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Article

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Annotated checklist of ferns (Polypodiophyta) in Fujairah Emirate (UAE)

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Abstract

A brief introduction and a review of ferns in Fujairah Emirate, United Arab Emirates, are given, including taxonomy, distribution, notes and illustrations. This checklist contains 7 species from 7 genera and 4 families (Polypodiophyta). *Salvinia minima* Baker (Salviniaceae) and *Lygodium japonicum* (Thunb.) Sw. (Schizaeaceae) are reported for the first time in Arabia. *Asplenium antiquum* Makino (Aspleniaceae), *Nephrolepis cordifolia* (L.) C.Presl and *N. exaltata* (L.) Schott (Polypodiaceae) are included as widely cultivated in Fujairah.

Key words: Arabia, *Actiniopteris semiflabellata*, *Adiantum capillus-veneris*, cultivated ferns, etymology, flora, *Hemionitis acrostica*, *Lygodium japonicum*, *Onychium divaricatum*, *Ophioglossum polyphyllum*, *Salvinia minima*, taxonomy, vernacular names

Introduction

This research forms part of the project, Flora of Fujairah, United Arab Emirates (UAE), 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).

The flora of the UAE contains tropical and subtropical plants but it is generally very poor as it is entirely located in the extremely arid region of the Arabian Peninsula, where there are practically no rivers or natural lakes and precipitation is low. In his study of the flora of the UAE Western (1989) included only 480 species. Later Jongbloed *et al.* (2003) listed 680 species. In the two volumes of the *Flora of the UAE*, Karim and Fawzi (2007) included 600 species, with 70 taxa not previously registered, although some of the taxa listed previously by other authors, especially mountain plants, were not mentioned in this work. Feulner (2011) published a comprehensive article on the flora of Mount Ru'us al-Jibal on the Musandam Peninsula, which is partly in Oman and partly in the territory of the emirate of Ras al-Khaima, UAE, and added 17 new records of plant species for UAE and North Oman. In addition, when

studying the local flora of Wadi Helo in Sharjah Emirate, El-Keblawy (2011) reported 230 species and suggested that further work could add more species to the flora of the country. This is fully supported by the floristic investigations of various researchers published in recent years (Feulner, 2011; Shahid, 2014; Shahid and Rao, 2014a, 2014b, 2015a, b, c, 2016a, b; Gairola *et al.*, 2015; Mahmoud *et al.*, 2015, 2016) that have revealed the presence of another 40 species new to the UAE (Gairola *et al.*, 2016). Most of these newly recorded plants are associated with anthropogenically disturbed sites such as farms, roadsides and lawns where they were most likely introduced, intentionally or accidentally. Only four of the mountain species are native. Our research during 2017–2020 adds significantly to the checklist of Fujairah and UAE floras (Byalt *et al.*, 2020 a, b; Byalt and Korshunov, 2020 a, b, c and other unpublished data) and allows us to compare our list with the previously obtained data for different plant groups.

Ferns are extremely rare in the UAE in comparison with other tropical regions and even in relation to neighbouring Oman, where 18 species of ferns and fern allies are known (Patzelt, 2015). This is due to the almost complete absence of constantly wet conditions. Jongbloed *et al.* (2003) listed, for the UAE, only 4 species from 4 genera, *Ophioglossum polyphyllum* A.Braun ex Seub. (Ophioglossaceae), *Adiantum capillus-veneris* L. (Pteridaceae), *Onychium divaricatum* (Poir.) Alston (Pteridaceae), and *Hemionitis pteridioides* (Reichard) Christenh. (Pteridaceae), and 4 for the adjacent areas of Oman (Musandam and South Hajar), *Actiniopteris semiflabellata* Pic.Serm. (Pteridaceae), *Asplenium ceterach* L. (Aspleniaceae), *Cosentinia vellea* (Aiton) Tod. (Pteridaceae) and *Pteris vittata* L. (Pteridaceae). Later Karim and Fawzi (2007) cited 5 species from 4 genera, *Adiantum capillus-veneris*, *Asplenium ceterach*, *Onychium divaricatum* (Pteridaceae), *Hemionitis pteridioides* (Pteridaceae) and *Cosentinia vellea*.

Rothfels *et al.* (2012) reported 7 fern and fern-allied species, *Adiantum capillus-veneris*, *Asplenium ceterach, Hemionitis acrostica* (Balbis) Mosyakin), *Equisetum ramosissimum* Desf., *Onychium divaricatum* and *Pteris vittata*, in Northern Oman and UAE.

Feulner mentioned 4 species, *Ophioglossum polyphyllum*, *Adiantum capillus-veneris*, *Cheilanthes acrostica*, and *Onychium divaricatum*, for Wadi Wuraya (Feulner, 2015; Judas and Feulner, 2015).

In the annotated checklist provided below, additional useful information such as vernacular names and the uses of the plants is given, based on the known information not only available for UAE but also for the rest of the world.

