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A NEW RARE MACROPHYTE RECORD FROM SW ASIA AND ECOLOGICAL CONDITIONS AT ITS HABITAT

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ABSTRACT. *Aldrovanda vesiculosa* L. is a cosmopolitan but very rare carnivorous aquatic angiosperm species from the family Droseraceae. The species was widespread and more common few decades ago but unfortunately it is being extinct in so many former distribution areas due to aquatic pollution and eutrophication. During the field trip to Karakuyu Lake we recognized a remarkable free-floating plant, after detailed investigation we identified the specimens as *Aldrovanda vesiculosa* which is a new record from Turkey and also SW Asia. In this publication, we provided detailed description of the species based on Turkish specimens, its habitat description, water physiochemical attributes, co-occurring macrophyte species list and botanical illustration of the species.

1. INTRODUCTION

Aldrovanda vesiculosa L. is a rare monotypic aquatic carnivorous plant that belongs to Droseraceae family. Even though it is a cosmopolitan aquatic plant, it is rare and under risk of extinction with "EN" IUCN threat category (1). The plant known from Europe, Africa, Australia, and East and Central Asia where it is native (1). It is also introduced to America (2).

During our studies of aquatic flora of Karakuyu Lake, we have collected a remarkable free-floating plant, after identification we realized that we have been collected *A. vesiculosa*. There is no *A. vesiculosa* record from Turkey except Kamiński (3) mentioned that there was a record from northern Turkey stated as "Turkey – in the north (herbarium of Institute of Plant Biology of Wroclaw University – no further detail)." There are two herbaria in Wroclaw University, WRSL and BRSL, we contacted with the both herbaria for the specimen but it could

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not be found on both herbaria. There is no *Aldrovanda* record from SW Asia except Melamed et al. (4) recorded it in Israel from 750.000 years old sediments.

This article documents the first record of *A. vesiculosa* from Turkey and SW Asia. The habitat characteristics including water chemical and physical attributes, co-occurring macrophytes and morphological features of the species are presented. Scientific illustration based on collected specimens is also provided.

2. MATERIALS AND METHODS

Karakuyu Lake which is also known as Çapalı Lake (5) is located in Dinar district of Afyonkarahisar province at lat 38°15' N, long 39° 22' E. It is a wetland originated artificial lake that created for irrigation purposes by the State Waterworks (DSI). The lakes elevation is 1006 meters, its total area is 1277,04 ha, average depth is ca. 2 m and its deepest point is 4 m.

Karakuyu Lake was visited two times in vegetation season in 2014 and two times for physicochemical analysis in 2014. The plant specimens were collected and preserved using a plant drying press than stored in herbarium ANK. Collected plant material investigated under stereo zoom microscope and identified using identification keys and descriptions on relevant literature (6, 7). Physicochemical parameters (Table 1) were analyzed according to American Public Health Association (APHA) methods (8). CO_2 concentration in the water calculated by using the pH, alkalinity and the temperature according to Prietto and Millero (9) on hamzas reef freshwater CO_2 level calculator on web (10).

3. RESULTS

A. vesiculosa recorded first time from Turkey and SW Asia. Vegetation of Karakuyu Lake where the *A. vesiculosa* recorded is dominated by *Schonoplectus lacustris* (L.) Palla and *Phragmites australis* (Cav.) Trin. Ex Steud. communities. *Aldrovanda vesiculosa* is common in reedbed clearings with *Ceratophyllum demersum* L., *Chara vulgaris* L., *Lemna trisulca* L., *Myriophyllum spicatum* L., *Utricularia australis* R. Br. and *Utricularia minor* L.. Other aquatic plants determined from the lake are *Alisma gramineum* Lej., *Nymphaea alba* L. *Potamogeton lucens* L., *Potamogeton natans* L., *Potamogeton berchtoldii* Fieber, *Ricciocarpus natans* (L.) Corda, *Sparganium erectum* L. and *Stuckenia pecctinata* (L.) Böerner.

***Aldrovanda vesiculosa* L., Sp. Pl. 281 (1753).**
Aquatic rootless, free floating submerged plants with filiform somewhat brunching stem from 8 to 20 cm long; leaves 8-14 mm, in dense whorls of 6-8; each with a cuneate basal part, with 0.5—1 cm long petioles and terminating in 4 setaceous segments (4-6 mm long) and an orbicular lobe (5-6 mm long and 6-9 mm broad), leaf blade of 2 semicircular lobes folding up along the midrib which slightly exceeds the semicircular lobes, Turkish specimens do not have flowers.

