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SMALL SHELLY FOSSILS AND CONODONTS FROM THE MYOBONG AND DAEGI FORMATIONS IN BAEGUNSAN SYNCLINE, YEONGWEOL-JEONGSEON AREA, KANGWEON-DO

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ABSTRACT

Cambrian small shelly fossils and conodonts are firstly described from the Myobong and Daegi Formations(Lower Paleozoic) distributed in the northern and southern wings of Baegunsan Syncline exposed in Yeongweol-Jeongseon area, Kangweon-do, and the two formations are stratigraphically correlated by the recovered fauna. Fifty-five samples were collected, and forty-five of them yielded 4,487 specimens of various kinds of microfossils. Microfauna in this study represents 22 species belonging to 21 genera of micro-skeletal assemblage composed of trilobites(4 species representing 4 genera), conodonts(2 species representing 3 genera), brachiopod(5 species representing 5 genera), hyolithids(3 species representing 2 genera), gastropod(1 species), coelenterate(1 species), sponge spicules(2 species representing 2 genera), and incertae sedis(4 species representing 4 genera). Microfaunas of both formations were compared with the previously reported faunas of Korea, China, etc. Microfauna in the present study indicates that Myobong Formation and Daegi Formation are 'late Early to early Middle Cambrian' and 'middle Middle Cambrian' in age, respectively.

INTRODUCTION

Since the beginning of study on the Lower Paleozoic conodonts of South Korea in 1970, the conodonts of Upper Cambrian to Middle Ordovician strata have been studied extensively to establish the solid biostratigraphic framework. Recently we have concentrated on finding conodonts from strata older than the Middle Cambrian in the northeastern part of the Okcheon Zone, where the Lower Paleozoic Choseon Supergroup is widely distributed. During this investigation, small shelly and sclerite fossils have been found in several different regions in Korea. One of these is Myobong Slate and Daegi Formation in Yeongweol-Jeongseon area. The only previous paleontological research on these formations was trilobite study by Kobayashi(1935 & 1966). Since that, there have not been any records of macro-or micro-paleontological approach. This study analyses and describes the microfaunas of both formations and considers the biostratigraphic implication of them.

STRATIGRAPHY AND SAMPLING LOCALITIES

The Myobong Slate overlies the Jangsan Quartzite, which is the basal lithostratigraphic unit of the Choseon Supergroup in the Duwibong-type sequence. The formation consists mainly of dark grey and greenish grey slates and phyllites with several thin beds of sandstones. Thin beds of limestones with several centimetres to several metres in thickness are also intercalated. Eighteen samples for this study were collected entirely from these limestone beds. Kobayashi (1966) described such macrofossils as trilobites and brachiopods, and he recognized four biostratigraphic zones in the formation, namely *Redlichia* Zone, *Elrathia* Zone, *Mapania* Zone, and *Bailiella* Zone in ascending order. He dated the formation as Early Cambrian to early Middle Cambrian in age.

The Daegi Formation overlies the Myobong Slate conformably. It is composed chiefly of milky white grey and dark grey massive limestones with intercalations of light pinkish or bluish grey limestones, dolomitic limestones, light pinkish limestones, and dark grey shales. Intraformational limestone conglomerates are rarely intercalated. Kobayashi(1966) described 23 species belonging to trilobites and brachiopods, and he established three biozones, namely *Megagraulos* Zone, *Solenoparia* Zone, and *Olenoides* Zone in ascending order. He also dated the formation as Middle Cambrian in age. Thirty-seven samples for the present study were collected from the Daegi Formation, and sampling localities and the number of collected samples are given in Fig. 1, and Table. 1, Table. 2, respectively.

FOSSIL FAUNA

A total of 55 samples were collected from the Myobong Slate and Daegi Foramtion(18 from the Myobong Slate and 37 from the Daegi Formation) in the south and north wings of the Baegunsan Syncline, 45 of them(13 from the Myobong Slate and 32 from the Daegi Formation) yielded 4,487 specimens of various kinds of microfossils(Tab. 1 & Tab. 2). State of preservation is relatively good, although most specimens represent fragmented natures. They are mostly calcium phosphatic in composition, and a few calcareous specimens represent as the internal mold states through the dissolution of the sampling processes. Constituents of some spcimens were replaced or coated with the rough calcium phosphatic grains. Color of shells varies through light gray, medium gray, dark gray, light pink, and white.

Microfauna in this study represents 22 species belonging to 21 genera of micro-skeletal assemblage composed of trilobites(4 species representing 4 genera), conodonts(2 species representing 2 genera), brachiopods(5 species representing 5 genera), hyolithids(3 species representing 2 genera), gastropod(1 species representing 1 genus), coelenterate(1 species representing 1 genus), sponge spicules(2 species representing 2 genera), and incertae sedis(4 species representing 4 genera), and the faunal component of each formation is as follows :

Mybong Slate : *Allatheca nanjiangensis, Hyolithellus tenuis, Hyolithellus* sp., *Allonnia erromenosa, Archiasterella quadratina, Ganloudina platybasala, Ernogia acculatus, Nanjiangofolliculus circocodonus, Microdictyon* ? sp. *Phyllochites involutus, Uncinaspira ruidocostata* in the northern wing ; and *Nanjiangofolliculus circocodonus, Microdictyon* ? sp. in the southern wing.

Daegi Formation : *Amictocracens teres, Ocruranus trulliformis, Treptotreta* sp., *Allatheca nanjiangensis, Hyolithellus tenuis, Hyolithellus* sp., *Allonnia erromenosa, Archiasterella quadratina, Ganloudina platybasala, Mirabifolliculus* ? sp., *Phyllochites involutus* in the northern wing ; *Kootenia punctata, Manchuriella minaformis* ?, *Yinites* sp., *Drepanura* ? sp., *Furnishina* sp., *Phakelodus te-*

