

LITHOSTRATIGRAPHY AND CONODONT BIOSTRATIGRAPHY OF THE CHOSEON SUPERGROUP (CAMBRO-ORDOVICIAN) IN THE EASTERN DANYANG AREA

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ABSTRACT

The Choseon Supergroup, especially stratigraphic interval across the Cambrian-Ordovician boundary, in eastern Danyang area was investigated to evaluate the previous lithostratigraphic classification, and to describe and correlate conodont faunas with the relevant ages of the rest of the world. All stratigraphic data including lithologic characters, stratigraphic relations and associated faunas, confirm that the Cambro-Ordovician lithostratigraphy of the area is largely equivalent to that of Duwibong area, except lateral variation. Three conodont zones were tentatively erected in the upper Hwajeol Formation, namely the *Proconodontus muelleri*, *Eoconodontus notchpeakensis*, and *Cordylodus proavus* Zones in ascending order, and one, the *Rossodus manitouensis* - *Scolopodus quadraplicatus* Zone, was recognised in the lower Dumugol Shale, based on 321 identifiable conodont specimens from 33 samples within five measured sections and three spot localities. This biostratigraphic zonation essentially corresponds to the zonal scheme of type area, resulting in identical correlation data.

INTRODUCTION

The Duwibong-type Choseon Supergroup is mainly distributed in the Paekunsan synclinal area across Taebaegsan region, eastern Yeongweol and Taebaeg city, Gangweon Province. The supergroup in this area forms the standard stratigraphy of the Lower Paleozoic in Korea.

In eastern Danyang area, a part of the southwest extension of the supergroup is exposed like a belt, with NE-trend, along east side of the Namhan River (Fig. 1).

On the basis of lithologic similarity and megafossil data (particularly trilobites, brachiopods and mollusks from the Hwajeol, Dumugol, Jigunsan, and Duwibong Formations) of Shiraki, Kobayashi (1966) divided the Choseon Supergroup in Danyang area into eight lithostratigraphic units, including the Jangsan, Myobong, Daegi, Sesong (?), Hwajeol, Maggol, Jigunsan and Duwibong Formations, in ascending order.

Prior to this, Kobatake (1942) made a draft on the stratigraphic classification of the Choseon Supergroup in the area, consisting of the relatively thin Yangdeog Series (his own term) of Cambrian age and the overlying thick Great Limestone Formation of Cambrian and Or-

dovician age.

Up to date, fossils including conodont, of the Cambro-Ordovician in the Duwibong area have been studied intensively in order to establish solid stratigraphic correlation, whereas no paleontologic data have been published on the relevant unit in the Danyang area, since Kobayashi (1958). A few available publications concerning the geologic mapping and structure of the Danyang area were Lee, D. S. (1966), Won, C. G. & Lee, H. Y. (1967), and Kim, J. H. & Koh, H. J. (1992).

This is the first conodont study of the Choseon Supergroup in eastern Danyang area, and this study may give an important suggestion on the stratigraphy of the area. And this work was carried out as the second in a planned series of our project "Lower Paleozoic biostratigraphy of the Danyang area". See Lee, B. S. *et al.* (1994) for the conodont study of Ogdong-Yeongchun area.

The aims of this investigation were twofold : firstly, to evaluate the lithostratigraphic classification and correlation ; and secondly, to describe and correlate conodont faunas with those from equivalent ages of Korea and the other countries.

All the conodont specimens are deposited at Department of Geology, Chonbuk National University.

