



A New Generic Record (*Azolla*, *Salviniaceae*) to the Aquatic Pteridoflora of Iraq

KEYWORDS

Azolla, *Salviniaceae*, *Azollaceae*, *Pteridophyta*, Aquatic plants, Ferns, Iraq.

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ABSTRACT The genus *Azolla* Lam. (*Salviniaceae* previously *Azollaceae*, *Pteridophyta*) with the species *Azolla filiculoides* Lam. were identified and recorded for the first time for the aquatic *Pteridophyta* of Iraq. The species appeared in two locations in Hartha marshland about thirty kms North Basrah Southern Iraq. A brief description for the genus *Azolla* and full description with diagnostic characteristics supported by photographs for the species *A. filiculoides* were given. Local habitat, geographical distribution, associated plant communities and accompanying species were illustrated. *Azolla filiculoides* was seen to have a clear association with *Lemna minor*. Key to the *Salviniaceae* genera of Iraq is provided and their distribution is mapped.

Introduction

Thirteen genera belong to seven families of *Pteridophyta* have been recorded in Iraq, twelve of that were fully described in the volume 2 of *Flora of Iraq* by Townsend and Guest, 1966. One genus with one species, *Thylopteris palustris* was latter described as new record for Iraq by Al-Hilli, 1977.

Azolla and *Azollaceae* were not previously reported in Iraq. Recently the family *Azollaceae* (which has been a distinct family) considered as a synonym to *Salviniaceae* on the basis of DNA sequences (Smith et al., 2006; Reid et al., 2006). *Salvinia* was the only genus of the family *Salviniaceae* mentioned in Iraq. In the world the *Salviniaceae* includes two genera: *Azolla* with 6-7 species and *Salvinia* with about eight species.

The species of *Azolla* are economically important. They provide a protected environment and a fixed source of carbon to the blue green filamentous algae *Anabaena azollae* (Wagner, 1997). It can be utilized as a biofertilizer on rice and many other crops. *Azolla* also a very important source of crude protein, it has a higher content of protein than most aquatic macrophytes, in addition to its richness in amino acid particularly lysine (Cagauan and Pullin, 1994; Pereira et al., 2001). It may also be used for weed and mosquito's control.

Response of wheat to soil fertilized with varying quantities of the water fern *Azolla filiculoides* was confirmed by Lilian Kguli. *Azolla filiculoides* is a cosmopolitan species occurring in South, Central and North America, Central and North Europe, South Africa, Australia and Asia (Weber, 2005; Hussner, 2006).

Zimmerman et al. (1991) found that the three species of *Azolla* native of America, *A. caroliniana*, *A. mexicana* and *A. microphylla* are closely related and they consider them as a single species synonym to *A. filiculoides* Lam. which is also native to America. The other 2 species, *A. pinnata* and *A. nilotica* are native to Africa (Hove Van, 1989).

Materials and Methods

Several trips to the marshlands of southern Iraq were made in Summer –Autumn 2015. *Azolla* specimens were found in two sites in Hartha 25 km North of Basrah (Figures 1, 2). Fresh *Azolla* were collected in October and November 2015 and photographed. Fresh materials were examined with light microscope. Measurements and diagnostic characters of the species were illustrated. Herbarium specimens were made and deposited in Basrah University Herbarium (BSRA). Plant associations and accompanying to *Azolla* in the sites were identified and photographed. Photographs of specimens collected by Dr. Khalid Faiq from Kalar, Sulaymaniyah, Kurdistan of Iraq were also examined.

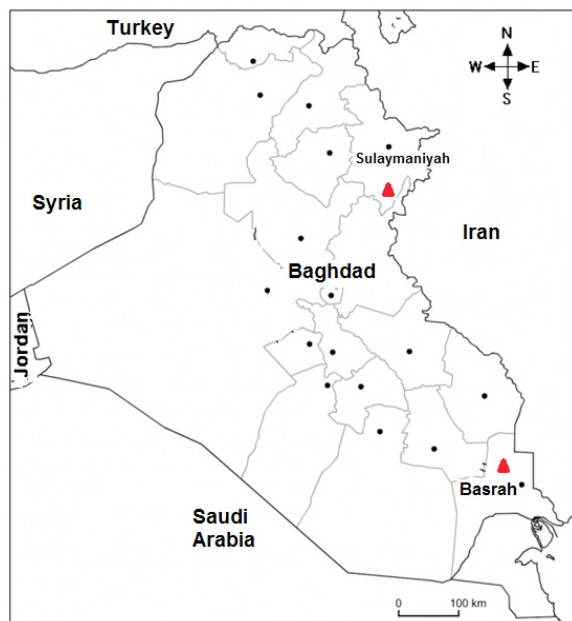


Figure 1: Distribution in Iraq of *Azolla filiculoides* (▲).



