nabi, tidal line, Dinarvand 8351 (Khuzestan Herbarium!), Minab, Korahi, tidal line, Dinarvand 8353 (Khuzestan Herbarium!).

Sphenocleaceae

Sphenoclea zeylanica Geartn. (Fig. 8b)

Emerged to semi-aquatic annual herb, 45-90 cm tall. Stem erect, branched in upper part, fleshy and more or less hollow. Leaves lanceolate, 4.5-8 cm long, 6-10 mm wide, entire, petiole 3-5 mm long. Spike 3-5 cm long, bracts and bracteoles short, spathulate. Flowers 2 mm long, calyx 5-lobed, lobes ovate, 1.5-2 mm long, corolla white, 2 mm long, stamens 5, less than 0.5 mm long. Capsule obconic, membranous, 5 mm in diam. Seeds numerous 0.5 mm long.

Flowering time: Spring.

Worldwide distribution: W Asia (Iran, Afghanistan, Pakistan) and E Asia.

Distribution in Iran: South.

Specimens examined: Iran: Khuzestan province: Sadat village, Bamdezh wetland, 35 m, Dinarvand 8822 (Khuzestan Herbarium!), Ahvaz to Shush, Between Albaji and Shavoor, 80 m, Mozaffarian 72217 (TARI!).

***Plantaginaceae* (*Callitrichaceae*)**

Callitriche L. (Dinarvand 2017)

Key to the species in Iran

1. Fruits with obvious pedicel, 5 mm long…….…..…..…… *C. brutia*
1. Fruits sessile…….....…… *C. palustris*

C. brutia Petagna

Submerged plant, upper part floating, up to 30 cm tall. Stem thin, branched. Upper leaves sessile, forming a rosette, obovate, 10 mm long, 3 mm wide, entire, obtuse, lower leaves linear, truncate base, 10-20 mm long, 0.8-1 mm wide. Flowers unisexual, one or two on per axil, sessile. Male flower with 2 bracts, oblong, 1 mm long, 0.5 mm wide, stamen 1. Female flower with 2 bracts, oblong, less than 1 mm long, 0.4 mm wide, styles 2, filiform. Fruit with obvious pedicel, 5 mm long, schizocarps separating into 4 nutlets, winged, obovate.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Turkey), Siberia, Europe and Africa.

Distribution in Iran: North.

Specimens examined: Iran: Gilan province: Langrod, Dioshel to Dioshel Poshte, 60 m, Naqinezhad 27846 (TUH!).

C. palustris L.

Submerged plant, upper part floating, up to 25 cm tall. Stem thin, branched. upper leaves sessile, forming a rosette, broadly elliptic to obovate, 10 mm long, 3 mm wide, entire, obtuse, lower leaves linear, truncate base, 8-20 mm long, 0.5-1 mm wide. Flowers unisexual, one or two on per axil, sessile. Male flower with 2 bracts, oblong, 1 mm long, 0.5 mm wide, stamen 1. Female flower with 2 bracts, oblong, less than 1 mm long, 0.4 mm wide, styles 2, filiform. Fruits sessile, schizocarps separating into 4 nutlets, winged only at apex, obovate.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Palestine) Siberia and Europe.

Distribution in Iran: North.

Specimens examined: Iran: Gilan province: Anzali wetland, Mozaffarian & Maassoumi 6923 (TARI!).

***Araceae* (*Lemnaceae*)**

Key to the genera in Iran

1. Roots absent. Fronds veinless, less than 1 mm long……..…….…….. *Wolffia*
1. Roots present. Fronds with obvious veins, more than 1 mm long……..…..…… 2
2. Root solitary on each frond. Fronds submerged or floating……..…….....…….. *Lemna*
2. Roots not solitary (7-10). Fronds floating…….....…….. *Spirodela*

Spirodela polyrrhiza (L.) Schleid. (Fig. 8c)

Free floating plant. Roots 7--10, 10-35 mm long, sheath cap 1.5-2 mm long, acute. Fronds asymmetrical, obovate, 4.5-9 mm long, 4-7 mm wide, entire, obtuse or rounded at apex, 7-12 veines.

