Fossil mackerel (Actinopterygii: Scombridae: *Scomber*) from the Neogene of South-Western Sakhalin, Russia

Ископаемая скумбрия (Actinopterygii: Scombridae: *Scomber*) из неогена юго-западного Сахалина

M.V. Nazarkin* & A.F. Bannikov

М.В. Назаркин, А.Ф. Банников

*M.V. Nazarkin, Zoological Institute, Russian Academy of Sciences, 1 Universitetskaya Emb., St Petersburg 199034, Russia. E-mail: m_nazarkin@mail.ru. *Corresponding author*

A.F. Bannikov, Borisyak Paleontological Institute, Russian Academy of Sciences, 123 Profsoyuznaya St, Moscow 117997, Russia. E-mail: aban@paleo.ru

The caudal part of a skeleton of mackerel *Scomber* sp. in the deposits of the *Kurasi Formation* of Middle-Upper Miocene of south-western Sakhalin Island is reported. It is the first finding of a fossil representative of the suborder Scombroidei in the Far East of Russia. The genus *Scomber* comprises 4 recent and about 10 fossil species from Oligocene to Pliocene of Europe, North America (California) and East Asia (Japan). Preservation of the material studied was not good enough to allow a detailed comparison of the Sakhalin mackerel with known both recent and extinct species of the genus.

Сообщается о находке задней части скелета скумбрии *Scomber* sp. в отложениях среднего-позднего миоцена курасийской свиты юго-западного Сахалина. Это первая находка ископаемых представителей подотряда Scombroidei на Дальнем Востоке России. В состав рода *Scomber* входит 4 современных и около 10 ископаемых видов из олигоцена-плиоцена Европы, Северной Америки (Калифорния) и Азии (Япония). Недостаточная сохранность исследованного материала не позволяет провести детальное сравнение сахалинской скумбрии с известными современными и вымершими видами этого рода.

Key words: fossil fish, Miocene, Sakhalin, Scombridae, *Scomber*

Ключевые слова: ископаемые рыбы, миоцен, Сахалин, Scombridae, *Scomber*

INTRODUCTION

The richest assemblage of deep-water fishes from the Neogene in the Far East of Russia comes from Middle to Upper Miocene beds of the Kurasi Formation of the Sakhalin Island. Remains known from these deposits represent 21 species from 20 genera and 17 families of fishes of 11 orders. They consist mainly of deep-water fishes characteristic of meso- and bathypelagic waters such as myctophids, stomiiforms, deep-water eels, and deep-sea smelts. Remains of representatives of other ecological groups in this ancient assemblage are not so often found and all together make less than a quarter of fossils collected by us. Among them, nerito-pelagic fishes, mainly clupeids, predominate. One more representative of neritic group is scombrids. Their remains are rare and are usually too fragmentary for identification below the family level. However, one recently found partial skeleton allows definitive identification as a representative of the genus *Scomber* Linnaeus, 1758. This is the first record of a fossil scombroid in the Far East Russia.

MATERIAL AND LOCALITY

A single partial skeleton of the caudal region of a fish with its counterpart was found on a coastal cliff of the Tartar Strait (47°52′9.48′′N; 142°05′44.34′′E) located about five kilometres south from the settlement of Penzenskoye and about two kilometres 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 the Kurasi Formation which is common along the south-western coast of the Sakhalin Island in the Tomari District (Savitskyi, 1982). The visible thickness of this formation in outcrops in this area reaches 1700 m. Deposits of this formation contain rich assemblages 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 environment 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).

The studied specimen is deposited in the main ichthyological collection of the Zoological Institute of Russian Academy of Sciences, St Petersburg, Russia (ZIN).

RESULTS

Order **PERCIFORMES**

Family **SCOMBRIDAE**

Genus ***Scomber*** Linnaeus, 1758

Scomber sp.
(Fig. 1)

Material. ZIN 55478, part and counterpart of the caudal region. Coastal cliff of Tartar Strait, 47°52′9.48′′N; 142°05′44.34′′E, about five kilometres south of Penzenskoye, Tomari District, Sakhalin Province, **Russia**; Kurasi Formation, Middle-Upper Miocene; coll. M.V. Nazarkin, Aug. 2013.

Description. An incomplete caudal portion of the skeleton including the second dorsal fin, caudal fin, and 12 posteriormost vertebrae. The length of the preserved part to the edge of hypurals is 86.0 mm, and its maximum depth is 34.5 mm. Accordingly, the standard length of this fish, estimated by proportions of the recent *S. japonicus* Houttuyn, 1782, was about 290 mm. Most of elements are in natural position and articulated. The series of the anal finlets, as well as most of the posterior dorsal finlets, underwent some post mortem displacement. In addition, the last dorsal finlet is disarticulated.

