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New records of the five alien species from the flora of United Arab Emirates

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Keywords: alien species, Amaranthaceae, Arabian Peninsula, chorology, Fujairah, geography of plants, Piperaceae, Portulacaceae, United Arab Emirates.

Summary. During floristic research in 2017–2022 in the Emirate of Fujairah in the United Arab Emirates (UAE), the authors discovered new alien species that complement the species composition of the flora of vascular plants in the Emirate and the UAE as a whole. The article presents new records of five alien species previously unknown from the flora of UAE and Fujairah: *Gomphrena serrata* L. (Amaranthaceae), *Portulaca pilosa* L., *P. grandiflora* Hook., *P. umbraticola* Kunth (Portulacaceae), and *Peperomia pellucida* (L.) Kunth (Piperaceae). *Gomphrena serrata* which is rare in the country was found only in one place in the mountainous region of Fujarah, and it is a novelty for the flora of the Arabian Peninsula as a whole, while *Portulaca pilosa* was observed in several different areas of Fujairah Emirate and is also known for Saudi Arabia, Yemen and Oman. *Peperomia pellucida* was found only in a single locality in the "Alamarey plant nursery" in Dibba town but in large number of individuals. For every species, synonyms, overall distribution, habitat preferences, affinity and taxonomic remarks as well as the list of localities are given. The herbarium materials were deposited in the Herbarium of the Komarov Botanical Institute (LE, Saint-Petersburg, Russia), duplicates were sent to the Herbarium of Altai State University (ALTB, Barnaul, Russia) and the Scientific Herbarium of Fujairah (FSH, Wadi Wuraya National Park, Fujairah, UAE).

Пять новых адвентивных видов для флоры Объединенных Арабских Эмиратов

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Ключевые слова: Аравийский полуостров, география растений, ОАЭ, Фуджейра, хорология, чужеродные виды, Amaranthaceae, Piperaceae, Portulacaceae.

Аннотация. В ходе флористических исследований в 2017–2022 гг. в эмирате Фуджейра в Объединенных Арабских Эмиратах (ОАЭ) авторами были сделаны новые находки чужеродных видов, которые дополняют видовой состав флоры сосудистых растений на территории эмирата и ОАЭ в целом. В статье представлены новые сведения о пяти чужеродных видах, ранее неизвестных во флоре ОАЭ: *Gomphrena serrata* L. (Amaranthaceae), *Portulaca pilosa* L., *P. grandiflora* Hook., *P. umbraticola* Kunth (Portulacaceae) и *Peperomia pellucida* (L.) Kunth

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(Piperaceae). Все они были впервые найдены в эмирате Фуджейра в восточной части ОАЭ. *Gomphrena serrata* редко встречается в стране, был обнаружен только в одном месте в горной части Фуджейры и является новым видом для флоры Аравийского полуострова в целом, в то время как *Portulaca pilosa* наблюдался в нескольких различных районах эмирата Фуджейра и также известен в Саудовской Аравии, Йемене и Омане. *Peperomia pellucida* также является редкостью в стране, был обнаружен только в одном месте, но в большом количестве в «питомнике растений Аламарей» в городе Дибба. Представлены виды, синонимы, общее распространение, предпочтения в среде обитания и таксономия видов с замечаниями по идентификации и дифференциации от наиболее похожих таксонов, встречающихся в районе исследования, а также список местонахождений. Гербарные материалы хранятся в Гербарии Ботанического института им. Комарова (LE, Санкт-Петербург, Россия), дубликаты отправлены в Гербарий Алтайского государственного университета (ALTB, Барнаул, Россия) и Научный гербарий Фуджейры (FSH, Вади Национальный парк Вурайя, Фуджейра, ОАЭ).

