Squaliform shark teeth of the genus *Centroscymnus* from the Miocene of Japan

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Abstract: Newly found fossil shark teeth of a sleeper shark are described. This is probably an undescribed species of the genus *Centroscymnus* belonging to the Family Somniosidae. These fossil teeth were discovered from the Middle Miocene Iseyama Formation (Northern Fossa Magna Region), Ueda City, Nagano Prefecture, central Japan. These teeth indicate the shape of a part of a symphysial tooth row, which belong to a left side of parasymphysial teeth and a left first anterior tooth. Judging from the main characters of a parasymphysial tooth, such as distal and mesial blades presented both joining in a notch, it is considered that the tooth differs from teeth of the genus *Centroscymnus*. This fossil is identified as the genus *Centroscymnus* sp.. This paper constitutes the first fossil record of the genus *Centroscymnus* from the Miocene of Japan.

Key words: *Centroscymnus*, Somniosidae, Middle Miocene, Iseyama Formation, Northern Fossa Magna Region, Nagano Prefecture, symphysial tooth row.

Introduction

The purpose of this study is to report newly found fossil shark teeth of the sleeper shark of the genus *Centroscymnus* from the Miocene of Japan. These specimens (GNSTKU-PV0010a-b) are well preserved which belong to a symphysial tooth row, a left side of parasymphysial teeth and a left side first anterior tooth, which are useful to be classified into the genus of the Family Somniosidae. Sleeper sharks are classified into eighteen deep-water benthic and oceanic species in seven genera: *Centroscymnus, Centroscymnus, Proscymnodon, Scymnodelatias, Scymnodelodon, Somniosus* and *Zameus* (Compagno et al., 2005). Formerly, the genus *Centroscymnus* are classified into three species, *C.coelolepis, C.pustoni* and *C.crepidater*, on the basis of external characteristic differences. However, *Centroscymnus crepidater* differs markedly in its tooth morphology from other species, *C.crepidater* was moved to the genus *Centroscymnus* (Garman, 1913). The present author named them as *Centroscymnus crepidater* (Garman, 1913). This is the first fossil record of the genus *Centroscymnus* from Japan.

Geological setting

Tertiary sedimentary rocks which consist of Early to Middle Miocene marine deposits, are distributed in the middle part of Ueda City, Nagano Prefecture, central Japan (Fig. 1). Geologic sections of this area are lithologically subdivided into following formations in ascending order: the Oomineyama, Tarouyama, Yokoo and Iseyama Formations (Yamagishi, 1964). The northern part of Ueda City, Yokoo and Motohara area strata, are divided into Yokoo and Iseyama Formations which are correlated to the upper part of Uchimura and Bessho Formations (Yamagishi, 1964). The northern part of Ueda City, Yokoo and Motohara area strata, are divided into Yokoo and Iseyama Formations which are correlated to the upper part of Uchimura and Bessho Formations (Yamagishi, 1964, Kosaka et al., 1992). The upper part of the Uchimura Formation and the lower part of the Bessho Formation biostratigraphically correspond to Zone N8 to N9 of Tertiary planktonic foraminiferan fossil zone of Middle Miocene in age (Blow, 1969, ...
Kosaka et al., 1992. And planktonic foraminiferal fossil, *Globigerinoides sicanus* and *Praeorbulina circularis*, occurred in the upper part of the Yokoo Formation, which correspond to Zone N8 to N9 (Kubota and Kosaka, 1990). This means that the boundary of the Yokoo and Iseyama Formations Middle corresponds to Miocene. As this setting is supported, it is considered that the fossil horizon was deposited in the period about 15 Ma.

The lower part of the Iseyama Formation is mainly composed of mudstone-rich alternation and laminated mudstone (Suzuki, 2005a). The fossil teeth of the sleeper shark reported in this paper was discovered from outcrop at the riverside of Kangawa-River in Motohara area, Sanada machi, Ueda City, Nagano Prefecture. (Figs. 1, 2, 3). This fossil locality corresponds with the lower part of the Iseyama Formation, which is situated between Yokoo and Iseyama Formations. This fossil horizon strata consist of parallel laminated mudstone with well-sorted thin sandstone layer, which include many other fossils, *Gennou-ishi*, calcareous nodule, and pyrite grain. Main associated fossils which indicate the paleoenvironment, are as follows: *Acharax tokunagai* (Yokoyama; Suzuki, 2005b, 2007b), *Mizuhobalis izumensis* (Yokoyama; Suzuki, 2005b, 2007b), *Ophiostichidae* (Echinodermata: Ophiuroidea), *Alepisaurus* sp. (Suzuki, 2008), and many fishes (Suzuki, 2005a, b, 2007a, b, 2008).

**Systematic description**

Class Chondrichthyes Huxley, 1880
Subclass Elasmobranchii Bonaparte, 1838
Order Squaliformes Goodrich, 1888
Family Somniosidae Jordan, 1888
Genus *Centroselachus* Garman, 1913

*Centroselachus* sp.

(Fig. 5.a., 5.b)

**Specimens.** -GNSTKU (Graduate School of Natural Science and Technology, Kanazawa University) -PV0010a-b.

**Locality.** -Kangawa-River in Motohara area.

**Horizon.** -The lower part of the Iseyama Formation (after Yamagishi, 1964).

**Remarks.** -Dental terminology is summarized by Kuga and Goto (1980), Herman et al. (1989), and Adnet and Cappetta (2001), whose terminology is widely accepted, is shown in Fig. 4. The classification is referred to Herman et al. (1989), Compagno et al. (2005) and Cappetta (2006).

