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Source: Paleontological Research, 7(3) : 185-194

Published By: The Palaeontological Society of Japan

URL: https://doi.org/10.2517/prpsj.7.185

Paleontological Research, vol. 7, no. 3, pp. 185-194, September 30, 2003

An Early Jurassic ammonite from a limestone conglomerate in the Kuzu Complex of the Ashio Belt

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Received October 18, 2002; Revised manuscript accepted April 15, 2003

Abstract. A specimen referable to an Early Jurassic ammonite, *Cleviceras* cf. *chrysanthemum* (Yokoyama, 1904), was discovered from a limestone conglomerate layer of the Kuzu Complex in the Ashio Belt, central Japan. *Cleviceras chrysanthemum*, a species comparable to the present specimen, is a diagnostic ammonite of early Toarcian age in the Circum-Pacific. The limestone conglomerate layer in question is a part of a sequence composed of, from top to bottom, siliceous shale, limestone conglomerate itself, calcareous sandstone, and again siliceous shale. The siliceous shale above and below the ammonite-bearing conglomerate bed carries radiolarian fossils which indicate the *Unuma echinatus* Assemblage Zone or *Tricolocapsa plicarum* Zone of Middle Jurassic age. The whole sequence is judged to be normally superposed by frequently observable normal graded bedding. Thus, the age indicated by the fossil ammonite for the limestone conglomerate is in contradiction with the age of the overlying and underlying beds. These facts suggest that the ammonite-bearing pebble of Early Jurassic age is a fragment transported from elsewhere and redeposited in its present position during a Middle Jurassic time. The description of the ammonite is given.

Key words: ammonite, Ashio Belt, Jurassic, Kuzu Complex, radiolarians.

Introduction

A Jurassic accretionary complex constitutes the basement of the Ashio Mountains in northern Kanto region. The Kuzu Complex (Kamata, 1996) exposed in its southeastern part, is a member of the complex. It is characterized by the intercalation of highly fossiliferous Permian limestone, on which stratigraphic and paleontologic studies have been repeatedly carried out (e.g., Fujimoto, 1961). Its stratigraphic classification was established on the basis of the apparently superposing relations of the constituent beds and Paleozoic fossils contained in the limestone, and was believed to embrace Carboniferous to Permian formations. With the discoveries of Triassic and Jurassic fossils from and below the limestone beds in the 1970's, this stratigraphy could no longer be retained. First a layer of limestone conglomerate was discovered to overlie the Permian limestone and a Triassic (Spathian to Norian) age was assigned to it by conodonts (Koike *et al.*, 1974). Late Triassic conodonts were found also from the bed below the limestone (Koike *et al.*, 1971). At about the same time Jurassic radiolarians were discovered from the siliceous shale of variegate color overlying the limestone conglomerate by Sashida *et al.* (1982).

The geologic structure of the Kuzu Complex has become accordingly the subject of intense restudy. Beginning with the finding of a thrust fault below the greenstone layer underlying the limestone bed (Koike *et al.*, 1971), the geologic structure of the sequence comprising the limestone beds had to be reconsidered. There are two interpretations: the superposed nappe theory first introduced by Yanagimoto (1973) and advanced by Kamata (1996) among others, and the gravity sliding model advocated by Aono (1985) and Sato *et al.* (1987).

The Kuzu Complex still offers stratigraphic, sedimentological and structural problems worthy of further investigations. During the course of a detailed study of the limestone conglomerate here in question by us (Y.K. and S.M.), an Early Jurassic ammonite was discovered. Before proceeding with a description of the ammonite we will discuss the discrepancy in age between it and the subjacent and superjacent radiolarians. The described ammonite and illustrated radiolarian specimens are kept in the Department of Earth Sciences, Yamaguchi University (DEYU).

