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486. ALLOMETRY OF *REESIDITES MINIMUS*, A CRETACEOUS AMMONITE SPECIES*

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白亜紀アンモナイト *Reesidites minimus* のアロメトリー： 北海道産白亜紀アンモナイト *Reesidites minimus* (HAYASAKA and FUKADA) のアロメトリーを攻究し，加うるにその個体発生と変異を詳細に吟味した。そのさい，保存の良い数個体につき，外殻から順次取り壊し，胚殻に至るまでの連続的観察と計測も行った。形態的特性の個体発生上の変化は，むしろ漸移的であるが，七段階が識別される。注意すべきは，幼殻・中年殻において，かなりの個体変異が観察されることである。さらに，*R. minimus* の渦線は $r=ae^{k\theta}$ という数式で表現される生長様式を示す。螺環の高さ・幅・へそ・直径の大きさ相互の関係は，相対生長式 $y=bx^{\alpha}$ で表わされ，本種においてはすべて三相アロメトリーと考えられる。直径約 13 mm. に見られる変移点は成熟期を示唆する。系統発生的相対生長について，*R. minimus* が *Subprionocyclus normalis* や *S. neptuni* としばしば一つのアロメトリー群を構成することは注目に価する。この場合，いづれにおいても，系統発生的相対生長直線は，*S. neptuni* の個体発生的相対生長直線と一致する。けっきょく，合致直線は，種の大きさ，ならびに種の相対生長系数と関係する。*R. minimus* の，祖先型からの進化型式については，ある形質に関しては偏向，他の形質に関しては退化である。だが，その最も特徴的な形質に関しては，プロテロジェネシスと結論される。

小畠郁生

Introduction

In the Cretaceous of Japan there is a considerable number of collignoniceratids species, which are now being studied by MATSUMOTO, although the ammonites belonging to the " Atlantic-Mediterranean families " are not so prolific as those belonging to the " Indo-Pacific families ".

As a subject of my graduation thesis of Kyushu University for the academic year 1953-54, Professor Tatsuro MATSUMOTO gave me an opportunity to study the ontogeny of "*Barroisiceras minimum*", one of the so-called Atlantic-Mediterranean elements. This species was named by H. YABE (1909, p. 440; 1927, p. 45; YABE and SHIMIZU 1925, p. 125; MS. *nom. nud.*) on account of its small size. According to him, this occurs characteristically in the " *Scaphites* bed " of Ikushumbets Valley, Hokkaido. However, it had been left undescribed for a long while until it was first described by I. HAYASAKA and A. FUKADA (1951) from the Upper Cretaceous near Katsurazawa, Ikushumbets, Hokkaido, while T. MATSUMOTO at one time listed the species (1942, p. 197, etc.) as *Reesidites minimus* (*nom. nud.*). MATSUMOTO (1959a, p. 66, pl. 7) has settled the subzone of '*Reesidites*' *minimus* at a definite level in the lower part of the Upper Yezo Group, uppermost part of the Upper Stage of the Gyliakian Series, which is probably uppermost Turonian age in terms of international scale. However '*Reesidites*' had

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been a *nomen nudum* until WRIGHT and MATSUMOTO (1954) gave the definition.

The so-called *Barroisiceras* has been reported from the Coniacian in Europe, Africa, South America and North America etc., and has been studied by many palaeontologists. Of many works J. B. REESIDE's paper (1932) is outstanding in classifying the previously too broadly used *Barroisiceras*. He established a number of subgenera and excluded three groups from the genus *Barroisiceras*. Dr. E. BASSE (1947) pointed out that the holotype of *B. haberfellneri* (HAUER) from the Alpine Gosau Beds is not identical with the beautiful French specimens drawn by GROSSOUVRE (1894), and she removed the latter from *Barroisiceras* to another new genus *Reesideoceras*.

As to the Japanese species WRIGHT and MATSUMOTO (1954, p. 130) made the genus *Reesidites* valid, and pointed out its connection with *Subprionocyclus* SHIMIZU, 1932, emended by themselves. Subsequently MATSUMOTO (1959a, p. 66; 1959b, p. 121) has remarked the relationships among some species of *Subprionocyclus*, *Reesidites*, and *Barroisiceras*. The best exposures along the Ikushumbets showed a stratigraphic succession of *Subprionocyclus normalis*, *Reesidites minimus* and *Barroisiceras* sp. in ascending order, although regretfully they have submerged under the artificial lake of the Katsurazawa dam since October 1957 as MATSUMOTO has already mentioned (1959a, p. 67).

For some reasons, probably of ecological and sedimentological factors, *Reesidites minimus* occurs abundantly in a particular layer but *S. normalis* occurs less so and *Barroisiceras* very rare.

Although the ontogeny of "*Barroisiceras minimum*" was described in detail by HAYASAKA and FUKADA in 1951, my study in 1953-54 was along another line and I have carried on further additional work. At the Annual Meeting of the Palaeontological Society of Japan, January 1964, Fukuoka, a Symposium was held on "Ontogeny and Evolution" and I was invited to read a short paper which presented a summary of results. The abstract of that paper has recently been published in Japanese (OBATA, 1964).

This paper contains the full results of my research on the ontogeny of *Reesidites minimus*, with special reference to the allometry of the species.

Observation

Material. The repositories of the listed specimens are as follows, with symbols in parentheses.

Department of Geology, Kyushu University, Fukuoka (GK)
Geological Institute, University of Tokyo (GT)

All the examined specimens, except otherwise stated, were collected by T. MATSUMOTO and N. KANBE in 1951 from the prolific horizon just below the second green sandstone in the lower part of the Upper Yezo Group. The localities are Ik946 (GK. H4024-H4046, H4051-H4052, H4056-H4059, H4064-H4077, H4087-H4088, H4091-H4092) and Ik938 (GK. H4047-H4050, H4053-H4055, H4060-H4063, H4078-H4086), Ikushumbets Valley, Sorachi-gun in Hokkaido. GK. H4090 is collected by T. OMORI from the zone of *Reesidites minimus*, at a exposure along the rail-way (now abandoned), near the entrance of Ban-no-sawa, Ikushumbets Valley, Hokkaido. At loc. Ik2013b, the Ponbets Valley, Mikasa City in Hokkaido, a specimen, GK. H4089 is obtained from the lower part of Upper Yezo Group, about 20 m below the green sandstone bed (T. MATSUMOTO Coll.). GT. I-3328 (loc. T40・41p2) from the upper part of "IId" [α], Saku formation in the Abeshinai-Saku area, Teshio Province, is also examined (T. MATSUMOTO Coll.). I have examined the holotype and some other specimens in FUKADA's collection too. As the fossils are usually contained in numbers in calcareous nodules together with other shells, they are in a favourable state of preservation and available for the examination of the ontogenetic development. Specimens are mostly those of the immature and middle stages, being usually orientated at random in limy nodules. Some well-preserved specimens have been examined as material for unravelling the ontogeny in the earlier stage of growth.

The data concerning *Subprionocyclus normalis*, *S. neptuni* and *S. branneri* are cited from MATSUMOTO (1959b and 1965) for comparison.

Measurements (in mm.). When the specimen is partly broken, the estimated figures are shown, with asterisk of the right shoulder, calculated from the half or partly observable ones which are indicated in square brackets. The measurements which are described in MATSUMOTO (1965) are omitted here.

							Tubercles	
Specimen	Diameter	Height	Breadth	B/H	Umbilicus	%	umbili.	ventrolat.
GK. H4025	15.9	7.0	4.4	0.63	4.8	30	[6]×2*	[14]×2*
GK. H4026	18.5	8.6	4.6	0.53	4.6	25	12	32
GK. H4027	17.8	8.0	4.4	0.55	4.8	27	11	25
GK. H4029	20.0	8.8	5.3	0.60	5.7	29	11	28
GK. H4030	26.8	11.3	6.6	0.58	8.1	30	15	41
GK. H4031	17.4	7.5	4.6	0.61	4.8	28	11	31
GK. H4032	22.6	10.3	—	—	5.5	24	13	37
GK. H4033	14.2	5.8	3.9	0.67	4.4	31	[5]×2*	[15]×2*
GK. H4034	14.9	6.6	4.3	0.65	4.0	27	11	38
GK. H4035	27.6	12.7	6.4	0.50	5.7	21	9	29
GK. H4037	15.1	6.8	—	—	4.2	28	12	[36]42*
GK. H4038	11.7	4.2	3.1	0.74	4.2	36	14	38
GK. H4040	12.3	4.4	3.1	0.70	4.5	37	11	28
GK. H4041	9.5	3.4	2.3	0.68	3.1	33	10	28
GK. H4042	11.7	5.0	—	—	3.6	31	9	36
GK. H4043	10.5	4.2	2.8	0.67	3.5	33	13	[17]×2*
GK. H4044	8.9	3.3	2.3	0.70	3.1	35	10	[17]×2*
GK. H4045	7.7	3.0	2.2	0.73	2.5	32	7	6
GK. H4046	*c.* 21.2	10.2	5.0	0.49	4.2	20	9	44
GK. H4047	33.3	17.0	—	—	6.3	19	[6]×2*	[14]×2*
GK. H4048	20.1	8.9	5.1	0.57	5.3	26	11	32
GK. H4049	33.3	17.4	8.8	0.51	5.2	16	[6]×2*	[20]×2*
GK. H4050	*c.* 25.3	11.4	6.6	0.58	*c.* 5.0	20	10	[8]×4*
GK. H4051	5.3	2.0	1.8	0.90	1.9	36	—	—
GK. H4052	7.4	3.2	—	—	2.6	35	4	20
GK. H4056	18.1	8.5	—	—	5.1	28	13	35
GK. H4057	13.6	5.8	3.4	0.59	4.1	30	11	20
GK. H4058	—	3.8	2.6	0.68	—	—	[6]×2*	[18]×2*
GK. H4059	11.5	5.1	2.9	0.57	3.1	27	[5]×2*	[19]×2*
GK. H4060	—	12.3	5.6	0.46	—	—	[4]×2*	[16]×2*
GK. H4062	10.3	4.0	2.5	0.63	3.0	29	[6]×2*	[15]×2*

GK. H4063	8.6	*c.* 3.1	—	—	3.0	35	[5]×4*	[14]×2*
GK. H4064	17.9	7.4	4.4	0.59	5.3	30	[8]×2*	[17]×2*
GK. H4065	14.3	6.5	3.7	0.57	3.8	27	11	36
GK. H4066	*c.* 19.2	*c.* 8.4	4.8	0.57	5.3	28	[6]×2*	[15]×2*
GH. H4067	—	4.4	2.9	0.66	—	—	[7]×2*	[20]×2*
GK. H4068	17.7	7.3	4.2	0.58	5.3	30	[6]×2*	[18]×2*
GK. H4069	—	6.4	3.9	0.61	—	—	[6]×2*	[7]×4*
GK. H4070	13.7	6.1	3.5	0.57	3.3	24	[6]×2*	[16]×2*
GK. H4071	—	6.2	3.7	0.60	—	—	[4]×2*	[15]×2*
GK. H4072	10.0	4.2	2.7	0.64	3.2	32	[7]×2*	[16]×2*
GK. H4073	—	5.5	3.4	0.62	3.9	—	[5]×2*	[8]×4*
GK. H4074	—	5.3	3.3	0.62	—	—	[3]×4*	[10]×4*
GK. H4075	7.6	2.7	2.1	0.78	2.3	30	3	10
GK. H4077	—	4.1	2.7	0.66	—	—	[3]×4*	[11]×4*
GK. H4078	11.7	4.2	3.3	0.79	4.0	34	12	36
GK. H4079	—	6.3	3.4	0.54	—	—	[7]×2*	[18]×2*
GK. H4080	—	3.1	2.4	0.77	—	—	[6]×2*	[17]×2*
GK. H4081	—	9.9	4.8	0.48	—	—	[3]×4*	[7]×4*
GK. H4082	11.4	4.6	3.5	0.76	4.3	38	11	[15]×2*
GK. H4083	17.6	7.5	4.0	0.53	5.2	30	[5]×2*	[17]×2*
GK. H4084	—	6.7	3.9	0.58	—	—	[5]×2*	[17]×2*
GK. H4085	12.8	5.8	3.4	0.59	3.6	28	—	—
GK. H4086	12.6	5.5	3.4	0.62	3.9	31	[5]×2*	[10]×4*
GK. H4087	—	15.8	7.4	0.47	—	—	[4]×2*	[8]×2*
GK. H4088	25.9	12.5	6.7	0.54	7.2	28	12	34
GK. H4091	21.6	11.9	—	—	4.6	21		
GK. H4092	16.9	8.7	—	—	4.0	24		
GT. I-3328	*c.* 42.5	*c.* 20.4	*c.* 9.4	0.46	*c.* 7.8	18	17	[16]×3*

Measurements on individual growth. Several specimens are selected for clarify the serial change of individual growth in immature stages. Measurements are in mm.

(1) GK. H4025

	Diameter	Height	Breadth	B/H	Umbilicus	%
1st vol. later	0.79	0.28	0.51	1.82		
2nd „ early	1.07	0.40	0.56	1.40	0.39	36
„ „ later	1.47	0.46	0.66	1.43	0.61	41
3rd „ early	2.01	0.64	0.79	1.23	0.91	45
„ „ later	2.70	0.86	0.96	1.12	1.20	44
4th „ early	3.66	1.20	1.19	0.99	1.60	44
„ „ later	5.05	1.72	1.49	0.87	2.13	42
5th „ early	7.15	2.56	1.80	0.70	2.87	40
„ „ later	10.39	4.10	2.60	0.63	3.73	36
6th „ early	15.19	6.50	4.30	0.66	4.59	30

(2) GK. H4033

	Diameter	Height	Breadth	B/H	Umbilicus	%
2nd vol. early	0.77	0.31	0.53	1.71		
„ „ later	1.09	0.41	0.59	1.44	0.37	34

3rd ,, early	1.50	0.53	0.76	1.43	0.56	37
,, ,, later	2.07	0.73	0.86	1.18	0.81	39
4th ,, early	2.93	1.08	1.13	1.05	1.12	38
,, ,, later	4.25	1.65	1.39	0.84	1.52	36
5th ,, early	6.45	2.77	1.80	0.65	2.03	31
,, ,, later	9.55	3.84	2.40	0.63	2.94	31
6th ,, early	13.85	5.70	3.80	0.67	4.31	31

(3) GK. H4036

	Diameter	Height	Breadth	B/H	Umbilicus	%
2nd vol. early	0.65	0.30	0.50	1.67		
,, ,, later	0.91	0.33	0.54	1.64	0.25	27
3rd ,, early	1.26	0.43	0.59	1.37	0.50	40
,, ,, later	1.72	0.56	0.79	1.41	0.73	42
4th ,, early	2.34	0.75	0.86	1.15	1.03	44
,, ,, later	3.18	1.02	1.09	1.07	1.41	44
5th ,, early	4.37	1.49	1.39	0.93	1.86	43
,, ,, later	6.15	2.23	1.77	0.79	2.43	40
6th ,, early	8.75	3.36	2.30	0.68	3.16	36

(4) GK. H4051

	Diameter	Height	Breadth	B/H	Umbilicus	%
2nd vol. early	0.80	0.33	0.53	1.54		
,, ,, later	1.11	0.41	0.63	1.54	0.37	33
3rd ,, early	1.54	0.56	0.76	1.36	0.47	31
,, ,, later	2.12	0.73	0.96	1.32	0.83	39
4th ,, early	2.85	0.96	1.12	1.17	1.16	41
,, ,, later	3.91	1.49	1.49	1.00	1.46	37
5th ,, early	5.36	1.88	1.75	0.93	1.91	36

(5) GK. H4055

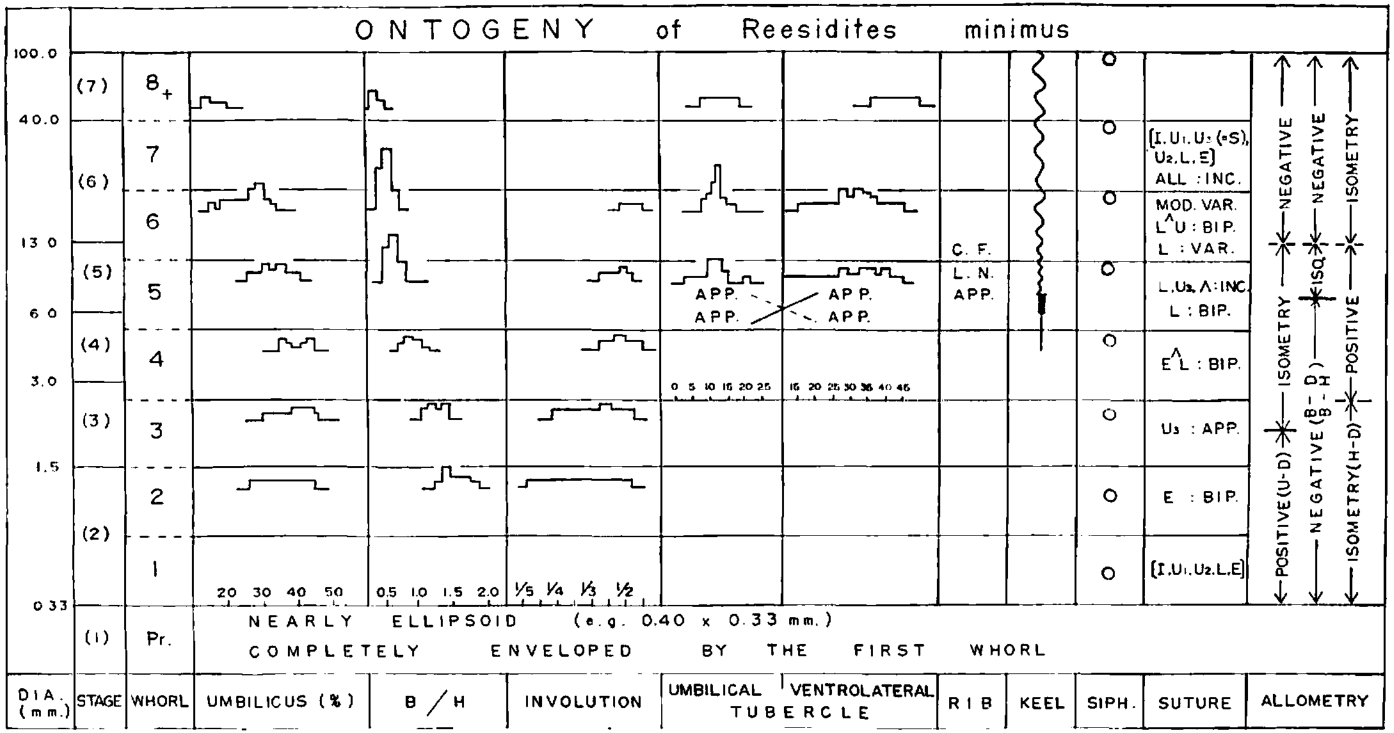
	Diameter	Height	Breadth	B/H	Umbilicus	%
2nd vol. early	0.79	0.28	0.50	1.79		
,, ,, later	1.09	0.33	0.54	1.64	0.48	44
3rd ,, early	1.47	0.53	0.66	1.25	0.61	44
,, ,, later				—		—
4th ,, early		0.99	0.96	0.97		

Ontogenetic development

Although the ontogenetic change of morphological character is more or less gradual, the following stages are distinguished. Fig. 1 is a summarized result of the study. Some examples of the transverse section and the sutural development of immature shells are shown in text-figs. 2-4. The photographed specimens are shown on Plates 4-5.