Material and methods

The specimens, collected during field work (2017–2020) in 60 locations as described earlier (Byalt et al., 2020a), were identified using the original descriptions in the protologues, all available local Floras and guides for UAE (Western, 1989; Böer, 2000; Jongbloed et al., 2003; Karim and Fawzi, 2007; Feulner, 2011) and Floras for neighbouring countries (Collenette, 1985, 1999; Cornes and Cornes, 1989; Migahid, 1989; Ghazanfar, 1992; Miller and Cope, 1996; Wood, 1997; Jongbloed et al., 2003; Norton et al., 2009). Morphological characters were observed in detail in the field, and later the collected herbarium material was compared with herbarium specimens available to the authors in the following herbaria: (**B**, **BM**, BNRH, BR, C, E, FI, FSH, GOET, K, L, LE, LD, LINN, MA, MIN, MO, MT, MW, NMNH, NY, O, P, PH, RB, S, SAV, SBT, U, UBT, W, WAG, WU. Herbarium Codes hereafter as in Thiers (2021); in bold – accessed via JSTOR Global Plants, 2021 and Global Biodiversity Information Facility, GBIF, 2021). The online resource, GBIF (2021) was used for additional information on the distribution of studied taxa which was first critically analysed by the authors of this paper. Our herbarium collections were deposited at LE and FSH. The names of the taxa, authors' abbreviations and places of publication were checked against the protologues and records in the International Plant Name Index (IPNI, 2021) and the World Checklist of Vascular Plants (WCVP, 2021). Accepted names are in bold. Taxonomic decisions on accepted names were made by studying the relevant literature (Smith et al., 2006; Rothfels et al., 2012; Christenhusz and Chase, 2014; PPG I, 2016) and the data in available taxonomic databases, Catalogue of Life (CoL, 2021), Plants of the World Online (POWO, 2021), Tropicos (2021) and the WCVP (2021). Distribution data are provided as recommended in the World Geographical Scheme for Recording Plant Distribution (Brummitt, 1992) and further updates on the website of the Taxonomic Database Working Group (TDWG, 2021).

Annotated checklist

1. Actiniopteris semiflabellata Pic.Serm., Webbia 17: 24, f. 4. 1962.

Morphological and ecological characteristics of this fern from Fujairah match with those given in the protologue (Pichi-Sermolli, 1962) and publications by Thulin, 1993; Verdcourt, 1999; Roux, 2009 and those at the website <u>*Pteridophytes of Africa* (2021)</u>.

This fern has fertile fronds up to 20–25(40) cm long. (Fig. 1). Growth form: terrestrial fern. Spor.: February–May in UAE.



Figure 1. *Actiniopteris semiflabellata* Pic.Serm. under a boulder in a dry side wadi gorge. Photograph by M.V. Korshunov

The specimens identified as *Actiniopteris semiflabellata* or those taxa that appeared as its synonyms were seen at JSTOR and through GBIF (<u>https://www.gbif.org/species/4205834</u>). **Specimens examined:** <u>BNRH0013991</u>!; <u>BR0000006986681</u>!; <u>BR0000006878993</u>!; <u>E00239740</u>!; <u>E00239741</u>!; <u>FI003084</u>; <u>UBT0000009</u>!; <u>UBT000010</u>!; <u>UBT0005883</u>!; <u>UBT0005884</u>!

Etymology: The species epithet reflects the fan-shaped leaves.

Vernacular name: Menna (Amharic) (Prelude Medicinal Plant Database, 2021).

Distribution worldwide: Burundi, Djibouti, Egypt, Ethiopia, Kenya, Madagascar, Mauritania, Mauritius, Namibia, Nepal, Oman, Rwanda, Réunion, Saudi Arabia, Socotra, Somalia, Sudan, Tanzania, Uganda, Yemen, Zaïre. (Pichi-Sermolli, 1962; Thulin, 1993; Kilian *et al.*, 2002; Roux, 2009; Patzelt, 2015; CoL, 2021; POWO, 2021).

Status in UAE: Native. Distribution in Fujairah: Wadi Al Sahm. Rare. On the Arabian Peninsula this fern is found in Saudi Arabia (Collenette, 1985, 1999), Yemen (Wood, 1997; Kilian *et al.*, 2002) and Oman (Ghazanfar, 1992; Feulner, 2011), but is very rare practically everywhere.

Selected specimens: Fujairah Emirate: Wadi Al Sahm, 5.4 km from E84 road (Maleha-Fujairah), 4.2 km North-West from Al Hail Castle (Al Hail Fort). Small wadi to mountain apex, 25° 6'10.20"N, 56°11'36.18"E, elevation 400–550 m: among stones and rocks on the sides of

side gorge on the right side of the big wadi, a few, 6.IV.2020, *V.V. Byalt & M.V. Korshunov 1827*, spor. (LE!, FSH!). So far, this is the only place that *Actiniopteris semiflabellata* has been found in UAE and this species should therefore be recommended for inclusion in the Red Data Books of the UAE and Fujairah (Byalt and Korshunov, 2020a).

