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Report

Preliminary report on the radiolarian age of the Upper Cretaceous Matoya Group (Shimanto belt) in the Toba District, Mie Prefecture, Southwest Japan

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Abstract: A detailed field mapping and radiolarian dating in the Toba District, the Shima Peninsula (eastern tip of the Kii Peninsula) have revealed Coniacian–Campanian mudstones of the Upper Cretaceous Matoya Group. This group belongs to the Shimanto belt (northern subbelt) that formed along the plate boundary where the Kula plate has been subducting beneath the paleo-Asian continent. Seven out of 51 radiolarian-bearing samples from different outcrops of mudstone yield relatively well-preserved radiolarian assemblages, which are concentrated in three age-groups: (i) Early Coniacian, (ii) Early Campanian or Middle Santonian–Middle Campanian, and (iii) Middle–Late Campanian. This evidence has a potential to chronologically and stratigraphically divide the Matoya Group into several units.

Keywords: radiolaria, Upper Cretaceous, Matoya Group, Shimanto belt, Toba, Shima, Mie Prefecture, Kii Peninsula, Southwest Japan

1. Introduction

The Matoya Group distributed in the eastern Kii Peninsula is an Upper Cretaceous accretionary complex in the Shimanto belt. Several previous studies on Albian to Campanian radiolarians, which mentioned to constrain the age of terrigenous clastic rocks of this group, have been published (Nakaseko *et al*., 1979; Nakaseko and Nishimura, 1981; Mizutani *et al*., 1982; Mizugaki, 1987; Obase, 1988; Tanabe and Kano, 1994; Yamanashi and Kashiwagi, 2010; Ohta *et al*., 2013). Nevertheless, in the Shima Peninsula (eastern tip of the Kii Peninsula) where the Toba District is located, the Matoya Group has been poorly dated because Yamagiwa (1957) and Obase (1988) did not list nor illustrate any radiolarians in their reports.

In this paper, the results of a biostratigraphical study on Early Coniacian to Late Campanian radiolarian-bearing mudstones in the Toba District is documented to provide age data, and will be used for the next issue of the regional stratigraphic investigation of the Matoya Group with more precise age determination. During the field survey, more than one hundred of rock sample for radiolarian dating in the Toba District were collected, and seven out of 51 radiolarian-bearing samples are treated for this preliminary report.

2. Geological setting

The Toba District is located in the Shima Peninsula (eastern tip of the Kii Peninsula), and occupies the area including a southern part of Toba City and a northern part of Shima City, Mie Prefecture (Fig. 1). In the Shima Peninsula, a thick sedimentary sequence called the Matoya Group (Yamagiwa, 1957) is dominated by terrigenous clastic rocks such as mudstone and sandstone associated with minor pelagic chert. This group formed as an accretionary complex in the Shimanto belt: Late Cretaceous subduction zone where the Kula plate has been subducting beneath the paleo-Asian continent. This group contacts with the Tsuiji Complex (Jurassic accretionary complex in the Chichibu belt) by the Butsuzo Tectonic Line to the northwest, and faces Ise Bay (Enshunada Sea) to the southeast. The structure of this group is relatively simple: NE–SW strike with moderate dip to NW.

3. Materials and method

The radiolarians examined in this study occur in mudstones. The rock samples were crushed, individually soaked in 5% HF solution for 10 to 15 hours, and washed through a 62 μm mesh sieve (235#). The resulting residue was boiled with 30% HCl and HNO_3 admixture for more

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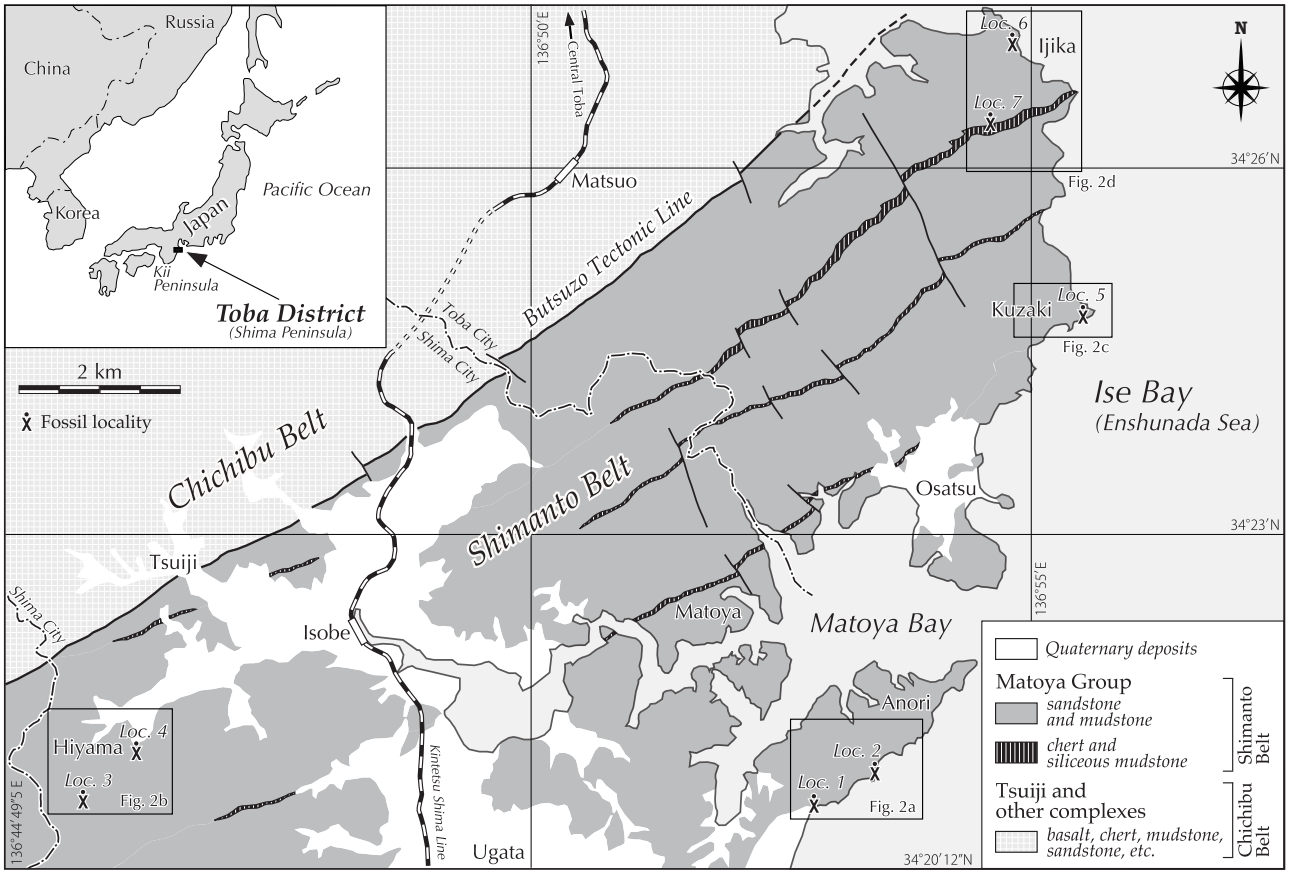

Fig. 1 Location map and geological sketch map of the Matoya Group in the Toba District.
The Toba District is located at the Shima Peninsula (eastern tip of the Kii Peninsula). The Matoya Group belonging to the Shimanto belt, is distributed along the coastline of Enshunada Sea, and contacts with Jurassic complexes in the Chichibu belt through the Butsuzo Tectonic Line. Detailed radiolarian localities with symbols are given in Fig. 2. Loc.: Locality.

than 20 minutes, sieved again and left to dry. The residue of each processed sample was then examined under a stereomicroscope and radiolarian remains were picked by hand with an ink brush for examination by scanning electronic microscope (SEM).

4. Localities and radiolarian assemblages

The sample localities (Locs. 1–7) are plotted on topographic maps published on the website of the Geospatial Information Authority of Japan (Fig. 2), and their outcrops are shown in Fig. 3. Identified radiolarian species are listed in Table 1 and given on Plates 1, 2 and 3. The outcrops are mostly composed of silty mudstones; they are not only laminated but also locally intercalated with sandstone beds. Well-preserved radiolarians are rarely included in all examined samples (Fig. 3h). Below is a description of the radiolarian assemblage of each locality.

4. 1. Locality 1 (Figs. 2a and 3a)

Location: 1.8 km southwest of Anori, Shima City. (34°20′43.8″ N/136°52′54.4″ E)
Sample number: TB 31-06.
Lithology: Black, slaty foliated mudstone.
Assemblage: *Dactyliosphaera* sp. aff. *D. silviae* Squinabol, *Orbiculiforma sacramentoensis* Pessagno, *Pseudoaulophacus praefloresensis* Pessagno, *Archaeospongoprunum hueyi* Pessagno, *Patellula planoconvexa* (Pessagno), *Rhopalosyringium magnificum* Campbell and Clark, *Cryptamphorella macropora* Dumitrică, *Diacanthocapsa* sp. cf. *D. ovoidea* Dumitrică, *Dictyomitra densicostata* Pessagno, *Amphipternis stocki* (Campbell and Clark), *Stichomitra manifesta* Foreman (Plate 1).

4. 2. Locality 2 (Figs. 2a and 3b)

Location: 900 m southwest of Anori, Shima City. (34°20′59.0″ N/136°53′31.2″ E)
Sample number: TB 31-03.
Lithology: Dark gray, weakly slaty foliated, silty mudstone, with fine-grained sandstone interbeds.
Assemblage: *Orbiculiforma* sp. cf. *O. railensis* Pessagno, *Alievium gallowayi* (White), *Pseudoaulophacus* sp. cf. *P. lenticulatus* (White), *Archaeospongoprunum hueyi* Pessagno,

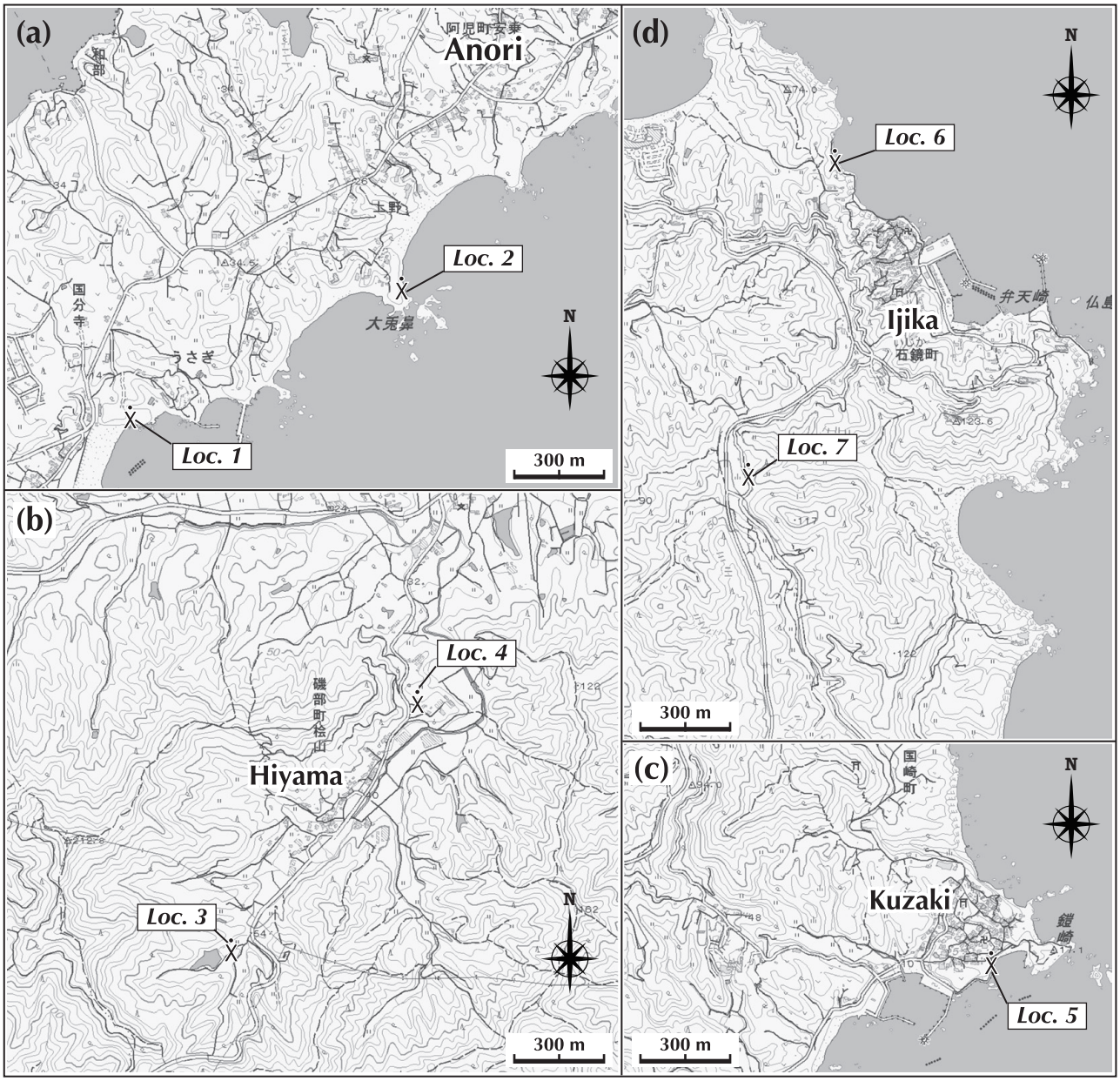

Fig. 2 Radiolarian localities.
Topographic maps are downloaded from the website of Geospatial Information Authority of Japan. URL of each map is as follows: (a) http://maps.gsi.go.jp/#16/34.351488/136.888393/ &base=std &ls=std&disp=1&vs=c1j0l0u0f1, (b) http://maps.gsi.go.jp/#16/34.348565/ 136.763424/&base= std&ls=std&disp=1&vs=c1j0l0u0f1, (c) http://maps.gsi.go.jp/#16/ 34.414690/136.922296/&bas e=std&ls=std&disp=1&vs=c1j0l0u0f1, (d) http://maps.gsi.go.jp/#17/34.444393/136.917077/&b ase=std&ls=std&disp=1&vs=c1j0l0u0f1. Loc.: Locality.

Rhopalosyringium magnificum Campbell and Clark, *Cryptamphorella sphaerica* (White), *Cryptamphorella* sp. B sensu Bąk (1996), *Eastonerius* sp. aff. *E. acuminatus* (Dumitrică), *Dictyomitra multicostata* Zittel, *Dictyomitra densicostata* Pessagno, *Thanarla* sp. aff. *T. veneta* (Squinabol), *Amphipternis stocki* (Campbell and Clark), *Amphipyndax tylotus* Foreman, *Amphipyndax* sp. cf. *A. tylotus* Foreman, *Xitus spicularius* (Aliev), (Plate 1).

