

[Original report]

## A new genus of the Family Dalatiidae (Chondrichthyes : Elasmobranchii) from the Miocene of Japan

SUZUKI, Hideshi\*

### Abstract

A new genus and species of a squaliform shark (Chondrichthyes: Elasmobranchii) *Squaliomicros sanadaensis* gen. et sp. nov. is described. On the basis of one specimen, a fossil shark tooth discovered in the Middle Miocene Iseyama Formation (Northern Fossa Magna Region) in Ueda City, Nagano Prefecture, central Japan, *Squaliomicros* differs markedly from related genera *Dalatius* Rafinesque 1810, *Euprotomicrus* Gill 1864, *Isistius* Gill 1864, *Squaliolus* Smith and Radcliffe 1912, *Acrosqualiolus* Adnet 2000, *Eosqualiolus* Adnet 2000, *Squaliodalatius* Adnet, Cappetta and Reynders 2006 and *Angoumeius* Adnet, Cappetta and Reynders 2006 in the Family Dalatiidae and in the Squaliformes incertae familiae by the following lower tooth characters: tooth width larger than height, present upper axial foramen, absent basal notch, distal apron reaching the basal end, present median labial hollow with groove situated inside, and a distinct distal depression presents on the labial face. Judging from these differences in dental characters, this specimen is regarded as probably an undescribed species. This paper constitutes the first discovery and description of the new genus *Squaliomicros* belonging to the Family Dalatiidae in the Miocene of Japan.

Key words: *Squaliomicros sanadaensis*, Dalatiidae, Middle Miocene, Iseyama Formation, Nagano Prefecture

### Introduction

On the basis of dental morphology, the squaliform shark can be classified approximately into the generic level, and the systematic value of dental characters which can be used in the identification of modern and fossil Squaliformes (Adnet and Cappetta, 2001; Cappetta, 2012). Extant Squaliformes comprise a large and varied order with 130 species of dwarf to medium-sized deep-water sharks in 7 families: Echinorhinidae, Squalidae, Centrophoridae, Etmopteridae, Somniosidae, Oxynotidae and Dalatiidae. Family Dalatiidae is classified into 10 species in 7 genera: *Dalatius*,

*Euprotomicroides*, *Euprotomicrus*, *Heteroscymnoides*, *Isistius*, *Squaliolus* and *Mollisquama* (Compagno *et al.*, 2005). Also fossil Squaliformes comprise 7 families, in particular the Family Dalatiidae, which is classified into 13 genera (including extant and unpublished genera) (Cappetta, 2006; Adnet, 2006; Cappetta, 2012). Based on the analyses of dental characters suggested by Herman *et al.* (1989), Adnet and Cappetta (2001), and Cappetta (2012), this fossil shark tooth specimen (SFMCV-0360) has many similarities with those of the extant genus *Dalatius*, *Euprotomicrus*, *Isistius* and *Squaliolus*. Although a few pronounced generic differences are recognized. The

---

Received: March 1, 2014; Accepted: February 5, 2015

\*Ueda Someyaoka Senior High School, 1710, Ueda, Ueda City, Nagano Prefecture, 386-8685 Japan.

Tel 0268-22-0435

Fax 0268-23-5333

E-mail: hide-sh@nagano-c.ed.jp

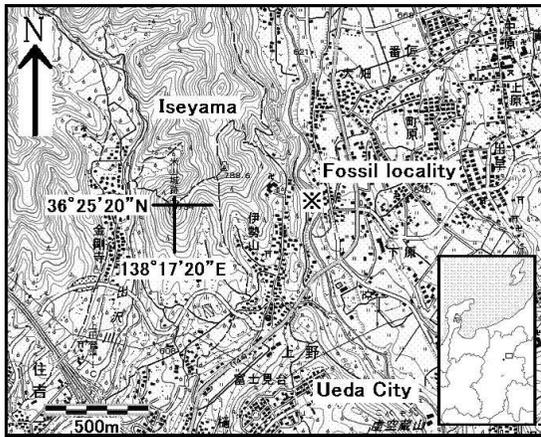


Fig. 1. Map showing the fossil locality of *Squaliomicrus sanadaensis* gen. et sp. nov.

