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A Skeleton of the Pike *Esox* cf. *lucius* L. from the Pleistocene of the Ishim–Irtysh Interfluve

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Abstract—A complete skeleton of the pike *Esox* cf. *lucius* L. from the Late Pleistocene deposits of the Ishim-Irtysh interfluve (village of Kotochiga, Western Siberia) is described. The specimen is morphologically close to the northern pike, which presently has a circumboreal range. A number of primitive characters in the structure and dentition of the dentary and palatine resemble some Pliocene specimens, although they are rather incomplete, precluding the estimation of the taxonomic value of such characters. The preservation of scales and bones in the pike from Western Siberian suggests immediate burial in the place of its death in a lacustrine basin. The material comes from loam, with traces of a paleocryogenic texture. The underlying sand bed contains abundant shells of freshwater mollusks, suggesting that the climate was comparable to that in the Recent or even softer. The ^{14}C dating giving the age about 25 ka (MIS3) was obtained for the first time in the horizon of buried soil at the base of the sand bed. Previously, the interfluve deposits in question were dated within the range from the Middle Pleistocene (MIS8) to the end of MIS2 of the Late Pleistocene.

Keywords: Esox cf. *lucius*, pike, skeleton, Pleistocene, Western Siberia, ^{14}C dating

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INTRODUCTION

In the extraglacial zone of the West Siberian Plain, including the northern Ishim–Irtysh interfluve, lacustrine deposits are widespread, the formation of which is usually associated with a backwater lake of the maximum Middle Pleistocene glaciation (Krasnov and Zarina, 1964; Volkov et al., 1969; etc.) or the last Pleistocene, Sartanian, glaciation (Grosswald, 1977; Arkhipov et al., 1980; Grosswald and Huge, 2002; etc.). It was generally accepted that, during these glaciations, the glacial shield in the north covered the plain from the Urals to Mid-Siberian Plateau.

According to an alternative concept (of shelf glaciation), the backwater basin was divided at the end of the Pleistocene into two relatively small lakes (Yenisei and Pur) and huge Mansi lake–sea, the maximum depth of which was near the city of Khanty-Mansiisk (150–160 m deep). Its northern boundary was drawn based on a ridge of frontal moraines, which was considered to be formed by an ice cap about 20–17 ka. This ridge is also traced westerly in the Pechora River Basin. It was dated based on field correlation and isolated ^{14}C dates (Arkhipov et al., 1980; Arkhipov, 1997; Volkova et al., 2003; etc.). However, later, the Paleolithic Mamontova Kur'ya Site was discovered on this ridge and dated about 40 ka (Pavlov et al., 2001). It was subsequently revealed that, during the maximum (about 20–17 ka), the last glaciation unlikely involved the Kara Sea coast (Svendsen et al., 2004; Astakhov, 2011, 2014). On the other hand, in the south, in the center of the Mansi lake–sea, presumably 150–160 m of depth, the Paleolithic Lugovskoe Site (Leshchinskii et al., 2006) with many ^{14}C dates from 30 ka (based on mammoth bones) to 11 ka was discovered. Thus, the concept of shelf glaciation in the Sartanian cryochron, with the formation of extensive Mansi lake–sea was not corroborated.

However, the lacustrine origin of the deposits composing the northern Ishim–Irtysh interfluve was rather confidently confirmed by the monographic study of these beds by Volkov et al. (1969). Based mostly on palynological data, these authors divided the interfluve strata into two members, lower and upper, with a buried soil between them. Based on a series of reference sections, one of them near the village of Kotochiga, they attributed the lower strata to the Samara (maximum) Glaciation, the upper strata to the Tazovo Glaciation of the Middle Pleistocene, and the buried soil to the Shirta Interglacial, when judging from palynological data on the section near the village of Kotochiga, vegetation was similar to the modern one. When studying the Pleistocene of the southwest of the West Siberian Plain in 2013 and 2014, we examined the section near the village of Kotochiga more thoroughly than previously. During the study, a complete pike skeleton was found. The section structure is generally similar to that described before (Volkov et al., 1969), but we recognized 16 beds, schematically described below (downward in the section) (Fig. 1a):

(1) 0–0.2 m. Humic horizon of Recent soil.