This research is part of the project "Flora of Fujairah, United Arab Emirates", under a cooperation agreement between the Office of the Crown Prince of Fujairah and the Komarov Botanical Institute of the Russian Academy of Sciences, St. Petersburg (Byalt et al., 2020a, b, c; Byalt, Korshunov, 2021a, b; etc.). During field research in 2017–2022 and as a result of the study of collected materials, the authors clarified information on the distribution of new alien plant species in the territory of the Emirate of Fujairah, United Arab Emirates (UAE). The article presents new records for five alien species previously unknown from the flora of UAE: *Gomphrena serrata* L. (Amaranthaceae), *Portulaca pilosa* L., *P. grandiflora* Hook., *P. umbraticola* Kunth (Portulacaceae), and *Peperomia pellucida* (L.) Kunth (Piperaceae).

In the UAE, the family Amaranthaceae is considered in the narrow sense and is represented by 9 species from 6 genera – *Achyranthes aspera* L., *Aerva javanica* (Burm. f.) Juss., *Alternanthera pungens* Kunth, *Amaranthus* (4 spp.), *Digeria muricata* (L.) Mart., and *Pupalia lappacea* (L.) Juss., but none from the genus *Gomphrena* (Western, 1989; Jongbloed, 2003; Karim, Fawzi, 2007).

Until now, 12 wild species of the genus *Portulaca* have been reported in Arabia (Al-Khulaidi, 2013; Flora of Saudi Arabia, 2020): *P. commutata* M. G. Gilbert (Yemen), *P. constricta* M. G. Gilbert (Yemen), *P. dhofarica* M. G. Gilbert (Oman, Yemen), *P. foliosa* Ker-Gawl. (Yemen), *P. grandiflora* Hook. f. (Saudi Arabia), *P. kermesina* N. E. Br. (Saudi Arabia), *P. kuriensis* M. G. Gilbert (Yemen), *P. oleracea* L. (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, UAE, Yemen and Socotra), *P. pilosa* L. (Saudi Arabia), *P. quadrifida* L. (syn. *P. hareschata* Forssk., *P. imbricata* Forssk., *P. linifolia* Forssk.) (Bahrain, Oman, Qatar, Saudi Arabia, UAE, Yemen, Socotra), *P. samhaensis* A. G. Mill. (Yemen) and *P. sedifolia* A. G. Mill. (Socotra). *P. oleracea* and *P. quadrifida* are widespread in the UAE. We found in UAE three more species of this genus in the wild (alien) – *P. grandiflora*, *P. pilosa*, and *P. umbraticola*.

On the Arabian Peninsula, the Piperaceae family is represented by 2 genera and 5 species: *Piper betle* L. (cultivated in Hadhramaut, Yemen), *Peperomia abyssinica* Miq. (Yemen), *P. blanda* (Jacq.) Kunth (syn. *P. arabica* Decne ex Miq.) and subsp. *leptostachya* (Hook. et Am) Dull. (Yemen, incl. Isl. Socotra), *P. pellucida* (L.) Kunth (Yemen and Oman), and *P. tetraphylla* (J. Forster) Hook. f. et Arn. (syn. *P. reflexa* (L. f.) A. Dietr.) (endemic of Isl. Socotra). All the species are found only in the south of the peninsula in Oman and Yemen (Ghazanfar, 1992; Miller, 1996; Wood, 1997; Al-Khulaidi, 2013) and are absent in Saudi Arabia. In addition, we found *Peperomia pellucida* also in UAE.

Material and methods

During botanical surveys in the UAE in 2017–2020, specimens of *Gomphrena serrata*, *Portulaca pilosa, P. grandiflora, P. umbraticola*, and *Peperomia pellucida* were collected by the authors in several localities in the Emirate of Fujairah, UAE (Fig. 1). Data on plant populations and habitats were also gathered during the expeditions. The following flora compendia and identification guides were used to identify specimens and determine their taxonomic status: local Floras and guides for UAE (Western, 1989; Jongbloed et al., 2003; Karim, Fawzi, 2007) and Floras for neighbouring countries (Daoud, Al-Rawi, 1985; Collenette, 1985, 1999; Cornes C., Cornes M., 1989; Ghazanfar, 1992; Migahid, 1996; Miller, Cope, 1996; Wood, 1997; Jongbloed et al., 2003; Norton et al., 2009; etc.). The statuses of the alien species were determined using the same flora compendia and identification guides, as well as: Norton et al. (2009), GBIF (2021).