4. 3. Locality 3 (Figs. 2b and 3c)
Location: 780 m southwest of Hiyama, Shima City. (34°20′37.9″ N/136°45′34.6″ E)
Sample number: TB 20-03.
Lithology: Dark to light gray, slaty foliated mudstone,

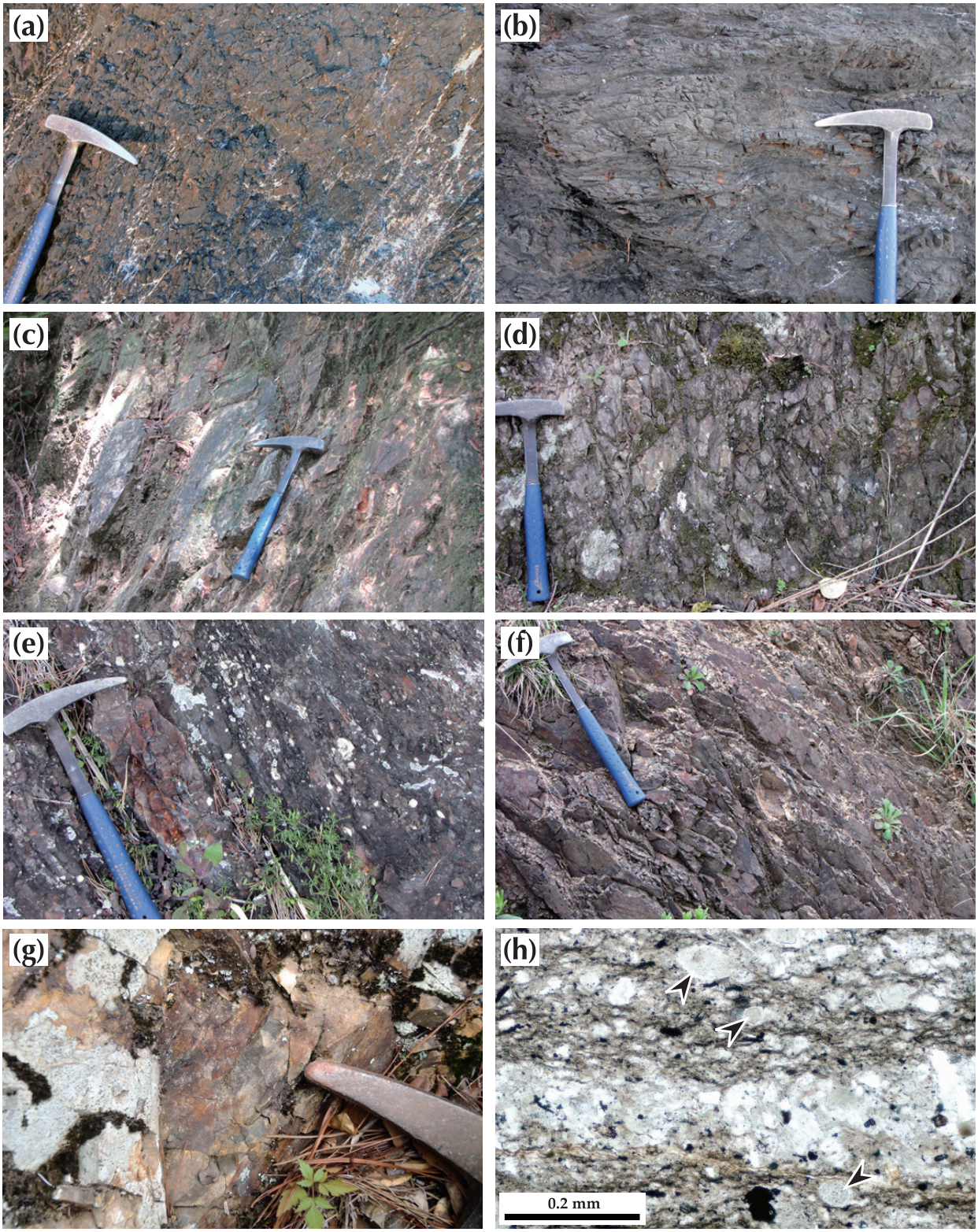

Fig. 3 Outcrop of radiolarian localities and a thin section of the mudstone.
(a) Locality 1 (TB31-06): Black slaty mudstone, southwest of Anori, (b) Locality 2 (TB31-03): Dark gray silty mudstone with fine-grained sandstone interbeds, southwest of Anori, (c) Locality 3 (TB20-03): Dark to light gray slaty mudstone, with planar lamination, southwest of Hiyama. (d) Locality 4 (TB20-02): Pale to dark gray silty mudstone, northeast of Hiyama, (e) Locality 5 (TB05-12): Dark gray silty mudstone with fine-grained sandstone interbeds at Kuzaki, (f) Locality 6 (TB01-04): Black silty mudstone with sandstone interbeds, northwest of Ijika, (g) Locality 7 (TB01-02a): Dark gray massive mudstone, southwest of Ijika, (h): Thin section of a representative silty mudstone, with radiolarian remains (arrows).

Table 1 List of radiolarian species detected from the Matoya Group in the Toba District.

	Radiolarian Species	Locality Number (Loc.)	7	6	5	4	3	2	1
		Sample Number	TB01-02a	TB01-04	TB05-12	TB20-02	TB20-03	TB31-03	TB31-06
Spumellaria	*Archaeocenosphaera*? *mellifera* O'Dogherty 1994			+					
	Conocaryomma universa (Pessagno 1976)		+						
	Conocaryomma californiaensis (Pessagno 1976)			+					
	Dactyliosphaera sp. aff. *D. silviae* Squinabol 1904								+
	Orbiculiforma sacramentoensis Pessagno 1973								+
	Orbiculiforma sp. cf. *O. railensis* Pessagno 1977							+	
	Alievium gallowayi (White 1928)							+	
	Alievium sp. cf. *A. gallowayi* (White 1928)				+	+			
	Alievium sp. cf. *A. praegallowayi* Pessagno 1972		+	+					
	Pseudoaulophacus lenticulatus (White 1928)				+	+			
	Pseudoaulophacus sp. cf. *P. lenticulatus* (White 1928)							+	
	Pseudoaulophacus praefloresensis Pessagno 1972								+
	Pseudoaulophacus sp. cf. *P. praefloresensis* Pessagno 1972		+						
	Pseudoaulophacus floresensis Pessagno 1963				+	+	+		
	Pseudoaulophacus pargueraensis Pessagno 1963		+						
	Pseudoaulophacus sp. cf. *P. pargueraensis* Pessagno 1963						+		
	Archaeospongoprunum sp. cf. *A. stocktonensis* Pessagno 1973						+		
	Archaeospongoprunum sp. aff. *A. andersoni* Pessagno 1973			+					
	Archaeospongoprunum hueyi Pessagno 1973							+	+
	Pyramispongia glascockensis Pessagno 1973		+						
	Patellula planoconvexa (Pessagno 1963)								+
	Patellula verteroensis (Pessagno 1963)		+	+		+	+		
Nassellaria	*Rhopalosyringium magnificum* Campbell and Clark 1944					+		+	+
	Rhopalosyringium sp. A sensu Bandini *et al*. 2008		+						
	Cryptamphorella sphaerica (White 1928)					+		+	
	Cryptamphorella macropora Dumitrică 1970						+		+
	Cryptamphorella sp. aff. *C. gilkeyi* (Dumitrica 1973)			+					
	Cryptamphorella wogiga Empson-Morin 1981				+				
	Cryptamphorella sp. B sensu Bąk 1996							+	
	Hemicryptocapsa polyhedra Dumitrică 1970			+					
	Theocampe urna (Foreman 1971)				+				
	Theocampe salillum Foreman 1971		+			+	+		
	Diacanthocapsa ovoidea Dumitrică 1970						+		
	Diacanthocapsa sp. cf. *D. ovoidea* Dumitrică 1970								+
	Diacanthocapsa sp. cf. *D. ancus* (Foreman 1968) sensu Dumitrică 1970						+		
	Eastonerius sp. aff. *E. acuminatus* (Dumitrică 1970)							+	
	Archaeodictyomitra squinaboli Pessagno 1976		+						
	Dictyomitra undata Squinabol 1904				+				
	Dictyomitra sp. cf. *D. gracilis* (Squinabol 1903)		+						
	Dictyomitra formosa Squinabol 1904		+	+					
	Dictyomitra duodecimcostata (Squinabol 1903) sensu Foreman (1975)				+				
	Dictyomitra multicostata Zittel 1876		+	+			+	+	
	Dictyomitra densicostata Pessagno 1976					+		+	+
	Dictyomitra sp. aff. *D. densicostata* Pessagno 1976		+						
	Dictyomitra koslovae Foreman 1975				+	+	+		
	Dictyomitra andersoni (Campbell and Clark 1944)		+						
	Thanarla sp. aff. *T. veneta* (Squinabol 1903)							+	
	Amphipternis stocki (Campbell and Clark 1944)		+	+		+	+	+	+
	Amphipyndax tylotus Foreman 1978							+	
	Amphipyndax sp. aff. *A tylotus* Foreman 1978							+	
	Xitus spicularius (Aliev 1965)							+	
	Torculum sp. aff. *T. bastetani* O'Dogherty 1994			+					
	Pseudodictyomitra tiara (Holmes 1900)		+	+					
	Pseudoeucyrtis sp. cf. *P. spinosa* (Squinabol 1903)		+						
	Stichomitra communis Squinabol 1903		+						
	Stichomitra manifesta Foreman 1978		+			+			+
	Stichomitra asymbatos Foreman 1968		+			+			
	Stichomitra sp. aff. *S. asymbatos* Foreman 1968						+		
	Stichomitra sp. cf. *S. conicus* (Nakaseko and Nishimura 1981)					+			

with planar lamination.
Assemblage: *Pseudoaulophacus floresensis* Pessagno, *Pseudoaulophacus* sp. cf. *P. parguerensis* Pessagno, *Archaeospongoprunum* sp. cf. *A. stocktonensis* Pessagno, *Patellula verteroensis* (Pessagno), *Cryptamphorella macropora* Dumitrică, *Theocampe salillum* Foreman, *Diacanthocapsa ovoidea* Dumitrică, *Diacanthocapsa* sp. cf. *D. ancus* (Foreman) sensu Dumitrică (1970), *Dictyomitra multicostata* Zittel, *Dictyomitra koslovae* Foreman, *Amphipternis stocki* (Campbell and Clark), *Stichomitra* sp. cf. *S. asymbatos* Foreman (Plate 2).

4. 4. Locality 4 (Figs. 2b and 3d)
Location: 280 m northeast of Hiyama, Shima City.
(34°21′5.3″ N/136°45′59.2″ E)
Sample number: TB 20-02.
Lithology: Pale to dark gray, weakly slaty foliated, silty mudstone.
Assemblage: *Alievium* sp. cf. *A. gallowayi* (White), *Pseudoaulophacus lenticulatus* (White), *Pseudoaulophacus floresensis* Pessagno, *Patellula verteroensis* (Pessagno), *Rhopalosyringium magnificum* Campbell and Clark, *Cryptamphorella sphaerica* (White), *Theocampe salillum* Foreman, *Dictyomitra densicostata* Pessagno, *Dictyomitra koslovae* Foreman, *Amphipternis stocki* (Campbell and Clark), *Stichomitra manifesta* Foreman, *Stichomitra asymbatos* Foreman, *Stichomitra* sp. cf. *S. conicus* (Nakaseko and Nishimura) (Plate 2).

4. 5. Locality 5 (Figs. 2c and 3e)
Location: Kuzaki, Toba City.
(34°24′46.3″ N/136°55′31.9″ E)
Sample number: TB 05-12.
Lithology: Dark gray, silty mudstone, with fine-grained sandstone interbeds.
Assemblage: *Alievium* sp. cf. *A. gallowayi* (White), *Pseudoaulophacus lenticulatus* (White), *Pseudoaulophacus floresensis* Pessagno, *Cryptamphorella wogiga* Empson-Morin, *Theocampe urna* (Foreman), *Dictyomitra undata* Squinabol, *Dictyomitra duodecimcostata* (Squinabol), *Dictyomitra koslovae* Foreman (Plate 2).

4. 6. Locality 6 (Figs. 2d and 3f)
Location: 520 m northwest of Ijika, Toba City.
(34°27′2.1″ N/136°54′53.5″ E)
Sample number: TB 01-04.
Lithology: Black, silty mudstone, with sandstone interbeds.
Assemblage: *Archaeocenosphaera*? *mellifera* O'Dogherty, *Conocaryomma californiaensis* (Pessagno), *Alievium* sp. cf. *A. praegallowayi* Pessagno, *Archaeospongoprunum* sp. aff. *A. andersoni* Pessagno, *Patellula verteroensis* (Pessagno), *Cryptamphorella* sp. aff. *C. gilkeyi* (Dumitrica), *Hemicryptocapsa polyhedra* Dumitrică, *Dictyomitra formosa* Squinabol, *Dictyomitra multicostata* Zittel, *Amphipternis stocki* (Campbell and Clark), *Torculum* sp. aff. *T. bastetani* O'Dogherty, *Pseudodictyomitra tiara* (Holmes), (Plate 3).

4. 7. Locality 7 (Figs. 2d and 3g)
Location: 910 m southwest of Ijika, Toba City.
(34°26′25.4″ N/136°54′42.3″ E)
Sample number: TB 01-02a.
Lithology: Dark gray, massive mudstone.
Assemblage: *Conocaryomma universa* (Pessagno), *Alievium* sp. cf. *A. praegallowayi* Pessagno, *Pseudoaulophacus* sp. cf. *P. praefloresensis* Pessagno, *Pseudoaulophacus parguerensis* Pessagno, *Pyramispongia glascockensis* Pessagno, *Patellula verteroensis* (Pessagno), *Rhopalosyringium* sp. A sensu Bandini *et al*. (2008), *Theocampe salillum* Foreman, *Archaeodictyomitra squinaboli* Pessagno, *Dictyomitra* sp. cf. *D. gracilis* (Squinabol), *Dictyomitra formosa* Squinabol, *Dictyomitra multicostata* Zittel, *Dictyomitra* sp. aff. *D. densicostata* Pessagno, *Dictyomitra andersoni* (Campbell and Clark), *Amphipternis stocki* (Campbell and Clark), *Pseudodictyomitra tiara* (Holmes), *Pseudoeucyrtis* sp. cf. *P. spinosa* (Squinabol), *Stichomitra communis* Squinabol, *Stichomitra manifesta* Foreman, *Stichomitra asymbatos* Foreman (Plate 3).

5. Age determination

In order to determine the age of radiolarian assemblages extracted from the mudstone samples in the Toba District, the biostratigraphic ranges of each species and the existing Upper Cretaceous zonations (e.g., Dumitrică, 1970; Foreman, 1975; Pessagno, 1976, 1977; Taketani, 1982; Sanfilippo and Riedel, 1985; Thurow, 1988; Hollis and Kimura, 2001; Hashimoto *et al*., 2015) are primarily used. Nevertheless, there are considerable problem that the ranges of some species are not compatible among the above authors, as pointed out by Bandini *et al*. (2008). For dating the radiolarian assemblages, this paper follows essentially the same approach as Bandini *et al*. (2008); a maximum range of each species, which is obtained by combining the ranges of each species from the above authors, is established.

Consequently, an age of the radiolarian assemblage from each sample can be determined based on the co-occurrence of included species, which range from the Coniacian to Campanian.

TB 31-06 (Locality 1)

Although several species having a wide range in age from Cenomanian to Early Maastrichtian, the occurrence of *Orbiculiforma sacramentoensis* gives a late Middle–early Late Campanian age.

TB 31-03 (Locality 2)

The co-occurrence of *Amphipyndax tylotus* and *Xitus spicularius* suggests a late Middle Campanian age.

TB 20-03 (Locality 3)

The co-occurrence of *Pseudoaulophacus floresensis*, *Patellula verteroensis* and *Diacanthocapsa ovoidea* gives a Middle Santonian–Early Campanian age.

Table 2 Biostratigraphic ranges of radiolarian species from the Matoya Group in the Toba District.