Axial skeleton. Twelve posteriormost caudal vertebrae are preserved, as well as distal portions of the neural spines of two preceding vertebrae. Based on the position of the second dorsal fin in relation to the anterior preserved neural spine, the total number of the caudal vertebrae was most probably not more than 16. Since a diagnostic feature of the genus *Scomber* is a total of 31 vertebrae (e.g. Collette & Nauen, 1983; Bannikov, 1985; Monsch & Bannikov, 2012), it could be assumed that the total number was 15 + 16 vertebrae in this Miocene specimen. Vertebral centra are robust, longer than deep and have strong anterior dorsal and ventral zygapophyses in anterior half of the specimen. The centra are constricted in the middle and bear longitudinal lateral ridges. The haemal spines are relatively short and slender, arising from the anterior half of the centrum obliquely posterodorsally in anterior five of the preserved vertebrae. The angle of the posterodorsal inclination becomes more acute in the succeeding vertebrae, in which the haemal spines arise from the posterior half of the centrum. The neural spines are also relatively short and slender. Those of the anterior five of the preserved vertebrae arise from the middle of the centrum, whereas in the succeeding vertebrae the neural spines arise from the posterior half of the centrum.

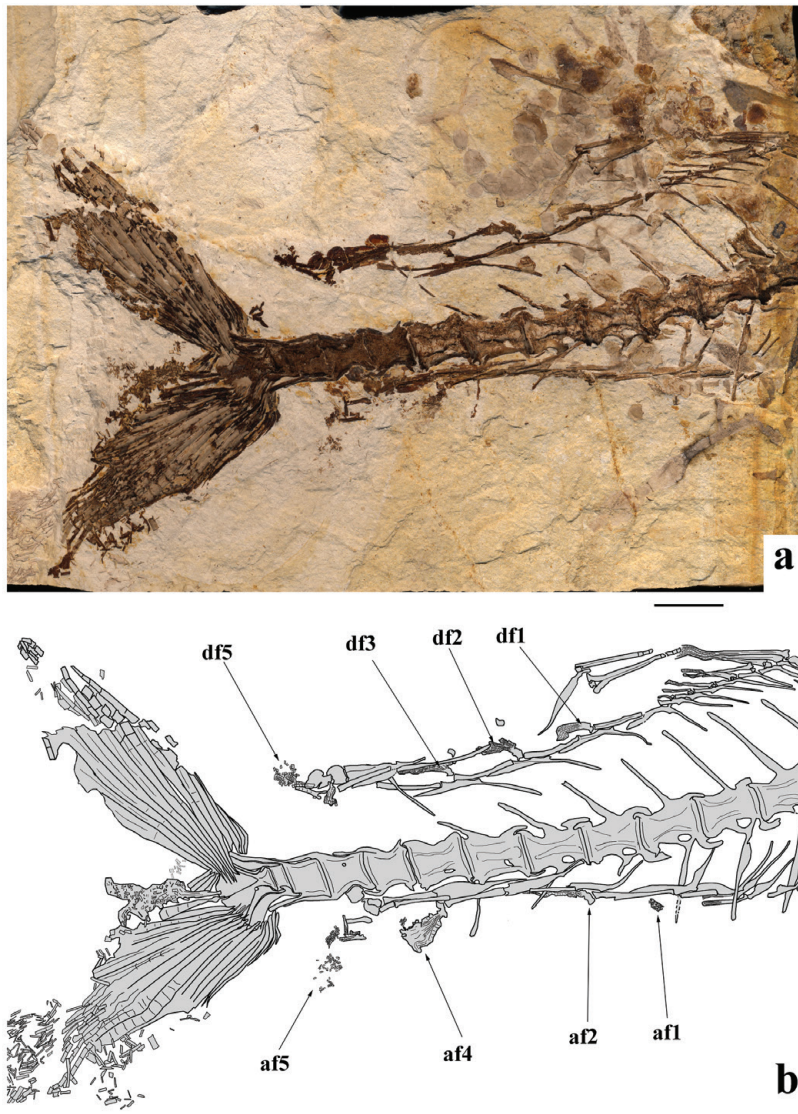

Fig. 1. *Scomber* sp.: photograph **(a)** and outline drawing **(b)** of specimen ZIN 55478 Abbreviations: af, anal finlet; df, dorsal finlet. Scale bar: 10 mm.

In the caudal peduncle, the vertebral spines are directed backward and cover the succeeding centra from both above and below. The anterior five of the preserved vertebrae exhibit distinct *foramina inferiora* at the base of the haemal spines.

Unpaired fins. The second dorsal fin is incomplete and relatively poorly preserved. Eight pterygiophores and 8 segmented and branched rays remained in caudal part of the fin are in their natural position. Two more segmented rays and one pterygiophore are visible separately above the imprint. Distal portions of most of the rays (and whole last ray) are missing. The last dorsal-fin ray is situated above the anterior portion of the 22th (restored) vertebra (i.e., slightly posterior to the attachment of the

last anal-fin ray). The dorsal-fin pterygiophores are slender and relatively strongly inclined posteriorly; these obviously decrease in length posteriorly in the series. There are five pterygiophores of the dorsal finlets. Four anterior pterygiophores form a sequential series, whereas the last one is displaced upwards and turned upside-down. Each pterygiophore consists of a long and curved proximal radial and an elongate rod-like middle radial. There is an additional rudimentary pterygiophore under the last dorsal pterygiophore (according to Nauen & Lauder (2000), the last finlet of *Scomber* is composed of the fifth and sixth finlets). The proximal end of the first pterygiophore of the dorsal finlet is situated between the haemal spines of the 20th and 21th (restored) vertebrae. The succeeding pterygiophores correspond one-to-one to the interneural spaces. Only four dorsal finlets are preserved (the fourth finlet is missing).

