Russian J. Theriol. 2 (1): 9–13

Sciuromorpha (Rodentia) from the Miocene of Zaissan Depression, Eastern Kazakhstan

Nina S. Shevyreva† & Galina I. Baranova

ABSTRACT. A series of the cheek teeth of sciuromorphous rodents from the middle Miocene Sarybulak Formation of Zaissan Depression, Eastern Kazakhstan has been investigated. These are referred to *Sarybulakia nessovi* **gen. & sp. nov.**, *Miopetaurista* sp., Pteromyidae indet. and *Tamias* sp.

KEY WORDS: Rodentia, Sciuromorpha, *Sarybulakia nessovi* **gen. & sp. nov.,** middle Miocene, Kazakhstan.

Sciuromorpha (Rodentia) из миоцена Зайсанской впадины, Восточный Казахстан

Н.С. Шевырева, Г.И. Баранова

РЕЗЮМЕ. Исследована серия зубов сциуроморфных грызунов из среднемиоценовой сарыбулакской свиты Зайсанской впадины в восточном Казахстане. Зубы отнесены к *Sarybulakia nessovi* **gen. & sp. nov.**, *Miopetaurista* sp., Pteromyidae indet. и *Tamias* sp.

КЛЮЧЕВЫЕ СЛОВА. Rodentia, Sciuromorpha, *Sarybulakia nessovi* **gen. & sp. nov.**, средний миоцен, Казахстан.

Introduction

The materials described herein were collected by the senior author during the work of the Saikan team in 1961–1991 (this team belonged to the Moscow Paleontological Institute of the Academy of Sciences of the USSR in 1961–1987 and to the cooperative “Biokhron” in 1988–1991) by screen-washing of the deposits of Sarybulak Formation. The latter formation is ubiquitously outcropping in the southern part of Zaissan Depression, Eastern Kazakhstan, in the basins of rivers streaming down from Saikan and Manrak ranges. The Sarybulak Formation was dated previously as late Miocene (Borisov, 1963). Subsequent studies of glirids (Kowalski & Shevyreva, 1997) and other rodents (Zazhigin & Lopatin, 2000) from this stratigraphic unit have challenged its age to the middle Miocene.

The materials examined herein are housed in the collection of the Paleontological Institute, Russian Academy of Sciences in Moscow (abbreviated PIN) and include ten isolated cheek teeth, some variously damaged and waterworn. Four of these teeth (two m2s and two m3s) are referred to a new taxon within the Pteromyidae, and other four are determined upon generic or family level only.

† Deceased. This joint paper was forethought long ago as description of a new pteromyid taxon based on two cheek teeth (PIN 2977/1929 and 1930). The authors agreed about a new taxon name, but the present text was not seen and discussed by the senior author, deceased in 1996. Later the junior author received additional materials on Sciuromorpha from the Miocene of Zaissan Depression which allowed to complete this paper.

The dental terminology is after Bryant (1945) and Wood (1962), with some specifications made by Mein (1970). In particular, we use the Mein’ term “anterosinusid” for the antero-external reentrant fold on the lower cheek teeth, situated between the labial end of anterolophid and protoconid.

Measurements. L — length (antero-posterior diameter), W — width (maximal transverse diameter, perpendicular to the longitudinal axis). All measurements are in mm.

Systematic paleontology

Order Rodentia Bowdich, 1821

Suborder Sciuromorpha Brandt, 1855

Family Pteromyidae Brandt, 1855

Sarybulakia **gen. nov.**

Type species. *Sarybulakia nessovi* **sp. nov.**

Diagnosis. A middle sized pteromyids with brachyodont dentition. The main cusps on the lower cheek teeth large and rounded. Anterosinusid, anteroconid and hypoconulid are lacking. Mesoconid occupies most part of the ectolophid. Enamel is smooth, but with development of sculpturing (crenulations) in shape of ridges and tubercles in the talonid basin, stronger developed in m3 than in m2.