Habitat: Wet silt between rocks and boulders.

Use: Medicinal: powdered roasted plant applied topically for severe burns (<u>Prelude Medicinal</u> <u>Plant Database, 2021</u>).

2. Adiantum capillus-veneris L., <u>Sp. Pl. 2: 1096</u>. 1753.

Morphological and ecological characteristics of this fern from Fujairah are in agreement with those given in the protologue (Linnaeus, 1753) and publications by Schelpe, 1970; Kornas, 1979; Jacobsen, 1983; Burrows, 1990; Ghazanfar, 1992; Thulin, 1993; Wood, 1997; Burrows and Johns, 2001; Roux, 2001, 2009; Verdcourt, 2002; Crouch *et al.*, 2011; Patzelt, 2015), and those at the website *Pteridophytes of Africa* (2021). This fern is easy to identify by its oblong sori and veins of the pinnules ending in the teeth of the serrations of the outer margins. (Fig. 2). Growth form: terrestrial or epilithic fern. Fl.: February–March in the UAE.



Figure 2. *Adiantum capillus-veneris* L. under a rocky wall in Wadi Wuraya. Photograph by V. V. Byalt

The specimens identified as *Adiantum capillus-veneris* or those taxa that appeared as its synonyms were seen at JSTOR and through GBIF (<u>https://www.gbif.org/species/2651816</u>). **Specimens examined:** <u>B-W20094-010</u>!; <u>B-W20094-020</u>!; <u>B-W20094-030</u>!; <u>B-W20094-040</u>!; <u>B-W20094-050</u>!; <u>B-W20094-060</u>!; <u>B-W20094-070</u>!; <u>BM001044128</u>!; <u>C10001577</u>!; <u>C10001578</u>!; <u>E00217747</u>!; <u>E00414281</u>!; <u>K001090049</u>!; <u>K001090050</u>!; <u>LINN-HL1252-8</u>!; <u>LINN-HS1617-8-2</u>!; <u>LINN-HS1617-8-3</u>!; <u>MO-255969</u>!; <u>P00607830</u>!; <u>PH00021830</u>!; <u>S10-34205</u>!; <u>SAV0002414</u>!; <u>SAV0002415</u>!; <u>SAV0006155</u>!; <u>SAV0006155</u>!; <u>SAV0006156</u>!; <u>SBT10503</u>!; <u>UBT0000011</u>!; <u>UBT0000012</u>!

Etymology: The species epithet means 'hair of Venus'.

Vernacular names: Maidenhair fern or venushair fern (Engl.); sabaha, sha'ar el ard (Arab.)

Distribution worldwide: Afghanistan, Alabama, Albania, Algeria, Angola, Arizona, Arkansas, Assam, Azores, Bahamas, Baleares, Bangladesh, Belize, Botswana, Brazil North, Brazil Northeast, Brazil South, Brazil Southeast, British Columbia, Bulgaria, California, Cambodia, Canary Is., Cape Provinces, Cape Verde, Chad, Chile Central, Chile North, China North-Central, China South-Central, China Southeast, Colorado, Comoros, Corse, Cuba, Cyprus, Djibouti, East Himalaya, Egypt, Ethiopia, Fiji, Florida, France, Free State, Georgia, Great Britain, Greece, Guatemala, Gulf States, Haiti, Hawaii, Honduras, India, Iran, Iraq, Ireland, Italy, Jamaica, Japan, Kazakhstan, Kentucky, Kenya, Korea, Kriti, Krym, KwaZulu-Natal, Laos, Lebanon-Syria, Lesotho, Lesser Sunda Is., Libya, Louisiana, Madagascar, Madeira, Malawi, Malaya, Mali, Maryland, Mauritania, Mauritius, Mexico Central, Mexico Gulf, Mexico Northeast, Mexico Northwest, Mexico Southeast, Mexico Southwest, Mississippi, Missouri, Morocco, Mozambique, Myanmar, Namibia, Nansei-shoto, Nepal, Nevada, New Caledonia, New Mexico, New South Wales, New York, Niger, Nigeria, North Carolina, North Caucasus, Northern Territory, Ohio, Oklahoma, Oman, Pakistan, Palestine, Peru, Philippines, Portugal, Puerto Rico, Queensland, Rodrigues, Réunion, Samoa, Sardegna, Saudi Arabia, Sicilia, Sinai, Society Is., Socotra, Somalia, South Australia, South Carolina, South Dakota, Spain, Sri Lanka, Sudan, Swaziland, Switzerland, Tadzhikistan, Taiwan, Tanzania, Tennessee, Texas, Thailand, Tibet, Tonga, Transcaucasus, Trinidad-Tobago, Tubuai Is., Tunisia, Turkey, Turkey-in-Europe, Uganda, Utah, Venezuela, Victoria, Vietnam, Virginia, West Himalaya, Western Australia, Windward Is., Yemen, Yugoslavia, Zambia, Zaïre, Zimbabwe (Schelpe, 1970; Kornas, 1979; Jacobsen, 1983; Burrows, 1990; Ghazanfar, 1992; Thulin, 1993; Wood, 1997; Burrows and Johns, 2001; Roux, 2001, 2009; Verdcourt, 2002; Crouch et al., 2011; CoL, 2021; POWO, 2021; Tropicos, 2021).