Flowering specimens not seen in Iran.

Worldwide distribution: W Asia (Iran, Turkey, Pakistan, Palestine) C Asia, Europe, America and Australia.

Distribution in Iran: North.

Specimens examined: Iran: Mazandaran province: Ghaemshahr, Shahpour bridge, before Shirgah, 160 m, Dinarvand & Mohammadi 8816 (Khuzestan Herbarium!), Ghaemshahr, Siah-Rood River, 28 m, Dinarvand & Mohammadi 8791 (Khuzestan Herbarium!), Ferydon Kenar, Azbaran village, 5 m, Dinarvand & Mohammadi 8804 (Khuzestan Herbarium!), Sari, Tajan River, 50 m, Dinarvand & Mohammadi 8785 (Khuzestan Herbarium!); Gilan province: Radarkhale, 5 km from Chaf to Chamkhane, Zehzad, Norian, Pakravan, & Taheri 67236 (TARI!), Havigh to Hashtpar, 20 m, Zehzad, Pakravan, & Taheri 67283 (TARI!), Anzali wetland to Abkenar, Iranshahr 29586 (IRAN!), Lahijan, Hasan Bekandeh, Amir Kalayeh wetland, Naqinezhad 21408 (TUH!).

Lemna L. (Dinarvand 2017)

Key to the species in Iran

1. Plant submerged. Fronds forming chains, lanceolate to oblong, acute at apex, with obviouse stalk (4-12 mm long)……..……..…….....…… *L. trisulca*
1. Plant floating. Fronds not forming chains, ovate, obovate, elliptic or orbicular, obtuse; stalk absent or very short……..…….....…….2
2. Fronds with spongy air meshes under surface…….…….....…… *L. gibba*
2. Frond without spongy air meshes under surface…….....…….. 3
3. Frond less than 2 mm long; cap obtuse……..…….…….....……. *L. minor*
3. Frond 3-4 mm long; sheath winged; Cap acute…….…….…….....…… *L. perpusilla*

L. gibba L. (Fig. 8d)

Free floating plant. Root solitary, 1-8 cm long, sheath cap 3-4 mm long, acute. Fronds with spongy air meshes under surface, asymmetrical, ovate or orbicular, 2-4.5 mm long, 1.5-3.5 mm wide, entire, obtuse or rounded at apex, with 3-5 veines.

Flowering specimens not seen in Iran.

Worldwide distribution: W Asia (Iran, Turkey, Pakistan, Palestine) Europe, India, Africa and America.

Distribution in Iran: North, Northwest, West, Center and South.

Specimens examined: Iran: Gilan province: 2 km from Ghazian to Khomam, Taleb Abad, Zehzad, Pakravan & Taheri 67295 (TARI!); W Azerbayjan province: Road of Miandoab to Urmia, 100 km to Urmia, 1280 m, Dinarvand & Mohammadi 8329 (Khuzestan Herbarium!), 5 km from Tasuj to Salmas, 1130 m, Taheri & Izadpanah 68171 (TARI!), Talatapeh to Urmia, Golemarz village, 1200 m, Taheri & Izadpanah 68337 (TARI!), Kermanshah: Islam Abad, 1400 m, Mozaffarian 74730 (TARI!); Chahar Mahale Bakhtiari province: 80 km from Izeh to Shahrekord, Dehno village, Dinarvand & Mohammadi 8245 (Khuzestan Herbarium!); Fars province: Bastak, 400 m, Iranshah & Terme 29589 (IRAN!); Khuzestan province: Ahvaz to Shadegan wetland, Dinarvand & Assadi 8366 (Khuzestan Herbarium!), Dezful, Sabili, Dinarvand 8078 (Khuzestan Herbarium!).

L. minor L. (Fig. 8e)

Free floating plant. Root solitary, 1-3.5 mm long, sheath cap 1.5-2 mm long, obtuse. Fronds, asymmetrical, elliptic or orbicular, 1-2 mm long, 1 mm wide, entire, obtuse or rounded at apex, with 3 veines.

Flowering specimens not seen in Iran.

Worldwide distribution: W Asia (Iran, Turkey, Pakistan, Palestine) C Asia, Europe, America and Australia.