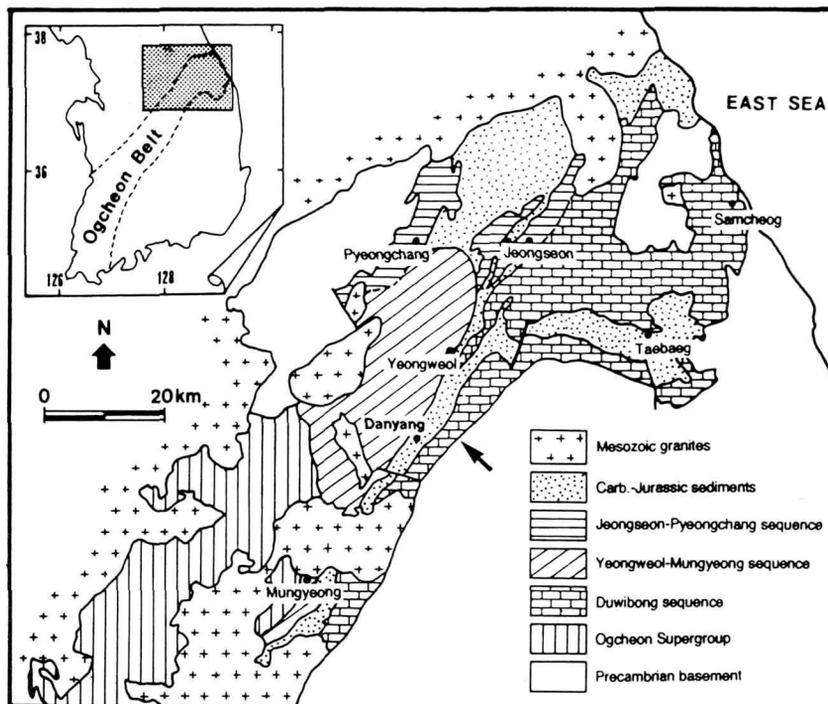


Fig. 1. Distribution of the Choseon Supergroup in the northeastern part of the Ogcheon Belt and location of study area (Choi, 1992).

LITHOSTRATIGRAPHY AND MEASURED SECTIONS

Previous Investigations

The first schematic classification of the Choseon Supergroup in eastern Danyang area was undertaken by Kobatake (1942), who divided the succession into two parts, the lower Yangdeog Series into "Quartzite" (100 m, =Jangsan Quartzite of the type area) and "Shale with limestone lenses" (100 m =Myobong Slate), and the Great Limestone Formation (Group) into "Lower part" (600 m, Limestone, calcareous micaceous phyllite and dolomite) and "Upper part" (2,500 m, Limestone, shale and sandstone, and Limestone and marly shale). His subdivision of the Yangdeog Series is very closely related to the type stratigraphy

Formation	Thickness (m)	General lithology	Fossils
Duwibong	50	Massive limestone	Ormoceroids
Jigunsan	10-20	Dark grey shale	Ormoceroids
Maggol	50-70	Mostly massive, but vermicular near the top	
Dumugol	50	Light grey shale	<i>Pomatotrema shinsoensis</i>
	30-40	Alternation of vermicular and non-vermicular limestones	
	10-20	Quartzite	
Hwajeol	500	Alternation of vermicular limestone, marl and well bedded limestone	<i>Dictyites Zone</i>
			<i>Kaolishania Zone</i>
			<i>Chuangia Zone</i>
Sesong	50	Alternation of quartzite, sandstone and bedded and vermicular limestones	
Daegi	400-500	Massive and thick limestone with intercalated marl or shale	
Myobong	100	Bluish grey or black phyllitic shale or slate containing sericite flakes and sometimes sandy thin lenses of white or light reddish limestone	
Jangsan	50-100	White or light grey quartzite; round gravels of white quartzite contained at places	

Fig. 2. Generalized stratigraphic sequence of the Choseon Supergroup in eastern Danyang area (Kobayashi, 1966).

but it is impossible to correlate exactly each of the Great Limestone Formation to the stratigraphy.

As mentioned above, Kobayashi (1966, p. 25, 26) classified lithostratigraphically the Choseon Supergroup in eastern Danyang area into eight formations, and recognised six fossiliferous horizons based on Shiraki's fossil collection, as shown in Fig. 2. His refined classification is nearly equivalent to that of Duwibong area, and is characterized by the absence of the Dongjeom Quartzite, which is incorporated within the basal Dumugol Shale. We take it that he has counted the lateral variation of the quartzite bed, particularly in thickness. He has been measured the thickness of the quartzite bed only to 10–20 m. His classification system was followed by Lee, D. S. (1966) who mapped Ogdong Sheet, north quadrangle of Danyang Sheet (Won, C. G. & Lee, H. Y., 1967).

Soon after, Won, C. G. & Lee, H. Y. (1967) proposed a stratigraphic classification scheme principally identical to that of Kobayashi (1966), except transitional interval of the Cambrian–Ordovician, in their geological map of the Danyang Sheet and explanatory text (Fig. 3). They denominated a new lithostratigraphic name “Cheondongri Formation”, incorporating the stratigraphic units assignable to the Hwajeol and Dongjeom formations of the type area on the ground of discontinuous exposures of quartzite (sandstone) beds probably related to lateral lithofacies change.

This Study

The Choseon Supergroup, unconformably overlain by the Precambrian granitoid basement to the east and unconformably underlain by the Upper Paleozoic Pyeongan Group to the west, in the eastern Danyang area consists of the lower Yangdeog and upper Great Limestone Groups of Cambrian and Ordovician age. The former is subdivided into the Jangsan and

Formation	Thickness(m)	General lithology
Dumugol	30-70	Alternation of vermicular limestone and shale;excluding any quartzite bed
Cheondongri	200-250	Alternation of sandstone, limestone and marl;<5(max. 1.5 m thick) sandstone beds are interbedded;irregular vermicular limestone in middle part;massive limestone dominant in upper part
	177-215	
	20-30 3-5	Dark grey and greenish grey, calcareous shale Dolomitic shale showing vermicular weathered surface
Pungchon(part)		Massive dolomitic limestone showing black weathered surface

Fig. 3. Generalized stratigraphy of the Cheondongri and adjacent formations in eastern Danyang area (Won, C. G. & Lee, H. Y., 1967).

