Vestnik zoologii, **49**(1): 49–56, 2015
DOI 10.1515/vzoo-2015-0005

DE GRUYTER OPEN

UDC 567.4/.5(478.9)

EARLY PLIOCENE STURGEONS AND BONY FISHES FROM THE DNIESTER VALLEY (REPUBLIC OF MOLDOVA)

O. M. Kovalchuk[1], V. A. Marareskul[2], D. S. Zakharov[3], T. F. Obadă[4]

[1]*National Museum of Natural History, NAS of Ukraine,*
vul. B. Khmelnitskogo, 15, Kyiv, 01601 Ukraine
E-mail: Biologiest@ukr.net
[2]*The State Service of Geology and Subsoil of Transnistria, Yunosti str., 58/3, Tiraspol,*
MD-3300 Republic of Moldova (the Trans-Dniester Region)
E-mail: marareskulvlad@gmail.com
[3]*Republican Scientific Research Institute of Ecology and Natural Resources, Kakhovskyi Tupik, 2, Bendery, 3200 Republic of Moldova (the Trans-Dniester Region)*
E-mail: zakharov-8@mail.ru
[4]*Institute of Zoology Academy of Sciences of the Republic of Moldova, Academiei str., 1, Chișinău, 2028 Republic of Moldova*
E-mail: theodorobada@gmail.com

Early Pliocene Sturgeons and Bony Fishes from the Dniester Valley (Republic of Moldova). Kovalchuk, O. M., Marareskul, V. A., Zakharov, D. S., Obadă, T. F. — A fossil fish remnants from the Early Pliocene strata of the Dniester valley (Republic of Moldova) are described in the paper. Seven species, belonging to 6 genera, 4 families and 4 orders (Acipenseriformes, Cypriniformes, Siluriformes, Esociformes) were identified in Nikolskoe and Uyutnoe localities. All of them are analogues of extant taxa. A brief review of development of the freshwater fish fauna in the Lower Dniester Basin during the Early Pliocene is presented.

Key words: sturgeons, Teleostei, Nikolskoe, Uyutnoe, Early Pliocene, MN 14, Dniester Basin, Republic of Moldova.

Осетровые и костистые рыбы раннего плиоцена из долины Днестра (Республика Молдова). Ковальчук А. Н., Мараескул В. А., Захаров Д. С., Обадэ Т. Ф. — В статье описаны ископаемые остатки рыб из отложений раннего плиоцена долины Днестра (Республика Молдова). Из местонахождений Никольское и Уютное идентифицированы семь видов, относящихся к 6 родам, 4 семействам и 4 отрядам (Acipenseriformes, Cypriniformes, Siluriformes, Esociformes). Все они являются морфологическими аналогами рецентных таксонов. В статье представлен краткий обзор развития пресноводной ихтиофауны в бассейне Нижнего Днестра на протяжении раннего плиоцена.

Ключевые слова: осетровые, Teleostei, Никольское, Уютное, ранний плиоцен, MN 14, бассейн Днестра, Республика Молдова.

Introduction

Numerous localities with remnants of the fossil vertebrates, dated by the Early and Middle Pliocene, are known from the territory of the Republic of Moldova (RM). Some of them yielded a rich fish fauna, including sturgeons and bony fishes. Thus, it is very interesting and important for the specification of the paleogeographical events on the south of Eastern Europe during the Late Neogene.

Nikolskoe and Uyutnoe localities were discovered in 1988 and preliminarily studied by A. N. Lungu (Pozdnyakov et al., 1992). Nikolskoe (fig. 1) is a sand quarry in the eastern outskirts of the eponymous village and exposes the Kuchurgan Alluvium consisting of fine- to medium-grained sands with rare gravel lenses. The exposed thickness is 5 to 6 m. There is no visible contact with underlying deposits of the Balta Formation (Vangengeim et al., 1995). Uyutnoe locality is also a sand quarry and situated two kilometers south from the Nikolskoe, between Uyutnoe and Konstantinovka, on the plateau surface. This is an outcrop about 3 m thick of medium- to coarse-grained sands with pebble and gravel lenses (Vangengeim et al., 1995). A cross-section with a total capacity of 4.7 m was described by V. Marareskul (from the top to bottom): 1) modern soil — 0.6–0.7 m; 2) silty loams — 0.6–0.7 m; 3) rusty-brown grained sands — 0.4–0.6 m; 4) horizontally-layered grained