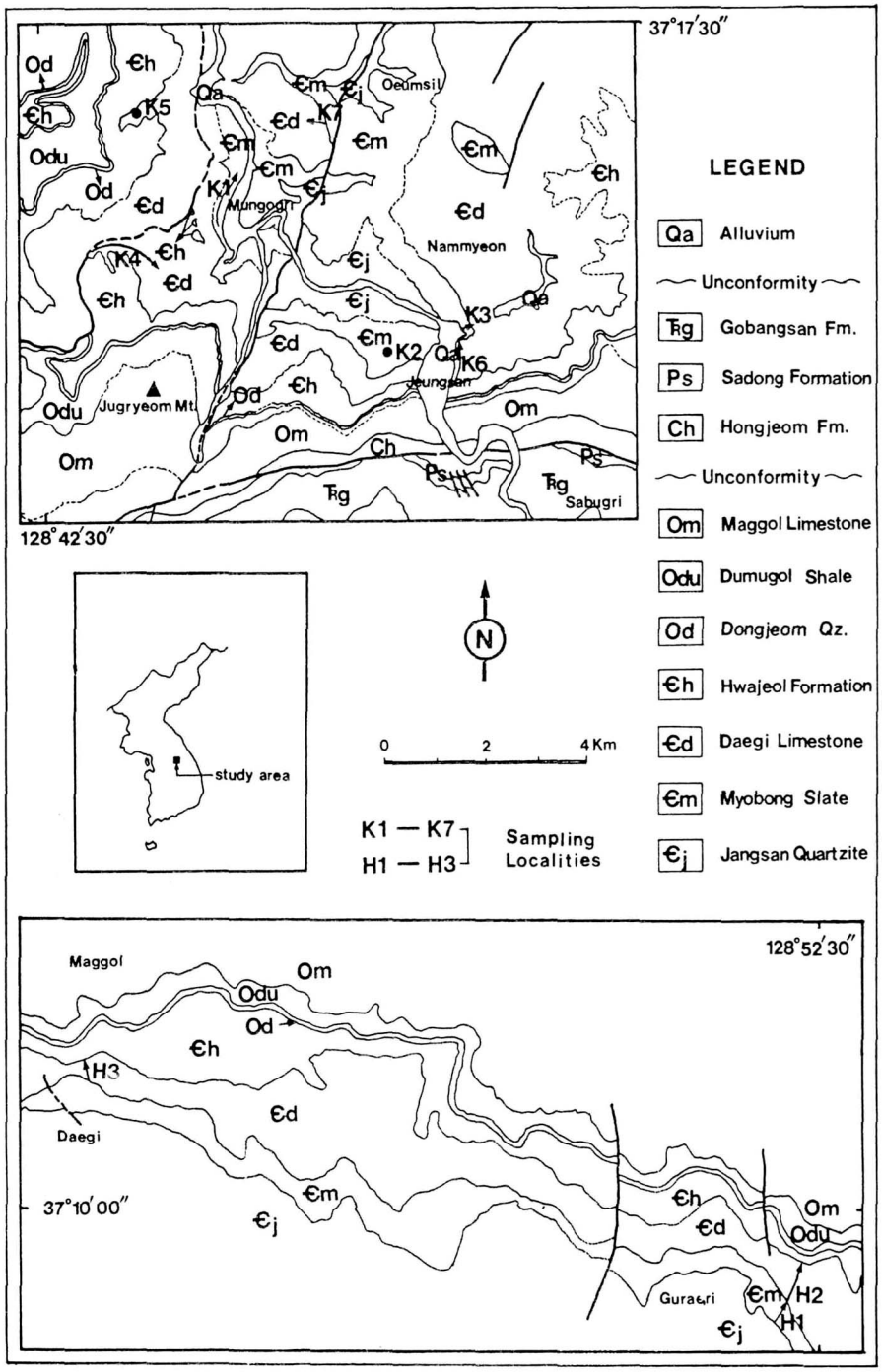


Fig. 1. Geologic maps and sampling localities in the Baegunsan Syncline area. Upper and lower map illustrate the northern and southern wings, respectively(K1~K7 and H1~H3 are sampling localities in each region).

nuis, Acrothele sp., *Amictocracens teres, Lingulella* sp., *Treptotreta* sp., *Hyolithellus tenuis, Hyolithellus* sp., *Allatheca nanjiangensis, Microdictyon* ? sp. in the southern wing.

The most striking difference between the two formations is that the trilobite taxa such as *Kootenia punctata, Manchuriella minaformis* ?, *Yinites* sp., and *Drepanura* ? sp., brachiopod taxa such as *Amictocracens teres, Ocruranus trulliformis, Treptotreta* sp., and *Lingulella* sp., and conodont taxa such as *Furnishina* sp. and *Phakelodus tenuis* are restricted to the Daegi Formation. Among these, trilobite and conodont species occur only in the southern wing area. Occurrences of small shelly and sclerite fooils, assigned to several biological categories, also show interesting trends. Hyolithid species including *Allatheca nanjiangensis, Hyolithellus tenuis,* and *Hyolithellus* sp. show abundant occurrences in samples of the Myobong Slate and seldom occurrences in samples of the Daegi Formation in the northern wing area, whereas in the southern wing area, only the lowermost sample of the Daegi Formation yielded these taxa. *Allonnia erromenosa, Archiasterella quadratina, Phyllochites involutus, Uncinaspira ruidocostata,* and *Ernogia acculatus* are restricted in the northern wing area, and are mostly distributed in the Myobong Slate and seldom in the Daegi Formation. *Ganloudina platybasala* occurs only in the Myobong Slate in the northern wing area. *Mirabifolliculus* ? *chytroformis* occurs only in two samples of the Daegi Formation in the northern wing and the only sample studied in the southern wing yielded a significant number of this species. Fragments of *Microdictyon* ? sp. show a wide distribution in all samples studied herein. Conclusively, all the trilobite, brachiopod, and conodont species occur in the Daegi Formation only, and other small shelly and sclerite fossils are distributed mainly in the underlying Myobong Slate.

Table. 1 and Table. 2 summarize the occurrence of fossil specimens in each sample of northern and southern wings of the Baegunsan Syncline, respectively.

BIOSTRATIGRAPHIC CONSIDERATION

Among the Myobong fauna consisting of 11 species of small shelly and sclerite fossils, the hyolithid species *Allatheca nanjiangensis* was firstly reported from the lowermost Cambrian Dengying Formation in northern Sichuan Province, China(Yang & He, 1984), and the other hyolithid species *Hyolithellus tenuis* was previously described from the lowermost Cambrian Meishucun Stage of Yunnan area,(Yang & He, 1984), and from the lowermost Cambrian strata of west Hubei Province in China (Qian & Bengtson, 1989 and Chen, 1984). Also such Cambrian strata in Korea as limestone beds of Mungyeong area(Lee, H.Y., 1987 and Lee, K.J., 1989) and Sambangsan Formation of Yeongweol area(Lee, H.Y. *et al.,* 1986, Cheong, C.G., 1991, and Lee, B.S. *et al.,* 1991) yielded this species. Table. 3 summarize the co-occurrences of taxa of the prersent study and other previous records.

The chancellorid(sponge-spicule-like) species *Allonnia erromenosa* was reported from the Meishucun stage in China(Jiang, 1984 and Qian & Bengtson, 1989) and from the Middle Cambrian Sambangsan Formation, Korea(Cheong. C.G., 1991 and Lee, B.S. *et al.,* 1991). *Archiasterella quadratina* was firstly reported from the Lower Cambrian strata in the Mungyeong area, Korea(Lee, H.Y., 1987). In addition, *Ernogia acculatus, Ganloudina platybasala, Mirabifolliculus* ? *chytroformis,* and *Nanjiangofolliculus* also have previous records in the Meishucun Stage or the Dengying Formation, both of which are lowermost Cambrian strata in China.

The traditional stratigraphic boundary problems include the Precambrian-Cambrian boundaries worldwide. During the last decade, paleontologists have been interested in the occurrences of the earliest Cambrian small shelly and sclerite fossils before the first appearance of

Table 1. Occurrence of small shelly fossils from productive samples in the northern wing area of the Baegunsan Syncline.

		MYOBONG SLATE												DAEGI FORMATION																											TOTAL
		K1			K2	K3								K4													K5	K6										K7			
	Taxa \ Sample Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
A	*Amictorcracens teres*																														60	22	103	11							196
A	*Ocruranus trulliformis*																6												2	3			12	22					4		49
A	*Treptotreta* sp.																		6	3	11	74	2							4	46		85	22	3	1					257
B	*Allatheca nanjiangensis*					37	20		14	21	42		21						26			12															8				201
B	*Hyolithellus tenuis*					47		6					1																							15	2		6	4	81
B	*Hyolithellus* sp.		5	28	46								112																			4					28				223
C	*Allonnia erromenosa*									58	38	49							1																						146
C	*Archiasterella quadratina*						31														5															1					37
D	*Ganloudina platybasala*					33	26	15	10	3	1	3	11						3																						105
D	*Mirabifolliculus ? chytroformis*																																		4	5					9
D	*Ernogia acculatus*						31	3		16	10	13	2																										8		83
D	*Nanjiangofolliculus circocodonus*	21																																							21
D	*Microdictyon* sp.									4				10	1		10	31	23			1	1	2	11	1		2	2		1	2									102
E	*Phyllochites involutus*					11	40			19	22	9	7																										17		125
F	*Uncinaspira ruidocostata*																																								1
G	Indet	46	44	104	134	58	46	33	7	28	11				38	6	11		108	13	9	30	22	5		4	14	2	23	46	113	41	32	17	13	14	4	31	17	1	1134
	TOTAL	46	70	132	180	186	194	57	31	124	120	102	165	10	39	6	27	31	167	16	25	117	25	7	11	5	14	4	27	53	224	65	232	72	20	64	14	31	52	5	2770

A : Brachiopods, B : Hyolithids, C : Sponge spicules, D : Incertae sedis, E : Coelenterate, F : Gastropod, G : Other micrd fossils.