Distribution in Iran: North and West.

Specimens examined: Iran: Mazandaran province: Kelardasht, Terme 29588 (IRAN!); Gilan province: Astara, Dinarvand 8173 (Khuzestan Herbarium!), 1 km from Havigh to Hashtpar, 20 m, Zehzad, Pakravan & Taheri 67284 (TARI!), Bozkia wetland, Zehzad, Norian, Pakravan & Taheri 67248 (TARI!), Chaf to Timchekhale, Zehzad, Norian, Pakravan & Taheri 67236 (TARI!), Lahijan, Amir Kalayeh wetland, Naghinezha 21396 (TUH!); Kurdistan province: 78 km from Paveh to Kermanshah, between Cheshme Kabod and Kor,1380 m, Mozaffarian 27463 (TARI!).

L. perpusilla Torr.

Free floating plant. Root solitary, 1-3.5 cm long, sheath winged, cap 2 mm long, acute. Fronds asymmetrical, obovate or rarly oblong, 3-4 mm long, 1.5-2.5 mm wide, entire, obtuse at apex, with 3 veines.

Flowering specimens not seen in Iran.

Worldwide distribution: The warm regions of world.

Distribution in Iran: North.

Specimens examined: Iran: Mazandaran province: E of Nowshahr, Chelendar, Wendelbo & Assadi 14590 (TARI!), Gilan: Asalem to Khalkhal, 200 m, Wendelbo & Assadi 18558 (TARI!); Ardabil province: Arasbaran protected area, Makidi, Assadi 22055 (TARI!); W Azerbayjan province: Mahabad, 1230 m, Izadpanah & Taheri 68346 (TARI!), Isfahan: Zayandeh-Rood River, 1320 m, Zehzad & Taheri 66864 (TARI!); Fars province: Tange Boragh, Mola Sadra dam to Kamfiroz, 2000 m, Dinarvand & Mohammadi 8674 (Khuzestan Herbarium!), 57 km from Shiraz to Kazeron, Dashte Arzhan, Salman spring, 1800 m, Zehzad & Taheri 67020 (IRAN!).

L. trisulca L.

Free submerged plant. Root solitary, 0.9-1.5 cm long, sheath cap 1-1.2 mm long, obtuse. Fronds forming chains, lanceolate to oblong, 5-10 mm long, 2-3 mm wide, acute at apex, stalk 4-12 mm long, with 3 veines.

Flowering specimens not seen in Iran.

Worldwide distribution: W Asia (Iran, Turkey, Afghanistan, Pakistan, Palestine) C Asia, Europe, Africa, America and Australia.

Distribution in Iran: North, West and Center.

Specimens examined: Iran: Gilan province: Radarkhane, 5 km from Chaf to Chamkhale, Zehzad, Norian, Pakravan, & Taheri 67236a (TARI!), Bozkia wetland, Zehzad, Norian, Pakravan & Taheri 67248d (TARI!), Anzali wetland, Ghahreman 28032 (TUH!), Lahijan, Amir Kalayeh wetland, Naqinezhad 21398 (TUH!); Kurdistan province: 48 km from Paveh to Kermanshah, Ravansar, 1430 m, Runemark & Mozaffarian 27443 (TARI!); Kermanshah province: Ravansar, 1400 m, Iranshahr & Terme 29584 (IRAN!); Fars province: Shiraz, Babahaji, 1500 m, Iranshahr & Terme 29585 (IRAN!).

Wolffia arrhiza (L.) Horkel ex Wimm.

Free floating plant. Root absent. Fronds 1 or 2, coherent, veinless, globular to eliptic, 0.5-0.9 mm in diam., often with 1 basal cavity reproducing daughter fronds.

Flowering specimens not seen in Iran.

Worldwide distribution: W Asia (Iran, Pakistan, Palestine), Europe and Africa.

Distribution in Iran: North.

Specimens examined: Iran: Gilan province: 2 km from Ghazian to Khomam, Taleb Abad, Zehzad, Pakravan & Taheri 67295a (TARI!), Bozkia wetland, Zehzad, Norian, Pakravan & Taheri 67248a (TARI!).

