CONTRIBUTION TO THE STUDY OF MAEOTIAN HIPPARION FAUNAS FROM THE REPUBLIC OF MOLDOVA

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Abstract. *The present work deals with the faunal structure and taphonomy of several Meotian faunas with Hipparion from the Upper Miocene of the Republic of Moldova. According to the local stratigraphic scale of continental formations, these Meotian faunal associations can be correlated with the Lower and Middle Turolian (MN11-12 biozones) of European Land Mammal Ages.*

Keywords: *Hipparion fauna, Upper Miocene, Republic of Moldova.*

Rezumat. Unele studii cu privire la siturile faunei meoţiene cu Hipparion din Republica Moldova. *În această lucrare sunt specificate unele informaţii cu privire la componenţa sistematică a asociaţiilor faunistice şi tafonomia siturilor faunei cu Hipparion din Miocenul superior, care sunt atribuite diferitor nivele stratigrafice ale Meoţianului din Republica Moldova. Conform scării stratigrafice a formaţiunilor geologice continentale, vârstele asociaţiilor faunistice din Meoţian sunt atribuite Turolianului inferior şi mediu (biozonele MN11-12).*

Cuvinte cheie: *Fauna cu Hipparion, Miocenul superior, Republica Moldova.*

According to ROSCA & HUBKA (1986), Meotian continental formations are represented by strata (up to 290 m thick) of continental unstratified clay with aleurite prolayers and fine-grained sands, which are known as the Cahul Formation. Deposits ascribed to this formation include important sites of *Hipparion* fauna such as: Ciobruciu, Tudora, Taraclia, Cimislia, Gura-Galbenei.

Ciobruciu, Stefan-Voda district. The site is located on the right bank of the Dniester River, at the western borders of Ciobruciu village.

Stratigraphic position, taphonomy, faunal determinations and descriptions have been already studied by PAVLOW (1913, 1914), GABUNIJA (1959), LUNGU (2001), and LUNGU & DELINSCHI (2006).

In Ciobruciu section, marine sediments of the Khersonian substage are overlain by 40 to 45 m thick sandy-argillaceous sediments referred to as the Balta Formation. According to the stratigraphic data and lithology, these continental sediments, represent lacustrine, fluviatile, and deltaic facies.

Gabunija (1959) listed the following terrestrial vertebrates from this site:

Reptilia: *Protestudo bessarabica* RJABININ, 1918;

Mammalia. Edentata: *Orycteropus gaudryi* F. MAJOR, 1888;

Carnivora: *Mustela palaeatica* WEITHOFER, 1888, *Ictitherium viverinum* ROTH & WAGNER, 1854, *Adcrocuta eximia* (ROTH et WAGNER, 1854), *Machairodus schlosseri* WEITHOFER, 1888, *Machairodus cultridens* CUVIER, 1824, *Simocyon primigenius* WAGNER, 1832;

Proboscidae: *Choerolophodon pentelici* (GAUDRY & LARTET, 1856), *Mastodon* sp., *Deinotherium giganteum* KAUP, 1829;

Perissodactyla: *Hipparion cf. verae* GABUNIA, 1979, *Hipparion cf. moldavicum* GROMOVA, 1952, *Aceratherium incisivum* KAUP, 1832, *Dihoplus schleiermacheri* (KAUP, 1832);

Artiodactyla: *Cervus* sp., *Palaeotragus rouenii* GAUDRY, 1861, *Palaeotragus* sp., *Helladotherium duvernovi* GAUDRY et LARTET, 1856, *Tragoportax frolovi* PAVLOW, 1913, *?Palaeoryx stützeri* SCHLOSSER, 1905, *Gazella deperdita* GERVAIS, 1847.

Gabunija (1959) defines the age of Ciobruciu fauna as Lower Meotian, an opinion shared by LUNGU & DELINSCHI (2006), and DELINSCHI (2008). KOROTKEVICH (1988) considered this site as Upper Khersonian.

Since 1987-2006, new excavations in Ciobruci site unearthed very interesting palaeontological material of small terrestrial vertebrates (LUNGU, 1990, 2001, LUNGU & DELINSCHI, 2006, DELINSCHI, 2008).