Table 2. Occurrence of small shelly fossils from productive samples in the southern wing area of the Baegunsan Syncline.

		M*	DAEGI FORMATION					TOTAL
		H 1	H 2				H 3	
Taxa	Sample Number	1	2	3	4	5	6	
A	*Kootenia punctata*			7	6			13
	Manchuriella minaformis ?			13	1			14
	Yinites sp.			3	1			4
	Drepanura sp.			1				1
B	*Furnishina* sp.			1	1			2
	Phakelodus tenuis			1	1			2
C	*Acrothelle* sp.			1			2	3
	Amictocracens teres				7	30	8	45
	Lingulella sp.			12	10			22
	Treptotreta sp.					51	153	204
D	*Hyolithellus tenuis*		7					7
	Hyolithellus sp.		9					9
	Allatheca nanjiangensis		22					22
E	*Nanjiangofolliculus circocodonus*	14						14
	Microdictyon ? sp.	3		2	1	5		11
F	Indet	5		519	644	157	19	1344
TOTAL		22	38	560	672	243	182	1717

A : Trilobites, B : Conodonts, C : Brachiopods, D : Hyolithids, E : Incertae sedis, F : Other microfossil, M* : Myobong slate.

trilobite. They have described a numerous taxa from many parts of the world(Cowie, 1984 and Qian & Bengtson 1989), and a significant number of research was accomplished in the strata in south China where the boundary strata are relatively well developed(see Cowie, 1985 and Kirschvink *et al.* 1991 for discussion). The interests have been, so far, confined in the presence of the microfauna during the pre-trilobite time, and the systematic paleontology of them. The stratigraphic use of this microfauna during the earliest Cambrian or even the time after the first appearance of trilobite needs the accumulation of detailed data from many stratigraphic sections distributed in many regions. As discussed in Lee, H.Y. *et al.*(1992), the age of the Myobong Slate remains as late Early Cambrian to early Middle Cambrian on the basis of previously reported trilobite macrofauna(Kobayashi, 1966).

The Daegi fauna consists mainly of four species of trilobite, two species of conodont and four species of brachiopod. The formation rarely include the hyolithid and related small shelly and sclerite fossils.

The trilobite species *Manchuriella minaformis* ? and *Kootenia punctata* were previously described in the *Solenoparia* Zone of the Daegi Formation and from the *Olenoides* Zone of the Machari Formation by Kobayashi(1935). Both biostratigraphic zones are Middle Cambrian in age(Kobayashi, 1966). *Yinites* sp. has previous records in the Lower Cambrian strata(Zhang *et al.*, 1980), and the present study is the first report of this taxon in Korea. Since the species occurred in younger strata than the *Redlichia*-bearing Myobong Slate, the stratigraphic range

Table 3. Correlation of the fossils from the present study with the faunas from inland and foreign regions.

TAXA		OTHER CORRELATIVE FAUNAS														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Trilobites	*Kootenia punctata*	*														
	Manchuriella minaformis ?		*													
	Yinites sp.			*												
Conodonts	*Furnishina* sp.											*				*
	Phakelodus tenuis											*				*
Brachiopods	*Acrothele* sp.				*											
	Amictocracens teres				*											*
	Lingullela sp.				*											*
	Treptotreta sp.				*											*
	Ocruranus trulliformis													*		
Gastropod	*Uncinaspira ruidocostata*									*						
Coelenterate	*Phyllochites involutus*								*							
Hyolithids	*Allatheca nanjiangensis*					*										
	Hyolithellus tenuis							*							*	*
	Hyolithellus sp.								*		*				*	*
Sponge spicules	*Allonnia erromenosa*						*								*	*
	Archiasterella quadratina												*		*	*
Incertae sedis	*Ernogia acculatus*													*		
	Ganloudina platybasala					*										
	Mirabifolliculus ? *chytroformis*					*										
	Nanjiangofolliculus circocodonus					*										
	Microdictyon ? sp.														*	

1. Kobayashi. 1935a. Lower Paleozoic. Neietsu(Yeongweol), Kangweondo.
2. Kobayashi. 1936b. Lower Paleozoic. Doten(Dongjeom), Kangweondo.
3. Zhang *et al.* 1980. Minghsinssu Fm. northern Guizhou Province.
4. Henderson & Mackinnon. 1981. Tasman Fm. Australia & New Zealand.
5. Yang & He. 1984. Dengying Fm. northern Sichuan Province.
6. Jiang. 1984. Meishucun Stage. Yunnan Province.
7. Chen. 1984. Meishucun Stage. west Hubei Province.
8. Qian & Yin. 1984. Meishucun Stage. central-west & north Guizhou Province.
10. Qian & Xiao. 1984. Meishucun Stage. Aksu-Wush. Xinjiang Proince.
11. Lee, H.Y. *et al.* 1986. Sambangsan Formation. Yeongweol-Pyeongchang. Kangweondo
12. Lee. 1987. unnamed Lower Paleozoic Limestone. Kurangni, Mungyong.
13. Qian & Bengtson. 1989. Meishucun Stage. Yunnan Province.
14. Lee, K.J. 1989. unnamed Lower Paleozoic Limestone. Kurangni, Mungyong.
15. Cheong. J.G. 1991. Sambangsan Formation. Yeongweol, Kangweondo.

of the species could be extended upward to probably Middle Cambrian at least in Korea. Another trilobite species *Drepanura* ? sp. is a poorly preserved pygidium fragment.

The brachiopod species *Amictocracens teres, Acrothele* sp., and *Treptotreta* sp. were previously reported from the Middle Cambrian strata. Among these, the range of *Treptotreta* extends to the early Late Cambrian time. Especially the brachiopod fauna of the Daegi Formation is closely related to the Middle to early Late Cambrian strata in western Queensland, Australia and the Tasman Formation in New Zealand (Henderson & MacKinnon, 1981). *Amictocracens teres, Acrothele* sp., *Treptotreta* sp., and long-ranging *Lingulella* sp. show common occurrences both in the Daegi formation and the strata of Austalia and New Zealand. Only *Ocruranus trulliformis* among the brachiopod species studied herein was previously reported from the lowermost Cambrian Meishucun Stage, China(Qian & Bengtson, 1989).

The long-ranging conodont species *Furnishina* sp. and *Phakelodus tenuis* were reported from the Middle to Late Cambrian strata worldwide. Thus, they do not provide any decisive criteria for the age determination.

The Daegi Formation also includes a minor amount of small shelly and sclerite fossils. These are *Allatheca nanjiangensis, Hyolithellus tenuis, Hyolithellus* sp., *Allonia erromenosa, Archiasterella quadratina, Ganloudina platybasala, Mirabifolliculus* ? *chytroformis,* and *Microdictyon* ? sp. These fossils except *Microdictyon* ? sp. were described mainly from the lowermost Cambrian strata in China. But considering the co-occurrence of these microfossils and trilobite, conodont, and brachiopod species in the Daegi Formation, these small shelly and sclerite fossils have limitations in any stratigraphic use. In this study, possible age of the Daegi Formation is tentatively assigned to the middle Middle Cambrian.

RESULTS AND CONCLUSIONS

Fifty-five samples were collected from the Myobong Slate and the Daegi Formation in Baegunsan Syncline area of Yeongweol-Jeongseon region. These include 18 samples from the Myobong Slate and 37 from the Daegi Formation. Forty-five samples of them yielded 4,487 specimens of various kinds of microfossils.