(2) 0.2–1.1 m. Light brown, nonlaminate loam.

(3) 1.1–1.45 m. Brownish gray, indistinctly bedded loam.

(4) 1.45–1.7 m. Bluish gray, nonlaminate loam.

(5) 1.7–2.97 m. Bluish gray loam, with large carbonate concretions.

(6) 2.97–3.04 m. Gray sand.

(7) 3.04–3.19 m. Bluish gray horizontally bedded loam.

(8) 3.19–3.22 m. Bluish gray loam.

(9) 3.22–3.45 m. Bluish gray horizontally bedded loam.

(10) 3.45–4.08 m. Bluish gray splintered loam.

(11) 4.08–4.3 m. Gray, thin-layer sand, with abundant mollusk shells.

(12) 4.3–4.5 m. Brownish gray loamy sand, humic buried soil.

(13) 4.5–5.45 m. Bluish gray loam, with carbonate concretions.

(14) 5.45–6.75 m. Gray fine-grained, silty sand.

(15) 6.75–10.55 m. Brownish gray, laminated loam.

We examined the section of interfluve loam in two exposures made in the steep right slope of the Barsuk River valley north of the village of Kotochiga (Fig. 1b), which are situated at a distance of 200–250 m from each other. In the western exposure, the lower part of the section (Beds 9–16) is investigated more completely and, in the eastern exposure, the upper strata (Beds 1–12) are. The reference horizon is sand of Bed 11, which are positioned at the same level in both exposures. The pike skeleton was found in a 3.4-m-deep ditch located 45 m west of the eastern exposure. In the ditch, Beds 10–12 and the upper part of Bed 13 were recognized. In the middle part of Bed 10, P. Osipenko, a student of Tyumen State University found a fish vertebra. The exposure made by us revealed a pike skeleton and large (up to 7 cm long) bivalve shells of very poor preservation. The composition and structure of Beds 10–13 in the ditch and exposures are closely similar, but here we describe them in more detail based on the ditch where the pike skeleton was found. The interval of 0–1.3 m of depth is composed of dealluvial deposits and, at 1.3–2.0 m of depth (Bed 10), there is fulvous brown, splintered loam formed mostly of platy chippings 2–4 cm long, dense, angular, covered by a dense ferruginous film. These are traces of epigenetic thick-net paleocryogenic texture of the platy type (after Mel'nikov and Spesivtsev, 2000). The bed is pierced by pseudomorphosis along an epigenetic ice–ground vein, the upper part of which is covered by dealluvial deposits. In the western exposure, such a pseudomorphosis begins in the lower part of Bed 9. Two more pseudomorphoses at the same stratigraphic level are observed between the exposures. Their positions do not support the idea that they belong to a polygonal network. They likely belong to isolated pseudomorphoses, which are widespread in the southwest of the West Siberian Plain south of 57° N (Aubekerov and Chalykh"yan, 1974; Aubekerov, 1990; Laukhin et al., 2012; etc.). Judging from the shape of pseudomorphoses, as the veins were formed, the active layer almost reached the middle of Bed 10. In the ditch examined, the pike skeleton was located at the bottom of the active layer and the vein separated its skull from the postcranial skeleton (Fig. 1a). Bed 11 is formed of light gray, fine-grain, thin-layer, perfectly sorted sand. Its bedding is oblique and lenticular, with abundant mollusk shells, frequently corresponding in position to the bedding. Mollusks are inhabitants of small water bodies of a moderately warm zone, which are characteristic of the Holocene of Belarus. In both exposures, sands of Bed 11 lack a trace of disturbed bedding. In the ditch, the upper sand part also seems intact, while the lower part is involved in disturbance of Bed 12. Bed 12 in exposures is strongly reworked by solifluction, which is obviously superimposed. This statement is also supported by rich humus in buried soil and development of solifluction in the southern part of the lowland. At present, solifluction is observed at low points in the Arctic Region and in high mountains. In the ditch, Bed 12 is indiscernible. Fragments of its humic horizon are included in the bottom layers of Bed 11 and in the upper part of Bed 13. In the exposures, Beds 11 and 12 are separated by distinct boundaries. The use of humus of the buried soil from Bed 12 of the western exposure for ^{14}C dating showed 25090 ± 1270 (SPbGU-7265).

