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A Barremian Occurrence of an Olcostephanid, a Perisphinctacean Ammonite, from the Choshi Group, Japan

By

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Abstract—This paper describes *Olcostephanus cadoceroides* (KARAKASCH) from the Barremian Kimigahama Formation of the Choshi area in the Kwanto district. This ammonite provides important evidence on the upper limit of olcostephanids. A new subgeneric name *Neoastieria* is proposed for the species, which probably descended from *O.* (*Subastieria*). The genus *Olcostephanus* is interpreted as having been adapted to a variety of environments and be widely distributed during the Valanginian to Mid-Hauterivian, but contracted rapidly in the Early Barremian.

Introduction

The genus *Olcostephanus*, a perisphinctacean ammonite, is widely distributed during the Valanginian (Early Cretaceous) and is generally considered to have become extinct in the Mid-Hauterivian (*e.g.* WRIGHT, 1957, L347).

Until now the only known Japanese occurrence of *Olcostephanus* has been from the Berriasian in the south Kitakami Mountains, Northeast Japan (SATO, 1958, pp. 590–592).

Now another species of *Olcostephanus* is confirmed from the Lower Barremian in Kwanto, Japan: a record that provides new evidence on the upper limit of olcostephanids. This paper describes this species and considers the true stratigraphic range of the genus.

At the east end of the Kwanto district, the Cretaceous outcrops over a small area along the coastline facing the Pacific Ocean. According to OBATA and MATSUKAWA (1982) the succession can be subdivided lithostratographically into five units, named the Ashikajima, Kimigahama, Inubouzaki, Toriakeura and Nagasakihana Formations in ascending order. The *Olcostephanus* was obtained from the numerous scattered calcareous nodules in the mudstone in the lower to middle part of the Kimigahama Formation, being associated with *Barremites* (*B.*) *difficilis, Pulchellia* sp., *Holcodiscus* sp., *Crioceratites* (*Emericiceras*) *emerici* and other species. Thus the ammonite fauna of the Kimigahama Formation shows a close affinity to that from the Tethys province, e. g. the stratotype of the Lower Barremian in France (BUSNARDO, 1965) and the Barremian of the Sably Mine of the Crimea in Russia (KARAKASCH, 1907) (Table 1). Accordingly, the Kimigahama Formation can be assigned to the Lower Barremian.

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Table 1. List of ammonites from the Kimigahama Formation in comparison with those from the stratotype of the Barremian and the formation in the Sably Mine, Crimea. Solid and broken lines under the specific names show the ammonites being obtained from the three or two areas commonly.