The anal fin is only represented by two last rays and four finlets. The last anal-fin ray is situated under the 21th (restored) vertebra. The pterygiophores of the anal finlets are relatively well preserved, whereas the finlets themselves are mostly destroyed and the third finlet is missing. Each pterygiophore consists of a long and curved proximal radial and an elongate rod-like middle radial. A small hook-like bone at the base of the fourth anal finlet probably represents an ossified distal radial.

Caudal fin and skeleton. The second preural centrum (PU2) is the shortest. The terminal vertebra is composed of the fusion of first preural and first and second ural centra (PU1+U1+U2). The hypurals seem to be fused into two plates connected with the terminal centrum, whereas the parhypural is free. The neural spine of PU2 is almost entirely missing. The neural spine of PU3 is stronger than that of the preceding vertebra. The haemal spine of PU2 appears to be free. As can be seen by imprints in the matrix, there were two epurals. The uroneurals seem to be fused with the urostyle. The caudal fin is relatively small and forked; distal ends of most of its rays are missing. There are 17 principal rays in the caudal fin, 15 of which are branched. Hypurostegy, the anterior extension of principal caudal fin ray bases to cover each side of the hypural plate, is observed. There are about seven procurrent rays both above and below.

Squamation. Scales are only poorly preserved. Imprints of a few relatively small cycloid scales with diameter of 2–3 mm can be distinguished near the specimen.

DISCUSSION

A deeply forked caudal fin with hypurostegy (bases of caudal-fin rays deeply overlapping the hypural plate) , presence of dorsal and anal finlets, and well-developed zygapophyses of the caudal centra are diagnostic characters of Scombridae. The relatively low counts of finlets and vertebrae as well as the structure of the caudal fin, namely the upper and the lower hypural plates separated, gave reasons to identify the specimen as a member of the subfamily Scombrinae. Unlike the fossil specimen, a Recent scombrin, *Grammatorcynus* Gill, 1862, has more numerous finlets (6–7 vs. 5), whereas *Rastrelliger* Jordan et Starks, 1908 has a deeper body. Therefore, the Miocene specimen can be attributed to the genus *Scomber*. This genus is represented by four extant species (Collette, 1999) and about ten recognisable Oligocene–Pliocene species (Bannikov, 2010). Most of fossil species were described from Europe: the Oligocene *S. voitestii* Paucă, 1929 from the Carpathians and *S. cubanicus* Daniltshenko, 1960 from the Caucasus; Miocene *S. gnarus* Bannikov, 1979 from the Caucasus and Crimea, *S. antiquus* Heckel in Heckel et Kner, 1861 from Italy, *S. susedanus* Steindachner, 1860 and *S. priscus* Kramberger, 1882 from Croatia and Serbia; Pliocene *S. calabrensis* Landini et Bannikov, 1983 from Italy. The Oligocene *S. saadii* Arambourg, 1967 from Iran also belongs to the Tethyan region. Only few fossil species of *Scomber* are known from the Pacific Province. The "Tertiary" (Miocene?) *S.*

nomurai Niino, 1951 was described from the Gunma Prefecture of Japan (Niino, 1951). Finally, *S. sanctaemonicae* (Jordan, 1919) was described from the Upper Miocene of California, USA (Jordan, 1919; 1921; David, 1943; Fierstine et al., 2012).

One more fossil mackerel was reported from the Middle Miocene of the Aichi Prefecture of Japan. This species was illustrated and briefly described as *Scomber* sp. and as *Scomber chitaensis,* new species, in one and the same publication by Ohe (1993), while a detailed description of this form is still absent. Lack of more detailed information about this Japanese mackerel makes it difficult to compare the latter to the Sakhalin specimen. Specifically, such critically important character as the number of the second dorsal-fin rays is unknown for the moment in the mackerel from the Aichi Prefecture. Another one Japanese fossil mackerel *Scomber* sp. is known from the Miocene Bessho Formation in Nagano Prefecture (Ohe, Koike, 1998) but its detailed description is still absent.

The Miocene specimen from Sakhalin does not differ greatly from the hitherto known species of *Scomber*; it is too fragmentary for the detailed comparison with other known species. Therefore, until a better preserved specimen becomes available, we prefer to regard the Sakhalinian specimen as *Scomber* sp.

An extant representative of the genus in the Sea of Japan, *S. japonicus,* is a comparatively warm-water species. It is distributed along the Asian coast of the Pacific Ocean up to Southern Kamchatka where it is rarely recorded (Sheiko & Fedorov, 2000). Catches of this species in the northern Sea of Japan, in Tartar Strait and Primorye, are noted during summer only (Novikov et al., 2002).

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