Reexamination of the Age of the Uppermost Sequence of the Sorachi Group in its Type Area, Hokkaido, Japan

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Reexamination of the Age of the Uppermost Sequence of the Sorachi Group in its Type Area, Hokkaido, Japan

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Abstract

The Sorachi Group of central Hokkaido is characterized by hemipelagic sediments and ophiolitic rock associations. To determine the precise age of the upper Sorachi Group, a key unit in the geotectonic evolution of Hokkaido, radiolarian fossil assemblages have been studied. The results indicate that the upper Sorachi Group may be Albian in age, much younger than previously believed. This age is similar to that obtained for the youngest pelagites of the Nikoro Group of the Tokoro Belt, eastern Hokkaido, although the paleoenvironmental and paleogeographic settings of the two groups may well have differed.

I. Introduction

The Sorachi Group, exposed in the axial part of Hokkaido (Fig. 1), constitutes a major stratigraphic unit in the Kamuikotan Belt and plays a very important role in the early history of the geologic evolution of Hokkaido and its surrounding area (e.g. OKADA, 1982, 1983; JOLIVET, 1986; GRAPES, 1986; KITO *et al.*, 1986). Previous integrated studies of the Sorachi Group showed a broad range of ages spanning Permian to Early Cretaceous times (see OKADA, 1982; KITO *et al.*, 1986). Recent study, however, has shown that all fossils indicating Permian to Triassic ages come from tectonic blocks of chert and limestone in an enveloping melange matrix. This matrix ranges in age from Jurassic (e.g. ISHIZUKA *et al.*, 1983) to Early Cretaceous (e.g. OKADA *et al.*, 1982; ISHIZUKA *et al.*, 1984). These age relationships highlight the need to differentiate between tectonic blocks and the ophiolitic type section (OKADA, 1982) when discussing the origin of the Sorachi Group of central Hokkaido. In the course of a paleomagnetic pilot study, we have added further information on the microfossil fauna of the type section and these results are reported below.

II. Geologic Setting of the Studied Section

The term 'Sorachi Group' was originally applied to describe the geology of the Furano area of the Sorachi District, central Hokkaido (see MATSUMOTO, 1954). In this area Kamuikotan metamorphic rocks (high pressure/low temperature crystalline

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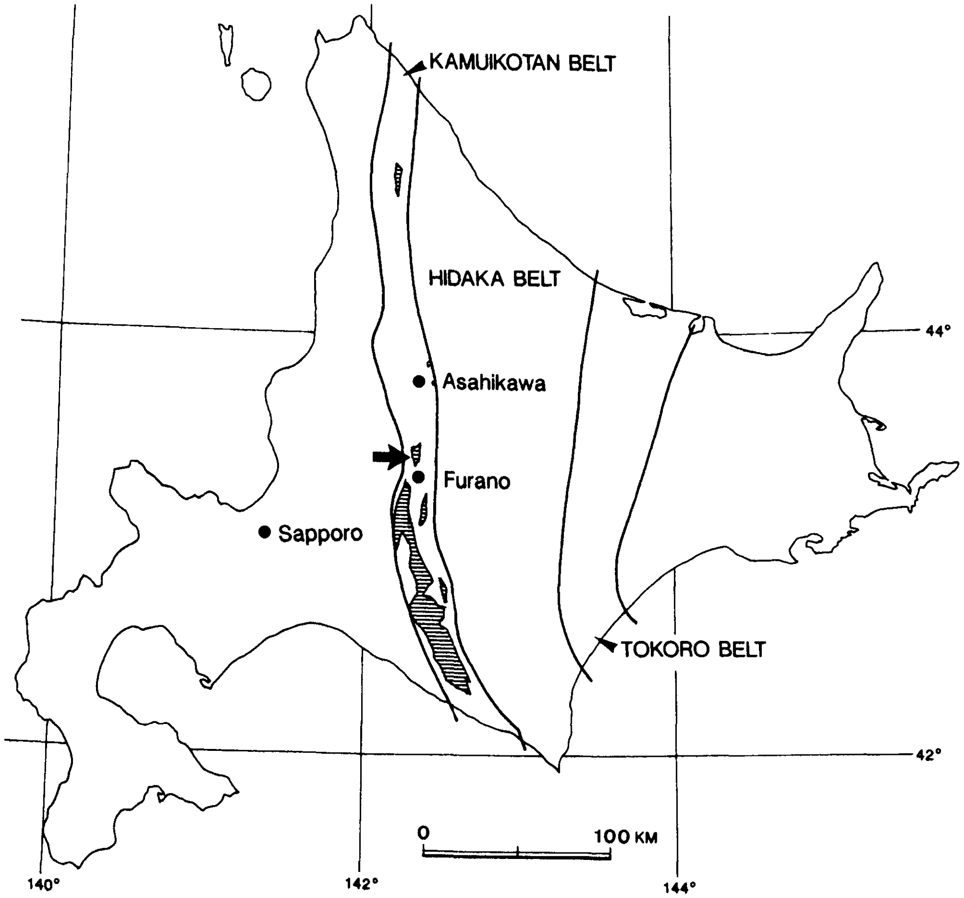


Fig. 1. Index map of Hokkaido showing the tectonic divisions of the axial part of Hokkaido. Ruled areas show the distribution of the Sorachi Group. Arrow indicates the study area.

