Bull. Natn. Sci. Mus., Ser. C (Geol.), **1** (1), March 22, 1975

Lower Cretaceous Ammonites from the Miyako Group

Part 5. *Diadochoceras* from the Miyako Group

By

Ikuwo OBATA

Department of Geology, National Science Museum, Tokyo

Introduction

The Lower Cretaceous *Diadochoceras* is an old-established genus and is important in that the type species, *D. nodosocostatum* (D'ORBIGNY), is considered a good index species of the uppermost part of the Upper Aptian (*e. g.*, WRIGHT, 1957, p. L 128). Moreover, this genus may be an interesting example of morphological convergence toward *Cheloniceras* in the subfamily Acanthohoplitinae (CASEY, 1965, p. 416). The genus has been studied by some Russian authors also (*e. g.*, MIKHAILOVA, 1963; EGOIAN, 1965,1969).

In the Japanese material, so far as the present knowledge goes, there are three species of *Diadochoceras* (cf. SHIMIZU, 1931, p. 35; MATSUMOTO et al., 1968, p. 142). In the present paper, I describe two species from the Miyako Group, northeast Japan. There is much to be done for proper understanding of the natural history of *Diadochoceras*. However, the present paper is not an adequate place for making further discussion on the systematic relations among *Diadochoceras* and its relatives, since the Japanese material is insufficient.

The repositories of the studied specimens are as follows (with symbols in parentheses): Department of Geology, National Science Museum, Tokyo (NSM–P); Geological and Paleontological Department of Tohoku University (TUS); Institute de Paléontologie, Muséum national d'Histoire naturelle, Paris (IPNP).

I desire to express my sincere thanks to Professor Tamio KOTAKA of Tohoku University, who has provided the specimens kept at the University on loan for the present study. I wish to record here my cordial thanks to Professor Tetsuro HANAI and Dr. Itaru HAYAMI of the University of Tokyo for their kind cooperation in the field work and in various other ways. Thanks are extended to Professor Jacques SORNAY, Institute de Paléontologie, Muséum national d'Histoire naturelle, Paris, who gave me every facility for study during my stay in Paris in 1973. Thanks are also due to Miss Reiko FUSEJIMA of the National Science Museum, Tokyo, for her help in many ways. Financial support was defrayed by the Ministry of Education in the form of the Grant in Aid for Scientific Researches.

Systematic Description

Order AMMONOIDEA

Superfamily Douvilleiceratacea

Family Parahoplitidae SPATH, 1922

Subfamily Acanthohoplitinae STOYANOW, 1949

Genus *Diadochoceras* HYATT, 1900

Type species. *Ammonites nodosocostatus* D'ORBIGNY, 1841, from the Upper Aptian, *i. e.*, "Clansayesian" deposit of France, by original designation.

Remarks. I follow CASEY (1961, p. 193; 1965, p. 416) in assigning *Diadochoceras* to the subfamily Acanthohoplitinae of the Parahoplitidae. MIKHAILOVA (1963) reviewed the genus and added four new species under the name of *Diadochoceras*, two of which have been removed later from that genus and placed under a new genus *Nodosohoplites* by EGOIAN (1965, p. 146). According to him (p. 148), *D. nodosocostatum* by MIKHAILOVA (1963, p. 68) is a synonym of *N. caucasicus* (LUPP.).

Diadochoceras nodosocostatiforme (SHIMIZU)

(Pl. 1, Figs. 1, 3–5; Text-figs. 1, 2)

1931. *Douvilleiceras nodosocostatiforme*, SHIMIZU, *Sci. Rep. Tohoku Imp. Univ.*, 2nd ser., vol. 15, no. 1, p. 35, pl. 1, figs. 6–7.
1959. *Diadochoceras nodosocostatiforme*, MATSUMOTO, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 9, no. 2 (merely listed in pl. 8).
1968. *Diadochoceras nodosocostatiforme*, HANAI et al., *Mem. Nat. Sci. Mus.*, no. 1, pl. 2, fig. 7.
1974. *Diadochoceras nodosocostatiforme*, OBATA, *Atlas of Japanese Fossils*, no. 36–215, p. 3, fig. 1, pl. 4.

Material. Holotype, TUS 35152 is re-examined. It was obtained from the upper fossiliferous bed at Matsushima (SHIMIZU, 1931, p. 7). NSM–P_1 7280, from loc. Hn. 4201 (OBATA and HAYAMI coll.). NSM–P_1 7543, from loc. Hn. 4201 (HANAI, OBATA and HAYAMI coll.). NSM–P_1 7544, 7545, from loc. Hn. 4151 (HANAI, OBATA and HAYAMI coll.).

Description. Individuals seem to grow up to about 40 mm. in diameter (*e. g.*, NSM–P_1 7543). In the smaller specimens including the holotype (TUS 35152 and NSM–P_1 7545) the last half whorl is unseptate. The shell has an umbilicus of moderate size, showing moderate involution. The umbilicus is rather deep, surrounded by high walls, which are slightly convex and are rounded well at rim. The whorl is subround in intercostal section, fairly depressed in the proportion of breadth to height. The maximum breadth is at about one-third of the flank from the umbilical margin. Flanks are rounded and gradually pass into the convex venter.

Simple, radial ribs are moderately strong, 12 to 14 in number on the last whorl. They are widely separate, and provided with tubercles in three rows. In a young specimen, *i. e.*, NSM–P_1 7280, ribs seem to be arranged rather closely, although exact calculation is impossible owing to the poor preservation. There are sometimes one to

three narrower and lower riblets or lirae on each interspace.

Among the tubercles the outer ventro-lateral ones are the largest and highest, being clavate in the later stages of growth. The inner ventro-lateral tubercles are situated a little above the middle of the flank, and are much smaller than the outer ones and somewhat clavate in the later stage (*e. g.*, TUS 35152, NSM–P_1 7543 and 7544). The umbilical tubercles are bullate and highest somewhere above the umbilical margin.