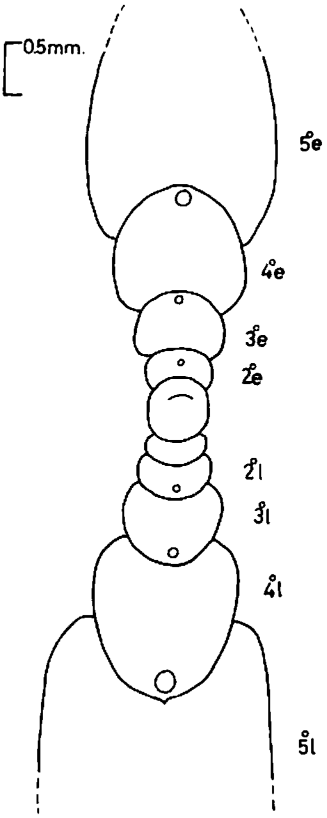
(1) *Protoconch.* The protoconch is not exposed, being completely enveloped by the succeeding first whorl (Fig. 5). It is roughly spherical or rather ellipsoidal in shape. Its diameter (i.e. the dimension along the shorter axis of the ellipsoid) is estimated at about 0.33 mm. Its width (i.e. the dimension along the longer axis of the ellipsoid) is 0.40 mm. (GK. H4055)

(2) *The first and the second whorls.* Diameter is less than *c.* 1.5 mm., shell is very to moderately evolute, with involu-

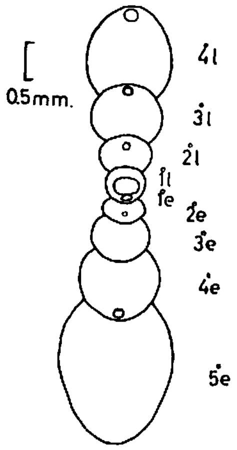


Text-fig. 1. Ontogenetic development of the characters.

DIA.: diameter, SIPH.: position of siphuncle, Pr.: protoconch, APP.: appearance, C.: coarse, F.: fine, L.: less, N.: non less, BIP.: bipartite, ∧ : saddles, INC.: incision, VAR.: variable, MOD.: moderately.



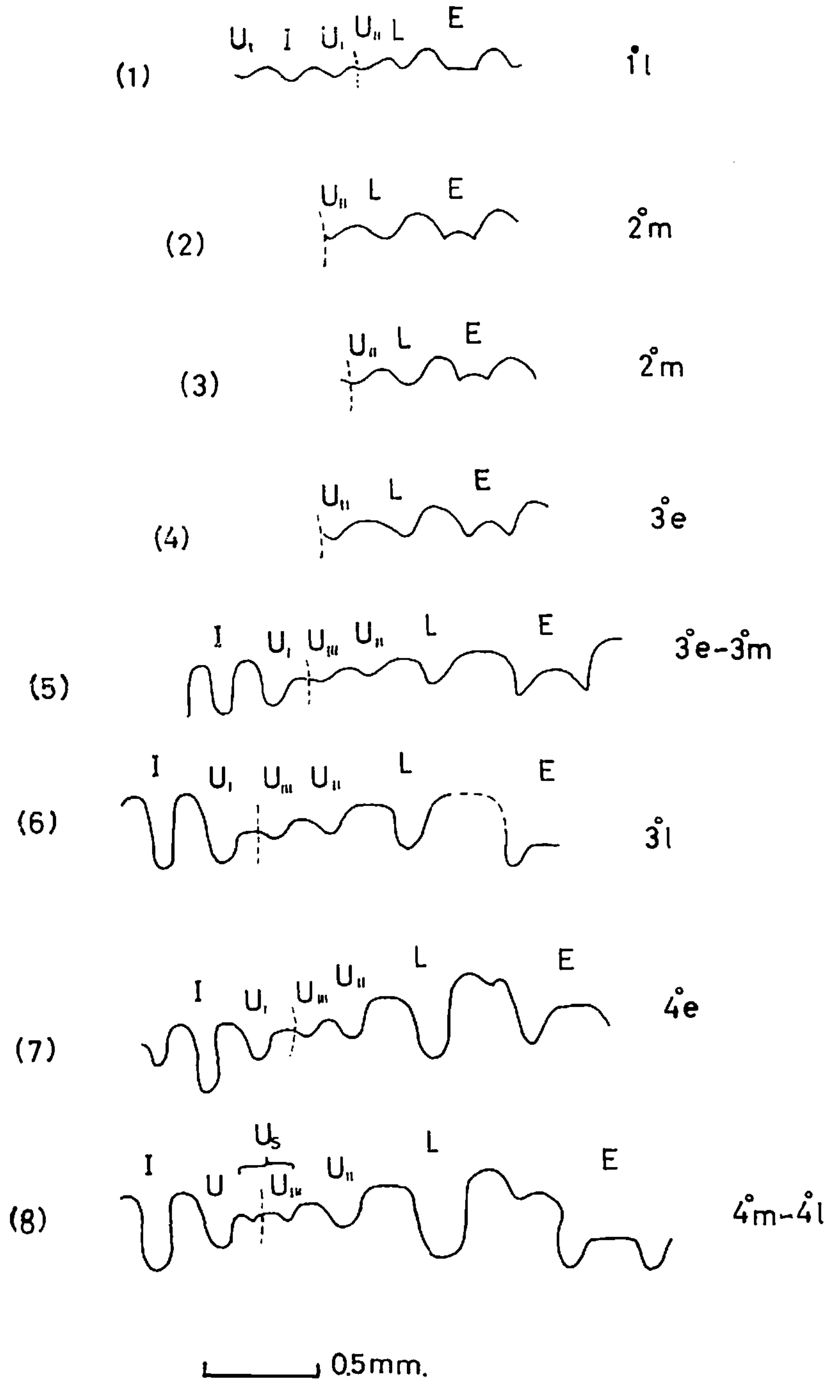
Text-fig. 2. Transverse section of GK. H4025, an immature specimen.



Text-fig. 3. Transverse section of GK. H4051, an immature specimen.

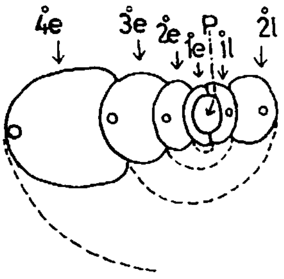
tion of 1/1.9 to 1/4.7, fairly widely to fairly narrowly umbilicate (the umbilicus being from 44% to 27% of the diameter) (Figs. 2, 3, 6); umbilicus is shallow and surrounded by gently sloping wall; whorls are less embraced, inflated and fairly to much depressed, height being far smaller than width with B/H from 1.8 to 1.3 (Figs. 2, 3, 6, 7). Surface is smooth without any trace of a ventral keel. The septal suture-line consists of I, U_1, U_2, L and E; E is large and subdivided from the beginning; I is relatively broad and not yet subdivided (Fig. 4). The siphuncle is subcentral or rather somewhat internal in the first volution and is displaced rather externally in the second one (Figs. 2, 3, 6).

(3) *The third whorl and the early part of the fourth one.* Diameter is less than *c.* 3.0 mm. Whorls are embraced, inflated and fairly depressed (B/H being from 1.4 to 1.1) (Figs. 2, 3, 7), umbilicus is fairly wide to moderate (from 45% to 31% of the diameter) and shallow with an inclined wall. Involution is variable, being moderate to very evolute (i.e. 1/1.9 to 1/4.0) (Figs. 2, 3, 7). Through the preceding stage and the earlier substage of the present one the diameter of umbilicus increases rapidly, showing positive allometry to the total diameter; then moderately, showing isometry, after 2 mm. of diameter (Fig. 21). The relation between height and diameter somewhat differs in the later substage from that in the earlier one, increasing slightly rapidly in height (Fig. 20). Surface is smooth without any trace of a ventral keel. In the suture-line of the early part of the third whorl U_3 begins to appear at the umbilical suture, and E and I are deep (Fig. 4). The siphuncle

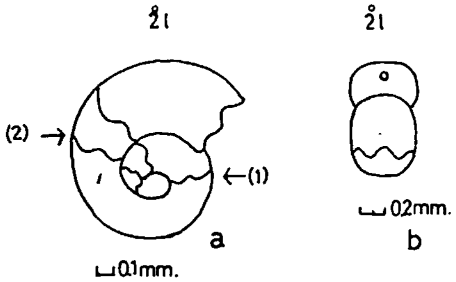


Text-fig. 4. Sutural development of immature shells.

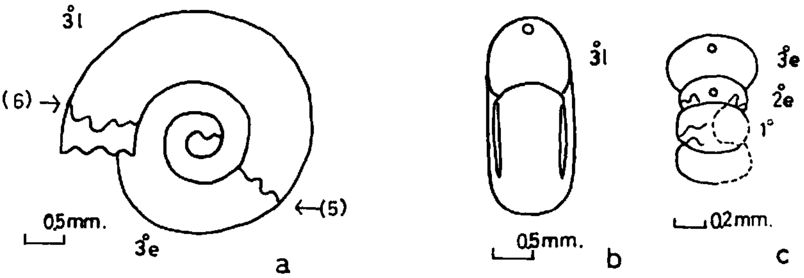
(1) : GK. H4054, 1°l; (2) : GK. H4054, 2°m; (3) : GK. H4053, 2°m; (4) : GK. H4053, 3°e; (5) : GK. H4039, 3°e-m; (6) : GK. H4039, 3°l; (7) : GK. H4053, 4°e; (8) : GK. H4053 4°m-l.



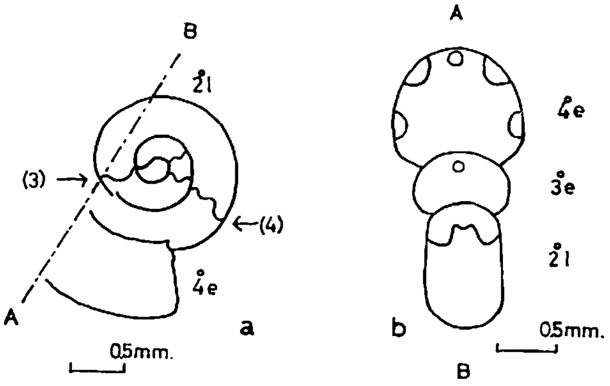
Text-fig. 5. Schematic figure of the cross-section of the earlier whorls in GK. H4055.



Text-fig. 6. Immature shell, at the later part of the second volution, of GK. H4054. a: lateral view, b: ventral view. (1) and (2) correspond to the illustrated sutures, (1) and (2) in text-fig. 4.



Text-fig. 7. Immature shell, at the third volution, of GK. H4039. a: lateral view of the later substage, b: ventral view of the later substage, c: cross-section of the earlier substage. (5) and (6) correspond to the illustrated sutures, (5) and (6) in text-fig. 4.

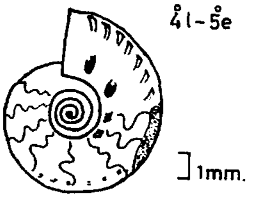


Text-fig. 8. Immature shell, at the earlier part of the fourth volution, of GK. H4053. a: lateral view, b: ventral view. (3) and (4) correspond to the illustrated sutures, (3) and (4) in text-fig. 4.

gradually approaches to the ventral side during the growth of the third whorl (Figs. 2, 3, 5, 7, 8).

(4) *The main part of the fourth and the early part of the fifth whorls.* Diameters are from *c.* 3.0 mm. to *c.* 6.0 mm. Umbilicus is fairly wide or moderate, being from 44% to 36% of the diameter (Figs. 2, 3). Whorls are embraced, being fairly evolute to moderate (1/2.7 to 1/1.7), almost as high as broad in the earlier substage and slightly higher than broad in the later substage (B/H being from 1.1 to 0.8) (Figs. 2, 3, 8). Flanks are smooth without ribbing but on the median line of the venter a faint keel is discernible.

In the late substage of some specimens the indistinct ventro-lateral tubercles begin to appear and then at the beginning of the next stage the umbilical tubercles and ribs appear successively (e. g. GK. H4052) (Fig. 9). But in some others the obscure umbilical tubercles appear first in the later substage or at the beginning of the next stage and forestall the ventro-lateral tubercles which appear in the next earlier substage (e. g. GK. H4043).



Text-fig. 9. Lateral view of immature shell, which shows the later part of the fourth to the earlier part of the fifth volution, of GK. H4052.

In the septal suture-line of the early substage the first lateral saddle between E and L is asymmetrically and shallowly divided, with the outer branch lower than the inner (Fig. 4). The siphuncle is situated almost at the ventral extremity (Fig. 8).

(5) *The main part of the fifth and the early part of the sixth whorls.* Diameters are from *c.* 6.0 to *c.* 13.0 mm. Shell is rather moderate in involution (i. e. mostly 1/2.3 to 1/1.9 and rarely 1/2.6); umbilicus is moderately wide to narrow, being from 40% to 27% of the diameter (Fig. 2). Whorls are fairly to much compressed, B/H being 0.6 to 0.8. At about 8 mm. of diameter whorl-breadth changes eminently its value of relative growth ratio and approaches the isometric relation to the whorl-height (Fig. 18), resulting in the nearly isometric relation between breadth and diameter (Fig. 19). In the stages preceding to this the whorl-breadth increased slowly, showing negative allometry to the whorl-height (Fig. 18). The venter is distinctly keeled on the median line. The keel is almost smooth in the earlier part of the fifth whorl, then faintly undulated at its intersection with the striae extended from the lateral ribs. In the early part of the sixth whorl it is serrated, sharp, narrow and prominent. Along the ventro-lateral edge there are numerous small tubercles at the end of the ribs, which are twice or three times as numerous as the umbilical tubercles. The umbilical shoulder is ornamented with relatively large umbilical tubercles which are extended obliquely forward and sometimes radially to the ribs. Flanks are ornamented with the flexiradiate ribs, which are bifurcated near the umbilical tubercles and also intercalated with some shorter ribs. The intercalated ribs are confined on the external half of the whorl. The ribs show generally a gently sigmoidal curvature on the main part of the flanks and are sharply bent forward at the submarginal inner ventro-lateral point, widen gradually from there towards the ventro-lateral tubercles, thence weakening

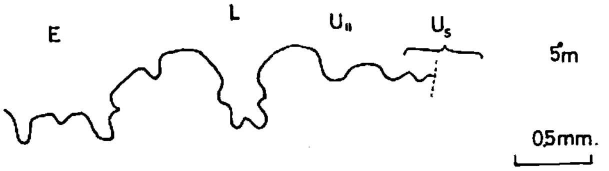


Fig.10

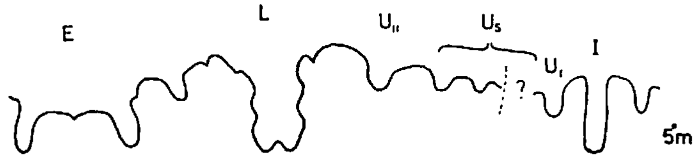
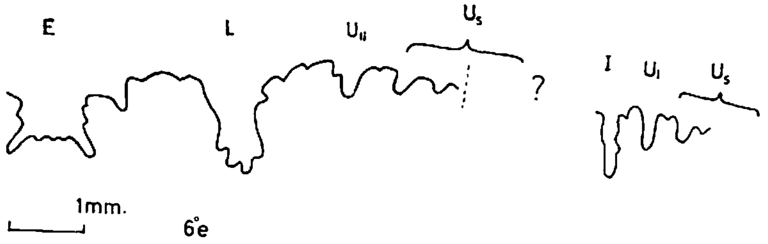


Fig.11

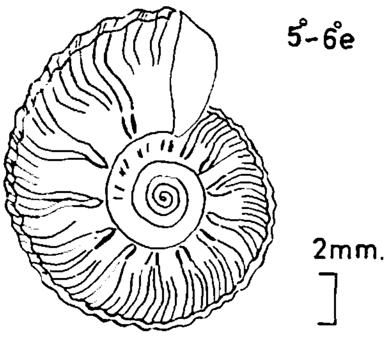
Text-fig. 10. Suture, at the middle part of the fifth volution, of GK. H4038, an immature specimen.