Table 1. Stratigraphy of the study area and age designations mainly for the Sorachi Group.

Stratigraphy (HASHIMOTO, 1955)			HASHIMOTO (1955)	OKADA *et al.* (1982)	KITO *et al.* (1986)	OKADA *et al.* (This paper)
Upper Yezo Group	Urakawa Formation		Santonian Turonian			
Middle Yezo Group	Nakagawa Formation	Kondoyama Sandstone Member	Cenomanian			
		Umanaigawa Shale Member	Albian			
		Kasamorizawa Sandstone and Conglomerate Member				
Lower Yezo Group	Furano Formation	Shimanoshita Shale Member				
		Tomitoi Sandstone Member	Aptian			
Sorachi Group	Shuyubari Formation		Jurassic	Valanginian	Barremian	Albian
	Yamabe Formation					

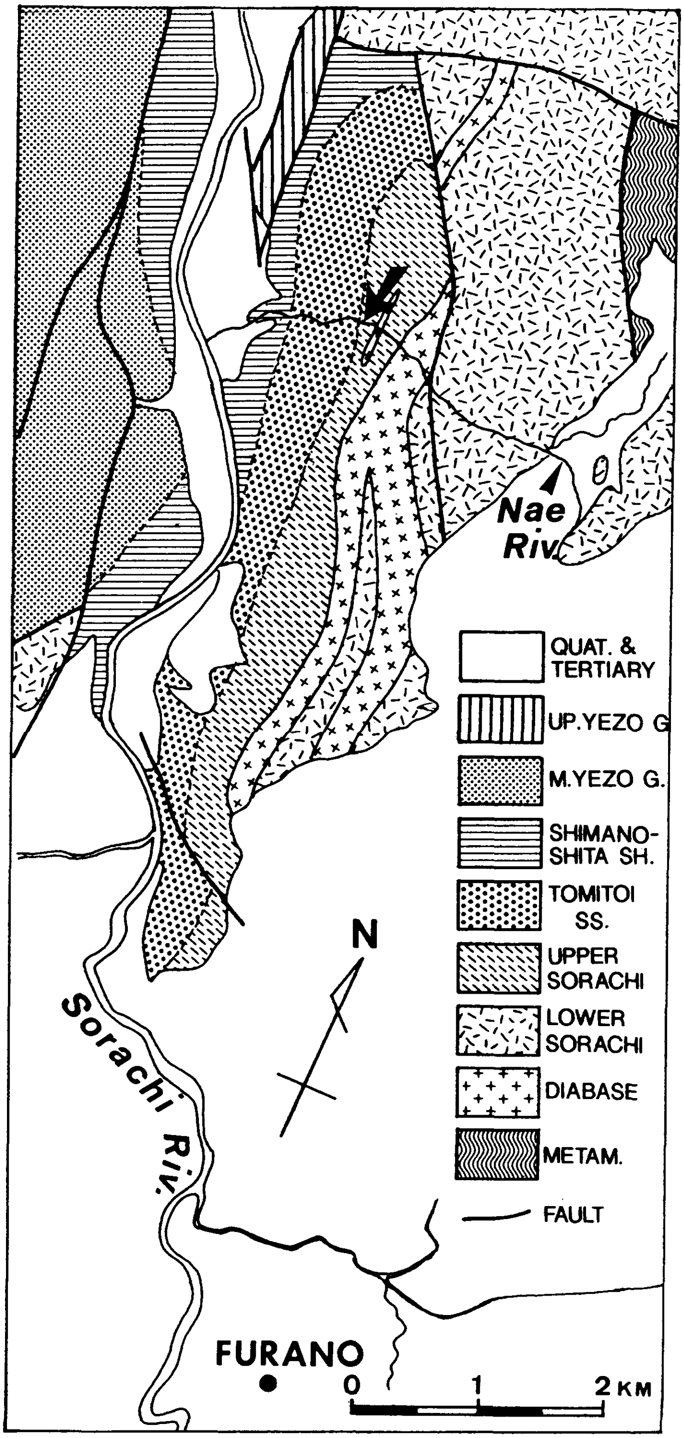


Fig. 2. Geologic sketch map of the Furano area showing the location of the studied sections with arrow. Adapted from HASHIMOTO (1955).

schists and serpentinites) are found with the Sorachi Group and the Cretaceous Yezo Supergroup (HASHIMOTO, 1955) (Fig. 2, Table 1). All of these rocks have been severely affected by complicated fault systems.

The Sorachi Group, composed mainly of chert, siliceous shale, hyaloclastite, basic tuff, pillow basalt and diabase, is divided into the Yamabe Formation (lower sequence) and the Shuyubari Formation (upper sequence) (HASHIMOTO, 1955). The Yamabe Formation is composed of pillow basalt, basic tuff, basaltic hyaloclastite and chert. The Shuyubari Formation consists of chert, basic tuff, hyaloclastite and diabase intrusions. The Sorachi Group, as described in this area, is in fault contact with the Kamuikotan metamorphic rocks.