Status in UAE: Native. Distribution in Fujairah: Masafi, Fujairah, Wadi Wuraya. Rare. Also recorded in Arabia: Oman, Qatar, Saudi Arabia, North and Northeastern UAE, Yemen and Bahrain.

Selected specimens: UAE: Hatta, 110 km ESE of Dubai 24°48'N, 56°10'E, heavily eroded hills with deeply scored wadis. In deep shade on wet sides of wadis. Abundant locally, 28.V.1982, *R.A. Western 213* (E00746575!); United Arab Emirates. Emirate of Fujairah, Wadi Wurayah National Park, 8 km NW from Khor Fakkan, 25°23'46" N, 56°16'10" E, 170–250 m a.s.l., wadi upper waterfall: on wet rocks and in water of spring, 21.III.2017, *V.V. Byalt 33, 44* (LE!).

Habitat: Moist shaded cliff with water dripping, under boulders and along wet wadi banks, sometimes along irrigation channels.

Use: Infusion made of fronds used for chest diseases, as an expectorant. Also used to induce vomiting, and to treat obstructions of the liver and spleen (Sakkir *et al.*, 2012).

3. *Hemionitis acrostica* (Balb.) Mosyakin, Phytotaxa 373(2): 165. 2018 ≡ Pteris acrostica
Balb., Elenco del Piante 98. 1801. ≡ *Cheilanthes acrostica* (Balb.) Tod. Giorn. Sci. Nat. Econ.
Palermo 1: 215. 1866.

Morphological and ecological characteristics of this fern from Fujairah agree with those given in the protologue (Balbis, 1801) and publications by Wood, 1997, Jongbloed *et al.*, 2003, Karim and Fawzi, 2007; Fraser-Jenkins *et al.*, 2017.

Hemionitis acrostica differs from related species by having lamina not covered in white powder beneath as in *H. farinosa* (Forssk.) Christenh. from Yemen, and undersurface of lamina more or less glabrous, not densely covered in scales or hairs as in *H. morla* Christenh. or *H. marantae* (L.) Christenh., also occurring in Arabia. This fern is different in its smaller size, as it is grown in drier conditions than in Oman. Growth form: terrestial fern. Spor. February–May in the UAE. (Fig.3).

The specimens identified as *Hemionitis acrostica* or those taxa that appeared as its synonyms were seen at JSTOR and through GBIF (<u>https://www.gbif.org/species/3747243</u>). **Specimens examined:** <u>MA233967</u>!; <u>MA0100382837</u>!; <u>MA0100438328</u>!; <u>MA0100457567</u>!; <u>MA0100457571</u>!; <u>MA0100457573</u>!; <u>MA0100457574</u>!; <u>MA0100457575</u>!; <u>MA0100484311</u>!; <u>MA0100486326</u>!; <u>MA0100505292</u>!; <u>MA0100505307</u>!; <u>MA0100532690</u>!; <u>MA0100532871</u>!; <u>MA0100532808</u>!; <u>MA0100532808</u>!; <u>MA0100532822</u>!; <u>MA0100533104</u>!; <u>MA0100538269</u>!; <u>MA0100539841</u>!; <u>MA0100539841</u>!; <u>MA0100542957</u>!; <u>MA0100562620</u>!; <u>MA0100562693</u>!; <u>MA0100570913</u>!; MA0100570919!; MA0100580864!; MA0100618967!; MA0100633818!; MA0100634474!; MA0100723137!; MA0100758487!; MA0100773236!; MA0100788391!; MA0100828538!; MA0100870018!; MT00192704!; W2018-0008484!; WU0089516!; WU0089517!; WU0089518!; WU0085763!; WU0091951!



Figure 3. *Hemionitis acrostica* (Balb.) Mosyakin in rock crevices in high mountains near the border with Oman. Photograph by V.M. Korshunov

Etymology: The species epithet refers to its similarity to Acrostichum ilvense L.

Vernacular name: kuzbarat al-baer, sabaha, sha'ar el ard (Arabic).