\*: 138° 18' 00.11\"E, 36° 25' 12.05\"N, Using the topographical map of “Sanada”, scale 1 : 25,000, published by Geographical Survey Institute.

aim of this paper is to propose a new monotypic genus belonging to the Family Dalatiidae within the Order Squaliformes in the Miocene of Japan.

#### Geological setting

The Northern Fossa Magna Region at the north of Ueda City in Nagano Prefecture consists of the following formations in ascending order: Oomineyama, Tarouyama, Yokoo and Iseyama Formations (Yamagishi, 1964). The Yokoo and Motohara area strata, which were divided into Yokoo and Iseyama Formations, were correlated with the 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 biostatigraphically correspond to Zone N8 to N9 of the Tertiary planktonic foraminiferal fossil zone of the Middle Miocene in age (Blow, 1969; Kosaka *et al.*, 1992). The 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 geological age of the boundaries of the Yokoo and Iseyama Formations were deposited in the Middle Miocene at the period around 15Ma. The presenting fossil shark tooth was discovered in an outcrop at the side of the Kangawa-River in the Motohara area, Sanada-machi, Ueda City, Nagano Prefecture, central



Fig. 2. Photograph of the outcrop at the fossil locality. The hammer length is 27.7cm.

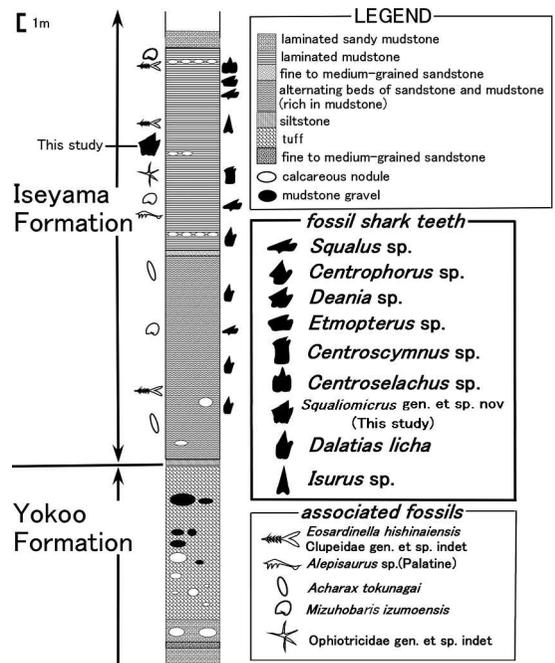


Fig. 3. Columnar section at the fossil locality, Kangawa River, Ueda City, Nagano Prefecture, central Japan. (modified from Suzuki, 2012).

Japan (Figs. 1, 2, 3). This fossil locality corresponds to the lower part of the Iseyama Formation. This fossil horizon strata consists of parallel laminated mudstone with a well-sorted thin sandstone layer, which yields many other fossils, Glendonites, calcareous nodules, and pyrite grains whose sizes are ca. 5-10  $\mu$ m in diameter. Main associated fossils are as follows: *Acharax tokunagai* (Suzuki, 2005b, 2007b), *Mizuhobaris izumoensis* (Suzuki, 2005b, 2007b),

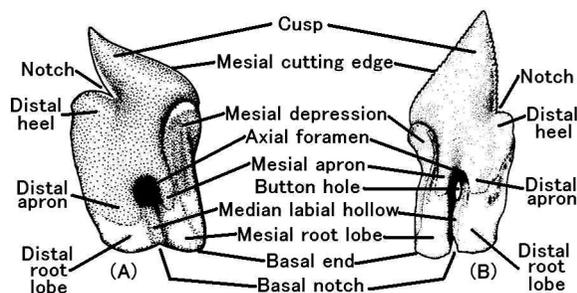


Fig. 4. Dental terminology from labial view. (A) : lower lateral tooth of *Squaliolus schaubi*. (B) : 3<sup>rd</sup> lower lateral tooth of *Dalatias licha* (modified from Welton, 1979; Compagno, 1984; Cappetta, 1987, 2012; Yabe and Goto, 1999 and Adnet and Cappetta, 2001).

Ophiotrichidae (Echinodermata:Ophiuroidea) (Suzuki, 2012), *Alepisaurus* sp. (Suzuki, 2008), and many other fishes including a deep-sea shark assemblage (Suzuki, 2005a, 2005, 2007a, 2007b, 2008a, 2008b, 2012).

