

Argyroneta aquatica (CLERCK, 1757) (Aranea: Cybaeidae) as a Biological Indicator for Environmental Pollution of Sultan Marsh National Park, Turkey

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Abstract: Sultan Marsh (Turkey) is one of the largest wetland of the Middle East and Europe. The marsh was designated as a Ramsar Site, a Nature Conservation Area, and recently a National Park by Turkish Government. Despite its strong conservation status, the marsh has undergone rapid degradation in recent years. However, major changes have been observed in Sultan Marsh in the last two decades. The water spider, *Argyroneta aquatica* (CLERCK, 1757), was lastly observed in 2000 in the region. Since then, this species has not been observed in the marsh. Increased of pollution in Sultan Marsh is the most probable cause for lacking the species. It may be argued that the water spider can be used as an ecological indicator to determine environmental changes.

Key words: Sultan Marsh, pollution, environmental change, *Argyroneta aquatica*, Turkey

Introduction

The spiders are very sensitive to small changes in environmental variables and habitat structure. Therefore, the spiders are good ecological indicators of contaminants, disturbance, vegetation complexity, and the diversity of other taxa. Spiders are distributed in all kinds of environments and hence they have to adapt to different environmental conditions. However, most species prefer a particular climatic zone and occupy a specific strategic niche in consonance with the availability of prey (De BAKKER *et al.* 2006). The water spider, *A. aquatica*, is the only spider that spends its entire life under water, adapted very well to aquatic conditions. It is not able to respire in the water due to lack of gills. However, the water spiders make an air chamber in the water and

keep air in it, and feeding, copulation, and oviposition are conducted in the dome. When the water spider swims in the water, air is attached to the surface hairs of its abdomen with the surface tension (FOELIX 1981).

The aim of the study is to determine why is *A. aquatica* not seen now in Sultan Marsh? We suppose that it is not observed anymore due to habitat condition change and pollution caused by heavy metals.

Study area

Sultan Marsh is located in Kayseri province, 38°14'057"North, 35°11'297"East, 1.074 m altitude. The region is surrounded by Mount Erciyes in the North (3916 m), Develi city in the East, the Aladaglar

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(3373 m on average) of Toros Mountain Range in the South and Yesilhisar in the West (Fig. 1).

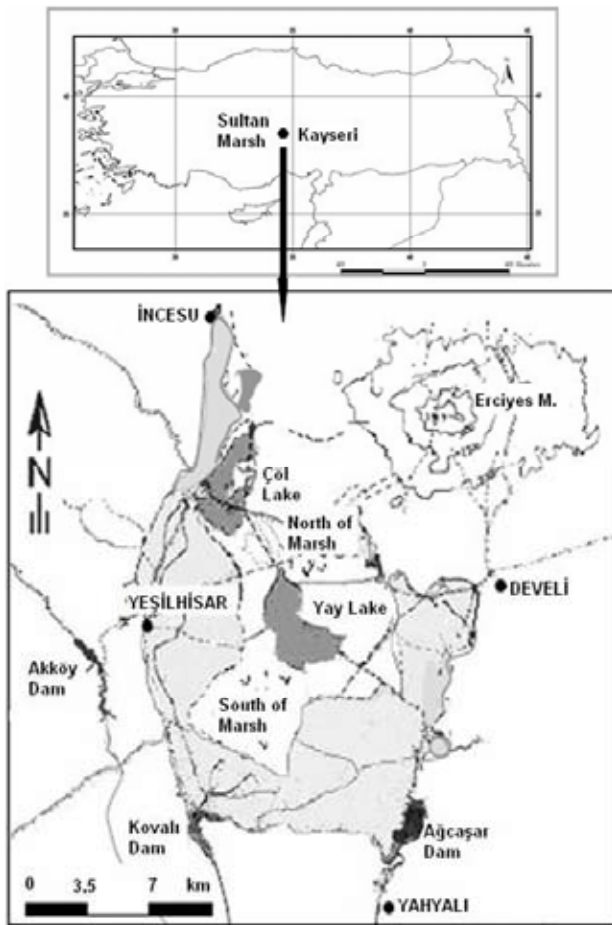


Fig. 1. Location of Sultan Marsh.