The alien plant status was determined by the following criteria (Egorov et al., 2016; Baranova et al., 2018): 1) an indication in the literature that the

species has been introduced into the study area or a larger region encompassing the study area; 2) the species occurred only or mainly in ruderal and/or weedy habitats; 3) the species occurred in isolation from its main natural geographic range. The status of the alien species was determined to be casual, naturalized, or invasive, using the approach developed by Pyšek et al. (2004) and which is quite widely used in Western Europe (Galasso et al., 2018). However, because our observations were made only once, the alien species status that we give might not be correct.

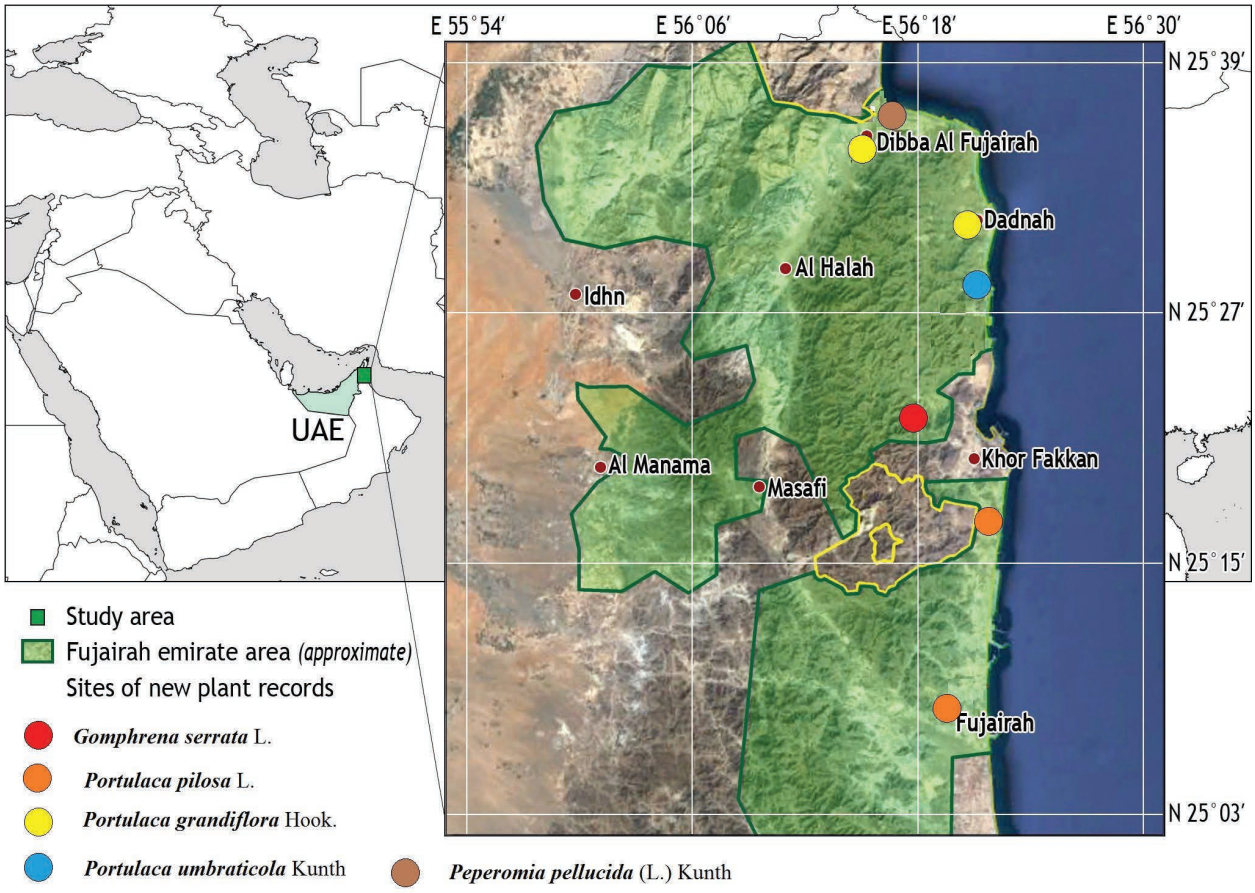

Fig. 1. Map of the distribution of new alien plants in the Emirate of Fujairah (based on Google Earth).