Sample	Locality	Species	Lower Creta.	Upper Cretaceous																					Paleogene
				Cenomanian			Turonian			Coniacian			Santonian			Campanian				Maastrichtian					
				Lower	Mid	Upper	Lower	Middle	Upper	Lower	Mid	Upper	L	M	Upper	Lower	Middle		Uppr	Lower		Upper			
TB 01-02a	(Loc. 7)	*Conocaryomma universa*																							
		Alievium sp. cf. *A. praegallowayi*																							
		Pseudoaulophacus sp. cf. *P. praefloresensis*																							
		Pseudoaulophacus pargueraensis																							
		Pyramispongia glascockensis																							
		Patellula verteroensis																							
		Rhopalosyringium sp. A sensu Bandini *et al*. 2008																							
		Theocampe salillum Foreman																							
		Archaeodictyomitra squinaboli																							
		Dictyomitra sp. cf. *D. gracilis*																							
		Dictyomitra formosa																							
		Dictyomitra multicostata																							
		Dictyomitra sp. aff. *D. densicostata*																							
		Dictyomitra andersoni																							
		Amphipternis stocki																							
		Pseudodictyomitra tiara																							
		Pseudoeucyrtis sp. cf. *P. spinosa*																							
		Stichomitra communis																							
		Stichomitra manifesta																							
		Stichomitra asymbatos																							
TB 01-04	(Loc. 6)	*Archaeocenosphuera? mellifera*																							
		Conocaryomma californiaensis																							
		Alievium sp. cf. *A. praegallowayi*																							
		Archaeospongoprunum sp. aff. *A. andersoni*																							
		Patellula verteroensis																							
		Cryptamphorella sp. aff. *C. gilkeyi*																							
		Hemicryptocapsa polyhedra																							
		Dictyomitra formosa																							
		Dictyomitra multicostata																							
		Amphipternis stocki																							
		Torculum sp. aff. *T. bastetani*																							
		Pseudodictyomitra tiara																							
TB 05-12	(Loc. 5)	*Alievium* sp. cf. *A. gallowayi*																							
		Pseudoaulophacus lenticulatus																							
		Pseudoaulophacus floresensis																							
		Cryptamphorella wogiga																							
		Theocampe urna																							
		Dictyomitra undata																							
		Dictyomitra duodecimcostata sensu Foreman (1975)																							
		Dictyomitra koslovae																							
TB 20-02	(Loc. 4)	*Alievium* sp. cf. *A. gallowayi*																							
		Pseudoaulophacus lenticulatus																							
		Pseudoaulophacus floresensis																							
		Patellula verteroensis																							
		Rhopalosyringium magnificum																							
		Cryptamphorella sphaerica																							
		Theocampe salillum																							
		Dictyomitra densicostata																							
		Dictyomitra koslovae																							
		Amphipternis stocki																							
		Stichomitra manifesta																							
		Stichomitra asymbatos																							
		Stichomitra sp. cf. *S. conicus*																							
TB 20-03	(Loc. 3)	*Pseudoaulophacus floresensis*																							
		Pseudoaulophacus sp. cf. *P. pargueraensis*																							
		Archaeospongoprunum sp. cf. *A. stocktonensis*																							
		Patellula verteroensis																							
		Cryptamphorella macropora																							
		Theocampe salillum																							
		Diacanthocapsa ovoidea																							
		Diacanthocapsa sp. cf. *D. ancus* sensu Dumitrică 1970																							
		Dictyomitra multicostata																							
		Dictyomitra koslovae																							
		Amphipternis stocki																							
		Stichomitra sp. aff. *S. asymbatos*																							
TB 31-03	(Loc. 2)	*Orbiculiforma* sp. cf. *O. railensis*																							
		Alievium gallowayi																							
		Pseudoaulophacus sp. cf. *P. lenticulatus*																							
		Archaeospongoprunum hueyi																							
		Rhopalosyringium magnificum																							
		Cryptamphorella sphaerica																							
		Cryptamphorella sp. B sensu Bąk 1996																							
		Eastonerius sp. aff. *E. acuminatus*																							
		Dictyomitra multicostata																							
		Dictyomitra densicostata																							
		Thanarla sp. aff. *T. veneta*																							
		Amphipternis stocki																							
		Amphipyndax tylotus																							
		Amphipyndax sp. aff. *A. tylotus*																							
		Xitus spicularius																							
TB 31-06	(Loc. 1)	*Dactyliosphaera* sp. aff. *D. silviae*																							
		Orbiculiforma sacramentoensis																							
		Pseudoaulophacus praefloresensis																							
		Archaeospongoprunum hueyi																							
		Patellula planoconvexa																							
		Rhopalosyringium magnificum																							
		Cryptamphorella macropora																							
		Diacanthocapsa sp. cf. *D. ovoidea*																							
		Dictyomitra densicostata																							
		Amphipternis stocki																							
		Stichomitra manifesta																							

TB 20-02 (Locality 4)

The co-occurrence of *Patellula verteroensis* and *Rhopalosyringium magnificum* suggests an Early Campanian age.

TB 05-12 (Locality 5)

The co-occurrence of *Pseudoaulophacus floresensis* and *Theocampe urna* suggests a Middle Santonian–middle Middle Campanian age.

TB 01-04 (Locality 6)

The co-occurrence of *Conocaryomma californiaensis* and *Pseudodictyomitra tiara* gives in an Early Coniacian age.

TB 01-02a (Locality 7)

The co-occurrence of *Pseudoaulophacus parguerаensis*, *Theocampe salillum*, *Pseudodictyomitra tiara*, *Stichomitra communis* and *Stichomitra manifesta* gives an Early Coniacian age.

The Matoya Group in the Toba District is currently assumed to be Early Coniacian to Late Campanian in age, and is probably divided into three age-groups: (i) Early Coniacian, (ii) Early Campanian (or Middle Santonian–middle Middle Campanian), and (iii) late Middle–early Late Campanian (Table 2). On the basis of the comparison between the sample localities and their age, it is revealed that localities 6 (TB01-04) and 7 (TB01-02a) of the oldest age-group (i) are situated at an upper horizon of the Matoya Group, whereas localities 1 (TB 31-06) and 2 (TB 31-03) of the youngest age-group (iii) at a lower horizon (See Fig. 1). This evidence has a potential to chronologically and stratigraphically divide the Matoya Group into several units.

6. Conclusion

This study preliminarily shows that the radiolarian assemblages from the Matoya Group in the Toba District are assigned in age to three age-groups: Early Coniacian, Early Campanian (or Middle Santonian–Middle Campanian) and Middle–Late Campanian. This result associated with the sample localities is possible to provide significant biostratigraphic and stratigraphic control in the Matoya Group; it will be divided into several units in a regional stratigraphic investigation in the near future.

7. Systematic Paleontology

Subclass **RADIOLARIA** Müller 1858
Order **SPUMELLARIA** Ehrenberg 1875

Family **XIPHOSTYLIDAE** Haeckel 1881, *emend*. De Wever *et al*. 2001

Genus ***Archaeocenosphaera*** Pessagno and Yang in Pessagno *et al*. 1989

Archaeocenosphaera? mellifera O'Dogherty 1994
(Plate 3, fig. 1)

1984 *Cenosphaera*? sp. A – Empson-Morin, pl. 1, fig. 6.
1988 *Hemicryptocapsa polyhedra* Dumitrică – Thurow, p. 401, pl. 1, fig. 1.
1988 *Hemicryptocapsa* sp. cf. *H. polyhedra* Dumitrică – Thurow, p. 401, pl. 5, fig. 2.
1992 *Hemicryptocapsa* sp. A. – Marcucci Passerini and Gardin, fig. 3.l.
1994 *Archaeocenosphaera*? *mellifera* n. sp. – O'Dogherty, p. 375–376, pl. 67, figs. 1–5.
1997 *Archaeocenosphaera*? *mellifera* O'Dogherty – Sýkora *et al*., pl. III, fig. 5.
1998 *Archaeocenosphaera*? *mellifera* O'Dogherty – Salvini and Marcucci Passerini, fig. 7o.
2001 *Archaeocenosphaera*? *mellifera* O'Dogherty – Bragin *et al*., figs. 4.5–4.6.
2007 *Archaeocenosphaera*? *mellifera* O'Dogherty – Bragina *et al*., p. 318, pl. I, fig. 7.
2011 *Archaeocenosphaera mellifera* O'Dogherty – Smrečková, pl. I, fig. 4.
2012 *Archaeocenosphaera*? *mellifera* O'Dogherty – Moez *et al*., pl. 4, fig. 12.
2015 *Archaeocenosphaera*? *mellifera* O'Dogherty – Bragina and Bragin, pl. III, fig. 12.

Remarks: Archaeocenosphaera? *mellifera* first described by O'Dogherty (1994) consists of spherical cortical shell with symmetrical meshwork and a polygonal surface.

Family **CONOCARYOMMIDAE** Lipman 1969, *emend*. De Wever *et al*. 2001

Genus ***Conocaryomma*** Lipman 1969

Conocaryomma universa (Pessagno 1976)
(Plate 3, fig. 13)

1976 *Praeconocaryomma universa* n. sp. – Pessagno, p. 42, pl. 6, figs. 14–16.
1981 *Conocaryomma universa* (Pessagno) – Empson-Morin, p. 260, pl. 3, fig. 5.
1982 *Praeconocaryomma universa* Pessagno – Taketani, p. 47, pl. 1, figs. 3a–3b, 4; pl. 9, fig. 4.
1982 *Praeconocaryomma universa* Pessagno – Mizutani *et al*., p. 63, pl. 5, fig. 11.
1988 *Conocaryomma universa* (Pessagno) – Thurow, p. 169, pl. 3, fig. 7.
1988 *Conocaryomma universum* (Pessagno) – De Wever *et al*., p. 398–399, pl. 2, fig. 18.
1992 *Praeconocaryomma californiaensis* Pessagno – Okamura, pl. 35, fig. 20; pl. 39, fig. 11.
1994 *Conocaryomma universa* (Pessagno) – Yamasaki and Tsujii, pl.II, fig. 7.
2005 *Praeconocaryomma universa* Pessagno – Popova-Goll *et al*., p. 20, pl. 1, figs. 19–20; pl. 6, fig. 14.
2008 *Praeconocaryomma universa* Pessagno – Bandini

et al., p. 17, pl. 1, figs. 8, 19; pl. 4, fig. 8.
2012 *Praeconocaryomma universa* Pessagno – Asis and Jasin, pl. 3, fig. 1.

Remarks: Cortical shell of the obtained specimen is composed of hemispherical nodes (mamma) and lattice of pore frames. Each mamma is surrounded by small circular pores.
Range: Coniacian to Middle Campanian (Pessagno, 1976), Coniacian to Middle Santonian (Taketani, 1982), Turonian to Upper Campanian (Thurow, 1988), and Coniacian? to lowermost Maastrichtian (Hollis and Kimura, 2001).

Conocaryomma californiaensis (Pessagno 1976)
(Plate 3, figs. 2)
1976 *Praeconocaryomma californiaensis* n. sp. – Pessagno, p. 41, pl. 7, figs. 1–8.
1982 *Praeconocaryomma californiaensis* Pessagno – Taketani, p. 47, pl. 9, figs. 1–2.
1992 *Praeconocaryomma californiaensis* Pessagno – Okamura, pl. 32, figs. 1–3.

Remarks: This specimen differs from *Conocaryomma universa* by having large ellipsoidal pores surrounding each mamma.
Range: Coniacian (Pessagno, 1976), Lower to Middle Coniacian or to Lower Campanian? (Taketani, 1982).

Family **DACTYLIOSPHAERIDAE** Squinabol 1904

Genus ***Dactyliosphaera*** Squinabol 1904

Dactyliosphaera* sp. aff. *D. silviae Squinabol 1904
(Plate 1, fig. 2)

Remarks: The examined specimen consists of a large circular disc-like test with pentagonal pore frames, and possesses probably twelve short spines that radiate from the periphery of the disc. But, it differs from *Dactyliosphaera silviae* in having smaller central convex area.

Family **HAGIASTRIDAE** Riedel 1971

Genus ***Orbiculiforma*** Pessagno 1973

Orbiculiforma sacramentoensis Pessagno 1976
(Plate 1, fig. 1)
1976 *Orbiculiforma sacramentoensis* n. sp. – Pessagno, p. 36–37, pl. 11, fig. 8.
1986 *Orbiculiforma sacramentoensis* Pessagno – Iwata and Tajika, pl. 5, figs. 6, 10.
1997 *Orbiculiforma* sp. – Yamasaki and Sakamoto, pl. III, fig. 12.

Remarks: This specimen consists of a disc-like test with meshwork of tetragonal to pentagonal pore frame, and possesses convex portion in the central area. It differs from other species of *Orbiculiforma* by having hexagonal outline.
Range: Upper Middle to lower Upper Campanian (Pessagno, 1976).

Orbiculiforma* sp. cf. *O. railensis Pessagno 1977
(Plate 1, fig. 14)

Remarks: The examined specimen is similar to *Orbiculiforma railensis* in having a circular disc-like test and central convex area surrounded by a narrow and deep groove, but slightly different by more than six short spines radiating from periphery of the test.

Family **PSEUDOAULOPHACIDAE** Riedel 1967, *emend*. Dumitrica 1997

Genus ***Alievium*** Pessagno 1972

Alievium gallowayi (White 1928)
(Plate 1, fig. 16)
1928 *Baculogypsina*? *gallowayi* n. sp. – White, p. 305, pl. 41, figs. 9–10.
1962 *Aulophacus gallowayi* (White). – Pessagno, p. 364, pl. 3, figs. 5–6.
1963 *Pseudoaulophacus gallowayi* (White) – Pessagno, p. 202, pl. 2, figs. 1, 3, 6; pl. 4, figs. 2, 5, 7; pl. 7, figs. 2, 4.
1972 *Alievium gallowayi* (White) – Pessagno, p. 299–300, pl. 25, figs. 4–6; pl. 26, fig. 5; pl. 31, figs. 2–3.
1976 *Alievium gallowayi* (White) – Pessagno, p. 27, pl. 8, figs. 13, 14; pl. 9, fig. 1.
1981 *Alievium gallowayi* (White) – Nakaseko and Nishimura, p. 142, pl. 2, fig. 3.
1982 *Alievium gallowayi* (White) – Taketani, p. 50–51, pl. 10, fig. 7.
1985 *Alievium gallowayi* (White) – Sanfilippo and Riedel, p. 594, fig. 6.1.
1988 *Alievium gallowayi* (White) – Thurow, p. 396–397, pl. 2, fig. 3.
1997 *Alievium gallowayi* (White) – Hashimoto and Ishida, pl. 3, fig. 21.
1998 *Alievium gallowayi* (White) – Ishida and Hashimoto, pl. 2, fig. 22.
2008 *Alievium gallowayi* (White) – Bandini *et al*., p. 16, pl. 1, fig.1; pl. 2, fig. 7; pl. 3, figs. 9, 25.
2015 *Alievium gallowayi* (White) – Hashimoto *et al*., p. 43, pl. 2, fig. 25.

Range: Santonian to Upper Campanian (Pessagno, 1976), Middle Campanian to lowermost Maastrichtian (Sanfilippo and Riedel, 1985), Campanian to Upper Maastrichtian (Thurow, 1988), uppermost Santonian to lowermost Maastrichtian (Hollis and Kimura, 2001), and Middle Campanian? to lowermost Maastrichtian (Hashimoto *et al*., 2015).

Alievium* sp. cf. *A. gallowayi (White 1928)
(Plate 2, figs. 15, 28)

Remarks: Although spines are lacked, the obtained specimens are similar to *Alievium gallowayi* in having subtriangular test with coarse meshwork.

Alievium* sp. cf. *A. preagallowayi Pessagno 1972
(Plate 3, figs. 3, 14)
Remarks: The obtained specimens are composed of more inflated subtriangular test than *Alievium gallowayi*, and similar to *Alievium praegallowayi* in having the nodes (situated at the vertices of triangular frames), which are aligned in curved row.

