The first reliable record of selachians from the Neogene deposits of Sakhalin Island

Первая достоверная находка селахий из неогеновых отложений острова Сахалин

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An isolated upper anterior shark tooth from the Early Miocene Holmsk Formation, Sakhalin Island, Russia, is identified as an *Alopias* close to extant *Alopias superciliosus* Lowe, 1841. This is the first reliable record of a fossil shark from the Sakhalin Neogene, and the most northern finding of a fossil thresher shark in Eastern Asia.

Сообщается о находке верхнего переднего зуба акулы-лисицы близкого современному виду *Alopias superciliosus* Lowe, 1841 в раннемиоценовых отложениях холмской свиты острова Сахалин. Это ископаемое является первой достоверной находкой остатков акул в неогене Сахалина, а также наиболее северной находкой ископаемых представителей этого рода в восточной Азии.

Key words: fossil sharks, Miocene, Sakhalin, Alopias

Ключевые слова: ископаемые акулы, миоцен, Сахалин, Alopias

INTRODUCTION

The remains of selachians (mainly isolated teeth, spines and vertebrae) are common fossils in the deposits of different age in all continents, including Antarctica (Glikman, 1967, 1980; Cappetta, 1987; Cione & Reguero, 1994; and many others). In the Eastern Asia, rich complexes of fossil selachians are known from the Mesozoic and Cenozoic beds of the Japanese archipelago (Yabumoto & Uyeno, 1994). In contrast, reliable findings of fossil selachians on the adjacent Sakhalin Island in particular, and in the Far East of Russia in general, are scare. Occasional findings of Sakhalin Mesozoic shark teeth include Hybodontidae and Polyacrodontidae from the Triassic deposits, and Ptychodus Agassiz, 1839 from the Late Cretaceous deposits (Glickman, 1980). The only finding of tooth of the extinct Neogene shark *Isurus hastalis* (Agassiz, 1838) on Sakhalin Island is from the Late Miocene beds of Sertunaisk Formation at northwest coast of the island (Kuzina & Ratnovsky, 1970; Zhidkova et al., 1974).

As a result of recent research in the Holmsk Formation of Sakhalin Island a single tooth of an alopiid shark has been found. Since the specimen from the Sertunaisk Formation appear to be lost, and no detailed description or reasons for it identification are available, the tooth from the Holmsk Formation represents the first reliable record of selachians in the Neogene deposits of the Sakhalin. This paper describes the discovered specimen in detail.

LOCALITY, MATERIAL AND METHODS

The fossil tooth was found on a coastal cliff of the Tatar Strait located about one kilometer south from the settlement of Nevodskove and three kilometers north from the town of Tomari (47°47.921'N 142°04.602'E). The cliff exposed clayish aleurolites of the Holmsk Formation which are common along the southwestern coast of the Sakhalin in the Holmsk and Tomari districts. Based on the analysis of fossil bivalves a conclusion was made that these fossiliferous beds were formed in comparatively deep marine environments in the first half of the Early Miocene (Zhidkova, 1982, 1986). The coaled pieces of wood, the numerous rests of bivalves and gastropods, the bones of cetaceans and disarticulated fish skeletons belonging to Clupeidae, Stomiidae, Macrouridae, Gasterosteidae and Alepisauroidei were also found in the same layers together with the fossil shark tooth. The presence of deep-water taxa of teleosts confirms a deep water origin of these beds.

The tooth measurements follow Glickman (1964: 47, fig. 24) to facilitate comparisons. The tooth proportions follow Shimada (2002, 2005). The photographs were obtained with computer programmes LAS EZ and COMBINE ZM.

SYSTEMATIC PART

Order LAMNIFORMES Berg, 1958

Family ALOPIIDAE Bonaparte, 1838

Genus Alopias Rafinesque, 1810

Alopias cf. superciliosus (Fig. 1)

Material. ZIN 54979. A right upper anterior tooth. The coastal cliff of Tatar Strait about one kilometer south of the settlement of Nevodskoye, Tomari District, Sakhalin Province, **Russia**; Holmsk Formation, Early Miocene; coll. M.V. Nazarkin, Sept. 2011.

