Additional Fossils from Southwest Japan

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Introduction and Acknowledgments

In the present article some fossil shark-teeth from the area of southern Kii Peninsula, Wakayama Prefecture and from the western part of Ehime Prefecture are described. These fossils are not so well preserved, but since they form the first record of shark-teeth from the two areas it is thought worthy to describe and illustrate them as additional to the fauna of the two areas. The fossil shark teeth from Wakayama Prefecture are from the stratigraphic units called the Uematsu and Tanami formations (Neogene Tertiary) and from the latter area, the teeth are from the Izumi Sandstone (Cretaceous).

Description

Family Lamnidae

Genus *Carcharodon* Smith, 1838

Carcharodon megalodon (Agassiz, 1843?)

Pl. 1, figs. 1, 2, 3, 7

Carcharodon megalodon Agassiz, 1833−1843, Rech. Poissons Foss., Tome 3, p. 247−249, Atlas Tome 3, pl. 29, figs. 1−8.

Carcharodon megalodon (Charlesworth) Eastman, 1804, Maryland Geol. Surv., Pal. Miocene, p. 82, pl. 31, figs. 1a-c, 2, 3, 4a−b.

Carcharodon megalodon Agassiz, Ishiwara, 1921, Sci. Rep., Tohoku Imp. Univ., Ser. 2 (Geol.), vol. 5, no. 3, p. 65, Pl. 10, fig. 33, pl. 11, figs. 1−8, pl. 12, figs. 1, 2.

Carcharodon megalodon (Charlesworth). Shikama, 1954, Sci. Rep., Yokohama Nat. Univ., Sec. 2, no. 3, Pl. 7, fig. 12.

Carcharodon megalodon Agassiz. Caretto, 1972, Boll. Soc. Paleont. Italiana, vol. 11, no. 1, p. 52−60, fig. 7, pl. 8, figs. 1−5c, pl. 9, figs. 1−4.

Carcharodon megalodon Agassiz. Hatai, Masuda and Noda, 1974, Saito Ho-on Kai Mus., Res. Bull., no. 43, p. 11, pl. 2, figs. 9, 15, 21, 24.

The nomenclature of *Carcharodon megalodon* was discussed by Hatai, Masuda and Noda (1974) in the work cited above. They described and discussed the nomenclature of the species, and the readers are referred to their article in the list above.

A single tooth broken lengthwise into two parts is in the collection. The characteristic denticulations on the teeth are well preserved and it as well as the large size are characteristic of the species. This broken specimen agrees well with the figures given in the works cited above.

Locality :− Suganohama, Kushimoto-cho. Uematsu Formation (Pl. 1, figs. 1, 2, 7). East coast of Tanami, Kushimoto-cho. Tanami Formation (Pl. 1, fig. 3).

Distribution :− Eocene of Alabama and South Carolina ; Oligocene of Germany. Miocene

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Contribution from the Department of Geology, No. 68 (Res. Repts. Kochi Univ.).

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of Belgium, France, Spain, Portugal, Switzerland, Malta, Corsica, Germany, Australia, Africa, Maryland, California, Victoria, Japan. Pliocene of Italy, Belgium, England, Japan ; Tertiary of the Arabian Desert, East Indies, West Indies, America, New Zealand and South Australia.

Family Isuridae

Genus *Isurus* Rafinesque , 1810

1963. *Isurus* Jordan, Stanford Univ., Publ. 99 (Family 60).
1967. *Isurus* Glickman in Orbruchev, Fundamentals of Paleontology (type – *Oxyrhina hastalis* Agassiz, 1843).
1972. *Isurus* Rafinesque, Caretto, Boll. Soc. Paleont. Italiana, vol. 11, no. 1, p. 40 (Type – *Isurus oxyrhynchus* Rafinesque).
1974. *Isurus* Hatai, Masuda and Noda, Saito Ho-on Kai Mus., Res. Bull., no. 43, p. 16.

The genus *Oxyrhina* Agassiz (1843) is used by Bauza, Quintero and Revilla (1963, p. 223) and also by Schultz (1966, p. 77) for the species widely known as *hastalis* in place of the genus *Isurus*, but as pointed out by Hatai, Masuda and Noda (Op. cit.) it seems best to use the generic name *Isurus* for the species called *hastalis*. This species is known from several localities in Japan.