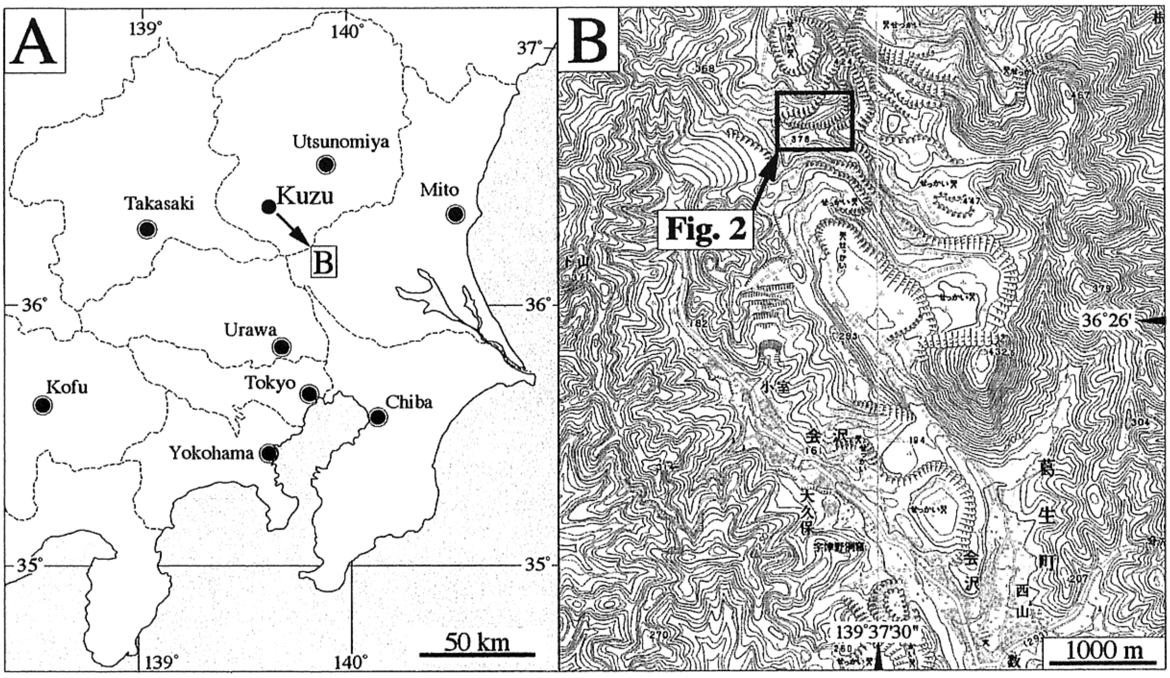


Figure 1. Index map showing the location of Kuzu Town (A) and location of Minowa Mine of Yoshizawa Lime Industry Co. Ltd. (B). Base map in 1:25,000-scale topographic maps of Japan, Quadrangle "Shimotsuke-Ohgaki" and "Senba", Geographical Survey Institute of Japan.

Geologic setting

The sequence described below is exposed in the quarry of the Minowa Mine of the Yoshizawa Lime Industry Co. Ltd., which is located at about 2.5 km north of Kuzu Town in Tochigi Prefecture (Figure 1). It is exposed on the stripped benches of the open pit, at the 359 and 349 m levels, and the beds generally strike in a N-S to NE-SW direction and dip toward the W or NW (Figures 2, 3). The sequence is composed of beds of, apparently in ascending order, gray massive limestone (a), dark gray to black limestone conglomerate (b), green to dark green siliceous shale (c), green to dark green siliceous shale intercalating limestone conglomerate and sandstone layers (d), well bedded gray to black chert (e). A schematic succession is given as a columnar section in Figure 4. Mutual stratigraphic relations between neighboring beds are not clear because of faulting in general (Figure 3), except for the erosive surface of the top of bed (a). Siliceous shale beds (c) and (d) are lithologically similar.

Radiolarians of Middle Jurassic age were discovered from the siliceous shale (c and d) (Figure 5). Moreover, radiolarians of Early to Middle Triassic age were already reported from the uppermost chert bed (e) (Isogawa *et al.*, 1988; Ohtaka *et al.*, 1998). A rather poorly preserved ammonite specimen of Early Jurassic age was discovered from a shale pebble included in the limestone conglomerate (d) on the bench at the 359 m level. The limestone conglomerate with sandstone layers is exposed on the bench for about 3–4 meters in height and 6–7 meters in width (Figure 6). The conglomerate and sandstone rest upon the siliceous shale and their dip and strike are nearly parallel. Well-bedded chert (e) lies in fault contact with the limestone conglomerate and sandstone (d). Black shale sheared and made slaty by faulting is exposed along the boundary between (d) and (e). The ammonite-bearing pebble is of a rectangular shape, with a length of 10 cm, a width of 6 cm, and a thickness of 3 cm. The pebble was exposed on the stripped surface subparallel to the bedding plane of the limestone conglomerate. The detailed succession of the part including this ammonite-bearing sequence (d) is as follows (Figure 7). Bounded by faults at its top and bottom surfaces, it is composed of (1) siliceous shale (about 50 cm thick), (2) calcareous sandstone (4 cm), (3) conglomeratic limestone (14 cm), (4) pebbly siliceous shale (22 cm), (5) calcareous sandstone and limestone conglomerate in alternation (about 50 cm), in ascending order (Figure 7). The radiolarian-bearing horizons are cited as RYSK-01, RYSK-02, RYSK-04, all in siliceous shale, besides the ammonite-bearing horizon in the limestone conglomerate. All the beds are likely to be continuous laterally, and maintain a constant thickness, at least within the limits of the exposure. The lithologic description of each bed is as follows.