Microfauna in this study was differentiated into 22 species belonging to 21 genera of microskeletal assemblage. These include trilobites(4 species representing 4 genera), conodonts(2 species representing 2 genera), brachiopods(5 species representing 5 genera), hyolithids(3 species representing 2 genera), gastropod(1 species), coelenterate(1 species), sponge spicules(2 species representing 2 genera), and incertae sedis(4 species representing 4 genera).

Through the biostratigraphic consideration of fossil contents of the Myobong Slate and Daegi Formation, the age of the formations are thought to be late Early to early Middle Cambrian and middle Middle Cambrian, respectively.

SYSTEMATIC PALEONTOLOGY

1. Trilobites

Phylum ARTHROPODA
Class TRILOBITA Walch, 1771
Order PTYCHOPARIIDA Swinnerton, 1915
Suborder PTYCHOPARIINA Richter, 1933
Superfamily DAMESELLACEA Kobayashi, 1935
Family DAMESELLIDAE Kobayashi, 1935
Subfamily DREPANURINAE Hupé, 1953
Genus *DREPANURA* Bergeron, 1899

Type species : *Drepanura premesnili* Bergeron, 1899

Drepanura ? sp.
Pl.1, fig. 7

Description : Pygidium rectangular in outline ; long lateral spines ; posterior margin between lateral spines serrated ; axial ring slightly convex, half the width of pleural region, tapering towards the end.

Remarks : Only one pygidium is included in this study. General morphological features are close to the genus *Drepanura*. The poor state of preservation and the paucity of occurrence, however, discourage even the generic assignment.

Occurrence : Sample H2-3

Material : 1.

Superfamily ASAPHISCACEA Raymond, 1924
Family ASAPHISCIDAE Raymond, 1924
Subfamily ASAPHISCINAE Raymond, 1924
Genus *MANCHURIELLA* Kobayashi, 1935

Type species : *Manchuriella typa* Kobayashi, 1935

Manchuriella minaformis ? Kobayashi, 1935
Pl. 1, figs. 3,4

1935 *Manchuriella minaformis* Kobayashi : p. 300, pl, 14, fig. 16, pl. 20, fig. 5.

Description : Glabella semi-elliptical, slightly tapering towards the anterior side ; glabellar furrows are not observable ; occipital ring rounded and convex at the posterior margin ; palpebral area wide, protruded towards the lateral sides and constricted at the posterior end to form the hemicircular shape ; eye ridges not prominent ; preglabella field flat and wide ; surface granulate.

Remarks : Only cranidia are observed in this study. Characteristics of the present species agree well with the original description. The lack of a keel in the axis of glabella, however, makes it difficult to assign this species to *Manchuriella minaformis* Kobayashi with certainty. Granulate surface texture might be the result of later precipitation of the mineral matters which could obscure such ornamentation as a keel and glabellar furrows.

Occurrence : Samples H2-3, H2-4.

Material : 14.

Order CORYNEXOCHIDA Kobayashi, 1935
Family DORYPYGIDAE Kobayashi, 1935
Genus *KOOTENIA* Walcott, 1888

Type species : *Bathyuriscus(Kootenia) dawsoni* Walcott, 1888

Kootenia punctata Kobayashi, 1935
Pl. 1. figs. 1,2

1935 *Kootenia punctata* Kobayashi : pp. 157-158, pl. 15, figs. 14-21.

Description : Glabella convex, parallel-sided, and deeply impressed laterally, anterior side straight to slightly round ; glabellar furrows not clearly discernible ; occipital ring produces a sharply defined spine which points posteriorly although the spine is not prominent in some specimens ; fixigena(fixed cheek) nearly as wide as glabella at the base, and decreasing in width towards the anterior to reach the half the glabella width in anterior portion beyond the position of the eye ; palpebral area medium in size, and located in the middle ; eye ridge not prominent ; preglabella field nearly as wide as or slightly narrower than the cheek ; punctate surface is not readily observable due to the probable taphonomic processes.

Remarks : All specimens studied are represented as cranidiums only. The species is characterized by the spine developed at the back side of occipital ring and the parallel-sided glabella. The characteristics of the species is identical to the original description by Kobayashi, except the wide preglabella field observed in the present species. This difference is regarded here as an intraspecific variation.

Occurrence : Samples H2-3, H2-4.

Material : 13.

Order REDLICHIIDA Richter, 1933
Suborder REDLICHIINA Harrington, 1959
Superfamily REDLICHIACEA Poulsen, 1927
Family YINITIDAE Hupé, 1953
Genus *YINITES* Lu, 1946

Type species : *Yinites typicalis* Lu, 1946

Yinites sp.
Pl. 1, figs. 5, 6

Description : Glabella elliptical, convex ; occipital and pre-occipital furrows convex posteriorly ; a small mesial occipital node developed ; palpebral area hemicircular, constricted at its anterior end so that the facial suture almost meet the axial furrow ; surface smooth but some specimens covered by densely distributed nodes.

Remarks : The present specimens represent only as cranidia. Sinuate fixed cheek at the anterior end of palpebral area and the presence of preoccipital furrow characterize this species. General features of some specimens show very similar characteristics of *Yinites typicalis,* Lu illustrated by kobayashi(1961). In this study, the specific assignment is withheld due to the fractural state of preservation in most specimens.

Occurrence : Samples H2-3, H2-4.

Material : 4

Undifferentiated Trilobite 1.
Pl. 1, fig. 8

Description : Pygidium rounded rectangular ; axial ring not clearly defined, but the central region gently convex upward ; lateral and posterior margins flat.

Remarks : Specimens included in this category show the close resemblances to the taxa belonged to the Agnostidae.

Occurence : Sample H2-3.

Material : 18.

2. Conodonts

Phylum CONODONTA
Gens *FURNISHINA* Müller, 1959

Type species : *Furnishina furnishi* Müller, 1959

Furnishina sp.
Pl. 1, fig. 11

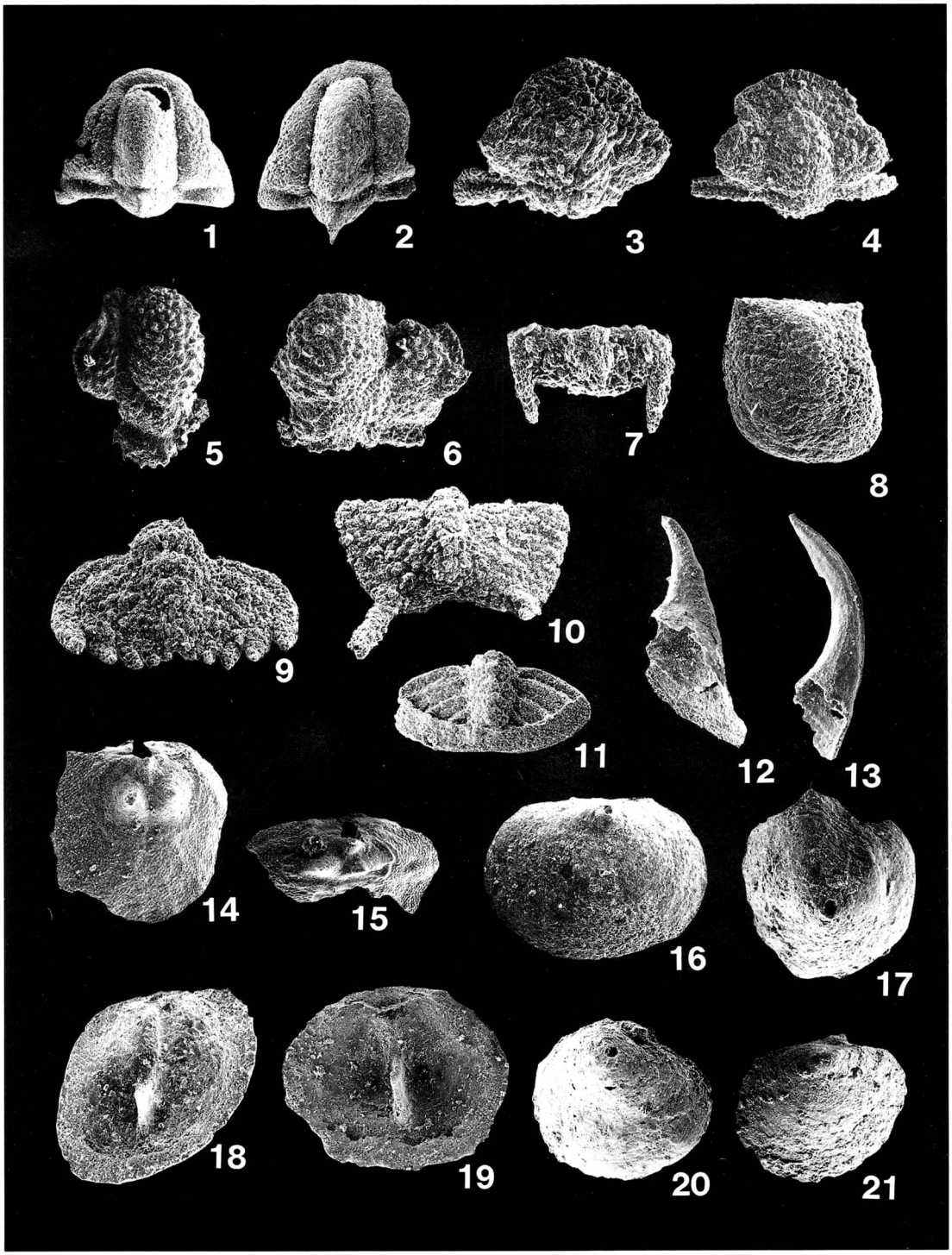
Description : See Lee, H.Y.(1975, P. 178).