The ribs are rather high and narrow between the umbilical and the inner ventro-lateral tubercles, then broadened and somewhat flattened on the ventral half of the whorl.

The suture is rather simple, but is incompletely preserved. E is of moderate breadth and depth. L is broader than and is as deep as E, and is divided into three lobules at the base by two comparatively large folioles. The first lateral saddle between E and L is rather tall and massive, asymmetric in outline with a steeper ventral slope, multipartite with several lobules, generally decreasing in breadth toward the top. U, I, and their neighboring saddles are not clearly exposed in the available material.

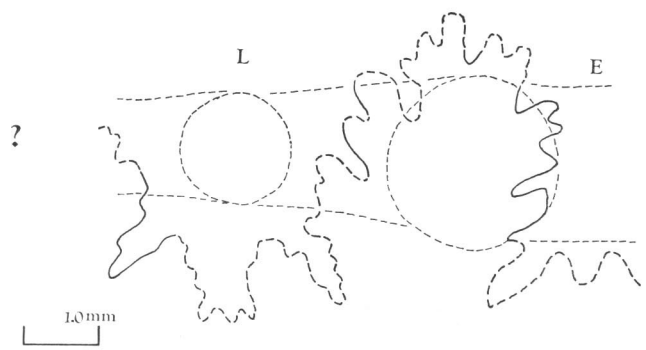


Fig. 1. *Diadochoceras nodosocostatiforme* (SHIMIZU). Last suture, at whorl-height=6.2 mm., breadth=8.9 mm., of the holotype, TUS35152, from the upper fossiliferous bed at Matsushima, Hiraiga Formation, Iwate Prefecture.

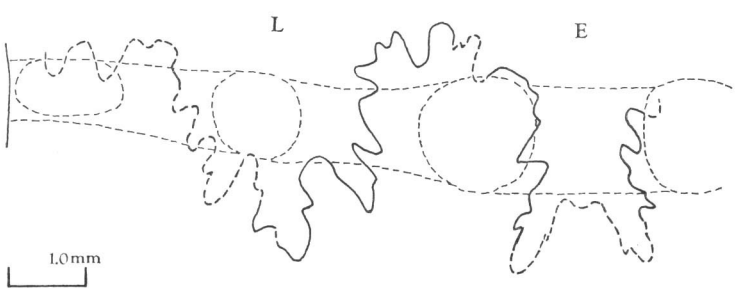


Fig. 2. *Diadochoceras nodosocostatiforme* (SHIMIZU). Suture, at whorl-height=4.8 mm., breadth=7.5 mm., of the specimen, NSM–P_1 7545, from loc. Hn. 4151, Matsushima, Hiraiga Formation, Iwate Prefecture.

Measurements.

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
NSM–P_1 7280	15.6 (1)	5.0 (0.32)	6.8 (0.43)	8.5 (0.54)	1.25
NSM–P_1 7545	20.6 (1)	6.8 (0.33)	7.8 (0.37)	10.8 (0.52)	1.38
TUS 35152 (holotype)					
(on costae)	26.1 (1)	9.6 (0.36)	9.3 (0.35)	12.2 (0.46)	1.31
(interspace)	18.9 (1)	6.8 (0.35)	7.0 (0.37)	10.4 (0.55)	1.48
For comparison					
D. nodosocostatum from France [D'ORBIGNY, 1840, p. 258, pl. 75, figs. 1–4].					
	35.0 (1)	13.6 (0.39)	13.0 (0.37)	16.0 (0.45)	1.23
D. nodosocostatum from western Caucasus [EGOIAN, 1965, p. 138].					
No. 50	45.6 (1)	16.4 (0.36)	17.0 (0.39)	21.0 (0.45)	1.23
No. 51	47.5 (1)	18.0 (0.37)	17.5 (0.36)	20.5 (0.43)	1.17
No. 101	42.0 (1)	16.7 (0.40)	14.2 (0.33)	17.5 (0.41)	1.23
No. 102	42.0 (1)	16.2 (0.38)	16.0 (0.39)	22.0 (0.52)	1.37
D. spinosum from northern Caucasus [MIKHAILOVA, 1963, p. 67].					
No. 2693/2	28.5 (1)	10.2 (0.36)	11.8 (0.41)	12.8 (0.44)	1.08
No. 2693/3	23.5 (1)	8.0 (0.34)	9.2 (0.39)	11.5 (0.49)	1.25
D. nodosocostatum from northern Caucasus [MIKHAILOVA, 1963, p. 68].					
No. 2693/1	34.2 (1)	12.8 (0.37)	14.1 (0.41)	13.5 (0.40)	0.95
No. 2693/4	19.5 (1)	7.5 (0.37)	8.4 (0.43)	?18.2 (0.46)	?2.16
D. hokodzense from northern Caucasus [MIKHAILOVA, 1963, p. 70].					
No. 2756/57	45.8 (1)	13.5 (0.29)	19.6 (0.43)	17.9 (0.39)	0.91
No. 1139	42.0 (1)	13.2 (0.31)	18.5 (0.44)	16.2 (0.39)	0.87
No. 3028	30.3 (1)	9.2 (0.30)	13.4 (0.47)	12.2 (0.41)	0.91
No. 3027	16.0 (1)	5.1 (0.32)	7.0 (0.44)	6.1 (0.38)	0.87
No. 3029	14.1 (1)	5.0 (0.35)	5.7 (0.40)	5.9 (0.42)	1.03
D. crebricostatum from northern Caucasus [MIKHAILOVA, 1963, p. 74].					
No. 2677	31.0 (1)	9.9 (0.32)	12.4 (0.40)	11.0 (0.35)	0.88
No. 2678	20.0 (1)	6.5 (0.33)	8.2 (0.41)	7.5 (0.37)	0.91
D. margariti from northern Caucasus [MIKHAILOVA, 1963, p. 73].					
No. 2693/5	39.0 (1)	13.3 (0.34)	15.5 (0.40)	13.6 (0.35)	0.87
No. 2693/6	17.2 (1)	5.8 (0.34)	7.2 (0.42)	7.0 (0.40)	0.97
D. inaequalis from western Caucasus [EGOIAN, 1965, p. 141].					
No. 52	38.0 (1)	14.7 (0.38)	13.4 (0.35)	15.3 (0.40)	1.14
D. recticostatum from western Caucasus [EGOIAN, 1965, p. 142].					
No. 53	46.6 (1)	20.0 (0.43)	14.5 (0.31)	16.3 (0.35)	1.12
No. 55	13.0 (1)	5.2 (0.40)	4.4 (0.34)	5.3 (0.40)	1.20
No. 103	14.5 (1)	6.0 (0.41)	5.0 (0.34)	6.0 (0.41)	1.20
D. rotundum from western Caucasus [EGOIAN, 1965, p. 143].					
No. 8	45.0 (1)	16.6 (0.37)	15.7 (0.34)	16.7 (0.37)	1.06
D. mutabilis from western Caucasus [EGOIAN, 1965, p. 145].					
No. 93	31.3 (1)	11.4 (0.36)	10.7 (0.34)	13.3 (0.42)	1.24
No. 94	27.0 (1)	10.9 (0.40)	9.3 (0.34)	12.3 (0.45)	1.32
No. 95	27.0 (1)	10.2 (0.37)	10.1 (0.33)	12.3 (0.45)	1.21
No. 96	28.7 (1)	11.2 (0.39)	10.2 (0.35)	12.1 (0.42)	1.18
No. 97	34.3 (1)	13.5 (0.40)	13.0 (0.37)	14.3 (0.42)	1.10
No. 98	18.0 (1)	7.4 (0.41)	6.3 (0.35)	8.0 (0.44)	1.26
No. 100	18.7 (1)	7.0 (0.37)	6.5 (0.34)	8.0 (0.43)	1.23

