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Mollusks on bone remains from Holocene deposits of Lake Sevan basin, Armenia

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Abstract

To present data on the mollusc fauna found on bone remains from natural deposits (including skulls, horn cores, and postcranial skeletons) on the northwestern shore of Lake Sevan. Identified remains include *Cervus elaphus* (red deer), *Bison* sp. (wisent), *Canis lupus* (grey wolf), *Vulpes vulpes* (red fox), *Bos* sp. (aurochs) and *Sus* sp. (boar). The study records ten species of freshwater mollusks associated with the mammal bones. Among these, two species – *Bithynia troscheli* Paasch, 1842 and *Planorbis carinatus* Müller, 1774 – are identified as glacial relicts.

Key Words

Holocene, mollusks, mammalia, bone remains, Lake Sevan.

Моллюски на костных остатках из голоценовых отложений бассейна озера Севан, Армения

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Резюме

В работе представлены данные о фауне моллюсков, обнаруженных в естественном захоронении костей (черепов, роговых стержней, посткраниального скелета) на северо-западном берегу озера Севан. Останки *Cervus elaphus* (благородный олень), *Bison* sp. (зубр), *Canis lupus* (волк), *Vulpes vulpes* (лисица), *Bos* sp. (тур), *Sus* sp. (кабан). Выявлено десять видов пресноводных моллюсков, сцементированных на костных остатках млекопитающих. Два из них, *Bithynia troscheli* Paasch, 1842 и *Planorbis carinatus* Muller, 1774, являются ледниковыми реликтами.

Ключевые слова

Голоцен, моллюски, млекопитающие, костные остатки, озеро Севан.

INTRODUCTION

A closed mountain basin, the bottom of which is filled with the waters of Lake Sevan, or as it was called in ancient times, the Geghama Sea, is one of the world's largest high-altitude lakes.

The Lake Sevan Basin is a vast tectonic area edged by mountain ranges and situated 1,900 m above sea level, the lowest part of which is covered with lake water. The natural landscape of Lake Sevan basin is highly diverse. The western and southern basins of the lake are characterised by typical volcanic relief forms. In many places the eruptions of lava reaching to Lake Sevan rendered very complex shapes to the coasts, forming multiple bays, creeks and capes. The lake shoreline that has recently been exposed above water level is formed of sand, clay and gravel deposits. The layers forming this stratum relates to paleo-fluvial deposits of the early Holocene. These rocks contain animal bone remains, which lay alternately with diagonally layered sand in two strata.

The species composition of the fauna is rich. There have been identified remains of *Bison* sp., *Bos* sp., *Cervus elaphus*, *Vulpes vulpes* and horn cores of *Ovis* sp. but the dominant remains belong to *Bos* sp.

Ten species of freshwater mollusks were found in silty-sandy rocks of grey colour, with layers of sand, cemented on the remains of the mammal skeletons. Two of them, *Bithynia troscheli* Paasch, 1842 and *Planorbis carinatus* Muller, 1774, are glacial relicts.

MATERIAL AND METHODS

The osseous material was collected during expeditions of the Laboratory of Zoology of Vertebrate Animals, Institute of Zoology of the NAS RA. The natural burial place of these bones is concentrated on the south-western coast of Lake Sevan near the village of Hayravank (near the Ayrivan monastery). The belt extends lengthways along a wave-cut zone as far as Cape Noraduz, over 500 metres of length and about 50–60 metres in width. The layers forming this stratum relate to paleo-fluvial deposits of the recent Holocene [1]. These rocks contain animal bone remains, which lay alternately with diagonally-layered sand in two strata.

Using a small hammer, mollusks were carefully separated from bones together with sand and silt. Large mollusks were sorted separately and small mollusks, mixed with sand and silt, were sieved through a special strainer. Sorting, measurement and identification of mollusks were carried out using a binocular microscope.

The identification was carried out according to [2–6].

RESULTS

The species composition of the “faunistic complex” is rich: remains of *Cervus elaphus* (red deer), *Bison* sp. (wisent), *Bos* sp. (aurochs), *Canis lupus* (wolf), *Vulpes vulpes* (fox), *Sus* sp. (boar) and horn cores of small carnivores were identified, the dominating remains belonging to large *Bos* sp. (male aurochs).