Distribution worldwide: Afghanistan, Algeria, Cape Verde, Djibouti, Ethiopia, Iran, Iraq, Krym, Lebanon-Syria, Libya, Morocco, Oman, Pakistan, Palestine, Saudi Arabia, Sinai, Spain, Transcaucasus, Tunisia, Turkey, Turkmenistan, West Himalaya, Yemen (Jermy and Paul, 1993; Wood, 1997, Karim and Fawzi, 2007; Fraser-Jenkins *et al.*, 2017; CoL, 2021; POWO, 2021).

Status in UAE: Native. Distribution in Fujairah: Wadi Wurayah (upper W. Siji), env. Tawayan, 1 km west of Jebel Bil Ays. Also recorded in Arabia: North Oman, Saudi Arabia, UAE, Yemen.

Selected specimens: UAE: Musandam, on Oman border of high ridge 1 km west of Jebel Bil Ays, under edge of limestone pavement protected from sun and goats, Fern to 10 cm, maximum height. Locally common, 3.XII.1997, *John Martin JM231* (E00163293!; Sharjah Nat. Hist. Museum!); UAE. Emirate of Fujairah, environs of Tawaian, 25°38. 989'N, 56°07.296'E, 1200–1367 m alt.: below stony plateau, on rocks and rocky ledges, 27.III.2017, *V.V. Byalt 334* (LE!); UAE, Fujairah Emirate, Al Tawyeen area, small village 0.8 km west-northwest of mountain peak. 25°38'59.41"N, 56° 7'17.88"E, elevation ca. 1360 m: on mountain rock ledges, in rock cracks, 13.III.2020, *V.V. Byalt & M.V. Korshunov 410*, veg. (FSH!).

Habitat: In rock crevices and terrace walls at high altitudes.

Use: unknown.

Note: Another similar fern with less dissected fronds and denser pubescence, *Cosentinia vellea* (Aiton) Tod is known for UAE only from Shaam Region and Wadi Diftah, southeast of Masafi (Ras Al-Khaimah Emirate) and in Oman. In Fujarah it has not yet been found, although it is found in Wadi Diftah on the very border with Fujarah Emirate (Rothfels *et al.*, 2012). It is rare and thus may be easily overlooked.

4. *Lygodium japonicum* (Thunb.) Sw. 1801. J. Bot. (Schrader) 1800(2): 106. ≡ *Ophioglossum japonicum* Thunb., <u>Syst. Veg. ed. 14 (J.A.Murrey): 926. 1784</u>.

Morphological and ecological characteristics of this fern growing in Fujairah match with those given in the protologue (Thunberg, 1784) and publications by Stuart, 2004; Roux, 2009 and Crouch *et al.*, 2011 and those at the website *Pteridophytes of Africa* (2021).

This alien fern, collected by the authors of this paper as young, undeveloped specimens less than 1 m in size, is different from the most closely related species, *Lygodium flexuosum* (L.) Sw., by fertile pinnae and sterile pinnae subdimorphic, pinnules 4–6 mm wide (not fertile pinnae and sterile pinnae monomorphic, pinnules 1–3 cm wide, as in the latter) (Zhang, Hanks, 2013). Growth form: climbing, terrestrial fern (Fig. 4).

The specimens identified as *Lygodium japonicum* were seen at JSTOR and through GBIF (<u>https://www.gbif.org/species/2650436</u>).

 Specimens
 examined:
 B200121791!;
 B200121792!;
 B200121793!;
 BM000815757!;

 BNRH0013511!;
 K000422442!;
 K001057833!;
 K001115402!;
 K001115403!;
 K001115404!;

 K001115405!;
 K001115406!;
 L0051888!;
 LD1762430!;
 LD1762558!;
 P00523234!;

 P00523235!;
 P00523236!;
 SBT10645!;
 SBT14087!;
 S-P-6581!;
 S-P-6583!

Etymology: The species epithet refers to the place where it was collected by C. Thunberg. **Vernacular name:** Japanese climbing fern.



Figure 4. *Lygodium japonicum* (Thunb.) Sw. as a common weed in a private nursery in Al Bidiya. Photographs by M.V. Korshunov

Distribution worldwide: Assam, Bangladesh, Cambodia, China North-Central, China South-Central, China Southeast, East Himalaya, Hainan, India, Japan, Jawa, Korea, Laos, Lesser Sunda Is., Malaya, Maluku, Nansei-shoto, Nepal, New Guinea, Pakistan, Philippines, Sri Lanka, Sulawesi, Sumatera, Taiwan, Thailand, Tibet, Vietnam, West Himalaya (Stuart, 2004; Roux, 2009; Crouch *et al.*, 2011; *Pteridophytes of Africa* (2021); CoL, 2021; POWO, 2021).

Distribution in UAE: Distribution in Fujairah: common weed growing in *Cycas revoluta* L. (Cycadaceae) pot plantations in some plant nurseries in Al Dibba, Al Bidiya, Rul Dadnah. For Fujairah, UAE, and the Arabian Peninsula generally, this species has not been reported (Collenette, 1989; Cornes and Cornes, 1989; Migahid, 1989; Wood, 1997, Jongbloed, 2003; Karim, Fawzi, 2007; Ghazanfar, 1992; Norton *et al.*, 2009).