Description. The tooth has a single cusp; lateral cusplets are absent (Fig. 1). There are enameloid shoulders instead the cusplets on each side of the cusp that hangs over the root branches. The crown is conical. awl-like, with a considerable distal inclination and a well pronounced S-shaped curvature in the lateral view. The enameloid is completely smooth, without ornamentation. The labial crown surface is slightly inflated, the lingual one is convex. The cutting edges are not serrated, slightly extending onto the labial surface near the half of tooth high. It is interrupted so that is not in the lower third of the crown. After a break, the cutting edges are continued in the form of sharp crests on the shoulders. The mesial edge is longer than the distal one. The tooth neck is thin. The root has a rather high protuberance which is not bulge and gradually expands laterally. The nutritive grooves are absent: the main double foramen is not large. The root branches are quite thick and short, roundish, with an obtuse angle between them. Basal contour of the tooth is arch-shaped. The mesial branch of the root is longer than the distal one.

Measurements (in mm): maximum tooth height 16.3; maximum tooth thickness (wr in Glikman, 1964) 10.0; lingual crown height (hcr) 10.3; crown thickness at base (wcr1) 8.3; crown thickness (dcr) 3.3; neck height (hz) 0.5; root thickness (dr) 4.9; root height (hr) 3.4. The crown acuteness 2.43; the tooth inclination 1.10; the crown height/ basal crown width ratio 1.61.

DISCUSSION

Identification of the tooth position. Most of recent and fossil lamniform sharks are characterised by the heterodont type of the dentition (Purdy et al., 2001; Compagno, 2002; Shimada, 2002, 2005). The following characters allow identification of the described tooth as an anterior one: a narrow awl-like cusp, slightly flattened ellipse in the crown cross section and convex lingual surface of the crown. Apparently, this

Fig. 1. Alopias cf. superciliosus, ZIN 54979: labial (a), lateral (b) and lingual (c) views. Scale bar: 10 mm.

tooth was from the upper jaw, as thresher's anterior lower jaw teeth are more short and wide, with poorly expressed labio-lingval Sshaped inflexion of the crown. The inclination of the crown indicates that the tooth was on the right side of the jaw.

Species and sex identification. The fossil tooth was identified as an *Alopias* because it has the following principal characteristics of anterior teeth of this genus: a smooth awllike crown with not notched, incomplete cutting edges; the lack of lateral cusplets; oval cross section of the crown; nutritive groove is absent; the root is not massive; the root lobes are roundish and forms the U-shaped curvature basally (Gruber & Compagno, 1982; Cappetta, 1987; Purdy et al, 2001; Shimada, 2002, 2005; Purdy, 2006). Among the known neogene and recent alopiid species only bigeye thresher *A. superciliosus* has such an elongated crown of anterior teeth (Bass et al., 1975; Shimada, 2005). The dental systems of this species possess the sexual dimorphism, where the teeth of males are considerably higher, thinner and have more flexed crowns than one of females (Bass et al, 1975; Gruber & Compagno, 1982). Thus, we identify this fossil tooth as belonging to a male of an *Alopias* close or identical to *A. superciliosus*.

Geographic and stratigraphic distribution. A recent thresher belongs to the monogeneric family, comprising only 3 or 4 species worldwide (Bass et al, 1975; Compagno, 1984, 2002). They are strongswimming, pelagic, coastal and deep-water sharks, distributed worldwide in the temperate and tropical waters. In the Eastern Asia, the threshers are found no further to the north than 35 degree of latitude on the pacific side of Japan. Alopias vulpinus is the sole species of recent threshers inhabiting the Sea of Japan, where it meets only in the southern part. Recent A. superciliosus is comparatively deep-water species with the ranges from the surface to at least 500 m deep, but mostly below 100 m depth (Compagno, 2002; Yoshino & Aonuma, 2002). Thus, this fossil tooth was found about 12 degree of latitude to the north from the recent species distribution area.

In fossil record this species has been identified from the Early Miocene deposits of North America; Middle Miocene of Italy, Portugal, France, North America and Japan; and from Pliocene deposits of Italy (Cappetta, 1987; Yabumoto & Uyeno, 1994; Purdy et al., 2001). Before this study the northernmost fossils of this species in the Neogene of the Eastern Asia were found on Honshu Island at about 36-37° latitude (Yabumoto & Uyeno, 1994). The new record from the Cholmsk Formation extends the geographic distribution of this species. Discovering of this warm-water shark can be the sign of warmer sea environment on Sakhalin during an Early Miocene than at the present time.

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