***Lythraceae* (*Trapaceae*)**

Trapa natans L. (Fig. 8f)

Submerged-leaf floating or sometime floating plant. Root pinnatifid to plumose, black free or rooted in the mud. Stem slender, unbranched. Floating leaves alternate, rosulate, lamina deltoid-rhombic, 2-4 cm long, 2-7.5 cm wide, above glabrous, below pubescent to villous, especially on the nerves, irregularly dentate and spiny at margin, petiole 5-12 cm long, with a fusiform swelling. Flower solitary, in the axils of the floating leaves, pedicels pubescent, sepals triangular, 5 mm long, pubescent, petals 5-8 mm long, white, stamens 4, 2-3 mm long. Nut with a prominent tetragonal to the rounded crown, or dome-shaped, rarely crownless, 2-4 cm long, black.

Flowering time: Spring.

Worldwide distribution: W Asia (Iran, Pakistan), Europe and Africa.

Distribution in Iran: North and Center.

Specimens examined: Iran: Gilan province: Anzali wetland, Dinarvand 8195 (Khuzestan Herbarium!), Somesara, Siah Darvishan wetland, Dinarvand 8950 (Khuzestan Herbarium!), 2 km from Ghazian to Khomam, Taleb Abad, Zehzad, Pakravan & Taheri 67286 (TARI!).