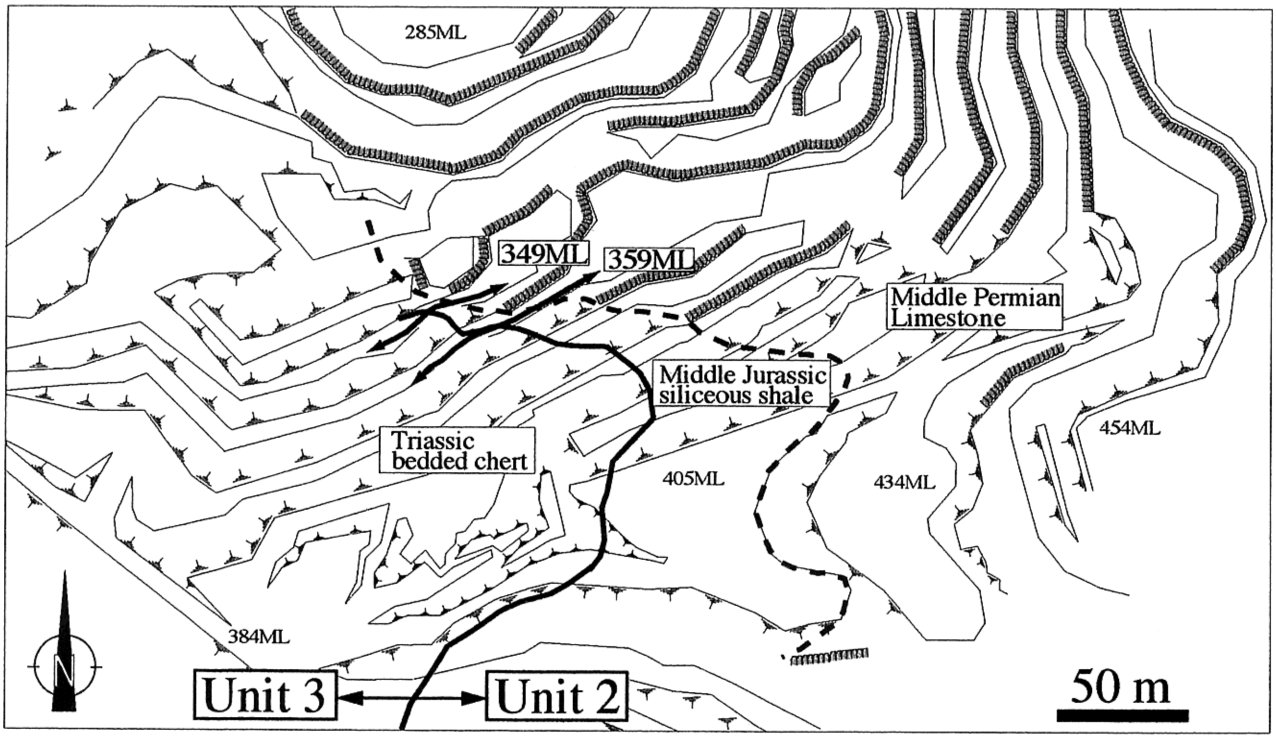


Figure 2. Sketch map of a part of the Minowa Mine, Kuzu (for location see Figure 1). Lines with ticks and gray bands show walls of stripped benches of the open pit, of which the meter level is indicated by numerals, for example, 349 ML. Thick lines denote the unit boundary. See Kamata (1997) for explanations of Units 2 and 3. Arrows with thick line indicate the route of the sketch map of Figure 3. ML: level of altitude (meter).

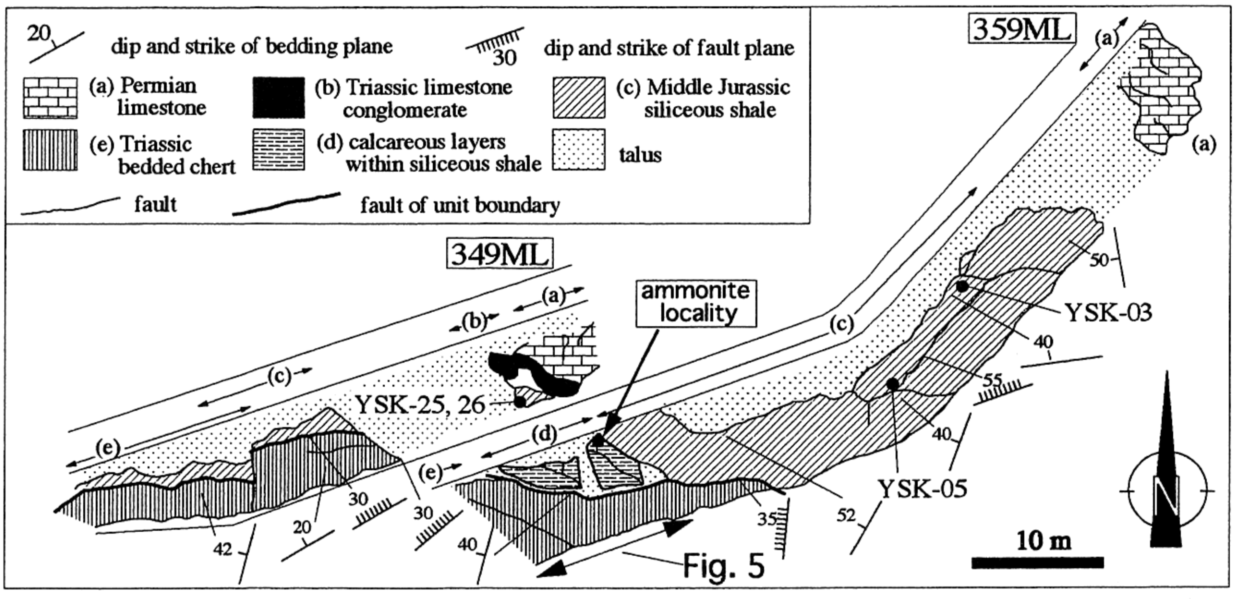


Figure 3. Sketch map of the stripped benches of 349 and 359 ML. YSK: fossil locality.