Mammalia Linnaeus, 1758

Order Artiodactyla Owen, 1848

Family Bovidae Gray, 1821

Genus *Bos* Linnaeus, 1758

Bos sp.

Figure 1;

Mammalia Linnaeus, 1758

Order Cetartiodactyla Montgelard et al., 1997

Family Bovidae Gray, 1821

Genus *Bison* (*Bison*) *bonasus* Linnaeus, 1758

Bison sp.

Figure 2

The bone remains are represented by a small number of specimens (fragmentary skulls and horny cores) from the Holocene faunal assemblages of: Tsamakaberd, Ayrivank and Shorzha [1; 7–10].

Order Artiodactyla Owen, 1848

Family Cervidae Gray, 1821

Genus *Cervus* Linnaeus, 1758

Cervus elaphus maral Ogilby, 1840

Figure 3

Synonym *Cervus elaphus maral*

A characteristic representative of the fauna of Armenia from the early Holocene to the late Middle Ages (inclusive). It ranks first among wild animals in materials from excavations of monuments in the Lake Sevan basin, in terms of both the number of finds of bones and individuals. The vast majority of deer bones belong to adult animals that were hunted for meat, skins and antlers. The bones and fallen antlers of adult animals were used to make tools such as hoes, digging tools and Manaserian presses [11–13].

Order Artiodactyla Owen, 1848

Family Bovidae Gray, 1821

Genus *Bos* Linnaeus, 1758

Bos sp.

Figure 4; Figure 5, a, b; Figure 6, a, b

These rocks contain animal bone remains, which lay alternately with diagonally layered sand in two strata. The species composition of the “faunistic complex” is rich: remains of *Cervus elaphus* (red deer), *Canis lupus* (wolf), *Vulpes vulpes* (fox), *Sus* sp. (boar) and horn cores of small cavicorns are identified, however the dominating remains belong to big *Bos* sp. (aurochs).

Mammalia Linnaeus, 1758

Order Cetartiodactyla Montgelard et al., 1997

Family Bovidae Gray, 1821

Genus *Bison* Hamilton Smith, 1827

Bison bonasus (Linnaeus, 1758)

Subspecies *Bison bonasus caucasicus*

(Turkin & Satunin, 1904)

Figure 1; Figure 2

The remains are represented by a small number of specimens (fragmentary skulls and horny cores) from the Holocene faunal assemblages of: Tsamakaberd, Ayrivank and Shorzha (Mejlumian & Manaseryan [7]; Mejlumian [1]; Manaseryan [8]; Manaserian [9]; Wecek, Hartmann, Pajmans & Manaseryan et al. [10].

Extinct species.



Figure 1. Skull fragment – *Bos* sp.
Рисунок 1. Фрагмент черепа – *Bos* sp.



Figure 2. Horn core – *Bison* sp.
Рисунок 2. Роговой стержень – *Bison* sp.

Order Artiodactyla Owen, 1848

Family Cervidae Goldfuss, 1820

Genus *Cervus* Linnaeus, 1758

Cervus elaphus maral Ogilby, 1840

Figure 3

Synonym *Cervus elaphus maral*

A characteristic representative of the fauna of Armenia from the early Holocene to the late Middle Ages (inclusive).

It ranks first among wild animals in materials from excavations of monuments in the Lake Sevan basin, in terms of both the number of finds of bones and individuals. The vast majority of deer bones belong to fairly large adults, but not old individuals, indicating that deer was the main species hunted for its meat and hide. Tools were made from the bones and shed antlers of adult animals – hoes, digging tools, wringer [11–13].



Figure 3. Skull – *Cervus elaphus*
Рисунок 3. Череп – *Cervus elaphus*

Order Artiodactyla Owen, 1848

Family Bovidae Gray, 1821

Genus *Bos* Linnaeus, 1758

Bos primigenius Bojanus, 1825

Extinct species.