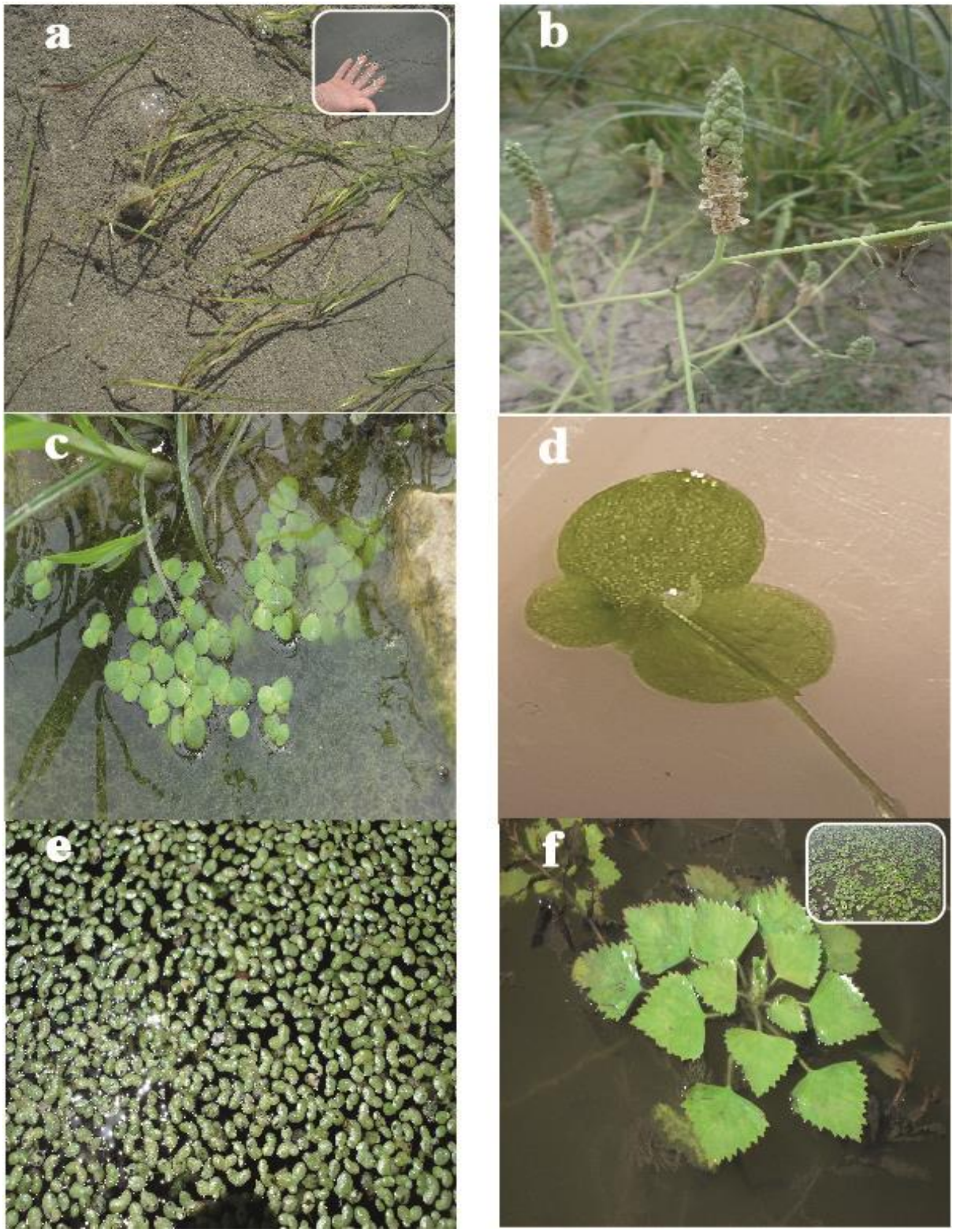

Fig. 8. Selected several aquatic plants of Iran in their habitats: a. *Halodule wrightii*, b. *Sphenoclea zeylanica*, c. *Spirodela polyrrhiza*, d. *Lemna gibba*, e. *L. minor*, f. *Trapa natans* (Photos by M. Dinarvand).

Pontederiaceae (Exotic)

Monochoria vaginalis (Burm.f.) C. Presl.

Emerged plant, 25-35 cm tall. Radical leaves with long petiole, up to 30 cm, lamina ovate and cordate at base, 5-6 cm long, 3-5 cm wide, apex acute to acuminate. Scapes 20-30 cm. Racem with 3-8 flowers, flowers 1 cm long, pedicellate 3-8 mm long. Perianth segments oblong to lanceolate, 8-10 mm long, purplish, stamens 6, 4-5 mm long. Capsule ovoid to ellipsoid, 7 mm long, 1-winged, ellipsoid, 0.8-0.9 mm long.

Flowering time: Summer.

Worldwide distribution: W Asia (Iran, Afghanistan, Pakistan), E Asia and America.

Distribution in Iran: North.

Specimens examined: Iran: Gilan province. Rudsar, Amlash, 40 m, Sharifi 68001 (TARI!).

Discussion

Turkey (with 9753 species) and Iran (with 8012 species) are the richest in species, in comparison to other Middle East countries (Ghazanfar & McDanile 2015). Historical floras such as Boissier's Flora Orientalis (1867–88), Parsa's Flore de l´Iran (1950–51), and Rechinger's Flora Iranica (1963–2012), cover most of the Flora of Iran.

To prepare the Flora of Iran in Persian and to review its vegetation as a national project of the Research Institute of Forest and Rangelands (Tehran, Iran), the total number of 66 species, one subspecies, two varieties, and two hybrids of vascular plants of the study area, belonging to 33 genera and 20 plant families have been identified. All of the angiosperms include 10 dicots with 17 species and 11 genera, as well as 10 monocots with 49 species and 22 genera. The richest families are *Potamogetonaceae* and *Hydrocharitaceae*. *Utricularia* L. with four species from dicots and *Potamogeton* L. with 14 species and one hybrid from monocots are the richest genera. However, the highest distribution belongs to *Ceratophyllum demersum* L., *Potamogeton crispus* L., *Potamogeton nodosus* Poir., and *Stuckenia pectinata* (L.) Borner. These species are problematic and have a high richness in the aquatic bodies of Pakistan (Gul *et al*. 2017). The families including *Alismataceae*, *Araceae*, *Butomaceae*, *Hydrocharitaceae*, *Juncaginaceae*, *Lentibulariaceae*, *Plantaginaceae*, *Potamogetonaceae*, and *Ruppiceae* are distributed in all neighboring countries (Kirim *et al*. 2014, Gul *et al*. 2017, Ikinci & Bayindir 2019, Khan *et al.* 2022).