Choshi Kimigahama F. (OBATA & MATSUKAWA, 1982)	France Stratotype of Barremian (BUSNARDO, 1965)	Crimea Sably Mine (KARAKASCH, 1907)
Hypophylloceras sp.	*Phylloceras tethys*	*Phylloceras ponticuli*
		P. milaschewitschi
	Salfeldiela sp.	*P. sablensis*
		P. eichwaldi
		P. prendeli
	Phyllopachyceras infundibulum	*P. infundibulum*
	P. eichwaldi	*P. stuckenbergi*
	P. baborense	*P. picturatum*
Lytoceras sp.	*Lytoceras densifimbriatum*	*Lytoceras subsequens*
	L. phestus	*L. phestus*
	L. vogdti	*L. actum*
Eogaudryceras sp.		
Eotetragonites sp.		
	Costidiscus recticostatus	*Costidiscus nodosostriatus*
	C. rakusi	*C. nodosocostatus*
Macroscaphites? sp.	*Macroscaphites yvani*	*Macroscaphites yvani*
		Crioceras pietetiaeforme
Crioceratites(Emericiceras) emerici	*Emericiceras* gr. *emerici*	*Hamulina* cf. *emerici*
C. sp.	*E.* gr. *barremense*	
	E. thidlieri	*Taxoceras porrectum*
	E. journoti	*T. dahnowi*
	E. cf. *clausum*	*T. sinzowi*
Acrioceras sp.	*Acrioceras tabarelli*	
Leptoceras sp.	*Leptoceras puzosianum*	
Leptoceras? sp.	*L.* sp.	
	Ancyloceras? mojsisovicsi	
	Heteroceras astieri	*Heteroceras haugi*
	Hemihoplites feraudi	
	H. sp.	
	Hamulina subcylindrica	*Hamulina heheneggeri*
	H. subcincta	*H.* cf. *subcincta*
	H. davidsoni	*H.* sp.
	Ptychoceras meyrati	*Ptychoceras meyrati*
	Dissimilites cf. *trinodosus*	
Olcostephanus(Neoastieria) cadocercides		*Astieria cadocercides*
		A. elegans
		A. taurica
Barremites(B.) difficilis	*Barremites difficile*	*Deemoceras difficile*
	B. vocontium	*D. subdifficile*
	B. psilotatum	*D. hemiptychum*
	B. aff. *psilotatum*	*D. tauricum*
	B. strettostoma	*D. strettostoma*
		D. charrieri
		D. renevieri
		D. davydovi
B.(Raspailiceras) aff. *cassida*	*Raspailiceras cassida*	
	Melchiorites fallaciosum	*Puzosia melchioris*
	M. aff. *cassidoides*	
	M. sp.	
	M.? neumayri	
	Astieridiscus sp.	
	Spitidiscus hugii	
	S. heeri	
	S. intermedius	
	S. aff. *querolensis*	
Holcodiscus sp.	*Holcodiscus kiliani*	*Holcodiscus caillaudi*
	H. perezi	*H. perezi*
	H. sp.	*H. gastaldi*
		H. fallacior
		H. rotula
		H. sophonisba
	Silesites seranonis	*Sileistes typus*
	S. vulpes	*S. vulpes*
	S. cf. *vulpes*	*S. quinquesulcatus*
	S. cf. *tenuis*	*S. tenuis*
		S. sulcistriatus
	Nicklesia sp.	
Pulchellia sp.	*Pulchellia compressissima*	*Pulchellia nicklesi*
	Heinzia sp.	

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Depository

The specimens with the prefix NSM are preserved in the Department of Paleontology, National Science Museum, Tokyo.

Systematic Description

Order Ammonoidea ZITTEL, 1884
Superfamily Perisphinctaceae STEINMANN, 1890
Family Olcostephanidae HAUG, 1910
Subfamily Olcostephaninae HAUG, 1910
Genus ***Olcostephanus*** NEUMAYR, 1875

Type species: *Ammonites astierianus* d'ORBIGNY, 1840: by original designation of NEUMAYR, 1875

Remarks: This genus was proposed by NEUMAYR (1875) with a brief diagnosis. Other olcostephanid genera have been proposed since then, mainly on the basis of ornamentation. But there are diverse opinions concerning the classification and

Table 2. Different opinions on the generic and subgeneric division of the Olcostephaninae.

Wright (1957)	Cooper (1981)
Olcostephanus (*Olcostephanus*)	*Olcostephanus* (*Olcostephanus*)
O. (*Rogersites*)	*O.* (*Subastieria*)
Subastieria	*O.* (*Parastieria*)
Parastieria	*O.* (*Jeannoticeras*)
Saynoceras	*O.* (*Mexicanoceras*)
	Dobrogeiceras
	Jeanthieuloyites
	Valanginites
	Saynoceras (*Saynoceras*)
	S. (*Ceratotuberculus*)
	Capeloites