Text-fig. 11. Suture, at the middle part of the fifth volution, of GK. H4039, an immature specimen.



Text-fig. 12. Suture, at the earlier part of the sixth volution, of GK. H4025, an immature specimen.

and finally disappearing towards the median keel. In some specimens the sculptures are not so distinct in this stage and the ribs are faint at the middle of the flanks (e.g. GK. H4040). In the earlier substage in the fifth whorl L begins to be bipartite, and then successively minor incisions occur in L, the adjacent saddles and U_s. I is narrow and deep. Minor elements of L are fairly variable by individuals in depth and arrangement, and the variation in the minor incisions becomes distinctive in the later substage. In some specimens L is clearly quartered at the middle of the fifth whorl (e.g. GK. H4038) (Figs. 10, 11, 12).



Text-fig. 13. Lateral view of an immature specimen, which shows the main part of the fifth and the early part of the sixth volution, of GK. H4038, which is characterized by its elegant ribs, large number of the marginal nodes and ribs.

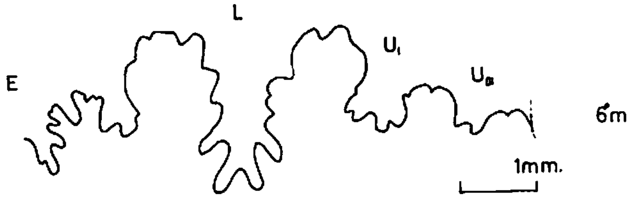
There are two types of varieties in this stage. One is characterized by its comparatively coarser and less numerous ribs and marginal nodes (e. g. GK. 4040) and the other by its more elegant, finer and larger number of ribs and marginal nodes (e. g. GK. H4038) (Fig. 13). Thus, the specimens exemplify a wide extent of variation of this species.

(6) *The main part of the sixth and the seventh whorls.* Diameters are from *c.* 13 to *c.* 40 mm. Shell is fairly involute to moderate (e. g. 1/1.5 at the diameter of *c.* 15 mm. in GK. H4025); umbilicus is fairly narrow to moderate (from 35% to 16% of the diameter), with a steep wall; whorls are fairly to much compressed (B/H is from 0.7 to 0.5), with convergent flanks, keeled on the median line of the narrow, roof shaped venter, which is not simply sagitate. The keel is somewhat undulated. Flanks of the shell are ornamented with flexiradiate primary and secondary ribs. The ribs show generally a gentle curvature near the middle of the flanks and they curve forward again at the submarginal inner ventro-lateral point forming an angle there. On the umbilical shoulder the end of the primary rib is elevated to a tubercle which is elongated radially or rather obliquely forward. Every rib is broadened externally and forms a clavate tubercles at the outer ventro-lateral edge. It extends further obliquely forward from the tubercles towards the median keel with decreasing strength, finally becomes faint and almost disappears near the keel. The elevation of the undulated keel is found at the inter-section of the keel and the extended weak rib ahead of the corresponding ventro-lateral tubercles. On the posterior part of the living chamber the similar ribbing continues but the ribs are coarser and broader and furthermore, flexiradiate lirae are better discernible than on the preceding parts.

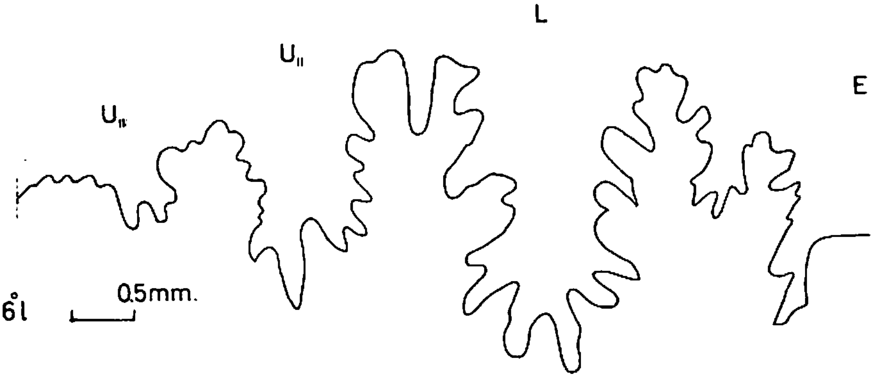
Elements of the suture-line are apparently numerous, although the formula is [I, U_1, $U_3(=s)$, U_2, L, E] (Figs. 14-15). The subdivisions of all the elements are added to those of the preceding stage. The same kinds of variety are also distinguishable as regards the suture of this stage. However, the differences among the individuals are rather gradual, being connected by some intermediate forms. The lobes become deep and U is narrow. In the later stage of the sixth whorl, the first lateral saddle is broad and asymmetrically bifid, first lateral saddle slightly narrower than the external one and divided relatively narrowly and asymmetrically, L is almost as broad as the first lateral saddle and as deep as E. The general pattern of the suture resembles that of *Subprionocyclus*, e. g. *S. hitchinensis* (BILLINGHURST), *S. neptuni* (GEINITZ), *S. normalis* (ANDERSON) and the related forms.

There are two main types of varieties in this stage. One is characterized by comparatively coarser and stouter ribs and smaller number of ribs and marginal tubercles (e. g. GK. H4027) (Pl. 5, fig. 2; Fig. 16). The other is characterized by more elegant and slender ribs and larger number of ribs and marginal tubercles (e. g. GK. H4032) (Pl. 4, fig. 3). In the latter type two subgroups are furthermore distinguished. One has a relatively narrow umbilicus (e. g. GK. H4026) (Pl. 4, fig. 2; Fig. 17). The other has relatively wide umbilicus (e. g. GK. 4030) (Pl. 4, fig. 12). I am inclined, however, to include these forms in one and the same species, because they occur in the same bed together with some intermediate specimens (Fig. 1).

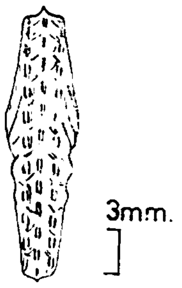
(7) *Full-grown shell after the eighth whorl.* Diameters are *c.* 40 mm. to *c.* 100 mm. Shell is very involute; umbilicus



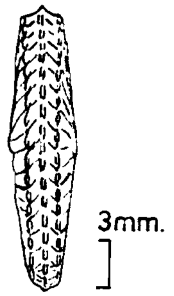
Text-fig. 14. Suture, at the middle part of the sixth volution, of GK. H4035, a middle age specimen.



Text-fig. 15. Suture, at the later part of the sixth volution, of GK. H4049, a middle age specimen.



Text-fig. 16. Peripheral view, at the sixth stage, of GK. H4027, which is characterized by comparatively coarse and stout ribs and small number of ribs and marginal tubercles.



Text-fig. 17. Peripheral view, at the sixth stage, of GK. H4026, which is characterized by elegant and slender ribs and large number of ribs and marginal tubercles.

is shallow and narrow (e. g. about 15% of the diameter at the end of this stage) with a perpendicular wall; whorls are distinctly compressed (e. g. B/H being 0.40 at the end of this stage) with subparallel, converging flanks. Keel is coarsely serrated on the narrow, fastigate venter. Somewhat flattened and broadened primary ribs, which spring from the umbilical bullae, and bifurcated or inserted secondary ones are very gently flexiradiate or almost rectiradiate on the flanks. They are curved gently forward at the submarginal inner ventrolateral point and broadened, forming clavae at the outer ventro-lateral edge. Ribs are extended and projected on the venter with decreasing strength, and the keel forms wave like elevations at its intersection with extended weak ribs. On the anterior part of the body chamber the ribs are broadened and many lirae which are parallel to the ribs, are observable.

Concluding Remarks

Validity of the genus. As WRIGHT and MATSUMOTO (1954, p. 130) have already remarked the genus *Reesidites*, with the type-species *R. minimus* (HAYASAKA and FUKADA), belongs to the Collignoniceratidae, and there is sufficient diagnosis to justify the distinction of the genus *Reesidites* from other allied genera. WRIGHT and MATSUMOTO stated that the sharp forward bend of the ribs, especially on the inner whorls, as they approach the ventro-lateral shoulder indicates the connection with *Subprionocyclus*, although the general features in the outer whorl of *Reesidites* with a fastigate venter with a coarsely serrate keel recalles *Barroisiceras sensu stricto*. This statement is confirmed by the present study of ontogeny in *Reesidites minimus*.

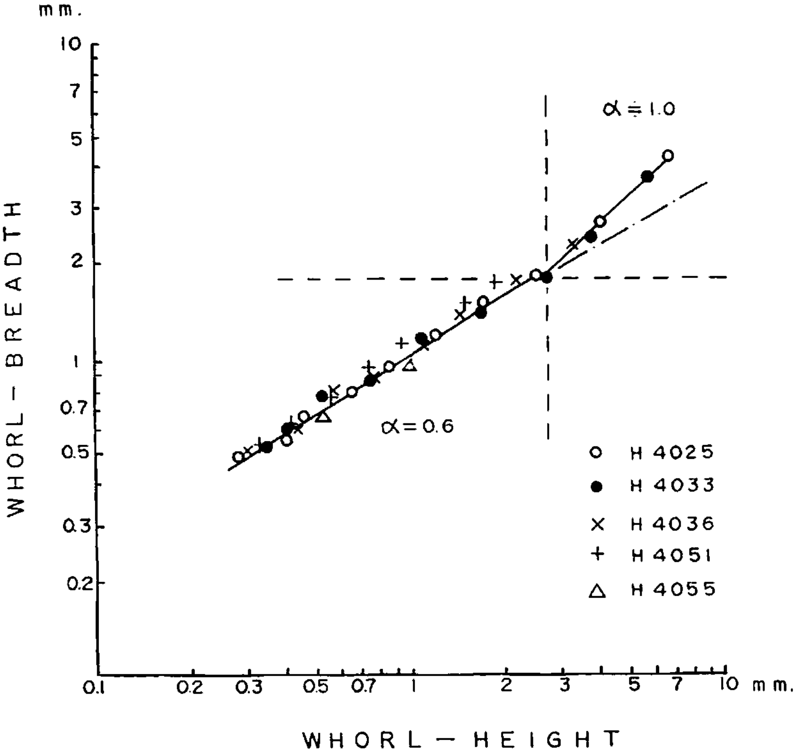
Species lineage. According to the biostratigraphic work in Hokkaido by MATSUMOTO (1959a, p. 66), *Subprionocyclus neptuni* (GEINITZ), *Subprionocyclus normalis* (ANDERSON) and then *Reesidites minimus* (HAYASAKA and FUKADA) occur in ascending order. They are often associated with *Sciponoceras intermedium*, in the zone of *Inoceramus teshioensis*, the upper part of the Upper Gyliakian. This is in harmony with the occurrence of the two former species in California. As to *Barroisiceras* undoubted examples are collected by him from a level immediately above the bed of *Reesidites minimus* or in the zone of *Inoceramus uwajimensis*, Ikushumbets area. On the occasion of describing *Subprionocyclus normalis* (ANDERSON) from California, MATSUMOTO (1959b, p. 121) remarked that the relationship is so intimate that *S. normalis* may be regarded as intermediate between *Subprionocyclus neptuni* and *Reesidites minimus*. Support is given to MATSUMOTO's conclusion from the ontogenetic observation of *Reesidites minimus*.

Variation. It is noteworthy that the stage in which certain morphologic characters appear is variable to some extent by individuals. It should be stressed that even in the young and middle stages of growth there are considerable variation in ornaments, shell-form and suture (see measurements and also Figs. 1, 10, 11, 16, 17). For example, at about 11 mm. of diameter there observed distinctly fairly wide scope of variability in the development of the sutural elements. In the fifth and the sixth stages of certain specimens (e. g. GK. H4046) even in the same suture-line the minor incisions of L are somewhat different from each other between the two sides.

Protoconch. As far as the available data are concerned, the size of protoconch in *Reesidites minimus* is one of the smallest group in the Japanese Cretaceous ammonites. It is far smaller than that of some gaudryceratids, phylloceratids and puzosiines. Its size is nearly the same as or a little smaller than that of *Desmophyllites diphylloides* (cf. OBATA 1960), one of the Desmoceratinae, and *Metaplacenticeras subtilistriatum* (cf. MATSUMOTO 1953), one of the Hoplitaceae.

Ontogenetic allometry. Judging from the serial data of several selected individuals, the spiral growth of *Reesidites minimus* is also represented by an equation of $r=ae^{k\theta}$, like that in some other ammonites (cf. OBATA 1960). A critical point, which is between the later part of the third whorl and the early one of the fourth, in the regressive line of spiral growth, corresponds to a critical point on the allometric line which shows a relation between height and diameter.

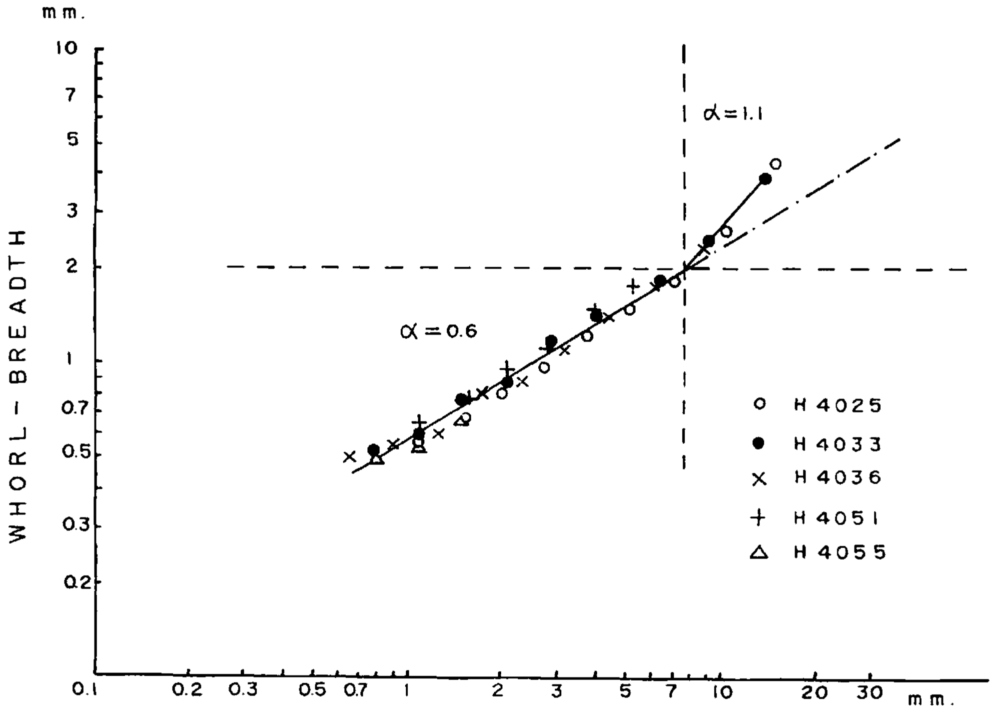
As to the dimensions of 'whorl-height, breadth, umbilicus and diameter in *Reesidites minimus* a relation between two of them is represented by an allometric expression $y=bx^{\alpha}$, as in the case of some desmoceratids (cf. OBATA 1959). Let us examine the ontogenetic allometry by a graphic method of the double logarithms. The relation between height and breadth is at least diphasic allometry below 7 mm. in height (Fig. 18). It is considered as triphasic allometry through the whole growth stages (Fig. 1). An eminent critical point is that of 2 mm. in breadth, in the earlier substage of the fifth stage of development. The point shows a change from negative to isometric growth



Text-fig. 18. Ontogenetic allometry of breadth to height: the double logarithmic graph shows the serial change of individual growth in immature stage, indicating the change from negative allometry to isometry at the critical point about 3 mm. in height. ○: GK. H4025, ●: GK. H4033, ×: GK. H4036, +: GK. H4051, △: GK. H4055.

of breadth to height (Fig. 18), and exactly corresponds to the distinct critical point of breadth to diameter, which shows a change from negative to isometric growth in the allometry between breadth and diameter (Fig. 19). A critical point of the allometry between height and diameter is in the later substage of the third stage of morphologic development, and shows a very slight increase of relative growth coefficient of height to diameter, dividing the earlier isometric line and the later positive one at about 3 mm. in diameter (Fig. 20). Relation between the diameter of umbilicus and that of the entire shell is also triphasic allometry (Fig. 1). A distinct critical point is at 2 mm. in diameter (Fig. 21). The point shows a change from positive to negative growth of umbilicus to diameter. It is in the third stage of the morphologic development.

Thus two critical points of allometry are antecedent to the appearance of a keel and ornaments, and the rest is accompanied with or comes after the appearance of ornaments. As an assumed critical point is in the early part of the sixth whorl (Fig. 1), it may be suggested that the point could mean the attaining to maturity. The peak of histogram corresponds to the latest critical point (Fig.