Remarks : Two specimens encountered in this study show close similarities to *Furnishina furnishi* reported in numerous studies.

PLATE 1

Fig. 1-2. *Kootenia punctata* Kobayashi, 1935, cranidia, 1 : Daegi Limestone, H2-4, X38, YSUG 1060. 2 : Daegi Limestone, H2-4, X42, YSUG1061. **Fig. 3-4.** *Manchuriella minaformis* ? Kobayashi, 1935, cranidia, 3 : Daegi Limestone, H2-3, X60, YSUG1062. 4 : Daegi Limestone, H2-4, X70, YSUG1063. **Fig. 5-6.** *Yinites* sp. cranidia fragments, 5 : Daegi Limestone, H2-3, X35, YSUG1064. 6 : Daegi Limestone, H2-3, X35, YSUG1065. **Fig. 7.** *Drepanura* ? sp. pygidium, Daegi Limestone, H2-3, X96, YSUG1066. **Fig. 8.** Undifferentiated trilobite 1, pygidium, Daegi Limestone, H2-3, X64, YSUG1067. **Fig. 9-11.** Undifferentiated trilobites pygidia, 9 : Daegi Limestone, H2-4, X83, YSUG1068. 10 : Daegi Linestone, H2-3, X46, YSUG1069. 11 : Daegi Limestone, H2-3, X50, YSUG1070. **Fig. 12.** *Furnishina* sp. lateral view, Daegi Limestone, H2-3, X64, YSUG1071. **Fig. 13.** *Phakelodus tenuis*(Müller, 1959) Miller, 1984, lateral view, Daegi Limestone, H2-4, X70, YSUG1072. **Fig. 14-15.** *Acrothele* sp. outer views of dorsal valves, 14 : Daegi Limestone, H3-6, X46, YSUG1073. 15 : Daegi Limestone, H2-5, X46, YSUG1074. **Fig. 16-19.** *Amictocracens teres* Henderson & MacKinnon, 1981, outer views of dorsal valves(16, 17) and inner views of ventral valves(18, 19), 16 : Daegi Limestone, H2-5, X60, YSUG1075. 17 : Daegi Limestone, H2-5, 96, YSUG1076. 18 : Daegi Limestone, K6-30, X77, YSUG1077. 19 : Daegi Limestone, H2-5, X55, YSUG1078. **Fig. 20-21.** *Ocruranus trulliformis* Jiang, 1980 outer views of dorsal valves, 20 : Daegi Limestone, K6-28, X77, YSUG1079. 21 : Daegi Limestone, K6-33, X64, YSUG1080.

PLATE 1



Occurrence : Samples H2-3, H2-4
Material : 2

Genus *PHAKELODUS* Miller, 1984
Type species : *Oneotodus tenuis* Müller, 1959

Phakelodus tenuis(Müller, 1959) Miller, 1984

Synonymy and Description : See Lee, H.Y.(1975, PP. 179-180).
Remarks : The present species is identical to the species described by H.Y.Lee(1975) and B.S.Lee(1987).
Occurrence : Samples H2-3, H2-4.
Material : 2.

3. Brachiopods

Phylum BRACHIOPODA
Class INARTICULATA Huxley, 1869
Order LINGULIDA Waagen, 1885
Superfamily LINGULACEA Menke, 1828
Family OBOLIDAE King, 1846
Subfamily OBOLINAE KING, 1846
Genus *LINGULELLA* Salter, 1866
Type species : *Lingula davisii* M'Coy, 1851

Lingulella sp.
Pl. 2, figs. 1-3

Description : Shell elongate oval to sub-triangular ; thin-shelled ; growth line concentric, moderately spaced.
Occurrence : Samples H2-3, H2-4.
Material : 22.

Order ACROTRETIDA Kuhn, 1949
Suborder ACROTRETIDINA Kuhn, 1949
Superfamily ACROTRETACEA Schuchert, 1893
Family ACROTHELIDAE Walcott & Schuchert, 1908
Subfamily ACROTHELINAE Walcott & Schuchert, 1908
Genus *ACROTHELE* Linnarsson, 1876
Type species : *Acrothele coriacea* Linnarsson, 1876

Acrothele sp. 1
Pl. 1, figs. 13, 14

1981 *Acrothele* sp. : Henderson & MacKinnon, p. 305, fig. 12.

Description : Two protegula distinct and might have been spinose ; surface of protegular

area finely pitted ; beyond the protegular margin, micro-ornament of the shell surface finely granular but moderately dense array of impersistent microlaminae.

Remarks : Only the ventral valves are studied, and the protegular spines are not observed. The general feature of the species are similar to those of Australasian species(Henderson & MacKinnon, 1981)

Occurrence : Samples H2-3, H3-6.

Material : 3.

Genus *TREPTOTRETA* Henderson & MacKinnon, 1981

Type species : *Treptotreta jucunda* Henderson & MacKinnon, 1981

Treptotreta sp.

Pl.2, figs. 4-8

Description : Shell conical, slightly wider than long ; blunt apex distinct, broadening anteriorly, lateral view of the ventral valve shows straight to weakly convex anterior portion and straight posterior portion ; median septum triangular ; growth lines fine, regular.

Remarks : General morphological features of the species described herein are very similar to *Treptotreta jucunda* originally described by Henderson & MacKinnon(1981). The specific assignment, however, is withheld due to the poor preservation of the present specimens.

Occurrence : Samples H2-5, H3-6, K4-18, K4-19, K4-20, K4-21, K4-22, K6-29, K6-30, K6-32, K6-33, K6-34, K6-35.

Material : 461

Genus *AMICTOCRACENS* Henderson & MacKinnon, 1981

Type species : *Amictocracens teres* Henderson & MacKinnon, 1981

Amictocracens teres Henderson & MacKinnon, 1981

Pl. 1, figs. 15-18

1981 *Amictocracens teres* Henderson & MacKinnon : pp. 295-297, figs. 5-6.

Description : Shell conical, a little wider than long ; protegular nodes conspicuous, and apex declined ; remaining growth stages with fine closely spaced growth lines ; median septum well developed, triangular and blade-like, continues posteriorly as a ridge which ultimately forms a buttress to the pseudointerarea ; cardinal muscle scars not conspicuous.