division of Olcostephaninae (Table 2). One opinion has been that the subfamily should be classified into four genera and two subgenera by whorl section, primary and secondary ribs and tubercles (WRIGHT, 1957). In another classification six genera and seven subgenera were recognized in the subfamily by whorl section and ribbing (COOPER, 1981) (Table 2). According to WRIGHT (1957, L344–L350), the Olcostephanidae, showing umbilical tubercles and bundled ribs, normally with strong constrictoins at some stages, are derived from the Perisphinctidae. The family is divided into four subfamilies: Spiticeratinae, Olcostephaninae, Polyptychitinae and Simbirskitinae by whorl section, degree of coiling and ornamentation. Under the Olcostephaninae he put several Early Cretaceous genera: four genera and two subgenera such as *Olcostephanus* (*Olcostephanus*) (NEUMAYR, 1875), *Olcostephanus* (*Rogersites*) (SPATH, 1924), *Subastieria* (SPATH, 1923a). *Parastieria* (SPATH, 1923b) and *Saynoceras* (MUNIER-CHALMAS and de LAPPARENT, 1893). The listed synonyms of *Olcostephanus* (s.l.) were *Holcostephanus* SAYN 1889, *Astieria* PAVLOW 1892 and ? *Capeloites* LISSON 1937. Other olcostephanid genera have been proposed by IMLAY (1938) and THIEULOY (1964, 1977), mainly on the basis of ornamentation. On the other hand, the Olcostephaninae were interpreted by COOPER (1981, pp. 161–173) as including six genera and seven subgenera (Table 2). He also divided the genus *Olcostephanus* into five subgenera being defined by cadicone shell form and bundled ribbing: *Olcostephanus* (NEUMAYR, 1875), *Subastieria* (SPATH, 1923a), *Parastieria* (SPATH, 1923b), *Mexicanoceras* (IMLAY, 1938) and *Jeannoticeras* (THIEULOY, 1964) by whorl section, ribbing and tubercles, on the basis of material from the Sunday's River Formation in South Africa.

Here we follow COOPER (1981, p. 161) in the definition of the genus *Olcostephanus*, and although the material which we have is not extensive, we attempt to summarize the characteristic features of the genus *Olcostephanus* with the advantage of some new facts.

In the genus *Olcostephanus* the following subgenera, with the type species in brackets, are to be included (Table 3):

Olcostephanus (*Olcostephanus*) NEUMAYR, 1875 [*Ammonites astierianus* d'ORBIGNY, 1840]

Olcostephanus (*Subastieria*) SPATH, 1923 [*Olcostephanus sulcosus* PAVLOW, 1892]

Olcostephanus (*Parastieria*) SPATH, 1923 [*Acanthoceras*? *peltoceroide* PAVLOW, 1892]

Olcostephanus (*Mexicanoceras*) IMLAY, 1938 [*Mexicanoceras kanei* IMLAY, 1938]

Olcostephanus (*Jeannoticeras*) THIEULOY, 1964 [*Ammonites jeannoti* d'ORBIGNY, 1840]

Olcostephanus (*Neoastieria*) subgen. nov. [*Astieria cadoceroides* KARAKASCH, 1907]

Subgenus ***Neoastieria***, nov.

Type species: *Astieria cadoceroides* KARAKASCH

Table 3. Diagram showing the diagnostic characters of the subgenera of the genus *Olcostephanus*.

	Shell size	Whorl section	Ornament				Number of Species	Age
			Profile	Rib	Tubercle	Constriction		
Olcostephanus (Parastieria)	small			broad flat bifurcated or trifurcated	none	weak	4	E.Haut.
O.(Jeannoticeras)	medium			fine bundled intercalated	none (adult)	weak	4	E.Haut.
O.(Mexicanoceras)	small			bundled intercalated	umbilical shoulder	weak	17	E.Haut.?
O.(Olcostephanus)	large			bundled intercalated	umbilical shoulder	moderately strong	66	M.Haut. ' Valang.
O.(Subastieria)	small			trifurcated	umbilical shoulder	strong	7	E.Haut. ' L.Valang.
O.(Neoastieria)	small			bifurcated	ventrolateral margin umbilical shoulder	strong	1	E.Barrem.

Subgeneric diagnosis: Shell is small, with a subcoronate whorl section. Primary ribs are prorsiradiate, usually present on the umbilical wall, commonly terminating in tubercles at the umbilical shoulder, from which arise slightly curved secondary ribs, usually in bifurcate bundles. Constrictions have broad and stout highly-elevated borders with tubercles at the ventro-lateral margin. Apertural margin does not show bifurcate ribs, but has an oblique constriction which cuts a few of the ribs behind it.

