

Paleogeographic Environments in the Northwestern Regions of the Black Sea Coast in the Early Pliocene

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After the regression of the early Pontian Sea, the whole area of Moldova and southwestern Ukraine faced the onset of continental sedimentation. In this region, deposits of Pliocene fluvial plains were recognized in three areas in the interfluvium of the Prut and South Bug rivers: the Kuchurgan, Stol'nicheny, and Karboliya areas (Bilinkis, 1987). Until recently, researchers have had no uniform view on the age interrelationships of these deposits and their position in the stratigraphic scale of the Eastern Paratethys. We studied a number of sections in the valley of the Kuchurgan River, the interfluvium of the Dniester and Prut rivers, the valley of Bol'shaya Salcha River, and in the vicinity of Odessa. We also partly revised materials on the mammal fauna that were collected in these areas and are stored in the Geological Institute of the Russian Academy of Sciences and used data from the literature. Our study showed a different age for these deposits. The Stol'nicheny fluvial deposits were formed in the first half of the early Cimmerian, the Kuchurgan deposits are dated at the terminal early and middle Cimmerian, and the Karboliya deposits are dated at the late Cimmerian.

Geological information and vertebrate fauna from the lower Pontian deposits and the above-listed fluvial members make it possible to draw certain conclusions about the development of the continental ecosystem in the northwestern Black Sea region from 7 to 3.5 Ma ago.

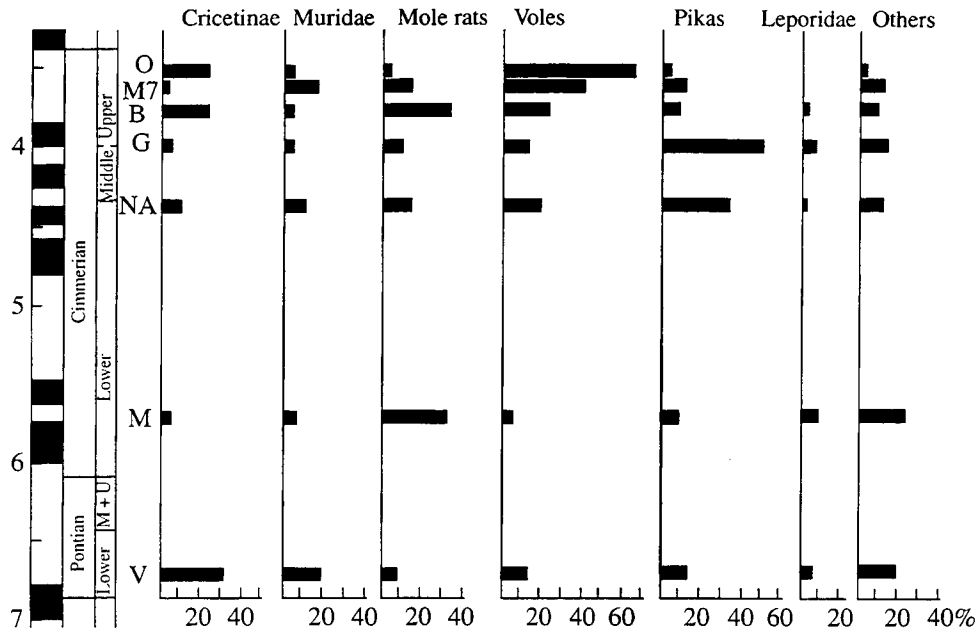
The composition of the early Pontian assemblage of small mammals suggests that the considered area was characterized by mosaic landscapes at that time and populated by their different ecological groups. The assemblage recorded in the localities of the Odessa–16 Station of the Bol'shoi Fontan (Topachevsky *et al.*, 1988) and the Vinogradovka locality of the Bolgrad area of the Odessa region, Ukraine (our collections), is dominated by hamsters (figure), dwellers of meadow and steppe biotopes. The presence of Gliridae, flying squirrels, and diverse Muridae (three species) indicate substantial development of arboreal vegetation, at least along the rivers. Riparian biotopes were inhabited by freshwater turtles of the *Chelydropsis* and *Sakya* genera