Specimens were deposited in the following herbaria (acronyms according to Index Herbariorum, 2022): Herbarium of the Komarov Botanical Institute of the Russian Academy of Sciences, Saint-Petersburg (LE), and the Scientific Herbarium of Fujairah (FSH, Wadi Wuraya National Park, Fujairah, UAE) (FSH, no acronym yet). Duplicates were sent to the Herbarium of Altai State University (ALTB, Barnaul, Russia).

A Garmin GPS 72H was used for the geographic coordinates of the collecting sites. The identification and corroboration were performed using different relevant floras. The location of the plants was determined using a GPS receiver or Google Maps. All coordinates use the WGS84 standard.

The locations of the study sites Emirate of Fujairah: Dibba Fujairah, Rul Dadnah, Al Fujairah city, Wadi Wurayah National Park and Reserve (8 km NW from Khor Fakkan) and Qidfa village.

Accepted abbreviations: United Arab Emirates – UAE, fl. – with flowers, fr. – with fruits, veg. – in a vegetative state, juv. – young, underdeveloped. LE – Herbarium of BIN RAS, FSH [no acronym yet] – Fujairah Scientific Herbarium (Byalt et al., 2020). The numbers in square brackets indicate the place of our research, recorded by GPS "[point 776] and others." They are given on the labels for the convenience of working with the herbarium.

New alien species in the flora of the Emirate of Fujairah (UAE)

Gomphrena serrata L. (*G. celosioides* Mart.) (Amaranthaceae): "UAE. Emirate of Fujairah, Wadi

Wurayah National Park, 8 km NW from Khor Fakkan, Centre of Bioreproduction of tahrs (ca. 25°23'25.8"N, 56° 18'19.5"E), 150 m alt.: weed in irrigated spot under tree (near shed for tars), 02 IV 2018, fl., fr., V. V. Byalt 776 / 406" (LE). – Casual. Xenophyte, ephemerophyte (Fig. 2).

Gomphrena serrata (*G. celosioides* Mart.) is native in the Americas – Argentina, Bolivia, Brazil, Paraguay, Uruguay, Mexico, USA (Florida, Georgia, Texas), Lesser Antilles et al. (Robertson, Clemants, 2004). It has widely naturalized in tropical and temperate Asia (India, Bhutan, Indonesia, Philippines, Singapore, Sri Lanka, Papua New Guinea, China, Taiwan, Thailand etc.), Africa (Botswana, Egypt, Ghana, Lesotho, Namibia, RSA, Sudan, Swaziland, Zimbabwe), and Australia (Reed, 1977; Holm et al., 1979; Grierson, Long, 1984; Wells et al., 1986; Kostermans et al., 1987; Moody, 1989; Auld, Medd, 1992; Bao et al., 2003; NGRP, 2009; GBIF, 2021, Hassler, 2020; etc.).

A study of the relevant literature and sites revealed that this plant species has not been reported in other countries of the Arabian Peninsula (Ghazanfar, 1992, 2003; Wood, 1997; Chaudhary, 1999; Omar, 2000; Norton et al., 2009; GBIF, 2021; etc.). Hence, it is the first time that *Gomphrena serrata* have been collected from this part of the world. A new alien genus and species for the Fujairah, UAE, and Arabia as a whole, except for Socotra Island (although geographically this belongs to Africa), where *G. serrata* (as *G. celosioides*) has been registered since 1989 (Miller, Morris, 2004; Al-Khulaidi, 2013).

