Description of a new subterranean nerite: *Theodoxus gloeri* n. sp. with some data on the freshwater gastropod fauna of Balıkdamı Wetland (Sakarya River, Turkey)

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**Abstract**

In the present study, conducted between 2001 and 2003, four taxa of aquatic gastropoda were identified from the Balıkdamı Wetland. All the species determined are new records for the study area, while one species *Theodoxus gloeri* sp. nov. is new to science. Neritidae is a representative family of an ancient group Archaeogastropoda, among Gastropoda. *Theodoxus* is a freshwater genus in the Neritidae, known for a dextral, rapidly grown shell ended with a large last whorl and a lunate calcareous operculum. Distribution of this genus includes Europe, also extending from North Africa to South Iran. In Turkey, 14 modern and fossil species and subspecies were mentioned so far. In this study, we aimed to uncover the gastropoda fauna of an important Wetland and describe a subterranean *Theodoxus* species, new to science.

**Key words**: Gastropoda, *Theodoxus gloeri* sp. nov., Sakarya River, Balıkdamı Wetland Turkey.

**Introduction**

Turkey has been recognized as one of the most important countries of both Europe and the Middle East referring to wetlands. The Balıkdamı Wetland, an impoundment of the upper course of the Sakarya River located near Sivrhisar (Eskişehir, Central Anatolia), is one of the most important bird conservation areas in Turkey. This area also encompasses the mouth of the torrential Göksu Stream, which is partly hyporheic (Magnin *et al.* 2000). And the entire area of Balıkdamı was declared a Natural Monument in 1988 and a Permanent Wildlife Reserve in 1994.

Up to now, there has been no study dealing with Gastropoda fauna of Balıkdamı wetland. However, in recent years, only one study focused on the freshwater Oligochaeta of Balıkdamı wetland (Arslan *et al.* 2007), and two new species of Phaladorlinae identified by the authors.

Neritidae as a family is nearly world-wide in its distribution, occur mainly in a tropical to temperate zone of the earth (Russel 1941). In shape, members of this family might be globose or patelliform, rather thin or thick shelled, from smooth to spiny, ribbed or lamellar ornamented forms. *Theodoxus* is a genus in the Neritidae, known for dextral, lunate aperture and a calcareous operculum, as in all members of this family.
Shell and color pattern plasticity observed among *Theodoxus* species is a challenge in the species level identification (Bodon & Giovanelli 1995; Glöer & Pešić 2015), thus, the other phenomena such as operculum morphology (Zettler et al. 2004; Glöer & Pešić 2015) and micro structure of radula (Feher et al. 2009) are used for precise identification. The distribution of this genus ranges from Europe and North Africa to South Iran (Glöer 2002: 48; Glöer & Meier-Brook 2003: 28; Bunje & Lindberg 2007).

Yıldırım (1999) listed both living and fossil species of *Theodoxus* in Turkey; *T. fluviatilis fluviatilis*, *T. fluviatilis euxinus*, *T. heldreichi heldreichi*, *T. heldreichi fluvicola*, *T. anatolicus*, *T. syriacus*, *T. altenai*, *T. subtermalis*, *T. jordani*, *T. cinctellus* as living, while *T. (Calvertia) karakovensis*, *T. (C) karakovensis strictus*, *T. (C) depressus*, *T. (C) bukowski* as fossil species. Thereafter, Yıldırım et al. (2006) removed the two species; *T. subtermalis* recorded from southeastern Turkey (Bilgin 1980) and *T. danubialis* from Lake Sapanca (Schütt 1988) from the earlier list on account of the fact that inconsistency in the native range of those. Although, the existence of *T. karasunus* (Mousson, 1874) in Turkey claimed by Eichorst (2014), however, there is no other record supported existence of this species. There is also argument on to generic position of *T. cinctellus*, this species subsequently ascertained to the genus *Neritina* (Glöer & Pešić 2012) due to characterized by a denticulated columellar border.

In the present study, we aimed at examining the taxonomic composition of Gastropoda species in the Balıkdamı Wetland as a means to evaluate the contribution of this component to the diversity of an important Turkish wetland fauna and describing the new subterranean species of *Theodoxus*.