Taphonomy. Remains of vertebrates were collected from argillaceous sands underlying Quaternary fluviatile terraces of the Dniester. Bone remains are homogeneously distributed within the deposits and they do not form accumulations. They show different degrees of rolling, fossilization, and colour. Gabunija (1959) thought that fossil remains of Ciobruci were brought by water in swampy river bank conditions, covered by willow and alder, while some specimens originate from more remote steppe and semi-steppe sites. Judging by lithology, bedding pattern, and fossilization, the burial area should represent a deltaic region of a Meotian river.

This site yielded remains of the following taxa of terrestrial vertebrates (LUNGU & DELINSCHI, 2006):

Amphibia: *Mioproteus cf. caucasicus* ESTES & DAREVSKI, 1977, *Rana* sp.;

Reptilia: *Cheledropsis* sp., *Melanochelis* sp., *Sakya* sp., *Protestudo* sp., *Lacerta* sp., *Ophisaurus* sp., *Natris* sp., *Elaphe* sp., *Vipera* sp;

Aves: *Struthio* sp., *Anas* sp.;

Mammalia. Insectivora: *Desmana* sp., *Soriciculus* sp., *Amblicoptus* sp.;

Lagomorpha: *Proochotona eximia* CHOMENKO, 1914;

Rodentia: *Spermophilinus cf. bredai-turolensis* DAXNER-HÖCK, 1975, *Myomimus dehmi* (DE BRUIJN, 1966), *Vasseuromys cf. thenii* DAXNER-HÖCK & DE BRUIJN, *Hansdebruijnia neutrum,* (DE BRUIJN, 1976), *Valerimys* sp., *Neocricetodon (Kowalskia) cf. lavocati* (HUGUENEY & MEIN, 1965);

Carnivora: *Ictitherium* sp.;

Perissodactyla: *Hipparion* sp., *Aceratherium* sp.;

Artiodactyla: *Cervavitus* sp., *Tragoportax amaltheus* GAUDRY, 1861.

The fauna of Ciobruciu indicates the presence of different biocoenoses. The occurrence of *Proochotona cf. eximia, Vasseuromys cf. thenii, Hansdebruijnia cf. neutrum, Valerimys* sp., *Neocricetodon cf. lavocati, Hipparion cf. moldavicum* etc. confirms a lower Meotian age that can be attributed to the Early Turolian (biozone MN11).

Taraclia, Causeni district. The site is located at the northwestern margin of Taraclia village, 25 km South of Tighina city. It is one of the largest sites of *Hipparion* fauna from Meotian (Turolian) in the Eastern Europe.

Lithology and stratigraphy indicate alluvial-lacustrine deposits of the Cahul Formation overlying marine sediments of Kersonian (Upper Sarmatian) age.

Taphonomy. In this section CHOMENKO (1913) distinguished seven bone lenses (I-VII), up to two meters wide, and 0.3-0.5 m thick, interrupted by 0.2-0.3 m thick unfossiliferous beds. The lithological features of the bone lenses, the absence of a coarse-grained material, the uniform orientation of bones into the layers, indicate their accumulation by a slowly flowing river. The burial zone possibly represented the delta of a Meotian river.

The distribution pattern of bones and their arrangement in lenses indicates variable water energy in streams transporting the animal remains.

The presence of articulated postcranial bones, skulls and mandibles and rounded bone fragments evidences the transportation of bones from sites at different distance from the burial. Turbulent streams could rumple and shatter the bones.

Large bone fragments indicate a considerable initial speed of water streams. It is probable that smaller bones were transported from more distant locations. When water speed decreased, only small bones fragments could be transported to the burial.

The presence of seven bone lenses in the section points to a long duration of the locality formation. Seasonal severe rainfalls could produce strong water streams that transported and deposited bone remains in the delta and floodplain of a Meotian river.

Non-uniform distribution of atmospheric precipitation might be responsible for the formation of the Taraclia vertebrate locality; droughts or catastrophic rainfalls could be among the causes of animals' deaths.

The fauna of Taraclia was studied by CHOMENKO (1913, 1914). Some forms of this faunal association are also described by RYABININ (1929), GROMOVA (1952), TROFIMOV (1954), and GODINA (1979).