Gomphrena serrata differs from the very closely related species *Gomphrena globosa* L., which is (or was?) sometimes cultivated in Fujiarah (Byalt, Korshunov, 2020d), by its white villous (not gray strigose) stem, tepals rigid after anthesis (in *G. globosa* not rigid after anthesis), inflorescences silvery (not purplish red, light purple, or white) and smaller inflorescence heads (9–13 mm but not 20–28 mm in diam.). From another similar species – *Gomphrena nitida*, it differs by having bractlets with denticulate crests (not with laciniate crests), inflorescence heads 9–13 mm diam. (not 12–16 mm as in *G. nitida*), usually tinged with red or pink (not yellowish white, or rarely reddish) and usually decumbent stems (usually erect) (see Clemants, 2004).

Portulaca pilosa L. (Portulacaceae): "UAE. Emirate of Fujairah, center part city of Al Fujairah (25°07'17"N, 56°20'12"E), weed in park near Government of Fujairah (in the crack of paths in the park). 29 III 2018, veg., V.V. Byalt s. n." (LE!); "United Arab Emirates. Emirate of Fujairah, village Qidfa (25°17'40.91"N, 56°21'28.51"E) [point 343], weed in landfill in waste place. 25 XI 2019, fl. juv., V. V. Byalt, M. V. Korshunov № 1672-2" (LE). – Naturalized. Xenophyte, ephemerophyte (Fig. 3, 5A, B).

Portulaca pilosa is native in tropical and subtropical America (Cuba, West Indies, Puerto Rico, Flordia, Mexico, Guatemala, Venezuela, Brazil, Uruguay) and is naturalized in tropical and subtropical regions of the world (Rechinger, 1976; Phillips, 2002; Lu, Gilbert, 2003; GBIF, 2021; USDA, 2022). Recorded as introduced (alien) in 11 countries (GBIF, 2021). In the Arabian Peninsula, *P. pilosa* was recorded only in Saudi Arabia (Migahid, 1996; Miller, Cope, 1996; Chaudhary, 1999; Collenette, 1999; Flora of Saudi Arabia, 2020) and not recorded for other countries (Ghazanfar, 1992; Wood, 1997; Karim, Fawzi, 2007; Norton et al., 2009; etc.).

The plants are used for medicinal purposes (http://www.efloras.org/florataxon.aspx?flora_id=2&taxon_id=242340919).

Hence, it is the first time that *Portulaca pilosa* specimens have been collected from this part of the world. A new alien species for Fujairah, UAE, and Eastern Arabia as a whole.

We have found it at first in Government Park at Al Fujairah City. The young plant had grown in a crack in the path near a fence of the park, not far from the gates (Fig. 5A). The second time it was found in Qidfa Village on waste landfill (Fig. 5 B) and on an irrigated pit in the same village.

Portulaca pilosa is similar in many aspects to *Portulaca grandiflora* Hook. f. et Arn., but it can be easily recognized by its smaller and pink, not spotted, at the base of flowers and not different colored, and so on (Table 1) (adapted from Abdul Gafoor, 2019 in http://www.efloras.org/florataxon.aspx?flora_id=5&taxon_id=242340919).

Portulaca grandiflora Hook. (Portulacaceae): "UAE. Fujairah Emirate, Al Dibba town, Al Shams Nursery, near Dibba Theatre (0.1 km to East). 25°36'9.81"N, 56°16'41.30"E, Elevation 6 m [point 767a]: cultivated and weed in plant market and nursery, between pots and in the pots, 28 IV 2020, veg., fr., V.V. Byalt, M.V. Korshunov № 2502" (LE); "UAE, Fujairah Emirate, Rul Dadhna, Al Jawhara Plants Nursery, 2 km by the unnamed road from E99 to Wadi Zikt dam. 25°30'52.69"N, 56°20'11.79"E, Elevation 33 m [point 805]: cultivated and run wild on wet sand between plastic pots with cultivated plants, 4 VII 2020, fl., fr., V. V. Byalt, M. V. Korshunov № 3951" (LE; FSH). – Casual. Ergaziophygophyte, ephemerophyte (Fig. 5C).

