Hooked Mako *Isurus planus* (Agassiz, 1856) from the Miocene of Sakhalin

Крючкозубый мако *Isurus planus* (Agassiz, 1856) из миоцена Сахалина

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An isolated upper lateral shark tooth from the Middle-Late Miocene Kurasiiskaya Formation, Sakhalin Island, Russia, is identified as an *Isurus planus* (Agassiz, 1856). This is the first record of hooked mako for Russia, and the northernmost finding of this fossil shark.

Сообщается о находке верхнего бокового зуба крючкозубого мако *Isurus planus* (Agassiz, 1856) в отложениях среднего-позднего миоцена острова Сахалин (курасийская свита). Это первая находка данного вымершего вида в России и наиболее северная точка его обнаружения.

Key words: Miocene, Sakhalin, fossil sharks, *Isurus planus*

Ключевые слова: миоцен, Сахалин, ископаемые акулы, *Isurus planus*

INTRODUCTION

Finding of ancient chondrichthians including selachians are uncommon fossils in the Paleogene and Neogene strata of the Far East of Russia. Teeth of fossil sharks in this territory are found on rare occasions. The number of the shark's remains, which have been collected from each known locality, doesn't exceed one tooth. That's why any new data on the Tertiary sharks from this wide territory are of special importance. During the field season in 2013 one lateral tooth of lamnid shark was collected in the Middle-Late Miocene deposits of southwestern Sakhalin Island. Below, this finding is described in details.

LOCALITY, MATERIAL AND METHODS

The fossil tooth was found on a coastal cliff of the Tatar Strait (47°52′9.48′′N 142°05′44.34′′E) located about five kilometers south from the settlement of Penzenskoye and about two kilometers north from the mouth of the Cherepok River (Tomari District, Sakhalin Province).

The cliff exposed clayish aleurolites and siliceous soapstones with layers of sandstones and diatomites. These beds belong to Kurasiiskaya Formation which are common along the southwestern coast of the Sakhalin Island in the Tomari District (Savitskyi, 1982). The deposits of this formation contain rich complexes of bivalves, foraminifers, and mesopelagic and neritic teleosteans. Based on the analysis of fossil bivalves and foraminifers, a conclusion was made that these fossiliferous beds were formed in comparatively deep marine environments in the Middle-Late Miocene (Savitskyi, 1982; Zhidkova, 1986; Gladenkov et al., 2002). The beds of this formation were deposited during the largest Cenozoic sea transgression in the Far East of Russia (Gladenkov et al., 2002).

Tooth preparation was made by needles under binocular microscope. Measurements follow Glickman (1964: 47, fig. 24) to facilitate comparison; the tooth proportions follow Shimada (2005). Maximum tooth height was calculated using a tooth imprint. The material is deposited in the fish collection of the Zoological Institute of Russian Academy of Sciences, St Petersburg (ZIN).

SYSTEMATIC PART

Order **LAMNIFORMES** Berg, 1958

Family **LAMNIDAE** Bonaparte, 1837

Genus ***Isurus*** Rafinesque, 1810

Isurus planus (Agassiz, 1856)
(Fig. 1)

Material. ZIN 55411, left upper lateral tooth. Coastal cliff of Tatar Strait about five kilometers south of the settlement of Penzenskoye, Tomari District, Sakhalin Province, **Russia**; Kurasiiskaya Formation, Middle-Late Miocene; coll. M.V. Nazarkin, Aug. 2013.

Description. The tooth with a single cusp; lateral cusplets are absent (Fig. 1). There are enameloid shoulders instead of cusplets on each side of the cusp which somewhat hangs over the root branches. The crown is wide, triangular and flattened labiolingually, considerably inclined distally. The medial edge of the crown is convex; the distal edge is mostly straight, but considerably concave at the crown base. The enameloid is completely smooth, without ornamentation. The labial crown surface is nearly flat; the lingual surface is slightly convex. The labial crown surface with a shallow concavity from the base of the crown to about two-third of its height. The cutting edges are complete, without serration, and almost reach the root. The tooth neck is very thin. The root is massive, wide and flat; without any protuberance. Root edges are roundish, slightly extend out of the crown margins. The root branches are merged and poorly divided by a small depression; distal branch is 1.2 times wider than the medial one. The nutritive groove is absent; there are eight small nutritive foramina, most of them being concentrated at the central part of the root.

Measurements (in mm): maximum tooth height 41.6; maximum tooth thickness (wr in Glikman, 1964) 34.2; lingual crown height (hcr) 30.6; crown thickness at base (wcr1) 33.0; crown thickness (dcr) 8.8; neck height (hz) 1.5; root thickness (dr) 9.9; root height (hr) 14.0. The crown acuteness 0.86; the tooth inclination 1.58; the crown height/ basal crown width ratio 0.94.

DISCUSSION

Species identification. This fossil tooth possesses smooth cutting edges, smooth labial and lingual coronal faces, lacks lateral cusplets; its central foramen does not open into a well-defined transverse groove; root lobes are not round and not extending noticeably beyond the basal limit of the crown. These characters clearly indicate that the tooth belongs to a shark of the genus *Isurus* (for *Isurus*, see Cappetta, 1987; Pardy et al., 2001; Pardy, 2006). Within the genus, the fossil tooth is very similar to a lateral teeth of *hastalis / planus* species group because of its triangular shape, the wide and totally labiolingually flattened crown, and the comparatively large size. Finally, the root apexes of the tooth are round and the crown is considerably inclined distally. These features are more characteristic of *I. planus* rather than *I. hastalis* which possesses square root apexes and a straighter crown (Kuga, 1985; Karasawa, 1989). This fossil tooth most probably represents an upper lateral tooth because, in *Isurus* species, the depression between the root branches is usually smaller in an upper lateral tooth than in a lower lateral tooth.