Myobong Formations, and the latter into the Daegi, Sesong, Hwajeol, Dongjeom, Maggol, Jigunsan and Duwibong Formations in stratigraphic order.

This stratigraphy corresponds basically to that of the type Duwibong area, especially in lithologic characters, stratigraphic relations and associated faunas. Some of the most important stratigraphic findings through field and laboratory observations are summarized below.

The Jangsan Quartzite, basal marker bed of the Choseon Supergroup, is relatively thin as thick as 100 m, and comprises thick shale beds. Also, the Myobong Slate, as well as the Daegi and Sesong Formations, includes several layers of phylletic rocks.

The rocks of the Cambrian - Ordovician boundary interval are composed of various types of limestones, including laminated, thin-bedded, nodular, pebble or flat-pebble (conglomerate), and crystalline limestones, which are associated with shale, sandstone, and quartzite. The Hwajeol and Dumugol Formations made of more sandy beds toward Danyang, and the Dongjeom Quartzite is exceedingly thin in places, and includes many sandy shale beds, so that all these and structural complexity probably due to successive deformations, can give rise to confusion in differentiating them one another with certainty in the field to some extent.

The Maggol and Duwibong Formations are dominated by dark grey laminated, nodular, medium to thick-bedded and dolomitic limestones. The Jigunsan Shale, intercalated between them, also locally very thin, as in Dongjeom Quartzite.

Considering all the published indirect data, and our field and conodont biostratigraphic evidences, overall lithostratigraphy of the Choseon Supergroup in the Danyang area is largely equivalent to that of the type area. Some lithologic and lateral variations are not so great. Furthermore, the sedimentary succession always comprises shallow water sediments with a Duwibong-type fauna.

Although the quartzite beds include some shale layers, and occur repeatedly in places (e. g. Gomjeol and Suchonri sections), the Dongjeom Quartzite is easily traceable in many exposures, for example, from NE to SW, at the entrance of Kuin-sa (Baekja-ri, Yeongchun-myeon), Gomjeol (Gobal-ri, Gagok-myeon), Salgujae - Songjeong (Daedae-ri, Gagok-myeon), Saemgol (Cheondong-ri, Danyang-eup), Murani (Sucon-ri, Danyang-eup), and Saeteo (Nodong-ri, Danyang-eup). All these stratigraphic data let us preferred to employ the Hwajeol Formation and Dongjeom Quartzite rather than the Cheondongri Formation.

Kim, J. H. & Koh, H. J. (1992) described that the Dongjeom Quartzite lay between the Cheondongri and Dumugol formations, comprises thin intercalations of shale and limestone, with 60-100 m in thickness in the Saemgol section. Our field observations in the section they examined, however, suggest that the Dongjeom Quartzite amounts only ca. 21.5 m thick, lie between the Hwajeol and Dumugol formations, and is composed of light brownish, medium to coarse-grained quartzites without any other kinds of lithofacies. It is interpreted that their Dongjeom Quartzite was included the interval ranging from a quartzite unit (true Dongjeom Quartzite) near a trout farm, to quartzite and shale beds (ca. 25.8 m, = a part of the Dumugol Shale) of protruding exposures near a meandering stream in Saemgol section, Cheondong-ri. According to definition of Kobayashi (1934), the Dongjeom Quartzite is consisted mainly of quartzites with a few interbeds of siliceous limestones in places (i.e. Yemi).

Measured Section

Our conodont study herein was concentrated on the Cambrian – Ordovician transition in order to solve discrepancy among authors in classification of the interval, as mentioned above. Therefore, limestone samples for this study were restricted to the upper Hwajeol and lower Dumugol formations. Further studies on other formations are in preparation.

From five measured sections and three localities, thirty-three samples were collected using serial or spot sampling methods. Detailed sampling localities are shown in Fig. 4, and are summarised as follows.

1. Yeosaengi valley, east of Kuin-sa, Baekja-ri, Yeongchun-myeon, Danyang-gun. Four spot samples (Bj 1–4) were collected from the Hwajeol Formation.

2. Roadside outcrops of Provincial route 519 between Yongso village and Deoggane, Bobal-ri, Gagok-myeon, Danyang-gun. Three limestone samples (Bb 1–3) were obtained from the lower part of the Dumugol Shale.