light-colored sands with thin orange sand layers — 0.2–0.7 m; 5) unconsolidated sands and gravels with fossil remnants of vertebrates — 0.4–0.7 m; 6) well-sorted sands with a horizontal stratification in the right part. Fossil vertebrates are sporadically found in the upper part of the layer. Visible thickness is 1.5 m.

These localities were dated by the Middle Pliocene, but later their age was justified and now it can be regarded as Early Pliocene, MN 14 (5.3–4.2 Ma). The present paper is based on the study of fish remnants from Nikolskoe and Uyutnoe localities, with remarks on the freshwater fish fauna in the Lower Dniester during the Early Pliocene.

Material and methods

The material under study is represented by 13 disarticulated bones, 12 of which (92 %) are determinable to species level. Almost all bones are waterworn and bear traces of postmortal transportation. Collection of fossil fish remnants was obtained by the screen-washing. These items are housed in the Geological and Paleontological Museum of the Transnistrian State University, Republic of Moldova (collection No. Nik11, Ut12). Determination of the remnants was provided by authors using diagnostic features. Recent fish bones, deposited in the Paleontological Museum of the National Museum of Natural History (NMNH-P) NAS of Ukraine, were used for comparison.

Ichthyologic systematics follows Movchan (2011), correlation of the Eastern Paratethys stages with European Mammal Neogene Zones — Nesin and Nadachowski (2001). The specimens were measured with aid of a binocular microscope with an ocular micrometer. All measurements are given in millimeters with 0.01 mm precision. The following measurements were taken: HPT — pharyngeal tooth height, L — length, W — width, WPT — pharyngeal tooth width. Bone terminology follows Sytchevskaya (1976) and Lepiksaar (1994), pharyngeal tooth terminology — Rutte (1962) and Sytchevskaya (1989). Drawings were prepared on stereomicroscope Wild M3C with mirror tube Wild TYP 308700.

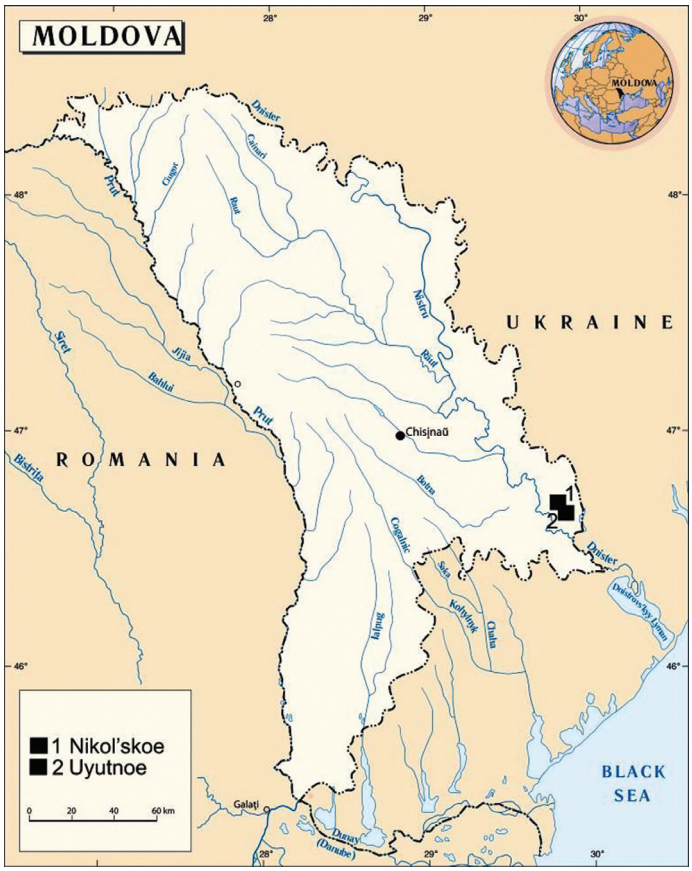

Fig. 1. Location map of the Early Pliocene sites with the fish remnants in the Republic of Moldova.

