

Jurassic Radiolarians from the Manba Unit of the Northern Chichibu Belt, Kanto Mountains, Central Japan

By

Kazuaki SEKINE¹, Haruo IJIMA² and Yasuji SAITO³

¹Ogano High School, 962-1 Ogano, Ogano-machi, Saitama, 368-01

²6 Kunikami, Minano-machi, Saitama, 369-16

³Department of Geology, National Science Museum,
3-23-1 Hyakunin-cho, Shinjuku-ku, Tokyo, 169

Abstract Jurassic radiolarians were newly found from the mudstone matrices of the Manba unit in the northern part of the Chichibu belt, Kanto mountains, central Japan. They are *Hsuum* sp., *Canoptum* (?) sp., *Stichocapsa* sp., *Syringocapsa* sp., *Protunuma* (?) sp., *Sethocapsa* sp., *Tricolocapsa* sp., and some unidentified nassellarians. This radiolarian assemblage including the genus *Canoptum* indicates the involvement of Early Jurassic sediments in this unit. The Manba unit is probably correlated with other geotectonic units in the northern Chichibu belt such as the Kazahaya-toge and Kamiyoshida units. This means that the formation of the Manba unit, ascribed to a subduction-accretion complex including melangé, commenced during the Early Jurassic.

Introduction

To the south of the Sanbagawa metamorphic belt is developed the Chichibu belt consisting of late Paleozoic and early to middle Mesozoic strata in the Kanto mountains, central Japan. The belt geotectonically comprises three parts: northern, central and southern. The strata of the northern part were divided into four formations as Sakahara, Kashiwagi, Manba, and Kamiyoshida in the ascending order (FUJIMOTO, 1935). The geologic age of the Manba Formation was considered to be the late Carboniferous to middle Permian on the basis of fusulinids from small limestone lenses (FUJIMOTO, 1936a, b; OKUBO & HIRAGUCHI, 1969). However, Triassic conodonts and Jurassic radiolarians were found from chert and mudstone of the Sakahara and Kamiyoshida formations (SATO *et al.*, 1977, 1982; TAKIZAWA, 1979; SASHIDA *et al.*, 1982a, b; SASHIDA & IGO, 1985; GUIDI *et al.*, 1984; KISHIDA & HISADA, 1985; HISADA *et al.*, 1988), and then the age of those formations has been re-examined by using radiolarians. Mode of geologic occurrence of each constituent rock in those formations, as well as fossil evidences mentioned above, suggests that the Chichibu belt are composed largely of Jurassic accretion complex with melangé including older slabs and blocks of chert, limestone and greenstones (e.g. HISADA, 1984, 1989; HISADA *et al.*, 1986, 1989; IJIMA *et al.*, 1990, 1993, 1994; MAKIMOTO & TAKEUCHI, 1992; SASHIDA

et al., 1992). Therefore, each formation of the northern Chichibu belt can be regarded as a geotectonic unit, rather than as an ordinary stratigraphic unit.

In this paper, we report some Jurassic radiolarians from the Manba unit which is composed largely of mudstone with a number of greenstone and limestone blocks of various-dimensions. The Manba unit, one of the geotectonic units of the northern Chichibu belt, is widely developed around the southern side of the Kanna-gawa river, Kanto mountains, but no fossils useful for age determination have been found. Among the radiolarians newly obtained is included *Canoptum* (?) sp., probably indicating the Early Jurassic age. Such radiolarian evidences are important to clarify a geotectonic evolution of the outer zone of the Japanese islands.

Geologic Setting

The geology of the northern Chichibu belt of the Kanto mountains consists of four geotectonic units divided by lithologic and tectonic characters: the Kazahaya-toge, Kashiwagi, Manba, and Kamiyoshida (Fig. 1). The Kazahaya-toge unit consists mainly of sandstone and shale with a minor amount of chert, being turbidite facies of late early Jurassic age (IJIMA *et al.*, 1993). The Kashiwagi unit is composed largely of acidic tuff and mudstone, probably being distal facies of turbidite including hemipelagic sediments. The Manba unit consists mostly of mudstone with a minor amount of tuff intercalations, contain-