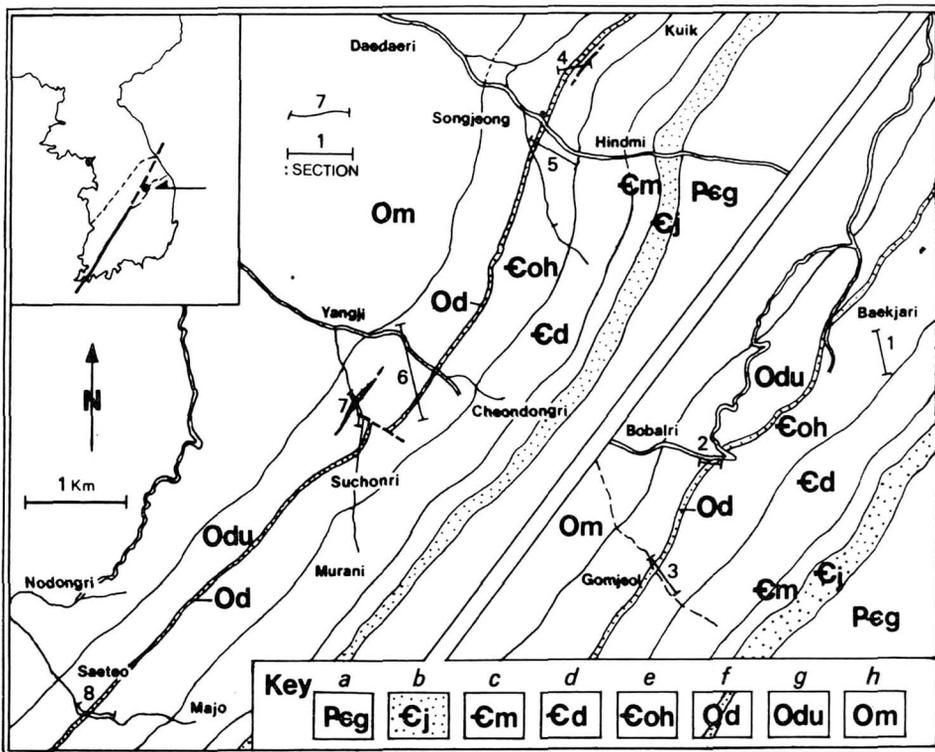


Fig. 4. Geologic map of the study area, showing sampling localities. 1, Baekjari ; 2, Bobalri ; 3, Gomjeol ; 4, Kuik ; 5, Songjeong ; 6, Cheondongri ; 7, Suchonri ; and 8, Saeteo sections. a, Precambrian granitoids ; b, Jangsan Quartzite ; c, Myobong Slate ; d, Daegi Limestone ; e, Hwajeol Formation ; f, Dongjeom Quartzite ; g, Dumugol Shale ; h, Maggol Limestone.

3. Gomjeol section, located at Bobal-ri, Gagok-myeon, Danyang-gun. Five samples (Gj 1-5) were taken from the Hwajeol and Dumugol formations.

4. Kuik section, at entrance of Kuik village, Daedae-ri, Gagok-myeon, Danyang-gun. Two horizons were sampled (Ki 1, 2) from the upper part of the Hwajeol Formation.