The list of the Taraclia fauna includes:

Reptilia: *Protestudo bessarabica* RJABININ, 1918;

Mammalia. Lagomorpha: *Proochotona exima,* CHOMENKO 1914; *Alilepus lascarevi* (CHOMENKO, 1914)

Rodentia: *Castor* cf. *praefiber* LINNE, 1902; *Hystrix bessarabica* RJABININ, 1918;

Carnivora: *Martes leporinum* (CHOMENKO, 1914); *Hyaenictitherium venator* SEMENOV, 1989; *Ictitherium viverinum* ROTH et WAGNER, 1854; *Lycyaena choeretis* (GAUDRY, 1862); *Thalassictis parvum* (CHOMENKO, 1914); *Adcrocuta exima* (ROTH et WAGNER, 1854); *Felis attica* WAGNER, 1857; *Paramachairodus orientalis* GAUDRY, 1862; *Metailurus parvulus* (HENSEL, 1862); *Machairodus giganteus* (WAGNER, 1857).

Proboscidea: *Deinotherium giganteum* KAUP., 1829; *Tetralophodon longirostris* (KAUP, 1832), *Zygolophodon turicensis* (SCHINZ, 1824)

Perisodactyla: *Hipparion moldavicum* GROMOVA, 1952; *Hipparion platygenis* GROMOVA, 1952; *Aceratherium incisivum* KAUP, 1832; *Diceros pachygnathus* (WAGNER, 1848); *Dihlopus orientalis* (SCHLOSSER, 1921);

Artiodactyla: *Microstonyx major* (GERVAIS, 1848-1852); *Cervavitus novorossiae* CHOMENKO, 1913; *Palaeotragus rouenii* GAUDRY, 1881; *Samotherium boissieri* F. MAJOR, 1888; *Helladotherium duvernovi* (GAUDRY & LARTET, 1856); ?*Camelopardalis* sp.; *Tragoportax amalthea* (ROTH. & WAGNER, 1854); *Tragoportax amalthea* var *parvidens* (SCHLOSSER, 1904); *Tragoportax rugosiforms* (SCHLOSSER, 1904); ?*Tragoportax validus* (CHOMENKO, 1913); *Palaeorix majori* SCHLOSSER, 1904; *Palaeorix stutzeri* SCHLOSSER, 1904; *Tragoreas oryxoides* SCHLOSSER, 1904; *Protragelaphus skouzesi* DAMES, 1883; *Procapra rodleri* (PILGRIM & HOPWOOD, 1928); *Pseudotragus capricorns* SCHLOSSER, 1904; *Gazella deperdita* GERVAIS, 1848; *Gazella capricornis* WAGNER, 1854; *Criotherium argalioides* F. MAJOR, 1891; *Procobus brauneri* CHOMENKO, 1913; *Procobus melania* CHOMENKO, 1913;

The distinctive feature of the Taraclia fauna is the presence of diverse antelopes, widespread in the Turolian in the eastern Mediterranean.

GABUNJA (1959) and DELINSCHI (2008) correlated the fauna with Middle Meotian. The fauna from Taraclia has a Turolian aspect. It can be attributed to the Middle Turolian (zone MN 12) of the European continental stratigraphic scale.

Cimislia. The site is located on the right banks of the Kogylnik River, near the town of Cimislia. A dense ravine network covers an area of about 100 hectares. The ravines expose (at about 90 m a.s.l.) bone-bearing beds. There are altogether 11 fossiliferous sites in the fluviatile-lacustrine deposits of the Balta Formation.

Taphonomy. Bone remains of terrestrial vertebrates occur in sands and clays of channel and floodplain alluvial facies. Bone concentrations of 1.0 by 1.5 m form local bone breccia lenses. A rapid burial is indicated by the chaotic bone arrangement. The material includes articulated bones, vertebrae, skulls with mandibles, and sporadic rolled bone fragments. It is possible that strong temporary water currents transported floating, not decomposed corpses, and as separate parts. Bones were buried in channel and floodplain settings of a Meotian river. Animals could have died as a result of flooding or drought.