Рис. 1. Карта расположения местонахождений с остатками рыб раннего плиоцена на территории Республики Молдова.

Systematic paleontology

More than 200 fossil remnants were collected on the Nikolskoe (46°52′ 32″ N, 29°51′ 41″ E) during its study. The following vertebrates are known from this site (Pozdnyakov et al., 1992; Vangengeim et al., 1995; Zakharov, Chepalyga, 2012): reptiles (*Testudo* sp.), and a long list of mammals (*Promimomys moldavicus* (Kormos, 1934), *Nannospalax macovei* (Kormos, 1934), *Trogontherium* cf. *minus* Newton, 1890, *Ochotona antiqua* Argyropulo et Pidoplichko, 1939, *Ochotona* cf. *eximia* (Khomenko, 1914), *Trischizolagus dumitrescuae* Radulescu et Samson, 1967, Soricidae indet., *Rhinoceros* (*Dicerorhinus*) sp., *Propotamochoerus* cf. *provincialis* Gervais, 1852, *Eostylocerus* sp.). Uyutnoe locality (46°51′41″ N, 29°52′42″ E) also comprises a rich vertebrate fauna, which is similar to those from Nikolskoe, except the presence of lizards (*Lacerta* sp.), birds (Aves gen. et sp. indet.), some mammals (*Castor* ex gr. *fiber* Linnaeus, 1758, *Alilepus* sp., *Hipparion* sp., *Pliocervus* sp., *Parabos boodon* Arambourg et Piveteau, 1929), and the absence of Soricidae (Pozdnyakov et al., 1992; Vangengeim et al., 1995).

Three fish species were identified from the Nikolskoe locality (*Acipenser gueldenstaedtii*, *Silurus glanis*, *Esox* sp.), and four other fish taxa (*Acipenser* sp., *Rutilus* sp., *Scardinius erythrophthalmus*, *Barbus* sp.) are in materials from the Early Pliocene strata of Uyutnoe.

Order ACIPENSERIFORMES Berg, 1940

Family ACIPENSERIDAE Bonaparte, 1831

Genus *Acipenser* Linnaeus, 1758

Acipenser gueldenstaedtii Brandt et Ratzeburg, 1833 — one opercular bone (Nik 11–1/1, fig. 2, *1*), three distal fragments of pinna pectoralis I (Nik 11–1/2–4, fig. 2, *2–4*). Length of operculare is 7.2 cm, width — 5.0 cm. This bone, taking into account morphology and meristic values, is belongs to the Russian sturgeon. Length of the preserved pectoral fin rays is 3.2, 2.4, and 2.2 cm, respectively. The systematic attribution of these bones is less certain. Besides, a large operculare and other bone fragments of *A. gueldenstaedtii* from the isochronous strata of Slavyanoserbka (RM) are in funds of NMNH-P.

Acipenser sp. — 1 marginalia with broken edges (Ut 12–1/1, fig. 2, *5*), L = 2.5 cm, W = 1.7 cm. This specimen of the sturgeon is similar to those from Priozernoe locality (RM), but has a smaller size.

Finds of the fossil remnants of various sturgeons (e. g., *Acipenser* sp., etc.) are so numerous in the heterochronous Pliocene strata of RM and Southern Ukraine (Tarashchuk, 1962). Taking into account their diversity and important biostratigraphic role, these fishes deserve to special study.

Order CYPRINIFORMES Goodrich, 1909

Family CYPRINIDAE Fleming, 1822

Genus *Rutilus* Rafinesque, 1820

Rutilus sp**.** — two isolated pharyngeal teeth (Ut 12–1/2–3, fig. 3, *1–2*). Pharyngeal teeth are large, with fungiform, laterally compressed crown and a distinct convex arcuate tooth back. Grinding surface is narrow and slightly convex. Pedicle is broken, oval in the cross-section. Height of the pharyngeal teeth is 5.8 and 6.0 mm, width of the crown — 9.4 and 16.9 mm, respectively. Pharyngeal teeth are similar to those in the extant *Rutilus frisii*, except bigger size. Possibly, systematic position of these remnants can be justified later (first of them may be also determined as a pharyngeal tooth fragment of *Carassius* sp.). *Rutilus frisii* and *Rutilus* sp. were identified in the Late Miocene (Pontian) and Early Pliocene on the south of Ukraine (Kamenskoe, Kuchurgan), and also from the Priozernoe locality in the Republic of Moldova.

