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A New Record of an alien species *Modiola caroliniana* (Malvaceae) for the flora of Iran

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Abstract
In recent years, several records of Malvaceae have been added to the flora of Iran. During a floristic study of the Hyrcanian region, *Modiola caroliniana* from the Malvaceae family was collected and identified for the first time in the low-altitude areas of Masal, Gilan province. It is hereby introduced as a new record for the flora of Iran. The alien species *M. caroliniana* is native to South America and has been introduced to Central America, North America, South and Northwest Africa, India, Japan, Korea in Asia, and Southern Europe. *Modiola* is a monotypic genus that differs from its related taxon *Modiolastrum* based on the number of seeds per mericarp and chromosome number. Other typical features of the plant include prostrate branches often rooting at nodes, small orange to brick-red corollas, and mericarps with two apical spines. The geographical distribution, photos of the plant, habitat, and distribution of the species in the world and Iran are provided at the present paper.
Key words: *Modiola caroliniana*; alien species; new record; Gilan; Iran

Introduction

Malvaceae s.l., according to its current expanded circumscription (including Tiliaceae, Sterculiaceae, and Bombacaceae), is the largest group of its order. It is a monophyletic taxon consisting of 9 subfamilies and 244 genera with over 4,225 species distributed worldwide (Cvetkovic et al., 2021; Wang et al., 2021). Based on recent treatments, the core Malvoideae corresponds to the traditionally circumscribed family, that is, Malvaceae s.s. (Vonbalthazar et al., 2004). The eumalvoids are widely distributed in tropical and temperate regions worldwide, but the greatest diversity (more than two-thirds of the genera) is found in the New World (Fryxell, 1997). The group is divided into three tribes, which are well supported by morphological and molecular data (Baum et al., 2004), the largest being Malveae with approximately 1,040 species in 70 genera. This tribe is probably best known for its many garden ornamentals (e.g., *Abutilon* Mill., *Alcea* L., *Lavatera* L., *Malope* L., *Malva* L.), and for its many weedy species for example, *Sida* L., *Malva, Malvastrum* A. Gray and *Modiola* Moench. The fruit schizocarp is characteristic of Malveae. The number of mericarps, their arrangement, the ornamentation of the walls, the degree of dehiscence, the internal structure, and the number of seeds are among the most important features for delimitation of genera in Malveae (Arecesberazin & Ackerman, 2017). In contrast to Malveae, the schizocarps of Hibisceae are always composed of five mericarps (the segments or disseminules in which the fruit is divided), each containing a single seed (Bayer & Kubitzky, 2003). Malveae tend to have a higher number of mericarps and these can contain more than one seed (up to eight in *Abutilon*). In recent years, several records of Malvaceae have been added to the flora of Iran (Amini et al., 2003; Pakravan, 2006; Arabameri & Khodayari, 2019; Bahadori et al., 2022). In this survey, the genus *Modiola* with its monotypic species, *Modiola caroliniana* (L.) G. Don, belonging to Malveae and Malvoideae from Malvaceae, which has not been reported from the flora of Iran (Riedl, 1976; Pakravan, 2008), is recorded for the first time from Iran (see Fig. 1). It is native to west and South America to South

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Brazil and introduced to Central America, North America, South and Northwest Africa, India, Japan and Korea in Asia and Southern Europe (POWO, 2024).

Materials and Methods

During a floristic study of Hyrcanian region, an interesting plant from a distinct taxon of the Malvaceae was noticed for the first time in the ruined areas along the river, roads, inside the gardens and residential areas of Masal region. A specimen of it was collected, dried, and deposited in the Agricultural and Natural Resources and Research Center of Gilan.The specimen was examined using flora references and relative papers (Kearney, 1951; Fryxell, 1988; Fryxell, 1997) and could be identified as *Modiola caroliniana*.