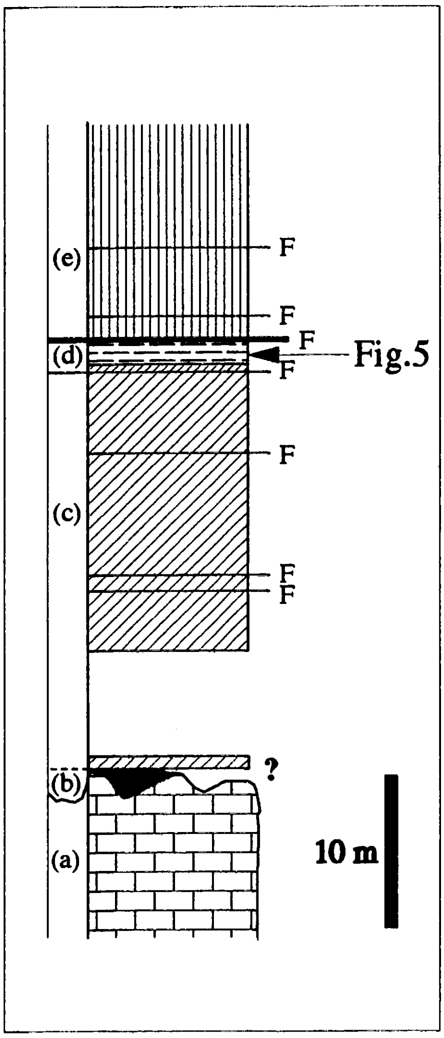


Figure 4. Generalized columnar section of the ammonite-bearing horizon and its neighboring beds, established on the 349 and 359 ML benches. F: faults. Patterns of beds have the same meaning as in Figure 3. Lithologic units (a) to (e), as denoted in text, are same as in Figure 3.

	YSK-03	YSK-05	YSK-25	YSK-26	RYSK-01	RYSK-02	RYSK-04
Tricolocapsa ruesti Tan					+	+	+
T. cf. *ruesti* Tan	+		+		+		
T. parvipora Tan	+	+					
T. (?) *fusiformis* Yao			+	+	+	+	+
T. cf. (?) *fusiformis* Yao					+		+
T. plicarum Yao				+	+	+	+
T. cf. *plicarum* Yao					+		
T. tetragona Matsuoka			+			+	
T. multispinosa Sashida					+		
T. sp.	+		+		+	+	+
Stichocapsa japonica Yao					+	+	+
S. sp.	+				+		
Eucyrtidiellum unumaense (Yao)					+		
E. pustulatum Baumgartner					+		
E. semifactum Nagai and Mizutani							+
E. sp.					+		+
Diacanthocapsa ? sp.						+	
Williriedellum ? sp.						+	
Transhsuum maxwelli (Pessagno)					+		
T. sp.							+
Protounuma sp.							+
Archeodictyomitra sp.					+	+	+
Archicapsa sp.					+	+	+
Pantanellium sp.					+		
Parvicingula sp.					+	+	

Figure 5. List of Middle Jurassic radiolarians from the Minowa Mine. Sampling locations YSK and RYSK are shown in Figures 3 and 7.

(1) Siliceous shale: Pale to dark green shale, characterized by well developed scaly cleavage. The upper part is tuffaceous and light green in color. It contains plenty of radiolarian tests besides microcrystalline quartz and clay minerals as well as a small amount of quartz grains of silt size. Lithologically this is quite similar to the siliceous shale (c).

(2) Calcareous sandstone: Fine-grained sandstone dark brown or dark gray in color. It is composed of calcareous clay matrix, light brown in color under open nicols, and well sorted fine- to coarse-grained limestone and dolomite grains in addition to micrite grains. Normal graded bedding is commonly observable.

(3) Limestone conglomerate: Conglomerate including gray limestone pebbles and black chert sharpstones, both up to 30 cm in diameter, and embedded in sandy matrix. Almost all the limestone pebbles are lithologically sparry bioclastite, and contain abundantly fusulinids and crinoids, besides pellets and ooids. The black chert sharpstones are presumably silicification products of the same limestone, judged by the fact that tests and casts of fusulinid fossils are included therein. Some rip-up clasts of siliceous shale, which are irregularly shaped and pale green, are included in this conglomerate bed. The rip-up clasts consist of microcrystalline quartz and clay minerals with radiolarian tests, and are lithologically very similar to the previous siliceous shale (1). These clasts show soft-sediment deformation and margins of the clasts are injected between the pebbles and grains of sandy matrix.