Fig. 2. Herbarium specimen of *Gomphrena serrata* L. from UAE (LE) (photo by M. Legchenko).

Fig. 3. Herbarium specimen of *Portulaca pilosa* L. collected in waste landfill in Qidfa (photo by M. Legchenko).

Table 1

Comparative features of species of *Portulaca* L. in the UAE

Species	Leaves	Flowers	Capsules	Seeds
Portulaca pilosa L.	linear-lanceolate, subterete	1 cm across. Petals only 5, pink or red-purple, not spotted at the base, obtuse	not winged	dark brown to black
P. grandiflora Hook. f. et Arn.	linear-oblong, subterete	2–5 cm across. Petals 5 or more, different colored (yellow, pink, white) but pale brown or yellow spotted at the base, emarginate	not winged	metallic grey or greyish-black
P. umbraticola Kunth	obovate, spatulate, or sometimes lanceolate, flattened	8-15 mm diam. Petals only 5, different colored, from white to yellow and orange-red (petals yellow, orange, copper, bronze, or white)	encircled by expanded, membranaceous wing	gray
P. oleracea L.	obovate or spatulate, flattened	3-10 mm diam. Petals only 5, yellow colored	not winged	black or dark brown
P. quadrifida L.	opposite, ovate-oblong to elliptic-oblong or ovate to ovate-lanceolate, fleshy	solitary terminal, yellow, 6–8 mm across	not winged	black

Fig. 4. *Portulaca umbraticola* Kunth growing wild on an abandoned sandy lawn by beach (photo by V. Byalt).