Figure 2: Photograph of area of study in Basrah showing habita and plants accompanying to *Azolla*.

Results

Key to the Salviniaceae genera

Root simple, unbranched , leaves uniform, alternate with each leaf papillate and divided into upper aerial lobe and a lower submerged lobe. Sporocarps occur on the first leaf of lateral branch.-----*Azolla*.

Root absent, leaves dimorphic in whorls of 3 with 2 lateral floating and the third submerged, dissected into 5- 12 filiform hairy segments. Sporocarps occur on submerged leaves----- *Salvinia*.

Azolla Lam. 1783

Azolla filiculoides Lam.

A small free floating aquatic fern 3-7 mm long. Root up to 25 mm long, simple, unbranched , numerous, hang down from beneath of the rhizome. Stem a horizontal rhizome lies under the surface of water. Fronds green or yellowish green or olive green, frequently tinged with red particularly in the winter.

Leaves 0.75-1.5 mm long and 0.5- 1 mm wide, scale-shaped, ovate, obtuse, with unicellular papillae , with hyaline margin of 2-4 cell rows, alternate, in two rows, distichous, each leaf has 2 lobes, a thin submerged lobe bearing the sporangia (carpospores) and an upper floating lobe which overlap neatly the leaf in front, the upper leaf lobe has a cavity contains. *Anabaena azollae* (a blue green alga). Carpospores 237.5-275 um long and 175-212.5 um wide, covered with glochida which are of 1-3 septa (Table 1, Figure 3, 4).

Habitat: Stangent or slow flowing waters, in ditches, canals, rivulets in date palm groves or marshlands, in brackish water with EC 9.5 mmos cm⁻¹, pH 8.4, temperature 9-25 °C.

Plant communities: The followings form the dominant plant associations with *A. filiculoides*.

Lemna minor

Myriophyllum spicatum

Ceratophyllum demersum

Accompanying species

Tamarix sp.

Suada aegyptiaca

Aster sp.

Phragmites australis

Lycium barbarum

Distribution

General : South America, Central America, North America,

Alaska, Europe, Africa, S.W. Asia, S.E. Asia, central Asia.

Local in Iraq:

LSM: Hemernian, near Haritha, 25 km north Basrah, Al-Mayah ,Al-Saadi and Abdulla, 1501, BSRA (Figure 3).

MSU: Kalar, about 120 km S. Sulaimanya, Khalid Faiq S.N. photograph!

Table 1 : Measurements of vegetative and reproductive characters of *A. filiculoides*.

Leaves and roots measurements in millimeters				
Root length	Fern length	Branch length	Leaves length	Leaves width
(2.5-11) 5.37	(3-6) 4.83	(3-5) 4.21	(0.75-1.5) 1	(0.5-1) 0.8
Carpospore measurements				
Carpospore length(um)	Carpospore width(um)	Glochida length (um)	Number of septa in glochida	Septa shape
(237.5-275) 251.87	(175-212.5) 200.62	(35-50) 42.5	1-3	Anchor-shape