D. magnificum from western Caucasus [EGOIAN, 1969, p. 169].					
No. 133	44.5 (1)	14.5 (0.33)	18.0 (0.42)	21.0 (0.47)	1.16
"	32.5 (1)	11.0 (0.34)	13.2 (0.41)	15.0 (0.46)	1.13
" (on costae)	32.8 (1)	11.0 (0.34)	13.8 (0.42)	19.0 (0.58)	1.37
D. ilonense from Madagascar [COLLIGNON, 1962, p. 43].					
Holotype	68.0 (1)	26.0 (0.38)	25.0 (0.37)	24.0 (0.35)	0.96

Comparison. As mentioned by the preceding authors (SHIMIZU, 1931, p. 36; MATSUMOTO, 1968, p. 143), *Diadochoceras nodosocostatiforme* (SHIMIZU) is closely allied to *D. nodosocostatum* (D'ORBIGNY) (1841, p. 258, pl. 75, figs. 1–4) from the Upper Aptian of France. The two species are similar in the whorl section and the general feature of ribbing of nearly the same size. However, *D. nodosocostatiforme* is distinguished from *D. nodosocostatum* in having larger and more clavate, outer ventro-lateral tubercles and less distinct riblets or lirae between two major ribs, as well as in minor difference of sutures (D'ORBIGNY, 1841, p. 258, pl. 75, figs. 1–4; EGOIAN, 1969, p. 311).

Diadochoceras spinosum described by MIKHAILOVA (1963, p. 67, pl. 7, figs. 1, 2) from northern Caucasus seems to resemble the present species in the general outline of shell form, width of umbilicus, clavate ventro-lateral tubercles and the suture, but is distinguished from the latter by the more compressed whorl and the presence of a few minor ribs between the two major ribs.

Diadochoceras magnificum described recently by EGOIAN (1969, p. 169, pl. 13, fig. 5) from western Caucasus also seems to resemble the present species in the shell form, width of umbilicus, and the suture. But the former is distinguished from the latter by the presence of a few minor but distinct ribs between the two major ribs, and less clavate ventro-lateral tubercles at nearly the same stage of growth.

Among the illustrated sutures of acanthohoplitids, a few examples from the northern Caucasus Mountains are closest to ours (see MIKHAILOVA, 1963, p. 69, fig. 4 a; p. 72, fig. 8). At any rate, the genus *Diadochoceras* seems to be closely related to some acanthohoplitids as the preceding authors have pointed out (*e. g.*, CASEY, 1965, p. 416).

Occurrence. Calcareous concretion in the upper fossiliferous sandstone, loc. Hn. 4151, Matsushima. In addition to this species, *Eodouvilleiceras matsumotoi* OBATA, *E.* aff. *matsumotoi* OBATA, *Valdedorsella getulina* (COQUAND), *Melchiorites yabei* (SHIMIZU), *Hypophylloceras* sp., and *Hamites* sp. occur in the same concretion. The holotype was obtained from "the upper fossiliferous bed" at Matsushima (SHIMIZU, 1931, p. 7); the bed corresponds stratigraphically to that of loc. Hn. 4151.

Loc. 4201, a calcareous concretion in the sandstone at Tairajima. In addition to this species, *Eodouvilleiceras matsumotoi* OBATA and *E.* aff. *matsumotoi* OBATA occur in the same concretion.

The above localities are in the southeast of Omoto village, Shimohei County, Iwate Prefecture. They are in the upper part of the lower Hiraiga Formation, Uppermost Aptian.

Diadochoceras(?) sp. aff. *D. nodosocostatiforme* (SHIMIZU)

Pl. 1, Fig. 2.

For a full list of synonymy for *D. nodosocostatiforme* see p. 2 in this paper.

Material. NSM–P_1 7546, from loc. Hn. 4151 (OBATA and HAYAMI coll.).

Description. This is a fairly small incomplete specimen, about 40 mm. in diameter, in which the last half whorl is unseptate. The shell has an umbilicus of moderate size. Nearly a half of the inner whorl is overlapped by the outer whorl. The umbilicus is rather deep and steep, being rounded at the shoulder. The flank of the outer whorl is gently convex, though rounded at the earlier stage, and is bounded on the nearly flattened venter by a rather subangular ventro-lateral periphery. The whorl seems to be fairly compressed, although the proportion of breadth to height cannot be accurately measured owing to the secondary compression. The maximum breadth is nearly at the mid-flank.