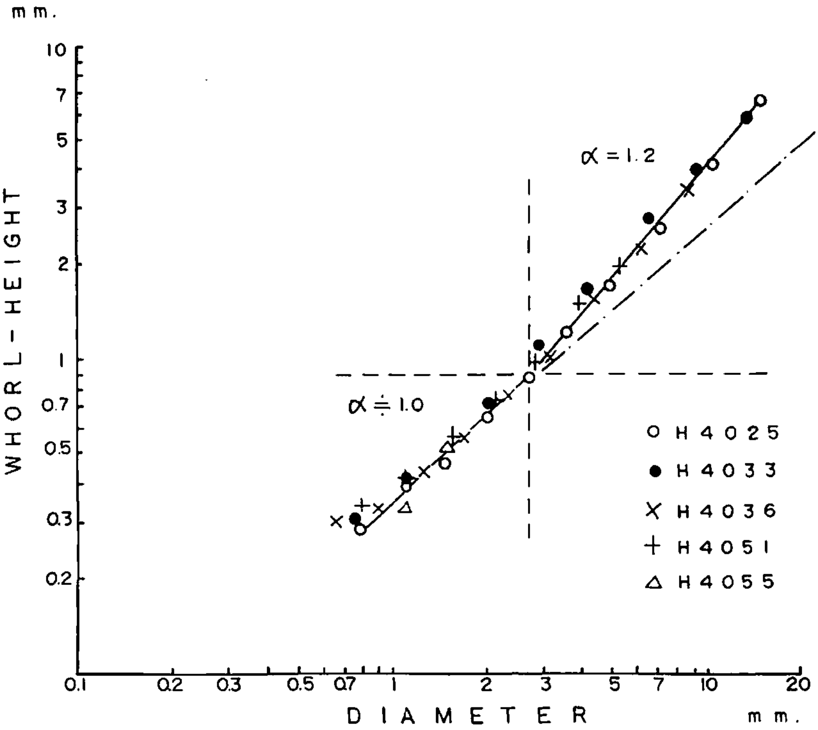


Text-fig. 19. Ontogenetic allometry of breadth to diameter: the double logarithmic graph shows the serial change of individual growth in immature stages, indicating the change from negative allometry to isometry at the critical point about 8 mm. in diameter. ○: GK. H4025, ●: GK. H4033, ×: GK. H4036, +: GK. H4051, △: GK. H4055.

24). In short, when we carefully examine the data, we find that the change of growth ratio occurs at a few critical points in the course of growth. It is shown that changes in the specific growth constants are a necessary consequence of the allometric growth. Thus, support is given, by biometric studies of ammonites, to the concept of allometry as a biological principle, as PARKINSON (1960) has recently discussed on the Carboniferous brachiopoda. As previous authors (e. g. HUXLEY 1932, NEWELL 1956) have remarked, allometric changes in form are highly characteristic of many species. *Reesidites minimus* is one of the examples (Fig. 1).

Phyllogenetic allometry. This may approximately correspond to lineage allomorphosis of WESTOLL (1950). Comparing *Reesidites minimus* with the three species of *Subprionocyclus* from Japan and California, the proportion of breadth to height on the average is as follows in the ascending order: *Reesidites minimus, Subprionocyclus normalis, S. neptuni* and *S. branneri* (Fig. 22).

Let us examine the phyllogenetic allometry by a graphic method of the double logarithms. *Reesidites minimus, Subprionocyclus normalis* and *S. neptuni* fall on the same linear line in the graph of

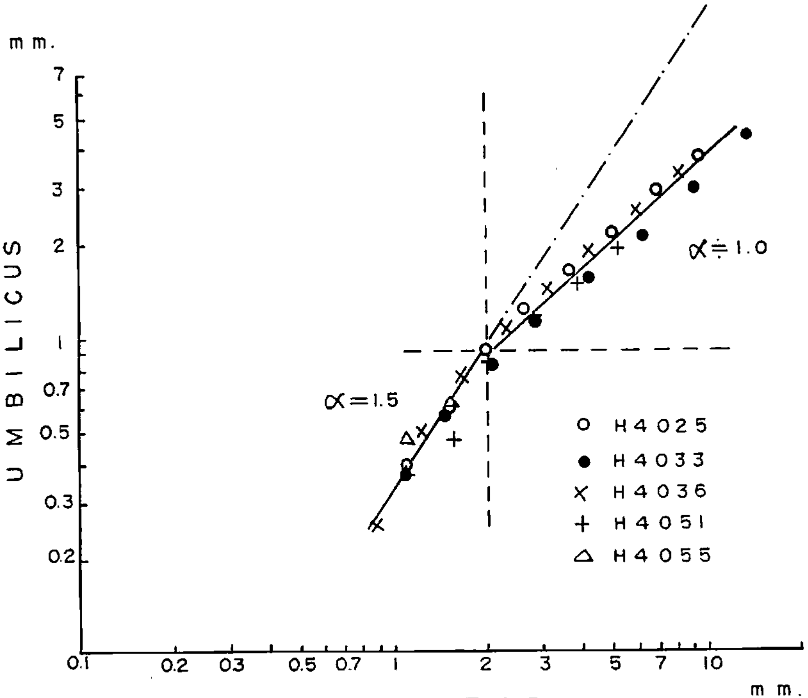


Text-fig. 20. Ontogenetic allometry of height to diameter: the double logarithmic graph shows the serial change of individual growth in immature stages, indicating the change from isometry to positive allometry at the critical point about 3 mm. in diameter. ○: GK. H4025, ●: GK. H4033, ×: GK. H4036, +: GK. H4051, △: GK. H4055.

height and breadth (Fig. 22). Furthermore, the same relation is recognized in the graph of height and diameter or breadth and diameter (Figs. 23-24). As regards the relation between breadth and diameter *S. branneri* belongs to the same allometric tribe [in the proper sense, cf. LUMER (1940)] as the other three species under consideration (Fig. 24), although it shows a slightly smaller height (Fig. 23) and larger umbilicus than those in others. Thus, it is noted that *Reesidites minimus* often forms an allometric tribe in conjunction with *Subprionocyclus normalis* and *S. neptuni*.

As JOYSEY (1956) has already pointed out, it is advocated that the parameters of the relative growth relationship between pairs of characters provide the most satisfactory basis of statistical comparison between fossil communities. Some examples of the situation are shown on Figs. 22-24.

Relation between phylogenetic allometry and ontogenetic allometry. As to the relation between phylogenetic allometry and ontogenetic one several works have been done by previous palaeontologists on some vertebrates: HERSH (1934) studied on Paleogene Titanotheres from North America; ROBB (1935) and REEVE and MURRAY (1942) discussed the evolution of horses; GRAY (1946) and LULL and GRAY (1949) examined the Ceratopsia.

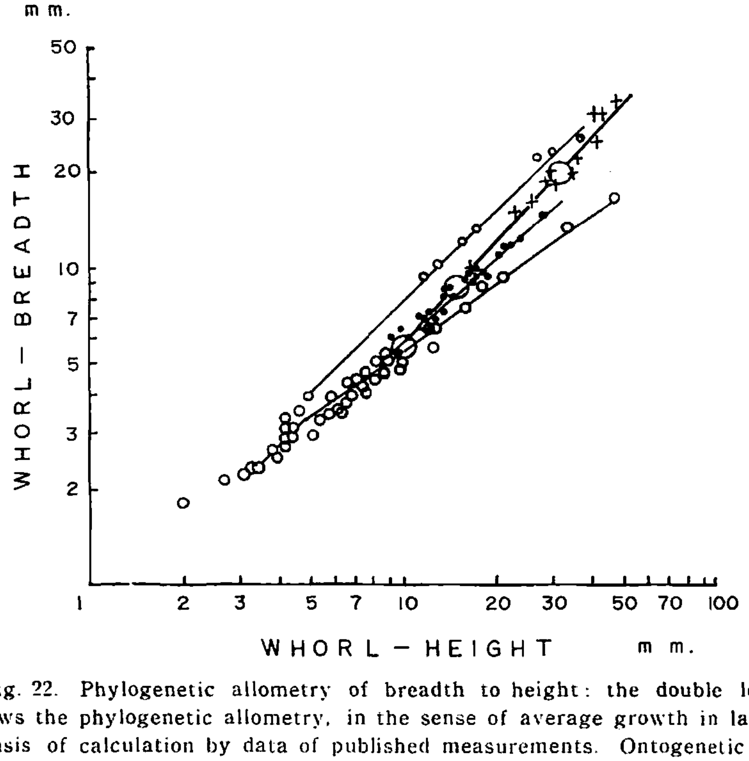


Text-fig. 21. Ontogenetic allometry of umbilicus to diameter: the double logarithmic graph shows the serial change of individual growth in immature stages, indicating the change from positive allometry to isometry at the critical point about 2 mm. in diameter. ○: GK. H4025, ●: GK. H4033, ×: GK. H4036, +: GK. H4051, △: GK. H4055.

Cretaceous dinosaurs. NEWELL (1948) mentioned some examples of the phylogenetic allometry on the invertebrate fossils, and remarked on the parallel relationship in the process of ontogeny and phylogeny. It seems to me that there is not yet sufficient material of biometry which shows strict coincidence between ontogenetic and phylogenetic lines, as WESTOLL (1950) has remarked.

Concerning the allometric tribe of the three species of ammonites, i.e. *Reesidites minimus*, *Subprionocyclus normalis* and *S. neptuni*, the relation between allomorphosis and ontogenetic allometry is very interesting. The line of phylogenetic allometry of breadth to height (Fig. 22), that of breadth to diameter (Fig. 24), and that of height to diameter (Fig. 23) correspond with the lines of ontogenetic allometry in *Subprionocyclus neptuni*. Thus, the corresponding line of phylogenetic allometry is controlled by the size and the relative growth coefficient of *S. neptuni* among the three species (Figs. 22–24).

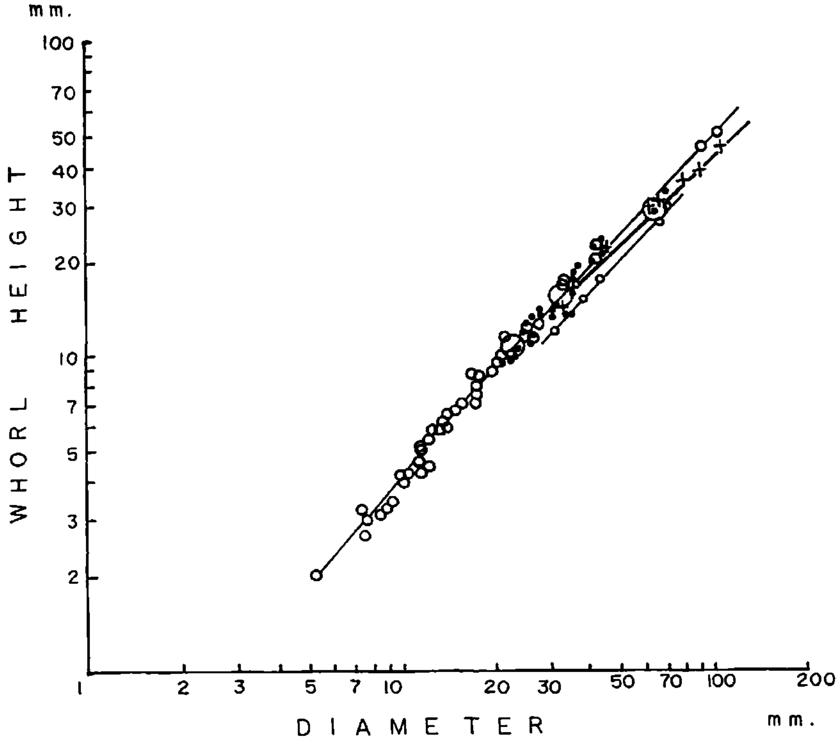
Deviation, reduction and proterogenesis. In *Subprionocyclus normalis* and *Reesidites minimus* the largest example attains to 70 mm. or more in shell diameter, but



Text-fig. 22. Phylogenetic allometry of breadth to height: the double logarithmic graph shows the phylogenetic allometry, in the sense of average growth in later stages, on the basis of calculation by data of published measurements. Ontogenetic allometry, in the sense of average growth, is also indicated by data of published measurements. Thus, in this case, the line of phylogenetic allometry corresponds with the line of ontogenetic allometry of *Subprionocyclus neptuni*. o: *Subprionocyclus branneri* ($\alpha=1.0$), +: *Subprionocyclus neptuni* ($\alpha=1.2$), ●: *Subprionocyclus normalis* ($\alpha=0.9$), ○: *Reesidites minimus* ($\alpha=0.7$), ◯: mean dimension of each species, —: ontogenetic allometry in the sense of mean growth, —: phylogenetic allometry ($\alpha=1.2$).

many specimens that are probably adult are below 40 mm. in diameter (Figs. 24–25). The two species are nearly equal in size.

In comparing the shell form and ornament of *Reesidites minimus* with those of *Subprionocyclus normalis* at about the same size in the young stages below 13 mm. of diameter, the histograms of measurements are fairly similar to in the two species, and are variable by size in the proportion of breadth to height, width of umbilicus and number of tubercles and flexuous ribs (Fig. 25). Beyond this size *S. normalis* shows no significant change in these characters, while *R. minimus* shows a remarkable change. Namely the percentage of umbilicus and the proportion of breadth to height are decreased; the involution and the number of ribs and ventro-lateral tubercles are increased. This change in the ontogenetic development of *Reesidites minimus* as compared with that of *Subpriono-*

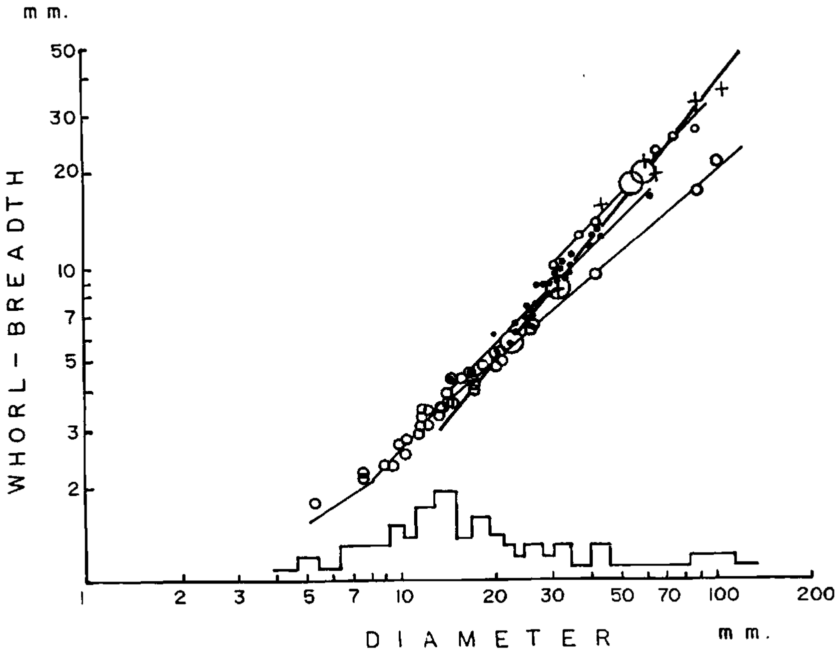


Text-fig. 23. Phylogenetic allometry of height to diameter: the double logarithmic graph shows the phylogenetic allometry, in the sense of average growth in later stages, on the basis of calculation by data of published measurements. Ontogenetic allometry, in the sense of average growth, is also indicated by data of published measurements. Thus, in this case, the line of phylogenetic allometry corresponds with the line of ontogenetic allometry of *Subprionocyclus neptuni*. o: *Subprionocyclus branneri* ($\alpha=1.1$), +: *Subprionocyclus neptuni* ($\alpha=0.9$), ●: *Subprionocyclus normalis* ($\alpha=1.0$), ○: *Reesidites minimus* ($\alpha=1.1$), ◯: mean dimension of each species, —: ontogenetic allometry in the sense of mean growth, —: phylogenetic allometry ($\alpha=0.9$).

cyclus normalis, a probable ancestor, can be regarded as a deviation.

Another significant difference between the two species is that the lower ventro-lateral tubercles are developed on the ribs for a limited period of the middle growth stage of *S. normalis* while they are free from the ribs at any growth stage of *R. minimus*, as has been described by MATSUMOTO (1959, p. 121). According to the same author in *Subprionocyclus neptuni* the lower ventro-lateral tubercles persist for a longer period than in *S. normalis*, almost as late as the adult body whorl, although they are weakened there. As far as the tuberculation is concerned this serial change is evidently a reduction.

On the other hand, it cannot be overlooked that the numerous, flexuous ribs, with branching from the umbilical bullae and also some intercalation, and ventro-lateral and ventral clavi on the ribs, without inner ventro-lateral tubercles, are seen on the inner young whorls of *S. neptuni* and *S. normalis*. These ornaments are fixed in *Reesidites minimus*, characterizing not the inner whorls (ex-



Text-fig. 24. Phylogenetic allometry of breadth to diameter: the double logarithmic graph shows the phylogenetic allometry, in the sense of average growth in later stages, on the basis of calculation by data of published measurements. Ontogenetic allometry, in the sense of average growth, is also indicated by data of published measurements. Thus, in this case, the line of phylogenetic allometry corresponds with the line of ontogenetic allometry of *Subprionocyclus neptuni*. The size histogram of *Reesidites minimus*, dealt with in this paper, is also shown. o : *Subprionocyclus branneri* ($\alpha=1.0$), + : *Subprionocyclus neptuni* ($\alpha=1.2$), ● : *Subprionocyclus normalis* ($\alpha=1.0$), ○ : *Reesidites minimus* ($\alpha=0.9$), ◯ : mean dimension of each species, — : ontogenetic allometry in the sense of mean growth, — : phylogenetic allometry ($\alpha=1.2$), ⎍ : size histogram of *Reesidites minimus*.

cept for the smoothish innermost part) but also the adult, outer whorl. Granted that *S. neptuni, S. normalis* and *R. minimus* evolved from one to another, as shown by their successively ascending stratigraphic occurrence, this *Reesidites* type ornaments can be said to have caenogenetically developed. This corresponds to proterogenesis of SCHINDEWOLF (1925, 1936).