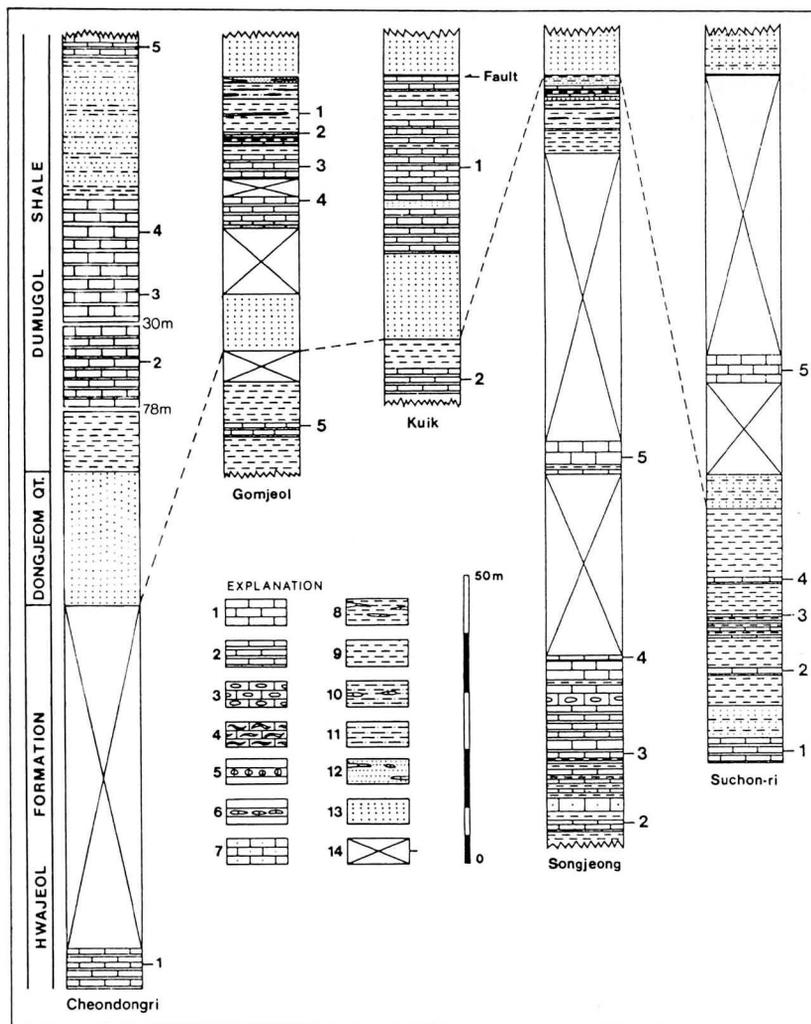


Fig. 5. Stratigraphic column of the Gomjeol, Kuik, Songjeong, Cheondongri and Suchonri sections. Key to explanation : 1, Massive limestone ; 2, Laminated limestone ; 3, Nodular limestone ; 4, Wavy-patterned (ribbon) limestone ; 5, Limestone conglomerate ; 6, Flat-pebble conglomerate ; 7, Crystalline ; 8, Shale with limestone lens ; 9, Shale ; 10, Sandy shale with limestone lens ; 11, Sandy shale ; 12, Sandstone with calcareous part ; 13, Sandstone and quartzite ; 14, Covered interval and sample horizon.

5. Songjeong section, exposed along stream toward Handmi, Daedae-ri, Gagok-myeon, Danyang-gun. Five samples (Hd 2–6) collected from the Hwajeol Formation, and one spot sample (Hd 1) from the Dumugol Shale at opposite roadside of Songjeong section.

6. Cheondongri section, cropped out along valley between Saeteo and Saemgol, Cheondong-ri, Danyang-eup. Five samples (Cd 1–5) were obtained from the upper Hwajeol and lower Dumugol formations.

7. Suchonri section, lay at halfway approaching to Murani, Suchon-ri, Danyang-eup. Five limestone samples (Sc 1–5) were taken from the upper Hwajeol Formation, and one from the lower Dumugol Shale, respectively.

8. Saeteo section, situated at Saeteo village near Nodongcheon, Nodong-ri, Danyang-eup. Three spot samples (Mj 1–3) were made respectively from the upper Hwajeol and lower Dumugol formations.

Each limestone sample varied from 2.5 kg in a sample up to approximately 6.0 kg. All limestones were weighed, crushed as large as 2–3 cm in diameter, and then processed in dilute (approximately 15%) acetic acid. This was followed by microscopic examination of the residues.

CONODONT FAUNA AND BIOSTRATIGRAPHY

Occurrence

Twenty of 33 samples collected from five measured sections and three spot localities, yielded 321 discrete conodont specimens, and these were classified into 34 species assignable to 16 genera based on multielement and form taxonomies (Table 1). Sample horizons are illustrated in Fig. 5.

In general, per-sample recovery is relatively low; only 10 samples contained more than 10 specimens. Stratigraphically, conodonts were abundant in limestone samples from alternation zone of limestone and sandy beds within upper Hwajeol Formation and partially from lower Dumugol Shale, and were extremely rare in lower horizons.

Most specimens were often fragmented, and displayed some degree of flattening, twisting and lateral bending due probably to post-depositional deformations. Cambrian forms were grey to dark grey, and Ordovician ones black, indicating a high degree of thermal maturity.

Zonation and Correlation

Three biostratigraphic zones were recognised in the Upper Cambrian of eastern Danyang area, including the *Proconodontus muelleri*, *Eoconodontus notchpeakensis*, and *Cordylodus proavang* zones in ascending order. Also, one conodont zone was recognised in the lower Dumugol Shale, namely the *Rossodus manitouensis* – *Scolopodus quadraplicatus* Zone.

As shown in Fig. 6, these conodont biozones were established largely based on composition of all examined sections. The *Proconodontus muelleri* Zone was recognized only in Suchonri section; the *Eoconodontus notchpeakensis* Zone in Baekjari and Songjeong sections, respectively; the *Rossodus manitouensis* – *Scolopodus quadraplicatus* Zone in Gomjeol, Kuik, Songjeong, Cheondongri, and Suchonri sections.

The *Proconodontus muelleri* Zone was defined by the first occurrence of the key species,

Table 1. Distribution and abundance of conodonts from productive samples of the Hwajeol and Dumgol formations, eastern Danyang area.