Isurus hastalis (Agassiz)

Pl. 1, figs. 4, 5, 6, 8, 9

Oxyrhina hastalis Agassiz, 1833–1843, Recherches sur les Poissons fossiles, Tome 3, p. 277–278, Atlas, Tome 3, pl. 34, figs. 1–17.
Isurus planus Agassiz, Jordan, 1907, Univ. Calif. Publ., Dept. Geol., Bull., vol. 5, no. 7, p. 107, fig. 9.
Isurus tumulus Agassiz, Jordan, 1907, Ibid., p. 109, figs. 10, 11.
Isurus smithii Agassiz, Jordan, 1907, Op. cit., p. 109, figs. 10, 11.
Isurus hastalis, Jordan and Beal, 1913, Ibid., vol. 7, no. 11, p. 250.
Isurus minutus Agassiz, Chapman, 1918, New Zealand Geol. Surv., Pal. Bull., no. 7, p. 17, pl. 5, figs. 1a–c, 2, 3.
Isurus hastalis, Hatai, Masuda and Noda, 1974, Saito Ho-on Kai Mus., Res. Bull., no. 43, p. 16, pl. 2, figs. 3, 4, 5, 13, 16.

Isurus hastalis is known by the names of *Isurus planus* (Agassiz), *Isurus tumulus* (Agassiz) and *Isurus smithii*, all from the Miocene of California. *Planus* is the upper lateral teeth, *tumulus* is the lower and *smithii* is the long and flexuous form of teeth. Jordan and Beal (1913, p. 250–251) state that the size of the teeth of this species (*hastalis*) sometimes attains two and one half inches in height, and this size of teeth points to a shark measuring sixty feet or more in length.

Isurus hastalis is a rather common shark in the Miocene deposits of Japan, as pointed out by Hatai, Masuda and Noda in the work cited above.

Locality :– Suganohama, Kushimoto-cho. Uematsu Formation (Pl. 1, figs. 4, 5, 6, 9). East coast at Tanosaki, Kushimoto-cho. Tanami Formation (Pl. 1, fig. 8).

Distribution :– Miocene of France, Belgium, Spain, Portugal, Switzerland, Württenburg, Malta, Italy, Sicily, Corsica, Virginia, Maryland, South Carolina, California, Oregon, Patagonia, Victoria, Japan and Australia. Pliocene of Southeast England, Belgium, South France, Italy,

Australia, New Zealand, Germany and Japan. Tertiary of the Canary and Cape de Verde Isles.

Isurus moniwaensis Hatai, Masuda and Noda, 1974
Pl. 1, figs. 10, 11

Isurus moniwaensis Hatai, Masuda and Noda, 1974, Saito Ho-on Kai Mus., Res. Bull., no. 43, p. 19, pl. 2, figs. 20, 22.

The two specimens at hand are identified with the named species. The present two teeth form the second record of this species from the Tertiary rocks of Japan.

The original description of this species is as follows.

"The single tooth at hand measures about 30 mm in height excluding root and about 40 mm with root included, curving backwards obliquely, both convex and concave sides sharp, outer side strongly inflated, inner side almost flat, root about 10 mm in height at middle part, about 37 mm in length, arched, bow-shaped, divergent, anterior part longer than posterior, basal part of tooth at inner part with several wrinckles, the outer part smooth."

Two teeth of the named species were obtained from the Uematsu Formation.

According to Hatai, Masuda and Noda (Op. cit.) the species *moniwaensis* resembles *Isurus benedictus* (Davies, p. 15, fig. 11, 1964) from Sapalwana, a locality situated at about 160 miles north of Durban in Zululand, Africa. But that species is larger in size and has a thicker root and a less broader base compared with *moniwaensis*.

The present record is the second for the named species, which was originally described on a specimen from north of the pumping house at Akaishi in the western part of Sendai City, Miyagi Prefecture.

Locality :— Suganohama, Kushimoto-cho. Uematsu Formation (Pl, 1, figs. 10, 11).

Distribution :— Miyagi and Wakayama Prefectures.

Family Carchariidae
Genus *Carcharias* Rafinesque, 1810
Carcharias obliqua (Agassiz, 1834, exact date unknown)
Pl. 1, figs. 12, 13, 14, 15

Odotus obliquus Agassiz, 1833—1843. Res. Poiss. Foss., Tome 3, p. 267—269, Atlas Tome 2, pl. 31, figs. 1—5, 8—10, pl. 36, figs. 22—26.

Odontaspis cuspidata (Agassiz). Eastman, 1904, Maryland Geol. Surv. Miocene, p. 78, pl. 30, figs. 1a, 1b.

Carcharias cuspidatus (Agassiz). Ishiwara, 1921, Sci. Rep., Tohoku Imp. Univ., Ser. 2 (Geol.), vol. 5, no. 3, p. 70, pl. 12, figs. 12—21.

Odontaspis (Synodonastapis) acutissima acutissima (Agassiz). Krucknow, 1965, Weiler-Festschr. (Senckenberg, Leth., Bd. 462), p. 227.