The Cimislia fauna (BARBU, 1959, BELIJAEVA, 1948, LUNGU &, TARABUKIN, 1966, TARABUKIN, 1968, LUNGU & DELINSCHI, 2008, DELINSCHI, 2005, 2008) includes:

Reptilia: *Protestudo bessarabica* (RJABININ, 1918);

Aves: *Struthio* sp.;

Mammalia. Insectivora: *Erinaceus* sp.;

Logomorpha: *Alilepus lascarevi* (CHOMENKO, 1914).;

Rodentia: *Hystryx* sp.;

Carnivora: *Promeles palaeattica* (WEITHOFER, 1888)*, Eomellivora rumana* Simionescu, 1938, *Miochyaenotherium bessarabicum* (SIMIONESCU 1938), *Thalassictis parvum* (CHOMENKO, 1914), *Adcrocuta eximia* (ROTH et WAGNER, 1854), *Machairodus giganteus* (WAGNER, 1857), *Paramachoirodus orientalis* GAUDRY, 1862, *Acinonys* sp., *Felis* sp.;

Proboscidea: *Tetralophodon* aff. *atticus* (WAGNER, 1857), *Zygolophodon turicensis* (SCHINZ, 1824), *Deinotherium giganteum* KAUP, 1829;

Perissodactyla: *Hipparion praegiganteum* TARABUKIN, 1968, *Hipparion moldavicum,* GROMOVA, 1952, *Hipparion matthewi* ABEL, 1926, *Aceratherium incisivum* KAUP, 1832, *Dihoplus aff pikermiensis* TOULA, 1906, *Chilotherium schosseri* (WEBER, 1905), *Acerorhinus* sp.;

Artiodactyla: *Microstonyx major* (GERVAIS, 1848-1852), *Cervavitus variabilis* ALEXEJEW 1915, *Cervavitus novorossiae* CHOMENKO 1913, *Palaeotragus rouenii* GAUDRY, 1861, *Helladotherium suchovi* (GODINA, 1977), *Miogazella pilgrimi* (BOHLIN, 1935), *Vetaprocapra capricornis* (PILGRIM, HOPWOOD, 1928) *Tragoportax frolovi* (PAVLOW, 1913), *Palaeoryx* aff. *pallasi* WAGNER, 1857, *Palaeoreas lindermayeri* WAGNER, 1848.

The fauna from Cimislia is one of the richest *Hipparion* faunas from Eastern Europe, but systematics of many taxa need a revision. Forms of open, savannah-like biotopes dominate in this fauna.

Recently, a new locality of terrestrial vertebrates was discovered in the quarry at the northern margin of Cimislia city (at the absolute elevation of 80 m). Bones occur in alluvial sediments of the Balta Formations (Delinschi 2005, 2008).

The bed of coarse-grained sand is exposed at the basis of the section. This bed contains intercalations of marl gravel and microconglomerate, which contains bones of small terrestrial vertebrates. They are overlain by clayey cross-bedded sands grading to compact clay.

These sediments account for a uniform alluvial sedimentation cycle, combining channel and meadow river facies. The following forms have been recorded from this site (DELINSCHI, 2008):

Reptilia: *Protestudo* sp., *Ophisaurus* sp., *Lacerta* sp., *Vipera* sp.;

Mammalia. Chiroptera: gen. et sp. inden.;

Insectivora: *Parasorex socialis* (VON MEYER, 1865), ?*Erinaceus* sp., *Ruemkelia* sp.

Logomorpha: *Alilepus lascarevi* (CHOMENKO, 1914).;

Rodentia: *Tamias atsali* DE BRUIJN, 1995, *Euroxenomys minutum rhenanum* (FRAZEN & STORCH, 1975), *Myomimus maritsensis* DE BRUIJN, DAWSON & MEIN, 1970, *Vasseuromis* sp., *Lophocricetus minuscilus* SAVINOV, 1977, *Neocricetodon (Kowalskia) browni* DAXNER-HOCK, 1992, *Neocricetodon (Kowalskia)* sp., *Pseudocricetus orienteuropaeus* TOPACEVSKI et SCORIK, 1992, *Hansdebruijnia* aff. *neutrum* (DE BRUIJN, 1976), *Apodemus* aff. *barbarae* (VAN DE WEERD, 1976);

Remains of murids and cricetids (*Muridae* and *Cricetidae*) dominate in the fauna.