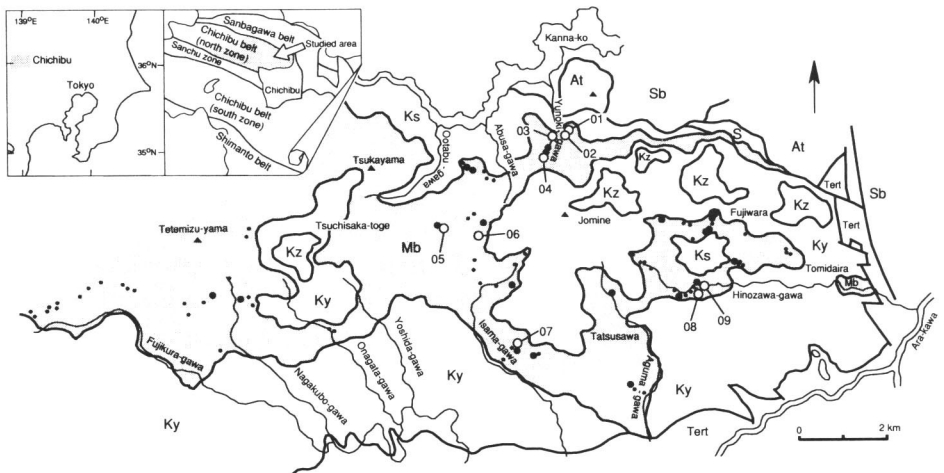


Fig. 1. Index and geotectonic maps showing sample localities of the Manba unit in the northern Chichibu belt, Kanto mountains. Sb: Sanbagawa metamorphic belt; Kz: Kazahaya-toge unit; Ks: Kashiwagi unit; Mb: Manba unit; Ky: Kamiyoshida unit; At: Cretaceous Atokura Formation; S: Serpentinite and metamorphic rocks. Radiolarians were found from sites of open larger solid circles.

ing various-sized blocks of greenstone, limestone and chert. No radiolarians available for age determination have been found from the Kashiwagi and Manba units. MAKIMOTO and TAKEUCHI (1992) regarded the Manba unit, together with the Kamiyoshida unit mentioned below, as a middle Jurassic mixed rock unit which consists of mudstone and chaotically mixed rocks containing blocks of greenstone, limestone and chert in muddy matrix. The Kamiyoshida unit consists of terrigenous clastic rocks including chert blocks. Most of chert blocks in this unit are severely brecciated and mingled with mudstone, suggesting that the unit was a collapse deposit formed in an accretion process. The Kamiyoshida unit includes two radiolarian assemblages of different age. One is of the late Early to early Middle Jurassic and the other is of the late Middle to early Late Jurassic (IIJIMA *et al.*, 1994). The former assemblage has been known from the Kazahaya-toge unit (IIJIMA *et al.*, 1993). These geotectonic units of the northern Chichibu belt form an almost horizontal structure, probably as a huge nappe of imbricated thrust sheets. They suffered low-grade metamorphism and are regarded as a subduction-accretion complex constituting the framework of the Japanese islands.

Jurassic Radiolarians from the Manba Unit

Although radiolarians have been recovered from the northern Chichibu belt (SASHIDA, 1992; SASHIDA *et al.*, 1982a, b; HISADA & KISHIDA, 1987; HISADA *et al.*, 1988; IIJIMA *et al.*, 1990, 1993, 1994; KANTO MOUNTAIN RESEARCH GROUP, 1994), well-preserved ones have been hardly obtained from the Manba and Kashiwagi units due to recrystallization in relation to regional metamorphism. We collected more than one hundred samples of mudstone and siliceous shale from the Manba unit. Sample localities and a list of radiolarian species identified from selected localities are shown in Fig. 1 and listed in Table 1. Among them, the genus *Canoptum* was reported from the western parts of the northern Chichibu belt of the Kanto mountains by HISADA and KISHIDA (1987) and HISADA *et al.* (1988), and also from the Raidenyama Formation of the middle Chichibu belt by SASHIDA and YATSUGI (1991). Species of the genus *Canoptum* are biostratigraphically important index fossil as they occur exclusively from Late Triassic to Early Jurassic (e.g. PESSAGNO *et al.*, 1979; PESSAGNO & POISSON, 1981; PESSAGNO & WHALEN, 1982; BLOOM, 1984; YEH, 1987). Co-occurrence of the *Canoptum* species and other Jurassic radiolarians indicates that Early Jurassic mudstone matrices are included in the Manba unit. This suggests that the Manba unit can be correlated with the turbidite facies of the Kazahaya-toge unit, and with the older part of the Kamiyoshida unit which were described by IIJIMA *et al.* (1993, 1994). Radiolarians from each locality are as follows.