Odontaspis taurus obliqua (Agassiz). Caretto, 1972, Boll. Soc. Italiana, vol. 11, no. 1, p. 29—30, fig. 4, pl. 3, figs. 4a—c, pl. 4, figs. 1—4.

Carcharias obliqua (Agassiz). Hatai, Masuda and Noda, 1974, Saito Ho-on Kai Mus., Res. Bull., no. 43, p. 20, pl. 2, figs. 1, 7, 10—12, 17—19, 25, 26.

Caretto in the above cited work included in the synonymy of this species, the following ones, viz., *Otodus obliquus* Agassiz, *O. laceolatus* Agassiz, *O. tricuspis* Agassiz, *O. sub-*

plicatus Agassiz, *Lamna elegans* Agassiz, *L. cuspidata* Agassiz, *L. compressa* Agassiz, *L. denticulata* Agassiz, *L. crassidens* Agassiz, *L. (Odontaspis) hopei* Agassiz, *L. (O.) acutissima* Agassiz, *L. (O.) verticalis* Agassiz, *L. (O.) contortidens* Agassiz and also *L. (O.) dubia* Agassiz. This shows how extremely variable are the teeth of this shark.

According to Caretto (op. cit.), *obliqua taurus*, and the well known species names of *accutissima* and *cuspidata* are included in the synonymy of the species.

Locality :— Suganohama, Kushimoto-cho. Uematsu Formation (Pl. 1, figs. 12, 13, 14). East coast of Tanosaki, Kushimoto-cho. Tanami Formation (Pl. 1, fig. 15)

Family Hexanchidae Gill, 1885

Genus *Hexanchus* Rafinesque, 1810

Hexanchus ehimensis Katto, n. sp.

Pl. 1, fig. 16

Four teeth, subulate, measuring from 2.5 to 7 mm in length, inclined at 40°, jaw with symphysial series of four subulate cristate teeth, attached to root that measures about 5—7 mm in height, root consisting of numerous vertical pillars attaining about 6—8 mm in length and about 10—12 pillars within a space of 0.5 mm.

Remarks :— This species resembles *Notidanus loozi* Vincent from the Sartov Region, USSR, illustrated by D. V. Obruchew (Fundamentals of Paleontology, vol. XI, Agnatha Pisces (English Edition, p. 214, pl. V, fig. 22) and *Hexanchus primigenius* (Agassiz) figured by Schultz (1968, fig. 31, pl. 1, figs. 1—6) from the Luschetzer Series also shows some resemblance with the named species, but the teeth are less inclined and of less height.

Locality :— Himezuka, Matsuyama City, Ehime Prefecture. Izumi Sandstone. Cretaceous.

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After the Manuscript was completed, the paper by Uyeno, Kashima and Hasegawa (given in above list), was received.

(Manuscript received September 30, 1976)
(Published; March 29, 1977)

PLATE I

Explanation to Plate I

(All figures × 2 natural size except figs. 3, 16)

Fgs. 1, 2, 3, 7. *Carcharodon megalodon* (Agassiz). Localities and Formations; Figs. 1, 2, 7. Suganohama, Kushimoto-cho, Wakayama Prefecture, Uematsu Formation, Miocene. Fig. 3 - East coast of Tanami, Kushimoto-cho, Wakayama Prefecture, Tanami Formation, Oligocene. × 1.5 natural size.

Figs. 4, 5, 6, 8, 9. *Isurus hastalis* (Agassiz). Localities and Formations; Figs. 4, 5, 6, 9. -Suganohama, Kushimoto-cho, Wakayama Prefecture, Uematsu Formation, Miocene. Fig. 8. - East coast of Tanosaki, Kushimoto-cho, Wakayama Prefecture, Tanami Formation, Oligocene.

Figs. 10, 11. *Isurus moniwaensis* Hatai, Masuda and Noda. Locality and Formation; Suganohama, Kushimoto-cho, Wakayama Prefecture, Uematsu Formation, Miocene.

Figs. 12, 13, 14, 15. *Carcharias obliqua* (Agassiz). Localities and Formations; Figs. 12, 13, 14. - Suganohama, Kushimoto-cho, Wakayama Prefecture, Uematsu Formation, Miocene. Fig. 15. - East coast of Tanosaki Kushimoto-cho, Wakayama Prefecture. Tanami Formation. Oligocene.

Fig. 16. *Hexanchus ehimensis* Katto, Sako and Hatai, n. sp. Locality and Formation; Himezuka, Matsuyama City, Ehime Prefecture, Izumi Group. Cretaceous. × 2.6 natural size.

Katto, J., Sako, Y., and Hatai, K., : Additional Fossils from Southwest Japan. Plate I