The Yezo Supergroup (OKADA, 1982) comprises the Lower Yezo Group, Middle Yezo Group, Upper Yezo Group and Hakobuchi Group, in ascending order.

The Lower Yezo Group (Aptian-Albian), which is well-developed in the study area, is further divided into the lower Tomitoi Sandstone Member (about 400 m thick) and the upper Shimanoshita Shale Member (700 to 1000 m thick). The Tomitoi Sandstone Member, which conformably overlies the Sorachi Group in this area, is characterized by flysch-type turbidite facies. The Shimanoshita Shale Member is composed mainly of claystone with minor turbidite sandstone beds. A notable feature of the Shimanoshita Shale Member is the occurrence of *Orbitolina* limestone bodies, which are most likely blocks displaced by slumping from shallow to deep sea environments (OKADA, 1982, 1983).

The Middle Yezo Group (Albian-Turonian) has been divided into the Kasamori-zawa Sandstone and Conglomerate Member, Umanaigawa Shale Member and Kondoyama Sandstone Member, in ascending order. Coarse clastic strata in the Middle Yezo Group in the study area are generally gravity-flow deposits characterized by turbidites.

The Upper Yezo Group (Coniacian-Santonian) is characterized by fine-grained sediments such as siltstones and claystones. Thin beds of fine- to medium-grained turbidite sandstones, however, are sometimes intercalated with the finer-grained sediments.

The Hakobuchi Group (Campanian-Maastrichtian) is characterized by coarse clastics and has yielded *Inoceramus schmidti*(MATSUMOTO and OKADA, 1973). This group, however, has not yet been mapped. From the Lower Yezo Group to the Hakobuchi Group the strata are conformable.

III. Studied Section

We have chosen the Nae River section, where the Sorachi and Lower Yezo Groups are well exposed, for micropaleontological study (Fig. 3). The Sorachi Group in this section consists of diabase and siliceous shale depösts. Detailed lithologies at representative outcrops in the Shuyubari Formation are shown in Fig. 4. The siliceous shale sequence is composed of dark claystone interbedded with thin and thick beds of chert and rhyolitic tuff. Thick chert beds are generally composed of 10 cm thick beds which are greenish blue to gray in color. A few calcareous nodules are found at some horizons. Rare micritic beds are also present.

At site S2, very thin beds (a few centimeters thick) of graded siltstone and

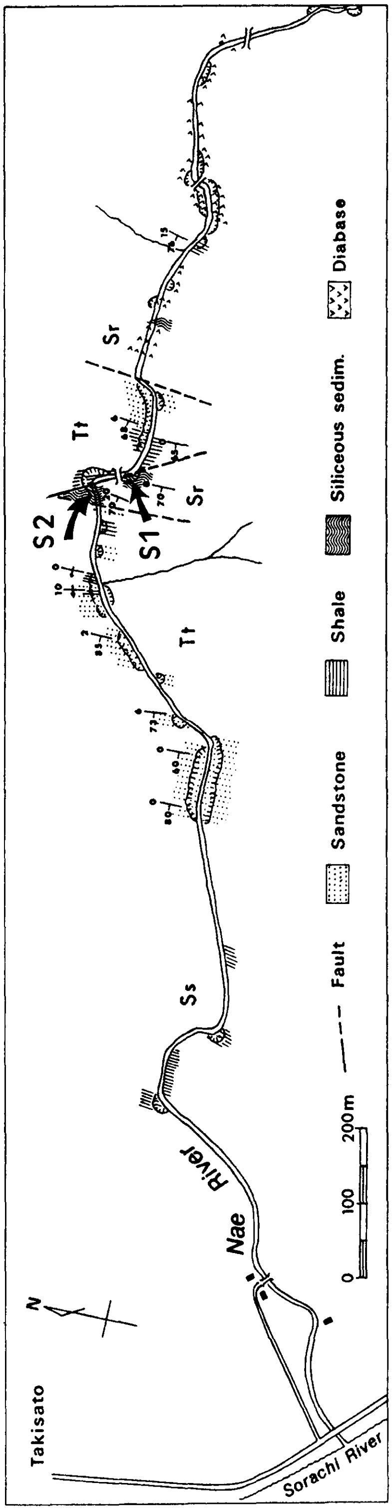


Fig. 3. Field map showing the outcrop conditions and geology along the Nae River. S1 and S2 indicate the sites where the study samples and columnar sections were obtained. Sr: Sorachi Group, Tt: Tomitoi Sandstone Member, Ss: Shimanoshita Shale Member.