Comparison. *Sarybulakia* **gen. nov.** was compared with the group of Miocene flying squirrels of Eurasia, including *Albanensia* Daxner-Höck & Mein, 1975, *Miopetaurista* Kretzoi, 1962, *Forsythia* Mein, 1970, *Aliveria* Bruijn *et al.*, 1980, *Parapetaurista* Qiu & Liu, 1986, *Shuanggouia* Qiu & Liu., 1986, and *Hylopetodon* Qiu, 2002 (Mein, 1970; Engesser, 1972; Bruijn *et al.*, 1980; Qiu & Liu, 1986; Bruijn, 1998; Qiu, 2002). *Sarybulakia* **gen. nov.** differs from all the genera mentioned above by anteroposteriorly shortened and parallelogram shaped m2, having well developed metalophid and hypolophid, by relatively short and triangular shaped m3 with the entoconid included in the posterolophid, and talonid basin filled by additional crenulations.

More specifically, *Sarybulakia* **gen. nov.** is similar with *Albanensia* in lacking of the anterosinusid (poorly developed in *Albanensia*, if present), in the mesostylid connecting to the metaconid, and in weakly developed metalophid in m3, but differs by m2 with smooth enamel, lacking of the hypoconulid, and having the hypolophid.

From *Miopetaurista* it differs by lacking of anterosinusid in m2, and by m3 without hypolophid and with larger mesostylid. *Sarybulakia* **gen. nov.** is similar with some species of *Miopetaurista* in development of the hypolophid and having similarly deep trigonid basin in m2.

Sarybulakia **gen. nov.** differs from *Forsythia* by larger size, lacking of anterosinusid and poorly differentiated entoconid in m3. It is similar with the latter in the position of mesostylid in m2–3, orientation and state of development of metalophid in m2, in shape of trigonid basin.

Sarybulakia **gen. nov.** differs from *Aliveria* by lacking of the anteroconid and anterosinusid, open trigonid in m3, or trigonid of different shape in m2, and by the mesostylid poorly separated from the metaconid and entoconid in m2. One species of *Aliveria* has a complete hypolophid in m2, like in *Sarybulakia* **gen. nov.**

Sarybulakia **gen. nov.** differs from the late Miocene *Hylopetodon* from China by lesser size, different proportions of lower molars, with m3 less elongated, by presence of a hypolophid in m2 and less developed enamel roughness on cheek teeth. Both taxa are similar in having of a well developed small mesostylid, connected to the metaconid and variously separated from the entoconid, and in lacking of the anterosinusid.

Other Chinese Miocene flying squirrels also differ from *Sarybulakia* **gen. nov.** *Parapetaurista* is much larger and has a well developed anterosinusid. *Shuanggouia* is smaller, with m3 not elongated, but with m1-2 less compressed antero-posteriorly; the entoconid in m3 is well differentiated, does not included in the posterolophid.

The cheek teeth of extinct flying squirrels usually complicated by additional enamel crenulations in form of rolls, ridges, and tubercles of different orientation and position. On the m3 talonid surface in *Sarybulakia* **gen. nov.** crimped ridges are descending from the posterior and side crown walls towards central basin, forming a hypolophid-like structure, bordering anteriorly a valley anterior to the posterolophid, or adjoining the ectolophid and posterolophid. In the m2 talonid the crenulation ridges are descending from the hypoconid obliquely towards the center of basin. Somewhat similar position of additional crimped ridges there is in m3 of *Aliveria brinkerinki* Bruijn *et al.*, 1980, where these ridges are going from the ectolophid posterior to the mesoconid and separating the posterior valley from the talonid basin. In *Forsythia* poorly developed ridges are descending from the lingual side of posterolophid towards the basin center. *Miopetaurista* has a different pattern of crenulations: crimped ridges and rolls are located anterior from the hypolophid and mesoconid on the anterior portion of the crown (*M. crusafonti* (Mein, 1970) and *M. gaillardi* (Mein, 1970)), or ridges go from the posterolophid and from the ectolophid (*M. lappi* (Mein, 1958), *M. gaillardi* (Mein, 1970)). In *M. dehmi* Bruijn *et al.*, 1980 additional crenulations are very weakly developed.

Albanensia considerably differs from *Sarybulakia* **gen. nov.** as well as from other Miocene flying squirrels in the pattern of enamel crenulations. Here the rough enamel surface is crumpled in ridges and folds which alter the usual shape of the main crown cusps and other crown structures.

Contents. Type species only.

Etymology. After Sarybulak River in Zaissan Depression, Eastern Kazakhstan, where (on the right bank of the river) the mammal locality within the Sarybulak Formation is situated.

Sarybulakia nessovi **sp. nov.**
Fig. 1A–C.