(Chkhikvadze, 1988), beavers, and desmans. The fauna of large mammals is inferred only from scarce finds in lower Pontian limestones (Dubrovo and Kapelist, 1979; Korotkevich, 1988). It included giraffes and camels, dwellers of savanna and dry open landscapes. Mastodonts, deinotheriums, rhinos, and microstonyxes inhabited brushwoods along rivers. The occurrence of camels and the complete absence of *Tragocerines*, which were typical for the Meotian, may indicate that climatic conditions were more arid during the Pontian than the Meotian. The presence of subtropical plants in the flora (Shchekina, 1966) points to a relatively high average annual temperature.

There are almost no paleontological data on the environments of the second half of the Pontian and the beginning of the Cimmerian. The early Cimmerian situation can be inferred from scarce finds in the Stol'nicheny fluvial deposits (Mugureny, Sagaidak, and Tritskoe localities). The fauna of small mammals of the Mugureny locality is characterized by taxonomic diversity; the different ecological groups are represented in more or less equal proportions, with the exception of some predominance of Spalacidae. The fauna of large mammals includes a small hipparion, a gazelle, a roe, and mastodonts. All these forms are typical for both open and wooded areas.

The fauna of brackish-water mollusks presents evidence that the climate in the early Cimmerian was warmer than that in the Pontian. It was also much more humid, which caused the formation of iron ore and laterite weathering crusts (Eberzin, 1940). Specifically, in the area of Odessa and along the Prut River, one can observe remnants of such a crust that developed upon the lower Pontian deposits. The time during which its formation began is presently unknown; however, most likely, it commenced in the earliest Cimmerian.

The maximum of climatic warming and, most likely, humidization occurred during the middle Cimmerian, the time of the formation of the Kuchurgan fluvial deposits. Apparently, the activation of tectonic movement in the Carpathians caused an increase in erosional processes. This resulted in a significant coarsening of clastic materials of Carpathian origin in the



Percentage of remains of small mammals in the studied localities.

V—Vinogradovka; M—Mugureny; NA—Novaya Andriashevka; G—Grebeniki 2; B—Budei; M7—Musait 7; O—Odessa catacombs.

Kuchurgan deposits as compared to the Stol'nichey fluvial deposits.

The vertebrate fauna (mammals and reptiles) indicates that mosaic landscapes were preserved. The fauna of rodents and lagomorphs experienced a quantitative restructuring; the dominating role was gained by pikas (Novaya Andriashevka and Grebeniki 2 localities). This was also noted by Topachevsky and Nesin (1989). Large mammals show that the dominant role was played by muntjacs of the genera *Muntiacus*, *Eostyloceros*, and *Paracervulus* together with small deers of the *Croizetoceros* and *Pliocervus* genera. All these forms were confined to biotopes with brush and arboreal vegetation situated along rivers. The same biotopes were inhabited by tapirs (unknown in older faunas), pigs *Propotamochoerus*, and mastodonts *Zygodolophodon borsoni*. Primates *Macaca* and *Dolychopithecus* (Dubrovo and Kapelist, 1979) are also known. The extremely rare occurrences of hipparion remains and complete absence of giraffes and camels are worth noting.

In the late Cimmerian, Karboliya fluvial deposits accumulated in the Prut area. These deposits rest on the eroded surface of a red weathering crust covering the lower Pontian deposits. This implies that the formation of the crust had terminated by the end of the middle Cimmerian. The sediment load of the fluvial plain shifted westward, so that the Karboliya alluvium began to discharge into the Dacian Basin. The size of clastic particles increases up the section (Khubka, 1982). This indicates that, by the end of the considered time, there was an increase in the intensity of the tectonic movements and, accordingly, erosion in the Carpathians.

The main difference of the small mammalian fauna from that of the preceding stages is an abrupt decrease in the quantity of pikas. Their niches were apparently occupied by voles (Budei and Musait 7 localities). By the end of the Cimmerian, voles of the family Arvicolidae reached an absolute predominance and displayed adaptive radiation. The genus *Promimomys*, which existed since the beginning of the Pontian, was joined by genera *Pliomys* and *Dolomys* (localities of the Odessa catacombs and the lower bed of the Kotlovina).