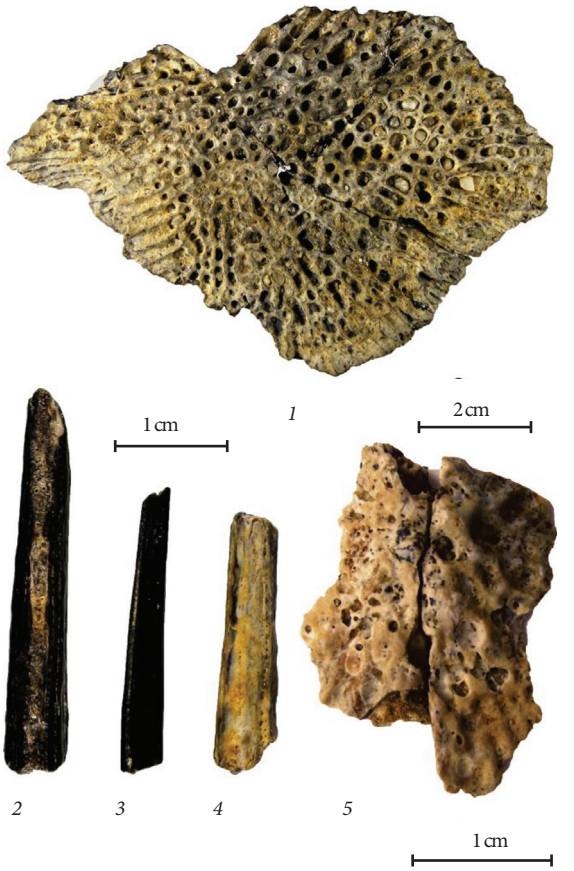

Fig. 2. *Acipenser gueldenstaedtii*: *1* — opercular bone; *2–4* — pectoral fin fragments (pinna pectoralis I); *Acipenser* sp.: *5* — marginalia.

Рис. 2. *Acipenser gueldenstaedtii*: *1* — operculare; *2–4* — фрагменты лучей грудного плавника (pinna pectoralis I); *Acipenser* sp.: *5* — жучка.

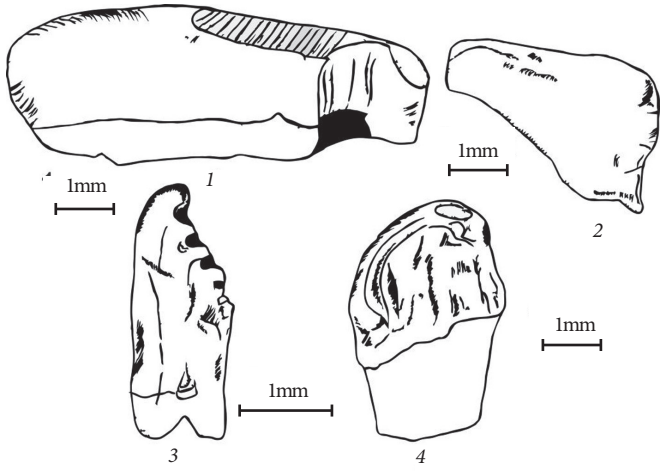

Fig. 3. Isolated pharyngeal teeth of carp fishes: *1–2* — *Rutilus* sp.; *3* — *Scardinius erythrophthalmus; 4* — *Barbus* sp.

Рис. 3. Изолированные глоточные зубы карповых рыб: *1–2* — *Rutilus* sp.; *3* — *Scardinius erythrophthalmus; 4* — *Barbus* sp.