Locality 01 : This is located at an east side of the Yunoki-gawa, Kamiizumi-

Table 1. List of radiolarians from the Manba unit of the northern Chichibu belt, Kanto mountains. 01, 02, 03, and 04, Yunoki-gawa, Kamiizumi-mura, Kodama-gun, Saitama Prefecture: 05 and 06, Ootabu-toge, Yoshida-machi, Chichibu-gun, Saitama Prefecture: 07, Isama-gawa, Yoshida-machi, Chichibu-gun, Saitama Prefecture: 08 and 09, Hinozawa-gawa, Chichibu-gun, Minano-machi, Saitama Prefecture.

Species	Locality number								
	01	02	03	04	05	06	07	08	09
<i>Hsuum</i> sp.		○	○	○					○
<i>Canoptum</i> (?) sp.		○							
<i>Stichocapsa</i> sp.	○	○		○					
<i>Stichocapsa</i> (?) sp.				○					
<i>Syringocapsa</i> sp.				○					
<i>Protunuma</i> (?) sp.									○
<i>Sethocapsa</i> sp.								○	
<i>Tricolocapsa</i> sp.			○			○			
<i>Tricolocapsa</i> (?) sp.					○		○		

mura, Saitama Prefecture (Figs. 1 and 2), where are developed dark grey to black mudstone and sandstone including large clasts or blocks of bedded chert and greenstone. The Manba unit is considered to rest over the Kashiwagi unit by a thrust fault. Although a part of the Manba unit at this locality is lithologically similar to the Kamiyoshida unit, the former characterized by melangé complex with greenstone clasts is different from the latter. The mudstone of this locality

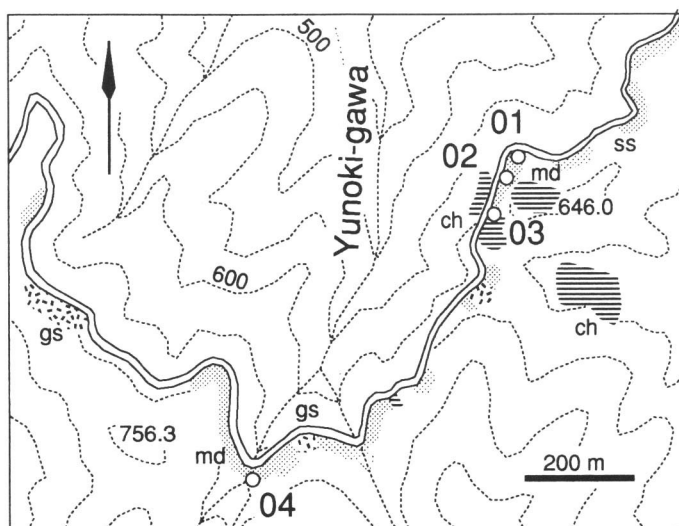


Fig. 2. Simplified route map showing the sample localities of radiolarians at Yunoki-gawa, Kamiizumi-mura, Saitama Prefecture. gs: greenstone; ch: chert; md: mudstone; ss: sandstone.

contains *Stichocapsa* sp. (Fig. 5: 8) and nassellarian gen. et sp. indet. A (Fig. 5: 4).

Locality 02: This is near the locality 01 and is on similar geologic situation (Figs. 1 and 2). Mudstone matrix of this locality contains such radiolarians as *Canoptum* (?) sp. (Fig. 5: 7), *Hsuum* sp. (Fig. 5: 1 and 5) and *Stichocapsa* sp. (Fig. 5: 9 and 11). Species of the characteristic genus *Canoptum* was reported not only from the Kanto mountains but also from the Mino and Chichibu belts of the other area (TAKADA & ISOZAKI, 1986; IMAZATO & OTOH, 1993; MIYAMOTO & KUWAZURU, 1993; SUZUKI, 1993; SUZUKI & ITAYA, 1994). This suggests that Early Jurassic unit can be widely developed within so-called Jurassic accretionary complex of the Japanese islands.