Figure 4; Figure 5, a, b; Figure 6, a, b

Fragments of skulls with cores and isolated horn cores, (over 20 specimens), are distinguished by their large size and greater girth of the horn core at the base than those of domesticated bulls in materials from excavations

(Ayrivank, Sevan fortress and Lchashen). [9; 14; 15]; Wolf (*Canis lupus*), Fox (*Vulpes vulpes*) and Boar (*Sus scrofa*)

Wolf (*Canis lupus*) – wolf bones are very rare amongst the excavated remains. Usually, as in this case, single bones are found. Fox (*Vulpes vulpes*) – fox bones (jaws and individual teeth) are found in remains from excavations more often than wolf bones but still only in small quantities as single bones. Boar (*Sus scrofa*) – boar bones are very rare in the excavated remains. [11; 16; 17].

The remains are not numerous and are represented by a small number of specimens (fragmentary skulls and horn cores) from the Holocene faunal assemblages of: Tsamakaberd, Ayrivank and Shorzha [[1; 7–10].

In silty and sandy rock of grey colour, separated by sand layers, mollusks there have been found remains of some invertebrate animals, cemented onto the remains of mammal skeletons.



Figure 4. Humerus – *Bos primigenius*

Рисунок 4. Плечевая кость – *Bos primigenius*

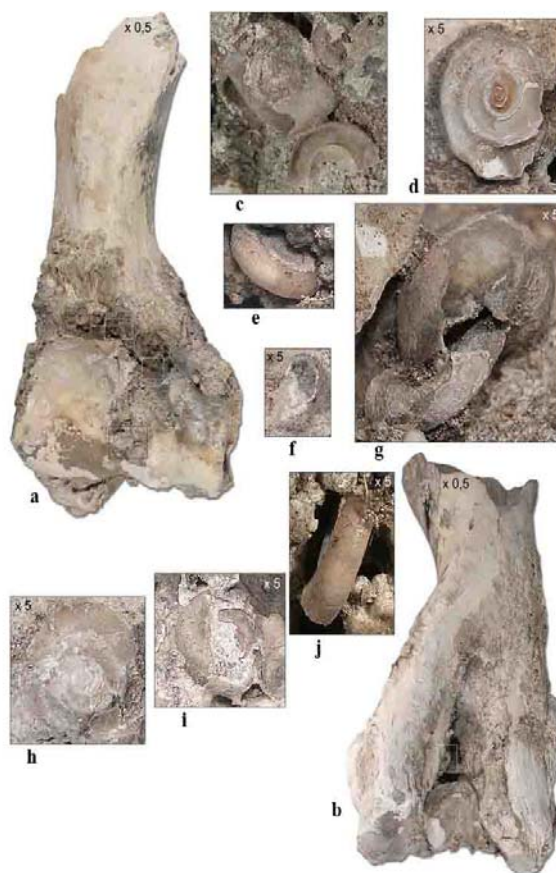


Figure 5. The shells of mollusks on bone remains of Family Bovidae: a, b – bone remains; c–j – shells of mollusks

Рисунок 5. Раковины моллюсков на костных остатках семейства Bovidae; a, b – костные остатки; c–j – раковины моллюсков