Narrow and simple ribs are almost radial and less distinct. They decrease in strength, but are broader and lower in the ventral half of the whorl, thus almost disappearing on the venter. Ribs are widely separate, and seven in number on the last half of the whorl. Sometimes a few lirae are found between ribs.

Ribs are provided with tubercles in three rows. The outer ventro-lateral tubercles are comparatively large and clavate. The inner ventro-lateral ones, situated somewhere above the middle of the flank, are much smaller than the outer ones, and are pointed. The umbilical tubercles are bullate.

Unfortunately the suture is not clearly exposed. The exposed parts at a height of about 12 mm. suggest the similar type of suture to that of *Diadochoceras nodosocostatiforme*.

Measurements.

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
NSM–P_1 7546	39.8 (1)	13.1 (0.32)	17.5 (0.43)	—	—

Comparison. The species resembles *Diadochoceras nodosocostatiforme* (SHIMIZU) in the simple ribbing, presence of three rows of tubercles, umbilicus of moderate size and moderate involution, as well as the general pattern of suture. The present species seems to have, however, more compressed whorl and more narrower and less distinct ribs in the later stage than *D. nodosocostatiforme*. In the former, moreover, the ventro-lateral margin is subangular, instead of rounded, and the inner ventro-lateral tubercles are pointed, instead of clavate. Thus, the present species may be distinguished from *D. nodosocostatiforme*, approaching to some species of *Hypacanthoplites* or *Nodosohoplites*.

However, identifying the species with that of *Diadochoceras* or the related genera or establishing a new species has to wait until more specimens are obtained, because available complete specimens of *D. nodosocostatiforme* are all below 30 mm. in diameter except two large fragments (NSM–P_1 7543 and 7544), and so a precise comparison at the same stages of growth is impossible for the present material.

Occurrence. Loc. Hn. 4151, a calcareous concretion in the upper fossiliferous sandstone, Matsushima, southeast of Omoto village, Shimohei County, Iwate Prefecture. The locality is in the upper part of the lower Hiraiga Formation; Uppermost Aptian. In addition to this species, *Diadochoceras nodosocostatiforme* (SHIMIZU) and several other speceis listed on p. 5 occur at the same locality.

Notes on some acanthohoplitids from France

In connection with the study of the Japanese material, I had an opportunity, when I visited Paris in November 1973, of examining a large number of specimens of the uppermost Aptian, *i. e.* "Clansayesian", kept at l'Institute de Paléontologie, Muséum national d'Histoire naturelle, Paris. Unfortunately, D'ORBIGNY's holotype of *Diadochoceras nodosocostatum*, type species of *Diadochoceras*, is not preserved at the Institute, because the type specimen was not collected by D'ORBIGNY himself, but by Messrs. REQUIEN, RENAUX, and PUZOS from the sandstone of Clansayes near Saint-Paul-Trois-Châtaux (Drôme). According to Dr. SORNAY's talk, Mr. REQUIEN's collection is in the Muséum d'Histoire Naturelle, Avignon, south France, which is now closed. Mr. RENAUX's collection is in the Faculté des Sciences, Montpellier, and Mr. PUZOS' collection has been lost probably.

Among the eighty-nine specimens examined, selected fourteen examples are listed below and are shown on Plates 2 and 3.

Material. IPNP 14, labeled as *Diadochoceras* aff. *nodosocostatum* (D'ORBIGNY) from Robion, Basses Alpes, France, "Clansayesian" (Coll. D'ORBIGNY, no. 5372). IPNP 1, IPNP 2, IPNP 3, IPNP 4, IPNP 5, labeled as *Diadochoceras nodosocostatum* (D'ORBIGNY), from Clansayes, Drôme, France, "Clansayesian" (Coll. GROSSOUVRE). IPNP 11 and IPNP 12, labeled as *Diadochoceras nodosocostatum* (D'ORBIGNY), from Clansayes, Drôme, France, "Clansayesian" (Coll. D'ORBIGNY, no. 5780). IPNP 6, IPNP 7, IPNP 8, IPNP 9, IPNP 10, labeled as *Diadochoceras* cf. *nodosocostatum* (D'ORBIGNY), from Clansayes, Drôme, France, "Clansayesian" (Coll. GROSSOUVRE). IPNP 13, from Clansayes, Drôme, France, "Clansayesian" (Coll. unknown, B 15109). All the specimens from Clansayes were probably obtained from the phosphate nodules in the glauconite-bearing sandstone (MOULLADE, 1965).

Measurements.

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
IPNP 14	30.7 (1)	11.1 (0.36)	10.6 (0.35)	14.2 (0.46)	1.34
[=D'ORBIGNY Coll. 5372]					
IPNP 1	51.9 (1)	17.4 (0.34)	19.9 (0.38)	*c* 22.1 (0.43)	1.11
1/4 vol. earlier	38.2 (1)	*c* 13.0 (0.34)	14.4 (0.38)	18.9 (0.49)	1.31
IPNP 11	*c* 25.3 (1)	6.9 (0.27)	*c* 9.3 (0.36)	*c* 11.3 (0.45)	*c* 1.22
[=D'ORBIGNY Coll. 5780]					
IPNP 9	34.1 (1)	*c* 11.4 (0.33)	*c* 12.5 (0.37)	*c* 15.4 (0.45)	*c* 1.23
IPNP 8	*c* 17.8 (1)	*c* 9.0 (0.51)	*c* 11.0 (0.62)	*c* 13.8 (0.78)	*c* 1.25
IPNP 10	23.7 (1)	*c* 7.9 (0.33)	7.9 (0.33)	—	—