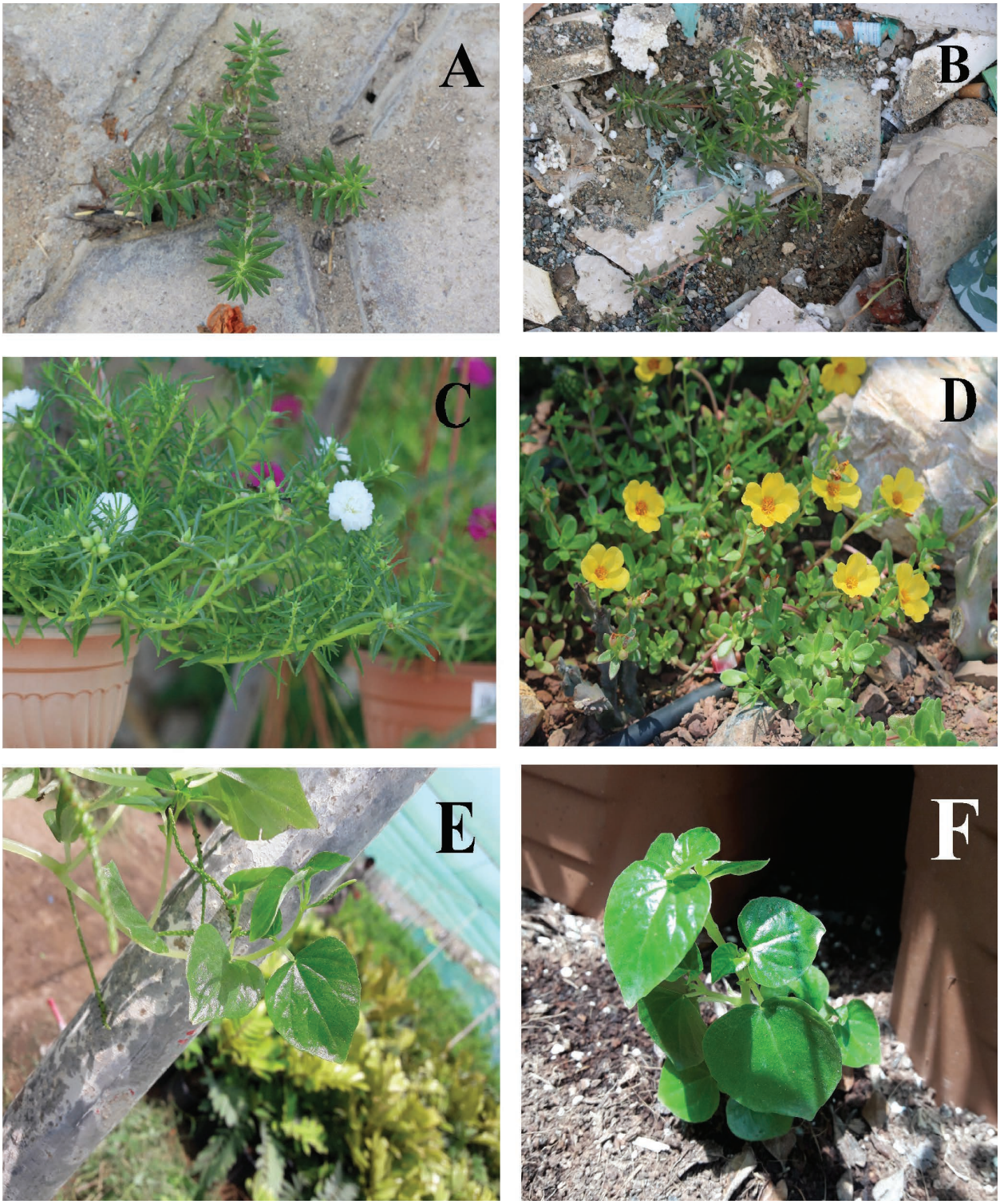

Fig. 5. A – *Portulaca pilosa* L. weed in the park near Government of Fujairah (photo by V. Byalt); B – *Portulaca pilosa* L. in waste landfill in Qidfa (photo by V. Byalt); C – *Portulaca grandiflora* Hook. f. et Arn. cultivated in a flowerpot near the villa (photo by V. Byalt); D – *Portulaca umbraticola* Kunth is cultivated on alpine slide near the villa at Al Dibba (photo by V. Byalt); E – *Peperomia pellucida* (L.) Kunth grows as weed in "Alamarey Nursery" at Dibba (photo by M. Korshunov); F – *Peperomia pellucida* (L.) Kunth grows as weed in "Alamarey Nursery" at Dibba (photo by M. Korshunov).

It is widely used as an ornamental plant, and its native range is Bolivia to Brazil and Argentina (POWO, 2022). Recorded as invasive in 30 countries (GBIF, 2021), including USA (Kraus et al., 2020), Australia (Randall et al., 2021), etc. In Arabia, it is cultivated in Saudi Arabia, Oman (Ghazanfar, 1992),

and the UAE (Byalt, Korshunov, 2020d). In Fujairah, it is grown quite often as an ornamental plant near villas, but in its wild form it is found only around plantings in plant nurseries in Al Dibba town and Rul Dadhna. Not yet invasive.

It well differs from the closely related species *Portulaca pilosa* L. by the features of flowers, capsules, and seeds (Matthews, 2003) (see Table 1).

Portulaca umbraticola Kunth (Portulacaceae): "UAE, Fujairah Emirate, Al Aqah, Le Meridien Al Aqah Beach Resort, near Shark roundabout, between «Fujairah Rotana Resort and Spa» and «Intercontinental Fujairah Resort», 25°30'25.89"N, 56°21'43.39"E, elevation 5 m [point 811]: run wild on abandoned lawn in beach part near hotel, on sand, 23 VII 2020, veg., fl., V. V. Byalt, M. V. Korshunov 4319" (LE; FSH). – Casual. Ergaziophygophyte, ephemerophyte (Fig. 4, 5D).