Locality 03: The materials exposed at this locality, south of the localities 01 and 02, are structurally and lithologically similar to them (Figs. 1 and 2). Siliceous mudstone samples from the Manba unit contains *Hsuum* sp. (Fig. 5: 2), *Tricolocapsa* sp. and nassellarian gen. et sp. indet. D (Fig. 5: 18).

Locality 04: From this locality, located at upper course of the Yunoki-gawa (Figs. 1 and 2), are found abundant radiolarian remains. Mudstone associated with greenstone clasts contains the following species of *Hsuum* sp. (Fig. 5: 3), *Stichocapsa* sp. (Fig. 5: 10), *S.* (?) sp. (Fig. 5: 13), *Syringocapsa* sp. (Fig. 5: 15), and nassellarian gen. et sp. indet. B and C (Fig. 5: 12 and 14).

Locality 05: This is along a forest road, west of Ootabu-toge pass, Yoshidamachi, Saitama Prefecture, where is developed dark grey to black mudstone including vari-sized clasts or blocks of greenstone, limestone and chert. Such lithology is characteristic of the Manba unit. (Figs. 1 and 3). *Tricolocapsa* (?) sp. (Fig. 5: 22) with poorly preserved radiolarians unavailable for age determination is found from the mudstone matrix of this site.

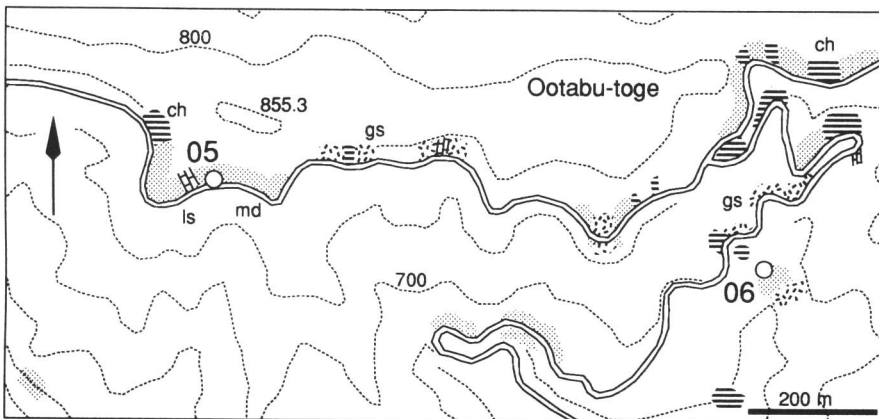


Fig. 3. Simplified route map showing the sample localities of radiolarans near Ootabu-toge pass, Yoshidamachi, Saitama Prefecture. ls: limestone. Other abbreviations are same as those in Fig. 2.

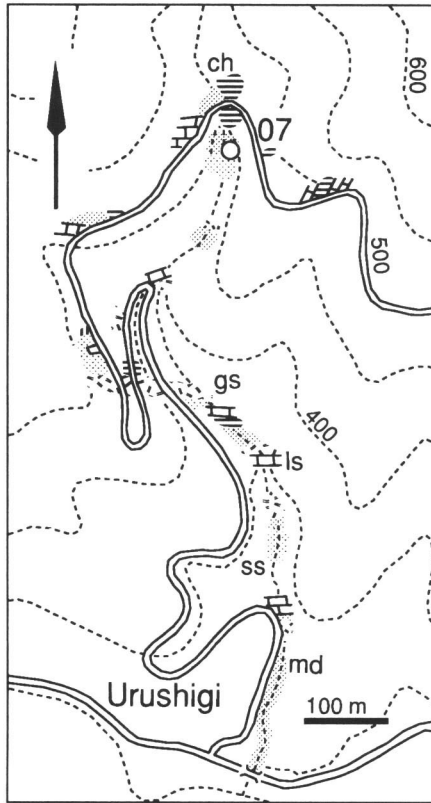


Fig. 4. Simplified route map showing a sample locality of radiolarians at Urushigi along the Isama-gawa river, Yoshida-machi, Saitama Prefecture. Abbreviations are same as those in Figs. 1 and 2.