IPNP 13=B15109	29.9 (1)	*c* 9.6 (0.32)	11.3 (0.38)	15.0 (0.50)	1.33
IPNP 3	31.6 (1)	12.2 (0.39)	11.0 (0.35)	11.7 (0.37)	1.06
1/4 vol. earlier	24.7 (1)	9.4 (0.38)	7.9 (0.32)	10.1 (0.41)	1.28
IPNP 12	26.4 (1)	*c* 7.4 (0.28)	*c* 10.4 (0.39)	*c* 10.0 (0.38)	*c* 0.96
[=D'ORBIGNY Coll. 5780b]					
IPNP 6	33.7 (1)	13.7 (0.41)	11.9 (0.35)	11.9 (0.35)	1.00
3/4 vol. earlier	19.8 (1)	7.3 (0.37)	7.7 (0.39)	8.4 (0.42)	1.09

Descriptive Remarks. Among the photographed specimens I have distinguished four species of acanthohoplitids. Two of them, *i. e.* IPNP 14 and IPNP 1, are similar in the shell form and ornament to D'ORBIGNY's holotype (1841, pl. 75, figs. 1–4) and so assigned to *Diadochoceras nodosocostatum* (D'ORBIGNY). In IPNP 14 the intercostal part of the whorl is round, a little depressed, and thickest at the umbilical shoulder, although the umbilicus is somewhat narrower than that of the holotype of D'ORBIGNY. In the diameter of umbilicus and the proportion of breadth to height the species is very similar to the Japanese species, *D. nodosocostatiforme* (SHIMIZU), but is different in the tuberculation and minor ribbing. The shape and strength of the tubercles are nearly the same as those of D'ORBIGNY's figure. The suture of the specimen is *Diadochoceras* type, although it is less taller than D'ORBIGNY's figure. In the younger stage there are two or four riblets between the two ribs. Thus the specimen well represents the characteristics of *D. nodosocostatum* as a whole, whereas there is a slight difference in the diameter of umbilicus between the former and D'ORBIGNY's specimen. IPNP 1 seems to be an adult example of *D. nodosocostatum*, although the tuberculation is rather weak.

Another group of the specimens, *e. g.* IPNP 9 and IPNP 13, is assigned to *Diadochoceras* aff. *nodosocostatum*. The species resembles *D. nodosocostatum* in the shell form, ornament, and the suture, but shows eminent tubercles and ribbing. In the former the tubercles are fairly strong; ventro-lateral and lateral tubercles are clavate, and umbilical tubercle is bullate. The species thus approaches to *Diadochoceras nodosocostatiforme* (SHIMIZU), the Japanese species, but is characterized by having less depressed whorl, more distinct tubercles and having two or three riblets between two major ribs. Ribs are low in height but broad in breadth and the riblets are rather sharp. The number of riblets between two ribs decreases with the growth of shell, *e. g.* two at the diameter of 30 mm., three at 25 mm., and four at 20 mm. in IPNP 13.

The third group of the specimens, *e. g.* IPNP 3 and IPNP 12, is tentatively assigned to *Nodosohoplites* cf. *caucasicus* (LUPP.). When compared with the two species of *Diadochoceras* mentioned above, the present species shows more compressed and less inflated whorl, narrower and nearly flat venter, and subangular to subrounded ventro-lateral shoulder. The ventro-lateral and lateral tubercles are clavate, and the umbilical tubercle is bullate. Between two major ribs riblets are frequently inserted. The number of riblets varies with individual and growth stage, ranging from one to six. A preserved suture-line is similar to that of *Hypacanthoplites*. The last one of the specimens, *i. e.* IPNP 6, is considered as a representative of young stage of *Nolaniceras nolani* (SEUNES).

Concluding Remarks

Two species of the genus *Diadochoceras* from the Miyako Group have been described. Their stratigraphic position is in the upper part of the lower Hiraiga Formation. They are associated with two species of *Eodouvilleiceras*. Species of the latter genus occur characteristically in the upper part of the Upper Aptian in the circum-Pacific region as well as in Europe and other parts of the world. Thus, the upper part of the lower Hiraiga Formation is safely assigned to the upper part of the Upper Aptian (OBATA, 1974). In the Japanese Islands, *Diadochoceras* sp. cf. *D. nodosocostatiforme* (SHIMIZU) was reported from the lower member of the Tomochi Formation, Kyushu, which is also associated with *Eodouvilleiceras* sp. aff. *E. horridum* (RIEDEL) (MATSUMOTO et al., 1968).

It is clear that the species of *Diadochoceras* were distributed not only in the Mediterranean region but also in the vast Pacific region during the later Aptian age. The genus *Diadochoceras* is a representative of morphologic convergence towards *Cheloniceras* in the Acanthohoplitinae as previously mentioned.

References

BESAIRIE, H., 1936. Recherches géologique à Madagascar. *Mém. Acad. Malg.*, **21**, 250 pp., 24 pls., 3 tables, 1 map.

CASEY, R., 1961, 1965. A monograph of the Ammonoides of the LOWER Greensand. Part III. *Palaeontogr. Soc.*, 1961, 119–216, pls. 26–35; Part VI. *Ibid.*, 1965, 399–546, pls. 67–90.

COLLIGNON, M., 1962. Atlas des fossiles caractéristique de Madagascar (Ammonites). *Service géol. Tananarive*, Fascicule **9** (Aptien), 64 pp., pls. 215–240.

EGOIAN, V. L., 1965. On some Clansayesian Ammonites from the western Caucasus. *Trudy Krasnodarsky Filial V.N.I.I.*, **16**, 112–160, 14 pls. (In Russian.)

——— 1969. Ammonites from the Clansayesian strata of the western Caucasus. *Ibid.*, **19**, 126–188; 264–317 including 26 pls. (In Russian.)

HANAI, T., I. OBATA and I. HAYAMI, 1968. Notes on the Cretaceous Miyako Group. *Mem. Nat. Sci. Mus.*, **1**, 20–28, pls. 1–4. (In Japanese with English abstract.)

HYATT, A., 1900. Cephalopoda. *In* ZITTEL's *Textbook of Palaeontology*, 1st English edition (EASTMAN), 502–604, London.