Remarks: The present subgenus is similar to *Olcostephanus* (*Subastieria*) (COOPER, 1981, p. 173) (late Valanginian to mid-Hauterivian) in the whorl section, but with constrictions that have strongly raised borders that bear tubercles at the ventro-lateral margin, and bifurcated secondary ribs instead of the trifurcated ones in *Subastieria*. The present subgenus has a likeness in the prorsiradiate curvature of the contrictions to *Olcostephanus* (*Olcostephanus*) (COOPER, 1981, p. 173) of Valanginian to mid-Hauterivian. However, it has a broad subcoronate whorl section and the raised constrictions with tubercles at the ventro-lateral margin. The present subgenus is different from the other subgenera: *O.* (*Mexicanoceras*) (COOPER, 1981, p. 173) (probably early Hauterivian), has a ventral furrow on the whorl section, and bundled and intercalated ribbing; *O.* (*Jeannoticeras*) (COOPER, 1981, p. 173) (early Hauterivian) has an oval whorl section, finely bundled ribbing and no tubercles on the umbilical shoulder; the early Hauterivian *Olcostephanus* (*Parastieria*) (COOPER, 1981, p. 173) has an oval whorl section and broad, flat, and bifurcated or trifurcated ribs.

Thus the subgenus *Neoastieria* is distinguished from Valanginian to mid-Hauterivian olcostephanids by the whorl section and mode of ornamentation. The subgeneric division of the genus *Olcostephanus* is diagrammatically summarized in Table 3.

Olcostephanus (*Neoastieria*) *cadoceroides* (KARAKASCH)

Pl. 1, Figs. 1–6; Text-fig. 1.

1907 *Astieria cadoceroides*, KARAKASCH, pp. 127–128, pl. 10, fig. 20a, b (in Russian).
1960 *Astieridiscus cadoceroides*, DRUSHITCHITZ and KUDRYAVDIEV, p. 307, pl. 14, fig. 4a, b (in Russian).
1975 *Parasaynoceras* sp., OBATA, HAGIWARA and KAMIKO, p. 28 (listed), pl. 1, fig. 20a, b.
1981 *Olcostephanus* ? *cadoceroides*, COOPER, p. 260, fig. 109.
1982 *Olcostephanus* (s.l.) sp., OBATA, MAIYA, INOUE and MATSUKAWA, p. 148, 151 (listed), pl. 1, figs. 2, 3.

Holotype: The holotype by original designation is the specimen illustrated by KARAKASCH, 1907, pl. 10, fig. 20a, b. Its locality is contained in the formation in the Sably Mine in the Crimea.

Material: NSM-PM 6909 collected by H. TSUDA and NSM-PM 9498 by S. HAGIWARA. These specimens have been obtained from loc. 7306. NSM-PM 6911 collected by H. TSUDA, from loc. 7307, and NSM-PM 6826 and NSM-PM 6910 by H. TSUDA, and NSM-PM 6817, NSM-PM 9587 and NSM-PM 6912 by S. HAGIWARA. These specimens were obtained from loc. 7403, Isejigaura, Choshi City, Chiba Prefecture. Some of the specimens (NSM-PM 6909, NSM-PM 6826, NSM-PM 9498, and