Genus *Scardinius* Bonaparte, 1837

Scardinius erythrophthalmus (Linnaeus, 1758) — one pharyngeal tooth (Ut 12–1/4, fig. 3, *3*). The conical tooth is hooked at the tip. Grinding surface is narrow with a higher edge that has 7 robust pointed jags and a lower edge without jags. Hook is robust and angle of grinding surface is 20 degrees. HPT is 6.1 mm, WPT — 2.5 mm. *Scardinius erythrophthalmus* is also known from the Kamenskoe in Southern Ukraine (Tarashchuk, 1962).

Genus *Barbus* Cuvier, 1816

Barbus sp. — one isolated pharyngeal tooth (Ut 12–1/5, fig. 3, *4*). Spatulate tooth has flattened chisel crown. Pedicle is broad and cylindrical in the cross-section. Tooth back is straight or slightly convex, with rounded belly and clearly expressed neck. Anterior part of the crown is convex; posterior is flattened and medially impressed. There is a weak hook at the tip. Grinding edge is bevelled towards the tooth belly. Grinding surface is narrow, with deep arcuate wrinkle. Height of the tooth is 9.7 mm, width — 6.4 mm. Presented specimen is rather similar to those in representatives of the *Barbus* Cuvier, 1816 and described here as *Barbus* sp. Fossil remnants of *Barbus* sp., presented by isolated pharyngeal teeth, were identified from the Early Pliocene strata of Priozernoe locality (Republic of Moldova).

Order SILURIFORMES Cuvier, 1817

Family SILURIDAE Cuvier, 1816

Genus *Silurus* Linnaeus, 1758

Silurus glanis Linnaeus, 1758 — one fragment of keratohyale (Nik 11–1/5, fig. 4, *1*), one vertebra without apophyses (Nik 11–1/6, fig. 4, *2*). Measurements of these remnants are the following: L keratohyale = 6.4 cm, W keratohyale = 1.6 cm; diameter of vertebra is 2.1 cm. It is morphologically similar to those in the European catfish, except the robustness and size. Fossil remnants of *Silurus* and *Parasilurus* are known from the Pliocene deposits of Grebeniki (Pozdnyakov et al., 1992), Priozernoe in the RM, and also were identified in materials from the south of Ukraine (Tarashchuk, 1962).

Order ESOCIFORMES Bleeker, 1858

Family ESOCIDAE Cuvier, 1816

Genus *Esox* Linnaeus, 1758

Esox sp. — one epihyale (Nik 11–1/7, fig. 4, *3*). L epihyale is 2.4 cm, width — 1.2 cm. Epihyale is similar in size and morphology to those in extant Northern pike. This species was also identified from the Early Pliocene strata of Priozernoe (RM), Kamenskoe and Kuchurgan on the territory of Southern Ukraine (Tarashchuk, 1962).

Discussion

Modern fish fauna of the Lower Dniester River comprises 4 species of the sturgeons (including *Acipenser gueldenstaedtii* and *A. stellatus*), 18 carp fish species (with allowance of *Rutilus frisii*, *Scardinius erythrophthalmus*, and *Barbus barbus* (Linnaeus, 1758)), European catfish, and also Northern pike (Usatîi et al., 2012). Almost all identified taxa are analogues of extant forms. It is important to focus on some ecotopic preferences of the identified taxa that can help to separate their possible habitats in the paleo-Dniester.

Acipenser gueldenstaedtii and *A. stellatus* are typical benthic inhabitants of coastal waters in seas and the lowland sections of rivers (FishBase 2014). These species recently are common in the Lower Danube (Holostenco, 2011) and Dniester (Usatîi et al., 2012;