JACOB, C., 1905. Étude sur les ammonites et sur l'horizon stratigraphique du gisement de Clansayes. *Bull. Soc. géol. France*, [4], **5**, 399–432, pls. 12–13.

MATSUMOTO, T., 1959. Zonation of the Upper Cretaceous in Japan. *Mem. Fac. Sci. Kyushu Univ.*, [D], **9**, 55–93, pls. 6–11.

——— K. KANMERA, & H. SAKAMOTO, 1968. Notes on Two Cretaceous Ammonites from the Tomochi Formation of Kyushu. *Japan. Jour. Geol. Geogr.*, **39**, (2–4), 139–148, pl. 2.

MIKHAILOVA, I. A., 1963. On the systematic position and scope of the genus *Diadochoceras*. *Paleont. Zhurnal*, **3**, 65–77, pl. 7. (In Russian.)

MOULLADE, M., 1965. Révision des stratotypes de l'Aptien: Clansayes (Drôme). *Colloque sur le Crétacé inférieur* (*Lyon, Septembre 1963*), 215–222.

OBATA, I., 1974. Lower Cretaceous ammonites from the Rikuchu coast, Iwate Prefecture, 3, 4. *Atlas of Japanese Fossils*, No. 36–215, 216. (In Japanese.)

ORBIGNY, A. D', 1840–42. *Paléontologie Francaise*. Terrains Crétacés. I, Céphalopodes. 662 pp., 148 pls. (1–120, 1840; 121–430, 1841; 431–662, 1842), Paris.

SHIMIZU, S., 1931. The marine Lower Cretaceous deposits of Japan, with special reference to the ammonites-bearing zones. *Sci. Rep. Tohoku Imp. Univ.*, [2], **15**, 1–40, pls. 1–4.

STOYANOW, A, 1949. Lower Cretaceous stratigraphy in southeastern Arizona. *Geol. Soc. America Mem.*, **38**, 169 pp., 27 pls.

WRIGHT, C. W., 1957. *In* MOORE, R. C. [Editor]: *Treatise on Invertebrate Paleontology, Part L, Mollusca, Cephalopoda, Ammonoidea.* L1–L490. Geol. Soc. Amer. & Univ. Kansas Press.

Explanation of Plates

Plate 1

Diadochoceras nodosocostatiforme (SHIMIZU) except otherwise stated.

All the figured specimens were collected from the upper part of the lower Hiraiga Formation, Miyako Group, Matsushima or Tairajima, southeast of Omoto village, Shimohei County, Iwate Prefecture.

Fig. 1. NSM–P_1 7280, from loc. Hn. 4201, Tairajima (OBATA and HAYAMI coll.). Frontal (a), lateral (b) and ventral (c) views, ×1.8.

Fig. 2. NSM–P_1 7546, *Diadochoceras* (?) sp. aff. *D. nodosocostatiforme*, from loc. Hn.4151, Matsushima (OBATA and HAYAMI coll.). Lateral (a), frontal (b) and ventral (c) views, ×0.9.

Fig. 3. NSM–P_1 7545, from loc. Hn. 4151, Matsushima (HANAI, OBATA and HAYAMI coll.). Ventral (a), lateral (b, d) and frontal (c) views, ×1.8.

Fig. 4. NSM–P_1 7543, from loc. Hn. 4201, Tairajima (HANAI, OBATA and HAYAMI coll.). Lateral view, ×0.9.

Fig. 5. TUS 35152, holotype, from the upper fossiliferous bed, which corresponds to loc. Hn. 4151 at Matsushima. Ventral (a), lateral (b, d) and frontal (c) views, ×1.8.

Plate 2

Acanthohoplitids from the uppermost Aptian, *i.e.* "Clansayesian", from Clansayes, Drôme, France, except otherwise stated.

Fig. 1. IPNP 6, *Nolaniceras nolani* (SEUNES), (GROSSOUVRE coll.). Lateral (a, c), frontal (b) and ventral (d) views, ×1.

Fig. 2. IPNP 14, *Diadochoceras nodosocostatum* (D'ORBIGNY), from Robion, Basses Alpes, France (D'ORBIGNY coll. no. 5372). Lateral (a, c), ventral (b) and frontal (d) views, ×1.

Figs. 3, 4. *Diadochoceras* aff. *nodosocostatum* (D'ORBIGNY), (GROSSOUVRE coll.). Lateral (a) and ventral (b) views, ×1. Fig. 3, IPNP 8; Fig. 4, IPNP 10.