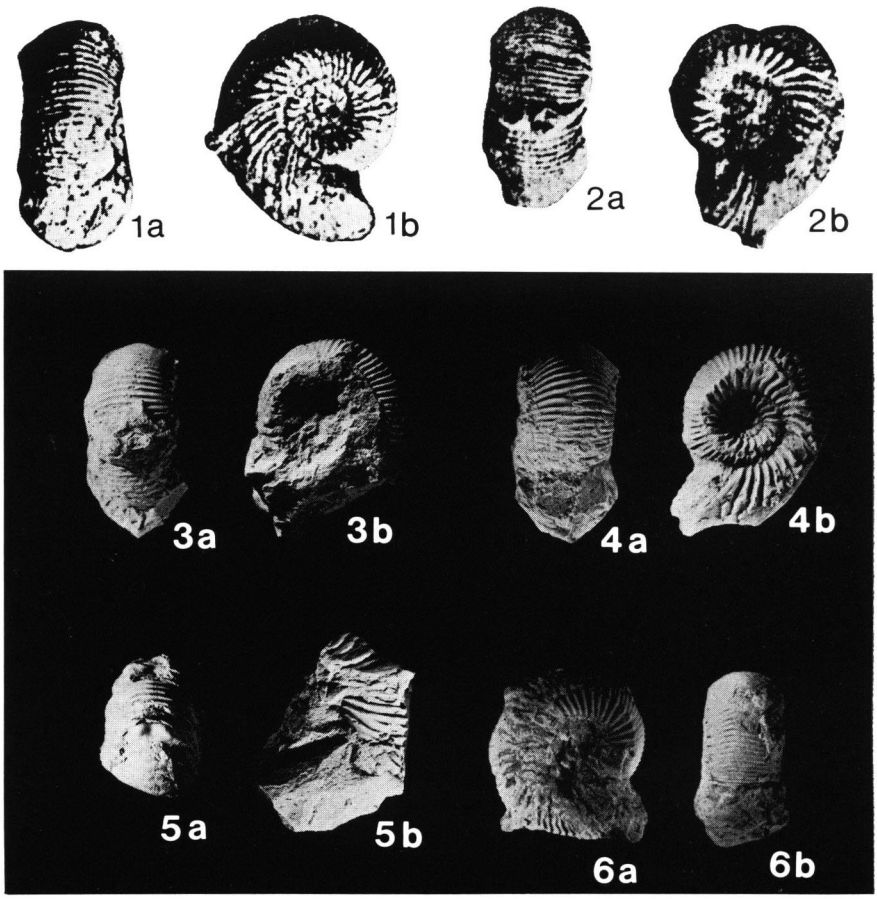
NSM-PM 6912) are partly replaced by pyrite. For descriptions of the localities yielding these specimens, see OBATA *et al.* (1975) and OBATA and MATSUKAWA (1982).

Description: The shell is small, the largest specimen in the collection being about 2 cm in diameter. It is evolute: one-fourth of the whorl height of the inner whorl is overlapped by the outer one. The umbilicus is moderate in size (about 35 percent of diameter) and deep. The whorl section is subcoronate, usually much broader than high, with steeply inclined, high umbilical wall, subrounded shoulders and a broadly rounded venter. There are about 30 primary ribs which are prorsiradiate on the umbilical wall. Secondary ribs branch from the primary ones at the tubercles on the umbilical shoulder. In the mature stage the ribs do not always bifurcate but are rarely single. Constrictions consisting of 3 or 4 per whorl are obliquely prorsiradiate on the apertural part but usually nearly rectiradiate, and obscure at the immature stage. They are broad and stout, with high borders that bear a distinct tubercle on the ventro-lateral margin at about 2 cm in diameter (e. g. NSM-PM 6909). These tubercles are obscure at the immature stage of about 1.6 cm diameter (e. g. NSM-PM 9498), but grow into a strong node on the ventro-lateral margin at the mature stage: the two ventro-lateral nodes on the constriction are very close together. The suture is unknown.

Measurements (in mm):

Specimen	D	U		H	B		B/H
NSM-PM 6909	22.3	6.3	(.27)	8.8 (.39)	10.3	(.46)	1.17
NSM-PM 9498	23.7	8.8	(.39)	9.2 (.39)	11.6	(.49)	1.26
NSM-PM 6826	22.6	7.5	(.33)	10.8 (.48)	12.0	(.53)	1.11
NSM-PM 6910	—	—	—	10.4	10.6		1.02
NSM-PM 6911	20.0	7.0+	(.35+)	6.6 (.33)	10.2	(.51)	1.55
NSM-PM 9587	21.7	7.0+	(.32+)	7.0 (.32+)	11.4	(.53)	1.63
NSM-PM 6817	16.6	5.1	(.31)	6.7 (.40)	9.0+	(.54+)	1.34+
NSM-PM 6912	19.0	—	—	7.0	9.9+		1.41
Astieria cadoceroides (KARAKASCH, 1907)							
	24.0	9.0	(.38)	8.0 (.33)	13.0	(.54)	1.63
Astieridiscus cadoceroides (DRUSHCHITZ and KUDRYAVTSEVA, 1960)							
	20.0	8.0	(.40)	7.0 (.35)	9.5	(.48)	1.36