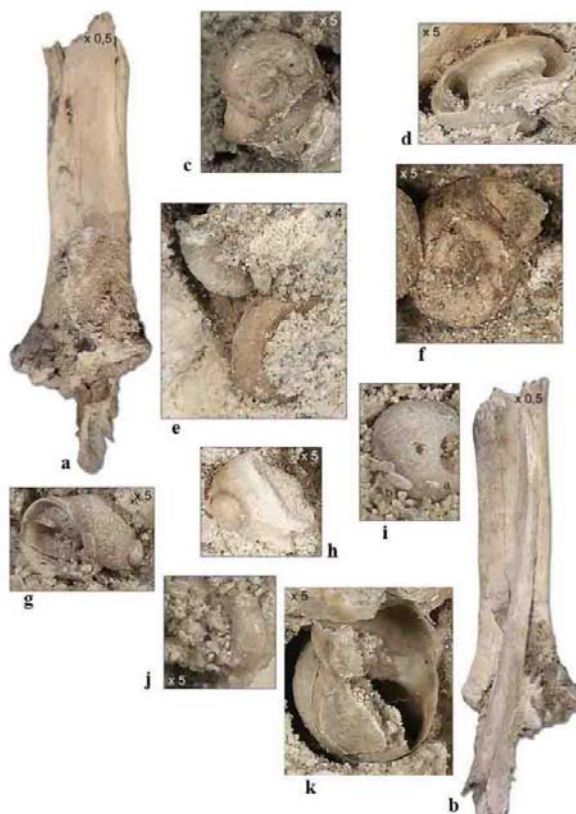


Figure 6. The shells of mollusks on bone remains of Family Bovidae: a, b – bone remains; c–k – shells of mollusks

Рисунок 6. Раковины моллюсков на костных остатках семейства Bovidae; a, b – костные остатки; c–k – раковины моллюсков

Gastropoda**Ectobranchia****Family Valvatidae Gray, 1840**Genus *Valvata* Muller, 1774*Valvata piscinalis* (Muller, 1774)

Figure 7, b

Shell is small, rounded turbinate, very thinly striated. Height of body whorl is equal to height of shell opening. It has 4–5 whorls, increasing at regular intervals. Shell: height – 6 mm; width – 5,5 mm.

It lives in rivers, lakes and ponds.

Discopoda**Family Bithyniidae Gray, 1857**Genus *Bithynia* Leach, 1818*Bithynia troschelii* Paasch, 1842

Figure 7, a

Shell is thinly transversely striated. Whorls are evenly swollen. Shell opening and operculum are rounded-oval. Operculum is with well-expressed lines of accretion. Shell: height – 8,5 mm; width – 6,5 mm.

The species is known from a reservoir located in the eastern part of the shore of Lake Sevan. At present, after the lake level dropped, the reservoir has also dried up. This is the only place in the entire South Caucasus where this species is known. This species is a glacial relict and is currently classified as a rare species [3].

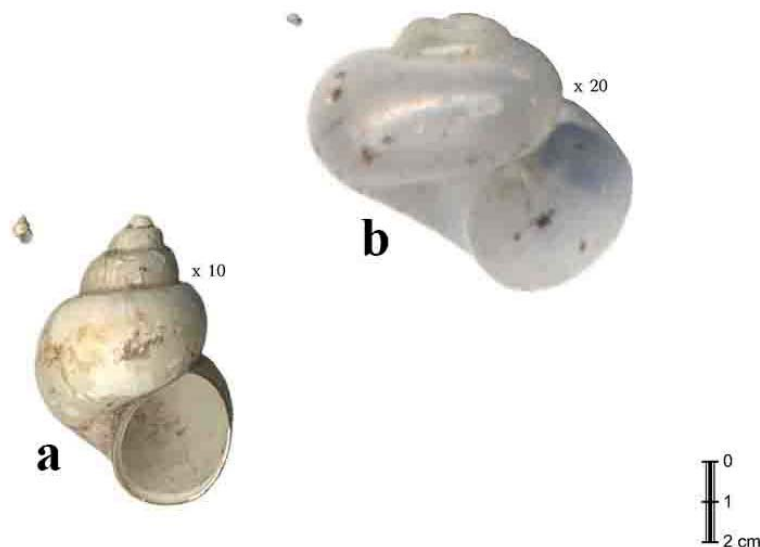


Figure 7. Family Valvatidae: a – *Bithynia trosheli*; b – *Valvata piscinalis*

Рисунок 7. Семейство Valvatidae: a – *Bithynia trosheli*; b – *Valvata piscinalis*

Basommatophora**Family Lymnaeidae Rafinesque, 1815**Genus *Lymnaea* Lamarck, 1799*Lymnaea stagnalis* (Linnaeus, 1758)

Figure 8, a

Shell is large, with the extended sharp body whorl. The first whorls increase slowly and poorly convex, the last whorls extend and swell rapidly: 6–8 whorls; shell opening is ovate, its height is a little bit more than height of whorl. Shell: height – 50 mm; width – 30 mm.