Taking into account the above data, it is possible to reconstruct environments in the area of the section during accumulation of Beds 10–12. Buried soil of Bed 12 was formed during the last warming of the Karginian thermochron (analogue of MIS3) under subaerial conditions. Therefore, the upper strata of interfluve loam is assigned to the terminal Upper Pleistocene rather than Middle Pleistocene. This was followed by an abrupt fall in temperature and development of solifluction still in subaerial conditions. Subsequently, conditions were replaced by subaquatic,

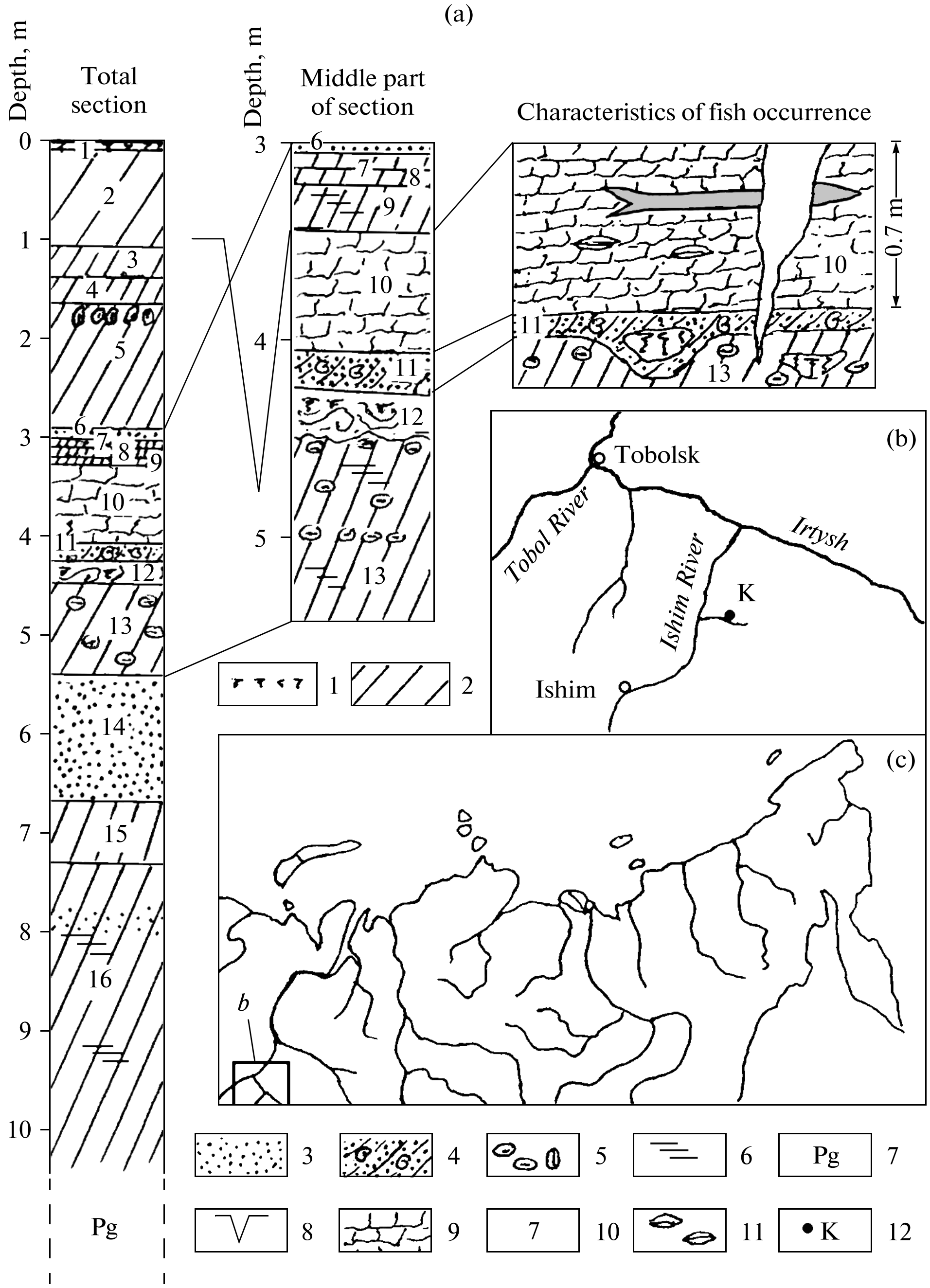
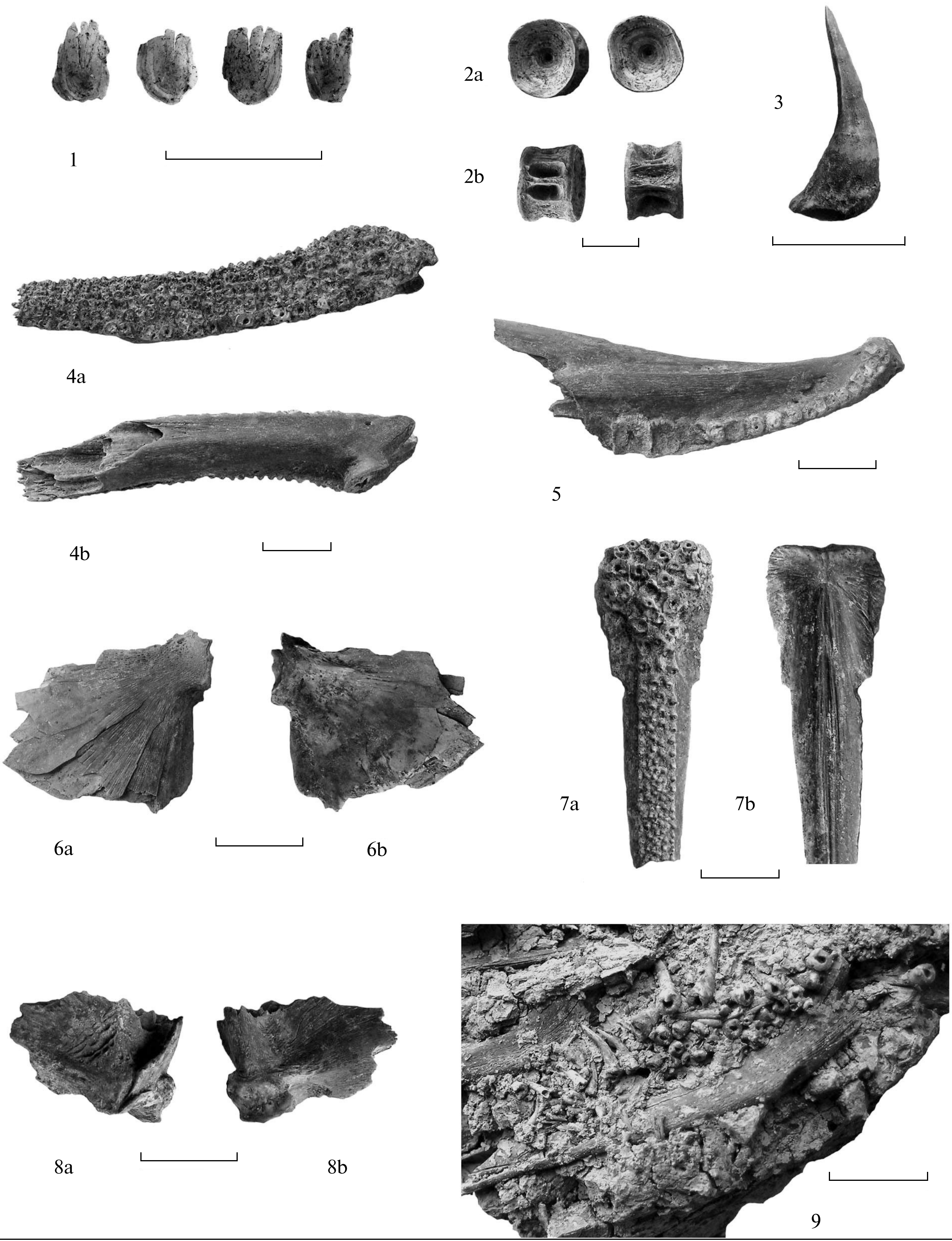