#### Systematic description

Class Chondrichthyes Huxley, 1876  
 Subclass Elasmobranchii Bonaparte, 1838  
 Order Squaliformes Goodrich, 1909  
 Family Dalatiidae Gray, 1851

#### *Squaliomiscrus* gen. nov.

**Type species.**—*Squaliomiscrus sanadaensis* sp. nov.: monotypic genus.

**Etymology.**—The genus name *Squaliomiscrus* is taken from the names of the related genera, *Squaliolus* and *Euprotomicrus*. The noun prefix *Squalio-* and suffix *-micrus* are reference to the family affinities.

**Diagnosis.**—Same as that of the type species. Dental terminology is shown in Fig. 4.

#### *Squaliomiscrus sanadaensis* sp. nov.

(Figs. 5a, 5b)

**Material.**—Holotype, a left lower lateral tooth, SFMCV (Shinshushinmachi Fossil Museum Collection Vertebrate)-0360, which was collected by the author.

**Etymology.**—The species name *sanadaensis* is derived from Sanada-machi where the fossil was found.

**Locality.**—Kangawa-River in Motohara area, Ueda City, Nagano Prefecture, Japan.

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

**Diagnosis.**—This genus is distinguished from related genera, *Dalatias*, *Euprotomicrus*, *Isistius*, *Squaliolus*, *Acrosqualiolus*, *Eosqualiolus*, *Squaliodalatias* and *Angoumeius*

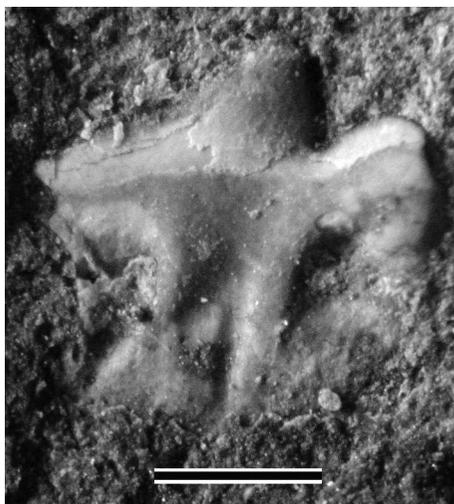


Fig. 5a. Holotype of a fossil left lower lateral tooth of *Squaliomiscrus sanadaensis* gen. et sp. nov. (SFMCV-0360), from the lower part of the Iseyama Formation (labial view). Scale bar equals 1mm.



Fig. 5b. The mold of SFMCV-0360. Scale bar equals 1mm.

by the following combination of characters: the tooth width is larger than its height, present upper axial foramen, absent basal notch, distal apron reached at the basal end, present median labial hollow with groove situated inside and distinct distal depression presented on the labial face.

**Measurements.**—Tooth height is 2.0+mm, tooth width is 2.4mm.

**Description of holotype.**—Besides the characters given in the diagnosis there are several additional features, which are shown in Fig. 5c. The tooth width is larger than its height. The tooth has a triangular principal cusp that joins the distal heel in a notch. The crown inclines slightly distally. The mesial cutting edge is sigmoidal, and the mesial and distal ones are smooth. The labial face of the crown is slightly convex. The apron is consequently from the upper axial foramen divided into a mesial and a distal pseudo-lobe. The mesial apron extends below the half root's height but the distal apron reaches the basal end. The mesial apron is narrower than the distal one. The labial face of the root shows the median labial hollow and the groove is situated inside. The median labial hollow, which is situated between both pseudo-lobes of the apron, runs from the crown-root junction to the basal end, and the groove runs from the half root's height to the basal end. The upper axial foramen is present at the junction of the pseudo-lobes. Well developed mesial and distal depressions are present below the crown-root junction.

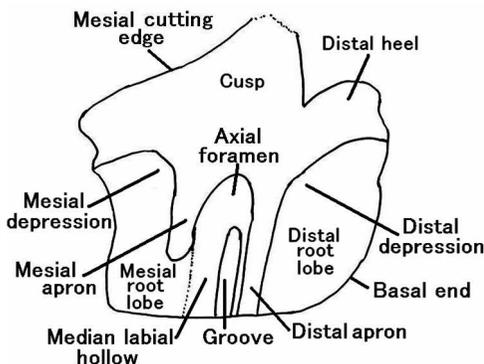


Fig. 5c. A line drawing of the lower lateral tooth of *Squaliomicrocrus sanadaensis* gen. et sp. nov.