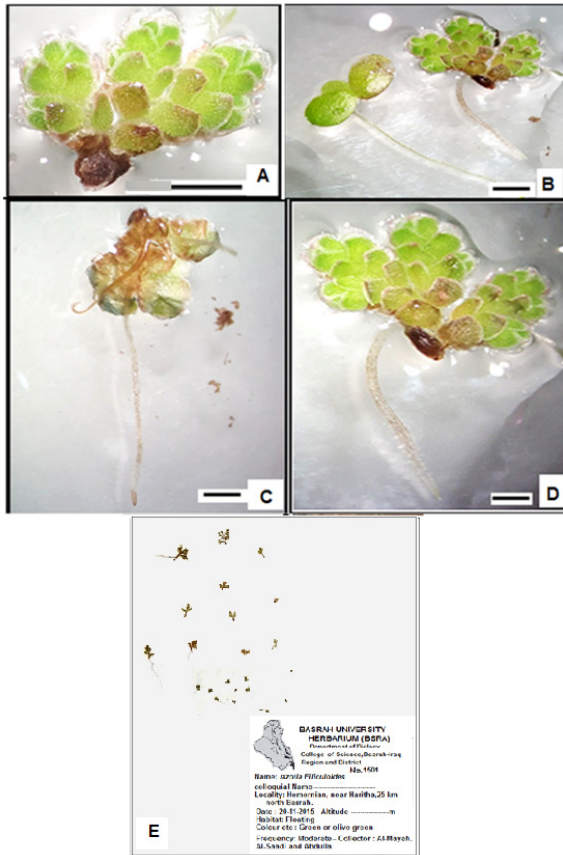
Discussion

The species of the genus *Azolla* were grouped under two subgenera: subgenus *Azolla* (*Euazolla*) with four species, *A.caroliana*, *A.mexicana*, *A. microphylla* and *A.ficuloides* Lam., all are native of America, and subgenus *Rhizosperma* with two species. *A.nilotica* and *A. pinnata* which are native of Africa. In subgen *Azolla*, *A. caroliana* and *A. microphylla* were considered as synonym to *A. filiculoides* (Evard and Van Hove , 2004).

After the amalgamation of *Azollaceae* with *Salviniaceae* (Smith et al., 2006) the two subgenera were treated as two distinct sections under *Azolla* in *Salviniaceae*. The *Salviniaceae* in its recent broad concept includes two genera: *Salvinia* which in Iraq has one species only *S.natans* that are widely distributed throughout southern Iraq, and *Azolla* with two sections: section *Azolla* and section *Rhizosperma* (not found in Iraq). *Azolla filiculoides* which added to the *Salviniaceae* of Iraq in this paper belongs to the section *Azolla*.

The recording of *Azolla* in Iraq (in this study) and also in Iran (Hashemloian and Azimi, 2009; Farahpour-Haghani et al.,2015) supports the cosmopolitan distribution of *A. filiculoides*. This means the genus has a wide genetic plasticity to tolerate variable environmental conditions. In our area the species found in habitat with high concentration of salinity (9.5 mmos cm⁻¹) and high light intensity. The presence of different halophyte species such as *Suada aegyptiaca* , *Tamarix* sp. and *Phragmites australis* indicateds its saline habitat.

As *Azolla filiculoides* is a native of America it is not easy to say how the species is entered or established in our area. The occurrence of the species in Iraq could be transported accidentally by ships, man or birds. Its distribution is still localized and restricted to certain areas, it is found in a few localities only, therefore it is of no economic value in Iraq, but it may become of great importance if the species succeeded to expand its distribution throughout our area. However, the distribution of the species should be under monitoring continuously to avoid uncontrolled invasion to the area.



E: Herbarium specimen

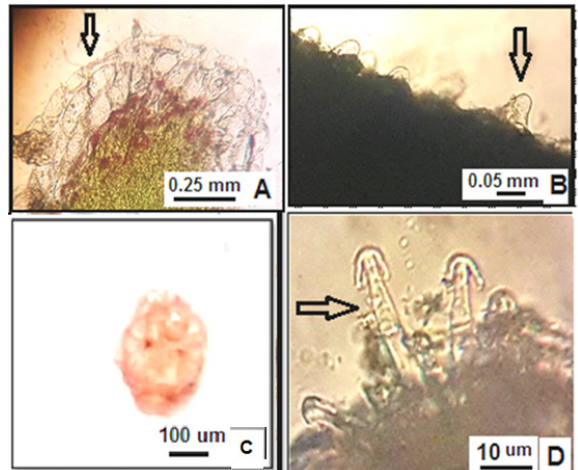


Figure 4 . *Azolla filiculoides* A: Number of hyaline border cells of leaves showing three rows; B : Unicellular papillae on the dorsal leaf lobe; C: Carpospore; D: Number of septa of glouchidia

Figure 3 : *Azolla filiculoides* , scale bar = 1 mm
 A : whole plant B: Associated with *Lemna minor* C :
 Roots from beneath of fronds D: Lateral view

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