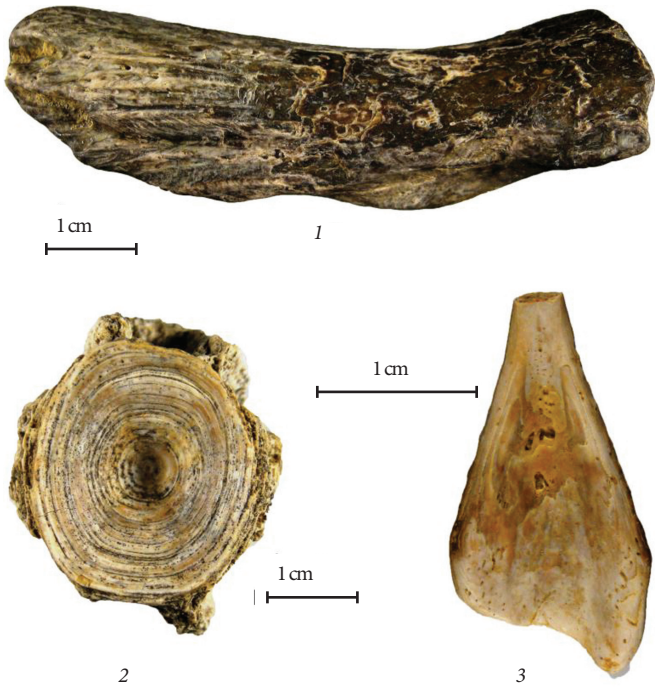

Fig. 4. *Silurus glanis*: *1* — keratohyale; *2* — vertebra; *Esox* sp.: *3* — epihyale.

Рис. 4. *Silurus glanis*: *1* — keratohyale; *2* — позвонок; *Esox* sp.: *3* — epihyale.

Siciu et al., 2013). It is an anadromous fish, which prefers warmer habitats and has a positive relationship to dissolved oxygen (Reinhatrz, 2002). *Rutilus frisii* prefers waters that are somewhat vegetated, because larval and young fish are protected by the vegetation and the mature fish can use it for food (Movchan, 2012). *Barbus barbus* is a rheophylic and lithophilous fish (Kotlik et al., 2004; Britton, Pegg, 2011), which prefers flowing waters with sandy to gravelly bottom (Rückert-Ülkümen, Yiğitbaş, 2007). Physical habitat is an important component regulating barbel distribution and abundance. Adults are common in the mid-channel areas of relatively high flow. European catfish inhabits large and medium-sized lowland rivers and backwaters (Kottelat, Freyhof, 2007). It is known as impressive predator with a wide range of food items (Copp et al., 2009). *Esox lucius* is a cool water species, which has a wide range of environmental tolerances (Casselman, Lewis, 1996) and characterized as a keystone piscivore that can shape the composition, abundance and distribution of fish communities (Craig, 2008). It is found in shallow, moderately productive and vegetated waters (Diana, 1979; Harvey, 2009). The investigated fish communities indicate freshwater to slightly brackish water environments. Diversity of the fish fauna indicates various habitats: 1) flowing water and a coarse-grained bottom; 2) slowly flowing to standing water and muddy bottom; and 3) standing-water habitat with seasonally stagnant conditions.

History of the development of the Dniester valley began at the moment when this river started crashing primary alluvial-deltaic plain. This process started more than 4 Ma ago (Chepalyga, 1987; Zakharov, Chepalyga, 2012). Dniester River valley with terraces of the modern type was subsequently formed at that time. Fish assemblages, quite similar to those from Nikolskoe and Uyutnoe localities in faunal composition and taxonomic diversity, are known from the Early and Middle Pliocene of the Republic of Moldova (e. g., Priozernoe), Kairy and Kuchurgan in Ukraine (Tarashchuk, 1962), Lozenets and Tchelopetchene 1 in Bulgaria (Kamenov, Kojumdshieva, 1983), Willershausen in Germany (Gaudant, 1997), and also Ptolemais and Vorio in Greece (Böhme, Ilg, 2003).

Conclusions

There are 12 fish species, belonging to 8 genera, 5 families, and 5 orders (Acipenseriformes, Cypriniformes, Siluriformes, Esociformes, Perciformes) are recently identified in materials from the Early Pliocene of the Lower Dniester Basin. They presented all major systematic groups, which are in the modern fish fauna of the lower reaches of this river. At the same time representatives of Clupeidae, Cobitidae, Catostomidae, Ictaluridae, Umbridae, Mugilidae, Atherinidae, Gasterosteidae, and Syngnathidae are still unknown in the isochronous fossil record of the studied area. It can be explained by the taphonomic features of sedimentation, and also introduction of individual taxa in historical time by a human. Amount of sturgeon taxa gradually increases during the Late Neogene: their remnants are presented in almost all Pliocene localities on the south of Eastern Europe. Carp fishes are the most numerous group in the Lower Dniester versus other freshwater fish families.