## Discussion

It is regrettable that this description has to be based on only one specimen, which is considered to be a lower lateral tooth by having the main oblique cusp. However, the specific characters of *Squaliomicrocrus sanadaensis* make it easy to distinguish and the diagnosis is distinct and straightforward. Almost all the related genera *Dalatius*, *Euprotomicrocrus*, *Isistius*, *Squaliolus*, *Acrosqualiolus*, *Eosqualiolus*, *Squaliodalatius* and *Angoumeius* belonging to the Family Dalatiidae and the Squaliformes incertae familiae are characterized by external character of the lower teeth as having a pseudo-apron which is divided into a mesial and distal part (Adnet and Cappetta, 2001; Cappetta, 2012). Table 1. compares important lower tooth characters of the genus *Squaliomicrocrus* with related genera. The lower tooth characters of *Squaliomicrocrus* agree well with Herman *et al.*'s (1989) diagnosis of the Family Dalatiidae. The new genus differs from the genus *Dalatius*, *Isistius* and *Angoumeius* in the main vertical cusp, the serrated cutting edge (*Isistius* is slightly serrated), the button-hole, the present basal notch, and the much larger tooth size. Bass *et al.* (1976), Welton (1979), Compagno (1984), Herman *et al.* (1989), Adnet and Cappetta (2001) and Cappetta (2012) indicated numerous similarities between *Euprotomicrocrus* and *Squaliolus* in dental characters. However, *Squaliomicrocrus* can be distinguished from those of two genera in that the tooth width is larger the height, the present upper axial foramen, the absent basal notch, the distal apron reaches the basal end, the present median labial hollow with groove situated inside, and in the distinct distal depression presented on the labial face. On one part of the Family Dalatiidae, tooth width is larger than the height in a lower commissural tooth. Nevertheless, its tooth appearance markedly differs from the other lower teeth ones and does not correspond to the new genus and species which have general proportion of lower teeth. Thus, it is apparent that *Squaliomicrocrus* can be distinguished from them by the combination of characters listed in Table 1. The observation based on the external morphology indicates that the species *Squaliomicrocrus sanadaensis* has an assortment of the generic level differences for related genera, and that it is possible to place the new species in another genus.

Table 1. Comparison *Squaliomicrus sanadaensis* gen. et sp. nov. with related genera. Comparative dental characters from Welton, 1979 ; Compagno, 1984 ; Cappetta, 1987, 2012 ; Herman *et al.*, 1989 ; Yabe and Goto, 1999 and Adnet *et al.*, 2006 and Reynders 2006.

Genus	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Dalatiidae (Family)	presence	oblique	serrated	presence	TH>TW	lower	presence	presence	bilobed	half	presence	absence	presence	absence
<i>Squaliomicrus</i> (this study)	unknown	oblique	smooth	presence	TH<TW	upper	absence	absence	bilobed	basal end	presence	presence	presence	presence
<i>Dalatiás</i>	presence	vertical	serrated	presence	TH>TW	lower	presence	presence	bilobed	half	presence	absence	presence	absence
<i>Euprotomicrus</i>	presence	oblique	smooth	presence	TH>TW	lower	presence	absence	bilobed	half	presence	absence	presence	absence
<i>Isistius</i>	presence	vertical	serrated	presence	TH>TW	lower	presence	presence	bilobed	half	presence	absence	presence	absence
<i>Squaliolus</i>	presence	oblique	smooth	presence	TH>TW	lower	presence	absence	bilobed	half	presence	absence	presence	absence
<i>Acrosqualiolu</i>	presence	vertical	smooth	presence	TH>TW	lower	presence	absence	bilobed	half	presence	absence	presence	absence
<i>Eosqualiolu</i>	presence	vertical	smooth	presence	TH>TW	lower	presence	absence	bilobed	half	presence	absence	presence	absence
<i>Squaliodalatiás</i>	presence	oblique	smooth	presence	TH>TW	lower	presence	presence	bilobed	half	presence	absence	presence	absence
<b>Squaliformes incertae familiae</b>														
<i>Angoumeius</i>	presence	vertical	smooth	presence	TH>TW	lower	presence	presence	bilobed	half	presence	absence	presence	presence