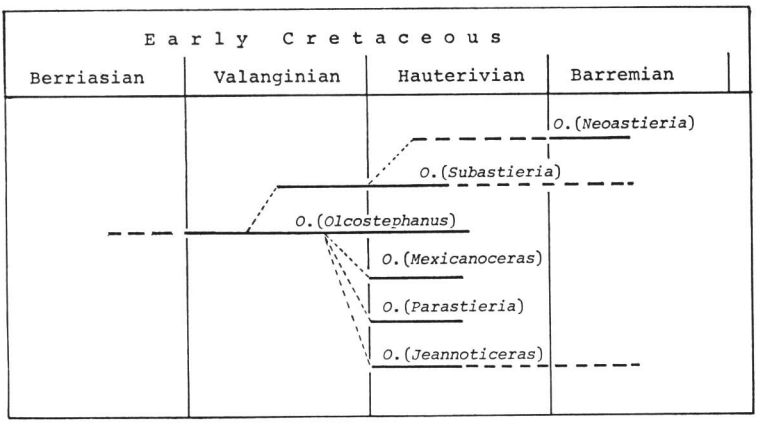
Remarks: The present specimens are closely similar to the holotye of *Astieria cadoceroides* KARAKASCH (KARAKASCH, 1907, pp. 127–128, pl. 10, fig. 20a, b) and the illustrated specimen of *Astieridiscus cadoceroides* (KARAKASCH) (DRUSHCHITZ and KUDRYAVTSEVA, 1960, p. 307, pl. 16, fig. 4a, b) in subcoronate whorl section, bifurcate ribbing, and strong constrictions with tubercles at the ventro-lateral margin (Text-fig. 1.). The breadth/height ratio varies to some extent (1.02 to 1.63) from individual to individual in the present collection. On the other hand, the breadth/height ratio of the Crimean specimens (1.36 and 1.63) (KARAKASCH, 1907; DRUSHCHITZ and KUDRYAVTSEVA, 1960) lies within the range of variation of the Japanese specimens. The constriction of the latter specimens, as compared with that of the same size (about 2 cm in diameter) in the former, shows some variation. One (e. g. NSM-PM 9498)



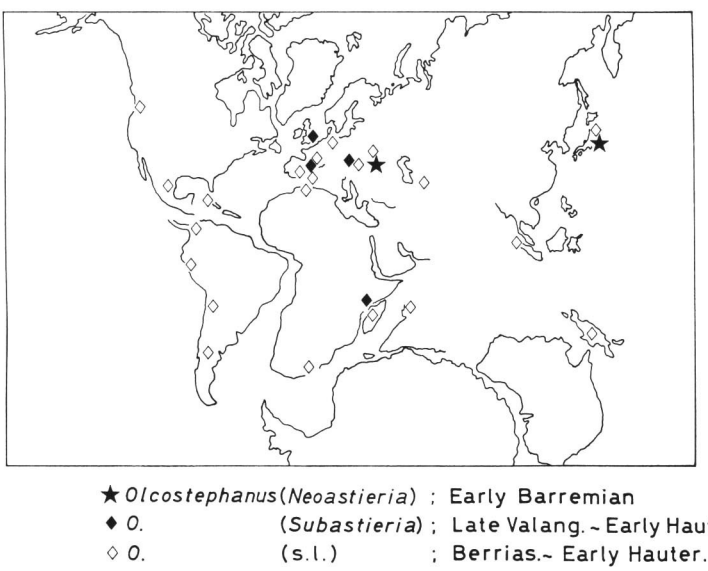
Text-fig. 1. Comparison of *Olcostephanus* (*Neoastieria*) *cadoceroides* between specimens from Choshi and those from the Crimea. 1a, b and 2a, b: specimens from the Crimea (adapted from KARAKASCH, 1907; 1a, b: DRUSHCHITZ and KURYAVTSEVA, 1960; 2a, b); 3a, b (NSM-PM 6826): 4a, b (NSM-PM 9498): 5a, b (NSM-PM 6910) and 6a, b (NSM-PM 6909): specimens from Choshi. × 0.8.