Acknowledgements. I wish to record here my cordial thanks to Professor Tatsuro MATSUMOTO, who has suggested this study, generously offered all the specimens of his valuable collection at my disposal, freely given me a stratigraphic information, shared precious time with me in fruitful discussion, and critically read the first draft. Dr. Atsuo FUKADA and Dr. Nobukazu KANBE kindly sent me some specimens at my disposal. Also I desire to express my thanks to Dr. Hiroshi OZAKI, Dr. Kametoshi KANMERA, and Dr. Koji FUJII for their kind help in various ways. Miss Misako KIDO has assisted in the preparation of the manuscript. Mr. Koichi TOISHI photographed the specimens. I am indebted to the Ministry of Education for the Grant in Aid for Scientific Researches which made this study possible.

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Explanation of Plate 4

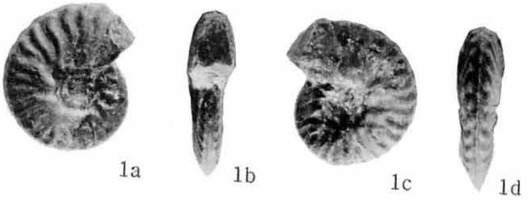
Reesidites minimus (HAYASAKA and FUKADA)

(All figures of natural size)

All the figured specimens were collected by T. MATSUMOTO and N. KANBE in 1951 from the prolific horizon just below the second green sandstone in the lower part of the Upper Yezo Group, Ikushumbets Valley, Sorachi-gun in Hokkaido. Two lateral (a, c), frontal (b) and ventral (d) views are shown on each specimen, except otherwise stated.

Fig. 1. GK. H4029 from loc. Ik946.
Fig. 2. GK. H4026 from loc. Ik946.
Fig. 3. GK. H4032 from loc. Ik946.
Fig. 4. GK. H4037 from loc. Ik946.
Fig. 5. GK. H4048 from loc. Ik938.
Fig. 6. GK. H4034 from loc. Ik946.
Fig. 7. GK. H4088 from loc. Ik946.
Fig. 8. GK. H4025 from loc. Ik946.
Two lateral (a, b) and ventral (d) views, and cross-section (b).
Fig. 9. GK. H4068 from loc. Ik946.
Two lateral (a, c) and ventral (d) views, and cross-section (b).
Fig. 10. GK. H4035 from loc. Ik946.
Fig. 11. GK. H4036 from loc. Ik946.
Two lateral (a, c) and ventral (d) views, and cross-section (b).
Fig. 12. GK. H4030 from loc. Ik946.
Fig. 13. GK. H4024 from loc. Ik946.

Photos by Koichi TOISHI, without whitening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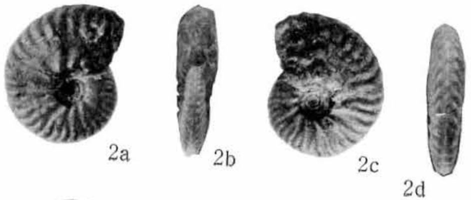
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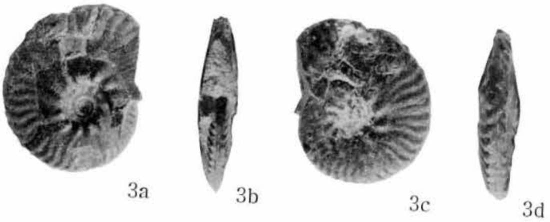
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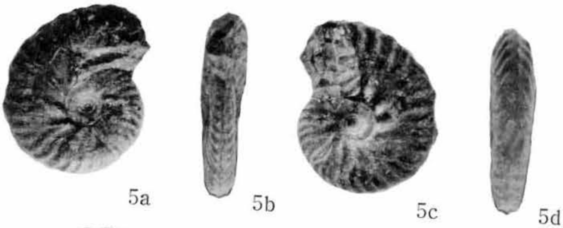
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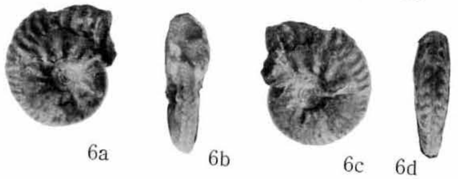
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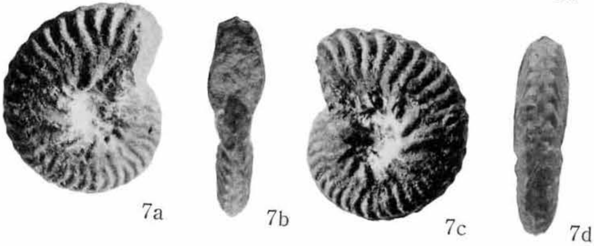
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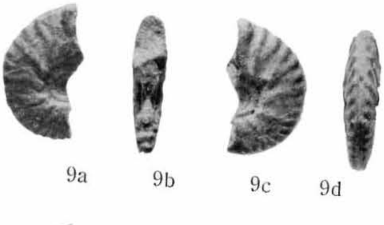
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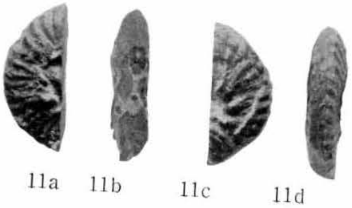
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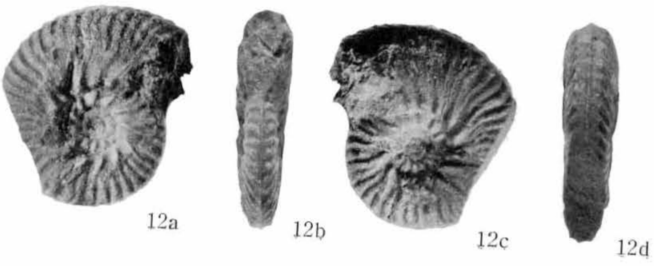
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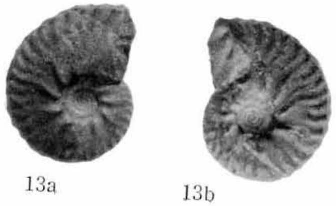
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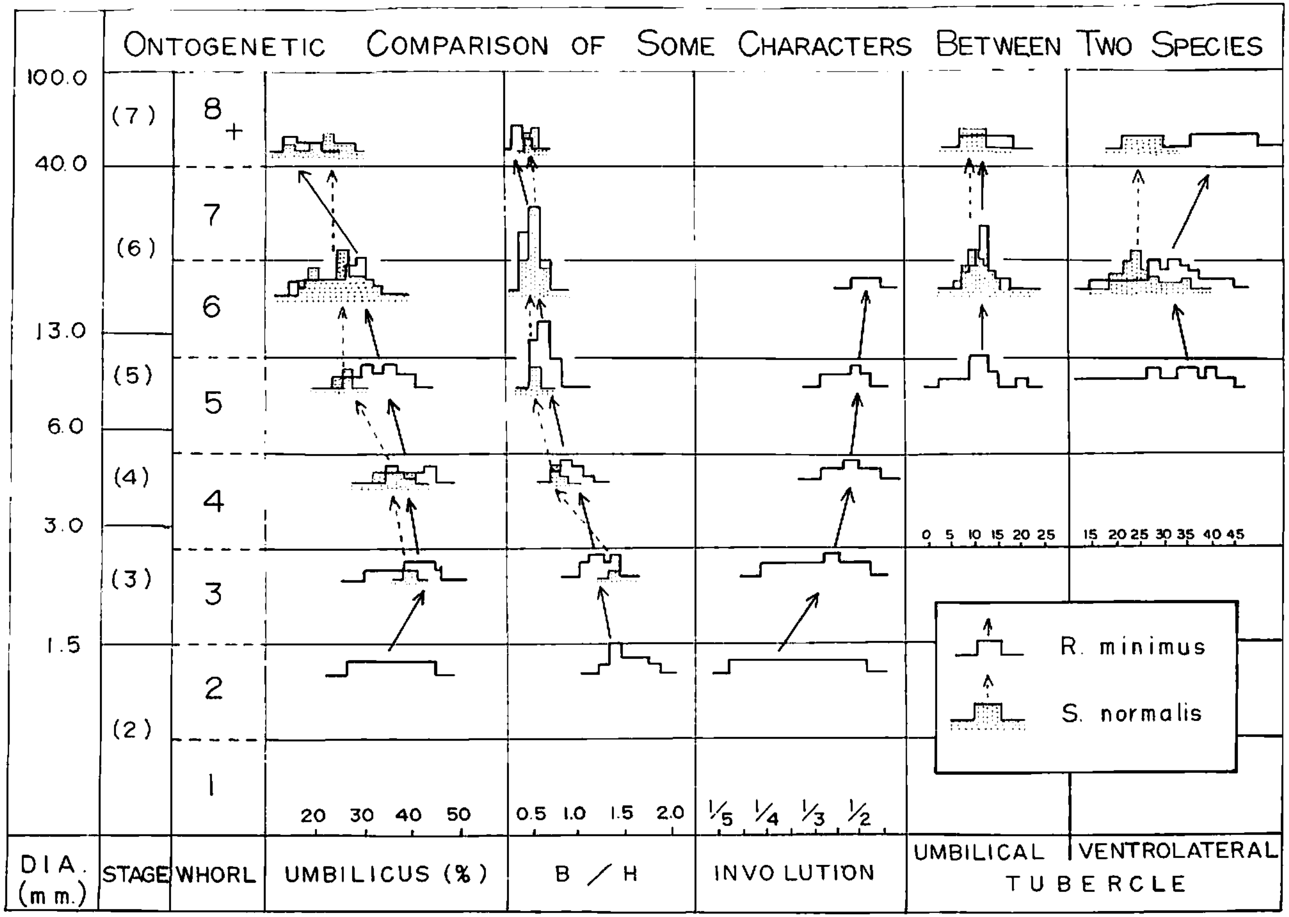

Text-fig. 25. Ontogenetic comparison of some characters between *Reesidites minimus* and *Subprionocyclus normalis* at about the same size in the middle and later stage. The histograms of measurements are shown in the width of umbilicus, proportion of breadth to height, and number of tubercles and flexuous ribs. Beyond 13 mm. in diameter *S. normalis* shows no significant change in these characters, while *R. minimus* shows a remarkable change.

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Explanation of Plate 5

Reesidites minimus (HAYASAKA and FUKADA)

(All figures of natural size)

The figured specimens, except for the holotype and GK. H4089, were collected by T. MATSUMOTO and N. KANBE in 1951 from the prolific horizon just below the second green sandstone in the lower part of the Upper Yezo Group, Ikushumbets Valley, Sorachi-gun in Hokkaido.

Fig. 1. GK. H4049 from loc. Ik938.
Two lateral (a, c) and ventral (d) views, and cross-section (b).

Fig. 2. GK. H4027 from loc. Ik946.
Two lateral (a, b), frontal (b) and ventral (d) views.

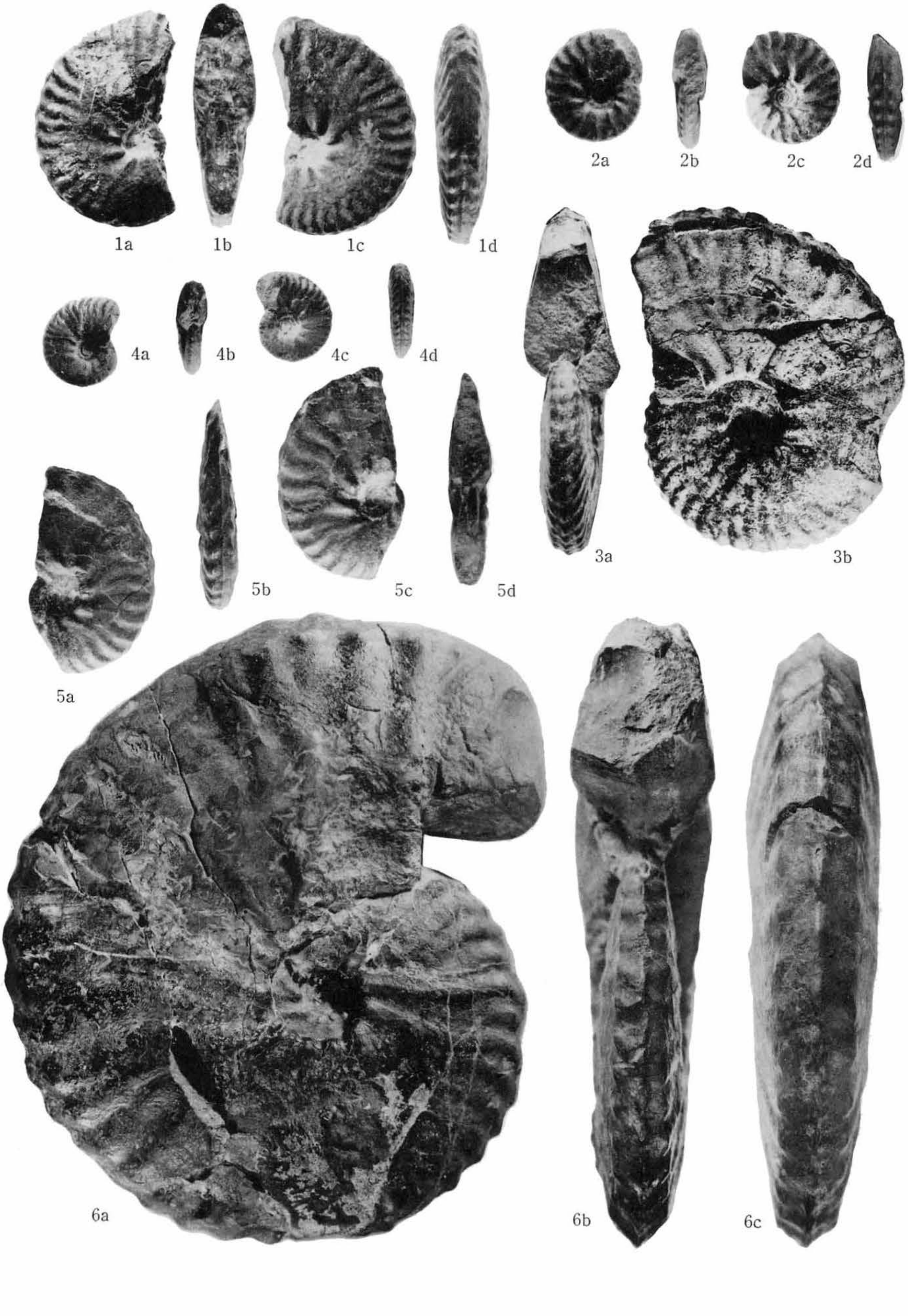
Fig. 3. GK. H4089 from loc. Ik2013b, the Ponbets Valley. Frontal (a) and lateral (b) views (Coll. T. MATSUMOTO) (reproduced from MATSUMOTO, 1965, pl. 15, fig. 2).

Fig. 4. GK. H4065 from loc. Ik946.
Two lateral (a, c), frontal (b) and ventral (d) views.

Fig. 5. GK. H4047 from loc. Ik938.
Two lateral (a, c) and ventral views and cross-section (d).

Fig. 6. Holotype from loc. Ik1103, Ikushumbets, Hokkaido University Collection. Lateral (a), frontal (b) and ventral (c) views (reproduced from MATSUMOTO, 1965, pl. 14, fig. 1).

Photos by Koichi TOISHI (except for fig. 6), without whitening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Abeshinai	安平志内	Ban-no-sawa	盤ノ沢
Ikushumbets	幾春別	Katsurazawa	桂沢
Ponbets	奔別	Saku	佐久
Sorachi-gun	空知郡		

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 58, pp. 64-66, June 30, 1965

487. NEW SPECIES OF *SALENIA* FROM THE MIOCENE OF JAPAN (ON SOME FOSSIL ECHINOIDS OF JAPAN, IV)

AKIRA MORISHITA

Institute of Earth Sciences, Faculty of Science, Nagoya University

日本中新世の *Salenia* 新種：岐阜県瑞浪層群から産出した海胆化石 *Salenia* の1新種を記載した。

森下 晶

Introduction and Acknowledgements

A new species of the genus *Salenia* from the Akiyo formation (Middle Miocene) exposed in the Toki City, Gifu Prefecture, Japan, is described. This is the second record of the genus *Salenia* as fossil in Japan, although it is known from the Cretaceous to the Recent in the various areas of the world.

Among the fossil echinoids, the Regularia are far less occurrences, compared with the Irregularia, as they are generally difficult to preserve, mainly for their fragile test. Some species of Irregularia in the Tertiary system of Mizunami had been described by the author several years ago. At the same time he had known the occurrences of some fragments of Regularia from the Mizunami group, and afterwards he could obtain several specimens of them, being comparatively well preserved. They belong to the genus *Salenia*, the family Saleniidae, the order Stirodonta.

According to Th. MORTENSEN, there are about 75 species of *Salenia*, mainly from the Cretaceous system in the world, but only 6 species of them left up to the Eocene epoch and only 1 species (*Salenia mooni* FOURTAU) up to the Miocene. The occurrence of *Salenia* from the Japanese Miocene, is therefore very precious.

All specimens in this paper had been collected by J. ITOIGAWA and I. KIMURA in their field surveys, respectively. The author wishes to acknowledge his indebtedness to Dr. Junji ITOIGAWA of the Institute of Earth Sciences, Faculty of Science, Nagoya University, and Mr. Ichirô KIMURA of the Institute of Geology, Aichi Gakugei University for their kind presentations of the valuable specimens to the author for study, and to Professor Heiichi TAKEHARA of the Institute of Earth Sciences, Faculty of Science, Nagoya University for his incessant encouragement.