We have not observed any flowering *A.vesiculosa* individuals in the field which is actualy not surprising because like many other aquatic plants *Aldrovanda* also relying mainly on vegetative propagation and displays reduced generative reproduction (1).

Examined specimen: TURKEY: B3 Afyon province, Dinar district, Karakuyu Lake, 1006 m. a.s.l, 09.06.2014, Yaprak & Körüklü BM169 (ANK).

According to Güner *et al.* (11) there are 9 carnivorous plant taxa in Turkey and one of them *Pinguicula habilii* Yıldırım, Şenol & Pirhan is endemic. With this new record the number of carnivorous plants of Turkey reaches 10 taxa from 4 genus and two families. The list of carnivorous plants of Turkey can be seen from below:

Droseraceae
Drosera intermedia Hayne
Drosera longifolia L.
Drosera rotundifolia subsp. *rotundifolia* L.
Aldrovanda vesiculosa L.

Lentibulariaceae
Pinguicula crystallina Sm.
Pinguicula balcanica Casper
Pinguicula balcanica subsp. *pontica* Casper
Pinguicula habilii Yıldırım, Şenol & Pirhan

TABLE 1. Results of water physicochemical parameters in the Karakuyu Lake.

Parameters	**Unit**	**June 2014**	**August 2014**
Temperature	°C	22,3	19,8
pH		7,75	7,69
Electrical Conductivity	µS/cm	34	35,6
Dissolved Oxygen	mg/L	7,34	7,65
Turbidity	NTU	1,42	3,25
Suspendend solids	mg/L	4	18
Alkalinity	mg/L	178,5	176,5
Total hardness	mg/L	174,5	174,6
Biochemical Oxygen Demand (BOD)	mg/L	5	4
Chemical Oxygen Demand (COD)	mg/L	13,4	8
Total Organic Carbon (TOC)	mg/L	3,99	1,33
Total nitrogen	mg/L	1,478	1,394
Ammonium nitrogen	mg/L	0,033	0,011
Ammonia	mg/L	0,031	0,010
Nitrites	mg/L	0	0,001
Nitrates	mg/L	1,609	< 0,085
Total Kjeldahl nitrogen	mg/L	1,114	1,387
Organic nitrogen	mg/L	1,089	1,378
Total phosphorus	mg/L	0,112	0,04
Ortho Phosphate	mg/L	< 0,2	< 0,2
CO_2	mM/L	0,28	0,34

FIGURE 1. The habitat of *Aldrovanda vesiculosa* L.

FIGURE 2. *Aldrovanda vesiculosa* L. photograph in the field.