Section and sample no. Species	Baekjari		Bobalri	Gomjeol		Kuik	Songjeong					Cheondongri			Suchonri					Saeteo	
	Bj3	Bj4	Bb2	Gj1	Gj2	Kil	Hd1	Hd3	Hd4	Hd5	Hd6	Cd1	Cd2	Cd5	Sc1	Sc3	Sc4	Sc5	Mj1	Mj3	
<i>Acontiodus propinquus</i>														3	2						
<i>A. shuiyuensis</i>														3							
<i>A. staufferi</i>														1							
<i>Cambrooistodus cambricus</i>		1																			
<i>Cordylodus angulatus</i>				1																	
<i>C. proavus</i> rounded el.												2				1					2
compressed el.											1	4									7
<i>Drepanodus</i> cf. <i>suberectus</i>																					1
<i>D. homocurvatus</i>				1										1							
<i>D. simplex</i>					1																
<i>Drepanoistodus basiovalis</i> oistodiform el.									2					2							
drepanodiform el.														2							
suberectiform el.														1							
<i>Eoconodontus notchpeakensis</i> rounded el.		1								1	1	1	1								1
compressed el.	2	5									8		10			3	4				3
<i>Hirsutodontus primitivus</i>		1																			
<i>Juanognathus</i> sp. cf. <i>J. variabilis</i>					1																
<i>Oistodus inaequalis</i>				1																	
<i>O. lecheguillensis</i> tricostate el.														1							
<i>O. suberectus</i>														2							
<i>O. sp.</i>				2																	1
<i>O. triangularis</i> acodiform el.																					
oistodiform el.																					2
<i>Oneotodus variabilis</i>														2							
<i>O. sp.</i>																					1
<i>Paltodus quinquecostatus</i>														16							
<i>Paroistodus proteus</i> oistodiform el.																					2
<i>Proconodontus muelleri</i>		20								1						1	1				
<i>P. posterocostatus</i>		1																			1
<i>Rossodus manitouensis</i>			10	11	5	2	6							5							
<i>Scandodus</i> sp.														1							
<i>Scolopodus bolites</i>			1			1										2					
<i>S. cornuiformis</i>														6							
<i>S. primitivus</i>																					1
<i>S. quadruplicatus</i>																					1
<i>S. quadracostatus</i>														15							
<i>S. warendensis</i>																3					
<i>S. n. sp.</i>						1	4														
<i>T. nakamurai</i>	20	8						6		4	3	12			2	5	1				3
<i>Variabiliconus bassleri</i>				1	5									15						1	
Total	22	37	11	17	12	4	12	6	2	13	5	29	51	59	3	9	6	3	3	3	17

and upper limit was drawn at the first appearance of *Eoconodontus notchpeakensis*. In Suchonri section. *P. muelleri* occurs only with *Teridontus nakamurai* from laminated limestones, 44.3 m below a thin quartzite bed (ca. 7 m) interpreted herein as the Dongjeom Quartzite. The lower limit of the zone is uncertain, because the conodont-yielded horizon is the lowest one examined herein.

The *Eoconodontus notchpeakensis* Zone was marked at stratigraphic interval between the basal occurrences of the key species and *Cordylodus proavus* which is the key species of the overlying zone. *Eoconodontus notchpeakensis* occurs in limestones within the interval of 205.0 m–178.3 m below the base of the Dongjeom Quartzite in Songjeong section. Although precise stratigraphic interval of the zone is uncertain particularly in Baekjari section due to restricted sampling, this zone contains *Eoconodontus notchpeakensis*, *Hirsutodontus primitivus*, *Proconodontus muelleri*, *P. posterocostatus* and *Teridontus nakamurai*.

The *Cordylodus proavus* Zone is the uppermost zone recognized herein in the Hwajeol Formation, eastern Danyang area. The lower boundary was delineated by the first appearance of *C. proavus*, but the upper boundary was not defined owing to paucity of samples. *C. proavus* occurs at horizons of 16.3 m below the top of the Hwajeol Formation in Songjeong section ; of 62.6 m below in Cheondongri section ; of 20.8 m below in Suchonri section ; and ca. 10 m below in Saeteo section, respectively. *C. proavus* associates with *Eoconodontus notchpeakensis* and *Teridontus nakamurai*. The sparsity of limestone samples from the uppermost portion of the Hwajeol Formation lent reservation to refined interpretation of the Cambrian–Ordovician boundary. In addition, the Lower Ordovician index conodonts have been recovered from that portion of Ogdong–Yeongchun area (Lee, B. S. *et al.*, 1994).

Three Hwajeol conodont zones recognised herein essentially correspond to those of Duwibong (Lee, B. S. & Lee, H. Y., 1988 ; Lee, B. S., 1989a, b, 1990, 1992 ; Lee, B. S. & Lee, J. D., 1993), and Ogdong–Yeongchun (Lee, B. S. *et al.*, 1994) areas. These are correlated to the *Proconodontus–Rotundoconus* and *Cordylodus proavus* zones (Changshanian to Fengshanian Stages) of North China (An, 1983), to the Assemblage Zone 3 to 4 of northern Iran (Muller, 1973), to the lower part of the *C. proavus* Zone of Australia (Druce & Jones, 1971), and to the *Proconodontus* and lower part of the *C. proavus* zones of western North America (Miller, 1980, 1982), respectively.