Description of Species

Order Stirodonta JACKSON

Family Saleniidae L. AGASSIZ

Genus *Salenia* GRAY

Salenia nipponica MORISHITA sp. nov.

Figs. 1–4

Description:—The test is rather small in size and hemispherical in shape. The apical system is raised distinctly. The

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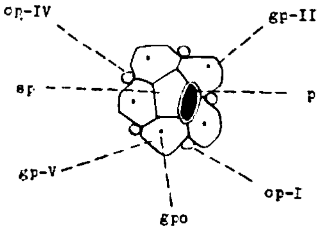
* Received Dec. 1, 1964; read Sept. 29, 1962 at Tokyo.



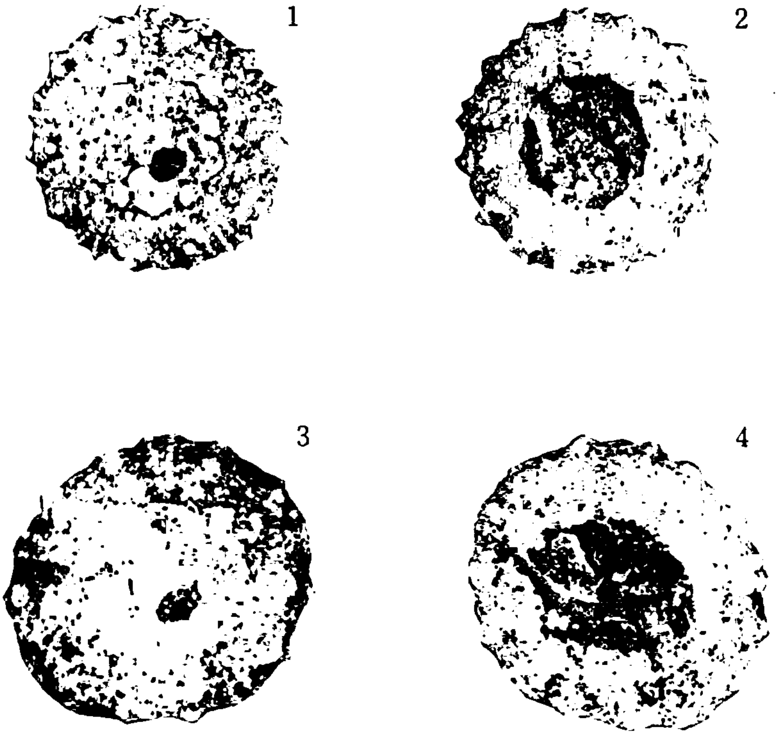
Text-fig. 1. Apical System of *Salenia*.
op : ocular plate, gp : genital plate,
gpo : genital pore, sp : suranal plate,
p : periproct.

five genital pores are situated at the centre of each genital plate, respectively. The ocular plates exsert and the madreporite is in the genital plate II that is more or less sunken.

The periproct on a small conical elevation, is eccentric, pushed out to the right, toward the ocular plate I, among the suranal plate, the genital plate I and V.

The ambulacra are narrow and straight, showing the largest width in the middle of the column. The primary tubercles of two rows are not crenulate and smaller than the interambulacral ones.

The interambulacra are wide. The primary tubercles are crenulate and larger than the ambulacral ones, but the secondary tubercles are small.



Figs. 1-4. *Salenia nipponica* MORISHITA sp. nov.
Fig. 1. Holotype. No. ESN30008. Aboral side. (×2.7)
Fig. 2. Holotype. No. ESN30008. Oral side. (×2.7)
Fig. 3. Paratype. No. ESN30009. Aboral side. (×2.7)
Fig. 4. Paratype. No. ESN30009. Oral side. (×2.7)

Measurements:—

	Test		Apical system
	Diameter	Height	Diameter
Holotype	13.0 mm	5.1 mm	6.2 mm
Paratype	13.5 mm	7.0 mm	8.0 mm

Remarks:—This species differs from *Salenia pacifica* DÖDERLEIN of Japanese Recent species in its smaller test, and from *Salenia hokkaidoensis* LORIOL of Japanese Pliocene species in its scanty ambulacral pores, and more spherical and smaller test.

Again, an American fossil species, *Salenia texana* CREDNER, differs from this species in larger test, larger and subcircular apical system, numbers of mammillated granules (24-26 in each row), and narrower, flexuous poriferous zone. Other American fossil species, *Salenia tumidula* CLARK, differs from this species in following points; namely test is subglobose, oral side is flat, periproct is oval, slightly pointed below, and numbers of mammillated granules are 15 or 16 in each row.

This species is rather allied to another American fossil species, *Salenia bellula* CLARK than the above two species, but *S. bellula* differs from this species in larger apical system, indistinct crenulated interambulacral tubercles and small test. And a new species must be proposed, judging from the rare Miocene species of *Salenia*.

Geological Horizon:—The lower part of Akiyo formation (Middle Miocene).

Locality:—Kujiri, Izumi-cho, Toki City, Gifu Prefecture.

Collectors:—J. ITOIGAWA and I. KIMURA.

Holotype: ESN30008.

Paratype: ESN30009.

Deposited in the Institute of Earth Sciences, Nagoya University.

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Izumi-cho 泉 町 Kujiri 久 尻

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 58, pp. 67-73, pl. 6, June 30, 1965

488. SOME MARINE MOLLUSCA FROM THE ALLUVIAL DEPOSITS OF YAMASHITA-CHO, WATARI-GUN, MIYAGI PREFECTURE

KOTARO HASE

宮城県亘理郡山下町沖積層産海棲化石：宮城県の南部太平洋岸に発達する，宮城県海岸平野の沖積層から，軟体動物を主とする合計 27 種の海棲化石を採集し，それらの産状と現生生態に関する調査に基いて，化石群集の性格と当時の堆積環境とを考察した。

長 谷 弘 太 郎

Introduction and Acknowledgements

The marine shell-bearing molluscs and other marine organisms listed in the present article were collected from the side wall of an irrigation canal at about three kilometers northeast of Yamashita-cho and nearly about one kilometer east of the highway north of the same town in Watari-gun, Miyagi Prefecture.

The ditch or irrigation wall measures about three meters in height or in depth from the land surface and consists largely of medium grained sand with a nearly 80 centimeters thick peat bed in the upper part, an alternation of clay and sand layers in the lower, and sand with sporadic distribution of granules in the main middle part, which yielded the marine shells and other organisms. The medium grained sands of the shell-beds and the exposed whole sequence totals about 20 meters in thickness and covers with unconformity the Sendai Group of Pliocene age (HANZAWA *et al.*, 1953).

The discovery of marine shells from the alluvial deposits was first made known by OKUTSU (1960), who recorded *Meretrix meretrix* (LINNÉ), *Paphia* (*Ruditapes*) *philippinarum* ADAMS et REEVE, *Ostrea* (*Crassostrea*) *gigas* THUNBERG, *Tellina* (*Merisca*) *diaphana* DESHAYES, *Navicula*, *Pinnularia* and *Linthia* from his Iwakiri Formation of the Nigatake Group. The formation is said to measure about 10-60 meters in thickness and to have wide distribution at the depth of about 10-20 meters below the ground surface. Since then there has been no record of the occurrence of marine shells from the alluvial deposits of the Miyagino coastal plain. The present report is the second record of marine shells from the allvuial deposits of the Miyagino plain.

The marine shells listed in the present article are thought to correspond in horizon to the Iwakiri Formation and to another facies of the marine fauna reported by OKUTSU (1960), differing therefrom only in ecological features, such as depth and local oceanographical conditions as mentioned later.

The present shells may be named the Yamashita molluscan fauna because it differs in composition from the one reported by OKUTSU (1960) in several important features such as in the great abundancy of *Spisula sachalinensis* (SCHRENCK) and *Saxidomus purpuratus* (SOW-

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* Received Dec. 3, 1964; read Nov. 24, 1964 at Sapporo.

ERBY), both of which are not found in the fauna reported by OKUTSU. Another important feature is that the species comprising the Yamashita fauna represent an ecological facies different from the one of the Iwakiri Formation of OKUTSU.

Here the writer expresses his hearty thanks to Professor Kotora HATAI of the Institute of Geology and Paleontology, Tohoku University, for his kind suggestions and to Dr. Shozo HAYASAKA of the same institute for his assistance with the marine fauna.

Remarks on the Yamashita Molluscan Fauna

The Yamashita molluscan fauna was collected from the alluvial deposits of the Miyagino coastal plain (NAKAGAWA, 1961), which represents the postglacial marine transgression and subrecent marine regression discussed in detail by NAKAGAWA (1961).

Comparing the Yamashita fauna with the one from the Iwakiri Formation already mentioned, it is noteworthy that only *Ostrea gigas* THUNBERG is mutual, all others being quite different. This shows that the conditions prevailing at the sites of their deposition must have been different. From the states of preservations of the molluscan shells from the two places (Iwakiri and Yamashita), it is evident that the ones from the Iwakiri Formation are rather well preserved and show little evidence of having been transported to their site of deposition or burial. However, the ones from Yamashita are mostly badly worn and comprise species which could not have lived in the environment indicated by the medium grained sands from where they were collected. In other words the majority were drifted to their place of burial. From this evidence it is suggested that the paleo-oceanographical conditions must have been considerably different. The locality of Yamashita was swept with longshore currents whereas the site of Iwakiri was probably in an embayment.

Taking the fauna of each locality into consideration it seems that the locality of Yamashita was originally deeper than that of Iwakiri, and swept by stronger currents. However, the climatological conditions are thought to have been similar, that is to say, both were under the influence of a temperature warmer than at the present at the same latitude.

List of the Marine Fauna

Anomia chinensis PHILIPPI (IGPS coll. cat. no. 86300)

A single very well preserved upper valve. It is of medium size for the species and measures about 31 mm in length. It retains the original coloration, but also shows some evidence of having been transported from some possibly nearby place.

Chlamys nipponensis KURODA (IGPS coll. cat. no. 86301. Pl. 6, figs. 3a, b)

A single left valve of this swimming form is in the collection. It measures 40 mm in width and about 48 mm in length from dorsal to ventral margins. It is worn, faded and partly broken at the ears. This specimen shows evidence of having been transported or at least eroded by subaqueous agencies.

Clinocardium californiense (DESHAYES) (IGPS coll. cat. no. 86302)

Two badly broken valves are in the collection. The smaller one measures 20 mm in length from anterior to posterior sides and the larger about 28 mm for the same length. The valves are faded, worn and fractured besides being broken.

Felaniella usta (GOULD) (IGPS coll. cat. no. 86303. Pl. 6, figs. 4a, b)

A single valve measuring about 23 mm in length from anterior to posterior sides. It is somewhat worn, faded yet rather well preserved.

Glycymeris vestita (DUNKER) (IGPS coll. cat. no. 86304. Pl. 6, figs. 2a, b)

Four well preserved valves of different sizes are in the collection. All are worn more or less, but one retains faint indications of the original color patterns. The smallest specimen measures 25 mm in length from anterior to posterior margins and the largest about 60 mm in length. It is interesting that this warm water species is found far north of its present area of distribution, showing that the conditions at the time of its flourishing may have been different from that of the present.

Glycymeris yessoensis (SOWERBY) (IGPS coll. cat. no. 86305)

Sixty-three isolated valves are in the collection; they comprise very small to full adult specimens. The size ranges from 15 to 50 mm in length from anterior to posterior margins. All are more or less worn, the valves faded, some are broken, a few bored by carnivorous gastropods, and many are penetrated variously by boring organisms (some probably due to marine annelids).

Gomphina melanaegis (RÖMER) (IGPS coll. cat. no. 86306)

Only two valves of this species are in the collection, of which the smaller measures 16 mm in length from anterior to posterior margin and the larger about 47 mm for the same. These valves are worn, faded and the larger one is partly broken.

Heteromacoma irus (HANLEY) (IGPS coll. cat. no. 86307. Pl. 6, figs. 5a, b)

Two valves are in the collection. The smaller measures 20 mm in length from anterior to posterior margin and the larger about 28 mm for the same. The valves are worn, faded and the smaller somewhat fractured.

Mercenaria stimpsoni (GOULD) (IGPS coll. cat. no. 86307)

A single badly broken specimen of this well known species is in the collection. The right valve is worn, faded and only the dorsal half of the specimen is preserved. This is a species typical of northern Japan.

Macoma tokyoensis MAKIYAMA (IGPS coll. cat. no. 86309)

A single right valve measuring 40 mm in length is in the collection. The specimen is partly broken, faded and worn.

Ostrea denselamellosa LISCHKE (IGPS coll. cat. no. 86310)

One upper valve measuring 50 mm in length from anterior to posterior margin and about 74 mm from dorsal to ventral borders. It is partly broken, worn, yet retains the original coloration.

Ostrea gigas THUNBERG (IGPS coll. cat. no. 86311)

Four broken upper valves, particularly of the umbonal area are in the collection. They are badly broken, much worn and faded. One specimen has the shell with many small holes made by some boring organism.

Petricola divergens (GMELIN) (IGPS coll. cat. no. 86312. Pl. 6, figs. 1a, b)

A single more or less well preserved specimen of this species is in the collection. It is more or less faded and somewhat worn, however the concentric growth lines are rather well preserved in part.

Phlyctiderma japonica (PILSBRY) (IGPS coll. cat. no. 86313. Pl. 6, figs. 6a, b)

A single valve measuring 14 mm in length from anterior to posterior margins is in the collection. It is rather well presereved but shows faint indications of wear and the shell is faded.

Protothaca euglypta (SOWERBY) (IGPS coll. cat. no. 86314)

Two broken specimens, one of the posterior half of the shell and the other of the upper (dorsal) half, are in the collection. They belong to different individuals. They are worn and faded.

Saxidomus purpuratus (SOWERBY) (IGPS coll. cat. no. 86315)

Thirty-nine isolated valves measuring up to 84 mm in length from anterior to posterior margins are in the collection. Mostly are badly worn, many broken, all faded but still retain the purple coloration of the inner side of the valve. Many of the broken valves are penetrated with holes of boring organisms. Some are more or less longer than others. This species is sometimes found as a boring shell in siltstone, in which case the shell appears more stunted than in those burrowing into the unconsolidated sediments of the sea bottom.

Spisula sachalinensis (SCHRENCK) (IGPS coll. cat. no. 86316. Pl. 6, fig. 9)

Sixteen valves including the broken ones are on the collection; they measure up to 113 mm in length from anterior to posterior margins. The majority of the specimens are faded, worn and broken in part. None retain the original coloration. Forms similar to what YOKOYAMA (1922) recorded as var. *imperialis* are rather common in the collection. This species is a characteristic one in northern Japan.

Spondylus cruentus LISCHKE (IGPS coll. cat. no. 86317. Pl. 6, figs. 7a, b)

A single upper valve measuring 37 mm from dorsal to ventral margins and 46 mm in length from anterior to posterior borders is in the collection. It is worn and somewhat faded.

Acmaea pallida (GOULD) (IGPS call. cat. no. 86318. Pl. 6, figs. 8a, b)

A single specimen, broken at apex and slightly worn as well as faded is in the collection.

Neptunea arthritica (BERNARDI) (IGPS coll. cat. no. 86319)

One broken, badly worn and faded lower part of the body whorl is in the collection. The canal, although much worn, still shows the characteristic features of the species.

Nererita didyma (RÖDING) (IGPS coll. cat. no. 86320. Pl. 6, fig. 10)

Two specimens; both are adults and well developed. They are both faded, worn and the outer lip is more or less broken. This species commonly lives on sandy bottoms at shallow depths.

Polytropa heyseana (DUNKER) (IGPS coll. cat. no. 86321. Pl. 6, figs. 12a, b)

Two specimens, both broken, faded and worn are in the collection. This species is commonly found living on rocky areas.

Purpura bronni (DUNKER) (IGPS coll. cat. no. 86322)

One badly broken specimen is in the collection. It is represented only by a part of the outer whorl which is completely faded. This is also a species found commonly in rocky areas.

Terebra bifrons HINDS (IGPS coll. cat.

no. 86323. Pl. 6, fig. 11)

A single rather well preserved specimen is in the collection. It is faded, slightly worn and the outer lip as well as apical regions are broken.

Strongylocentrotus (?) sp. indet.

A fragment of the test of an echinoid probably of *Strongylocentrotus* is in the collection. The test is badly faded and worn.

Lithothamnium (?) sp. indet.

A single specimen, worn, small and probably only a part of a much larger individual is in the collection.

Annelida gen. sp. indet.

A single calcareous worm tube is in the collection. It is broken at ends but not faded nor worn. This tube may belong to *Serpula vermicularis* LINNAEUS, which is said to be distributed all around the Japanese Islands.

The molluscan fauna and other marine invertebrates in the collection can be rearranged into the undermentioned five groups.

Rock dweller (attached forms)
Anomia chinensis PHILIPPI
Ostrea denselamellosa LISCHKE
Ostrea gigas THUNBERG
Spondylus cruentus LISCHKE
Lithothamnium (?) sp. indet.