Genus ***Pseudoaulophacus*** Pessagno 1963

Pseudoaulophacus lenticulatus (White 1928)
(Plate 2, figs. 16, 29)
1928 *Baculogypsina*? *lenticulata* n. sp. – White, p. 306, pl. 41, figs. 9, 11.
1962 *Aulophacus lenticulatus* (White) – Pessagno, p. 364, pl. 6, figs. 1–2.
1963 *Pseudoaulophacus lenticulatus* (White) – Pessagno, p. 202, pl. 2, figs. 8–9.
1976 *Pseudoaulophacus lenticulatus* (White) – Pessagno, p. 28, pl. 9, figs. 11–12.
1981 *Pseudoaulophacus lenticulatus* (White) – Nakaseko and Nishimura, p. 158, pl. 2, figs. 7a–7b.
1982 *Pseudoaulophacus lenticulatus* (White) – Taketani, p. 51, pl. 10, fig. 11.
1982 *Pseudoaulophacus lenticulatus* (White) – Mizutani *et al*., p. 59, pl. 7, figs. 7a–7b; pl. 8, fig. 3.
1985 *Pseudoaulophacus lenticulatus* (White) – Sanfilippo and Riedel, p. 596, figs. 6.4a–6.4b.
1988 *Pseudoaulophacus lenticulatus* (White) – Thurow, p. 404, pl. 2, fig. 6.
1988 *Pseudoaulophacus lenticulatus* (White) – De Wever *et al*., p. 170, pl. 1, fig. 1.
1992 *Pseudoaulophacus lenticulatus* (White) – Iwata *et al*., pl. 1, fig. 12.
1992 *Pseudoaulophacus lenticulatus* (White) – Okamura, pl. 29, fig. 12.
1998 *Pseudoaulophacus lenticulatus* (White) – Salvini and Marcucci Passerini, fig. 8.d.
2008 *Pseudoaulophacus lenticulatus* (White) – Bandini *et al*., p. 18, pl. 1, figs. 22–23.
2015 *Pseudoaulophacus lenticulatus* (White) – Hashimoto *et al*., p. 46, pl. 1, fig. 23.
2015 *Pseudoaulophacus lenticulatus* (White) – Kopaevich *et al*., pl. VI, fig. 9.
Range: Coniacian to Upper Campanian (Pessagno, 1976), Coniacian to Lower Campanian? (Taketani, 1982), Lower to Middle Campanian (Sanfilippo and Riedel, 1985), Uppermost Coniacian to Upper Campanian (Thurow, 1988), Coniacian? to lowermost Maastrichtian (Hollis and Kimura, 2001), and Middle Campanian? to Lower Maastrichtian (Hashimoto *et al*., 2015).

Pseudoaulophacus* sp. cf. *P. lenticulatus (White 1928)
(Plate 1, fig. 15)
Remarks: This specimen is similar to *Pseudoaulophacus lenticulatus* in having a circular shell with central convex portion, short spines which occur from periphery of the shell.

Pseudoaulophacus preafloresensis Pessagno 1972
(Plate 1, fig. 3)
1972 *Pseudoaulophacus preafloresensis* n. sp. – Pessagno, p. 309–310, pl. 27, figs. 2–6.
1982 *Pseudoaulophacus preafloresensis* Pessagno – Yamauchi, pl. 3, fig. 5; pl. 4, fig. 17.
1994 *Pseudoaulophacus floresensis* Pessagno – Yamasaki and Tsujii, pl. II, fig. 9.
2007 *Pseudoaulophacus preafloresensis* Pessagno – Bragina *et al*., pl. II, fig. 1.
Remarks: This species is different from *Pseudoaulophacus lenticulatus* by its subangular shell and from *Pseudoaulophacus floresensis* by having a shell which is concave around its central convex portion.
Range: Coniacian to Upper Campanian (Pessagno, 1976) and Middle Santonian to lowermost Maastrichtian (Hollis and Kimura, 2001).

Pseudoaulophacus* sp. cf. *P. preafloresensis Pessagno 1972
(Plate 3, fig. 15)
Remarks: This specimen resembles *Pseudoaulophacus preafloresensis* in having a subtriangular shell and centreal convex area surrounded by slight concave.

Pseudoaulophacus floresensis Pessagno 1963
(Plate 2, figs. 1, 17, 30)
1963 *Pseudoaulophacus floresensis* n. sp. – Pessagno, p. 200, pl. 2, figs. 2, 5; pl. 4, fig. 6; pl. 7, figs. 1, 5.
1972 *Pseudoaulophacus floresensis* Pessagno – Pessagno, p. 304, pl. 26, fig. 6; pl. 28, figs. 4–6; pl. 29, figs. 1–2; pl. 31, fig. 1.
1976 *Pseudoaulophacus floresensis* Pessagno – Pessagno, p. 28, pl. 9, fig. 6.
1981 *Pseudoaulophacus floresensis* Pessagno – Nakaseko and Nishimura, p. 158, pl. 2, fig. 4.
1982 *Pseudoaulophacus* sp. cf. *P. floresensis* Pessagno – Taketani, p. 51, pl. 10, figs. 10–11.
1982 *Pseudoaulophacus floresensis* Pessagno – Mizutani *et al*., p. 60, pl. 8, fig. 2; pl. 8, fig. 3.
1985 *Pseudoaulophacus floresensis* Pessagno – Sanfilippo and Riedel, p. 595–596, figs. 6.3a–6.3b.
1988 *Pseudoaulophacus floresensis* Pessagno – Thurow, p. 404, pl. 2, fig. 5.
1992 *Pseudoaulophacus floresensis* Pessagno – Iwata *et al*., pl. 1, fig. 11.
1992 *Pseudoaulophacus floresensis* Pessagno – Okamura, pl. 33, figs. 8–10; pl. 36, figs. 3–5.
2005 *Pseudoaulophacus floresensis* Pessagno – Popova-Goll *et al*., p. 22, pl. 1, fig. 13; pl. 8, fig. 11.
2008 *Pseudoaulophacus floresensis* Pessagno – Bandini *et al*., p. 18, pl. 1, figs. 20–21.
Range: Middle Santonian to Upper Campanian (Pessagno, 1976), Lower Campanian to lowermost Maastrichtian (Sanfilippo and Riedel, 1985), Lower Campanian to Upper Maastrichtian (Thurow, 1988), Middle Santonian

to lowermost Maastrichtian (Hollis and Kimura, 2001), and Lower Campanian to Lower Maastrichtian (Hashimoto *et al*., 2015).

Pseudoaulophacus pargueraensis Pessagno 1963
(Plate 3, fig. 16)

1963 *Pseudoaulophacus pargueraensis* n. sp. – Pessagno, p. 204, pl. 2, figs. 4, 7; pl.6, figs. 4–5.
1972 *Pseudoaulophacus pargueraensis* Pessagno – Pessagno, p. 309, pl. 30, fig. 4.
1982 *Pseudoaulophacus pargueraensis* Pessagno – Taketani, p. 51, pl. 10, fig. 12.
1981 *Pseudoaulophacus pargueraensis* Pessagno – Nakaseko and Nishimura, p. 158 pl. 2, fig. 5.
1982 *Pseudoaulophacus pargueraensis* Pessagno – Mizutani *et al*., p. 59–60, pl. 7, fig. 8.
1982 *Pseudoaulophacus pargueraensis* Pessagno – Yamauchi, pl. 3, fig. 8.
1985 *Pseudoaulophacus pargueraensis* Pessagno – Sanfilippo and Riedel, p. 596, figs. 6.5a–6.5d.
1988 *Pseudoaulophacus pargueraensis* Pessagno – Thurow, p. 404, pl. 2, fig. 7.
2008 *Pseudoaulophacus pargueraensis* Pessagno – Bandini *et al*., p. 18, pl. 1, figs. 24–25.

Remarks: *Pseudoaulophacus pargueraensis* consists of a circular shell with lobate periphery, which is a most differentiated character from other species of *Pseudoaulophacus*.
Range: Lower Santonian to Lower Campanian (Pessagno, 1972), Lower to Middle Campanian (Sanfilippo and Riedel, 1985), Lower to Upper Campanian (Thurow, 1988), and Coniacian? to lowermost Maastrichtian (Hollis and Kimura, 2001).

Pseudoaulophacus* sp. cf. *P. pargueraensis Pessagno 1963
(Plate 2, fig. 2)
Remarks: This poorly-preserved specimen is similar to *Pseudoaulophacus pargueraensis* in having a weakly-developed lobate periphery.

Family **ARCHAEOSPONGOPRUNIDAE** Pessagno 1973

Genus ***Archaeospongoprunum*** Pessagno 1973

Archaeospongoprunum* sp. cf. *A. stocktonensis Pessagno 1973
(Plate 2, fig. 4)
Remarks: This specimen consists of ellipsoidal shell with two polar spines, one of which is broken. It is similar to *Archaeospongoprunum stocktonensis* rather than *Archaeospongoprunum rumseyensis* Pessagno based on the outline of the shell.

Archaeospongoprunum* sp. aff. *A. andersoni Pessagno 1973
(Plate 3, fig. 4)
Remarks: This specimen resembles *Archaeospongoprunum andersoni* by having an elongate cylindrical test with fine meshwork comprised of tetragonal to pentagonal pore frames, but differs from it by having three indistinct lobe. *Archaeospongoprunum bipartitum* also consists of an elongate cylindrical test with two lobes, but meshwork of its test is much coarser than this specimen.

Archaeospongoprunum hueyi Pessagno 1973
(Plate 1, figs. 4, 17–18)

1973 *Archaeospongoprunum hueyi* n. sp. – Pessagno, p. 61–62, pl. 13, fig. 1.
1976 *Archaeospongoprunum hueyi* Pessagno – Pessagno, p. 33, pl. 11, fig. 5.
1992 *Archaeospongoprunum hueyi* Pessagno – Okamura, pl. 34, figs. 5, 18.
1997 *Archaeospongoprunum hueyi* Pessagno – Hashimoto and Ishida, pl. 3, fig. 25.
2015 *Archaeospongoprunum hueyi* Pessagno – Hashimoto *et al*., p. 44, pl. 1, fig. 18.

Remarks: Test is elongate and ellipsoidal with two polar spines and with spongy meshwork. Each spine consists of four longitudinal grooves and ridges, which are arranged not spirally but straight.
Range: Lower Campanian (Pessagno, 1973), lower upper Campanian (Pessagno, 1976), Campanian to Lower Maastrichtian (Hollis and Kimura, 2001), and Middle Campanian to Upper Maastrichtian (Hashimoto *et al*., 2015).

Family **PYRAMISPONGIIDAE** Kozur and Mostler 1978, *emend*. De Wever *et al*. 2001

Genus ***Pyramispongia*** Pessagno 1973

Pyramispongia glascockensis Pessagno 1973
(Plate 3, fig. 17)

1973 *Pyramispongia glascockensis* n. sp. – Pessagno, p. 79–80, pl. 21, figs. 2–5.
1976 *Pyramispongia glascockensis* Pessagno – Pessagno, p. 37, pl. 1, fig. 9.
1982 *Pyramispongia glascockensis* Pessagno – Taketani, p. 51, pl. 10, fig. 12.
1982 *Pyramispongia glascockensis* Pessagno – Yamauchi, pl. 2, fig. 9.
1988 *Pyramispongia glascockensis* Pessagno – Thurow, p. 405, pl. 2, fig. 23.
1992 *Pyramispongia glascockensis* Pessagno – Marcucci Passerini and Gardin, fig. 3o.
1998 *Pyramispongia glascockensis* Pessagno – Salvini and Marcucci Passerini, pl. 8, fig. i.
2004 *Pyramispongia glascockensis* Pessagno – Bąk, figs. 5.15–5.16.

Range: Cenomanian to Coniacian (Pessagno, 1976), Middle Cenomanian to Lower Santonian (Taketani, 1982), Lower Cenomanian to Middle Turonian (Thurow, 1988), and Lower Cenomanian to Turonian? (O'Dogherty, 1994).

Family **SPONGURIDAE** Haeckel 1862

Genus ***Patellula*** Kozlova in Petrushevskaya and Kozlova 1972

Patellula planoconvexa (Pessagno 1963)
(Plate 1, fig. 5)

1963 *Stylospongia planoconvexa* n. sp. – Pessagno, p. 199, pl. 3, figs. 4–6; pl. 6, fig. 1.
1972 *Patellula planoconvexa* (Pessagno) – Petrushevskaya and Kozlova, p. 527, pl. 3, fig. 13.
1979 *Patellula planoconvexa* (Pessagno) – Nakaseko *et al*., pl. 8, fig. 1.
1994 Patellula planoconvexa (Pessagno) – Yamasaki and Tsujii, pl. II, fig. 13.

Patellula verteroensis (Pessagno 1963)
(Plate 2, figs. 3, 18; Plate 3, figs. 5, 18)

1963 *Stylospongia verteroensis* n. sp. – Pessagno, p. 199, pl. 3, figs. 1–3; pl. 6, figs. 2–3; pl. 7, figs. 3, 6.
1972 *Patellula verteroensis* (Pessagno) – Petrushevskaya and Kozlova, p. 527, pl. 3, figs. 8–9.
1981 *Patellula verteroensis* (Pessagno) – Empson-Morin, p. 257, pl. 2, figs. 1–5.
1988 *Patellula verteroensis* (Pessagno) – Thurow, p. 403, pl. 2, figs. 19–20.
1989 *Patellula verteroensis* (Pessagno) – Tumanda, p. 34–35, pl. 9, figs. 15–16.
1994 *Patellula verteroensis* (Pessagno) – O'Dogherty, p. 328–329, pl. 60, figs. 25–26.
1994 *Patellula verteroensis* (Pessagno) – Yamasaki and Tsujii, pl. II, fig. 14.
1998 *Patellula verteroensis* (Pessagno) – Erbacher, p. 370, pl. 1, fig. 24.
2004 *Patellula verteroensis* (Pessagno) – Bąk, pl. 7, fig. 13.

Range: Probably Lower Campanian (Pessagno, 1963), and Middle Cenomanian to Lower Turonian? (O'Dogherty, 1994).

Order **NASSELLARIA** Ehrenberg 1875

Family **CANNOBOTRYIDAE** Haeckel 1881

Genus ***Rhopalosyringium*** Campbell and Clark 1944

Rhopalosyringium magnificum Campbell and Clark 1944
(Plate 1, figs. 6, 19–20; Plate 2, fig. 19)

1944 *Rhopalosyringium magnificum* n. sp. – Campbell and Clark, p. 30, pl. 7, figs. 16–17.
1968 *Rhopalosyringium*? *magnificum* Campbell and Clark – Foreman, p. 55, pl. 6, figs. 7a–7b.
1981 *Rhopalosyringium magnificum* Campbell and Clark – Empson-Morin, p. 265, pl. 8, figs. 1A–1D.
1982 *Rhopalosyringium magnificum* Campbell and Clark – Yamauchi, pl. 5, fig. 1.
1992 *Rhopalosyringium* sp. – Okamura, pl. 38, fig. 23.
1998 *Rhopalosyringium magnificum* Campbell and Clark – Ishida and Hashimoto, pl. 2, fig. 20.
2006 *Rhopalosyringium magnificum* Campbell and Clark – Musavu-Moussavou and Danelian, p. 154, pl. 2, figs. 3–5.
2015 *Rhopalosyringium magnificum* Campbell and Clark – Hashimoto *et al*., pl. 1, fig. 14.

Range: Campanian to Lower Maastrichtian (Hollis and Kimura, 2001), and Middle? to Upper Campanian (Hashimoto *et al*., 2015).

***Rhopalosyringium* sp. A** sensu Bandini *et al*. 2008
(Plate 3, fig. 19)

2006 *Rhopalosyringium*? sp. – Denyer and Baumgartner, fig. 7P.
2008 *Rhopalosyringium* sp. A – Bandini *et al*., pl. 1, fig. 10; pl. 3, fig. 19.