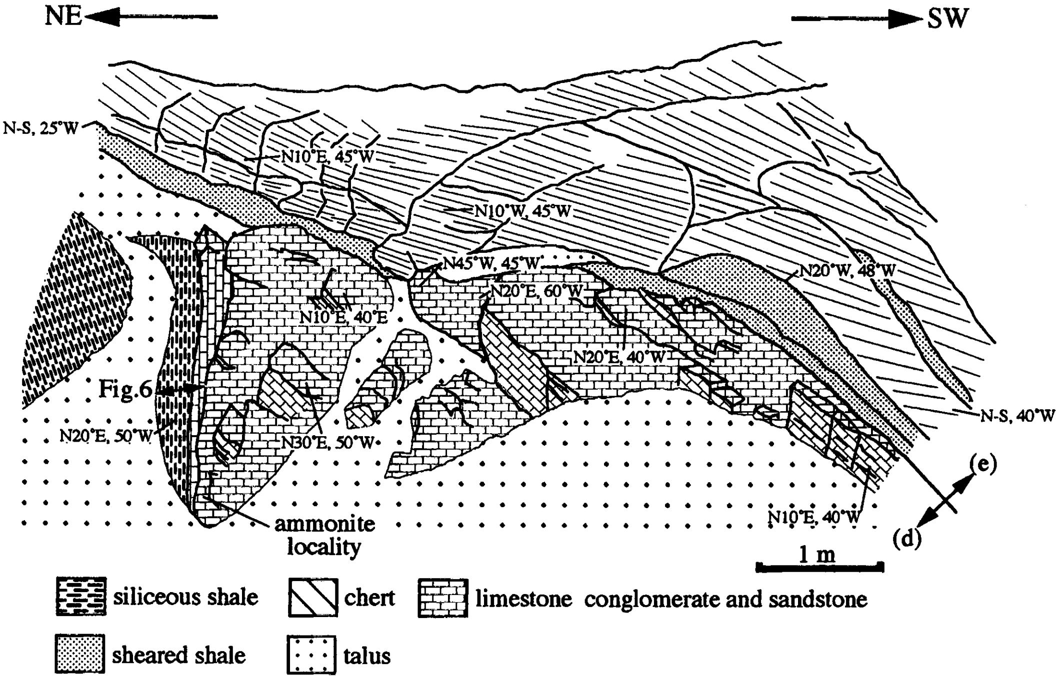


Figure 6. Sketch of the outcrop showing the occurrence of the limestone conglomerate and sandstone on the 359ML bench in the quarry of the Minowa Mine (e) and (d) are the lithologic units of Figure 3.

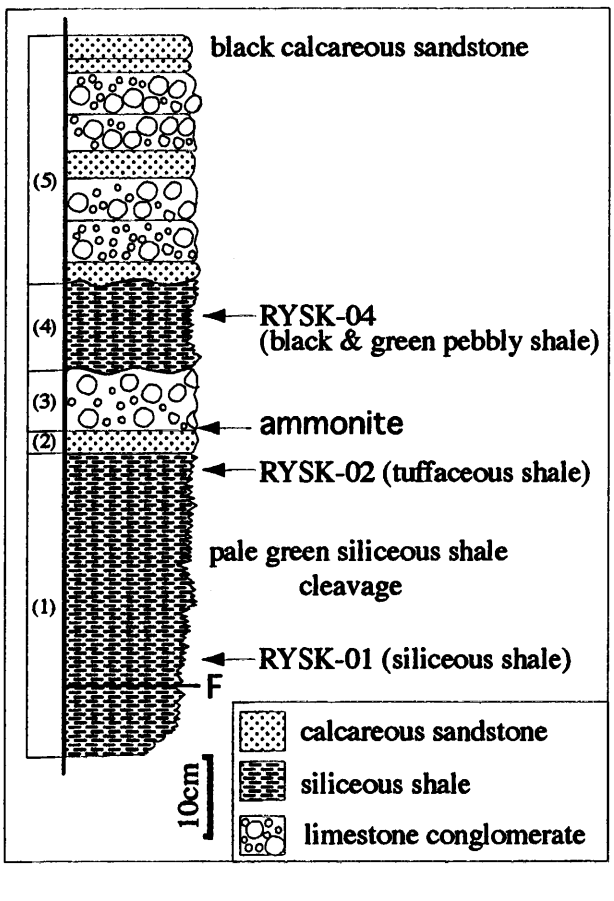
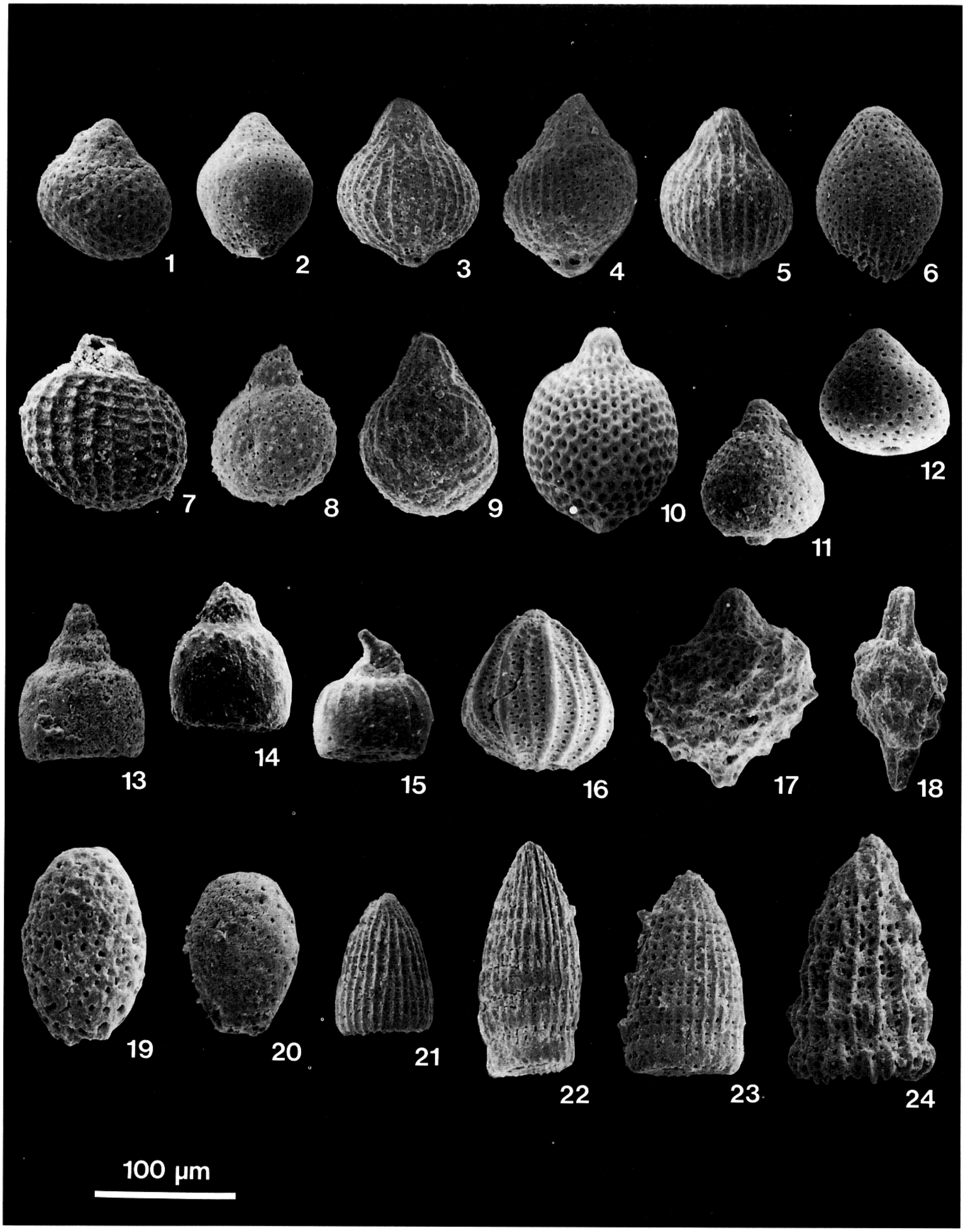