Locality 06: This is south of Ootabu-toge pass and constituent rocks are similar to those of locality 06 (Figs. 1 and 3). Rather large blocks of greenstone and chert are embedded in mudstone matrix. The dark grey or black mudstone contains *Tricolocapsa* sp. and other poor-preserved radiolarians (Fig. 5: 20).

Fig. 5. Scanning electron micrographs of Jurassic radiolarians from the Manba unit of the northern Chichibu belt, Kanto mountains. 1: *Hsuum* sp. from Loc. 02; 2: *H.* sp. from Loc. 03; 3: *H.* sp. from Loc. 04; 4: nassellarian gen. et sp. indet. A from Loc. 01; 5: *H.* sp. from Loc. 02; 6: *H.* sp. from Loc. 09; 7: *Canoptum* (?) sp. from Loc. 02; 8: *Stichocapsa* sp. from Loc. 01; 9: *St.* sp. from Loc. 02; 10: *St.* sp. from Loc. 04; 11: *St.* sp. from Loc. 02; 12: nassellarian gen. et sp. indet. B from Loc. 04; 13: *St.* (?) sp. from Loc. 04; 14: nassellarian gen. et sp. indet. C from Loc. 04; 15: *Syringocapsa* sp. from Loc. 04; 16: *Protunuma* (?) sp. from Loc. 09; 17 and 18: nassellarian gen. et sp. indet. D from Loc. 03; 19: *Sethocapsa* sp. from Loc. 08; 20: *Tricolocapsa* sp. from Loc. 06; 21: *T.* (?) sp. from Loc. 07; 22: *T.* (?) sp. from Loc. 05. Scale bar is 100 μ m for all figures.