has only an oblique constriction in the apertural part which cuts a few ribs behind it; others have few such constrictions (e. g. NSM-PM 6909, NSM-PM 6910). The Crimean specimens may have similar constrictions, although the apertural constriction is not clear. *Astieria cadoceroides* KARAKASCH (1907) has been mistakenly recorded from the Upper Valanginian of the Crimea by COOPER (1981, p. 260). The fact is that the holotype of *Astieria cadoceroides* KARAKASCH (1907) was obtained from the formation in the Sably Mine which is assigned to the Lower Barremian (KARAKASCH, 1907, pp. 382, 383).

Occurrence: Loc. 7306, 7307 and 7403, calcareous nodules in the lower part of the Kimigahama Formation, Isejigaura, Choshi-city, Chiba Prefecture. The horizons



Text-fig. 2. Diagram showing the stratigraphic range and phylogenetic relationships of the subgenera of the genus *Olcostephanus*.



Text-fig. 3. Map showing the distribution of the olcostephanids from Berriasian to Early Hauterivian. Paleogeographic map is taken from A. G. SMITH & J. C. BRIDEN (1977).

are probably Lower Barremian. In addition to this species, *Pulchellia* sp., *Eotetragonites* sp, and others at 7306, and *Barremites* (*Berremites*) *difficilis*, *Holcodiscus* sp., *Crioceratites* (*Emericiceras*) *emerici* and others occur at loc. 7403.

Concluding Remarks

1. The occurrence of *Olcostephanus* (*Neoastieria*) *cadoceroides* (KARAKASCH) is

confirmed from the Lower Barremian in Japan. This is important for olcostephanid phylogeny.

2. The stratigraphic range and phylogenetic relationships of the subgenera of the genus *Olcostephanus*, including the new data are given in Text-figure 2.

3. *Olcostephanus* (*Neoastieria*) in the Lower Barremian supports the idea that the subgenus represents the end member of *Olcostephanus* derived from *Olcostephanus* (*Subastieria*). Phylogenetic changes in ornamentation have been noted, i. e. trifurcate ribs to bifurcate ones and the appearance of the ventro-lateral tubercles, in the lineage of *Subastieria* to *Neoastieria*.

4. The genus *Olcostephanus* is interpreted as having been adaptable to various environments and to have been widely distributed during the Valanginian to Mid-Hauterivian, because of the diversity in ornamentation, as in the branching of the secondary ribs, the tuberculation and other features. The geographical distribution of the genus narrowed in the Early Barremian. Consequently, the number of species also decreased (e. g. WIEDMANN and DIENI, 1968; LEANZA and WIEDMANN, 1980 and KEMPER, RAWSON and THIEULOY, 1981): so far as our present knowledge goes the maximum number was not less than 66 species in the Early Hauterivian, and reduced to only one species in the Early Barremian (Text-fig. 3 and Table 3).

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Explanation of Plate 1

All the figured specimens were collected from the lower to middle part of the Kimigahama Formation, Isejigaura, Choshi City, Chiba Prefecture.

Fig. 1. NSM-PM 6909, from loc. 7306 (H. TSUDA coll.). Front (a), lateral (b, d) and ventral (c) views, × 1.5.