Figure 7. Columnar section of the part including the ammonite and radiolarian-bearing horizons of the bed (d) of Figure 4. See text for the explanations of the lithologic units (1) to (5). RYSK: horizon of radiolarian fossils.

A pebble of calcareous shale of light brownish color in which the ammonite in question was discovered is included in this conglomerate. The pebble is roughly rectangular in shape and can be distinguished clearly from the neighboring matrix. Lithologically the pebble shows fine lamination a few mm thick and slaty fissility parallel to the lamination. This calcareous shale is composed of a very fine shaly matrix with minor amounts of quartz, muscovite and black organic matters. Irregularly shaped interspaces are scattered throughout the matrix. The calcareous shale is highly porous. A wood fragment accompanied the ammonite (Figure 9).

(4) Pebbly siliceous shale: Siliceous shale composed of shaly matrix including limestone pebbles up to 10 cm in diameter. Dark green and black in color.

(5) Conglomerate intercalated with sandstone layers: Mostly limestone conglomerate, with a few intercalated calcareous sandstone beds. Normal graded bedding is often seen in sandstone beds. Some beds of gravels of the limestone conglomerate show also upward-fining, and gradually change into sandstone toward the upper horizon.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100 μm

Figure 9. *Cleviceras* cf. *chrysanthemum* (Yokoyama, 1904) discovered from the shale pebble embedded in the limestone conglomerate bed (d) in the Minowa Mine. Note accompanying wood fragment. Scale bar is 3 cm long.

Geologic ages

The geologic ages of the fossil-bearing horizons are as below, but as mentioned previously are discordant.

Radiolarians.— Radiolarians were discovered from three horizons (see Figure 7): two of them, RYSK-01 (in siliceous shale) and RYSK-02 (in tuffaceous siliceous shale), are in the lower siliceous shale bed (1) below the ammonite-bearing limestone conglomerate. The other, RYSK-04 (in pebbly siliceous shale), is in the upper siliceous shale bed (4) above the ammonite horizon. The radiolarians collected are well preserved for specific identification. Thirteen species belonging to 10 genera are identified (Figure 5). Representative specimens are illustrated in Figure 8. All the assemblages of the radiolarians discovered from three horizons are identical in composition, which is characterized by the coexistence of *Tricolocapsa ruesti* Tan, *T.* (?) *fusiformis* Yao, *T. plicarum* Yao, *T. tetragona* Matsuoka, *Eucyrtidiellum unumaense* (Yao), *E. pustulata* Baumgartner, *E. semifactum* Nagai and Mizutani, *Stichocapsa japonica* Yao and *Trashsuum maxwelli* Pessagno. Of these, *Tricolocapsa* and *Eucyrtidiellum* are diagnostic genera of the *Unuma echinatus* Assemblage Zone (Yao *et al*., 1982; Matsuoka *et al*., 1994), which indicates the *T. plicarum* Zone age (Matsuoka and Yao, 1986; Matsuoka, 1995) of Bajocian to early Bathonian age. Moreover, it is known that both *T. tetragona* Matsuoka and *E. semifactum* Nagai and Mizutani are restricted to the upper part of the *T. plicarum* Zone (Matsuoka, 1995; Nagai and Mizutani, 1990). The biostratigraphic correlation mentioned above indicates that the present radiolarian fauna from the siliceous shale is assignable to the upper part of the *T. plicarum* Zone, which is likely late Bajocian to early Bathonian in age.