Rock dwellers (living on surface)
Acmaea pallida (GOULD)
Neptunea arthritica (BERNARDI)
Polytropa heyseana (DUNKER)
Purpura bronni (DUNKER)

Sand or silt dweller (burrowing forms)
Clinocardium californiense (DESHAYES)
Felaniella usta (GOULD)
Glycymeris vestita (DUNKER)
Glycymeris yessoensis (SOWERBY)
Gomphina melanaegis RÖMER
Heteromacoma irus (HANLEY)
Macoma tokyoensis MAKIYAMA
Mercenaria stimpsoni (GOULD)
Petricola divergens (GMELIN)
Phlyctiderma japonica (PILSBRY)
Protothaca euglypta (SOWERBY)
Saxidomus purpuratus (SOWERBY)
Spisula sachalinensis (SCHRENCK)

Sand or silt bottom dwellers (on surface)
Neverita didyma (RÖDING)
Terebra bifrons HINDS

Swimming form (attached only in immature stage)
Chlamys nipponensis KURODA

Among the forms listed above according to environment, the species which probably lived at the site of burial are, *Glycymeris yessoensis*, *Spisula sachalinensis* and *Saxidomus purpuratus*. These three species are characterized by their thick and large shells, abundancy, and in that they live buried shallowly in sand or silty bottoms. The other mentioned species which burrow shallowly into sandy or silty bottoms are represented in the fauna by only one to a few specimens, all of which are badly broken, much worn or nearly completely faded. This suggests that they must have been subjected to transportation because if they lived in the area of their site of burial, they should be more abundant individually, show less amount of wear and probably not occur with random orientation.

The species which are thought to have lived at or near the site of burial are such as *Neverita didyma* and *Terebra bifrons*. These species live generally in sandy areas where they sometimes half burry their shells, move slowly on the surface, and usually in environments where the wave or water action is not strong. Although their shells are more or less worn and faded, their grade of wear seems to be less than those listed under the other categories.

The species listed under the first two categories are all thought to be foreign to the site of burial and were most probably drifted by currents from rocky beaches or areas of exposed rocky bottoms to be buried in a place where they never could have lived.

The majority of the species listed under the third category are thought to have lived more closer to the strand than *Spisula sachalinensis*, *Saxidomus purpuratus* and *Glycymeris yessoensis*, three species which frequently and the first of which always flourish in depths or areas off the shore zone and at places where bottom current is not strong. It may be mentioned that *Phlyctiderma japonica*, *Heteromacoma iris*, *Petricola divergens*, *Saxidomus purpuratus*, and *Protothaca euglypta* sometimes bore into soft rocks as siltstone (sandy or tuffaceous).

From the foregoing remarks it may be suggested that the fauna represents a thanatocoenosis and not a biocoenosis.

Particularly interesting is the occurrence of *Glycymeris vestita*, and *Terebra bifrons* in the fauna. The former is represented by four isolated valves and the latter by a single one. These are interesting in that as Recent they are known to be distributed in areas south of their site of occurrence as fossil. This points to that the temperature of the sea water at the time of their living in the area of Yamashita was higher than at present, or that the northward flowing warm water currents may have been stronger than at present. At any rate those two species

Explanation of Plate 6

(All figures in natural size unless stated otherwise)

Figs. 1a, b. *Petricola divergens* (GMELIN), IGPS coll. cat. no. 86312. Left valve, a. outer side, b. inner side. ×1.5

Figs. 2a, b. *Glycymeris vestita* (DUNKER), IGPS coll. cat. no. 86304. Right valve, a. outer side, b. inner side.

Figs. 3a, b. *Chlamys nipponensis* KURODA, IGPS coll. cat. no. 86301. Left valve, a. outer side, b. inner side.

Figs. 4a, b. *Felaniella usta* (GOULD), IGPS coll. cat. no. 86303. Right valve, a. outer side, b. inner side.

Figs. 5a, b. *Hetromacoma irus* (HANLEY), IGPS coll. cat. no. 86307. Right valve, a. outer side, b. inner side.

Figs. 6a, b. *Phlyctiderma japonica* (PILSBRY), IGPS coll. cat. no. 86313. Left valve, a. outer side, b. inner side. ×1.5

Figs. 7a, b. *Spondylus cruentus* LISCHKE, IGPS coll. cat. no. 86317. Left valve, a. outer side, b. inner side.

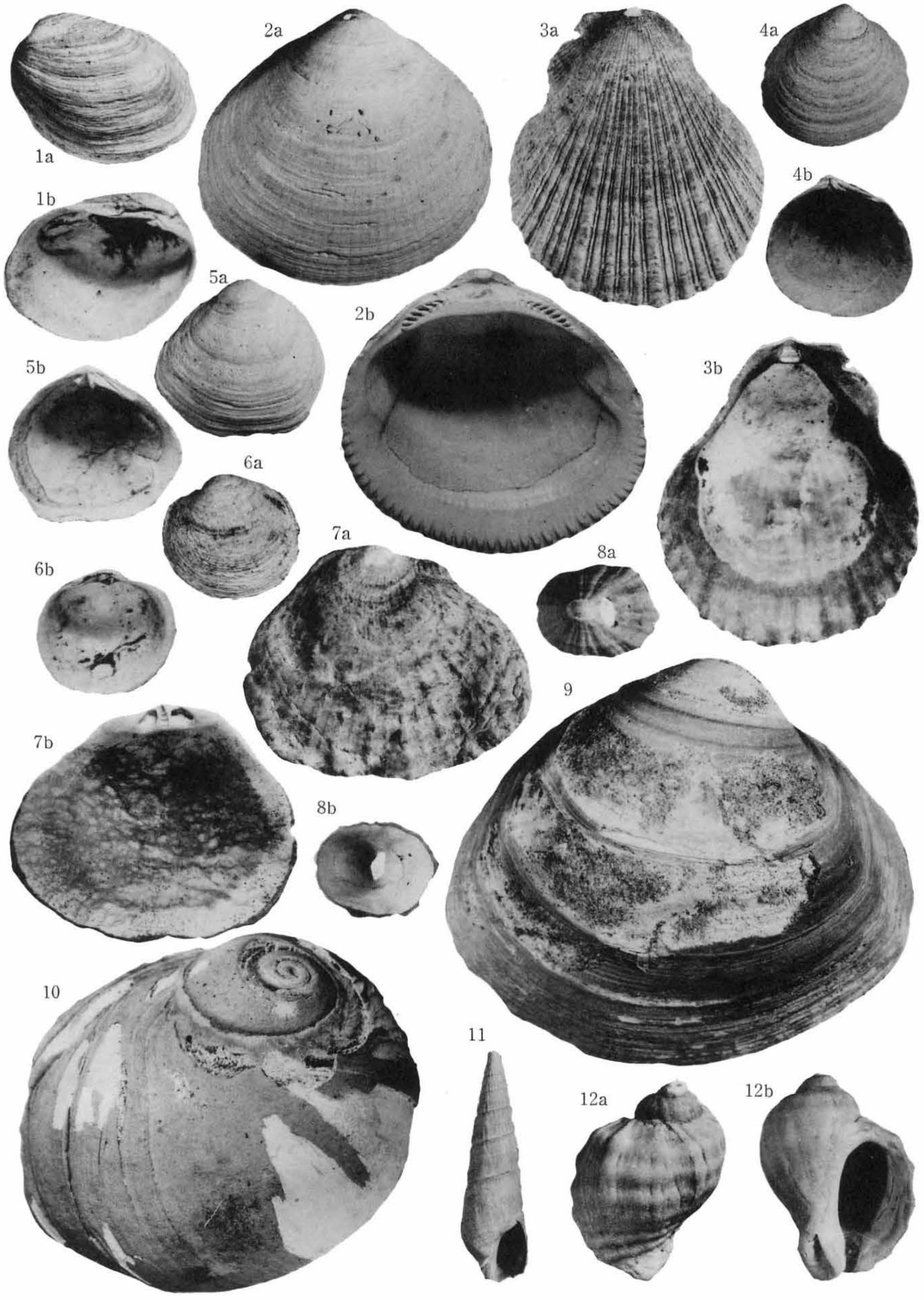
Figs. 8a, b. *Acmaea pallida* (GOULD), IGPS coll. cat. no. 86318. a. apical view, b. apertural view.

Fig. 9. *Spisula sachalinensis* (SCHRENCK), IGPS coll. cat. no. 86316. ×2/3

Fig. 10. *Neverita didyma* (RÖDING), IGPS coll. cat. no. 86320.

Fig. 11. *Terebra bifrons* HINDS. IGPS coll. cat. no. 86323.

Figs. 12a, b. *Polytropa heyseana* (DUNKER), IGPS coll. cat. no. 86321. a. lateral view, b. apertural view.


1a
1b
2a
2b
3a
3b
4a
4b
5a
5b
6a
6b
7a
7b
8a
8b
9
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11
12a
12b

point to a warm stage during the deposition of the alluvial sediments in the area studied.

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489. AN OCCURRENCE OF A NEW *SCUTELLUM* IN THE SILURIAN OF SHIKOKU ISLAND*

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四国シルリア系産の *Scutellum* 新種： 横倉山のシルリア系石灰岩から採集された，特殊な *Scutellum* 属の頭部について記載した。 また，Thysanopeltidae の有刺尾部をもつグループの分類学的位置についても論及し，あわせて，飛驒山地デヴォン系産 *Scutellum* ? の尾部，九州シルリア系産 *Octobronteus* ? の尾部も簡単に記載した。 上記3種は，北上山地デヴォン系産 *Thysanopeltella paucispinosa* に次ぎ，東亜におけるこの科の 2 番目の記載である。

小 林 貞 一・浜 田 隆 士

I. Introduction

The Thysanopeltidae are well represented in Europe, Northern and Central Asia, Australia and North America, but exceedingly rare in Eastern and Southern Asia. According to REED (1912), *Bronteus* aff. *lunatus* BILLINGS is contained in the Ordovician fauna of the Himalayas, but it is so far a solitary representation in Southern Asia and a pygidium and two cranidia which he examined are too fragmentary to confirm their affinity to *B. lunatus*, *B. andersoni* NICHOLSON and ETHERIDGE or any other species.

As noted by the senior author (1951), *Bronteus richteri* SUN, 1931, from the Middle Ordovician of Shihtzupu, Kweichou is founded on a pygidum which apparently agrees better with the Lichidae than the Thysanopeltidae. It is probable to belong to *Amphilichas browni* (SUN) which was described from the same locality. A cranidium from the Middle Ordovician of Taihungshan, Hupeh which was called *Bronteus* sp. by SUN (1931) is on the other hand possibly combined with the pygidium of *Taihungshania shui* SUN from the same place. The authors know no other trilobite of the Thysanopeltidae from China except for *Bronteus planus* which is listed together with *Coronocephalus rex* as a member of the Silurian Hanchiatien fauna in the borderland between Szechuan and Kweichou (Comm. on Compl. Geol. China etc., 1956).

There is, however, *Thysanopeltella paucispinosa* (OKUBO), 1951, which was found in the Middle Devonian of the Kitakami Mountains, North Japan (Fig. 1, Loc. 1). *Octobronteus* sp. was reported by the junior author (HAMADA, 1961) from the Wenlockian G_2 stage in Central Kyushu of West Japan (Fig. 1, Loc. 4). *Scutellum japonicum*, sp. nov. here described is, therefore, the third species in Eastern Asia which was recently discovered by Mr. J. HAMADA in the Silurian limestone of Mt. Yokokura in the Island of Shikoku, West Japan (Fig. 1, Loc. 3).

In addition, *Scutellum* (?) sp. was recently found by Mr. Y. YASUÉ in the Devonian formation in the Hida plateau, Central Japan (Fig. 1, Loc. 2) (NOMURA,

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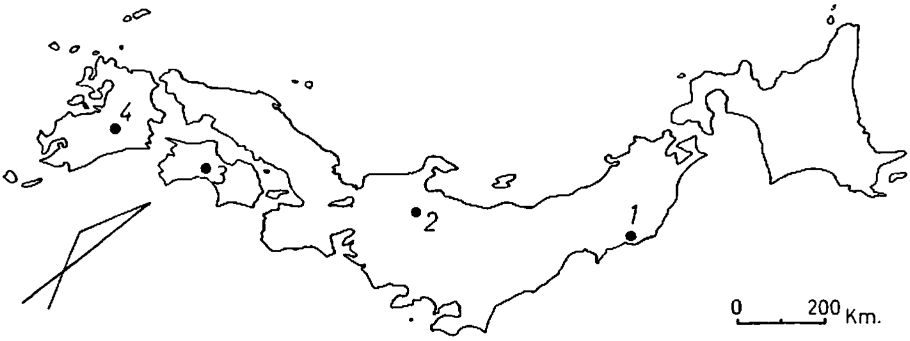
* Received Dec. 7, 1964; read Jan. 24, 1965 at Tokyo.



Text-fig. 1. Localities of the Thysanopeltidae in Japan.

1: *Thysanopeltella paucispinosa* (OKUBO)
Coblenzian-Givetian; Nakazato Series, Ofunato, Iwaté Prefecture, Kitakami mountains, N.E. Honshu.
2: *Scutellum* (?) sp.
Coblenzian-Eifelian; Takaharagawa Series, Fukuji, Gifu Prefecture, Central Honshu.
3: *Scutellum* (Subgen. nov.) *japonicum* KOBAYASHI & HAMADA
Upper Wenlockian?; G_2 Stage? (Yokokura limestone), Yokokura-yama, Kôchi Prefecture, Shikoku, S.W. Japan.
4: *Octobronteus* sp.
Upper Wenlockian: G_2 Stage (calcareous ss. & sh.), Gion-yama, Miyazaki Prefecture, Kyushu, S.W. Japan.

1964). *Octobronteus* (?) sp. and *Scutellum* (?) sp. are also briefly described on this occasion.

Because the family is known to have flourished in Kazakhstan on one side and in Australia on the other, it is probable that many other species will be discovered in future in the areas between the two sides.

Before going further, the authors record here their sincere thanks to Mr. Jun'ichi HAMADA of Kagawa Prefecture, Shikoku, and Mr. Yoshihiro YASUÉ, B. Sc. of Yokohama National University, the collectors of the specimens for their kind offer of the materials and informations on the occurrences. Our deep thanks are due to Dr. Tokio SHIKAMA, Prof. of Yokohama National University for his kind permission of the study on the fossil in his institute collection.

II. Notes on the Thysanopeltidae

Family Thysanopeltidae HAWLE and CORDA, 1847

[i.e. Bronteidae ANGELIN, 1854; Goldiidae RAYMOND, 1913; Eobronteidae SINCLAIR, 1949; Scutelluidae R. and E. RICHTER, 1955]

This family was repeatedly discussed by many palaeontologists. (See REED, 1928; RICHTERS, 1956, etc.). In Treatise on Invertebrate Paleontology RICHTERS (1959) classified the family into 4 genera and 6 subgenera as follows:

Scutellum PUSCH, 1833
- (*Scutellum*) s. str.
- (*Kolihapeltis*) PRANTL and PŘIBYL, 1947
- (*Paralejurus*) HAWLE and CORDA, 1847
- (*Planiscutellum*) R. and E. RICHTER, 1956

(*Scabriscutellum*) R. and E. RICHTER, 1956
(*Thysanopeltis*) HAWLE and CORDA, 1847
Eobronteus REED, 1928
Weberopeltis MAKSIMOVA, 1957
Octobronteus WEBER, 1945

MAKSIMOVA's classification (1960) differs from the preceding in (1) that these subgenera are all promoted to the generic rank, and (2) that the following two genera are referred to this family.

Bronteopsis NICHOLSON and ETHERIDGE, 1879
Dulanaspis TCHUGAEVA, 1956

Because *Bronteopsis* looks intermediate in character between the Styginidae and Thysanopeltidae, its taxonomic position has been a moot question (WHITTINGTON, 1950). SKJESETH (1955) states, however, that "the unity among the styginids is too clear to include the genus *Bronteopsis* in the family Scutellidae". Treatise on Invertebrate Paleontology regards it as a distinct genus of the Styginidae. *Dulanaspis* is an aberrant genus not only for the Thysanopeltidae but also for the superfamily Illaenacea. Another aberrant genus is *Craigheadia* which was proposed by HUPÉ for *Bronteus craigensis* REED, 1904, having an extraordinarily large axial lobe for either *Bronteus* or *Eobronteus*.

In 1960 SNADJR proposed a new classification of the Scutellidae in which 7 new genera were erected with the type-species as follows:

Brevíscutellum	(*Bronteus transversum* HAWLE and CORDA)
Cornuscutellum	(*Bronteus rhinoceros* BARRANDE)
Metascutellum	(*Bronteus pustulatus* BARRANDE)
Microscutellum	(*Bronteus hawlei* BARRANDE)
Protobronteus	(*Eobronteus reedi* SINCLAIR)
Protoscutellum	(*Bronteus simulans* BARRANDE)
Spiniscutellum	(*Bronteus umbelliferus* BARRANDE)

As can be recognized from the type-species, all of them bear pygidia with entire margins. A brief note is given here on the classification of the Thysanopeltidae having spiniferous pygidia.

In 1957 the senior author has proposed *Thysanopeltella* for the *acanthopeltis* group by PRANTL and PŘIBYL. Subsequent to MAKSIMOVA (1960, RICHTERS, 1959) erected *Weberopeltis* on the basis of *Bronteus aculeatus* WEBER, 1945, from the Lower Devonian of the North Urals. Now the Thysanopeltidae having spiniferous pygidia can be classified in the following manner:

1. *Thysanopeltis* or the so-called *speciosus* group s. str. in which the marginal border is indented; denticles are all small, numerous, somewhat irregularly aligned and regardless of the segmentation of the pygidium.
2. *Thysanopeltella* or the *acanthopeltis-clementinum* group in which the spines of the pygidium are regular pleural or/and interpleural projections inseparable from the segmentation.
   - 2a. *Thysanopeltella* s. str. with the bifurcated median rib on the pygidium.
   - 2b. *Weberopeltis* with a simple median rib on the pygidium.

The spines are pleural projections in *Bronteus clementinus* BARRANDE and interpleural ones in *Bronteus acanthopeltis* BARRANDE. The pleural spines are long and interpleural ones short in *Bronteus trutati* BARROIS. The pygidium is semi-circular to semi-parabolic in them, while it is subpentagonal in *Bronteus (Thysanopeltis) paucispinus* OKUBO. This species has, however, eight pairs of pleural spines as usual. Therefore it may be said that this is *Bronteus furciferus* BARRANDE having pleural spines.