Remarks : Australasian species originally described by Henderson & MacKinnon(1981) is identical to the present species.

Occurrence : Samples H2-4, H2-5, H3-6, K6-30, K6-31, K6-32, K6-33.

Material : 241.

Phylum, Class, Order, & Family Uncertain

Genus *OCRURANUS* Liu, 1979

Type species : *Ocruranus finial* Liu, 1979

Ocruranus trulliformis(Jiang, 1980) Qian & Bengtson, 1989

Pl. 1, figs. 19,20

1989 *Ocruranus trulliformis*(Jiang, 1980) Qian & Bengtson : pp. 107-108, fig. 69

Description : Conical shell bears wide aperture at its base ; subapical field as wide as half of the shell surface ; apex declined and slightly overturned posteriorly ; upfolded margin of the subapical field forms a smooth transition to the lateral shell margin ; aperture circular to somewhat flattened posteriorly.

Remarks : The convex posterior part of the subapical field is not prominent in the studied specimens, compared to the species described by Qian & Bengtson(1989).

Occurrence : Samples K4-16, K6-28, K6-29, K6-32, K6-33, K7-38.

Material : 49.

4. Hyolithids

Phylum MOLLUSCA
Class HYOLITHA Marek, 1963
Family ALLATHECIDAE Missarzhevsky, 1969
Genus *ALLATHECA* Missarzhevsky, 1969

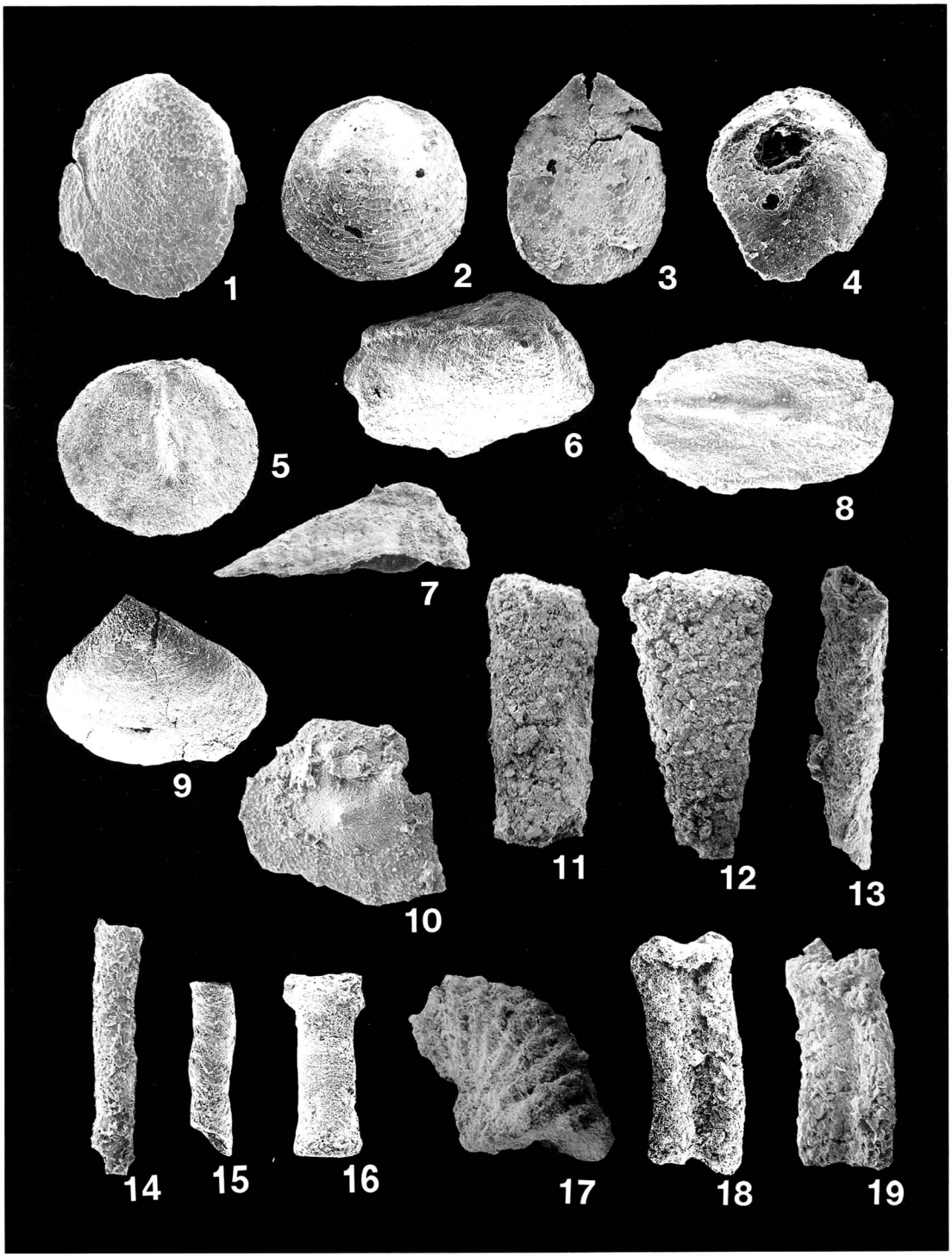
Allatheca nanjiangensis Yang & He, 1984
Pl. 2, figs. 10-12

1984 *Allatheca nanjiangensis* Yang & He : p. 38, pl. 1, figs. 6-10.

PLATE 2

Fig. 1-3. *Lingulella* sp. outer(1, 2) and inner(3) views of dorsal valves, 1 : Daegi Limestone, H2-4, X42, YSUG1081. 2 : Daegi Limestone, H2-4, X55, YSUG1082. 3 : Daegi Limestone, H2-4, X46, YSUG1083. **Fig. 4-8.** *Treptotreta* sp. inner(4), outer(6), and lateral(7) views of dorsal valves, 4 : Daegi Limestone, H2-5, X96, YSUG1084. 6 : Daegi Limestone, H2-5, X55, YSUG 1086. 7 : Daegi Limestone, H6-32, X50, YSUG1087. inner(5, 8) views of ventral valves, 5 : Daegi Limestone, H2-5, X50, YSUG1085. 8 : Daegi Limestone, K6-30, X46, YSUG1088. **Fig. 9-10.** Undifferentiated brachiopods, outer views of dorsal valves, 9 : Daegi Limestone, H2-3, X38, YSUG1089. 10 : Daegi Limestone, H2-3, X69, YSUG1090. **Fig. 11-13.** *Allatheca nanjiangensis* Yang & He, 1984 dorsal(11, 12) and lateral(13) views, 11 : Daegi Limestone, H2-2, X49, YSUG 1091. 12 : Myobong Slate, K3-10, X33, YSUG1092. 13 : Daegi Limestone, H2-2, X41, YSUG 1093. **Fig. 14-15.** *Hyolithellus tenuis* Missarzhevsky, 1966, lateral views, 14 : Myobong Slate, K3-12, X29, YSUG1094. 15 : Daegi Limestone, H2-2, X70, YSUG1095. **Fig. 16.** *Hyolithellus* sp., dorsal view, Daegi Limestone, H2-2, X70, YSUG1096. **Fig. 17.** *Uncinaspira ruidocostata* He, 1984 lateral view, Myobong Slate, K3-9, X50, YSUG1097. **Fig. 18-19.** *Phyllochites involutus* Qian & Yin, 1984 outer views, 18 : Myobong Slate, K3-5, X38, YSUG1098. 19 : Myobong Slate, K3-9, X38, YSUG1099.

PLATE 2



Description : Straight to slightly curved conch ; conch cross section variable, most specimens included in this study show high, rounded, convex dorsum, broadly convex venter, and rounded ventro-lateral margins.