Geographic and stratigraphic distribution. Two recent species of the genus *Isurus* are widely distributed in temperate and tropical waters of the World (Compagno, 1984; 2002). Fossil records of mako sharks are known starting from the Early Paleocene of Mexico (Gonzalez-Rodriguez et al., 2013).

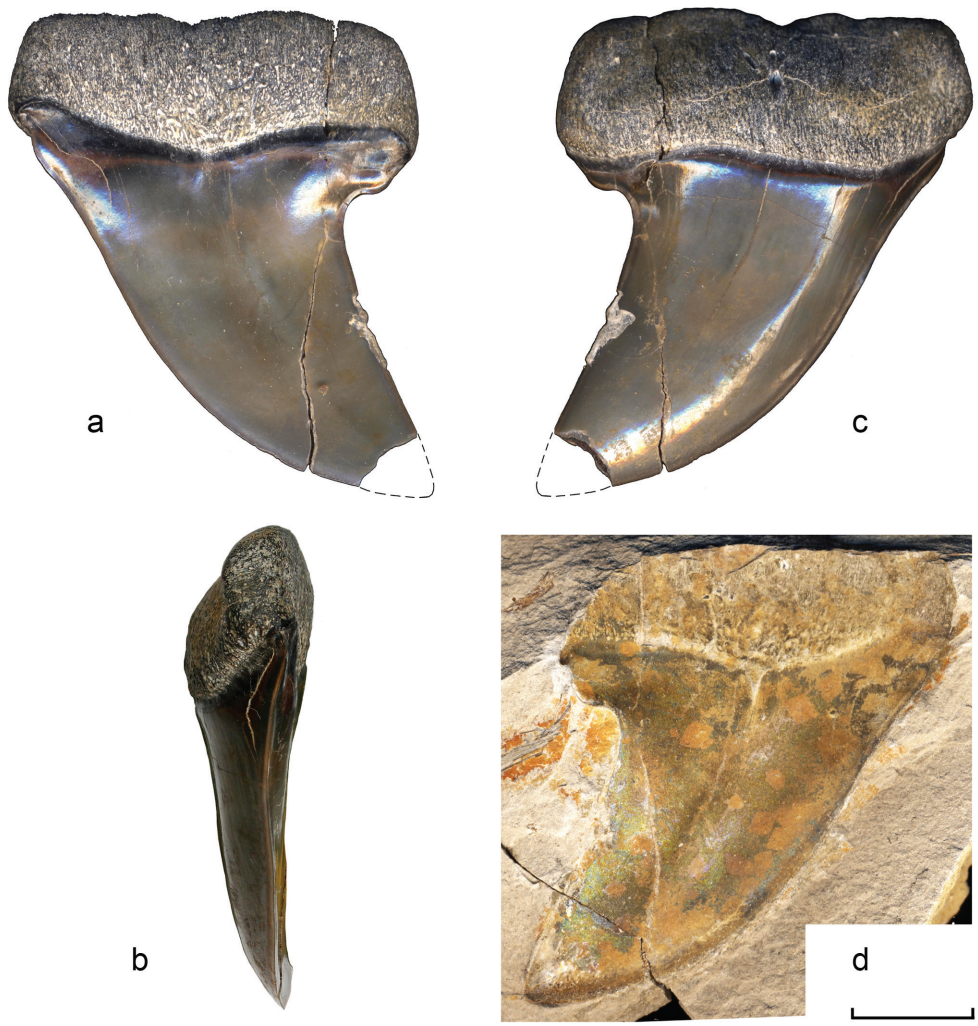

Fig. 1. *Isurus planus*, ZIN 55411: labial **(a)**, mesial **(b)** and lingual **(c)** views, **(d)** – an imprint of the labial tooth side. Scale bar: 10 mm.

This group apparently reached the greatest species variety during the Middle Miocene. In the deposits of that time of the Pacific Rim six species of *Isurus* in Japan (Kuga, 1985; Yabumoto & Uyeno, 1994) and five species in Mexico (Gonzalez-Rodriguez et al., 2013) were found. Unlike other fossil species of this genus, which were cosmopolitan, distribution of *I. planus* was apparently limited by the Pacific Ocean (Kuga, 1985). For the present, it has been known since the Late Oligocene until the Middle Miocene of Australia (Kemp, 1991), and from the Middle to Late Miocene of California (USA) (Agassiz, 1856; Jordan & Hannibal, 1923), Mexico (Gonzalez-Rodriguez et al., 2013) and Japan (Karasawa, 1989; Kuga, 1985; Yabumoto & Uyeno, 1994; Takakuwa et al., 2009). This species is one of the common fossil sharks in Japan (Kuga, 1985) but it was thus recorded for the first time in Russia. This finding from the Sakhalin represents the northernmost known locality of occurrence of *I. planus*.

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