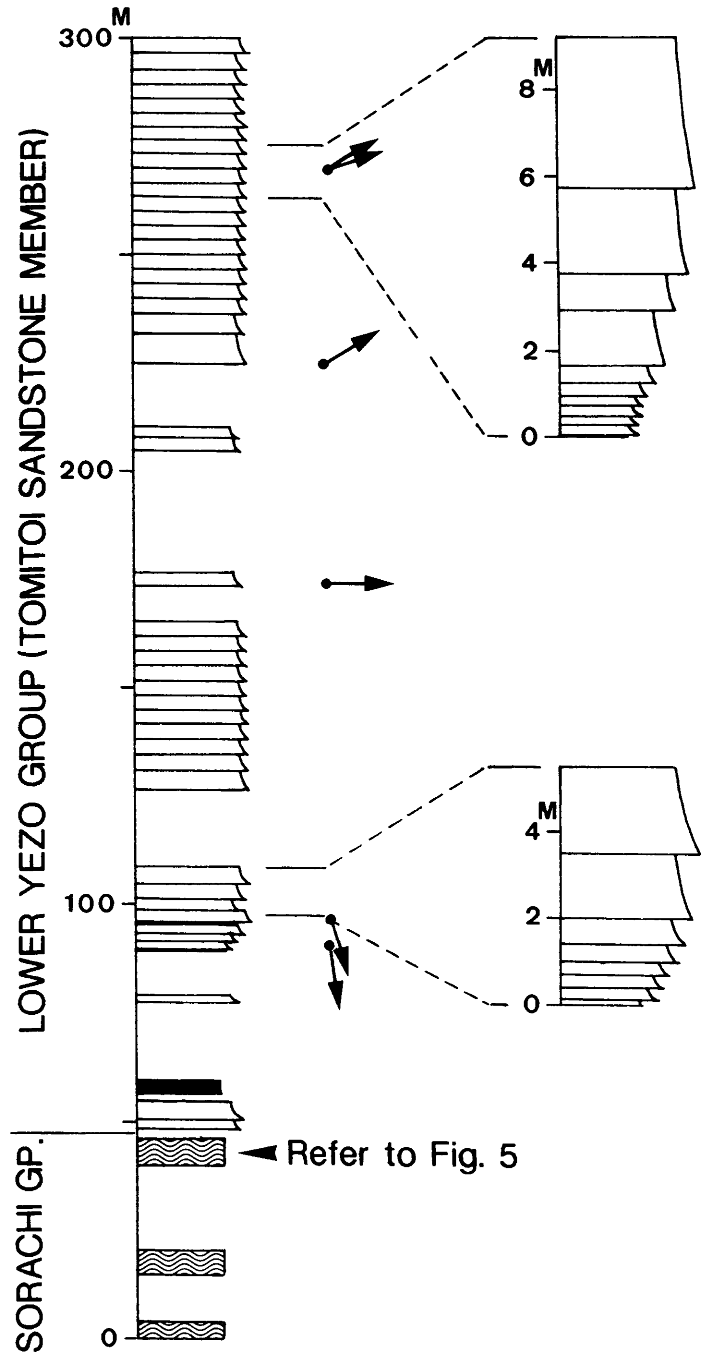


Fig. 4. Columnar sections showing the lithology and paleocurrent directions along the Nae River. Enlarged parts show examples of the thickening- and coarsening-upwards sedimentation unit.

fine-grained sandstone are sporadically interbedded with the siliceous sediments. Chert and micritic beds contain radiolarian fossils which are generally well preserved.

Above the Sorachi Group, the overlying Tomitoi Sandstone Member of the Lower Yezo Group is well exposed along the Nae River. The contact between the Sorachi and Lower Yezo Groups, however, is not exposed.

The Tomitoi Sandstone Member is represented by typical turbidite sandstones showing the sandy flysch facies. Some of these graded sandstones show flute casts, groove casts and other sole marks. Nominal paleocurrent directions inferred from these sedimentary structures are indicated in Fig. 4. The Tomitoi Sandstone sequence also contains some coarsening-upwards sedimentation units, approximately 5 to 10 m thick. The lithological features of the Tomitoi Sandstone Member are shown in Fig. 4.

IV. Micropaleontological Notes

In order to determine the age of the uppermost sequence of the Sorachi Group type section, we have collected micropaleontological samples at two sites (S1 and S2) along with paleomagnetic samples. The sampling positions are shown in columnar sections in Fig. 5. The faunal characteristics of the radiolarians in each of the sections are described below:

1. Section S1

Two samples, S1-300 and S1-1110, were analyzed (Table 2, Plates 1, 2). Sample S1-300 is very rich in well-preserved radiolarians. The predominant species are *Triactoma echiodes*, *Acaeniotyle umbilicata*, *Alievium helenae*, *Sphaerostylus lanceola*, *Thanarla pulchra*, *Archaeodictyomitra lacrimula*, *A. apiara*, *Pseudodictyomitra lilyae*, *P. carpatica*. *Parvicingula boesii*, *Xitus spicularius*, *Mirifusus(?) cf. chenodes*, *Sethocapsa uterculus*, and *Eucrytis micropora*.

Sample S1–1110 contains generally less abundant radiolarians relative to sample S1–300, but like sample S1–300 they are also well preserved. Important species are *Acaeniotyle umbilicata*, *Archaeospongoprunum* cf. *tehamaensis*, *Alievium helenae*, *Hemicryptocapsa* cf. *polyhedra*, *H.* sp. aff. *H. tuberosa*, *Sethocapsa* sp., and *Cyrtocapsa* cf. *grutterinki*.