Holotype. PIN 2976/1145, a little worn and not water-worn left m2.

Referred material. PIN 2977/1931, a heavily worn and water-worn left m2; PIN 2977/1929, little worn left m3 with the metaconid tip broken off; PIN 2977/1930, unworn left m3 missing part of the crown with protoconid and metaconid.

Type locality. "Pod Cherepakhoi" [Under the turtle] locality, right bank of Sarybulak River, Zaissan Depression, Eastern Kazakhstan.

Stratigraphic level. Sarybulak Formation, middle Miocene.

Diagnosis. As for the genus.

Etymology. In honor of Russian paleontologist and investigator of the Mesozoic mammal faunas Lev A. Nessov.

Description. m2 has the length to width ratio 0.79 (holotype) and 0.80 (PIN 2977/1931). The entoconid is the smallest of the main cusps. The trigonid basin is well pronounced, transversely elongated, and bounded posteriorly by a complete metalophid. The talonid is intersected by a relatively high hypolophid, joining the hypoconid and entoconid. A small mesostylid is separated from the entoconid by a deep notch and joined to the metaconid. There are some blurred enamel ridges descending from hypoconid to the talonid basin.

m3 has the length to width ratio 1.03 (PIN 2977/1929). The hypoconid is the largest of the cusps, occupying whole the posterior tooth margin. The entoconid is weakly developed and inserted to the posterolophid as a roll-like thickening on the lingual tooth side. The entoconid was upheld by a weakest root, which is,