Ammonite.—As described later, the ammonite discovered from the calcareous shale pebble of the bed (3) in Figure 6 is determined to be *Cleviceras* cf. *chrysanthemum* (Yokoyama). The species *chrysanthemum* was formerly assigned to the genus *Harpoceras*, but Jakobs *et al.* (1994) transferred it to the genus *Cleviceras* created by Howarth (1992). Japanese *chrysanthemum* is known to range from the *Protogrammoceras nipponicum* Assemblage Zone to the *Dactylioceras helianthoides* Assemblage Zone (Hirano, 1973; Sato and Westermann, 1991), which are correlated to the Tenuicostatum, Falciferum and Bifrons Zones of the lower and middle Toarcian, including possibly uppermost Pliensbachian. As the present ammonite belongs to the same genus, it permits a similar dating, although it is not definitely conspecific with *C. chrysanthemum.* In the Circum-Pacific region, *C.* cf. *chrysanthemum* is known from the North American Kanense Zone of the lower Toarcian (Jakobs, 1997). Comparable species are in fact widely known elsewhere, e.g., East Siberia and South America (Jakobs *et al*., 1994).

Obviously, the early to middle Toarcian age indicated by the ammonite is not compatible with the Bajocian to early Bathonian age provided by the radiolarian assemblages. This discrepancy requires explanation. A plausible one is now offered.

Discussion of age of sequence

Lithologically, the siliceous shale (c) and (d) of this suc-

← **Figure 8**. Representative radiolarian species collected from the siliceous shale bed (d) of the studied section. All Middle Jurassic in age. **1**. *Tricolocapsa ruesti* Tan, from RYSK-01. **2**. *T.* (?) *fusiformis* Yao, from RYSK-02. **3–5**. *T. plicarum* Yao. 3, 4, from RYSK-01; 5, from RYSK-04; 6, *T.* cf. *plicarum* Yao, from RYSK-01. **7**. *T. tetragona* Matsuoka, from RYSK-02. **8**. *T. multispinosa* Sashida, from RYSK-01. **9**. *T.* sp., from RYSK-01; 10. *Willireidellium* sp., from RYSK-02. **11, 12**. *Stichocapsa japonica* Yao. 11, from RYSK-01, 12, from RYSK-04. **13**. *Eucyrtidiellum unumaense* Yao, from RYSK-01. **14**. *E. pustulata* Baumgartner, from RYSK-01. **15**. *E. semifactum* Nagai and Mizutani, from RYSK-04. **16**. *Protounuma* sp., from RYSK-04. **17**. *Stichocapsa*? sp., from RYSK-02. **18**. *Pantanellium* sp., from RYSK-01. **19, 20**. *Archicapsa* sp., from RYSK-01. **21–23**. *Archeodictyomitra* sp., from RYSK-01. **24**. *Trashsuum maxwelli* Pessagno, from RYSK-01. Scale bar equals 100 μm.

cession are judged to be of hemipelagic origin, as indicated by their lithologies characterized by the predominance of microcrystalline particles, radiolarian tests and clay matrix, although a small amount of silt-sized angular quartz grains is also included. This strongly suggests that the siliceous shale member of the present sequence represents the sediments on the hemipelagic sea floor continuously accumulated during Middle Jurassic time. This implies that the siliceous shale beds (beds 1 and 4) of the present succession could be compared with that of the chert-clastics sequence of the Jurassic accretionary complex in Japan (Matsuoka, 1989; Matsuda and Isozaki, 1991). The same siliceous shale is an important member of the Kuzu Complex in general, always ranging from Middle to early Late Jurassic in age, as suggested by its radiolarian contents (Kamata, 1996, 1997).

In contrary, the limestone conglomerate from which the ammonite specimen was unearthed is presumably of shallow sea origin, as suggested by the fact that the fossil fauna ubiquitously discovered from the limestone pebbles is judged to have been derived from the underlying Permian limestone of the Nabeyama Formation. The Permain limestone itself is construed to have been deposited on the top of a submarine topographic high, made by a basaltic bank on the ocean floor, as claimed by the study of Kobayashi (1979). This suggests that the limestone pebbles, including ammonite-bearing calcareous sandstone, were emplaced at the present position by temporary introduction of the shallow sediments into the hemipelagic environment. This hypothesis is supported also by the ammonite-bearing pebble older than both the underlying and overlying siliceous shale beds.