Sultan Marsh is one of the largest and most important wetlands of Turkey, Middle East and Europe, embodying saline and fresh water ecosystems, and providing a shelter for 301 bird species. This region has a rare ecosystem, where fresh and salt water habitats co-exist. It is the only region in Europe where Cranes, Flamingos, Herons and Pelicans breed together. The region is an important gathering place for birds on the migration routes. Mammals, fish species, reptiles, water turtles, frogs and leeches exist on islets and in water (YALÇIN *et al.* 2007). Also, the water spider, *A. aquatica*, has been observed here in 2000 year (SEYYAR, DEMİR, 2009).

Material and Methods

Since 2000 year, the field surveys in Sultan Marsh have been undertaken many times to collect the wa-

ter spider, but it was not observed in its habitat. In addition, water condition and heavy metal level in Sultan Marsh were also investigated. Three different stations were chosen as sampling areas and water samples were taken from these stations in May 2009. Temperature, pH and dissolved oxygen values were measured by WTW multiparameter. Samples of water were taken by submerging pre-cleaned PE bottles approximately 20 cm beneath the water surface. Suspended particulate matter was separated by filtering water samples through 0.45- μm preweighed Whatman GF/C filters. Filtered solutions were acidified to 0.5% (v/v) by using concentrated nitric acid as for the precipitation samples. Determinations of the elements in all samples were carried out by Varian ICP-OES. The samples were analyzed in triplicate.

Results

There has been no research about water spider to indicate the pollution in the marsh. The present study is undertaken to examine the water spider as a biological indicator for environmental pollution. The data obtained from this research is shown in Fig. 2, 3 and Table 1.

As it seen in Fig. 2 and 3, heavy metal pollution of Sultan Marsh has gradually increased. It was determined that concentration of the all heavy metals increased in Sultan Marsh, except for Cr, according to earlier studies.

Cadmium is a toxic element and exists together with Zn in the nature. The most important sources of Cd pollution are metal industry, plastics and sewers. It is easily taken up and enters the food web. According to ALLEN (1989), plants in unpolluted environment contain 0.01–0.3 $\mu\text{g g}^{-1}$ Cd. In this study, Cd concentrations of water samples were found as 0.52 $\mu\text{g L}^{-1}$. According to earlier data by AKSOY *et al.* (2005), Cd concentration increased almost 3 times. AKSOY *et al.* (2005) stated that Sultan Marsh has been contaminated with Cd, as shown in this study.

There are many sources of zinc like fossil fuels, metal manufacturing and fertilization. It is an essential mineral for organisms. It has a critical role in the structural and functional integrity of the cells. It