It may be a matter of opinion to accept *Thysanopeltis* as an independent genus or as a subgenus of either *Scutellum* or *Scabriscutellum*. The spiny segments of the pygidium evidently bear a greater taxonomic value in the classification of the Thysanopeltidae. Therefore *Thysanopeltella* must be an independent genus and *Weberopeltis* is here considered a subgenus of *Thysanopeltella*. With regard to the fusion of the median rib, the latter is a step more advanced than the former.

The cephalon of *T.* (*W.*) *aculeatus* is quite distinctive among various forms of the Thysanopeltidae. It is noteworthy that this cephalon resembles those of *Scutellum furciferum* and also *Cornuscutellum rhinoceros* (BARRANDE) in the possession of prominent protective spines on the glabella and fixed cheeks.

Bronteus tarak WEBER from the Middle Devonian limestone of the Turkhestan range, *B. yakoviei* WEBER from the Middle Devonian of Lunievsk coal-district of the Ural mountains and *B. radiatus* in BERLING's collection from the outcrop No. 13 in Turkhestan which the senior author has previously referred to *Thysanopeltella*, all belong to its subgenus *Weberopeltis*. The last species for which he has proposed *Scutellum* (*Thysanopeltella*) *weberi* on account of the synonimy with *Bronteus radiatus* MÜNSTER, 1840 is represented by the pygidium most intimate to that of *Weberopeltis aculeatus* in the great development of the pleural spines.

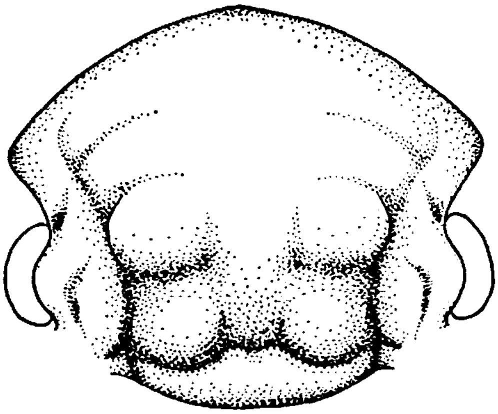
III. Description of Species

Genus *Scutellum* PUSCH, 1833

Scutellum (Subgenus nov.) *japonicum* KOBAYASHI and HAMADA, sp. nov.

Plate 7, Figures 1-3, text-fig. 2.

Description: — Cranidium moderately convex; glabella almost as long as broad, widest at about one-fourth the length from the anterior and the breadth is almost half reduced in posterior; glabellar outline somewhat constricted at posterior lateral furrows and therefrom strongly expanded forward and slightly broadened backward; glabellar convexity moderate except near the anterior margin where the frontal lobe is slant forward; glabella trilobated by a pair of longitudinal furrows; anterior furrow shallow, extending a little forward and as far as one-third the breadth of the glabella; middle furrow shorter and somewhat shallower than the preceding; posterior furrow strong and expanding inward in form of a



Text-fig. 2. Cranidium of *Scutellum* (Subgen. nov.) *japonicum* KOBAYASHI and HAMADA, sp. nov. (×2.7) triangle and interrupted by a median lobe; posterior lateral lobe oval, convex and protruded back into neck ring; occipital furrow profound and transverse in the median part but carved on the lateral sides; occipital ring engraved at the protrusions, but its breadth is greater than the posterior lobe of the glabella. Whole surface of the glabella striated by lines subparallel to the anterior margin of the glabella. Dorsal furrows deep in posterior but shallow in anterior. Fixed cheek narrow; eyes relatively large and opposed at the posterior glabellar furrows. Eye-ridge and palpebral lobe form a weak elevation as seen by cross light; semi-circular lobe present on the antero-lateral side of the glabellar base.

Measurements:—No preglabellar area is seen on the holotype cranidium. The glabella inclusive of the occipital ring is 19.5 mm. long and 23.9 mm. wide at the anterior expansion and 13.2 mm. wide at the occipital ring. This ring is 3.8 mm. long in the median part. The cranidium is about 21.5 mm. through the eyes. The convexity of the cranidium attains the maximum in the frontal part of the glabella where it is 3.2 mm. high.

Comparison:—In the outlines of the cranidium and the glabella this species is very similar to *Scutellum*, especially to the group of *S. paliferum*. In its convexity and the sagittal section of the glabella it resembles *Paralejurus*, although the convexity is not so strong in this species as in *Paralejurus*. Three glabellar furrows are present, but anterior and middle ones weak, while posterior ones are well developed. Like *Thysanopeltis* and *Scabriscutellum* the glabella is trilobated and the eyes are relatively large, but the glabella does not rapidly tapering back in this species.

The most distinctive features of this species are the backward projection of the posterior glabellar lobe by which the occipital ring is strongly engraved on the lateral sides and the inward expansion of the posterior lateral furrow in form of a triangular depression. Through the combination of these characteristics this species cannot be placed in any existing subgenus of *Scutellum*. It represents most probably an unnamed subgenus or genus by itself.

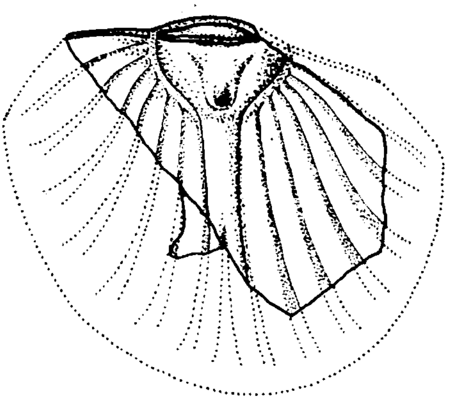
Occurrence:—From the Silurian pinkish brown limestone slab on the northeastern slope of Yokokura-yama, Kôchi Prefecture in Shikoku, Southwest Japan where the junior author made a detailed field survey (HAMADA, 1961). Though the slab does not contain other fossils than this trilobite, there are various kinds of the Tabulata such as *Falsicatenipora*, *Favosites*, *Heliolites* and *Dania* (?), among which the Halysitidae were also studied by him (HAMADA, 1958), in the limestone around the locality. Geological age of the limestone is presumed upper Wenlockian.

Repository:—Geological Institute, Faculty of Science, University of Tokyo. Collected by Mr. Jun'ichi HAMADA.

Scutellum (?) sp.

Plate 7, Figures 4a, b; text-fig. 3.

An imperfect and slightly twisted pygidium whose outline is unknown except the straight anterior pleural margin. The axial lobe is short, convex, subtriangular and longitudinally trilobated. A median tubercle may be present in the rear part of the axial lobe. The median rib issuing therefrom is stout, prominent and somewhat broadened distally, but the bifurcated part cannot be seen clearly. The pleural ribs are flat. On each side of the median rib seven pleural ribs are separated from one an-



Text-fig. 3. Restoration of a pygidium of *Scutellum* (?) sp. (slightly distorted, ×2.2)

other by pleural furrows of moderate strength, but these furrows have no flat bottom. The doublure exposed on the right side of the median rib is very wide. Test is smooth.

It is indeterminable that the margin of the pygidium is entire, indented or spiniferous, but it is certain that this form belongs to the Thysanopeltidae. If the margin is entire, it is probably a member of *Scutellum* (*Scutellum*), if not *Scabriscutellum*.

Measurements:—Axial lobe 7.4 mm. in width and 4.8 mm. in length where the articulating ring occupies 0.9 mm. long; median lobe of axial lobe 2.5 mm. wide; axial rib 2.0 mm. at the narrowest part in the middle portion; axial rib is probably bifurcated at a place 7.5 mm. distant from the rear end of median tubercle.

Occurrence:—The specimens was collected on a spur northeast of Hitoégané, Kamitakara-mura, Yoshiki-gun, Province of Hida, Gifu Prefecture in schalstein of the Devonian Fukuji Series. *Favosites hidensis* KAMEI contained in gray limestone (HAMADA, 1959) intercalated in the schalstein suggests Middle Devonian for the age of this form.

Repository:—Institute of Earth Science, Faculty of Liberal Arts, Yokohama National University, Yokohama. Collected by Mr. Yoshihiro YASUÉ, B. Sc.

Genus *Octobronteus* WEBER, 1954

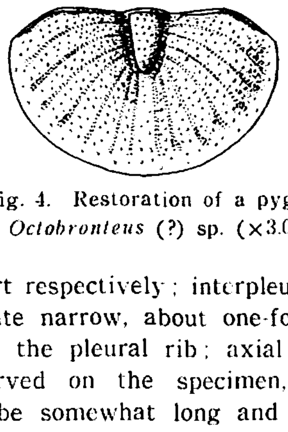
[=*Stromeraspis* PRANTL & PŘIBYL, 1947]

Octobronteus (?) sp.

Plate 7, Figures 5a, b, 6; text-fig. 4.

1961. *Octobronteus* sp. HAMADA, *Jour. Fac. Sci., Univ. Tokyo, Sect. 2, Vol. 13, Pt. 1*, p. 29 (listed).

Description:—Represented only by a fragmentary specimen. Insofar as the pygidium can be restored, it is found that the pygidium has a broad subelliptical outline; seven or eight pleural ribs are counted on each side; pleural ribs are flat-topped and convex forward in front part and almost straight in rear part respectively; interpleural furrow quite narrow, about one-fourth as wide as the pleural rib; axial lobe is unpreserved on the specimen, but it should be somewhat long and narrow, judging from the long and straight axial furrow that interrupts the pleural ribs; marginal border somewhat narrow; surface is coarsely granulate.



Text-fig. 4. Restoration of a pygidium of *Octobronteus* (?) sp. (×3.0)

Measurements:—The whole length of pygidium, although its terminal part is lost, is 7.1 mm.; width of lateral lobe 5.0

mm.; pleural rib is 0.9 mm. wide at the antero-lateral part; anterior interpleural furrow 0.2 mm. in width; probable length of the axial lobe is 2.5 mm.

Observations:—This granulose small pygidium is characteristic in its truncated pleural ribs at the axial furrow. Flat-topped seven or eight pleural ribs are separated by narrow interpleural furrows. From these aspects *Octobronteus* appears to be an appropriate reference for it. Because of the poor material the specific identification of this pygidium is impossible.

Occurrence:—From calcareous sandstone and shale bed of the G_2 stage at Kuraoka, Gion-yama, Miyazaki Prefecture, Kyushu of Southwest Japan. This stage is overlain by the lower Ludlovian G_3 limestone with *Schedohalysites kitakamiensis* and *Conchidium* cf. *C. knightii* (HAMADA, 1956; 58; 62). The geological age of the stage is, therefore, determined at upper Wenlockian. It was procured in association with other trilobites, i.e. *Coronocephalus kobayashii* HAMADA (1959) and *Proetus* sp., and other fossils such as *Falsicatenipora shikokuensis* HAMADA, *Acanthohalysites kuraokensis* HAMADA (1958), *Lingula* sp., and *Troconema* sp. (1961, 62).

Repository:—Geological Institute, Faculty of Science, University of Tokyo. Collected by Takashi HAMADA.

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Explanation of Plate 7

Scutellum (Subgen. nov.) *japonicum* KOBAYASHI and HAMADA, sp. nov.

Figs. 1-3. Top, frontal and lateral views of the holotype cranidium. ×2.7. Upper Wenlockian G_2 stage?, Yokokura-yama, Shikoku, Southwest Japan. Coll. Mr. J. HAMADA.

Scutellum (?) sp.

Figs. 4a, b. Fragmental pygidium. 4a, ×1; 4b, ×2.2. Coblenzian—Eifelian Takaharagawa series, Fukuji, Central Honshu. Coll. Mr. Y. YASUÉ.

Octobronteus (?) sp.

Figs. 5a, b, 6. Fragmental pygidium. An outer cast (5a) and its clay mould (5b) and the counter part of 5a (6). ×3.0. Upper Wenlockian G_2 stage, Gion-yama, Kyushu, Southwest Japan. Coll. T. HAMADA.

2

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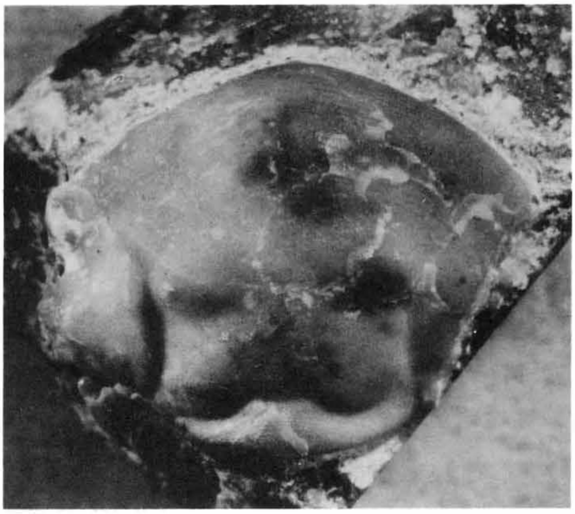

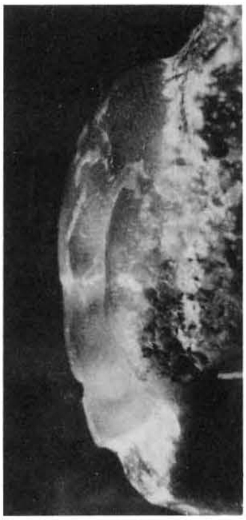

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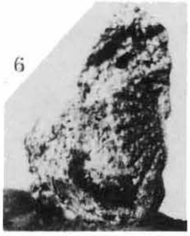
4b

4a



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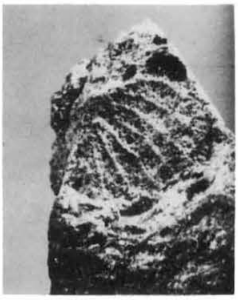
5b

5a



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Postscript

According to MAKSIMOVA (1960), *Weberopeltis bultitchenkoi* MAKSIMOVA and *W. burjensis* MAKSIMOVA from the Devonian of the Rudi Altai and also *Bronteus arcuticum* WEBER, 1945, from the Devonian of the Urals have simple median ribs on their pygidia. The last species has long spines like *W. aculeatus* and *W. weberi*. In *Bronteus eugeni* TSCHERNYSHEVA, 1951, however, the median rib may be forked at the terminus. Here the senior author records his sincere thanks to Drs. N. E. TSCHERNYSHEVA and Z. A. MAKSIMOVA for the following two references.

1. TSCHERNYSHEVA, N. E. (1951) : Upper Silurian and Devonian Trilobites from the Kuznetsk Basin.
2. MAKSIMOVA, Z. A. (1960) : Devonian and Carboniferous Trilobites from the Rudi-Altai. Palaeontological Basis of the Palaeozoic Stratigraphy of the Rudi-Altai, Part 7.

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例会通知

	開催地	開催日	講演申込締切日
第91回例会	長崎大学	1965年9月25日	1965年8月25日
第92回例会	千葉大学	1965年11月6,7日	1965年10月10日

第91回例会（長崎大学）：シンポジウム・化石群集と堆積相（世話人　勘米良亀齢・九大　および鎌田泰彦・長崎大学芸学部）なお，宿泊その他一般の連絡先は高橋　清（長崎大教養部）である。

第92回例会（千葉大学）：シンポジウム・東南アジア及び中近東の地史古生物（世話人 橋本亘・前田四郎）

会員消息

○ 会員高井冬二・鎮西清高両君は，イスラエルにおける古人類発掘の仕事を終え，ニューデリーでの第22回万国地質学会議に出席のあと，それぞれ1965年1月中旬，1964年12月下旬に帰国した。

○ 文部省科学研究費海外研究によるフィリピン地層・古生物調査班（浅野　清・金谷太郎・首藤次男・高柳洋吉君）は，1964年11月中旬から12月中旬にかけて，また，同タイ国班（小林貞一・鳥山隆三・勘米良亀齢・猪郷久義・浜田隆士・柳田寿一君）は，1964年12月中旬から1965年2月下旬にかけて，それぞれ調査を行ない，全員無事帰国した。

○ 会員小林貞一・高井冬二・松本達郎・棚井敏雅・神戸信和・浜田隆士・鎮西清高君は，1964年12月14日から同31日までのニューデリーにおける，第22回万国地質学会議および第6回国際古生物学連合総会に出席した。

○ 会員神戸信和君はニューデリーでの第22回万国地質学会議に出席のあと，Hannover の地質調査所に留学のためドイツに向け出発した。

○ 会員奈須紀幸君は1964年11月中旬にユネスコ海洋研修の講師としてブラジルに出張1965年2月上旬帰国した。

News

◎ 1968年チェッコスロバキアで開催される第23回万国地質学会議の会長には Dr. Jisef SVOBODA, Member of the Czechoslovak Academy of Sciences. 幹事には Dr. Arnost DUDEK, Director of the Geological Survey of Chechoslovakia が選ばれた。通信は下記へ宛られたい。

Organizing Committee. 23rd Session of the International Geological Congress,
Ustredni ústav geologicky, Malostranské náméstí 19, Praha 1, Czechoslovakia.

◎ 1967年9月6日より8日までカナダの Calgary で Alberta Society of Petroleum Geologists の主催によるデボン系に関する国際討論会（International Symposium on the Devonian System）が開催される．会期の前後にはカナダ各地の見学旅行がおこなわれる。連絡先は下記の通りである。

The Secretary, International Symposium on the Devonian System,
P.O. Box 53, Calgary, Alberta, Canada

1965年6月25日　印　刷
1965年6月30日　発　行

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