Selected specimens: UAE, Fujairah Emirate, Al Bidiya, Desert Oasis Nursery Bidyah, 0.7 km West from Bidiyah Association for Culture and Folklore, 25°26'9.06"N, 56°20'17.72"E, elevation 14 m [point 794]: weed in plastic pots and between pots with cultivated young *Cycas revoluta*, 4.VI.2020, *V.V. Byalt, M.V. Korshunov 3502*, veg., spor. (LE!; FSH!); 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 *Cycas revoluta*, 13.VI.2020, *V.V. Byalt & M.V. Korshunov 3576*, veg. (LE!; FSH!).

Habitat: weed in pots with cultivated *Cycas*, rare between pots and near walls of greenhouses. Use: Ornamental plant.

5. Onychium divaricatum (Poir.) Alston, Bol. Soc. Brot. sér. 2, 30: 21. 1956.

Morphological and ecological characteristics of this fern from Fujairah agree with those given in the protologue (Poiret, 1808) and publications by Thulin, 1993; Wood, 1997, Karim and Fawzi, 2007.

This fern is different from related species of Arabian ferns by its small delicate parsleylike habit with pinnules less than 2 mm broad. The sori are marginal, more or less covered by the reflexed margins of the pinnules (not the pinnules more than 2 mm broad in *Pteris* and *Adiantum*). Scales mostly at the base of the petiole, never continuous along the whole length of the petiole and rhachis as in *Hemionitis*, *Dryopteris* and *Polysticum* from Yemen and Oman (Wood, 1997). Samples of *Onychium divaricatum* are generally smaller than plants in Oman as they are grown in drier conditions. Growth form: small tufted terrestrial fern. Spor. February–April in the UAE. (Fig. 5).



Figure 5. *Onychium divaricatum* (Poir.) Alston on rock ledges in higher mountains. Photograph by V.M. Korshunov

The specimens identified as Onychium divaricatum or those taxa that appeared as its synonyms were seen at JSTOR and through GBIF (https://www.gbif.org/species/5566707). examined: BM001044039!; BM001044045!; BR000008458025!; Specimens BR0000017897501!; BR0000017897518!; C0376832F!; C0376833F!; C0668051F!; E00239744!; E00239745!; E00239746! K001057818!; K001057819!; L3578384!; L3578385!; L3578386!; MIN53033! <u>MIN1342971</u>! <u>MW0731140</u>!; MW0731141!; NMNH01473539!; NMNH01473540!; NMNH01473541!; NMNH01473398!; NY03893817!; O-V2206106!; P00963592!; P00965025!; P01260845!; P01260846!; P01260847!; P01260848!; P01260849!; P01260850!; P01260851!; P01260852!; P01260853!; P01260854!; P01260855!; P01260856!; P01260857!; P01260858!; P01260859!; P01260861!; P01260862!; P01260863!; P01260864!; P01260865!; P01260866!; P01260867!; P01260868!; P01260869!; P01260870!; P01260871!; P01260872!; P01260873!; P01260874!; P01260875!; P01260876!; P01260877!; P01260878!; P01260879!; P01261004!; P01261330!; P01261331!; P01261332!; P01261333!; P01261334!; P01261335!; P01261336!; P01261337!; P01261338!; P01261339!; P01261341!; P01261342!; P01261343!; P01261344!; P01261346!; P01261347!; P01261348!; P01464291!; P01464364!; P01464365!; P01464366!; P01572890!; P01572891!; P01572892!; P01572893!; **RB216728!**; U1040323!; U1040356!; WAG130258!; WAG130259!; WAG130260!

Etymology: The species epithet refers to the plant's divaricate branches

Vernacular names: abu jarit, eajir, hambaz, bikhatraa (Arabic).

Distribution worldwide: Djibouti, Ethiopia, Gulf States, Iran, Oman, Saudi Arabia, Socotra, Somalia, Sudan, Yemen (Thulin, 1993, Wood, 1997, Karim and Fawzi, 2007; CoL, 2021; POWO, 2021).

Status in UAE: Native. Distribution in Fujairah: Wadi Khabb, Wadi al Fay near Mukhtaraqah, Wadi Wurayah, 8 km northeast of Masafi, environs of Al Tawyeen, 3.5 km West to Ghub.