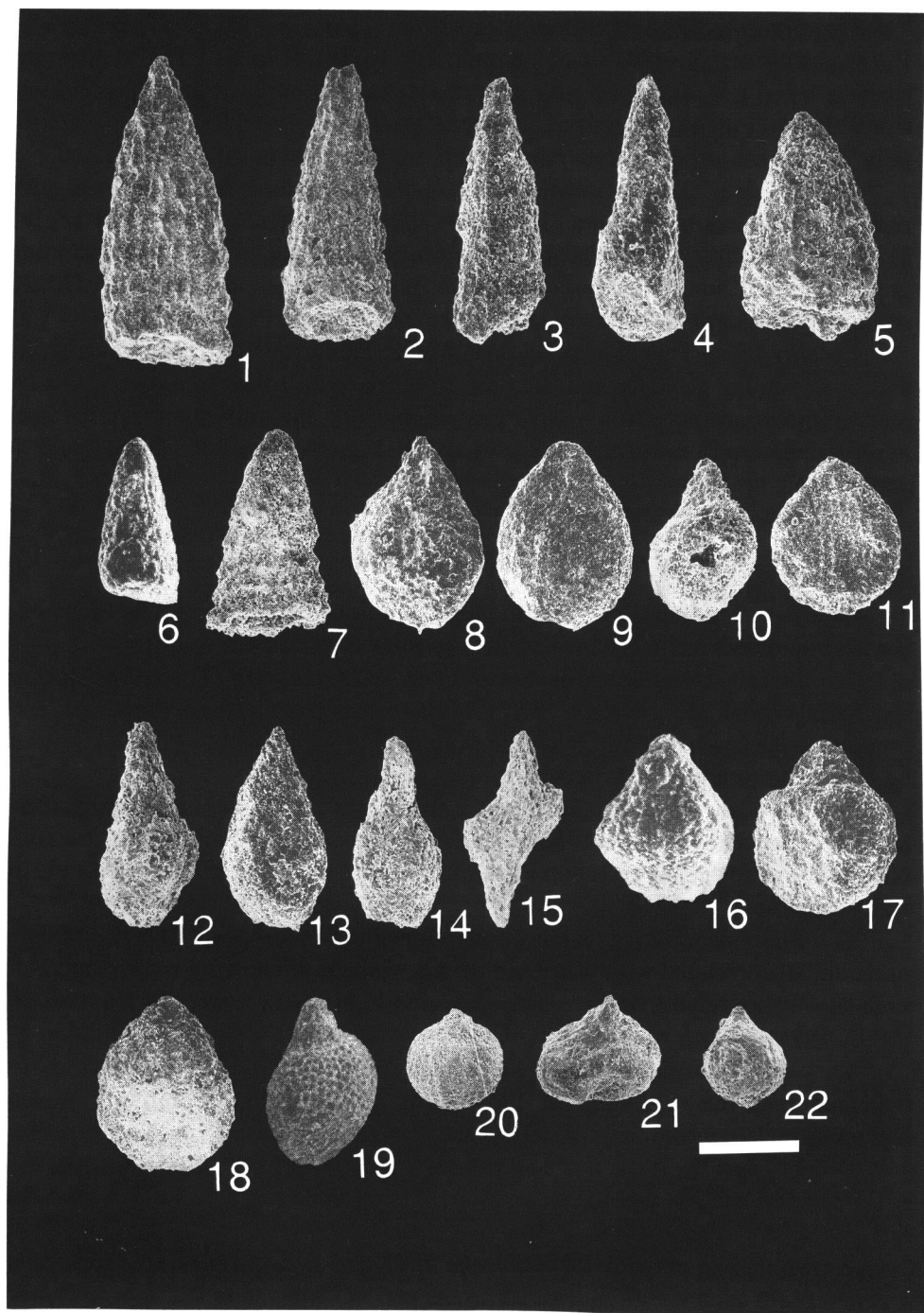


Fig. 5.

Locality 07: This location is north of Urushigi, along a tributary of Isama-gawa river, Yoshida-machi, Saitama Prefecture (Fig. 1). The Manba unit consists largely of mudstone with subordinate sandstone, including several limestone blocks (Fig. 4). From the mudstone matrix are found *Tricolocapsa* (?) sp. (Fig. 5: 21) and other nassellarians which are paleontologically unidentified.

Locality 08: This is located at Nanpoh-zawa, along the Hinozawa-gawa river, Minano-machi, Saitama Prefecture (Fig. 1). Rock association of the Manba unit of this site is similar to those of other localities, in particular including greenstone and limestone clasts and/or blocks. Mudstone as a matrix of them contains *Sethocapsa* sp. with other nassellarians (Fig. 5: 19).

Locality 09: This is near the locality 08, along the Hinozawa-gawa river, and is in similar geologic and tectonic situation with other localities (Fig. 1). Such radiolarians as *Hsuum* sp., *Protunuma* (?) sp. and other unidentified nassellarians are found from dark grey to black mudstone of the unit (Fig. 5: 6 and 16).

Concluding Remarks

Analysis of radiolarians from the Manba unit of the northern Chichibu belt, Kanto mountains, central Japan yields the following results:

1) Jurassic radiolarians such as *Hsuum* sp., *Canoptum* (?) sp., *Stichocapsa* sp., *Syringocapsa* sp., *Protunuma* (?) sp., *Sethocapsa* sp., *Tricolocapsa* sp., and other nassellarians are found from the Manba unit, which had been considered to be late Carboniferous to Triassic strata.

2) Co-occurrence of *Canoptum* (?) sp. and other Jurassic radiolarians indicates that the Manba unit includes Early Jurassic sediments in part, because occurrence of the genus *Canoptum* is known exclusively from the Late Triassic to Early Jurassic.

3) The paleontologic evidence mentioned above supports that the Manba unit can be correlated with other geotectonic units in the northern Chichibu belt such as the Kazahaya-toge and partly Kamiyoshida units reported by Iijima *et al.* (1993, 1994).

4) Such informations newly obtained from the Manba unit lead us to conclude that the formation of those units as subduction-accretion complex including melangé commenced during the Early Jurassic.

Acknowledgements

We would like to thank Professors Y. AITA and T. SAKAI of the Utsunomiya University for identification of radiolarians and valuable comments through this study. Special thanks are due to Mr. H. HASEGAWA of Kagemori Junior High

School, Chichibu City and the School Board of Kamiizumi-mura, Saitama Prefecture for help in field study. The present study has been financially supported in part by the Grant-in-Aid for Scientific Research for Y. S. (No. 06640590) from the Ministry of Education, Science and Culture, Japan.