Description: Test, lacking strictures, is spindle-shaped, rounded apically, and is composed of two segments; cephalis minute, hemispherical and thorax cylindrical without aperture ring. Seven to eight edged costae are visible in a lateral view, which arise near the apex and extend distally on the thorax. Thoracic pores are arranged longitudinally but irregularly, forming single or double rows between adjacent costae.
Remarks: This species is similar to *Rhopalosyringium scissum*, but distinguished from it in having edged costae and lack of the cephlo-thoracic stricture.
Occurrence: Coniacian–Santonian chert of the Nicoya Complex (Denyer and Baumgartner, 2006) and turbiditic sequence of the Berrugate and Sabana Grande formations (Bandini *et al*., 2008) in Costa Rica.

Family **WILLIRIEDELLIDAE** Dumitrică 1970

Genus ***Cryptamphorella*** Dumitrică 1970

Cryptamphorella sphaerica (White 1928)
(Plate 1, fig. 21; Plate 2, fig. 20)

1928 *Baculogypsina*? *sphaerica* n. sp. – White, p. 306, pl. 41, figs. 12–13.
1962 *Aulonia sphaerica* (White) – Pessagno, p. 366, pl. 6, fig. 3.
1963 *Holocryptocapsa*? *sphaerica* (White) – Pessagno, p. 206, pl. 1, fig. 3; pl. 5, figs. 1–2.
1970 *Cryptamphorella sphaerica* (White) – Dumitrică, p. 82, pl. XII, figs. 73a–73b, 74a–74c, 75a–75b, 77; pl. XX, figs. 133a–133b.
1981 *Cryptamphorella sphaerica* (White) – Nakaseko and Nishimura, p. 149, pl. 5, figs. 1–2.
1989 *Cryptamphorella sphaerica* (White) – Tumanda, p. 36, pl. 7, fig. 18; pl. 10, fig. 15.
1998 *Cryptamphorella sphaerica* (White) – Ishida and Hashimoto, fig. 3.20.
2005 *Cryptamphorella sphaerica* (White) – Popova-Goll *et al*., p. 11–12, pl. 1, fig. 16; pl. 6, fig. 11.
2015 *Cryptamphorella sphaerica* (White) – Hashimoto

et al., p. 44–45, pl. 1, fig. 26.
Range: Middle Santonian to lowermost Maastrichtian (Hollis and Kimura, 2001), and Campanian? to Lower Maastrichtian (Hashimoto *et al*., 2015).

Cryptamphorella macropora Dumitrică 1970
(Plate 1, fig. 7; Plate 2, fig. 5)
1970 *Cryptamphorella macropora* n. sp. – Dumitrică, p. 81, pl. X, figs. 64a–64b, 65; p. XI, figs. 67, 69–72a–72b; pl. XX, fig. 132; pl. XXI, figs. 137, 140a–140b, 141.
1981 *Cryptamphorella macropora* Dumitrică – Nakaseko and Nishimura, p. 149, pl. 4, figs. 6–7; pl. 14, fig. 6.
1988 *Cryptamphorella macropora* Dumitrică – Thurow, p. 400, pl. 1, fig. 3.
1997 *Cryptamphorella macropora* Dumitrică – Hashimoto and Ishida, pl. 3, fig. 11.
1998 *Cryptamphorella macropora* Dumitrică – Ishida and Hashimoto, pl. 2, fig. 18.
Range: Coniacian? to lowermost Maastrichtian (Hollis and Kimura, 2001).

Cryptamphorella* sp. aff. *C. gilkeyi (Dumitrica 1973)
(Plate 3, fig. 6)
Remarks: This specimen is similar to *Cryptamphorella gilkeyi*, which was originally described as *Wiliriedellum*? *gilkeyi* by Dumitrica (1973), in its subspherical test with three segments, third of which is completely covered by triangular or polygonal depressions limited by sharp crests. Nevertheless, it differs from *Cryptamphorella gilkeyi* by lacking of a large sutural pore and having six (or much more) small pores in each depression. The radiolarian assemblage suggests a much younger age (early Coniacian) is given to this specimen, whereas an Aptian or Albian age was assigned to *Cryptamphorella gilkeyi* by Dumitrica (1973) and O'Dogherty (1994). On the basis of these morphology and age, they seem to be different species.

Cryptamphorella wogiga Empson-Morin 1981
(Plate 2, fig. 31)
1981 *Cryptamphorella wogiga* n. sp. – Empson-Morin, p. 266, pl. 12, figs. 3A–3D.
Remarks: Pores on abdomen are recessed into ridged pentagonal to hexagonal pore frames, which interlock to form irregular polygonal network.

***Cryptamphorella* sp. B** sensu Bąk 1996
(Plate 1, fig. 22)
1996 *Cryptamphorella* sp. B – Bąk, p. 100, fig. 9D.
Remarks: This specimen consists of three segments. It differs from *Cryptamphorella conara* by having an oval abdomen and from *Cryptamphorella macropora* by lacking a large sutural pore.
Occurrence: The Macelowa Marl Member in the Pieniny Klippen belt, Polish Carpathians (Bąk 1996).

Genus ***Hemicryptocapsa*** Tan 1927

Hemicryptocapsa polyhedra Dumitrică 1970
(Plate 3, fig. 7)
1970 *Hemicryptocapsa polyhedra* n. sp. – Dumitrică, p. 72, pl. XIV, figs. 85a–85c.
1981 *Hemicryptocapsa polyhedra* Dumitrică – Nakaseko and Nishimura, p. 153, pl. 4, fig. 2; pl. 14, fig. 5.
1992 *Hemicryptocapsa polyhedra* Dumitrică – Marcucci Passerini and Gardin, fig. 3f.
2006 *Hemicryptocapsa polyhedra* Dumitrică – Denyer and Baumgartner, fig. 7Q.
2008 *Hemicryptocapsa polyhedra* Dumitrică – Bandini *et al*., pl. 1, fig. 17; p. 3, fig. 15.
Remarks: *Hemicryptocapsa polyhedra* is similar to *Hemicryptocapsa prepolyhedra* in general features, especially having a subspherical test with polygonal facets, but is distinguished from it by lacking of perforate ridges which limit polygonal facets.
Range: Lower Cenomanian to Middle Coniacian (Taketani, 1982).

Family **ARTOSTROBIIDAE** Riedel 1967

Genus ***Theocampe*** Haeckel 1887

Theocampe urna (Foreman 1971)
(Plate 2, fig. 32)
1970 Artostrobiid gen. et sp. indet – Kling, pl. 7, fig. 8.
1971 *Artostrobium urna* n. sp. – Foreman, p. 1677–1678, pl. 4, figs. 1–2.
1973b *Theocampe urna* (Foreman) – Foreman, pl. 15, fig. 21.
1974 *Artostrobium urna* (Foreman) – Riedel and Sanfilippo, p. 775, pl. 11, figs. 4, 6.
1981 *Artostrobium urna* Foreman – Nakaseko and Nishimura, p. 148, pl. 17, fig. 10.
1982 *Theocampe urna* (Foreman) – Taketani, p. 53, pl. 2, fig. 12.
1988 *Theocampe tina* (Foreman) – Thurow, p. 407, pl. 1, fig. 6.
1985 *Theocampe urna* (Foreman) – Sanfilippo and Riedel, p. 606, figs. 7a–7c.
1987 *Artostrobium urna* Foreman – Yamasaki, pl. 2, fig. 16.
1992 *Artostrobium tina* Foreman – Okamura, pl. 39, fig. 1.
1992 *Artostrobium urna* Foreman – Okamura, pl. 39, fig. 2.
1998 *Artostrobium urna* Foreman – Ishida and Hashimoto, pl. 1, fig. 21.
Remarks: This species has a wide range of variation in the external form and ornamentation, and resembles to *Theocampe tina*. However, this species is distinguished from the latter by having a more constricted test and short and inflated abdomen as pointed out by O'Dogherty (1994) and Hollis and Kimura (2001). The examined specimen

also possesses a prominent apertural ring.
Range: Lower Coniacian to Lower Campanian? (Taketani, 1982), Middle Coniacian to Middle Campanian (Sanfilippo and Riedel, 1985), Turonian to Middle Campanian (Thurow, 1988), and Coniacian? to Middle Campanian (Hollis and Kimura, 2001).

Theocampe salillum Foreman 1971
(Plate 2, figs. 6, 21; Plate 3, fig. 20)
1970 *Theocampe salillum* sp. – Kling, pl. 7, figs. 1, 5.
1971 *Theocampe salillum* n. sp. – Foreman, p. 1678–1679, pl. 4, fig. 5.
1973a *Theocampe salillum* Foreman – Foreman, p. 430, pl. 13, fig. 2.
1973b *Theocampe salillum* Foreman – Foreman, pl. 15, fig. 12.
1974 *Theocampe salillum* Foreman – Riedel and Sanfilippo, p. 780, pl. 11, figs. 8–10.
1981 *Theocampe salillum* Foreman – Empson-Morin, p. 263, pl. 5, figs. 4A–4C.
1981 *Theocampe salillum* Foreman – Nakaseko and Nishimura, p. 164, pl. 13, figs. 4, 7.
1982 *Theocampe salillum* Foreman – Taketani, p. 53, pl. 2, fig. 14.
1985 *Theocampe salillum* Foreman – Sanfilippo and Riedel, p. 605, figs. 4a–4c.
1988 *Theocampe salillum* Foreman – De Wever *et al*., p. 171, pl. 1, fig. 8.
1998 *Theocampe salillum* Foreman – Ishida and Hashimoto, pl. 1, fig. 17.
2012 *Theocampe salillum* Foreman – Asis and Jasin, pl. 2, fig. 10.
Range: Santonian to Upper Campanian (Sanfilippo and Riedel, 1985), and Lower Coniacian to Lower Campanian? (Taketani, 1982).

Family **CARPOCANIIDAE** Haeckel 1881, *emend*. De Wever *et al*. 2001

Genus ***Diacanthocapsa*** Squinabol 1903

Diacanthocapsa ovoidea Dumitrică 1970
(Plate 2, fig. 7)
1970 *Diacanthocapsa ovoidea* n. sp. – Dumitrică, p. 63, pl. V, fig. 25a; pl. VI, figs. 26–28b.
1982 *Diacanthocapsa ovoidea* Dumitrică – Mizutani *et al*., p. 72, pl. 5, fig. 6.
1987 *Diacanthocapsa ovoidea* Dumitrică – Yamasaki, pl. 2, fig. 8.
1992 *Diacanthocapsa ovoidea* Dumitrică – Iwata *et al*., pl. 2, fig. 10; pl. 3, figs. 9–10.
1994 *Diacanthocapsa ovoidea* Dumitrică – O'Dogherty, p. 220, pl. 37, figs. 1–16
1998 *Diacanthocapsa ovoidea* Dumitrică – Salvini and Marcucci Passerini, p. 269, fig. 9o.
2007 *Diacanthocapsa ovoidea* Dumitrică – Musavu-Moussavou *et al*., p. 269, pl. 3, fig. 4.
Range: Middle Cenomanian to Lower Turonian? (O'Dogherty, 1994), and Lower Campanian (Dumitrică, 1970).

Diacanthocapsa* sp. cf. *D. ovoidea Dumitrică 1970
(Plate 1, fig. 8)
Remarks: This specimen is broken, but almost similar to *Diacanthocapsa ovoidea* in having a lengthened-oval outline and in having small circular pores on the test surface, which are arranged irregularly in apical portion and longitudinally in distal portion.

Diacanthocapsa* sp. cf. *D. ancus (Foreman 1968) sensu Dumitrică 1970
(Plate 2, fig. 8)
1968 *Theocapsomma ancus* n. sp. – Foreman, p. 32–33, pl. 4, fig. 3.
1970 *Diacanthocapsa* sp. cf. *D. ancus* (Foreman) – Dumitrică, p. 64–65, pl. VI, figs. 35a–35b; pl. VII, fig. 40; pl. XX, fig. 125.
1992 *Diacanthocapsa* sp. – Okamura, pl. 38, fig. 5.
1997 *Diacanthocapsa* sp. cf. *D. ancus* (Foreman) – Hashimoto and Ishida, pl. 2, fig. 13.
1998 *Diacanthocapsa* sp. cf. *D. ancus* (Foreman) – Ishida and Hashimoto, pl. 2, fig. 9.

Genus ***Eastonerius*** Empson-Morin 1981

Eastonerius* sp. aff. *E. acuminatus (Dumitrică 1970)
(Plate 1, fig. 23)
1982 *Diacanthocapsa acuminata* Dumitrică – Matsuyama *et al*., pl. IV, fig. 15.
1997 *Diacanthocapsa acuminata* Dumitrică – Hashimoto and Ishida, pl. 3, fig. 22.
1998 *Diacanthocapsa acuminata* Dumitrică – Ishida and Hashimoto, pl. 2, fig. 10.
Remarks: *Eastonerius acuminatus*, which was emended from *Diacanthocapsa acuminata* by Empson-Morin (1981), consists of oval three-segmented test with a rounded apical end, and possesses a short inverted conical abdomen. Although not always well-visible, sutural pores are recognized. The present specimen is similar to *Eastonerius acuminatus* in having oval test and external ornamentations, but different from it by probably consisting of four segments.

Family **ARCHAEODICTYOMITRIDAE** Pessagno 1976

Genus ***Archaeodictyomitra*** Pessagno 1976

Archaeodictyomitra squinaboli Pessagno 1976
(Plate 3, fig. 21)
1976 *Archaeodictyomitra squinaboli* n. sp. – Pessagno, p. 50, pl. 5, figs. 2–8.
1981 *Archaeodictyomitra squinaboli* Pessagno – Nakaseko and Nishimura, p. 147, pl. 6, fig. 7; pl. 15, fig. 1.

1989 *Archaeodictyomitra squinaboli* Pessagno – Tumanda, p. 36, pl. 7, fig. 7.
1992 *Dictyomitra* sp.– Okamura, pl. 37, fig. 6.
1997 *Archaeodictyomitra squinaboli* Pessagno – Hashimoto and Ishida, pl. 1, fig. 4.

Remarks: This species consists of elongated conical test with eight or nine segments and without distinct constrictions. 11 to 12 longitudinal costae are visible in a lateral view. *Dictyomitra multicostata* is similar to *Archaeodictyomitra squinaboli* in their outline, which is elongated conical, but different from the latter by having shallow strictures between post-abdominal segments.
Range: Cenomanian? to Upper Campanian (Pessagno, 1976), and Campanian (Hollis and Kimura, 2001).

Genus ***Dictyomitra*** Zittel 1876, *emend*. Pessagno 1976

Dictyomitra undata Squinabol 1904
(Plate 2, fig. 34)
1904 *Dictyomitra undata* n. sp. – Squinabol, p. 231, pl. 10, fig. 2.
1997 *Dictyomitra undata* Squinabol – Sýkora *et al*., pl. V, fig. 8.
2004 *Dictyomitra undata* Squinabol – Bąk, fig. 4.3.
2008 *Dictyomitra undata* Squinabol – Bandini *et al*., pl. 4, fig. 5.
2011 *Archaeodictyomitra undata* (Squinabol) – Bandini *et al*., p. 20, pl. 11, fig. 1.

Dictyomitra* sp. cf. *D. gracilis (Squinabol 1903)
(Plate 3, fig. 22)
Remarks: This specimen resembles to *Dictyomitra gracilis* in possessing a spindle-shape test with longitudinally extending costae, but differs by possessing slightly intense constriction.