It inhabits permanent reservoirs and lives on vegetation. In Lake Sevan it is widely distributed.

Family Lymnaeidae Rafinesque, 1815Genus *Lymnaea* Lamarck, 1799*Lymnaea stagnalis* var. *goktschana* Mousson, 1873

Figure 8, b

Shell is thin-walled, transparent, thinly striated; height of shell opening is more than height of body whorl; last whorl is expanded and oval. Shell: height – 30 mm; width – 16 mm.

It is known only from Lake Sevan [5].

Family Lymnaeidae Rafinesque, 1815Genus *Lymnaea* Lamarck, 1799*Lymnaea auricularia* Linnaeus, 1758

Figure 8, c

Shell is earlike, thinly striated, body whorl is sharp. It has 4 whorls. Shell opening is ovate or oval. The height of shell opening is much more than height of body whorl. Shell: height – 25 mm; width – 25 mm.

Inhabit permanent reservoirs and lives on vegetation. It inhabits flat sites adjoining Lake Sevan not higher than 2000 m above sea level.

Family Lymnaeidae Rafinesque, 1815Genus *Lymnaea* Lamarck, 1799*Lymnaea ovata* (Draparnaud, 1805)

Figure 8, d

Shell is ovate or earlike. Whorls increase rapidly, the penultimate whorl is convex, the last one is very swollen. Shell opening sometimes is oval, more or less expanded. Shell: height – 26 mm; width – 20 mm.

In Armenia the species is widely distributed. In Lake Sevan it was one of abundant species formerly [2]. Lives in small lakes and ponds.

It often occurs in deposits of the whole Quaternary period [4].

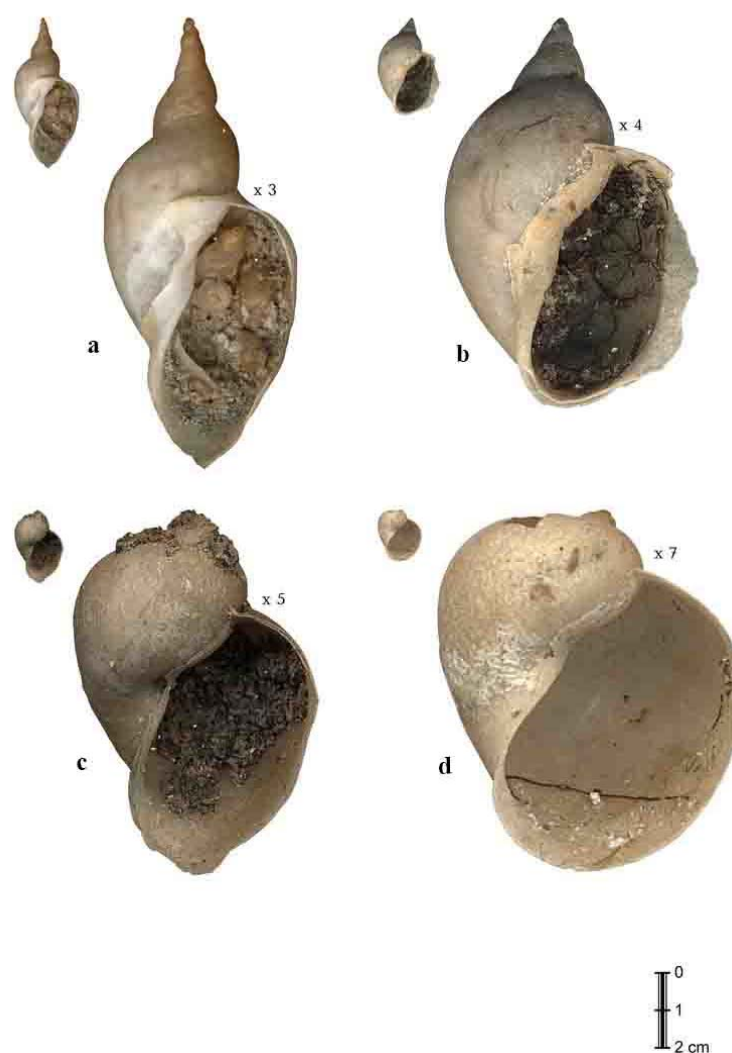


Figure 8. Family Lymnaeidae: a – *Lymnaea stagnalis*; b – *Lymnaea stagnalis* var. *gorkchaana*; c – *Lymnaea auricularia*; d – *Lymnaea ovate*