Fig. 1. Section near the village of Kotochiga and its details (a); position of the section near the village of Kotochiga (K) on the Ishim–Irtysh interfluve (b); position of the region of the village of Kotochiga in northern Asia (c). Designations: (1) humic horizon of Recent and buried soils of Bed 12; (2) loam; (3) sand; (4) shore–lacustrine sand of Bed 11 and mollusks in it; (5) carbonate concretions; (6) horizontal bedding; (7) Paleogene underlying Pleistocene deposits; (8) position of individual pseudomorphoses along ground–ice veins; (9) loam of Bed 10 with thick-net paleocryogenic texture; (10) Bed number; (11) bivalve shells in Bed 10; (12) position of the Kotochiga section in Ishim–Irtysh interfluve (for more detail, see Fig. 1b).

shallow-water and the climate became considerably warmer and approached interglacial rather than interstadial, although sand of Bed 11 is dated to the Sartanian cryochron rather than Shirta Interglacial. It remains uncertain whether or not there was drying at the beginning of the formation of Bed 11; however, most of Bed 10 was probably accumulated under lacustrine conditions outside the development of high standing permafrost or the absence of such conditions. At that time, the pike died in the lake and was buried under lacustrine deposits. Its skeleton was probably well preserved because of a very quiet hydrologic mode

Plate 7



Explanation of Plate 7

Figs. 1–9. *Esox* cf. *lucius* L., specimen PIN, no. 5537/1, details of complete skeleton; Kotochiga locality; Late Pleistocene: (1) scale; (2) vertebrae: (2a) frontal view, (2b) dorsal and ventral views; (3) mandibular tooth; (4) palatinum dex.: (4a) ventral and (4b) dorsal views; (5) dentale dex., dorsal view; (6) operculum dex. fragment: (6a) external and (6b) internal views; (7) vomer: (7a) ventral and (7b) dorsal views; (8) quadratum dex. fragment: (8e) external and (8b) internal views; (9) palatal teeth and cranial bones. Scale bar, 1 cm.

in the lake. Subsequent cooling and the onset of permafrost resulted in deep freezing of lacustrine loam, formation in them of platy cryotexture, and disruption of large bivalve shells. The absence of such cryotextures at the points of development of pseudomorphoses along the ground–ice veins in other sections of southwestern Siberia suggests that, between the formation of cryotexture in loam and ground–ice veins in the vicinity of the Kotochiga section, there could have been a stage of some warming.

DESCRIPTION OF THE SPECIMEN

The material is a complete skeleton (68 cm of standard length) with preserved scale cover and natural arrangement of cranial bones, pectoral fins, and postcranial bones. The individual age of the pike established by the scale and vertebrae is 7 +.

The scale cover is well preserved, allowing the estimation of individual age based on isolated scales. The dentary is dorsoventrally flattened and has near the symphyseal region a relatively short field of symphyseal teeth arranged in three rows. The internal row includes two teeth; two succeeding external rows are longer. In addition, labial to them, there are traces of the reduced fourth row, which existed at earlier age stages (Pl. 7, fig. 5). The palatine has along the external edge a series of irregularly arranged increased alveoli; similar alveoli are also observed on the vomerine head. Both bones are flattened, as is observed in a number of fossil members of the genus *Esox*, for example, *E.* cf. *lucius* L. from the Oler Formation of the Indigirka River Basin and Late Pliocene European *E. moldavicus* Sytch. (Sytchevskaya, 1989), which are considerably more ancient than the specimen described here.