Dictyomitra formosa Squinabol 1904
(Plate 3, figs. 8, 23)
1904 *Dictyomitra formosa* n. sp. – Squinabol, p. 232, pl. 10, fig. 4.
1973a *Dictyomitra torquata* Foreman – Foreman, p. 430, pl. 13, fig. 7.
1976 *Dictyomitra formosa* Squinabol – Pessagno, p. 51–52, pl. 8, figs. 10–12.
1982 *Dictyomitra formosa* Squinabol – Mizutani *et al*., p. 66, pl. 9, fig. 1.
1982 *Dictyomitra formosa* Squinabol – Taketani, p. 58, pl. 4, figs. 6a–6b; pl. 11, fig. 13.
1988 *Dictyomitra formosa* Squinabol – Thurow, p. 400, pl. 1, fig. 23.
1992 *Dictyomitra formosa* Squinabol – Okamura, pl. 28, fig. 2; pl. 36, fig. 33; pl. 37, figs. 2–3.
1992 *Dictyomitra formosa* Squinabol – Iwata *et al*., pl. 5, fig. 5.
1994 *Dictyomitra formosa* Squinabol – O'Dogherty, p. 80–81, pl. 4, figs. 8–12.
1997 *Dictyomitra formosa* Squinabol – Hashimoto and Ishida, pl. 2, fig. 15.
2008 *Dictyomitra formosa* Squinabol – Bandini *et al*., p. 16–17, pl. 2, fig. 23; pl. 3, fig. 13; pl. 4, fig. 3.
2009 *Dictyomitra formosa* Squinabol – Djerić *et al*., fig. 8.11.
2011 *Dictyomitra formosa* Squinabol – Smrečková, pl. 1, fig. 17.
2015 *Dictyomitra formosa* Squinabol – Hashimoto *et al*., p. 45, pl. 2, fig. 2.

Remarks: As mentioned by Pessagno (1976) and O'Dogherty (1994), test of this species is moderately or markedly lobulate in outline with continuously arranged longitudinal costae, and post-abdominal segments are separated by relatively deep strictures. It is distinguished from *Dictyomitra duodecimcostata* and D*ictyomitra multicostata* as described below.
Range: Coniacian to Lower Campanian (Pessagno, 1976), Coniacian to Santonian (Taketani, 1982), Middle Turonian to Lower Campanian (Thurow, 1988), Upper Albian to Lower Turonian? (O'Dogherty, 1994), Middle Coniacian? to Upper Campanian (Hollis and Kimura, 2001), and Middle Coniacian? to Upper Campanian (Hashimoto *et al*., 2015).

Dictyomitra duodecimcostata (Squinabol 1903) sensu Foreman (1975)
(Plate 2, fig. 35)
1903 *Lithostrobus duodecimcostatus* n. sp. – Squinabol, p. 438, pl. X, fig. 21.
1972 *Dictyomitra duodecimcostata* (Squinabol) group – Petrushevskaya and Kozlova, p. 550, pl. 2, figs. 10–115.
1973b *Dictyomitra torquata* Foreman – Foreman, pl. 15, figs. 9–11.
1975 *Dictyomitra duodecimcostata* (Squinabol) – Foreman, p. 614, pl. 1G, fig. 5; pl. 7, fig. 8.
1978 *Dictyomitra duodecimcostata duodecimcostata* (Squinabol) – Foreman, p. 746, pl. 4, figs. 8–9.
1981 *Dictyomitra formosa* Squinabol – Nakaseko and Nishimura, p. 150–151, pl. 8, figs. 7–8; pl. 16, figs. 4, 11.
1997 *Dictyomitra duodecimcostata* (Squinabol) – Yamasaki and Sakamoto, pl. 1, fig. 6.
2008 *Dictyomitra formosa* Squinabol – Bandini *et al*., p. 16–17, pl. 1, figs. 5, 15; pl. 2, fig. 10.

Remarks: According to the original description by Squinabol (1904), *Dictyomitra duodecimcostata* consists of pyramidal test. Foreman (1975) also mentioned that the expanded segments after the initial conical ones increase distally in size. The obtained specimen of *Dictyomitra duodecimcostata* is different from *Dictyomitra formosa* in having the pyramidal-shaped test with discontinuous costae, which are thicker than those of the latter species. Test generally consists of eight segments. Post-abdominal segments are inflated and separated by extremely deep strictures.

Dictyomitra multicostata Zittel 1876
(Plate 1, figs. 24; Plate 2, figs. 10–11; Plate 3, figs. 9, 24)
1876 *Dictyomitra multicostata* n. sp. – Zittel, p. 81, pl. 2, figs. 2–4.
1944 *Dictyomitra multicostata* Zittel – Campbell and Clark, p. 39–40, pl. 8, figs. 22–24, 35–42.
1968 *Dictyomitra multicostata* Zittel – Foreman, p. 63–65, pl. 7, figs. 4a–4b.
1968 *Dictyomitra lamellicostata* n. sp. – Foreman, p. 65–66, pl. 7, figs. 8a–8b.
1968 *Dictyomitra* sp. cf. *D. multicostata* Zittel – Foreman, p. 63–65, pl. 7, figs. 9a–9b.
1973b *Dictyomitra torquata* Foreman – Foreman, pl. 10, fig. 8c.
1976 *Dictyomitra multicostata* Zittel – Pessagno, p. 52–53, pl. 14, figs. 4–9.
1981 *Dictyomitra multicostata* Zittel – Nakaseko and Nishimura, p. 151, pl. 8, fig. 1; pl. 16, fig. 1.
1987 *Dictyomitra multicostata* Zittel – Yamasaki, pl. 1, fig. 16.
1994 *Dictyomitra multicostata* Zittel – O'Dogherty, p. 82–83, pl. 4, figs. 17–19.
1997 *Dictyomitra multicostata* Zittel – Hashimoto and Ishida, pl. 2, fig. 1.
2007 *Dictyomitra multicostata* Zittel – Musavu-Moussavou *et al*., p. 267–268, pl. 2, figs. 12–13.
2008 *Dictyomitra multicostata* Zittel – Bandini *et al*., p. 17, pl. 4, fig. 4.
2015 *Dictyomitra multicostata* Zittel – Hashimoto *et al*., p. 45, pl. 1, fig. 5.
Remarks: This species is similar to *Dictyomitra formosa*, but different by having a slender spindle-shaped or elongate mildly lobulate test with widely spaced costae (Pessagno, 1976; O'Dogherty, 1994).
Range: Middle Campanian to Lower Maastrichtian (Pessagno, 1976), and Turonian to Maastrichtian (Thurow, 1988).

Dictyomitra densicostata Pessagno 1976
(Plate 1, figs. 9–10, 25; Plate 2, fig. 23)
1976 *Dictyomitra densicostata* n. sp. – Pessagno, p. 51, pl. 14, figs. 10–14, 16.
1992 *Dictyomitra formosa* Squinabol – Okamura, pl. 31, fig. 5.
1997 *Dictyomitra densicostata* Pessagno – Hashimoto and Ishida, pl. 1, fig. 19; pl. 2, fig. 4.
1998 *Dictyomitra densicostata* Pessagno –Ishida and Hashimoto, pl. 1, fig. 18.
2007 *Dictyomitra* sp. cf. *D. densicostata* Pessagno – Musavu-Moussavou *et al*., p. 268, pl. 2, figs. 14–15.
2015 *Dictyomitra densicostata* Pessagno – Hashimoto *et al*., p. 45, pl. 1, fig. 6.
Remarks: Test of this species is distinctly lobulate with finely costae throughout. It differs from *Dictyomitra multicostata* by costae on post-abdominal segments which are spaced closely than those of the latter species.
Range: Upper Coniacian to Campanian (Pessagno, 1976), Middle Coniacian? to Lower Maastrichtian (Hollis and Kimura, 2001), and Middle Campanian? to Lower Maastrichtian (Hashimoto *et al*., 2015).

Dictyomitra* sp. aff. *D. densicostata Pessagno 1976
(Plate 3, fig. 26)
Remarks: This specimen resembles to *Dictyomitra densicostata*, but slightly differs by its short test having less post-abdominal segments than those of the latter species.

Dictyomitra koslovae Foreman 1975
(Plate 2, figs. 9, 22, 33)
1971 *Dictyomitra* sp. – Foreman, p. 1677, pl. 3, fig. 5.
1975 *Dictyomitra koslovae* n. sp. – Foreman, p. 614, pl. 7, fig. 4.
1978 *Dictyomitra koslovae* Foreman – Foreman, p. 746–747, pl. 4, fig. 10.
1981 *Dictyomitra koslovae* Foreman – Nakaseko and Nishimura, p. 151, pl. 8, figs. 2–5; pl. 16, figs. 2–3.
1982 *Dictyomitra koslovae* Foreman – Mizutani *et al*., p. 67–68, pl. 9, figs. 5–8.
1985 *Dictyomitra koslovae* Foreman – Sanfilippo and Riedel, p. 599–600, figs. 7.4a–7.4b, 7.4d–7.4e.
1987 *Dictyomitra koslovae* Foreman – Yamasaki, pl. 1, fig. 22.
1989 *Dictyomitra koslovae* Foreman – Iwata and Tajika, pl. 2, fig. 7.
1992 *Dictyomitra koslovae* Foreman – Iwata *et al*., pl. 1, fig. 1.
1994 *Dictyomitra koslovae* Foreman – Yamasaki and Tsujii, pl. 1, figs. 3–5.
2008 *Dictyomitra koslovae* Foreman – Bandini *et al*., p. 17, pl. 1, fig. 16; pl. 2, figs. 11, 24; pl. 3, fig. 14.
2009 *Dictyomitra koslovae* Foreman – Djerić *et al*., fig. 8.6.
2015 *Dictyomitra koslovae* Foreman – Hashimoto *et al*., p. 45, pl. 1, fig. 3.
Remarks: *Dictyomitra koslovae* is distinctly different from other species of *Dictyomitra* by having the fourth segment which is markedly wider than the next one or two segments (Foreman, 1975).
Range: Middle Coniacian to Lower Campanian? (Taketani, 1982), Middle to Upper Campanian (Sanfilippo and Riedel, 1985), Middle to Upper Campanian (Thurow, 1988), Upper Coniacian to Lower Maastrichtian (Hollis and Kimura, 2001), and Middle? to Upper Campanian (Hashimoto *et al*., 2015).

Dictyomitra andersoni (Campbell and Clark 1944)
(Plate 3, fig. 25)
1944 *Lithocampe andersoni* n. sp. – Campbell and Clark, p. 42–43, pl. 8, fig. 25.
1968 *Dictyomitra andersoni* (Campbell and Clark) – Foreman, p. 68, pl. 7, figs. 6a–6d.
1971 *Dictyomitra andersoni* (Campbell and Clark) –

Foreman, p. 1677, pl. 3, fig. 8.
1978 *Dictyomitra andersoni* (Campbell and Clark) – Foreman, p. 746, pl. 4, fig. 6.
1981 *Dictyomitra* sp. A – Nakaseko and Nishimura, p. 151, pl. 8, fig. 6.
1982 *Dictyomitra urakawensis* n. sp. – Taketani, p. 59, pl. 4, figs. 8a–8b; pl. 11, fig. 16.
1987 *Dictyomitra tiara* Campbell and Clark – Yamasaki, pl. 1, fig. 18.
1989 *Dictyomitra urakawensis* Taketani – Tumanda, p. 36, pl. 8, figs. 4–5.
1992 *Dictyomitra urakawensis* Taketani – Okamura, pl. 35, fig. 5.
1997 *Dictyomitra urakawensis* Taketani – Hashimoto and Ishida, pl. 1, fig. 21.
1997 *Dictyomitra tiara* Campbell and Clark – Hashimoto and Ishida, pl. 2, fig. 2.
1997 *Dictyomitra andersoni* (Campbell and Clark) – Hollis, p. 69, pl. 16, figs. 11–16.
2015 *Dictyomitra andersoni* (Campbell and Clark) – Hashimoto *et al*., p. 45, pl. 1, fig. 4.

Remarks: As mentioned by Hollis (1997), *Dictyomitra urakawensis* described by Taketani (1982) is a synonym of this species.
Range: Middle Coniacian? to Lower Maastrichtian or to Paleocene (Hollis and Kimura, 2001), and Middle Campanian? to Maastrichtian or to Paleocene? (Hashimoto *et al*., 2015).

Genus ***Thanarla*** Pessagno 1977

Thanarla* sp. aff. *T. veneta (Squinabol 1903)
(Plate 1, fig. 26)
Description: Test is elongate and conical to campanulate, and is composed of seven segments; Cephalothorax is conical and relatively short, inflated abdomen shows an annular form. Post-abdominal segments is cylindrical, narrower than proximal segments, gradually increasing in width as added. Final post-abdominal segment is slightly narrower. Constrictions are weakly developed, but markedly distinct between the annular abdomen and first post-abdominal segment. Edged costae are developed throughout, converging apically and widely spaced on the post-abdominal segments (ten costae are visible in lateral view).
Remarks: The examined specimen is similar to *Thanarla veneta* in general form, but distinguished by having an elongate test with seven segments (*Thanarla veneta* consists of four segments). *Dictyomitra koslovae* resembles to this species, but differs by lacking costae on its apical portion.

Family **AMPHIPYNDACIDAE** Riedel 1967

Genus ***Amphipternis*** Foreman 1973b

Amphipternis stocki (Campbell and Clark 1944)
(Plate 1, figs. 11–12, 28–29; Plate 2, figs. 12–13, 24; Plate 3, figs. 11, 30)
1944 *Stichocapsa*? *stocki* n. sp. – Campbell and Clark, p. 44, pl. 8, figs. 31–33.
1968 *Amphipyndax stocki* (Campbell and Clark) – Foreman, p. 78, pl. 8, figs. 12a–12c.
1972 *Amphipyndax stocki* (Campbell and Clark) – Petrushevskaya and Kozlova, p. 545, pl. 8, figs. 16–17.
1973a *Amphipyndax stocki* (Campbell and Clark) – Foreman, p. 430, pl. 13, fig. 5.
1975 *Amphipyndax stocki* (Campbell and Clark) – Pessagno, p. 1016, pl. 4, figs. 6–8.
1978 *Amphipyndax stocki* (Campbell and Clark) – Foreman, p. 745, pl. 4, fig. 4.
1981 *Amphipyndax stocki* (Campbell and Clark) – Nakaseko and Nishimura, p. 145, pl. 12, fig. 5.
1982 *Amphipyndax stocki* (Campbell and Clark) – Taketani, p. 52, pl. 2, fig. 9a–9b; pl. 10, figs. 13–14.
1982 *Protostichocapsa stocki* (Campbell and Clark) – Empson-Morin, p. 516–517, pl. 4, figs. 1–12.
1994 *Stichomitra stocki* (Campbell and Clark) – O'Dogherty, p. 147–150, pl. 18, figs. 9–15.
1998 *Stichomitra stocki* (Campbell and Clark) – Erbacher, p. 370–371, pl. 2, fig. 1.
2006 *Stichomitra stocki* (Campbell and Clark) – Musavu-Moussavou and Danelian, p. 155, pl. 2, figs. 11–13.
2007 *Stichomitra stocki* (Campbell and Clark) – Musavu-Moussavou *et al*., p. 273, pl. 4, figs. 9–12.
2015 *Amphipyndax stocki* (Campbell and Clark) – Hashimoto *et al*., p. 43, pl. 1, fig. 10.
2016 *Amphipternis stocki* (Campbell and Clark 1944) – Noda and Kurihara, pl. 1, figs. 6, 11, 18; pl. 2, fig. 4.

Remarks: *Amphipternis stocki* shows a wide range of morphological variation in the proximal portion of the test (O'Dogherty, 1994), and resembles to *Stichomitra mediocris*. However, they are distinguishable; *Amphipternis stocki* is composed of externally constricted test with smaller pores, larger numbers of rows of pores per segment, and is also marked by a large sutural pore on first post-abdominal segment.
Range: Middle Cenomanian to Turonian? (O'Dogherty, 1994), and Middle Coniacian? to Lower Maastrichtian (Hollis and Kimura, 2001).