Nº	lower lateral teeth characters ( except Nº1)
1	Dignathic heterodonty
2	Lower teeth with main cusp
3	Mesial cutting edge of the cusp
4	Distal heel
5	Tooth height : width (TH:TW)
6	Axial foramen situated
7	Basal notch
8	Button hole
9	Apron uniform
10	Distal apron reached
11	Median labial hollow
12	The groove situated inside of Median labial hollow
13	Mesial depression
14	Distal depression

The new genus markedly resembles representatives of the Family Dalatiidae in generic characters. While morphologically the genus *Squaliomicrus* and 2 genera, *Euprotomicrus* and *Squaliolus*, are very similar, pronounced differences were recognized in some morphological characters. With those differences, it can be concluded that this specimen is significantly different from the 2 genera. As mentioned above, as a result of a comparison between one lower tooth belonging to the Family Dalatiidae and its related genera in general proportion, the tooth fossil is recognized as an undescribed species belonging to the Family Dalatiidae. This specimen, which was discovered in the Miocene of Japan, is named *Squaliomicrus sanadaensis*.

#### Acknowledgements

This paper is a part of the contents which the author submitted to Kanazawa University as a dissertation for the degree of Ph.D. Dr. Kazue Tazaki of the Prof. Emeritus, Kanazawa

University and Dr. Masatoshi Goto of the Prof. Emeritus, Tsurumi University, gave me many helpful suggestions and discussions. Professor Sho Tanaka of the Department of Marine Biology, School of Marine Science and Technology, Tokai University, helped me in the identification of recent deep-sea sharks. Dr. Tomoyoshi Kosaka of the Prof. Emeritus, Shinshu University, provided encouragement and geological guidance. Thanks are also due to Daniel Topal for reading and correcting this English text. Anonymous reviewers provided various constructive comments to the original manuscript. I would like to express sincere gratitude to them.

#### References

- Adnet, S., 2006, Palaeo Ichthyologica. Nouvelles faunes de Sélaciens (Elasmobranchii, Neoselachii), del'Eocène moyen des Landes (Sub-Ouest, de la France), *Palaeo Ichthyologica*, **10**, 1-128.\*\*\*  
 Adnet, S. and Cappetta, H., 2001, A palaeontological