Given the great similarity of the fish associations from Nikolskoe, Uyutnoe, Priozernoe and Grebeniki with localities in the Kuchurgan gravel of Southern Ukraine, it can expect to find even more carp and perch species. The question of the presence of *Parasilurus* in the Pliocene strata on the south of Eastern Europe is still relevant. It is possible to find the remnants of the new extinct fish species, as well as the completion of faunal lists by excavations of the heterochronous localities. Further study of the heterochronous Pliocene ichthyocomplexes from the territory of the Republic of Moldova, Ukraine and Russian Federation can help us to determine the dynamics and ways of formation of the extant freshwater fish assemblages in the Eastern Europe during the Late Cenozoic and conditions for their existence.

We extend our gratitude to Prof. Dr. L. I. Rekovets (Wroclaw University of Environmental and Life Sciences, Poland), and Dr. E. K. Sytchevskaya (Borissiak Paleontological Institute, Russian Academy of Sciences, Russian Federation) for their valuable comments and advice.

References

Böhme, M., Ilg, A. Database of Vertebrates: fossil Fishes, Amphibians, Reptiles and Birds (fosFARbase) localities and taxa from the Triassic to the Neogene. — 2003. — www.wahre-staerke.com

Britton, J. R., Pegg, J. Ecology of European Barbel Barbus barbus: Implications for River, Fishery, and Conservation Management // Reviews in Fisheries Science. — 2011. — **19**, N 4. — P. 321–330.

Casselman, J. M., Lewis, C. A. Habitat requirements of northern pike (Esox lucius) // Canadian Journal of Fisheries and Aquatic Sciences. — 1996. — **53,** suppl. 1. — P.161–174.

Chepalyga, A. L. Climatic events in the Cenozoic of Paratethys // Climates of the Earth in the geological past: Collection of papers. — Moscow : Nauka, 1987. — P. 214–225. — Russian : *Чепалыга А. Л.* Климатические события кайнозоя Паратетиса.

Copp, G. H., Britton, J. R., Cucherousset, J. et al. Voracoius invader or benign feline? A review of of the environmental biology of European catfish Silurus glanis in its native and introduced ranges // Fish and Fisheries. — 2009. — N 10. — P. 252–282.

Craig, J. F. A short review of pike ecology // Hydrobiologia. — 2008. — N 601. — P. 5–16.

Diana, J. S. The feeding pattern and daily ration of a top carnivore, the northern pike (Esox lucius) // Canadian Journal of Zoology. — 1979. — Is. 57. — P. 2121–2127.

FishBase 2014 / Eds R. Froese, D. Pauly.— www.fishbase.org.

Gaudant, J. L'ichthyofaune pliocene de Willershausen am Harz (Basse Saxe, Allemagne) — un reexamen // Stuttgarter Beiträge zur Natürkunde. Ser. B. — 1997. — N 257. — 51 S.

Harvey, B. A biological synopsis of northern pike (Esox lucius) // Canadian Manuscript Report of Fisheries and Aquatic Sciences. — 2009. — N 2885. — i-v+31 p.

Kamenov, B., Kojumdshieva, E. Stratigraphy of the Neogene in the Sofia Basin // Paleontology, Stratigraphy and Lithology (Bulgarian Academy of Sciences). — 1983. — **18**. — P. 69–84.

Kotlik, P., Bogutskaya, N. G., Ekmekçi, F. G. Circum Black Sea phylogeography of Barbus freshwater fishes: divergence in the Pontic glacial refugium // Molecular Ecology. — 2004. — **13**. — P. 87–95.

Kottelat, M., Freyhof, J. Handbook of European freshwater fishes. — Berlin, 2007. — 646 S.

Lepiksaar, J. Introduction to osteology of fishes for paleozoologists. — Göteborg, 1994. — 75 p.