Species such as *Eucrytis micropora*, *Archaeodictyomitra lacrimula* and *Thanarla pulchra* (sample S1–300) are characteristic of the *E. tenuis* Zone of FOREMAN (1975). At the same time, *Sethocapsa uterculus* is restricted to the *Dibolachras tytthopora* to *Crolanium pythiae* Zones of SCHAAF (1981). The age of the *E. tenuis* Zone is late Valanginian to early Aptian, and the *D. tytthopora* to *C. pythiae* Zones span the Hauterivian to Barremian. Therefore, sample S1–300 suggests a possible age range of Hauterivian to Barremian.

Sample S1–1110 does not contain *Eucrytis tenuis* and *Archaeodictyomitra lacrimula*, but does bear species belonging to the *Acaeniotyle umbilicata* Zone of FOREMAN (1975). Furthermore, the assemblage includes a species conferable to *Hemicryptocapsa polyhedra*, which characterizes the late Albian according to SCHAAF (1981). Thus, section S1 is quite possibly Albian in age.

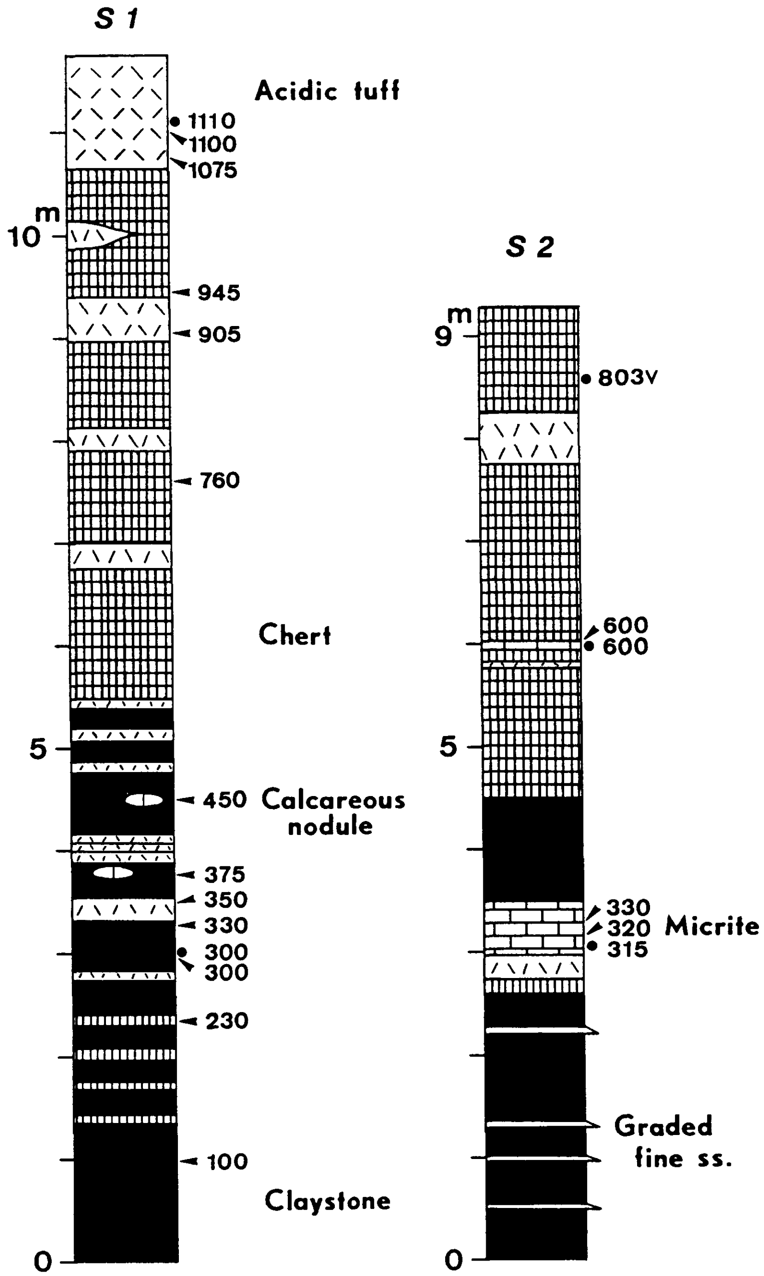


Fig. 5. Lithologic columns from sites S1 and S2 showing the stratigraphic positions of the examined samples. Positions with solid circles indicate the paleontological samples, and those with triangles indicate the paleomagnetic samples.

Table 2. Radiolarian assemblages from sections S1 and S2.