The samples of the lower part of the Dumugol Shale in the eastern Danyang area, yielded more diverse and abundant conodonts than the Upper Cambrian samples, namely *Acontiodus propinquus*, *A. shuiyuensis*, *A. staufferi*, *Cordylodus angulatus*, *Drepanodus homocurvatus*, *D. basiovalis*, *D. simplex*, *Oistodus inaequalis*, *O. lecheguillensis*, *O. suberectus*, *O. triangularis*, *Paroistodus proteus*, *Rossodus manitouensis*, *Scolopodus bolites*, *S. cornuiformis*, *S. primitivus*, *S. quadracostatus*, *S. quadraplicatus*, *S. quinquecostatus*, and *Variabiliconus bassleri*. This fauna allows the tentative recognition of the *Rossodus manitouensis–Scolopodus quadraplicatus* Zone, which comprises entire interval considered herein. For example, *R. manitouensis* occurs as higher as 35.1 m above the base of the Dumugol Shale in Gomjeol section, and *S. quadraplicatus* occurs as higher as 20.7 m above in Suchonri section.

The *Rossodus manitouensis–Scolopodus quadraplicatus* Zone recognized in the lower part of the Dumugol Shale, is parallel with the *Chosonodina herfurthi–Rossodus manitouensis* Zone and *Scolopodus quadraplicatus* Zone previously erected in Paekunsan synclinal area by Seo, K. S. (1990). This biostratigraphic range is correlated respectively to the upper part of the

SYSTEM		SER. OF EUROPE		SERIES OF N.AMERICA		KOREA		CHINA		IRAN		AUSTRALIA		NORTH AMERICA																
						DUWIBONG AREA (Lee, 1988, 1992; Seo, 1991)		OGDDNG-DANYANG (This study)		NORTH CHINA (An <i>et al.</i> , 1983)		MILA GROUP (Müller, 1973)		QUEENSLAND (Jones, 1971)		WESTERN USA (Sweet <i>et al.</i> , 1971; Eth. & CL, 1981; Miller, 1980, 82)														
CAMBRIAN	UPPER	DRESBACHIAN	FRANCONIAN	HWAJEOI FORMATION	TREMPPEALEAUAN	CANADIAN	DUMMUGOL SHALE	DUMUGOL SHALE	LIANGCHIAASHAN	SHIRGESHT FORMATION	WARENDIAN	DATSONIAN	DAYS	CORDYLODUS PROAVUS	E															
																Westergaardodina matsushitai	?	GUSHAN STAGE	Westergaardodina matsushitai	1	PRE-PAYNTONIAN S.									
																Proconodontus		CHANG-SHAN S	D. ? palmeri-p.rotundatus	2										
		Proconodontus muelleri		FENGSHAN STAGE	Proconodontus -Rotundoconus	3																								
		Proconodontus notchpeakensis				4																								
		Proconodontus muelleri				5																								
	LOWER	HWAJEOI MEMBER	DUMMUGOL SHALE	DUMUGOL SHALE	LIANGCHIAASHAN	YELI STAGE	DONGJIEOM QUARTZITE	DUMUGOL SHALE	LIANGCHIAASHAN							SHIRGESHT FORMATION	WARENDIAN	DATSONIAN	DAYS	CORDYLODUS PROAVUS	B									
																						Westergaardodina matsushitai	?	GUSHAN STAGE	Westergaardodina matsushitai	1				
																						Proconodontus		CHANG-SHAN S	D. ? palmeri-p.rotundatus	2				
																						Proconodontus muelleri		FENGSHAN STAGE	Proconodontus -Rotundoconus	3				
																						Proconodontus notchpeakensis				4				
																						Proconodontus muelleri				5				
UPPER	HWAJEOI MEMBER	DUMMUGOL SHALE	DUMUGOL SHALE	LIANGCHIAASHAN	YELI STAGE	DONGJIEOM QUARTZITE	DUMUGOL SHALE	LIANGCHIAASHAN	SHIRGESHT FORMATION	WARENDIAN	DATSONIAN	DAYS	CORDYLODUS PROAVUS	C																
															Westergaardodina matsushitai	?	GUSHAN STAGE	Westergaardodina matsushitai	1											
															Proconodontus		CHANG-SHAN S	D. ? palmeri-p.rotundatus	2											
															Proconodontus muelleri		FENGSHAN STAGE	Proconodontus -Rotundoconus	3											
															Proconodontus notchpeakensis				4											
															Proconodontus muelleri				5											
UPPER	HWAJEOI MEMBER	DUMMUGOL SHALE	DUMUGOL SHALE	LIANGCHIAASHAN	YELI STAGE	DONGJIEOM QUARTZITE	DUMUGOL SHALE	LIANGCHIAASHAN	SHIRGESHT FORMATION	WARENDIAN	DATSONIAN	DAYS	CORDYLODUS PROAVUS	D																
															Westergaardodina matsushitai	?	GUSHAN STAGE	Westergaardodina matsushitai	1											
															Proconodontus		CHANG-SHAN S	D. ? palmeri-p.rotundatus	2											
															Proconodontus muelleri		FENGSHAN STAGE	Proconodontus -Rotundoconus	3											
															Proconodontus notchpeakensis				4											
															Proconodontus muelleri				5											
UPPER	HWAJEOI MEMBER	DUMMUGOL SHALE	DUMUGOL SHALE	LIANGCHIAASHAN	YELI STAGE	DONGJIEOM QUARTZITE	DUMUGOL SHALE	LIANGCHIAASHAN	SHIRGESHT FORMATION	WARENDIAN	DATSONIAN	DAYS	CORDYLODUS PROAVUS	E																
															Westergaardodina matsushitai	?	GUSHAN STAGE	Westergaardodina matsushitai	1											
															Proconodontus		CHANG-SHAN S	D. ? palmeri-p.rotundatus	2											
															Proconodontus muelleri		FENGSHAN STAGE	Proconodontus -Rotundoconus	3											
															Proconodontus notchpeakensis				4											
															Proconodontus muelleri				5											