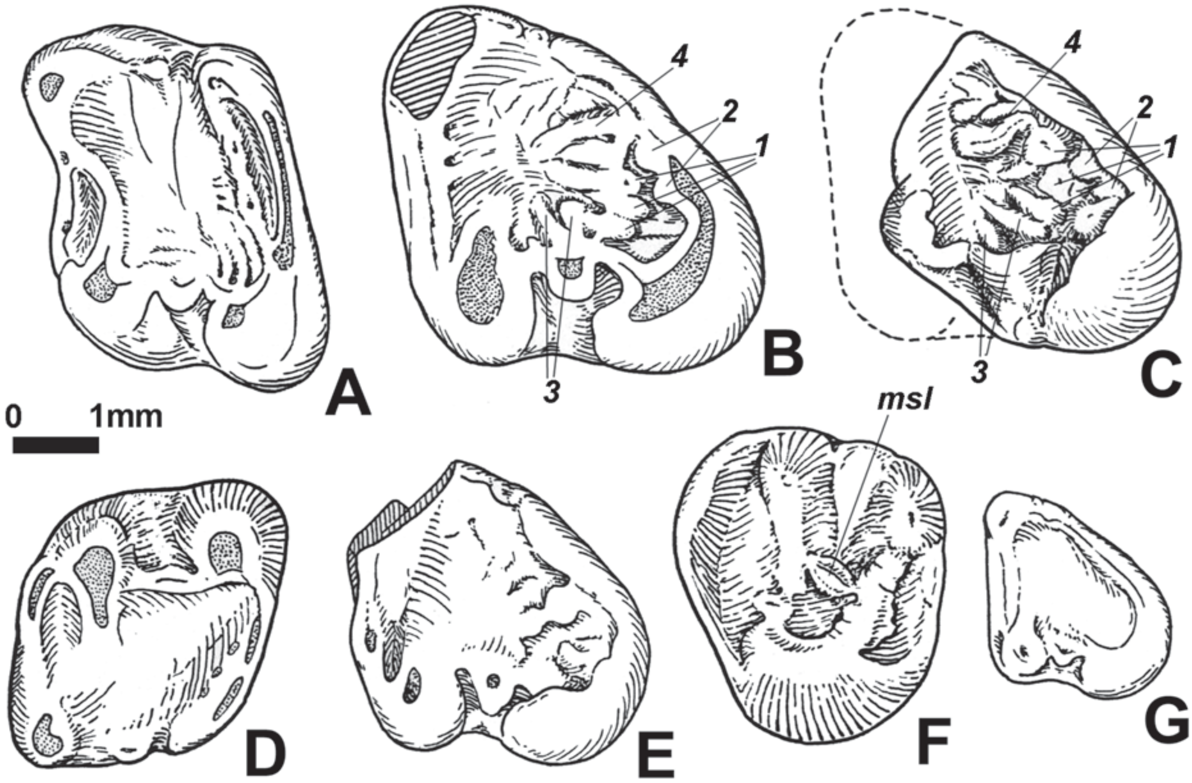

Figure 1. Teeth of *Sarybulakia nessovi* **gen. & sp. nov.** (A–C), *Miopetaurista* sp. (D, E), Pteromyidae gen. & sp. indet. (F), and *Tamias* sp. (G) in occlusal view. Zaissan Depression, Eastern Kazakhstan; Sarybulak Formation, middle Miocene.
A — PIN 2976/1145, holotype, left m2; B — PIN 2977/1929, left m3; C — PIN 2977/1930, left m3; D — PIN 2976/1144, right m2; E — PIN 2977/1933, left m3; F — PIN 2976/1146, left P4; G — PIN 2976/1147, left m3.
Abbreviations: 1–4 — crenulations; msl — mesolophule. Scale bar is 1 mm.

as other three roots of the tooth, broken off. Metalophid is a very short ridge adjacent to the protoconid. The trigonid basin is weakly expressed. Mesostylid is small, separated from the entoconid and metaconid by fine notches. The enamel on talonid is covered by well developed crenulations. A group of crenulations anterior to the posterolophid have a tendency to form a ridge, analogous to the hypolophid in position (Fig. 1B, C - *1*). One crenulation tubercle, merging to the posterolophid, could be considered as the entoconid analogue (Fig. 1B, C - *2*). There also some enamel folds lingually to the mesoconid and connected with this cusp (Fig. 1B, C - *3*). A high longitudinal enamel ridge, going along the talonid lingual border, becomes more flattened and connected to the posterolophid with the wear.

Measurements. PIN 2976/1145, m2, holotype: L=2.6, W=3.25. PIN 2977/1931, m2: L=2.75, W=3.5. PIN 2977/1929, m3: L=3.6, W=3.5.

Miopetaurista Kretzoi, 1962

Miopetaurista sp.

Fig. 1D, E.

Material. PIN 2976/1144, a middle worn and rolled right m2; PIN 2977/1933, a little worn left m3.

Description. Cheek teeth are relatively small, anteroposteriorly shortened (L/W ratio is 0.9 for m2 and 1.1 for m3). Enamel is smooth.

m2 is of parallelogram or rhomb shape in occlusal view. The paraconid, metaconid, and hypoconid are of size and shape typical for other flying squirrels. The entoconid is included into the posterolophid, forming its lingual extremity. The ectolophid is with a small mesoconid, shifted towards the crown center. The mesostylid is well developed and separated from both the metaconid and entoconid. The metalophid starts from the protoconid and does not reach the middle of the crown, leaving trigonid basin open. The hypolophid and hypoconulid are absent. A well developed anterolophid is swollen at the level of protoconid. The anterosinusid is lacking. The posterolophid was covered by a thickened enamel with tubercular crenulations.

m3 is rounded to triangular-shaped in transverse cross-section. The posterolingual edge of the crown is oblique, and the posterior part of the crown is projecting posteriorly and occupied by a large hypoconid, extending into the labial crown side and continuing lingually into the robust posterolophid with inclusive entoconid. The mesoconid is relatively large. The mesostylid is small, but well delimited. The metalophid is developed even more weakly than in m2. The anterolophid is also swollen in front of the protoconid, like in m2. There are additional enamel crenulations in shape of rolls going from the hypoconid and posterolophid towards the talonid basin.

Measurements. PIN 2976/1144, m2: L=2.8, W=3.0. PIN 2977/1933, m3: L=2.85, W=2.6.

Comparison. The teeth described agree well with the diagnosis of *Miopetaurista* provided by Daxner-Höck & Mein (1975). They belong to one of the smallest species within the genus. This species could be characterized by lacking of the anterosinusid, greatly developed posterolophid, and by specific complication of the enamel crenulations in m3. *Miopetaurista* sp. from Zaissan is somewhat similar with *M. asiatica* Qiu, 2002 in m2-3 proportions and some details. However, the latter species is considerably larger and has a much weaker posterolophid.

Bruijn (1998) noted that *Miopetaurista* was confined to Europe during middle Miocene - early Pliocene. Discovery of *M. asiatica* and Zaissan *Miopetaurista* sp. have challenged this view, indicated much wider geographic range of the genus.