Рисунок 8. Семейство Lymnaeidae: a – *Lymnaea stagnalis*; b – *Lymnaea stagnalis* var. *gorkchaana*; c – *Lymnaea auricularia*; d – *Lymnaea ovate*

Family Planorbidae Rafinesque, 1815

Genus *Planorbis* Muller, 1974

Planorbis carinatus Muller, 1774

Figure 9, a

Shell is thin-walled, thinly and densely transversely striated. It has 4-5 whorls. The upper side of shell is concave. On the last whorl of shell there is a distinct threadlike keel which passes at middle height. Shell: height – 3mm; width – 18 mm.

It formerly inhabited Lake Sevan and was one of the dominant mollusk species in Lake Sevan. Shells which have been exposed above water and have lost their corneous layer long ago and become white, occur now in quantity on the lakeside. Akramovski [2]; Harutyunova [3].

Family Planorbidae Rafinesque, 1815

Genus *Planorbis* Muller, 1974

Planorbis planorbis (Linnaeus, 1758)

Figure 9, b

Shell is thinly transversely striated, concave on top and almost flat at the bottom. Keel on border of the lower side of shell is almost threadlike, with deep lines above and

below, delimiting it from the rest of the shell surface. Shell: height – 3,5 mm; width – 18 mm.

It is the most common species, occurring everywhere in small reservoirs and along the littoral margins of large reservoirs. The species is the most pollution resistant of all freshwater mollusks.

Family Planorbidae, Rafinesque, 1815

Genus *Gyraulus*, Agassiz, 1837)

Gyraulus laevis (Alder, 1838)

Figure 9, c

Shell is very thinly transversely striated without spiral striation. It has 4 whorls increasing fairly rapidly. There is no keel. The upper side is flat; whorls are convex, as though turned. The lower side is concave, whorls are slightly flattened. Shell opening is semi-oval, slightly slanting, the upper edge is extended forward. Shell: height – 1 mm; width – 4 mm.

Inhabits small clean reservoirs of spring origin. It is uncommon.

Its fossils are known from deposits of the Quaternary period. [4].

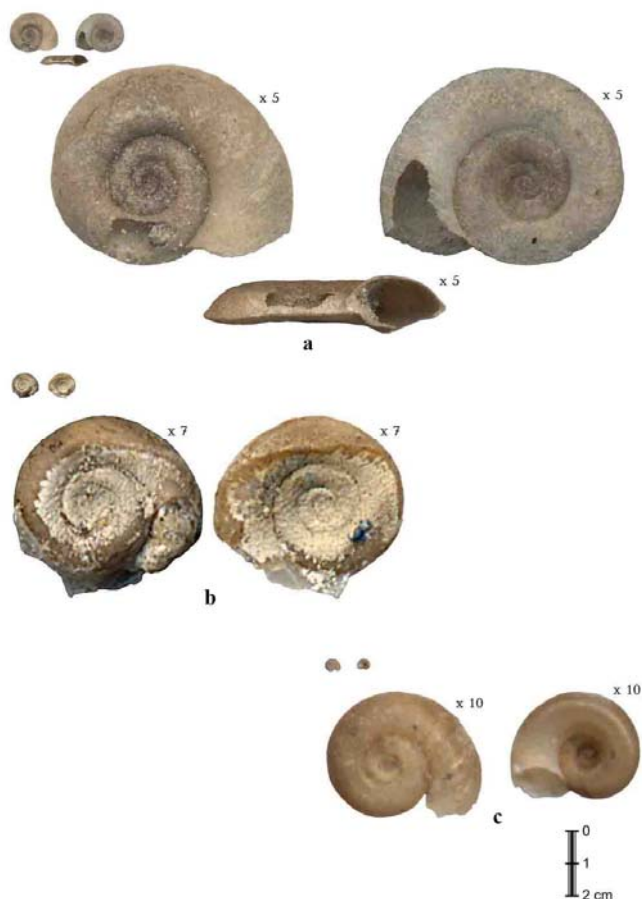


Figure 9. Family Planorbidae: a – *Planorbis carinatus*; b – *Planorbis planorbis*; c – *Gyraulus laevis*