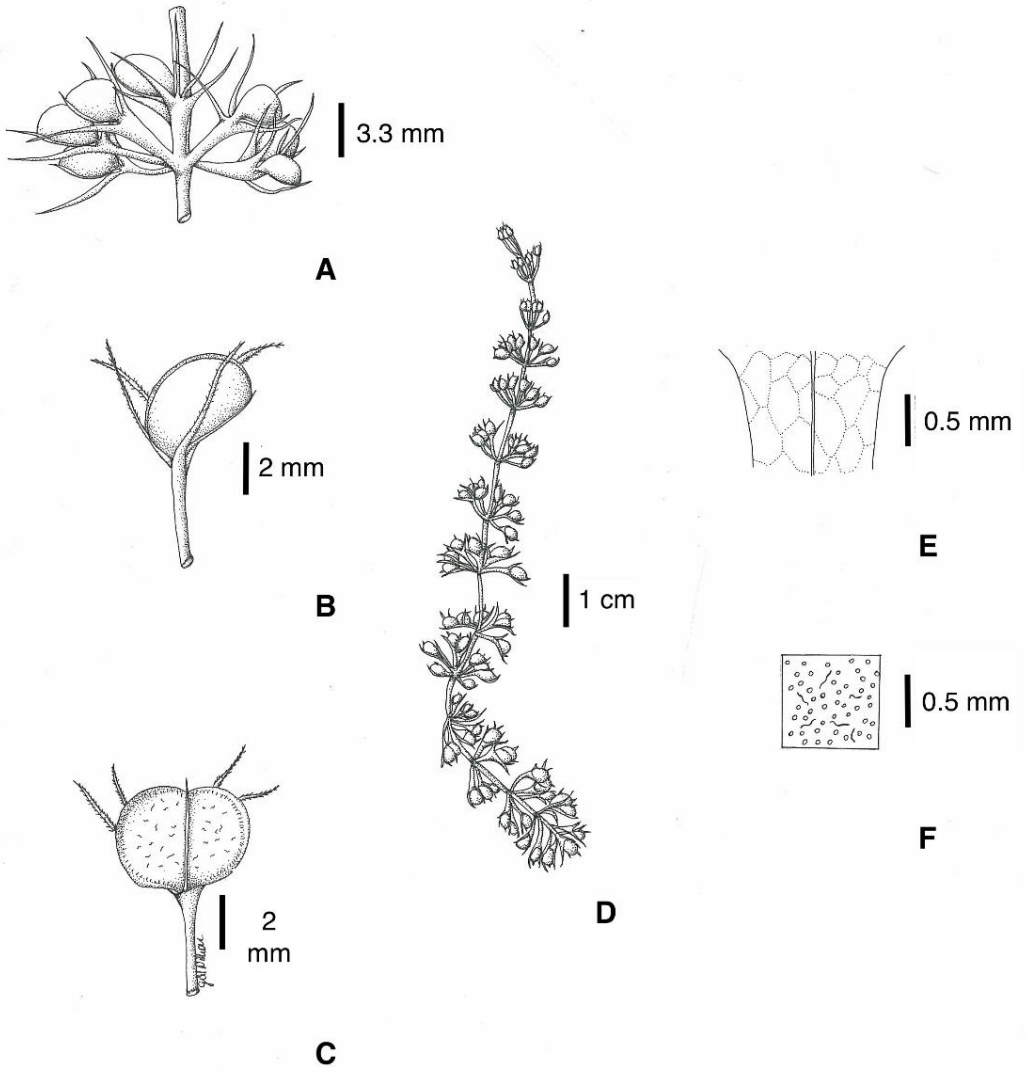

FIGURE 3. Scientific illustration of *Aldrovanda vesiculosa* L.
A: Whorl of leaves, B: A closed trap, C: A trap with open blades, D: Whole plant, E: Petiole, F: Inner surface of a trap

4. DISCUSSION

Adamec (7) reported that *A. vesiculosa* is clearly a photosynthetic strict CO_2 user and needs minimum ca. 0.1 mM and optimum 0.3 to 1 mM CO_2 levels. In the Turkish population, we have calculated dissolved CO_2 levels as 0.24 mM in June and 0.34 mM in August, the former is higher than the minimum level and the latter is in between optimum values. Even though the average deepth of the lake is 2 m, we only observed *A. vesiculosa* in shallow littoral parts (0,2 to 0,6 m deep) of the lake where the bottom covered with thick layer of dead *Schonoplectus lacustris* and *Phragmites australis* material. Water physicochemical parameters in the Karakuyu Lake generally compatible with formerly reported ecological requirements for *A. vesiculosa* populations such as low turbidity, pH range, water temperature and the nutrient concentrations except for Nitrates. We measured 1,609 mg/L Nitrate concentration in Karakuyu Lake on June which is approximately 80 times higher than the optimum concentrations reported by Adamec (7) but Kamiński (12) reported 1.63 mg/L Nitrate concentration from "Staw Nowokuźnicki" Pond which is slightly higher than our measurement.

Flora and vegetation of the lake was studied on 1982 (13) and *A. vesiculosa* was not recorded in the study. It is most likely the plant introduced to the lake after that. There are some studies supported that it may spread by migratory waterbirds to new sites (14, 15, 16). Nergiz and Tabur (17) reported 50 migratory waterbirds (7 winter migrants, 22 summer migrants, and 21 transit migrants) from the Karakuyu Lake which may be the reason of the introduction.

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Author Contribution Statement AEY-specimen collection and identification, data analysis and manuscript writing. STK-specimen collection and identification. GNT-scientific illustration and manuscript writing.

Declaration of Competing Interests The authors declare no conflict of interest.

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