Remarks : This species is identical to the Chinese species *Allatheca nanjiangensis* described by Yang & He. Also it is noticed that the similarity of this species to *Allatheca degeeri* reported from the strata distributed in Massachusetts, U.S.A. by Landing(1988). Also some specimens involved in Cheong, C.G.(1991) could be assignable to this species. An attempt to synonymize these species, however, is withheld because of the paucity of well preserved specimens in this study.

Occurrence : Samples H2-2, K3-5. K3-6, K3-8, K3-9, K3-10, K3-12, K4-18, K4-21, K6-36.

Material : 223

Order ORTHOTHECIDA Marek, 1966
Family HYOLITHELLIDAE Walcott, 1886
Genus *HYOLITHELLUS* Billingsi, 1878

Hyolithellus tenuis Chen, 1984
Pl. 2, fig. 13, 14

1984 *Hyolithellus tenuis* Chen : p. 55, pl. 2, figs. 16 & 17.

Description : Conch small, slender, straight to slightly curved ; conch cross section circular ; surface smooth

Remarks : The long slender conch with circular transverse section characterize the species. Chinese species described by Chen and the species reported from the Sambangsan Formation(Cheong, C.G., 1991) seem to be identical to the present species.

Occurrence : Samples H2-2, K3-5, K3-7, K3-12. K6-35, K6-36, K7-38, K7-39.

Material : 88.

5. Coelenterate

Phylum COELENTERATA
Class, Order, & Family Uncertain
Genus *PHYLLOCHITES* Qian & Yin, 1984

Type species : *Phyllochites involutus* Qian & Yin, 1984

Phyllochites involutus Qian & Yin, 1984
Pl. 2, figs. 18, 19

1984 *Phyllochites involotus*(*sic.*) Qian & Yin : p. 111, pl. 6, figs. 1-4.(*Phyllochites involotus* should read *Phyllochites involutus*)

Description : Shell palmate, margins forming shelf-like overturned curvatures towards inside ; middle longitudinal portion depressed.

Remarks : Palmate feature of the species is characteristic. Original description of the species(Qian & Yin, 1984) includes specimen with only one margin forming a overturned curva-

ture. In this study, this difference is regarded as an intraspecific variation, and both features are included in the species characteristics.

Occurrence : Samples K3-5, K3-6, K3-9, K3-10, K3-12, K7-38.

Material : 125.

6. Sponge spicules

Phylum PORIFERA
Class & Order Uncertain
Genus *ALLONNIA* Doré & Reid, 1965

Allonnia erromenosa Jiang, 1984
Pl. 3, figs. 1, 2

1984 *Allonnia erromenosa Jiang* : p. 4, fig. 12.

Description : Unit consists of three radial arms which slightly curve upwards ; arms conical, and meet at their proximal ends at approximately 120° each other ; stout arms are uniform in size and shape ; three arms contact at their proximal ends and form a triple junction ; downward side of each spicule contains a small round pit towards its proximity ; surface smooth.

Remarks : Three radial spicules and a triple junction at their proximity characterize the species. Species illustrated by Jiang(1984) is identical to the present species in its characteristic features. *Allonnia tripodophora* Doré & Reid described by Qian & Xiao(1984) has long, slender arms compared to the present species.

Occurrence : Samples K3-9, K3-10, K3-11, K4-18.

Material : 146.

Genus *ARCHIASTERELLA* Sdzuy, 1969

Type species : *Archiasterella pentactina* Sdzuy, 1969

Archiasterella quadratina Lee, 1987
Pl. 3, figs. 3, 4

1987 *Archiasterella quadratina* Lee : p. 105, pl. 1, fig. 12.

Description : See Lee, H.Y.(1987. p. 105)

Remarks : The specimens involved in this study are identical to the species originally described by Lee(1987). The present specimens have slightly curved arms to the upward side. Also the downward side of each arm contains a small round pit towards its proximal end.

Occurrence : Samples K3-6, K4-20, K6-35.

Material : 37.

7. Gastropod

Phylum MOLLUSCA
Class GASTROPODA Cuvier, 1797
Family PELAGIELLIDAE Knight, 1956
Genus *UNCINASPIRA* He, 1984

Type species : *Uncinaspira pristina* He, 1984

Uncinaspira ruidocostata He, 1984
Pl. 2, fig. 17

1984 *Uncinaspira ruidocostata* He : pp. 25-26, pl. 2, figs. 10-13.

Description : Shell tightly coiled, curved throughout its length through an angle of almost 90° ; coiling nearly planispiral ; shell cross section elliptical ; aperture flared, elliptical ; regularly spaced annulation subdued near the apex.

Remarks : Only one specimen studied here is a broken piece. Apex and a part of aperture are lost, although the general feature enables the present authors to assign it to the species originally described in China(He, 1984). *Lapworthella rete* Yue, 1987 described by Qian & Bengtson(1989) is similar to the present species, but the former has rounded rectangular cross section. Annulation pattern of *Archaeospira ornata* Yu, 1979 of the same study shows wider distribution pattern than that of the species studied here.

Occurrence : Sample K3-9.

Material : 1.