Genus ***Amphipyndax*** Foreman 1966

Amphipyndax tylotus Foreman 1978
(Plate 1, fig. 30)
1978 *Amphipyndax tylotus* n. sp. – Foreman, p. 745, pl. 4, figs. 1–2.
1981 *Amphipyndax tylotus* Foreman – Nakaseko and Nishimura, p. 145, pl. 12, figs. 11a–11b; pl. 17, fig. 13.

1982 *Amphipyndax tylotus* Foreman – Empson-Morin, p. 512, pl. 3, figs. 1–7.
1985 *Amphipyndax tylotus* Foreman – Sanfilippo and Riedel, p. 598, figs. 7.2a–7.2b.
1987 *Amphipyndax tylotus* Foreman – Yamasaki, pl. 1, fig. 3.
1997 *Amphipyndax tylotus* Foreman – Hashimoto and Ishida, pl. 3, fig. 8.
1998 *Amphipyndax tylotus* Foreman – Ishida and Hashimoto, pl. 2, fig. 3.
2015 A*mphipyndax tylotus* Foreman – Hashimoto *et al*., p. 43–44, pl. 1, fig. 9.

Remarks: This species was first described to belong to genus *Amphipyndax* by Foreman (1978), whose sense has been followed by numerous succeeding literatures.
Range: Middle Campanian to Maastrichtian (Sanfilippo and Riedel, 1985; Thurow, 1988; Hashimoto *et al*., 2015), and Middle Campanian to Lower Maastrichtian (Hollis and Kimura, 2001).

Amphipyndax* sp. aff. *A. tylotus (Foreman 1978)
(Plate 1, figs. 31–32)

Remarks: The obtained specimens are similar to *Amphipyndax tylotus* in general form. Nevertheless, it is probably doubtful that these specimens belong to genus *Amphipyndax*, because their cephalis are small and conical, not knob-like.

Family **XITIDAE** Pessagno 1977

Genus ***Xitus*** Pessagno 1977

Xitus spicularius (Aliev 1965)
(Plate 1, fig. 27)

1965 *Dictyomitra spicularia* n. sp. – Aliev, p. 39, pl. 6, fig. 9; pl. 14, fig. 4.
1977 *Xitus antelopensis* n. sp. – Pessagno, p. 55, pl. 9, figs. 10, 20, 25; pl. 12, fig. 16.
1977 *Xitus plenus* n. sp. – Pessagno, p. 55, pl. 9, figs. 15, 21, 26; pl. 12, fig. 15.
1977 *Xitus spicularius* (Aliev) – Pessagno, p. 56, pl. 9, fig. 7; pl. 10, fig. 5.
1986 *Xitus*? sp. B – Iwata and Tajika, p. 408, pl. 3, fig. 3.
1988 *Xitus spicularius* (Aliev) – Thurow, p. 408, pl. 3, fig. 19; pl. 7, fig. 1.
1994 *Xitus spicularius* (Aliev) – O'Dogherty, p. 127–129, pl. 3, fig. 19; pl. 7, fig. 1.
2007 *Xitus spicularius* (Aliev) – Musavu-Moussavou *et al*., p. 275–276, pl. 4, figs. 17–18.
2008 *Xitus spicularius* (Aliev) – Bandini *et al*., p. 408, pl. 3, fig. 24.
2012 *Xitus spicularius* (Aliev) – Asis and Jasin, pl. 1, fig. 15.

Range: Berriasian to Cenomanian (Thurow, 1988), and Middle Coniacian to Middle Campanian (Hollis and Kimura, 2001).

Genus ***Torculum*** O'Dogherty 1994

Torculum* sp. aff. *T. bastetani O'Dogherty 1994
(Plate 3, fig. 12)

2004 *Stichomitra communis* Squinabol – Bąk, figs. 4.12–4.13.

Description: Test is multi-segmented and large conical, having seven post-abdominal segments with distinct strictures. Cephalis is conical and smooth without apical horn. Thorax and abdomen are trapezoidal and sparsely perforated. Post-abdominal segments consist of circular to polygonal pore frames, showing somewhat spongy meshwork. First and second post-abdominal segments are externally characterized by a ring of relatively large tubercles. Remaining post-abdominal segments constantly increase in width as added.
Remarks: *Torculum bastetani* proposed by O'Dogherty (1994) is more elongate conical to cylindrical in outline and covered by somewhat spongy meshwork. *Stichomitra communis* is similar to the examined specimen in having circular to polygonal pore frames and relatively deep strictures, but distinguished by lacking of large tubercles.

Family **PSEUDODICTYOMITRIDAE** Pessagno 1977

Genus ***Pseudodictyomitra*** Pessagno 1977

Pseudodictyomitra tiara (Holmes 1900)
(Plate 3, figs. 10, 27)

1900 *Dictyomitra tiara* n. sp. – Holmes, p. 701, pl. 38, fig. 4.
1977 *Pseudodictyomitra* sp. B – Pessagno, p. 52, pl. 9, fig. 3.
1982 *Pseudodictyomitra nakasekoi* n. sp. – Taketani, p. 60–61, pl. 12, figs. 4–6.
1982 *Pseudodictyomitra nakasekoi* Taketani – Mizutani *et al*., p. 70, pl. 4, figs. 8–9.
1989 *Pseudodictyomitra nakasekoi* Taketani – Tumanda, p. 39, pl. 9, fig. 3.
1992 *Pseudodictyomitra nakasekoi* Taketani – Okamura, pl. 25, fig. 3; pl. 27, figs. 2–3.
1994 *Pseudodictyomitra tiara* (Holmes) – O'Dogherty, p. 109–110, pl. 8, figs. 9–11.
1998 *Pseudodictyomitra tiara* (Holmes) – Salvini and Marcucci Passerini, fig. 6n.
2006 *Pseudodictyomitra nakasekoi* Taketani – Bragina and Bragin, pl. II, fig. 8.
2006 *Pseudodictyomitra nakasekoi* Taketani – Denyer and Baumgartner, fig. 7T.
2007 *Pseudodictyomitra tiara* (Holmes) – Musavu-Moussavou *et al*., p. 109–110, pl. 3, fig. 274.

Range: Middle Cenomanian to Lower Coniacian (Taketani, 1982), Cenomanian to Turonian (Thurow, 1988), and Lower to Upper Cenomanian (O'Dogherty, 1994).

Family **EUCYRTIDIIDAE** Ehrenberg 1847

Genus ***Pseudoeucyrtis*** Pessagno 1977

Pseudoeucyrtis* sp. cf. *P. spinosa (Squinabol 1903)
(Plate 3, fig. 28)
Remarks: Test of this specimen consists of a large spherical portion (post-abdominal segments) with a long robust apical horn and a long terminal cylindrical tube, main part of which is broken. On the basis of these external features, it probably belongs to *Pseudoeucyrtis spinosa*, but slightly different by lacking spines on the spherical portion.

Genus ***Stichomitra*** Cayeux 1897

Stichomitra communis Squinabol 1903
(Plate 3, fig. 29)
1903 *Stichomitra communis* n. sp. – Squinabol, p. 141, pl. 8, fig. 40.
1981 *Stichomitra communis* Squinabol – Nakaseko and Nishimura, p. 162, pl. 11, fig. 11; pl. 16, fig. 14.
1982 *Stichomitra communis* Squinabol – Taketani, p. 54–55, pl. 3, fig. 9; pl. 11, fig. 5.
1989 *Stichomitra communis* Squinabol – Tumanda, p. 40, pl. 7, fig. 7.
1992 *Stichomitra communis* Squinabol – Okamura, pl. 37, fig. 28.
1994 *Stichomitra communis* Squinabol – O'Dogherty, p. 144–145, pl. 17, figs. 6–16.
1997 *Stichomitra communis* Squinabol – Hashimoto and Ishida, pl. 1, fig. 3.
1997 *Stichomitra communis* Squinabol – Sýkora *et al*., pl. V, fig. 7.
1998 *Stichomitra communis* Squinabol – Salvini and Marcucci Passerini, fig. 8j.
1998 *Stichomitra communis* Squinabol – Erbacher, pl. 1, fig. 12.
2001 *Stichomitra communis* Squinabol – Bragin *et al*., figs. 6.15–6.17.
2006 *Stichomitra communis* Squinabol – Musavu-Moussavou and Danelian, p. 155, pl. 2, fig. 15.
2007 *Stichomitra communis* Squinabol – Musavu-Moussavou *et al*, p. 271–272, pl. 4, figs. 7–8.
2012 *Stichomitra communis* Squinabol – Asin and Jasin, pl. 2, fig. 2.
2015 *Stichomitra compsa* Foreman – Hashimoto *et al*., p. 47, pl. 1, fig. 13.
Range: Lower Cenomanian? to Lower Coniacian (Taketani, 1982), and Lower Aptian to Lower Turonian? (O'Dogherty, 1994).

Stichomitra manifesta Foreman 1978
(Plate 1, fig. 13; Plate 2, fig. 25; Plate 3, fig. 31)
1972 *Diacanthocapsa* sp. B – Petrushevskaya and Kozlova, p. 536, pl. 7, fig. 5.
1978 *Stichomitra manifesta* n. sp. – Foreman, p. 748, pl. 5, fig. 4.
1982 *Stichomitra manifesta* Foreman – Taketani, p. 55–56, pl. 3, figs. 8a–8b; pl. 11, figs. 7–8.
1992 *Stichomitra manifesta* Foreman – Iwata *et al*., pl. 3, fig. 9.
1997 *Stichomitra manifesta* Foreman – Hashimoto and Ishida, pl. 3, fig. 2.
1998 *Stichomitra manifesta* Foreman – Ishida and Hashimoto, pl. 2, fig. 7.
2008 *Lithocampe manifesta* (Foreman) – Bandini *et al*., pl. 3, fig. 16; pl. 4, fig. 6.
2012 *Lithocampe manifesta* (Foreman) – Asis and Jasin, pl. 2, fig. 11.
Remarks: According to Foreman (1978), *Stichomitra manifesta* is distinguished from other species of *Stichomitra* by having a large hemispherical thorax greater in length than the succeeding segments, and in the usual case, test is composed of four or five segments, but rarely of seven. The examined specimens possess four segments, except for the specimen illustrated in plate 3, fig. 31 which has seven segment.
Range: Coniacian to Lower Campanian? (Taketani, 1982), and Middle Coniacian? to Lower Maastrichtian (Hollis and Kimura, 2001).

Stichomitra asymbatos Foreman 1968
(Plate 2, fig. 27; Plate 3, fig. 32)
1968 *Stichomitra asymbatos* n. sp. – Foreman, p. 73–75, pl. 8, figs. 10a–10c.
1972 *Stichocapsa asymbatos* (Foreman) – Petrushevskaya and Kozlova, p. 546, pl. 8, figs. 1–3.
1974 *Stichomitra asymbatos* Foreman group – Riedel and Sanfilippo, p. 780, pl. 10, figs. 1–7.
1978 *Stichomitra asymbatos* Foreman group – Foreman, p. 748, pl. 4, fig. 15.
1982 *Stichomitra asymbatos* Foreman – Taketani, p. 54, pl. 4, fig. 13; pl. 11, figs. 3–4.
1982 *Stichomitra asymbatos* Foreman – Yamauchi, pl. 5, fig. 8.
1987 *Stichomitra asymbatos* Foreman – Yamasaki, pl. 1, fig. 15.
1992 *Stichomitra asymbatos* Foreman – Iwata *et al*., pl. 5, fig. 9.
1997 *Stichomitra asymbatos* Foreman – Hashimoto and Ishida, pl. 3, fig. 17.
1998 *Stichomitra asymbatos* Foreman – Ishida and Hashimoto, pl. 2, fig. 4.

Stichomitra* sp. aff. *S. asymbatos Foreman 1968
(Plate 2, fig. 14)
Remarks: This specimen is probably different from *Stichomitra asymbatos* by having a more inflated test with five segments.

Stichomitra* sp. cf. *S. conicus (Nakaseko and Nishimura 1981)
(Plate 2, fig. 26)
Remarks: This specimen resembles to *Stichomitra* conicus in having a test which is proximally conical and distally subcylindrical shape, but slightly differs by having transverse rows of pores which are smaller in size.

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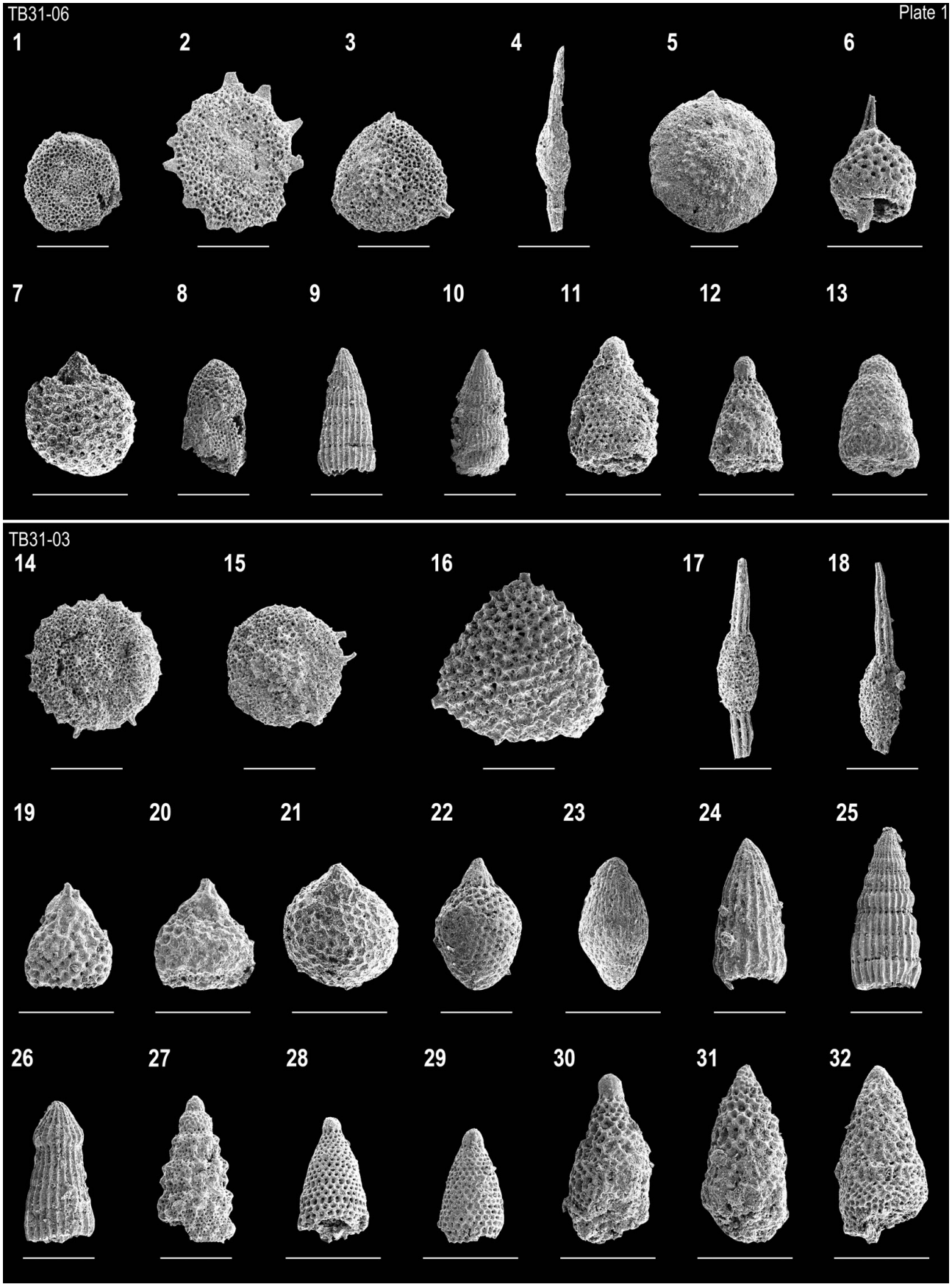
Plate 1 SEM images of Upper Cretaceous radiolarians from the Matoya Group in the Toba District.