The fauna of large mammals shows that the role of muntjacs somewhat decreased, with the only remaining genus *Paracervulus*, and that the number of roes increased (two species of *Procapreolus*). Brushwoods along rivers were still inhabited by *Propotamochoerus* and mastodonts. However, *Zygodolophodon borsoni* occurred only rarely, whereas the role of *Anancus arvernensis* increased. The hippopotamus was also present (Godina and David, 1973; Korotkevich, 1988). Along with animals associated with humid wooded biotopes, the watershed plateaus were apparently inhabited by gazelles; very rare hipparions; and newly appearing camels, which reached high numbers by the end of the Cimmerian. These changes in the mammalian assemblages indicate a certain climatic aridization at that time.

During the formation of the Kuchurgan and Karboliya deposits (middle-late Cimmerian), the considered area was populated by an extremely rich reptile fauna. Turtle faunas of the Kuchurgan and Karboliya fluvial deposits are similar. They include the snapping turtle *Chelydropsis nopcsai*, freshwater species *Melanochelis pidopličkoj* and *Sakya riabinini*, the marsh turtle *Emydoidea antiqua*, the land tortoise *Tes-*

tudo černovi, and other forms. The Karboliya deposits yielded diverse remains of snakes (this group is not studied in the Kuchergan deposits), which can be assigned to more than ten species of six genera (*Eryx*, *Natrix*, *Coluber*, *Elaphe*, *Coronella*, and *Vipera* and the lizard *Pseudopus*) (Khozatskii, 1982; Chkhikvadze, 1988; Redkozubov, 1991). The entire reptile assemblage points to highly mosaic landscapes. There are forms associated with dry and mostly rocky steppe biotopes, ranging even to semidesert stations (*Coluber* and *Eryx*), as well as species indicative of humid forest (*Vipera* and *Elaphe*) and riparian biotopes (*Chelydropis*, *Sakya*, *Melanochelys*, and *Emydoidea*). According to Redkozubov (1991), the abundance of aquatic turtles, the presence of forms that have a high carapace (like *Testudo černovi*) and that lack fossorial adaptations, sand boas of the genus *Eryx*, and lizards of the *Pseudopus* genus indicate that temperatures were positive all year (p. 15). It is remarkable that the later faunas show an abrupt decrease in the number and diversity of turtles (only marsh forms were retained). The snake fauna lost sand boa *Eryx*, which was a possible result of climatic cooling about 3.5 Ma ago.

A comparison of our data with materials from more western areas shows that the second half of the Cimmerian (second half of the Dacian and beginning of the Romanian, according to the Romanian scale) was marked by coal formation in the Dacian Basin (Andreescu *et al.*, 1986). This points to a warm and humid climate and a considerable role of forests and uliginous vegetation. Evidently, the climatic aridization in the terminal Cimmerian had a greater effect on the eastern areas.

In sum, it is worth noting that the area of the northwestern coast of the Black Sea during the time interval 7–3.5 Ma (Pontian–Cimmerian) was a fluviatile, poorly dissected plain with mosaically distributed open and wooded, highly irrigated, biotopes. The climate was warm and humid with positive winter temperatures. Relative aridization is recorded in the early Pontian and terminal Cimmerian.

At the genus level, the systematic composition of small mammalian fauna was generally stable from the early Pontian to the end of the middle Cimmerian. Evolutionary changes in some lineages occurred mainly at the species and subspecies level. At the middle–lower Cimmerian boundary, the fauna lost a number of genera, and during the second half of the late Cimmerian, a number of new genera appeared. The quantitative ratios of dominant groups endured considerable changes.

Many typical Miocene forms apparently became extinct in the fauna of large mammals at some point in the beginning of the Cimmerian. In the mid-Cimmerian, the remarkable appearance of inhabitants of extremely humid wooded biotopes, which are unknown both in earlier and later assemblages, is observed.

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