- and phylogenetical analysis of squaliform sharks (Chondrichthyes:Squaliformes) based on dental characters. *Lethaia*, **34**, 234-248.\*\*
- Adnet, S., Cappetta, H., and Reynders, J., 2006, Nouveaux genres de Squaliformes (Chondrichthyes) du Paléogène des Landes (Sub-Ouest, de la France). *Paläont. Zool.*, **80**, 60-67.\*\*
- Bass, A.J., D'Aubrey, J.D. and Kistnasamy, N., 1976, Shark of the east coast of south Africa VI. The families Oxynotidae Squalidae Dalatiidae and Echinorhinidae, *Oceanographic research Inv. Rep.*, **45**.\*\*
- Blow, W. H., 1969, Late Middle Eocene to Recent planktonic foraminiferal biostratigraphy. Proceeding First International Conference on Planktonic Microfossils, Geneva, 1967, **1**, 199-421.\*\*
- Bonaparte, C. L., 1838, Selachorum tabula analytica, *Nuovi Ann. Sci. Natur. Bologna*, **2**, 195-214.\*\*
- Cappetta, H., 1987, Handbook of Paleichthyology. vol 3B Chondrichthyes II, Gustav Fischer Verlag Stuttgart, New York, 139p.\*\*
- Cappetta, H., 2006, Fossilium Catalogus 1. Animalia, Pars 142, Elasmobranchii Post-Triadici, Index specierum et generum, Backhuys Publishers, Leiden, 472p.\*\*
- Cappetta, H., 2012, Handbook of Paleichthyology. vol 3E Chondrichthyes Mesozoic and Cenozoic Elasmobranchii: Teeth, Verlag Dr. Friedrich Pfeli, München, 512p.\*\*
- Compagno, L. J. V., 1984, FAO species catalogue. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 1. Hexanchiformes to Lamniformes. *FAO Synopsis*, **125**, 1-249.\*\*
- Compagno, L. J. V., Dando, M. and Fowler, S. 2005, Sharks of the World. Princeton University Press, Princeton and Oxford, 368p.\*\*
- Gill, T. N., 1864, Second contribution to the selachology of California. *Proc. Acad. Natur. Sci.*, Philadelphia, **16**, 147-151.\*\*
- Goodrich, E. S., 1909, Vertebrata Craniata. I. Cyclostomes and fishes. In: Lankester, E. R. (ed.), A Treatise on Zoology, part 9, 518p.\*\*
- Gray, J. E., 1851, List of the specimens of fish in the collection of the British Museum, Part 1. Chondropterygii, 160p.\*\*
- Herman, J. Hovestadt-euler, M. and Hovestadt, D. C., 1989, Contributions to the study of the comparative morphology of teeth and other relevant ichthyodorulites in living supraspecific taxa of Chondrichtyan fishes. Part A, Selachii, **3**, *Bull. Inst. Roy. Sci. Natur., Belg.*, **59**, 101-157.\*\*
- Huxley, T. H., 1876, On *Ceratodus forsteri*, with observation on the classification of fishes. *Proc. Zool. Soc.*, 24-59.\*\*
- Kosaka, T., Midori, T., Hoyanagi, K., Kubota, M. and Miyahigashi, Y., 1992, Late Cenozoic stratigraphy and paleogeographic changes in the Northern Fossa Magna. *Mem. Geol. Soc. Japan*, **37**, 71-83.\*
- Kubota, M. and Kosaka, T., 1990, Planktonic foraminifers from the Yokoo Formation, northern Fossa Magna, central Japan. *Jour. Fac. Sci. Shinshu Univ.*, **25**, 35-42.\*
- Rafinesque, C. S., 1810, Caratteri di alcuni nuovi generi e nuove specie di animali e piante della Sicilia. *Con varie osservazioni sopra i medesimi*, **1**, 3-69.\*\*
- Smith, H. M., and Radcliffe, L., 1912, The squaloid sharks of the Philippine Archipelago. *Proc. U. S. Natl. Mus.*, **41**, 677-685.\*\*
- Suzuki, H., 2005a, Fossil fishes from the type locality of the Middle Miocene Iseyama Formation from the northern part of the Ueda City, Nagano Prefecture, central Japan. *Res. Rep. Shinshushinmachi Fos. Mus.*, **8**, 13-18.\*
- Suzuki, H., 2005b, On the fossil of kitefin shark from the Middle Miocene Iseyama Formation, Sanadamaichi, Nagano Prefecture, central Japan. *Earth Science (Chikyu Kagaku)*, **59**, 383-388.\*
- Suzuki, H., 2007a, First description of fossil shark teeth of the genus *Centrophorus* (Elasmobranchii: Squaliformes) from the Miocene of Japan. *Jour. Geol. Soc. Japan*, **113**, 1, 23-26.\*
- Suzuki, H., 2007b, Discovery of fossil teeth of dogfish, the genus *Squalus* from the Northern Fossa Magna Region, Nagano Prefecture, central Japan and its significance. *Earth Science (Chikyu Kagaku)*, **61**, 67-72.\*
- Suzuki, H., 2008a, A fossil palatine of an alepisauroid fish from the Middle Miocene Iseyama Formation, Ueda City, Nagano Prefecture, central Japan. *Jour. Geol. Soc. Japan*, **114**, 43-46.\*
- Suzuki, H., 2008b, Squaliform shark teeth of the genus *Centroselachus* from the Miocene of Japan. *Jour. Geol. Soc. Japan*, **114**, 536-539.\*\*
- Suzuki, H., 2012, A fossil deep-sea shark assemblage

- from the Middle Miocene, Ueda City, Nagano Prefecture, central Japan. *Earth Science (Chikyu Kagaku)*, **66**, 47-61.\*
- Welton, B. J., 1979, Late Cretaceous and Cenozoic Squalomorphii of the Northwest Pacific Region. Ph. D. thesis, University California Berkeley, 533p.
- Yabe, H. and Goto, M., 1999, Terminology of the elasmobranch teeth. *Jour. Fos. Res.*, **32**, **1**, 14-20.\*
- Yamagishi, I., 1964, Geology in the Northern District of Ueda City, Nagano Prefecture, with Special Reference to Green Tuffs. *Jour. Geol. Soc. Japan*, **70**, **6**, 315-338.\*
- \* : in Japanese with English abstract  
 \*\* : in English  
 \*\*\* : in French  
 \*\*\*\* : in Italian