Systematic paleontology

Family Hildoceratidae Hyatt, 1867
Subfamily Harpoceratinae Neumayr, 1875
Genus **Cleviceras** Howarth, 1992

Type species.—*Ammonites exaratus* Young and Bird, 1828, by original designation.

Cleviceras cf. ***chrysanthemum*** (Yokoyama, 1904)

Figure 9

cf. *Hildoceras chrysanthemum* Yokoyama 1904, p. 11, 12, pl. 2, figs. 1-4.

cf. *Harpoceras* (*Harpoceras*) *chrysanthemum* (Yokoyama). Hirano, 1973, p. 1-4, pl. 1, figs. 1-3.

Hildoceratoides chrysanthemum (Yokoyama). Dagys, 1974, p. 56-58, pl. 10, figs. 1-4; pl. 11, figs. 1, 2; pl. 12, fig. 1.

Harpoceras cf. *chrysanthemum* (Yokoyama). Hillebrandt, 1987, pl. 7, figs. 1, 2; pl. 8, fig. 1.

Cleviceras cf. *C. chrysanthemum* (Yokoyama). Jakobs *et al.*, 1994, pl. 1, figs. 19, 20; Jakobs, 1997, p. 50, pl. 4, figs. 1, 2, 5.

Material.—An outer cast of a part of the whorl, strongly flattened parallel to the bedding plane of sandy shale. Not diagonally deformed. Length of the preserved whorl fragment is about 5 cm.

Description.—Overall ontogenetic development of the shell is unknown, because of the very poor state of preservation. Coiling is presumed to be evolute, and the rate of growth of the whorl slow. The whorl section is unknown. The umbilicus seems to be wide and shallow. Ventral region, of which the shape is unknown, is provided with a sharp, prominent ventral keel. Ribbing is of the type of *Harpoceras*, especially of the genus *Cleviceras* Howarth, which is composed of rather sharp, distant, rounded-topped and falcate simple ribs, observable only on relatively well preserved part (younger part) of the whorl; on the preserved last part of the whorl they appear not to be falcate but this is probably because the innermost part of the flank is missing. No suture line is observable.

Comparison.—Despite the poor condition of preservation, the characteristic ribbing strongly suggests that the specimen is a member of the subfamily Harpoceratinae. Among many ammonites of the subfamily known from Japan, the following species show similar ornamentation. *Protogrammoceras yabei* (Hirano, 1971), from the Nishinakayama Formation of the Toyora Group, especially the specimen shown on his pl. 18, fig. 9, has slightly falcate, wide and dense ribs on the flank, but this species includes individuals with denser, more straight ribs (as shown in his pl. 18, figs. 6-8), making the identification is unlikely. *Paltarpites* aff. *platypleurus* (Buckman), also known from the Nishinakayama Formation, presents a similar ornamentation of dense, flat-topped and weakly falcate ribs. The present specimen from Kuzu is, however, more sparsely ribbed, though the general ribbing style is alike, and is not directly comparable to that form. *Harpoceras chrysanthemum*, also described from the Nishinakayama Formation, looks very close to the present specimen. As seen on the lectotype of the species, figured by Hirano (1973, pl. 1, fig. 1), the general pattern of ribbing is similar to that of the present specimen, particularly the falcate and more or less spacious ribbing on the flank. Unfortunately the Kuzu specimen is too fragmentary to be identified as *H. chrysanthemum* itself, so ultimately we treat it as a comparable species of *H. chrysanthemum.*

Remarks.—*Harpoceras chrysanthemum* was first described from the Toyora Group of West Japan (Yokoyama, 1904) as a species of *Hildoceras*. Later this generic identification was rejected because of the absence of a longitudinal groove at the middle of the flank, which is the most important diagnostic character of the genus, and the species was assigned to *Harpoceras*, accompanied by other species (Hirano, 1973). *Harpoceras* was established on the type species *Ammonites falcifer* J. Sowerby, and covers a rather wide variety of forms; the type species representing a spectrum of forms with very involute coiling and dense, fine, and strongly falcate ribbing, whereas the group of *Ammonites exaratus* Young and Bird, on which the genus *Cleviceras* was created by Howarth (1992), shows more sinuous, strong and distant ribbing. The present specimen discovered from Kuzu, is closer to the latter type, to which *Harpoceras chrysanthemum* belongs. Although the fragmentary preservation precludes definite identification, it is here compared with this species.

Geologic age.—Early to Middle Toarcian, as discussed above.

Acknowledgments

We are indebted to N. Tsuchizawa and N. Tsubaki of Yoshizawa Lime Industry Co. Ltd., and H. Hiratsuka of Sumitomo-Osaka Cement Co. Ltd. for their kind permission to carry out the survey in the mines and utilization of the facilities. We wish to express our sincere thanks to H. Hirano (Waseda University) and an anonymous reviewer for their critical reading of the manuscript. The authors thank Hisayoshi Igo (National Science Museum), Hisaharu Igo (Tokyo Gakugei University), K. Sashida and S. Adachi (University of Tsukuba) for invaluable discussions and suggestions concerning the field survey. The first author (Y.K.) would like to express his appreciation to Y. Kikuchi (University of Tsukuba) for his kind help in taking photographs of the ammonite specimen.

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