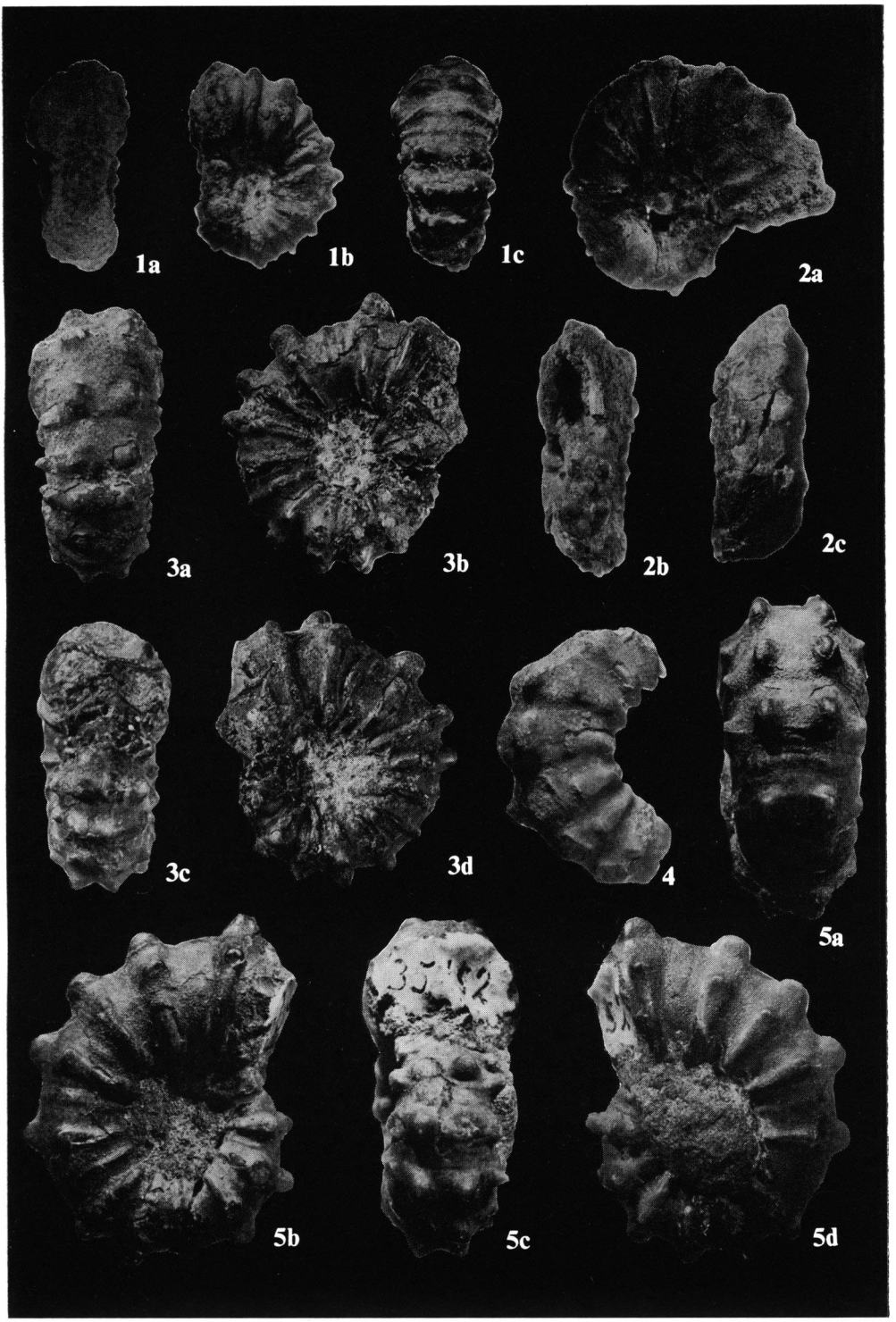
Figs. 5–7. *Diadochoceras* aff. *nodosocostatum* (D'ORBIGNY). Fig. 5, IPNP 13 (collector unknown, B15109). Lateral (a, c) and ventral (b, d), views, ×1; Fig. 6, IPNP 9 (GROSSOUVRE coll). Ventral (a), lateral (b) and frontal (c) views, ×1; Fig. 7, IPNP 11 (D'ORBIGNY coll., no. 5780a). Ventral (a) and lateral (b) views, ×1.