Cimislia fauna is correlated with the Upper Meotian, but its taxonomic composition evidences a younger age than that of Cioburciu and probably Taraclia sites.

Cimislia fauna is dated to the later part of the Meotian (Middle Turolian, upper part of MN12 or MN12-13 boundary.

Gura-Galbenei, Cimislia district.

The site is situated in the Kogylnik River valley, at the eastern margin of Gura-Galbenei village, 20 km N of Cimislia city.

The outcrop exposes a 50 m thick member of grey-green compact clay alternating with fine-grained quartz-micaceous sand of lacustrine-alluvial origin. These sediments, referred to as Balta Formations, show a rhythmic structure with several alluvial cycles. Each cycle begins with medium-grained quartz-micaceous sands grading upwards to fine-grained sands, covered by compact clays.

The geological age of the locality is under discussion. By stratigraphic position and taphonomic features, Gura-Galbenei should be quite similar to the Cimislia site.

According to SUHOV (1945), KONIKOV (1957), and DELINSCHI (2008) the faunal association from Gura-Galbenei includes the following forms:

Mammalia. Lagomorpha: *Alilepus* sp.

Carnivora: *Machairodus* sp.

Proboscidea: *Mammut borsoni* (HAYS, 1834)

Perissodactyla: *Hipparion* sp., *Chilotherium schlosseri* (WEBER, 1905), *Aceratherium incisivum* KAUP, 1832.

Artiodactyla: *Microstonyx major* (GERVAIS, 1848-1852), *Cervavitus variabilis* ALEXEJEW, 1915, *Helladotherium duvernoyi* GAUDRY & LARTET, 1856, *Gazella deperdita* GERVAIS, 1847

Tudora, Stefan Voda district

The site is located on the right bank of the Dniester River, at the northwestern margin of Tudora village.

Taphonomy. As shown by bones occurrence in compact clays and fine-grained clayey sandstones, and in humus clays, the burial is associated with a shallow water basin of lacustrine or estuary type. Sands intercalations and sporadic pebbles indicate temporary currents as the accumulation agent of the animal remains.

Krokos (1914) noted the presence in the bone bed of a leaf flora including *Salix, Ulmus, Populus* and other forms that evidence a damp temperate climate.

Tudora fauna was described by PAWLOV (1913, 1914), KROKOS (1916), and GABUNIJA (1959).

According to BELJAEVA (1948) and DELINSCHI (2008), the faunal association from Tudora includes the following forms:

Reptila: *Protestudo bessarabica* (RJABININ, 1918),

Mammalia Carnivora: *Adcrocuta exima* (ROTH & WAGNER, 1854);

Perissodactila*: Hipparion tudorovense* GABUNIA, 1959,

Aceratherium incisivum KAUP, 1932, *Aceratherium simplex* (KROKOS, 1914)

Artiodactyla: *Microstonyx* aff. *major* GERVAIS (1848-1852), *Tragoportax amaltheus* (GAUDRY, 1861) *Palaeoryx majori* SCHLOSSER, 1904, *Gazella deperdita* GERVAIS, 1848.

The majority of the forms of Tudora fauna are common in the Meotian faunal associations from Moldova and Ukraine. The fauna also includes a new form of *Hipparion* (*H. tudorovense*) and a rhinoceros (*Aceratherium simplex*). Based on these data, Gabunija (1959) dated Tudora fauna at the Upper Meotian. This is in agreement with the local geology as continental fossiliferous formations overlain by marine sediments of the Lower Pontian.

The fauna from the Tudora locality is poorly studied. Until recently, it was considered younger than those from Cimislia, and it was correlated with the upper part of MN12 or lower part of MN13. In this case, faunas of Cimislia and Tudora are synchronous or the Tudora fauna may have Early Pontian age.

CONCLUSIONS

. Fossil Hipparion fauna of the Meotian age occur in Moldova in deltaic and lacustrine-alluvial facies frequently forming large lense-like concentrations.

Meotian faunal associations have a Turolian aspect possibly attributable to mammal zones MN11-MN13.

. In the Late Miocene, the area of the modern Moldova was situated at the boundary between different palaeobiogeographic provinces that influenced the formation and evolution of the local theriofauna.

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