Selected specimens: UAE, Emirate of Fujairah: Wadi al Fay near Mukhtaraqah, 15 km SW of Dibbah, Stony volcanic slopes, in rock crevices, 22.II.1980, *J.R. Edmondson 3086A* (E00746553!); UAE, Fujairah Emirate, rocky slopes facing the highway 8 km northeast of Masafi, along the highway to Dibba, 2.III.1986, *L. Boulos & R. Al-Hasan 15915* (E00746549!); UAE: Fujayrah: Ruus al Jibal in Wadi Khabb, 20 km west of Dibbah. Limestone slopes and rock crevices, 22.II.1980, *J.R. Edmondson 3095* (E00746541!); UAE. Emirate of Fujaira, environs of Tawaian, 25°38. 989'N, 56° 07. 296'E, 1200–1367 m alt.: below stony plateau, on rocks and rocky ledges, 27.III.2017, *V.V. Byalt 329, 37*7 (LE!); Fujairah Emirate, Al Tawyeen (Taween) area, small village 0.8 km west-northwest of mountain peak. 25°38'59.41"N, 56°

7'17.88"E, elevation ca. 1360 m: on mountain rock ledges, in rock cracks, 13.III.2020, *V.V. Byalt & M.V. Korshunov 348, 348a, 372 bis*, veg. (LE!); UAE, Fujairah emirate, 0.6 km east-northeast of cell tower on the mountain peak, 3.5 km West of Ghub, 8 km west-southwest of Dibba, 25°34'34.49"N, 56°10'6.31"E, elevation 730 m: on mountain sides, in stone wadi, in cracks, 24.III.2020, *V.V. Byalt & M.V. Korshunov 1081a*, veg., spor. (LE!). UAE. Emirate of Sharjah: 25°22.997'N, 56°01.211'E, 470 m, gorge on borders with Fujairah: on rocks; on stony-gravelly slope; rocks near spring, 31.III.2017, *V.V. Byalt 505* (LE!).

Habitat: In crevices of hard limestone or basalt rocks, stony slopes with big boulders and on rock ledges, mostly in the shade.

Use: not known.

6. *Ophioglossum polyphyllum* A.Braun ex Seub., Fl. Azor. 17. 1844. ≡ *O. vulgatum* L. var. *polyphyllum* (A.Braun) Milde, Fil. Eur.: 188. 1867.

Morphological and ecological characteristics of *Ophioglossum polyphyllum* from Fujairah are in agreement with those given in the protologue (Seubert, 1844: 17) and publications by Schelpe, 1970; Jacobsen, 1983; Burrows, 1990; Ghazanfar, 1992; Thulin, 1993; Wood, 1997; Burrows and Johns, 2001; Roux, 2001, 2009; Crouch *et al.*, 2011; Patzelt, 2015 and those at the website *Pteridophytes of Africa* (2021).

In Fujairah, this fern, is generally taller than usual (ca. 15–20 cm) as it is growing in dense shade under shrubs and under irrigation, with rhizomes 14-18(-70) mm long; stipe 40-65 mm long and sterile lamina $30-50\times10-20$ mm. Growth form: terrestrial fern. Spor. February–May in UAE.

The specimens identified as *Ophioglossum polyphyllum* or those taxa that appeared as its synonyms seen at JSTOR and through GBIF (<u>https://www.gbif.org/species/7667287</u>).

Specimens examined: <u>BM001038208</u>!; <u>BM001038214</u>!; <u>BM001038215</u>!; <u>BM000785302</u>!; <u>BNRH0013285</u>!; <u>BNRH0013288</u>; <u>E00217751</u>!; <u>GOET009043</u>!; <u>P00466556</u>!; <u>P00466557</u>!; <u>P00522344</u>!; <u>P00522345</u>! <u>P00522346</u>! <u>UBT0000672</u>!; <u>W0000506</u>!; <u>W0000507</u>!.

Etymology: The species epithet reflects the multiple leaves at the top of the rhizome.

Vernacular name: Adder's-tongue fern.

Distribution worldwide: Afghanistan, Angola, Arizona, Azores, Bangladesh, Botswana, Burundi, Canary Is., Cape Provinces, Cape Verde, Chad, Djibouti, Egypt, Ethiopia, Free State, Gulf States, Hawaii, India, Iran, Iraq, Kenya, Kuwait, KwaZulu-Natal, Lesotho, Malawi, Mexico Central, Mexico Northeast, Mexico Northwest, Mexico Southwest, Morocco, Mozambique, Namibia, New South Wales, Northern Provinces, Northern Territory, Oman, Pakistan, Palestine, Queensland, Saudi Arabia, Socotra, Somalia, South Australia, St.Helena, Tanzania, Texas, Tibet, Tunisia, Uganda, Victoria, West Himalaya, Western Australia, Yemen, Zambia, Zaïre, Zimbabwe (Schelpe, 1970; Jacobsen, 1983; Burrows, 1990; Ghazanfar, 1992; Thulin, 1993; Wood, 1997; Burrows and Johns, 2001; Roux, 2001, 2009; Kilian *et al.*, 2002; Crouch *et al.*, 2011; CoL, 2021; POWO, 2021; Tropicos, 2021).