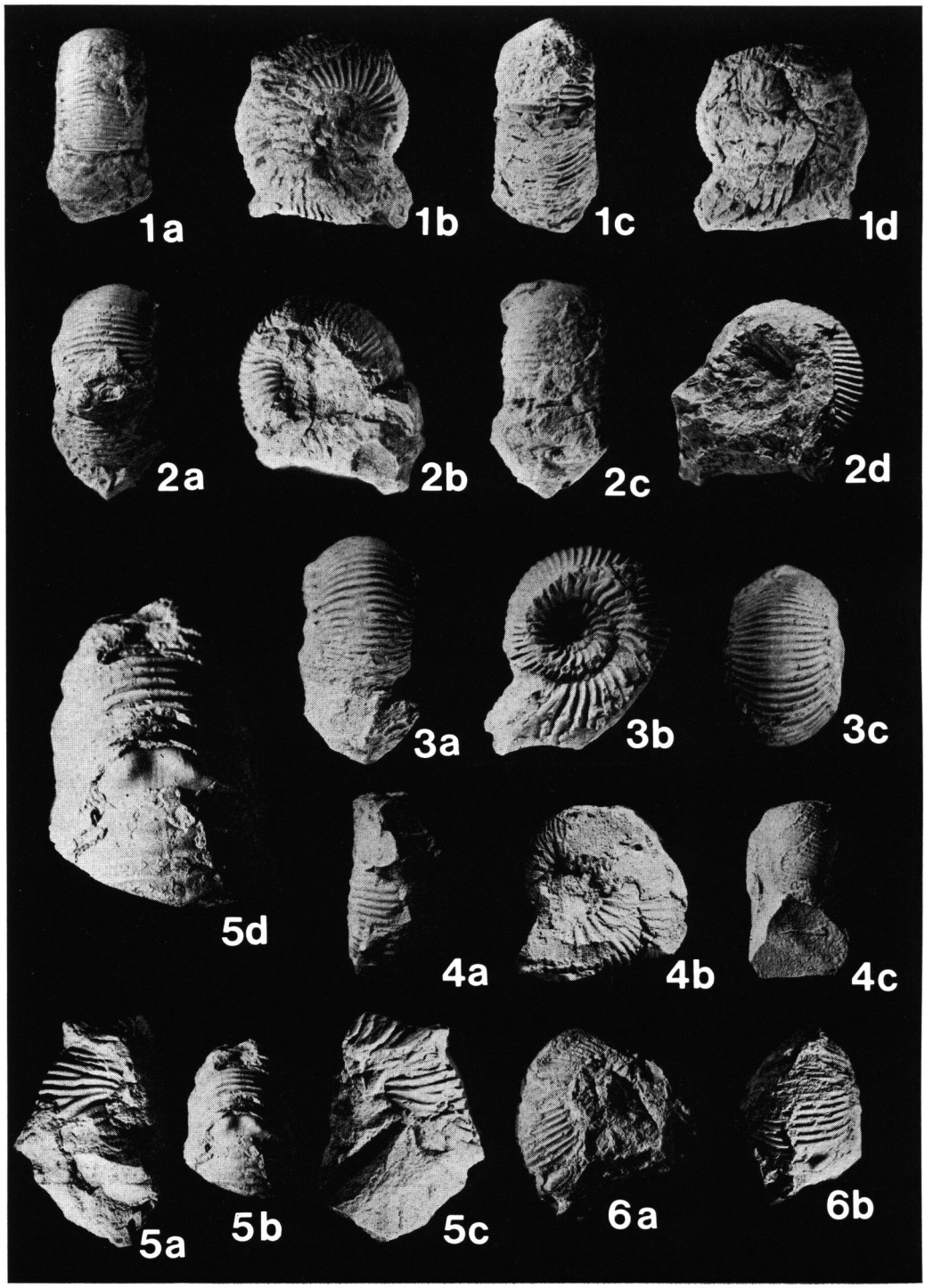
Fig. 2. NSM-PM 6826, from loc. 7403 (S. HAGIWARA coll.). Front (a), lateral (b, d) and ventral (c) views, × 1.5.

Fig. 3. NSM-PM 9498, from loc. 7306 (S. HAGIWARA coll.). Front (a), lateral (b) and ventral (c) view, × 1.5.

Fig. 4. NSM-PM 6817, from loc. 7403 (S. HAGIWARA coll.). Ventral (a), lateral (b) and front (c) views, × 1.5.

Fig. 5. NSM-PM 6910, from loc. 7403 (H. TSUDA coll.).

Fig. 6. NSM-PM 6912, from loc. 7403 (S. HAGIWARA coll.).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