Pteromyidae gen. & sp. indet.
Fig. 1F.

Material. PIN 2976/1146, an unworn left P4.

Description. P4 is of generalized sciurid type and belonging to an animal of size compatible with *Sarybulakia nessovi* **gen. & sp. nov.** The occlusal surface is of rounded outline, with the labial margin longer than the lingual margin owing to development of a large anteriorly projecting parastyle in the anterolabial corner of the tooth. The protocone is large and high and situated on the lingual crown side. The hypocone is lacking. The paracone and metacone are high and pointed. The protoloph and metaloph are approaching and joining the protocone, slightly converging lingually. The anterior cingulum is narrow and connects the parastyle with the protocone. The posterior cingulum is thicker and stretched between the protocone and metacone. The mesostyle is large but low, well separated, and occupying all labial space between the paracone and metacone. Structure of the transverse ridges is very characteristic for this tooth. The protoloph has a well pronounced paraconule just at the base of protocone, and future labially it is complicated by weakly expressed folds. The metaloph is also folded by transverse furrows and its part, adjacent to the protocone, is broadened to form a metaconule. The most specific feature is presence of a longitudinal ridge, connecting the protoloph with the metaloph, which was not observed in P4 of other flying squirrels. It is designated here as mesolophule. Other accessory structures, characteristic for some species of *Miopetaurista*, like protolophule (=accessory loph) and ridges, going from the metaloph towards the posterior cingulum, are lacking.

Measurements. PIN 2976/1146, P4: L=2.75, W=3.0.

Family Sciuridae Fischer, 1817

Tamias Illiger, 1811

Tamias sp.
Fig. 1G.

Material. PIN 2976/1147, a little worn left m3.

Description. The hypoconid is the most developed among the main crown cusps. It occupies all posterolabial part of the crown. The protoconid and metaconid are well pronounced. The entoconid is not separated but included into the posterolophid. The thickened lingual crown edge is posteriorly and labially oblique, which give a triangular outline to the crown occlusal surface. The mesoconid is well marked, occupies almost all space of the ectolophid, and shifted from the labial margin to the crown center. Accordingly, there is a considerable labial valley. The mesostylid is small, tightly adjacent to the metaconid, and delimited by hardly discernible enamel notches. The anterolophid is low. The anteroconid is not recognizable. The metalophid can be traced only adjacent to the protoconid, so the trigonid basin is lacking. A small hollow between the protoconid and anterolophid can be considered as weakly pronounced anterosinusid. The enamel surface is smooth. The roots are broken, but their bases indicate three main roots and a fourth smaller under the entoconid.

Measurements. PIN 2976/1147, m3: L=1.58, W=1.38.

Comparison. By size, shape, and structure the Zaissan specimen is completely corresponds to m3 in extinct and extant chipmunks of the genus *Tamias*. Small sciurids usually referred to these recent genus, are frequently found in the Mio-Pliocene faunas of Eurasia. The best published information concerns the following taxa: *T. orlovi* Sulimski, 1964 from various Pliocene localities in Poland (Black & Kowalski, 1974), *T. eviensis* Bruijn *et al.*, 1980 from the early Miocene of Greece (the most ancient record of the genus in Europe), *T. sihongensis* Qiu & Liu, 1986 from the early Miocene of Jiangsu Province in China, and *T. ertemtensis* Qiu, 1991 from the latest Miocene of Inner Mongolia in China. Unfortunately, m3 is the least diagnostic tooth in this group. All Pliocene-Miocene and Recent species of *Tamias* are very similar in the size and proportions of m3. The Zaissan chipmunk stands out for its smallest size. Materials on the Recent *T. sibiricus* (Laxmann, 1769) reveal great ontogenetic and individual variation of the characters of m3, used sometimes for diagnostics of species within the genus, like size of the mesoconid, character of mesostylid detachment, expression of deepening or reentrant fold between the paraconid and anterolophid, and others. This hamper species determination of the Zaissan tooth. According to Bruijn *et al.* (1980: 258) "The stability of the dental pattern of *Tamias* from the Early Miocene through the Recent suggest that this group is among the most ancient and successful models of modern rodents and it is expected that the genus will be traced back into the Oligocene of Asia."