Status in UAE: Native. Wadi Wurayah, Al Fujaira city. Rare. In Arabia also recorded from North and South Oman (Patzelt, 2015), Qatar (Abdel Bary, 1995; Abdel Bary, 2012), Saudi Arabia, UAE, Kuwait, Bahrain and Yemen (Kilian *et al.*, 2002).

Selected specimens: Fujairah Emirate: Al Fujairah, wasteland near Fujairah Corniche road, opposite Fujairah International Marine Club, 25°7'22.82"N, 56°21'23.00"E, elevation 3 m: weed in an irrigated traffic island, under a decorative shrub, 9.V.2020, *V.V. Byalt, M.V. Korshunov s.n.*, spor. (FHS!).

Habitat: Occasionally in disturbed sandy coastal areas or in silt at higher altitudes in the Hajar Mountains.

Use: In the past it was eaten as salad greens (Jongbloed et al. 2003; Norton et al., 2009).

7. Salvinia minima Baker, J. Bot. 24: 98. 1886.

Morphological and ecological characteristics of this fern from Fujairah agree with those given in the protologue (Baker, 1886) and the publication by Nauman (1993).

This alien fern is different from the most closely related species, *Salvinia auriculata* Aubl., by the arrangement of the hairs on the abaxial leaf surface. Those in *S. minima* are free, while those of *S. auriculata* (and several other species) are joined at their tips, the hairs resembling an "egg-beater" (Nauman, 1993). The plants we found also have free hairs on the abaxial leaf surface as well as very small and flat fronds. Some species of *Salvinia* are known to have escaped from cultivation in various regions (Proctor, 1985). Growth form: floating fern. Spor.: Sterile (Fig. 6).

The specimens identified as *Salvinia minima* were seen at JSTOR and through GBIF (<u>https://www.gbif.org/species/5274860</u>).

Specimens examined: <u>BM000769847</u>!; <u>K000590856</u>!; <u>K000590864</u>!; <u>K00059088</u>1!; <u>P00636746</u>!; <u>P00636751</u>!; <u>P00636752</u>!

Etymology: The species epithet refers to the size of the plant.

Vernacular name: Water spangles, floating fern.

Distribution worldwide: Argentina Northeast, Argentina Northwest, Belize, Bolivia, Brazil North, Brazil Northeast, Brazil South, Brazil Southeast, Brazil West-Central, Colombia, Costa

Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Mexico Gulf, Mexico Northeast, Mexico Southeast, Mexico Southwest, Nicaragua, Panamá, Paraguay, Peru, Puerto Rico, Uruguay, Venezuela (Nauman, 1993; CoL, 2021; POWO, 2021; Tropicos, 2021).

Status in UAE: Alien. Distribution in Fujairah: in Al Dibba.

Note: This species was found only once, in the decorative pond with *Nymphaea* spp. in a private plant nursery at Dibba. For Fujairah, UAE and the Arabian Peninsula generally, this species has not been reported.

Selected specimens: Fujairah Emirate, Al Dibba, Green Oasis Nursery, 0.6 km southwest of Street Number 35, or 0.8 km north of Federal Electricity & Water Authority, 25°36'5.21"N, 56°15'45.67"E, elevation 10 m: floating in the decorative pool, a few, 3.V.2020, *V.V. Byalt, M.V. Korshunov 2625*, veg. (LE!).

Use: Decorative plant for aquariums.



Figure 6. *Salvinia minima* Baker in a private nursery in Al Dibba, in a decorative pond with *Nymphaea* spp. Photograph by M.V. Korshunov

Cultivated ferns in Fujairah.

In addition to wild and adventive species in Fujairah, as in other Emirates, some decorative fern species are cultivated. They are rarely grown here due to the extremely arid climate and only in the very shady gardens of the villas. The authors of the current paper have seen these plants in some nurseries where they are cultivated for sale and assume that some other fern species may be found in cultivation in Fujairah (Byalt, Korshunov, 2020d).

**Asplenium antiquum* Makino (Aspleniaceae Newm.) – Bird's-nest fern. Fern. Ornamental. Eastern Asia. Rare.

*Nephrolepis cordifolia (L.) C. Presl (Lomariopsidaceae Alston, incl. Nephrolepidaceae Pic. Serm.) – Fishbone fern, tuberous sword fern. Ornamental. Oceania (Hawaii). Rather rare.
*Nephrolepis exaltata (L.) Schott –Boston sword fern, wild Boston fern, Boston Blue Bell Fern, tuber ladder fern, fishbone fern. Pantropical species. Ornamental. Rather common.

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Authors' contributions

Vyacheslav V. Byalt (VB) initiated the project: together with MK collected, preserved, identified and labelled plants, analysed material prepared by MK, wrote the manuscript, participated in discussion and revision of the manuscript, and coordinated the project.

Mikhail V. Korshunov (MK) together with VB collected, preserved and identified plants, and participated in discussion of the manuscript.

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