Species / Sample number	S1 300	S1 1100	S2 315	S2 600	S2 803V
Acaeniotyle umbilicata	+	+	+		+
Acanthocircus dicranacanthos				+	
Alievium helenae	+	+		+	+
Archaeodictyomitra apiara	+			+	+
Archaeodictyomitra lacrimula	+				
Archaeospongoprunum cf. *cortinaensis*				+	+
Archaeospongoprunum cf. *tehamaensis*		+		+	
Cyrtocapsa cf. *grutterinki*		+			
Eucyrtis columbaria					+
Eucyrtis bulbosa					+
Eucyrtis micropora	+			+	+
Hemicryptocapsa cf. *polyhedra*		+		+	
Hemicryptocapsa sp. aff. *H. tuberosa*		+	+		
Hemicryptocapsa (?) spp.		+			+
Holocryptocanium cf. *barbui japonicum*	+			+	
Mirifusus (?) cf. *chenodes*	+				
Novixitus (?) sp.	+				
Obesacapsula rotunda					+
Obesacapsula (?) sp.				+	
Parvicingula boesii	+			+	+
Pseudoaulophacus (?) sp.	+				+
Pseudodictyomitra carpatica	+	+	+	+	+
Pseudodictyomitra leptoconica				+	
Pseudodictyomitra lilyae	+			+	+
Pseudodictyomitra puga	+				
Praeconocaryomma sp.				+	+
Sethocapas trachyostraca				+	+
Sethocapsa uterculus	+				+
Sethocapsa spp.	+	+		+	+
Siphocampium (?) sp. aff. *S. davidi*				+	
Sphaerostylus lanceola	+			+	
Staurosphaera septempolata				+	+
Thanarla cf. *broweri*			+	+	+
Thanarla pulchra	+			+	
Triactoma echiodes	+			+	
Xitus spicularius	+			+	+
Xitus (?) sp. A		+	+		+
Zhamoidellum cf. *ornatum*	+			+	+

2. Section S2

Two samples, S2–315 and S2–600, were investigated from section S2 (Table 1, Plates 1, 2). While sample S2–315 contains rare, poorly preserved radiolarians, *Alievium helenae*, *Hemicryptocapsa* sp. aff. *H. tuberosa*, and *Pseudodictyomitra carpatica* were identified.

Well-preserved, abundant radiolarians were found in sample S2–600. The predominant species are *Sphaerostylus lanceola*, *Staurosphaera septempolata*, *Archaeospongoprunum* cf. *tehamaensis*, *Triactoma echiodes*, *Alievium helenae*, *Sethocapsa* cf. *trachyostraca*, *S. uterculus*, *Thanarla pulchra*, *Eucyrtis micropora* (Plate 2), *Pseudodictyomitra carpatica*, *P. lilyae*, *Acanthocircus dicranacanthos*, and *Parvicingula boesii*.

Well-preserved radiolarians were also commonly found in sample 803V. The species identified are chiefly *Archaeodictyomitra apiara*, *Zhamoidellum* cf. *ornatum*, *Podobursa triacantha*, *Parvicingula boesii*, *Staurosphaera septemporata*, *Pseudodictyomitra lilyae*, *P. carpatica*, *Xitus spicularius*, *X.*(?) sp. A, *Sethocapsa uterculus*, and *Obesacapsula rotunda* (Plates 1, 2).

Sample S2–315 does not contain any index fossils charactering either FOREMAN's (1975) or SCHAAF's (1981) zonation, but a radiolarian assemblage characteristic of the Early Cretaceous is present. Sample S2–600, however, bears an assemblage which is correlatable to FOREMAN's (1975) *Eucrytis tenuis* Zone. In addition, *Sethocapsa uterculus* is restricted to the *Dibolachras tytthopora* to *Crolanium pythiae* Zones of SCHAAF (1981). Therefore, these radiolarians suggest an age of Hauterivian to Barremian, identical to that obtained from sample S1–300.

V. Concluding Remarks

One of us (OKADA) has reported preliminary data suggesting that the age of the uppermost sequence of the Sorachi Group in its type area is Valanginian (OKADA *et al.*, 1982). As described above, the present work has added new data providing a more precise age for the uppermost sequence of the Sorachi Group.

Plate 1

Scanning electron micrographs of radiolarians. Scale bar in all figures=100μm.