According to Herman et al. (1989: 119-121), the genus *Centroselachus* belongs to the Family Somniosidae Jordan, 1888, and is described as follows: “This genus has markedly dignathic heterodony. The lower teeth are strongly compressed and have a triangular principal cusp. The cusp slightly inclined distally. The mesial cutting edge is sigmoidal. The distal cutting edge tends to be almost vertical and joins the distal heel in a notch. Both cutting edges are smooth. The crown and root are labiolingually flattened but the labial face of the crown is weakly convex. A short quadrangular apron is present. The apron is not over-hanging the root but forms one part with it. The labial face of the root shows numerous foramina, mainly surrounding the apron. The basal notch is situated in the central root end. The tooth is twice as high as its base width. The parasymphysial teeth are present. The tooth has a triangular principal cusp. The cusp erects and has distinct distal and mesial blades both joining in a notch. Other lower teeth are lacking a mesial blade. The basal notch is situated in the central root end. The crown is as high as the crown base width.”
Description. -This fossil is a symphysial tooth row which consists of a left side of parasympyphysial teeth and left first anterior tooth.

The left anterior tooth is strongly compressed and has a triangular principal cusp. The cusp slightly inclined distally. The mesial cutting edge is sigmoidal and the distal cutting edge tends to be almost vertical and joins the distal heel in a notch. Both cutting edges are smooth. The crown and root are labiolingually flattened but the labial face of the crown is slightly convex. A narrow vertically elongated apron is present reaching the central root end. The labial face of the root shows numerous foramina which are mainly surrounding below the apron. The large upper mesial and distal foramina are present. The basal notch is situated in the central root end. The mesial blade is absent. The tooth is twice as high as its base width.

The left side of parasympyphysial teeth is present. The tooth has a triangular principal cusp. The cusp erects and has distinct distal and mesial blades both joining in a notch. The labial face of the root shows numerous foramina situated surrounding below the apron. The tooth is twice as high as its base width.

Measurements.-Left parasympyphysial tooth height is 2.9 mm, tooth width is 1.5 mm. Left first anterior tooth height is 3.0 mm, tooth width is 1.5 mm.

Comparison

Comparing characters of these fossils with those of the Recent species, Centroscymnus crepidater Bocage and Capello, 1864 (Herman et al., 1989), tooth height, width, outline and following characters are obviously belonging to the genus Centroscymnus.

The anterior tooth has following characters: 1) teeth labiolingually flattened, 2) triangular cusp slightly inclined distally, 3) cutting edges smooth, 4) mesial cutting edge sigmoidal, 5) distal cutting edge tends to be almost vertical, 6) mesial blade lacked, 7) distal heel joining cusp in a notch, 8) labial face of crown slightly convex, 9) large upper mesial and distal foramina situated surrounding below the apron, 10) basal notch situated central root end, 11) tooth length two times bigger than tooth width.

The parasympyphysial tooth has following characters: 1) cusp erected, 2) distinct distal and mesial blades presented both joining cusp in a notch, 3) large mesial and distal foramina situated surrounding below the apron, 4) basal notch situated central root end, 5) tooth length two times bigger than tooth width.

Conclusion

The genus Centroscymnus includes two species, Centroscymnus coelolepis and C. owstoni (Compagno et al., 2005). The genus Centroscymus is monotypic, Centroscymus crepidater, which was separated from the genus Centroscymnus because the parasympyphysial tooth has distinct distal and mesial blades, and both blade joining cusp in a notch (Garman, 1913). Comparison of the characters of these specimens with Recent species, Centroscymnus crepidater, and Centroscymnus coelolepis (Fig. 6), and C. owstoni (Fig. 7) are shown in Table 1. These fossil characters are almost similar to the Recent species, C. crepidater. Judging from these characters, it is identified as the genus Centroscymus belonging to the Family Somniosidae, Centroscymnus sp. And also it is concluded that this fossil is very close to Centroscymnus crepidater Bocage and Capello, 1864 in morphology.

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Table. 1. Comparison with the tooth characters of Recent genera, Centroselachus and Centroscymnus (after Herman et al., 1989).

<table>
<thead>
<tr>
<th>Genus</th>
<th>Centroselachus</th>
<th>Centroscymnus</th>
</tr>
</thead>
<tbody>
<tr>
<td>lower tooth</td>
<td>This study</td>
<td></td>
</tr>
<tr>
<td>teeth at junction both halves of a jaw</td>
<td>parasympsisyal teeth</td>
<td>parasympsisyal teeth</td>
</tr>
<tr>
<td>apron</td>
<td>long and narrow foramina</td>
<td>short and broad</td>
</tr>
<tr>
<td>foramina (labial side)</td>
<td>surrounding the apron</td>
<td>surrounding the apron</td>
</tr>
<tr>
<td>sulcus (lingual side)</td>
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<td>absent</td>
</tr>
<tr>
<td>root notch</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>root ends</td>
<td>angled</td>
<td>angled</td>
</tr>
<tr>
<td>cusp</td>
<td>erected</td>
<td>erected</td>
</tr>
<tr>
<td>cutting edge</td>
<td>smooth</td>
<td>smooth</td>
</tr>
<tr>
<td>mesial blade</td>
<td>present</td>
<td>absent</td>
</tr>
<tr>
<td>distal blade</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>tooth width: height</td>
<td>1:2</td>
<td>1:2</td>
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</tbody>
</table>

**References**


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