The specimen in question (Pl. 7) is almost identical in morphology to Recent *Esox lucius* L.; however, some bones of its skull show specific distinctive structural features. These are primarily certain flattening and maltirow arrangement of teeth in the symphyseal region of the dentary, which is not typical for extant Eurasian pikes. The latter usually have a high anterior region of the dentary, with a single row of symphyseal teeth; an increase in the number of tooth rows to two is only observed as a rare variation (Gruzdeva and Vasilieva, 1988). In fossil (Sytchevskaya, 1976, 1989) and subfossil forms (Lebedev, 1960; Tsepkin, 1971), an increase in the number of rows of symphyseal dentary teeth at least to two is observed more frequently. Another distinctive feature of the pike from Kotochiga is the flattened palatine and vomer. In this respect, it is similar to some Pliocene and Pleistocene taxa (Sytchevskaya, 1976, 1989), but differs from extant species, in which these elements are curved somewhat dorsally. The estimation of taxonomic significance of the above-listed features requires additional examination; therefore, the Pleistocene West Siberian specimen is tentatively identified as *Esox* cf. *lucius* L.

The character of preservation of the specimen gives evidence that it was immediately buried at the point of death in quiet water of a lake or floodplain. In addition to the perfect preservation of this complete skeleton, the quiet conditions of the burial are supported by the preservation of scales, absence of bone rounding, and particularly the preservation in the natural positions of cranial bones and palatal teeth. Some damages, such as split of some bones are connected with subsequent influence of cryogenic processes. All bones of the skeleton are stained brown and slightly fossilized.

The pike (*Esox lucius* L.) is one of most widespread freshwater fish species in the Recent flat boreal water bodies of Eurasia and North America. Inhabiting water bodies widely varying in ecology, it always occupies the niche of obligatory ichthyophagous predators in the biotope with shore thickets of higher aquatic plants (Berg, 1948; Sabaneev, 1970; Nikolsky, 1971). In Pliocene and Pleistocene fish assemblages of Siberia, the pike is one of dominant elements, showing morphological stability over a rather long time.

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REFERENCES

Arkhipov, S.A., Chronology of geological events in the Late Pleistocene of Western Siberia, *Geol. Geofiz.*, 1997, vol. 38, no. 12, pp. 1863–1884.

Arkhipov, S.A., Astakhov, V.I., Volkov, I.A., and Panychev, V.A., *Paleogeografiya Zapadno-Sibirskoi ravniny v maksimum poslednego oledeneniya* (Paleogeography of the West Siberian Plain in the time of the Maximum of the Last Glaciation), Novosibirsk: Nauka, 1980.

Astakhov, V.I., Chapter 25. Ice margins of northern Russia revisited, in *Quaternary Glaciations-Extent and Chronology*, vol. 15: *Development in Quaternary Science*, Ehlers, J., Gibbard, P.L., and Huges, P.D., Eds., Amsterdam: Elsevier, 2011, pp. 323–336.

Astakhov, V.I., The postglacial Pleistocene of the northern Russian mainland, *Quater. Sci. Rev.,* 2014, vol. 92, pp. 388–408.

Aubekerov, B.Zh., Cryogenic structures and cryolitozones of the Pleistocene of Kazakhstan, *Izv. Akad. Nauk SSSR, Ser. Geogr.*, 1990, no. 4, pp. 102–110.

Aubekerov, B.Zh. and Chalykh"yan, E.V., *Kainozoi zony kanala Irtysh–Karaganda* (Cenozoic of the Zone of the Irtysh–Karaganda Canal), Almaty: Nauka, 1974.

Berg, L.S., *Ryby presnykh vod SSSR i sopredel'nykh stran* (Freshwater Fish of the USSR and the Adjacent Countries), 4th ed., Moscow–Leningrad, 1948, vol. 1.