Fig. 1. *Sphaerostylus lanceola* (PARONA) group
S2–600

Fig. 2. *Staurosphaera septemporata* PARONA
803V

Fig. 3. *Triactoma echiodes* FOREMAN
S1–300

Fig. 4. *Archaeospongoprunum* cf. *tehamaensis* PESSAGNO
S2–600

Fig. 5. *Alievium helenae* SCHAAF
S1–300

Fig. 6. *Pseudoaulophacus* sp.
S1–300

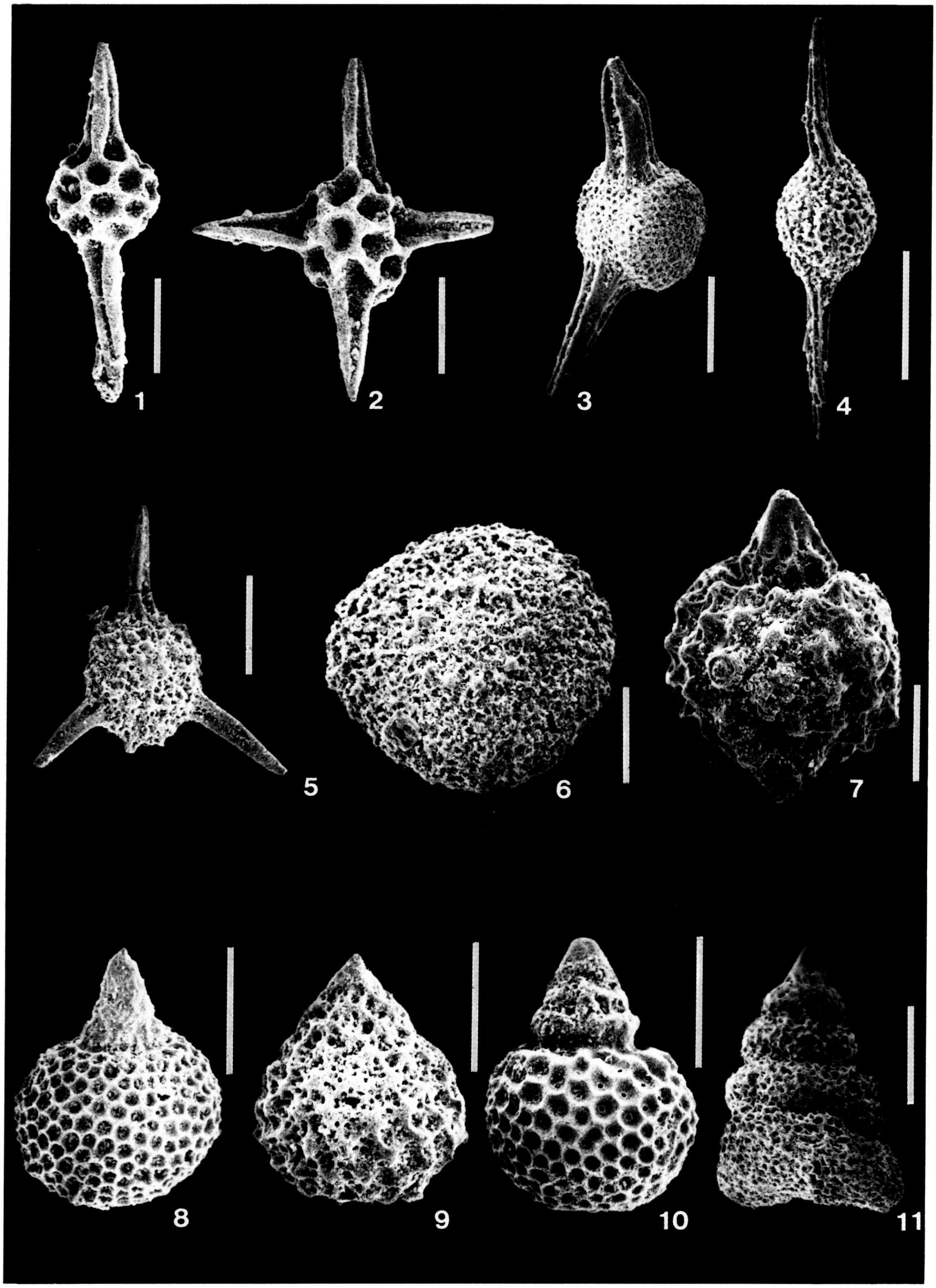
Fig. 7. *Sethocapsa trachyostraca* FOREMAN
S1–300