In recent years and during this project, 14 taxa have been recorded for Iran and/or world by the authors and their colleagues (Dinarvand 2008, 2010, 2012, Abbasi *et al*. 2017, 2018, 2021). The other species that were identified by other botanists in Iran, including two species of *Sparganium erectum* L. and *Sparganium natans* L. from Neour Lake (Naqinezhad & Bidarlord 2015), *Potamogeton natans* L. from Golestan National Park (Akhani 1999), *Bergia capensis* L., *B. aquatica* Roxb. from Khoram Abad (Ghahreman & Visekarami 2000), and *Utricularia minor* L. from Mazandaran province (Naqinezhad *et al.* 2008). In the tidal line of the southern parts of Iran, on the Marin area, three species of seagrass were also collected *viz*., *Thalassodendron ciliatum* (Forssk.) Hartog, *Halodule wrightii* Asch., and *Halophila ovalis* (R.Br.) Hoo.f. which are very rare and limited to a small habitat. In the Red Data Book (Jalili & Jamzad 1999), these species are introduced as raric plants.

Aquatic ecosystems are subject to severe changes due to activities related to the construction of dams and lack of proper use of water resources, preventing the desalination of plains and drying of wetlands, particularly natural factors such as droughts, rising temperatures, and climate change. Following this, population decline and species extinction have recently led to the expansion of desert areas. In some countries with similar geographical conditions to Iran (Turkey and Pakistan), vascular aquatic plants are reduced (Kirim *et al*. 2014, Gul *et al*. 2017, Khan *et al.* 2022). Although, there are

around 50 families and 500 species in the wetlands of Turkey (Kirim *et al*. 2014, Ikinci & Bayindir 2019). Probably, the higher number of aquatic plants in Turkey is due to high precipitatioin. In the Flora Iranica (Dandy 1971), *Zosteraceae* with one genus and a single species was reported from Iran by an old collection by Haussknecht from the port of Anzali (Gilan province), on the shores of the Caspian Sea. In Flore de l´Iran, Parsa (1950), again mentioned the same collection of Haussknecht. In the present study, authors visited exactly the same area twice at two different times, but unfortunately failed to refind these specimens. Following the herbarium of Gilan University and Gilan Agricultural and Natural Resources Research and Education Center, authors found no samples collected there again. It should be noted that, the Caspian Sea coast in that exact area, has now turned to a promenade cum swimming area. Therefore, it seems that, this species has been eradicated from Iran.

Althenia filiformis F.Petit has been reported in the Flora Iranica (Dandy 1971) from Neyriz Lake, which seems to be Bakhtegan wetland, but in the study of collected samples, in the national herbaria of the country, particularly Shiraz University Herbarium, no such sample was observed. During field visits, it was unfortunately observed that, Bakhtegan Wetland, the only suspected habitat reported in Iran, has been dried up. Interestingly, in the Flora Iranica, it is mentioned that, this species needs to be reconsidered due to its distance from other habitats in Europe and Africa, while its presence in Iran is doubtful. In this research, the authors tried to find an example of the same in other neighboring areas, but unfortunately failed in this task. Therefore, it seems that, this species too has been eliminated or even has never been existed in Iran (Abbasi *et al*. 2019). In the Flora Iranica (Dandy 1971), *Blyxa* (*Hydrocharitaceae*), doubtfully attributed to the species *B. octandra* (Roxb.) Planch. ex Thwaites, was reported for Iran based on an old collection from Khuzestan province, but in this study and as well as collected samples of the different parts of Iran, by visiting the national herbaria and field investigations (especially from the mentioned habitat), no such sample was observed. In this relation, Dandy (*l.c.*) also mentioned that, he has not observed any specimen of this genus in Iran, and even if found, it must be *Blyxa aubertii* Rich. In general, the presence of this species in Iran is doubtful.

During the present investigation, some species such as *Damasonium alisma* Mill., *Potamogeton trichoides* Cham. & Schltdl., and *Wolffia arrhiza* (L.) Horkel ex Wimm. were not observed in the natural environment of Iran, therefore, it seems that, they are totally eradicated from the aquatic environment of the country. Because of repeated visits paid by authors during different seasons of the year in Iran, these reported species in previous sources could not be found again. In spite of this, authors have been lucky enough to find some dried specimens preserved along with other aquatic specimens of the herbarium sheets.