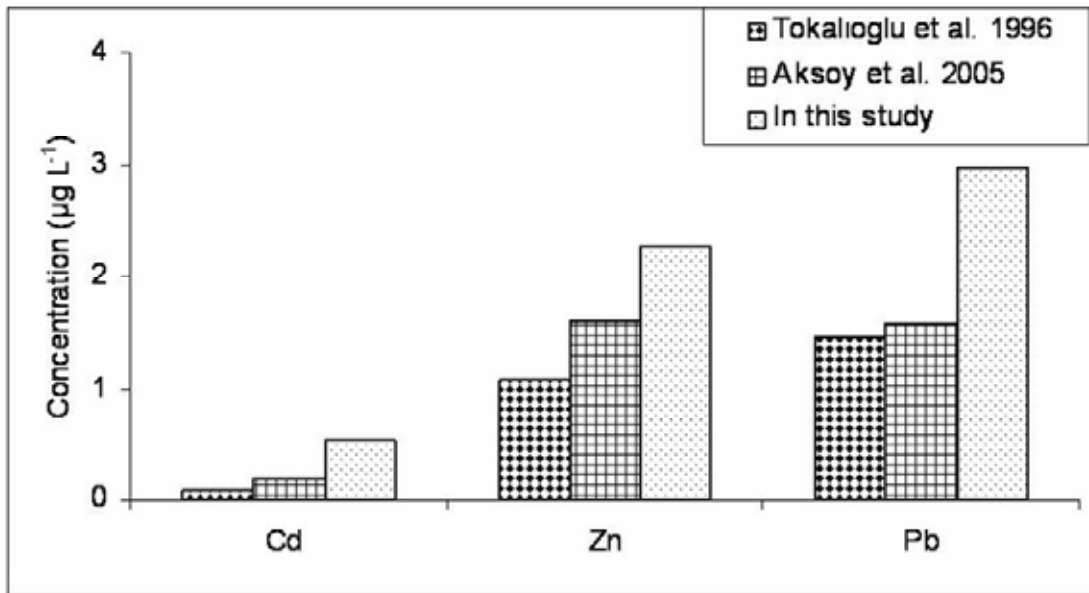


Fig. 2. Heavy metal concentration (Cd, Zn and Pb) in Sultan Marsh water.

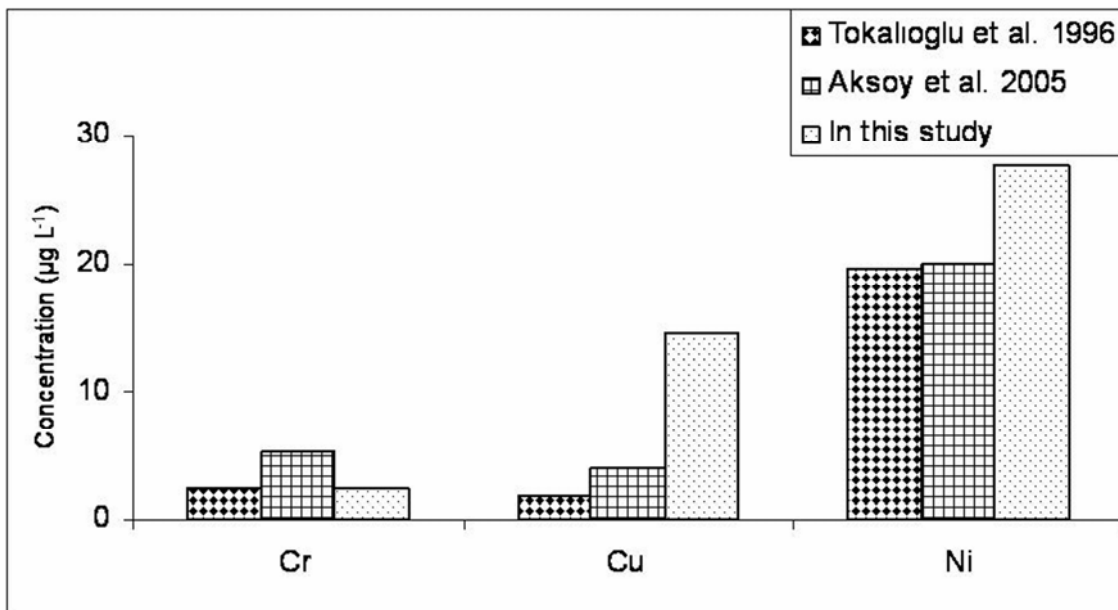


Fig. 3. Heavy metal concentration (Cr, Cu and Ni) in Sultan Marsh water.

takes role in gene expression and organism growth. Its toxicity is low (CLEARWATER *et al.* 2002). The most important reason for Zn pollution is highest human activity such as discharge of sewage sludge and use of fertilizers. In research area, similar kind of human activity is very high. When our results are compared to earlier studies, it is seen that Zn concentration increased gradually.

Lead is not an essential element for living organisms. Lead exists in accumulator industry sludge, in waste water from toy production, printing and petroleum industries and in exhaust gases (AKSOY *et al.* 2005). Leaded gasoline was in use in Turkey until recently. This is probably the most efficient mechanism of anthropogenic Pb pollution in the lake. AKSOY *et al.* (2005) stated that there is Pb contami-

nation in Sultan Marsh, which through not excessive at the present time could be dangerous for fauna and flora in future. Since on, Pb concentration increased nearly 2 times. Our result supports their foresight.