TB31-06 (Locality 1, southwest of Anori, Shima City)
1: *Orbiculiforma sacramentoensis* Pessagno
2: *Dactyliosphaera* sp. aff. *D. silviae* Squinabol
3: *Pseudoaulophacus praefloresensis* Pessagno
4: *Archaeospongoprunum hueyi* Pessagno
5: *Patellula planoconvexa* (Pessagno)
6: *Rhopalosyringium magnificum* Campbell and Clark
7: *Cryptamphorella macropora* Dumitrică
8: *Diacanthocapsa* sp. cf. *D. ovoidea* Dumitrică
9,10: *Dictyomitra densicostata* Pessagno
11,12: *Amphipternis stocki* (Campbell and Clark)
13: *Stichomitra manifesta* Foreman

TB31-03 (Locality 2, southwest of Anori, Shima City)
14: *Orbiculiforma* sp. cf. *O. railensis* Pessagno
15: *Pseudoaulophacus* sp. cf. *P. lenticulatus* (White)
16: *Alievium gallowayi* (White)
17,18: *Archaeospongoprunum hueyi* Pessagno
19,20: *Rhopalosyringium magnificum* Campbell and Clark
21: *Cryptamphorella sphaerica* (White)
22: *Cryptamphorella* sp. B sensu Bąk (1996)
23: *Eastonerius* sp. aff. *E. acuminatus* (Dumitrică)
24: *Dictyomitra multicostata* Zittel
25: *Dictyomitra densicostata* Pessagno
26: *Thanarla* sp. aff. *T. veneta* (Squinabol)
27: *Xitus spicularius* (Aliev)
28,29: *Amphipternis stocki* (Campbell and Clark)
30: *Amphipyndax tylotus* Foreman
31,32: *Amphipyndax* sp. aff. *A. tylotus* Foreman

All scale bars are equal to 0.1 mm.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TB31-03
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Plate 2 SEM images of Upper Cretaceous radiolarians from the Matoya Group in the Toba District.

TB20-03 (Locality 3, southwest of Hiyama, Shima City)
1: *Pseudoaulophacus floresensis* Pessagno
2: *Pseudoaulophacus* sp. cf. *P. pargueraensis* Pessagno
3: *Patellula verteroensis* (Pessagno)
4: *Archaeospongoprunum* sp. cf. *A. stocktonensis* Pessagno
5: *Cryptamphorella macropora* Dumitrică
6: *Theocampe salillum* Foreman
7: *Diacanthocapsa ovoidea* Dumitrică
8: *Diacanthocapsa* sp. cf. *D. ancus* (Foreman) sensu Dumitrică (1970)
9: *Dictyomitra koslovae* Foreman
10,11: *Dictyomitra multicostata* Zittel
12,13: *Amphipternis stocki* (Campbell and Clark)
14: *Stichomitra* sp. aff. *S. asymbatos* Foreman

TB20-02 (Locality 4, northeast of Hiyama, Shima City)
15: *Alievium* sp. cf. *A. gallowayi* (White)
16: *Pseudoaulophacus lenticulatus* (White)
17: *Pseudoaulophacus floresensis* Pessagno
18: *Patellula verteroensis* (Pessagno)
19: *Rhopalosyringium magnificum* Campbell and Clark
20: *Cryptamphorella sphaerica* (White)
21: *Theocampe salillum* Foreman
22: *Dictyomitra koslovae* Foreman
23: *Dictyomitra densicostata* Pessagno
24: *Amphipternis stocki* (Campbell and Clark)
25: *Stichomitra manifesta* Foreman
26: *Stichomitra* sp. cf. *S. conicus* (Nakaseko and Nishimura)
27: *Stichomitra asymbatos* Foreman

TB05-12 (Locality 5, Kuzaki, Toba City)
28: *Alievium* sp. cf. *A. gallowayi* (White)
29: *Pseudoaulophacus lenticulatus* (White)
30: *Pseudoaulophacus floresensis* Pessagno
31: *Cryptamphorella wogiga* Empson-Morin
32: *Theocampe urna* (Foreman)
33: *Dictyomitra koslovae* Foreman
34: *Dictyomitra undata* Squinabol
35: *Dictyomitra duodecimcostata* (Squinabol) sensu Foreman (1975)

All scale bars are equal to 0.1 mm.

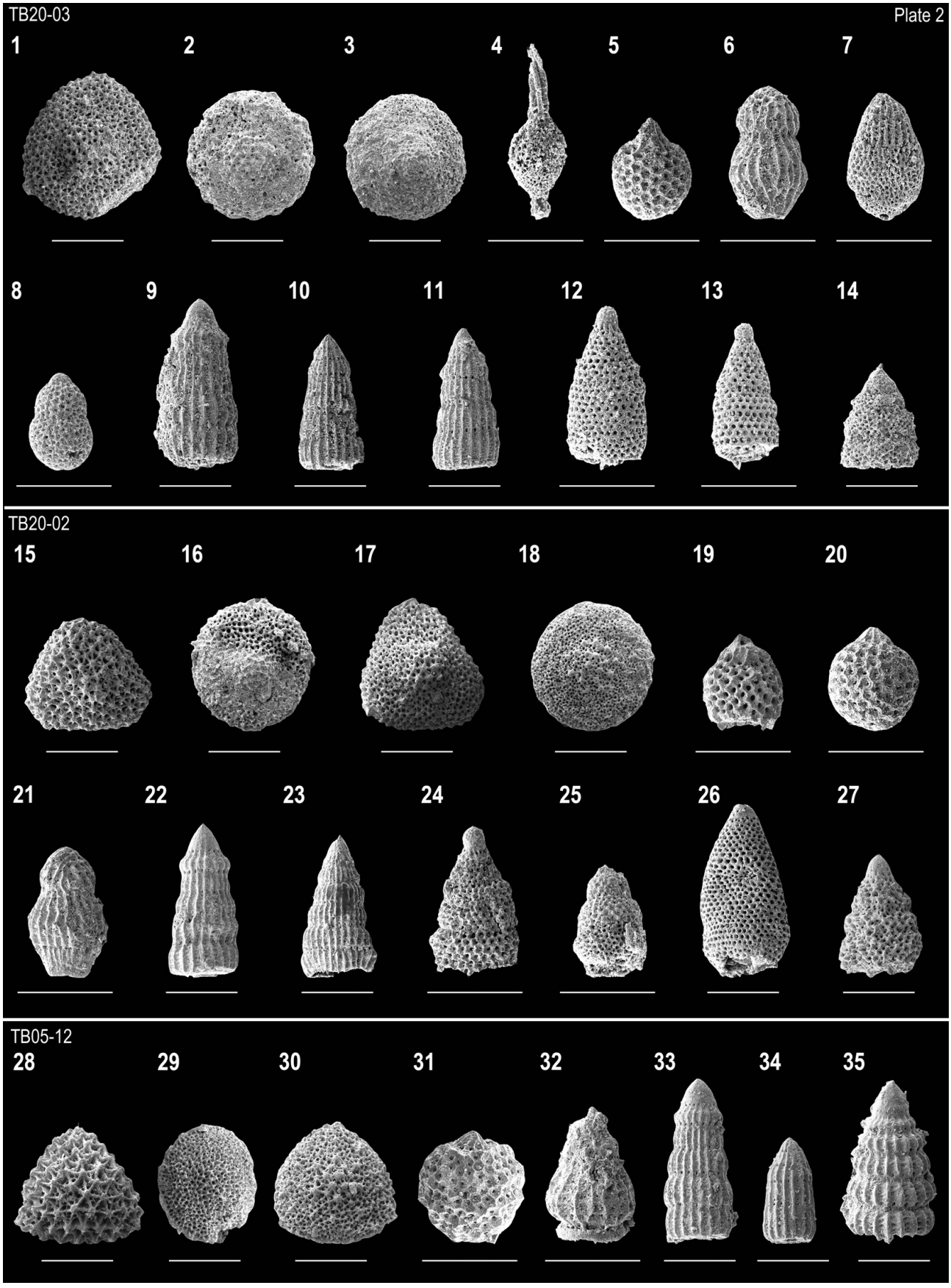
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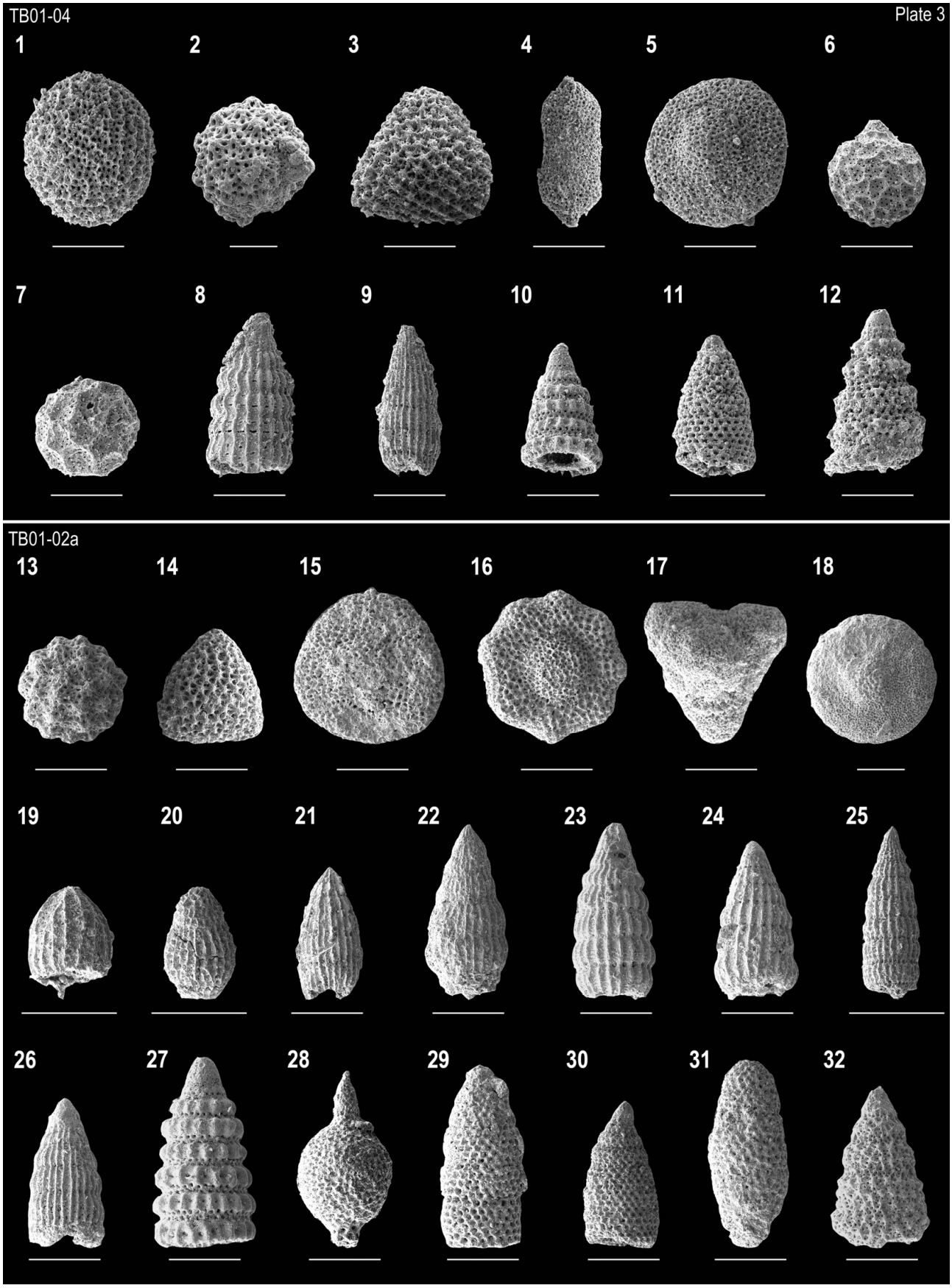
Plate 3 SEM images of Upper Cretaceous radiolarians from the Matoya Group in the Toba District.

TB01-04 (Locality 6, northwest of Ijika, Toba City)
1: *Archaeocenosphaera*? *mellifera* O'Dogherty
2: *Conocaryomma californiaensis* (Pessagno)
3: *Alievium* sp. cf. *A. praegallowayi* Pessagno
4: *Archaeospongoprunum* sp. aff. *A. andersoni* Pessagno
5: *Patellula verteroensis* (Pessagno)
6: *Cryptamphorella* sp. aff. *C. gilkeyi* (Dumitrica)
7: *Hemicryptocapsa polyhedra* Dumitrică
8: *Dictyomitra formosa* Squinabol
9: *Dictyomitra multicostata* Zittel
10: *Pseudodictyomitra tiara* (Holmes)
11: *Amphipternis stocki* (Campbell and Clark)
12: *Torculum* sp. aff. *T. bastetani* O'Dogherty

TB01-02a (Locality 7, southwest of Ijika, Toba City)
13: *Conocaryomma universa* (Pessagno)
14: *Alievium* sp. cf. *A. praegallowayi* Pessagno
15: *Pseudoaulophacus* sp. cf. *P. praefloresensis* Pessagno
16: *Pseudoaulophacus parguerаensis* Pessagno
17: *Pyramispongia glascockensis* Pessagno
18: *Patellula verteroensis* (Pessagno)
19: *Rhopalosyringium* sp. A sensu Bandini *et al*. (2008)
20: *Theocampe salillum* Foreman
21: *Archaeodictyomitra squinaboli* Pessagno
22: *Dictyomitra* sp. cf. *D. gracilis* (Squinabol)
23: *Dictyomitra formosa* Squinabol
24: *Dictyomitra multicostata* Zittel
25: *Dictyomitra andersoni* (Campbell and Clark)
26: *Dictyomitra* sp. aff. *D. densicostata* Pessagno
27: *Pseudodictyomitra tiara* (Holmes)
28: *Pseudoeucyrtis* sp. cf. *P. spinosa* (Squinabol)
29: *Stichomitra communis* Squinabol
30: *Amphipternis stocki* (Campbell and Clark)
31: *Stichomitra manifesta* Foreman
32: *Stichomitra asymbatos* Foreman

All scale bars are equal to 0.1 mm.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三重県鳥羽地域における上部白亜系的矢層群（四万十帯）の放散虫年代：予察報告

中江　訓・栗原敏之

要　旨

紀伊半島東部に位置する鳥羽地域における野外地質調査と放散虫化石に基づく時代決定により，的矢層群の泥岩がコニアシアン期–カンパニアン期を示すことが明らかにされた．この層群は四万十帯（北帯）に属し，古アジア大陸下にクラプレートが沈み込むプレート境界に沿って形成されたものである．放散虫化石を産する51地点のうち7地点の露頭から比較的保存の良い放散虫化石群集が得られ，これらは３つの地質時代（前期コニアシアン期，前期カンパニアン期ないし中期サントニアン期–中期カンパニアン期，中期–後期カンパニアン期）に分類される．このことは，的矢層群がさらに細分できる可能性があることを示している．

難読･重要地名

Anori：安乗，Hiyama：桧山，Ijika：石鏡，Isobe：磯部，Kii：紀伊，Kuzaki：国崎，Matoya：的矢，Matsuo：松尾，Osatsu：相差，Shima：志摩，Shimanto：四万十，Toba：鳥羽，Tsuiji：築地，Ugata：鵜方．