References

- BLOOM, C. D., 1984. Upper Triassic radiolaria and radiolarian zonation from western north America. *Bull. Amer. Paleont.*, 85: 1–82.
- FUJIMOTO, H., 1935. Geological study of the northern part of the Kwanto mountains. Part I. *Jour. Geol. Soc. Japan*, 42: 137–151. (In Japanese.)
- , 1936a. Stratigraphical and palaeontological studies of Titibu System of the Kwanto mountainland, part I Stratigraphy. *Sci. Rep. Tokyo Bunrika Daigaku*, Sec C, 6: 157–188.
- , 1936b. Stratigraphical and palaeontological studies of Titibu System of the Kwanto mountainland, part II Palaeontology. *Sci. Rep. Tokyo Bunrika Daigaku*, Sec C, 6: 29–125.
- GUIDI, A., J. CHARVET & T. SATO, 1984. Finding of granitic olistoliths and pre-Cretaceous radiolarians in the northwestern Kanto mountains, Gunma Prefecture, central Japan. *Jour. Geol. Soc. Japan*, 90: 853–856.
- HISADA, K., 1984. Geology of the Paleozoic and Mesozoic strata in the Ashigakubo-Kamozawa area, southern Kanto mountains. *Jour. Geol. Soc. Japan*, 90: 139–156. (In Japanese with English abstract.)
- , 1989. Nappe of the Chichibu complex in the Kuroyama area, eastern part of the Kanto mountains, central Japan. *Ann. Reep. Inst. Geosci., Univ. Tsukuba*, (15): 49–53.
- , Y. KISHIDA & K. SASHIDA, 1986. Upper Jurassic chert of the Hashidate Group in the Kanto mountains, central Japan. *Mem. Osaka Kyoiku Univ.*, III, 35: 89–94.
- & Y. KISHIDA, 1987. Earliest Jurassic radiolarian assemblage obtained from the Hebiki Formation of the northern Chichibu belt in the Kanto mountains, central Japan. *Jour. Geol. Soc. Japan*, 93: 521–523. (In Japanese.)
- , Y. KAMIKAWA, Y. KISHIDA, & N. YAMAGIWA, 1988. Geologic ages of limestone, chert and shale of the northern belt of the Chichibu terrain in the western Kanto mountains, central Japan. *Mem. Osaka Kyoiku Univ.*, III, 37: 183–193. (In Japanese with English abstract.)
- , H. UENO & Y. KAMIKAWA, 1989. Chichibu accretionary complex in the Kanto mountains, central Japan. *Struct. Geol. (Jour. Tectonic Research Group of Japan)*, (34): 85–94. (In Japanese with English abstract.)
- IIJIMA, H., K. SEKINE & H. HASEGAWA, 1990. Geology of the north subbelt of the Chichibu belt in the Hinozawa area, northeast Kanto mountains. *Bull. Natn. Sci. Mus., Tokyo*, Ser. C, 16: 1–14. (In Japanese with English abstract.)
- , ——— & Y. SAITO, 1993. Jurassic radiolarians from the clastic rock unit of the northern part of the Chichibu belt in the Kanto mountains, central Japan. *Ibid.*, 19: 81–89.
- , ——— & ———, 1994. Geologic age of the Kamiyoshida unit of the Chichibu belt, Kanto mountains, Japan. *Ibid.*, 20: 119–131.
- IMAZATO, A. & S. OTOH, 1993. Jurassic radiolarians from the Nyukawa area, northernmost part of the Mino Belt. *News of Osaka Micropaleontologists, Spec. Vol.*, (9): 131–141. (In Japanese with English abstract.)
- KANTO MOUNTAIN RESEARCH GROUP, 1994. The northern subbelt of the Chichibu belt along the Kannna river in the Kanto mountains, central Japan. *Earth Science (Chikyu Kagaku)*, 48: 83–101. (In Japanese with English abstract.)