**Material and Methods**

**Field Study**

The field study carried out on The Balıkdamı Wetland located on the Sakarya River in the southern Eskişehir Province, West-Central Anatolia, Turkey (about 800 m a.s.l.), and has a surface area of 1,470 hectares (Fig. 1). The International Bird Area includes two parts here: the eastern portion commonly known as Balıkdamı, comprising 503 hectares of extensive reed beds (*Phragmites australis*) with an area of temporary open water (during winter and spring) and mudflats; and the western part, 967 hectares, consisting of marsh and grassland of the villages of Kurtçeyh and Ahiler (Magnin & Yarar 1997).

![Figure 1. Map of the study area. Grey Line: International Bird Area Border, Black Line: River Sakarya and its Stream Göksu, Black Circles: Villages in the study area, Red Circles: Sampling Stations in the research Area, Star: The Station 1, type locality of the new species.](image-url)
The samples were collected with a dip net and a sieve. After the samples were processed in the field using a series of sieves with decreasing mesh sizes, specimens were extracted from raw samples in laboratory, under stereo microscope, and transferred into Eppendorf tubes. Holotype and paratypes of the new species described herein are deposited in the Çanakkale Onsekiz Mart University, Limnology Museum (COMULM) and Eskişehir Osmangazi University, Museum of Hydrobiology (OGUHB), Turkey.

Results

Systematics

Family Neritidae
Subfamily Neritinae
Genus *Theodoxus* Montfort 1810
Subgenus *Theodoxus*

*Theodoxus gloeri* sp. nov.

Description: The hemispherical shell is small, relatively thin and translucent with no pigmentation. Shell sculpture is ornamented with elevations of fine lamella arranged at regular intervals ranging from 15 to 20 in adults. Apex is prominent and smooth at surface. Aperture is semicircular, smooth and without denticles at columellar edge. The shell is up to 2.92 mm (mean: 2.36 mm ±0.31) in height and 3.28 mm (2.95 mm ±0.21) in width (Total No of specimens: 8).

![Figure 2. *Theodoxus gloeri* sp. n. Upper Row (1-A, 1-B): The holotype specimen; Lower Row (2-A, 2-B, 3): The paratypes, 4 - Juvenile.](image-url)
**Type Material:** 17 ex. from Balıkdamı Wetland- Sakarya River, Eskişehir, Turkey; 39.15277, N 31.61562 E and 39.16116, N 31.61819 E (Figure 1), 2002, Naime ARSLAN leg. One the specimens regarded as the holotype that it has following dimensions: shell height 2.92 mm, shell width 3.1mm deposited in COMULM–G 0052. Remainders were paratypes from same locality left in either COMULM with the catalog number of G 0053 (7 specimens) or OGUHB in the catalog no: 01759 (9 specimens).

**Remarks:** Shell of the *Theodoxus gloeri* sp. nov. is more smaller than those of *Th. pilidei pilidei* (4-6 mm, according to Tournouër, 1879: 262, see also Figure 3) and *Th. pilidei botenai* (much larger than in *Th. pilidei pilidei* according to Wenz 1942: 144-pl2). Unlike these sibling fossils, *Theodoxus gloeri* has obviously protruded protoconch with smooth surface and it also has fine lamellar elevations emerging from teleoconch at regular intervals. Empty shells of *Theodoxus gloeri* were found without opercula. In the literature (i.e. Bandel 2001; Lozouet 2004), there are several ribbed (along with spiral lines) species of Neritimorpha such as *Nerita undata*, *N. plicata* and *Bourdieria faviai*, however, no any other species like two forms of *Th. pilidei* and *Th. gloeri* in which have a shell with lamellar structure in parallel with its growth lines.

**Figure 3.** The picture of fossil *Theodoxus pilidei pilidei* (from Wenz 1942).

**Habitat:** Sampling sites of this species is a large wetland constitutes the headwater of the Sakarya River, located on the bird migration route. This species that was sampled in one station accidentally, is most probably a hypogean form.

**Etymology:** The species is named after Peter Glöer an outstanding malacologist on freshwater gastropoda.

**Faunistic Data**

In the present study, a total of 4 Gastropoda species representing 3 genera were identified (Table 1). Among the seven sampling stations set up in the study area, we have observed gastropod specimens only in three stations which are 1, 3 and 4. *Melanopsis buccinoidea* (Olivier 1801) sampled from station 3 and 4, *Theodoxus fluviatilis* (Linnaeus 1758) and *Pseudamnicola natolica* (Küster 1852) specimens were found only in station 1. All species identified during the study are new records for Balıkdamı wetland. One species, *Theodoxus gloeri* sp. nov. is new to science.