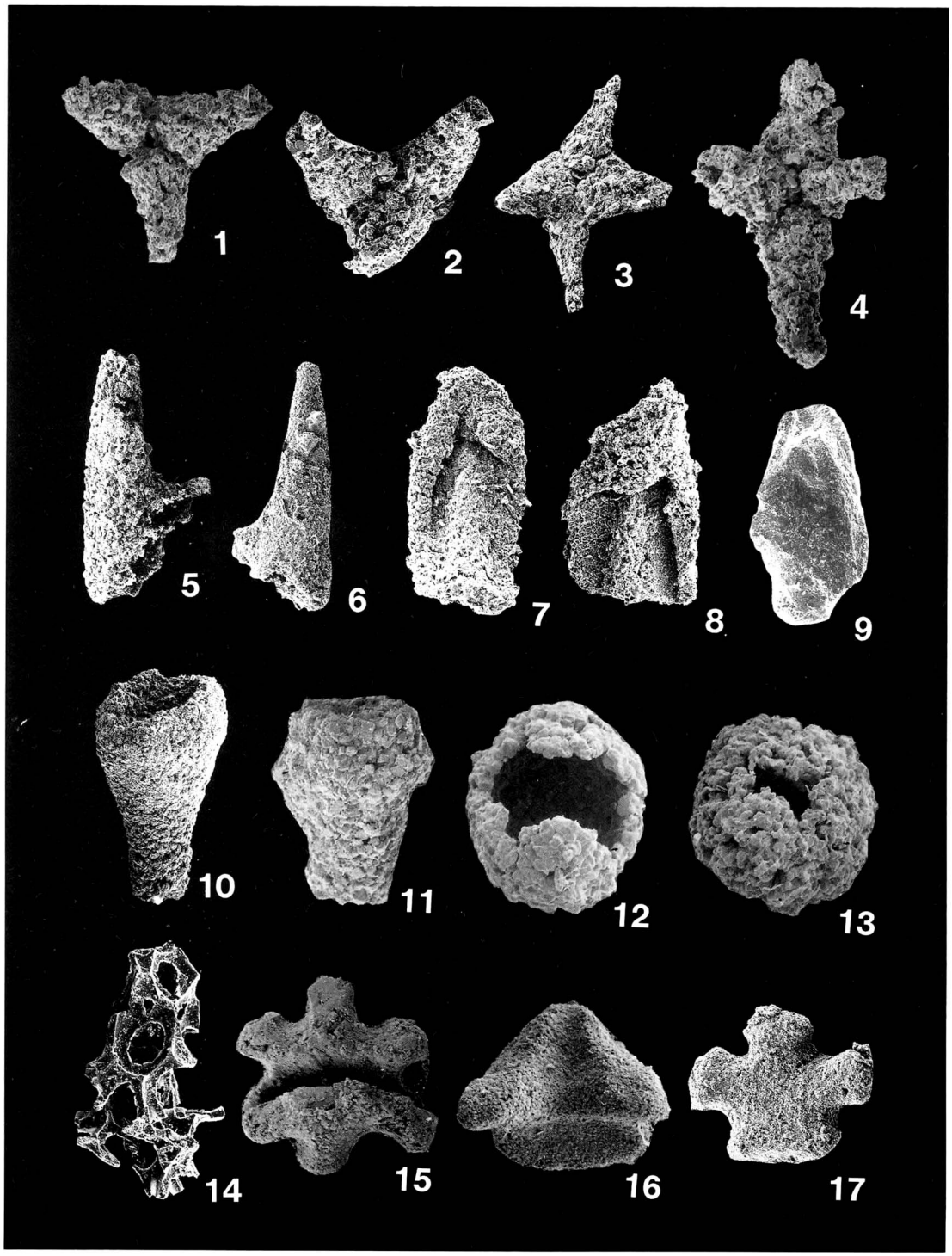
8. Incertae sedis

Group CONODONTIFORMES
Family DISTACODIDAE
Genus *GANLOUDINA* He, 1980

PLATE 3

Fig. 1-2. *Allonnia erromenosa* Jiang, 1982 upper views, 1 : Myobong Slate, K3-9, X63, YSUG 1100. 2 : Myobong Slate, K3-9, X60, YSUG1101. **Fig. 3-4.** *Archiasterella quadratina* Lee, 1987. upper views, 3 : Myobong Slate, K6-6, X55, YSUG1102. 4 : Myobong Slate K6-6, X90, YSUG 1103. **Fig. 5-6.** *Ganloudina platybasala* Yang & He, 1984 lateral views, 5 : Myobong Slate, K3-1, X38, YSUG1104. 6 : Myobong Slate, K3-1, X42, YSUG1105. **Fig. 7-9.** *Ernogia acculatus* Jiang, 1982 inner views, 7 : Myobong Slate, K3-11, X38, YSUG1106. 8 : Myobong Slate, K 3-6, X26, YSUG1107. 9 : Myobong Slate, K3-7, X50, YSUG1108. **Fig, 10-11.** *Mirabifolliculus* ? *chytroformis* Yang & He, 1984 lateral views, 10 : Daegi Limestone, K6-35, X45, YSUG1109. 11 : Daegi Limestone, K6-35, X50, YSUG1110. **Fig. 12-13.** *Nanjiangofolliculus circocodonus* Yang & He, 1984 upper views 12 : Myobong Slate, H1-1, X50, YSUG1111. 13 : Myobong Slate, H1-1, X65, YSUG1112. **Fig. 14.** *Microdictyon* ? sp. 14 : Daegi Limestone, K4-17, X58, YSUG 1113. **Fig. 15-17.** Undifferentiated small shelly fossils 15 : Daegi Limestone, H2-2, X37, YSUG 1114. 16 : Daegi Limestone, K4-18, X58, YSUG1115. 17 : Daegi Limestone, H2-3, X38, YSUG 1116.

PLATE 3



Gonloudina platybasala Yang & He, 1984
Pl. 3, figs. 5, 6

1984 *Ganloudina platybasala* Yang & He : p. 39, pl. 4, figs. 1, 2, 4, & 5.

Description : Conical shell depressed laterally, slightly inclined posteriorly ; base is projected posteriorly ; basal cavity deep, and elliptical in cross section.

Remarks : Morphological features of the species are identical to those of Chinese species originally described by Yang & He(1984). Some specimens included in this study, however, show indistinct posterior projections of their bases.

Occurrence : Samples K3-5, K3-6, K3-7, K3-8, K3-9, K3-10, K3-11, K3-12, K4-18.

Material : 105.

Genus *MIRABIFOLLICULUS* Yang & He, 1984

Type species : *Mirabifolliculus chytroformis* Yang & He, 1984

Mirabifolliculus ? chytroformis Yang & He, 1984
Pl. 3, fig. 10

1984 *Mirabifolliculus chytroformis* Yang & He : p. 42, pl. 3, figs. 13-15.

Description : Shell vase-shaped, upper portion is expanded to make rounded triangular shape, neck is rather narrow and long ; aperture at upper end is slightly elongate in outline, lower end is slightly convex ; surface smooth.

Remarks : Chinese species described by Yang & He(1984) has a basal portion expanded to form a flat, wide base. Otherwise, it is identical to the present species.

Occurrence : Samples K6-34, K6-35.

Material : 9.

Genus *NANJIANGOFOLLICULUS* Yang & He, 1984

Type species : *Nanjiangofolliculus circocodonus* Ynag & He, 1984

Nanjiangofolliculus circocodonus Yang & He, 1984
Pl. 3, figs. 11, 12

1984 *Nanjiangofolliculus circocodonus* Yang & He ; p. 43, pl. 3, figs. 8-12.

Description : Shell spherical to bowl-shaped ; shape of the central cavity is equicentric sphere ; aperture circular ; wall thick and surface smooth.

Remarks : Walls of spceimens included in the study are almost exclusively recrystallized.

Occurrence : Samples H1-14, K1-1.

Material : 35.

Family Uncertain

Genus *ERNOGIA* Jiang, 1982

Type species : *Ernogia acculatus* Jiang *in* Luo *et al.*, 1982

Ernogia acculatus Jiang, 1989
Pl. 3, figs. 7-9

1989 *Ernogia acculatus* Jiang : Quan & Bengtson, pp. 100-101, fig. 64.

Description : Shell ovately triangular in plan view, shell curved so that the lateral view is almost bow-shaped, curvature is not prominent is some specimens ; surface covered by faint nodes.

Remarks : Beak-like structure at the apex described by Qian & Bengtson(1989) is not noticed in the specimens studied here, probably due to the poor state of preservation.

Occurrence : Samples K3-6, K3-7, K3-9, K3-10, K3-11, K3-12, K7-38.

Material : 83.

Group & Family Uncertain

Genus *MICRODICTYON* Bengtson, Matthews & Missarzhevsky, 1981

Type species : *Microdictyon effusum* Bengtson, Matthews & Missarzhevsky, 1981

Microdictyon ? sp.

Pl. 3, fig. 13

Description : Frameworks connected at different angles to form a three dimensional reticulate pattern ; outgrowth of frameworks form the elliptical pores ; surface smooth.

Remarks : Only fragmented specimens are included in this study. *Microdictyon* spp. described by Bengtson *et al.*(1986) have similar morphological features to the specimens studied here.

Occurrence : Samples H1-1, H2-3, H2-4, H2-5, K3-9, K4-13, K4-14, K4-16, K4-17, K4-18, K4-21, K4-22, K4-23,K4-24, K4-25, K6-27, K6-28, K6-30, K6-31.

Material : 113.

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강원도 영월-정선지역의 백운산향사대에 분포하는 묘봉층과 대기층에 대한 미화석연구

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요 약

강원도 영월 및 정선지역의 백운산향사대에 분포하는 묘봉층과 대기층에서 산출된 캠브리아기의 미화석을 최초로 기재하고, 이들 화석군에 의하여 두 층을 층서학적으로 연구하였다. 채취된 55개의 시료중 45개의 시료에서 4,487개체의 다양한 미화석이 산출되었다. 이들은 삼엽충 4속 4종, 코노돈트 2속 2종, 완족류 5속 5종, Hyolithids 2속 3종, 복족류 1종, 강장동물 1종, 해면동물 골각부 2속 2종, 및 소속불명 4속 4종 등 총 21속 22종으로 분류되었다. 기재된 미화석군은 기존의 국내, 중국, 호주등의 지층에서 산출된 화석군과 대비되었으며, 이들이 지시하는 시대는 묘봉층과 대기층이 각각 'late Early to early Middle Cambrian' 및 'middle Middle Cambrian'으로 밝혀졌다.

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