Movchan, Yu. V. Fishes of Ukraine. — Kyiv : Zoloti vorota, 2011. — 444 p. — Ukrainian : Мовчан Ю. В. Риби України.

Nesin, V. A., Nadachowski, A. Late Miocene and Pliocene small mammal faunas (Insectivora, Lagomorpha, Rodentia) of Southeastern Europe // Acta zoologica cracoviensia. — 2001. — **44**, N 2. — P. 107–135.

Pozdnyakov, I. A., Pashchenko, V. V., Kashlaly, I. D. Geological structure, hydrogeological and geotechnical conditions of the Tiraspol area // Report on the results of comprehensive geological, hydrogeological and engineering-geological survey at a scale of 1 : 200 000 L-35-XII sheet (Tiraspol) in 3 books. — Chişinău, 1992. — 823 p. — Russian : *Поздняков И. А., Пащенко В. В., Кашлалы И. Д.* Геологическое строение, гидрогеологические и инженерно-геологические условия площади Тираспольского листа.

Reinhartz, R. Sturgeons in the Danube River. Biology, status, conservation. Literature study // International Association for Danube Research. — Bezirk Oberpfalz, Landesfischereiverband Bayern, e.V, 2002. — 150 p.

Rutte, E. Schundzahne von Süsswasserfischen // Palaeontographica Abteilung. Ser. A. — 1962. — **120**. — P. 165–212.

Rückert-Ülkümen, N., Yiğitbaş, E. Pharyngeal Teeth, Lateral Ethmoids, and Jaw Teeth of Fishes and Additional Fossils From the Late Miocene (Late Khersonian/Early Maeotian) of Eastern Paratethys (Yalova, Near Istanbul, Turkey) // Turkish Journal of Earth Sciences. — 2007. — **16**. — P. 211–224.

Suciu, R., Onără, D., Paraschiv, M. et al. Sturgeons in the Lower Danube River // Danube News. — 2013. — **15**, N 28. — P. 10–12.

Sytchevskaya, Y. K. The fossil esocoid fishes of the USSR and Mongolia // Trudy Paleontological Institute. — Moscow : Nauka, 1976. — **156**. — 116 p. — Russian : *Сычевская Е. К.* Ископаемые щуковидные СССР и Монголии.

Sytchevskaya, Y. K. Freshwater Neogene Ichthyofauna of Mongolia // Trudy Sovmestnoy Sovetsko-Mongolskoy Paleontologicheskoy Ekspeditsii. — Moscow : Nauka, 1989. — N 39. — 144 p. — Russian : *Сычевская Е. К.* Пресноводная ихтиофауна неогена Монголии.

Tarashchuk, V. I. Materials for the study of freshwater fishes from Neogenic and Anthropogenic deposits of Ukraine // Zbirnik Prac Zoologichnogo muzeyu. — 1962. — N 31. — P. 3–27. — Ukrainian : *Таращук В. І.* Матеріали до вивчення прісноводних риб з неогенових та антропогенових відкладів України.

Usatîi, A., Crepis, O., Usatîi, M. et al. Diversitatea ihtiofaunei, raportul numeric şi extinderea arilor de răspândire a unor specii de peşti din sectoarele mijlociu şi inferior al fl. Nistru // Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţele vieţii. — 2012. — N 1 (316). — P. 134–143.

Vangengeim, E. A., Pevzner, M. A., Tesakov, A. S. Chronological Relationship of Pliocene Deposits in Fluviatile Plains between the Prut and Southern Bug River // Stratigraphy and Geological Correlation. — 1995. — **3**, N 1. — P. 54–64.

Zakharov, D. S., Chepalyga, A. L. Problems of the earliest stages of Dniester valley evolution: alluvial of Kuchurganian sections // Geoecological and bioecological problems of the North Black Sea Coast: Proceedings of the intern. conference (Tiraspol, 9–10 November 2012). — Tiraspol : PGU publ., 2012. — P. 109–111. — Russian : *Захаров Д. С., Чепалыга А. Л.* Проблема ранних этапов развития долины Днестра: основные разрезы аллювия кучурганского гравия.

Received 8 September 2014
Accepted 26 November 2014