Discussion

The extinct flying squirrels are sufficiently represented and diversified in the Miocene-Pliocene mammal assemblages of Eurasia. The maximum number of their genera and species was recorded for the end of middle Miocene (MN 7-8). History and taxonomic position of this sciuromorph group is not clear; particularly its monophyly is not unequivocally demonstrated. The modest materials on flying squirrels from the middle Miocene of eastern Kazakhstan extend the geographic range of the group. These Kazakh taxa could be of potential interest, connecting the better known Chinese and European Miocene assemblages of flying squirrels.

ACKNOWLEDGEMENTS. One of us (GB) is sincerely grateful to Alexey Lopatin (PIN, Moscow) for presenting the additional materials on Sciuromorpha from the Miocene of Zaissan Depression for study and valuable comments on the paper, and to Alexander Averianov (ZIN, St. Petersburg) for translation and editing the paper.

References

Black C.C. & Kowalski K. 1974. The Pliocene and Pleistocene Sciuridae (Mammalia, Rodentia) from Poland // Acta Zoologica cracoviensia. Vol.19. No.19. P.461–486.

Borisov B.A. 1963. [Stratigraphy of the Upper Cretaceous and the Paleogene-Neogene of Zaissan Depression] // Materialy po Geologii i Poleznym Iskopaemym Altaya i Kazakhstana, Novaya Seriya. T.94. P.11–75 [in Russian].

Bruijn H. de. 1998. Vertebrate from the Early Miocene lignite deposits of the opencast mine Oberdorf (Western Styrian basin, Austria). Rodentia 1 (Mammalia) // Annalen des Naturhistorischen Museums in Wien. Ser.A. Bd.99. P.99–137.

Bruijn H. de, Meulen A.J. van der & Katsikatsos G. 1980. The mammals from the lower Miocene of Aliveri (Island of Evia, Greece). 1. The Sciuridae // Proceedings of the Koninklijke Nederlandse Akademie van Wetenshappen, Section B. Vol.83. No.3. P.241–261.

Bryant M.D. 1945. Phylogeny of the Nearctic Sciuridae // American Midland Naturalist. Vol.33. No.2. P.257–390.

Daxner-Höck G. & Mein P. 1975. Taxonomische Probleme um das Genus *Miopetaurista* Kretzoi, 1962 (Sciuridae) // Paläontologische Zeitschrift. Bd.49. Hf.1–2. S.75–77.

Engesser B. 1972. Die obermiozäne Säugetier Fauna von Anwil (Baselland) // Tätigkeitsberichte der Naturforschenden Gesellschaft Baselland. Bd.28. S.37–363.

Kowalski K. & Shevyreva N.S. 1997. Gliridae (Rodentia: Mammalia) from the Miocene of the Zaysan Depression (Eastern Kazakhstan) // Acta Zoologica cracoviensia. Vol.40. No.2. P.199–208.

Mein P. 1970. Les Sciuroptères (Mammalia, Rodentia) néogènes d'Europe Occidentale // Géobios. Vol.3. Fasc.3. P.7–77.

Sulimski A. 1964. Pliocene Lagomorpha and Rodentia from Węże-1 (Poland) // Acta Palaeontologica Polonica. Vol.9. No.2. P.149–264.

Qiu Z. 1991. The Neogene mammalian faunas of Ertemte and Harr Obo in Inner Mongolia (Nei Mongol), China. 8. Sciuridae (Rodentia) // Senkenbergiana lethaea. Vol.71. No.3–4. P.223–255.

Qiu Z. 2002. Sciurids from the late Miocene Lufeng hominoid locality, Yunnan // Vertebrata PalAsiatica. Vol.40. No.3. P.165–176.

Qiu Z. & Liu Y. 1986. The Aragonian vertebrate fauna of Xiacaowan, Jiangsu. 5. Sciuridae (Rodentia, Mammalia) // Vertebrata PalAsiatica. Vol.24. No.3. P.195–209.

Wood A.E. 1962. The early Tertiary rodents of the family Paramyidae // Transactions of the American Philosophical Society of Philadelphia, New Series. Vol.52. Pt.1. P.1–261.

Zazhigin V.S. & Lopatin A.V. 2000. [The history of Dipodoidea (Rodentia, Mammalia) in the Miocene of Asia] // Paleontologicheskii Zhurnal. No.3. P.90–102 [in Russian with English summary].