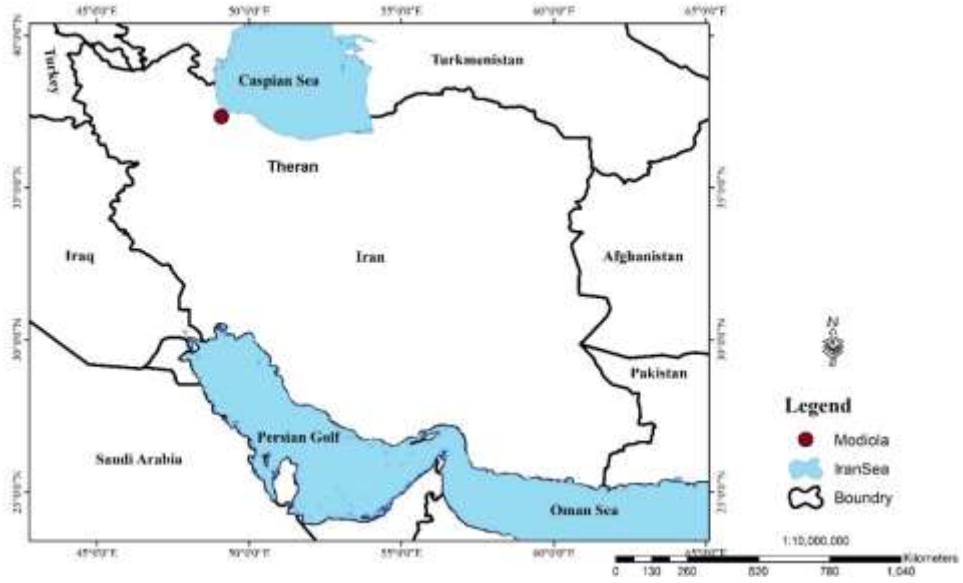

Figure 1. Distribution map of *Modiola caroliniana* in Iran.

Results and Discussions

Modiola caroliniana (L.) G.Don

Perennial plant, with different procumbent or prostrate branches arising from rootstock, 25-100cm tall, often rooting at nodes. Stipules measure 3-4 × 1.5-3 mm. Leaves ovate to suborbicular-reniform, 1.5-4 × 1.5-4 cm, with 3-7 lobes. Petioles 2-7 cm tall. The flowers are solitarily or rarely in pairs in the leaf axils, pedicels 2-4cm tall, hairy. Epicalyx segment 3, lanceolate, 4-5 mm tall. Sepals 5-7 mm tall, hairy. Petals orange to brick-red, little longer than sepals. Staminal column shorter than petals and yellow. Mericarps 16-22, 2-celled, reniform, 5-6 mm tall, dorsally setose with two apical spines. Seeds reniform, 1 per cell.

Examined specimen

Iran, Guilan, Masal, Taskoh village, near road, 37° 20' 35" N, 49° 04' 58" E, 150 m, 23/02/1403, Moradi & Mahdavi (GILAN-8510) (Fig. 1 & 2).

Taxonomical remarks

Based on Phylogenetic relationships, *Modiola caroliniana* is closely related to *Modiolastrum*, It forms a clade with *this genus(* Tate et al., 2005). The two genera are difficult to separate in vegetative condition but differ primarily in the number of ovule per carpel, with *Modiola* having two, one in each chamber, and as far as known in chromosome number, with *Modiola* having 2n=18 and *Modiolastrum* 2n=10,30,100. (Hill & Fryxell, 1980). Other features include pedicel length and flower size.

Habitats

Modiola caroliniana is native to South America. It has become widely naturalized in many parts of the world. It grows in disturbed places, usually moist habitats, shores of ponds and reservoirs, low sandy areas, lawns, roadsides. In the study area, it grows densely in ruined places along the river, roads, gardens and residential areas of Tasko village in Masal region (Fig. 3). In recent years, the Masal region and Tasko village have received many travelers and tourists who come to this region due to the development of tourism. These visitors have destructive effects on the environment and the nature of the region. The destruction is intensified by land use changes and villas construction. It seems likely that the seeds of this plant were brought to this area for the first time by tourists. This plant was observed together with the following species in the area: *Lamjum album* L. subsp. *album*, *Chelidonium majus* L., *Ulmus minor* Mill., *Alnus glutinosa* (L.) *Gaertn.* subsp. *barbata* (C. A. Mey.) Yaltiric, *Pterocarya fraxinifolia* (Poir.) Spach, *Sambucus ebulus* L., *Veronica persica* Poir., *Urtica dioica* L. subsp. *dioica*, *Mentha pulegium* L..

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Figure 2. Herbarium specimen of *Modiola caroliniana*

Figure 3. *Modiola caroliniana* close up (left) and a view of its dense growth in the new habitat (right)

Previously, another alien species of Malvaceae, named *Sida rhombifolia* L., was recorded from Nowshahr (Amini et al., 2003). *Sida rhombifolia* is considered a weed and invasive plant that is spreading in tea and fruit gardens, along roadsides, and forest edges. It also proliferates inside the open and degraded forests of Gilan and Mazandran, becoming a significant environmental and agro-horticultural problem in these areas.

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