**Discussion**

The freshwater snails of Balıkdamı are widespread in Turkey, considering the Turkish continental mollusk’s distribution patterns. For example, *Melanopsis buccinoidea*, a circum Mediterranean species, is widespread for its genus, especially in southern regions of Turkey (Heller et al. 2005); *Theodoxus fluviatilis* is very common in central Europea (Glöer 2002) which is also common in Turkey (Yıldırım 1999). Besides, *Pseudamnicola natolica* – the spring inhabitant taxa, is endemic to Turkey (Yıldırım 1999). We sampled the
last species in the study site where groundwater resources densely feed the stream was station 1. Unlike the earlier study of Şeşen & Schütt (2009) in the Sakarya River, no Fagotia species was found either actual or fossil in our field survey in Balkıdami Wetland. Whereas the authors have found Fagotia samples living in huge numbers and also fossil at Çifteler Region also known as Headwater of Sakarya River called “Sakaryabaşı” located at the downstream compared to our study area.

Table 1. Freshwater snails sampled from the study area with geographic coordinates.

|                | 1st Station | 2nd Station | 3rd Station | 4th Station | 5th Station | 6th Station | 7th Station |
|----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Coordinates    | N9.152128°  | N39.183903° | N39.201997° | N39.197939° | N39.168866° | N39.201132° | N39.188227° |
|                | E31.615326° | E31.608868° | E 1.661739° | E31.624146° | E31.612043° | E31.644702° | E31.581144° |

*M. buccinoida* + +

*Th. fluviatilis* +

*P. natolica* +

*Th. gloeri* sp. nov. +

As far as we know, *Theodoxus subterrelcitus* Schütt, 1963 is only one subterranean representative of Neritidae, living in the Metkovich Cave, near the city Trebinje in Bosnia and Herzegovina (Welter-Schultes 2012; animalbase.uni, 2015). Although our *Theodoxus* sp. n. we describing herein has a little common peculiarities with this cave species such as uncolored shell, nevertheless, distinctly differed by the ornaments on the shell surface. Despite intensive efforts of sampling at the study area, plenty of empty shells were found belong to the species describing herein.

The fossil *Neritina pilidei* (Tournouër, 1879) is the type species of *Theodoxus pilidei pilidei* (Tournouër, 1879) which is the most similar to the *Theodoxus gloeri* sp. nov. All close relatives of this species, as itself; *N. militaris* and *N. platystoma* were both fossil (Tournouër 1842). According to Wenz (1942), both *Th. pilidei pilidei* (Tournouër, 1879) and *Th. pilidei botenai* (Porumbaru, 1881) are Pleistocene fossil species discovered from the same territory around Prahova and Nisipul (Romania) respectively. The two subspecies separated by its’ lamella which provide a unique structure of the species; *Th. pilidei botenai* has a rib-like lamella than those of *Th. pilidei pilidei*. Although the type locality was stated as inner territory of Romania, the subspecies also sampled from the littoral zone of Black Sea- Constanta, on the *Modiola phaseolina* surface at 45 meters (Grossu 1986). To date, there is no living descendant of this unique species known to have existence. In Turkey, there are four fossil taxa recorded of *Theodoxus: Th. (Calveria) bukowski*ii (Oppenheim, 1919), *Th. (Calveria) depressus* Taner 1973, *Th. (Calveria) karakovensis strictus* Taner 1973, *Th. (Calveria) karakovensis* Taner 1973 and one both fossil and living *Th. heldreichi heldreichi* (Martens 1879) (Taner 1973; Yıldırım 1999). All the fossil specimens and the extant taxa living today are not similar to *Th. gloeri* in appearance. In fossil records of Turkey, there has never been a specimen that bearing lamella observed so far (Y. İslamoğlu, pers. comm. 20 April, 2015).

*Theodoxus gloeri* is similar to *Theodoxus pilidei pilidei* which was found in Romania (the type locality) as a fossil. Our finds, however, have not fossil species characteristics such as having thickness and opaqueness. In contrast, they are fragile and translucent structure, as if being a remnant of a newly dead snail. Such a pattern of shell, additionally, with no color on the periost suggests that a snail living as subterranean form. On the other hand, as the sampling of hypogean organisms has difficulties, obtaining a subterranean gastropod as living is rare occasion (Glöer & Pešić 2014). Though, we conclude that the *Theodoxus gloeri* is an endemic to its type locality, further research recommended in order to obtain more precise information about ecology and evolution of the new species.
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