- KISHIDA, Y. & K. HISADA, 1985. Late Triassic to Early Jurassic radiolarian assemblage from the Ueno-mura area, Kanto mountains, central Japan. *Mem. Osaka Kyoiku Univ.*, Ser. III, 34: 103–129.
- MAKIMOTO, H. & K. TAKEUCHI, 1992. Geology of the Yorii district. With geological sheet map at 1: 50,000, Geol. Soc. Japan. (In Japanese with English abstract.)
- MIYAMOTO, T. & J. KUWAZURU, 1993. Finding of Early Jurassic radiolarians from the Hashirimizu Formation at the Hikawa valley, Kumamoto Prefecture, Kyushu and its geological significance. *News of Osaka Micropaleontologists, Spec. Vol.*, (9): 165–175.
- OKUBO, M. & M. HORIGUCHI, 1969. Geology of the Manba district. With geological sheet map at 1: 50,000, Geol. Soc. Japan. (In Japanese with English abstract.)
- PESSAGNO, E. A., Jr., W. FINGI & P. L. ABBOTT, 1979. Upper Triassic radiolaria from the San Hipolito Formation, Baja California. *Micropaleontology*, 25: 160–197.
- & A. POISSON, 1981. Lower Jurassic radiolaria from the Gumuslu allochthon of south-western Turkey (Taurides occidentales). *Bull. Min. Res. & Expl. Inst. Turkey*, (92): 47–69.
- & P. A. WHALEN, 1982. Lower and Middle Jurassic radiolaria (multicyrtid Nassellariina) from California, east-central Oregon and the Queen Charlotte Islands, B. C. *Micropaleontology*, 28: 111–169.
- SASHIDA, K., 1992. Early Jurassic radiolarians from the Shomaru Pass-Higashiagano area, Hanno City, Saitama Prefecture, central Japan. *News of Osaka Micropaleontologists, Spec. Vol.*, (8): 35–46. (In Japanese with English abstract.)
- & H. IGO, 1985. Jurassic radiolarians in the Kanto region. Circum-Pacific Jurassic IGCP #171, 3rd Field Conference Japan: 25–34.
- , ———, H. IGO, S. TAKIZAWA, & K. HISADA, 1982a. On the occurrence of Jurassic radiolarians from the Kanto region and Hida mountains, central Japan. *Ann. Rep. Inst. Geosci., Univ. Tsukuba*, (8): 74–77.
- , ———, ———, ———, ———, T. SHIBATA, K. TSUKUDA, & H. NISHIMURA, 1982b. Jurassic radiolarians from the Kanto mountains. *News of Osaka Micropaleontologists, Spec. Vol.*, (5): 51–56. (In Japanese with English abstract.)
- & M. YATSUGI, 1991. Note on the middle Chichibu belt of the Kanto mountains, central Japan. *Ann. Rep., Inst. Geosci., Univ. Tsukuba*, (17): 56–62.
- SATO, T., S. TAKIZAWA & T. KODATO, 1977. Revision of stratigraphy and structure of the Sakahara Formation at its type locality. *Jour. Geol. Soc. Japan*, 83: 631–637. (In Japanese with English abstract.)
- , ———, T. KUWAHATA, H. AONO, M. FUSEYA & Y. ARAKAWA, 1982. Jurassic formations distributed in the uppermost reaches of the Kanna River in the Kanto mountains. *Ann. Rep. Inst. Geosci., Univ. Tsukuba*, (8): 78–80.
- SUZUKI, H., 1993. The Canoptum assemblage (Radiolaria) from the Umenoki unit (the northern Chichibu belt) in the Kamikatsu Town area, Tokushima Prefecture, Southwest Japan. *News of Osaka Micropaleontologists*, (9): 109–117. (In Japanese with English abstract.)
- & T. ITAYA, 1994. Accretionary complexes of the Kurosegawa, Northern Chichibu and Sanbagawa belts in the Kamikatsu Town area (Shikoku), Southwest Japan. *Jour. Geol. Soc. Japan*, 100: 585–599. (In Japanese with English abstract.)
- TAKATA, M. & Y. ISOZAKI, 1986. Occurrence of Jurassic radiolarians from the “Mikawa Group” in eastern Yamaguchi Prefecture. *Jour. Geol. Soc. Japan*, 92: 447–450. (In Japanese.)
- TAKIZAWA, S., 1979. Stratigraphy of the Chichibu belt of the Kanto mountains. Commemorative Vol. Prof. Kanuma, M.: 89–102. (In Japanese with English abstract.)
- Yeh, KUEI-YU, 1987. A revised classification for Family Canoptidae (Radiolaria). *Mem. Geol. Soc. China*, (8): 63–72.