Conclusion

Of 183 vascular plant families in the flora of Iran, 57 families included as aquatic species, out of which only 21 species considered as true hydrophytes. Some of these taxa have the vast distribution and numerous species are being landlocked to a just special wetland or even a partial of it. A glance at the aquatic plants of Iran after 12 years (between 2008–20) field surveys, due to the exclusive and limited presence of some aquatic species in certain wetlands depending on the existence of water for survival, indicated that, these plants are at high risk of extinction. On the other hand, field observations showed that, the fragile ecosystems of these species are very sensitive to quantitative and qualitative changes. The harsh climate and human activities together with their impacts in various forms such as industrial, civil, and agricultural activities, changing aquatic resources, grazing, as well as developing artificial landscapes, are major reasons

for the gradual reduction of species richness. Aquatic species have fragile ecosystems that need strong management to survive.

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خلاصه

کشور ایران با مساحت ۱/۶۵ میلیون کیلومتر مربع در جنوب‌غربی آسیا واقع شده است. براساس تنوع اقلیمی و ساختار ژئوبوتانیکی، ایران بیشترین تنوع را دارد و با حدود ۷۸۶۴ گونه گیاهی آوندی، دومین کشور غنی پس از ترکیه در جنوب‌غربی آسیا است. گیاهان آوندی آبزی با تعداد ۲۳ تیره، حدود یک درصد از فلور ایران را تشکیل می‌دهند. جهت تهیه فلور آبزی ایران و بررسی پوشش گیاهی آن در طرح ملی مؤسسه جنگل‌ها و مراتع کشور (تهران، ایران)، تعداد ۲۰ تیره گیاهی آبزی توسط نگارندگان مورد بررسی قرار گرفت. نمونه‌برداری از ۲۳۸ نقطه محل رویشی گیاهان آبزی طی سال‌های ۹۹-۱۳۸۷ از رودخانه‌ها، تالاب‌ها و سایر اکوسیستم‌های آبی ایران انجام شد. در سال‌های اخیر و طی انجام بررسی حاضر، تعداد ۱۴ گونه از ایران توسط نگارندگان و همکاران، ثبت و معرفی شدند. در این تحقیق، کلیدهای شناسایی جدید برای همه آرایه‌های آبزی ایران به همراه توصیف گونه‌ها براساس مطالعات ریخت‌شناسی و استفاده از سیستم رده‌بندی APGIV ارایه می‌شود. در نهایت، تعداد ۳۳ جنس، ۶۶ گونه، یک زیرگونه، دو واریته و دو دورگ متعلق به تعداد ۲۰ تیره از سه گروه گیاهان شناور، گیاهان غوطه‌ور و گیاهان باتلاقی از ایران توصیف شده است.

واژه‌های کلیدی: تالاب، فلور، گیاهان شناور، گیاهان غوطه‌ور، هرباریوم

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شماره: ۱۲۴/۱۲۷۳۴ مورخ: ۱۳۷۷/۱۲/۱۱

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به نام خداوند بخشنده مهربان

رستنیها

(سیستماتیک و تنوع زیستی قارچ‌ها و گیاهان)

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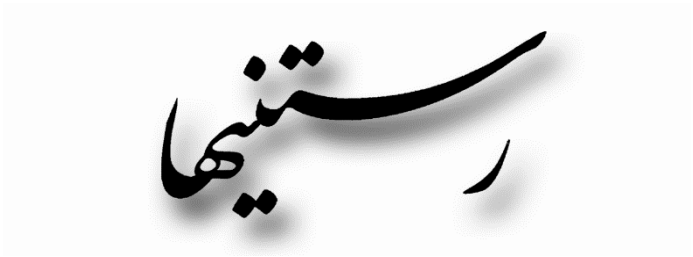
وزارت جهاد کشاورزی
سازمان تحقیقات، آموزش و ترویج کشاورزی



(سیستماتیک و تنوع زیستی قارچ‌ها و گیاهان)

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بازنگری تاکسونومیکی گیاهان آوندی آبزی در ایران

مهری دیناروند

مصطفی اسدی

و

شبنم عباسی