Grosswald, M.G., The last Eurasian glacial cover, in *Materialy glyatsiologocheskikh issledovanii* (Materials of Glaciological Studies), Moscow: Inst. Geokhim. Akad. Nauk SSSR, 1977, pp. 45–60.

Grosswald, V.G. and Huge, T.J., The Russian component of the Arctic Ice Sheet during of the last Glacial Maximum, *Quater. Sci. Rev.*, 2002, vol. 21, pp. 121–146.

Gruzdeva, M.A. and Vasilieva, E.D., Divergence of the northern pike *Esox lucius* L. and Amur pike *E. reicherti* Dyb. pikes with reference to cranial characters, *Vopr. Ikhtiol.*, 1988, vol. 28, no. 4, pp. 567–578.

Krasnov, I.I. and Zarina, E.P., Quaternary System, in *Geologiya SSSR* (Geology of the USSR), Moscow: Nedra, 1964, vol. 44, pp. 192–242.

Laukhin, S.A., Larin, S.I., and Gusel'nikov, V.L., The first record of traces of ancient permafrost in the Kurgan Region, *Vestn. Tyumen. Gos. Univ. Nauki Zemle*, 2012, no. 7, pp. 104–112.

Lebedev, V.D., *Presnovodnaya chetvertichnaya ikhtiofauna evropeiskoi chasti SSSR* (Quaternary Freshwater Ichthyofauna of the European Part of the USSR), Moscow, 1960.

Leshchinskii, S.V., Maschenko, E.N., Ponomareva, E.A., et al., Complex paleontological and stratigraphical studies of the Lugovskoe locality (2002–2004), *Arkheol. Etnogr. Antropol. Evraz.,* 2006, vol. 25, no. 1, pp. 54–69.

Mel'nikov, V.P. and Spesivtsev, V.I., *Kriogennye obrazovaniya v litosfere Zemli* (Cryogenic Formations in the Lithosphere of the Earth), Novosibirsk: Sib. Otd. Ross. Akad. Nauk, 2000.

Nikolsky, G.V., *Chastnaya ikhtiologiya* (Special Ichthyology), Moscow: Vyssh. Shkola, 1971.

Pavlov, P., Svendsen, J.I., and Indrelid, S., Human presence in the European Arctic nearly 40000 years ago, *Nature*, 2001, vol. 413, pp. 64–67.

Sabaneev, L.P., *Zhizn' i lovlya presnovodnykh ryb* (Life of Freshwater Fishes and Fishing), 4th ed., Kiev, 1970.

Svendsen, J.I., Alexanderson, H., Astakhov, V.I., et al., Late Quaternary ice sheet history of northeastern Eurasia, *Quater. Sci. Rev.*, 2004, vol. 23, pp. 1229–1271.

Sytchevskaya, E.K., Fossil Esocidae of the USSR and Mongolia, *Tr. Paleontol. Inst.*, 1976, vol. 156, pp. 1–116.

Sytchevskaya, E.K., A Freshwater ichthyofauna from the Neogene of Mongolia, *Tr. Sovm. Sovet.–Mongol. Paleontol. Eksped.*, 1989, vol. 39, pp. 1–144.

Tsepkin, E.A., Fish remains from excavations at the ancient Kremlin and Zaryad'e, *Mater. Issled. Arkheol. SSSR*, 1971, vol. 167 (Antiquities of the Moscow Kremlin), pp. 186–192.

Volkov, I.A., Volkova, V.S., and Zadkova, I.I., *Pokrovnye lessovidnye otlozheniya i paleogeografiya yugo-zapada Zapadnoi Sibiri v pliotsen-chetvertichnoe vremya* (Covering Loesslike Deposits and Paleogeography of the southwest of Western Siberia in the Pliocene–Quaternary Tim), Novosibirsk: Nauka, 1969.

Volkova, V.S., Arkhipov, S.A., Babushkin, A.E., et al., *Kainozoi Zapadnoi Sibiri* (Cenozoic of Western Siberia), Novosibirsk: GEO, 2003.

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