Рисунок 9. Семейство Planorbidae: a – *Planorbis carinatus*; b – *Planorbis planorbis*; c – *Gyraulus laevis*

Bivalvia

Astartida

Family Pisidiidae Gray, 1857

Genus *Euglesa* Leach, 1832

Euglesa casertana (Polli, 1791)

Figure 10

Shell is usually ovate, rarely triangular, poorly and irregularly striated, usually more or less matte, moderately swollen, with pores. Crowns are wide, but not towering, are approximately on 2/3 lengths of shell. Shell: height – 6 mm; length – 7 mm; thickness – 4 mm.

In Armenia it is the most common of all species of the genus, occurring in all areas and in all zones. In Lake Sevan it is common but not very abundant.

All ten mollusks studied now inhabit the Lake Sevan Basin. One of them, *Planorbis carinatus*, a glacial relict, was one of dominant species of mollusks in Lake Sevan. Shells which have been exposed above water and have lost their corneous layer long ago and become white, occur now in quantity along the lakeside. It is referred to now as a category of vanishing species. *Bithynia troschellii*, a glacial relict, also referred to as a vanishing species. *Gyraulus laevis* was found by us in quantity on bone remains, and now also enters is considered as rare species. The other species found are widely distributed in Armenia.

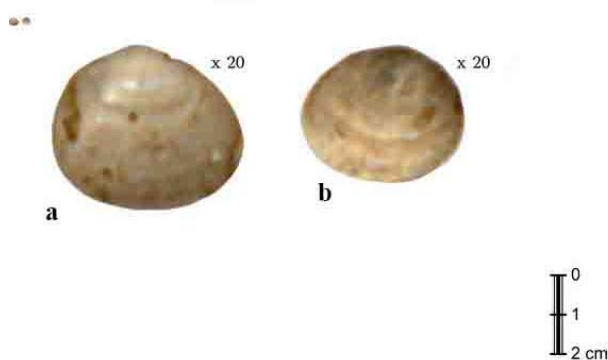


Figure 10. Family Pisidiidae: a, b – *Euglesa casertana*

Рисунок 10. Семейство Pisidiidae: a, b – *Euglesa casertana*

CONCLUSION

The formation of freshwater Lake Sevan, the largest one in the Caucasus, is connected with warming climate and thawing of the last glaciation. On the northwestern shore of the lake, there have been found the osseous remains of mammals (skulls, horn shafts of bulls and bison, bones of the postcranial skeleton) with cemented freshwater mollusks. Ten species of freshwater mollusks have been identified. Two of these, *Bithynia troschelii* Paasch, 1842 and *Planorbis carinatus* Muller, 1774, are glacial relics.

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БЛАГОДАРНОСТЬ

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AUTHOR CONTRIBUTIONS

Laura J. Harutyunova, Ivan G. Gabrielyan, Nina U. Manaseryan and Andranik A. Gyonjyan carried out the analysis and processing of the data obtained and participated in the writing of the manuscript. Lyudmila S. Mirumyan, Ruzanna G. Harutyunyan, Marine V. Vardanyan, Madina Z. Magomedova and Patimat D. Magomedova, conducted the scientific analysis of the data obtained. All authors are equally responsible for plagiarism, self-plagiarism and other ethical transgressions.

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Лаура Дж. Арутюнова, Иван Г. Габриелян, Нина У. Манасерян, Андраник А. Генджян проводили анализ и обработку полученных данных и участвовали в написании рукописи. Людмила С. Мирумян, Рузанна Г. Арутюнян, Марина В. Варданян, Мадина З. Магомедова, Патимат Д. Магомедова проводили научный анализ полученных данных. Все авторы в равной степени несут ответственность при обнаружении плагиата, самоплагиата или других неэтических проблем.

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