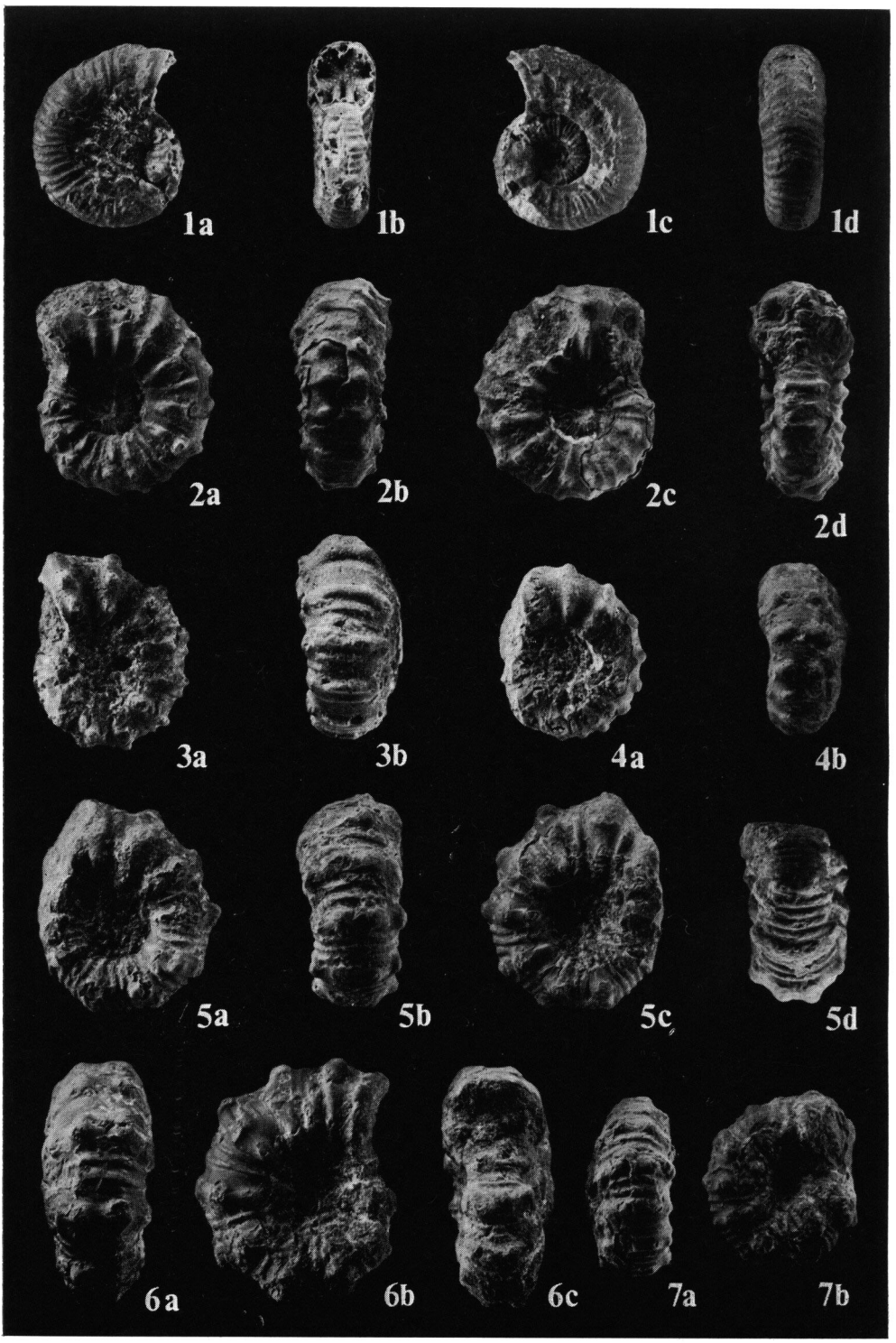
Plate 3

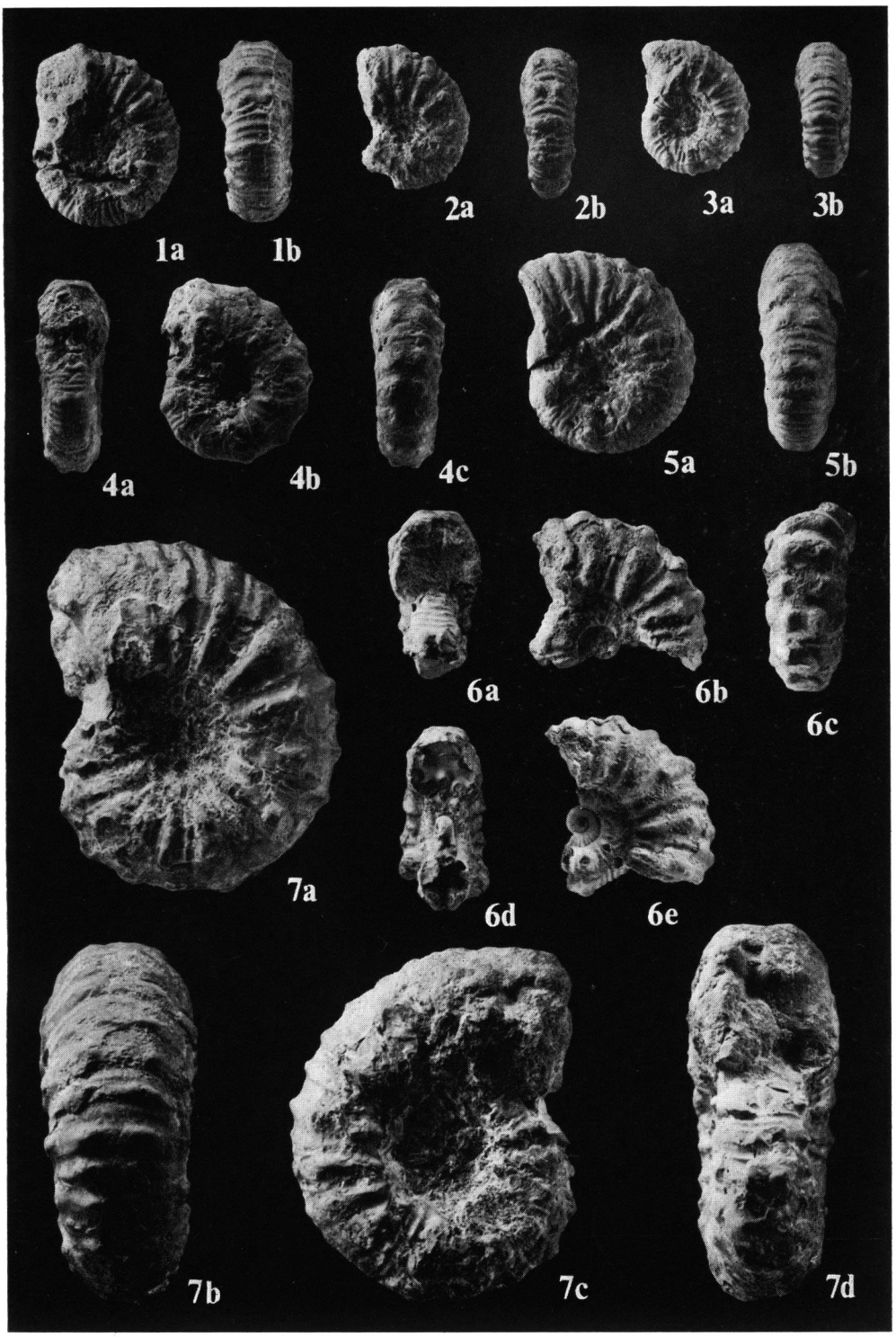
Acanthohoplitids from the uppermost Aptian, *i.e.* "Clansayesian", from Clansayes, Drôme, France.

Figs. 1–6. *Nodosohoplites* cf. *caucasicus* (LUPP.), (GROSSOUVRE coll., except otherwise stated). Fig. 1, IPNP 2; Fig. 2, IPNP 4; Fig. 3, IPNP 5. Lateral (a) and ventral (b) views, ×1. Fig. 4, IPNP 12, frontal (a), lateral (b) and ventral (c) view, ×1, (D'ORBIGNY coll. no. 5780b). Fig. 5, IPNP 7, lateral (a) and ventral (b) views, ×1. Fig. 6, IPNP 3, frontal (a), lateral (b, e), ventral (c), and sectional (d) views, ×1.

Fig. 7. IPNP 1. *Diadochoceras nodosocostatum* (D'ORBIGNY), (GROSSOUVRE coll.). Lateral (a, c), ventral (b) and frontal (d) views, ×1.


1a
1b
1c
2a
3a
3b
2b
2c
3c
3d
4
5a
5b
5c
5d


1a
1b
1c
1d
2a
2b
2c
2d
3a
3b
4a
4b
5a
5b
5c
5d
6a
6b
6c
7a
7b


1a
1b
2a
2b
3a
3b
4a
4b
4c
5a
5b
6a
6b
6c
7a
6d
6e
7b
7c
7d