Fig. 8. *Sethocapsa* sp.
S1–300

Fig. 9. *Cyrtocapsa* cf. *grutterinki* TAN SIN HOK
S–1110

Fig. 10. *Sethocapsa uterculus* (PARONA)
803V

Fig. 11. *Obesacapsula rotunda* PESSAGNO
803V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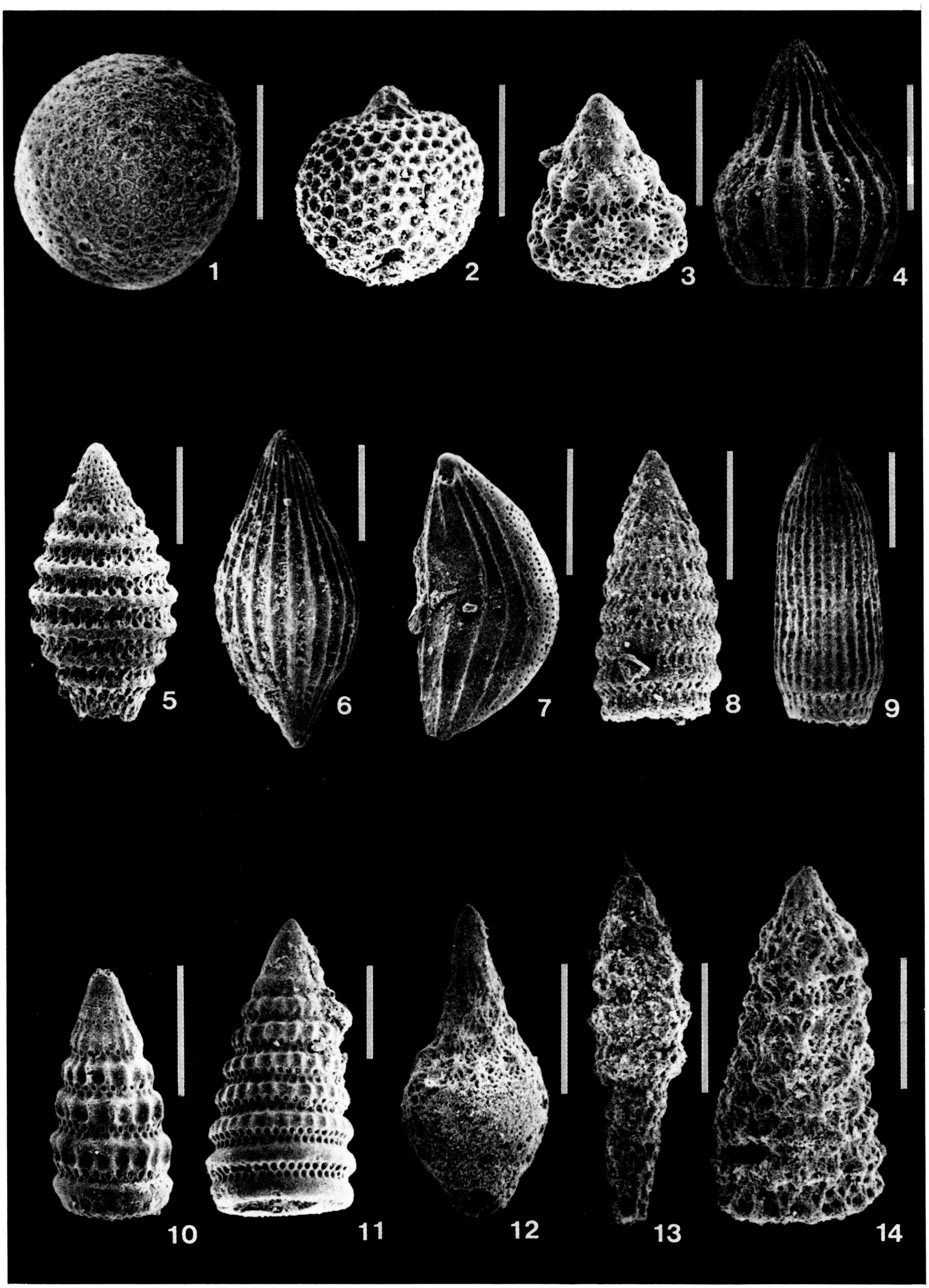

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Radiolarian assemblages from the lower portion (S1–300) of section S1 suggest an Hauterivian to Barremian age, whereas those from the top of the section (S–1110) suggest an Albian age. At section S2, radiolarians from the upper part (S2–600 and 803V) suggest a Valanginian to Barremian age. The upper portion of section S2, however, was not dated.

Considering the available data, the upper sequence of the Sorachi Group in its type area ranges from Hauterivian to Albian, superseding previous assignments of this sequence to the Valanginian and of the Lower Yezo Group to the late Valanginian to early Barremian (KITO *et al.*, 1986). The new age and stratigraphic relationships (i.e. thin sandstone layers in the upper Sorachi sequence) suggest that there was no significant gap in time between deposition of the upper Sorachi and Lower Yezo sequences.

The Early Cretaceous age of the Sorachi Group is also common to that of the melange subbelt of the Hidaka Belt (KIMINAMI *et al.*, 1986) and the Nikoro Group of the Tokoro Belt (OKADA *et al.*, 1989). The upper Sorachi Group, however, must have been deposited much closer to a volcanic arc than the Nikoro Group since the Sorachi sediments are characterized by terrigenous muds and rhyolitic tuff as well as chert and micritic sediments. In sharp contrast to the Sorachi sediments, the Nikoro sediments are composed mainly of non-terrigenous chert and micrite, which were

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Plate 2

Scanning electron micrographs of radiolarians. Scale bar in all figures=100μm.

Fig. 1. *Holocryptocanium* cf. *barbui japonicum* NAKASEKO & NISHIMURA
S1–300

Fig. 2. *Hemicryptocapsa* (?) sp.
S1–1100

Fig. 3. *Xitus* (?) sp. A in NAKASEKO & NISHIMURA, 1981
803V

Fig. 4. *Thanarla pulchra* (SQUINABOL)
S1–300

Fig. 5. *Parvicingula boesii* (RÜST)
803V

Fig. 6. *Archaeodictyomitra lacrimula* (FOREMAN)
S1–300

Fig. 7. *Eucyrtis columbaria* RENZ
803V

Fig. 8. *Pseudodictyomitra leptoconica* (FOREMAN)
S2–600

Fig. 9. *Archaeodictyomitra apiara* (TAN SIN HOK)
S1–300

Fig. 10. *Pseudodictyomitra lilyae* (TAN SIN HOK)
803V

Fig. 11. *Pseudodictyomitra carpatica* (LOZYNYAK)
803V

Fig. 12. *Mirifusus* (?) cf. *chenodes* (RENZ)
S1–300

Fig. 13. *Eucyrtis micropora* (SQUINABOL)
S2–600

Fig. 14. *Xitus spicularius* (ALIEV)
803V

interpreted on the basis of micropaleontological and preliminary paleomagnetic data to have been deposited near the equator on the Izanagi Plate in Late Jurassic to Late Cretaceous times (OKADA *et al.*, 1989). Therefore, it is highly likely that the paleogeographic separation between the Sorachi Group (type section) and the Nikoro Group was great in Early Cretaceous time and that they have obtained their current proximal position due to subsequent tectonic transport.

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