Its native range is Mexico to tropical America (POWO, 2022). Introduced in some other countries, in Africa, Europe and E. and SE. Asia (GBIF, 2021). In Fujairah, it is sometimes cultivated as an ornamental plant near villas and hotels. We found it growing wild on an abandoned sandy lawn by the beach near the hotel "Fujairah Rotana Resort and Spa" on the East Bank (Fig. 4). Also, we saw it as having escaped from cultivation in the city of Khor-Fakkan (Emirate of Sharjah) near the curb of an asphalted path near a residential building.

It well differs from the closely related species *Portulaca oleracea* L. by the features of flowers, capsules, and seeds (Matthews, 2003) (see Table 1).

Peperomia pellucida (L.) Kunth (Piperaceae): "UAE, Fujarah Emirate, Al Dibba town, Alamarey Nursery, 0.5 km South from Khalid Hadi Resort Dibba. 25°34'33.97"N, 56°14'6.15"E, Elevation 45 m [point 797]: weed in and between plastic pots with cultivated trees, 13 VI 2020, fl., V. V. Byalt, M. V. Korshunov № 3542" (LE; FSH). – Localy naturalized. Xenophyte, colonophyte (Fig. 5E, F).

Annual, shallow-rooted herb, and its native range is tropical and subtropical America, tropical Africa, Madagascar (POWO, 2022). Recorded as invasive in 29 countries or islands (GBIF, 2021), including India (Sudhakar Reddy et al., 2008), USA (Kraus et al., 2020), Australia (Randall et al., 2021; etc.).

According to our observations, this plant is growing as a common weed in a private plant nursery ("Alamarey Nursery") in Dibba town. It usually forms small clumps on damp sand (in places of regular and abundant watering) in the shade, in pots and between pots with cultivated plants. Most commonly found in and around *Cycas revoluta* L. (Cycadaceae) pots. This may indicate that *Piperomia pellucida* was accidentally introduced with plant material from India or Pakistan (from where *Cycas* are brought to nurseries and grown for sale – according to nursery staff), where *Peperomia* is a fairly common weed (POWO, 2022).

The main distinguishing features of *Peperomia pellucida* (L.) Kunth from other species of the genus grown wild on the Arabian Peninsula can be seen in Table 2.

Table 2

Comparative features of *Peperomia pellucida* and other Arabian species (based on Miller, 1996)

Species	Growth form	Leaves	Spikes
Peperomia pellucida (L.) Kunth	Delicate annual herb	alternate, broadly ovate to suborbicular or transversely ovate, thin, semi-translucent, cordate at the base	solitary, terminal and leaf-opposed
P. abyssinica Miq.	Perennial creeping herb	alternate, ovate to elliptic or obovate, thick, not translucent, rounded or cuneate at the base	solitary, terminal and leaf-opposed
P. blanda (Jacq.) Kunth	Perennial erect or ascending herb	mainly opposite, a few in whorls of 3 above, obovate, thick, not translucent, rounded or cuneate at the base	solitary or in groups of 2–5, in the axils of the upper leaves and terminal
P. tetraphylla (J. Forst.) Hook. f. et Arn.	Perennial prostrate herb	opposite or mostly in whorls of 3–4, obovate or broadly elliptic to suborbicular, thick, not translucent, rounded or cuneate at the base	solitary, terminal

Conclusion

Peperomia pellucida (L.) Kunth (Piperaceae) has been recorded for the first time in the Fujairah Emirate and the UAE as a whole. So far, it has been found only in one plant nursery, but it is represented there in a large number of individuals, actively weeds and, apparently, is a potentially invasive species in irrigation, for example, in shady gardens near villas. Other species found by us are *Gomphrena serrata* L. (Amaranthaceae), rare in the country, found only in one place in Fujairah and new to the flora of the Arabian Peninsula as a whole. *Portulaca pilosa* L., *P. grandiflora* Hook. and *P. umbraticola* Kunth (Portulacaceae) were similarly first recorded as alien from the Fujairah Emirate and the UAE in general; these were found in a small number of specimens and are not invasive yet.

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