In fresh waters, Cr concentration is between 0.1 and 117 µg/L (SHANKER *et al.* 2005). In this study, it was seen that Cr concentration did not increase according to earlier data.

Cu occurs naturally in rocks, water and air, and it is an essential element for all surviving organisms. It is an important constituent of many enzymes of oxidation-reduction reactions (LEPP 1981). The most important reason for Cu pollution is production of home tools, metal manipulating, timber industry and ashes. But, Cu concentration in Sultan Marsh environment increased highly (~8.4 times) from 1996 to 2009. This was probably caused by domestic waste, herbicide and pesticide used in the surrounding agricultural areas.

Ni mainly comes from metal manufacturing and septic tanks. In lakes and streams, Ni concentration is low (DUMAN *et al.* 2007). Similar to other metal, there is an increasing trend for Ni.

In Table 1, water conditions of habitat of the water spider in Mizoro Pond situated in the north of Kyoto basin in Japan (water spider lives in there) and Sultan Marsh (water spider is not observed in there anymore) are given. Because seasonal changes in water conditions of the wetland can be seen, this study was done in the same month with Masumoto. This study is done concurrently with Masumoto's study to compare the findings.

It is found that the temperature in Sultan Marsh is higher than Masumoto's study. Dissolved oxygen is nearly similar to Masumoto's data. The pH is important data for living organism and increased two times in Sultan Marsh compared to Masumoto's

data. The alkaline pH can affect the life of water spider in a negative way.

Discussion

The heavy metals are considered as one of the major toxic pollutants for its long persistence in the environment. They cannot be degraded but can accumulate in water, soil, bottom sediments and organisms. The effect of a pollution stress on an ecosystem will progressively reduce species diversity and subsequently have adverse effects on productivity (AKSOY *et al.* 2005).

Sultan Marsh is one of the most important habitats for a variety of plant and animal species but major changes have been observed here in the last two decades (CELIK *et al.* 2008). Especially, its hydrologic, physical, and biological characteristics have been altered by a major irrigation project in the Develi Basin.

Some studies had been done about heavy metal effect on different macrophytes in Sultan Marsh. Recently, a study by DEMIREZEN, AKSOY 2004 has revealed that heavy metal pollution has serious influences on Sultan Marsh. In fact, they detected heavy metal (Cd, Pb, Cr, Ni, Zn and Cu) pollution in beds of sediments, water and plants (*Typha angustifolia* L., 1753 and *Potamogeton pectinatus* L., 1753). DEMIREZEN, AKSOY (2006) stated that there were biological indicators of serious metal pollution (Fe, Mn). It has been observed that heavy metal pollution exists in small or large quantities in *Phragmites australis* (CAV.) TRIN.ex STEUDEL, 1841, *Ranunculus sphaerospermus* BOISS, BLANCHE, 1856 plants and sediments. Indeed, the Cr rate was found to be very high in plants and sediments (AKSOY *et al.* 2005).

In conclusion, water in Sultan Marsh are mainly contaminated by Cd, Pb, Ni, Cu, Zn and partly by Cr. Pollution in the area is noteworthy and have been

Table 1. Comparison of water conditions in Mizoro Pond and Sultan Marsh.

Water conditions	MASUMOTO <i>et al.</i> , 1998 (sampling were done in Mizoro Pond on May 1, 1996)	This study (sampling were done in Sultan Marsh on May 15, 2009)
Temperature (°C)	17.2–18.2	22.4–30.2
pH	4.48–4.50	8.22–8.8
DO (mg/L)	0.32–1.09	0.45–1.02

gradually increasing. Water conditions of the habitat of water spider have been changed. So, *A. aquatica* which was lastly seen in 2000 year does no longer exist in this wetland. If not prevented, pollution may endanger the survival of the species in the region for the following years.

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