Fig. 6. Correlation chart of the Upper Cambrian and Lower Ordovician conodont zones of eastern Danyang area, with those of China, Iran, Australia, and North America.

Cordylodus rotundatus - *Acodus oneotensis* Zone of North China (An, 1983), to the *Chosonodina herfurthi* - *Acodus* Zone of Australia (Druce & Jones, 1971), and to the Fauna C and D of North America (Sweet, Ethington & Barnes, 1971; Ethington & Clark, 1980).

SUMMARY

In view of lithologic characters, stratigraphic relations and associated faunas, the Lower Paleozoic Choseon Supergroup in the eastern Danyang area forms part of a series of facies belt which extends for considerable distances subparallel to the stratigraphy of Duwibong-type succession in the Paekunsan syncline, eastern Yeongweol and Taebaeg City, Kangweon Province. Therefore, the Choseon Supergroup in this area can be classified into nine lithostratigraphic units, including the Jangsan, Myobong, Daegi, Sesong, Hwajeol, Dongjeom, Dumugol, Maggol, Jigunsan, and Duwibong formations in ascending order.

Following this interpretation, although lateral variation and structural complexity obscure differentiation in places of units one another to some extent, the Cambrian - Ordovician boundary rocks were herein referred to the Hwajeol Formation and Dongjeom Quartzite rather than Cheondongri Formation (Won, C. G. & Lee, H. Y., 1967), and so-called the Lower to Late Ordovician "Maggol Formation" was classified into the Maggol Limestone, Jigunsan Shale, and Duwibong Limestone.

PLATE 1

Selected conodonts from the Cambro - Ordovician of eastern Danyang area.

Fig. 1, 6-7. *Eoconodontus notchpeakensis* Miller, lateral views of rounded and compressed elements, Hwajeol and Dumugol Fms., samples Hd 5, Hd 4 and Cd 1, $\times 117$, $\times 127$ and $\times 134$. **Fig. 2, 8.** *Teridontus nakamurai* (Nogami), posterolateral and lateral views, Hwajeol Fm., sample Hd 3, $\times 109$ and $\times 140$. **Fig. 3.** *Proconodontus muelleri* (Miller), Lateral view, Hwajeol Fm., sample Bj 4, $\times 60$. **Fig. 4-5, 9-10.** *Cordylodus proavus* Müller, lateral views of rounded and compressed elements, Hwajeol Fm., samples Sc 3, Mj 3 and Cd 1, $\times 88$, $\times 92$, $\times 52$ and $\times 150$. **Fig. 11.** *Drepanodus homocurvatus* (Lindström), lateral view, Dumugol Sh.b, sample Gj 1, $\times 70$. **Fig. 12.** *Oistodus* sp., lateral view, Dumugol Sh., sample Gj 1, $\times 189$. **Fig. 13.** *Oneotodus* sp., lateral view, Dumugol Sh., sample Cd 5, $\times 124$. **Fig. 14.** *Cornuodus* (?) form, lateral view, Dumugol Sh., sample Cd 3, $\times 105$. **Fig. 15.** *Scolopodus bolites* Repetski, posterior view, Dumugol Sh., sample Ki 1, $\times 82$. **Fig. 16.** *Rossodus manitouensis* Repetski, Dumugol Sh., sample Cd 2, $\times 145$. **Fig. 17.** *Drepanodus simplex* (Furnish), lateral view, Dumugol Sh., sample Gj 2, $\times 245$. **Fig. 18, 20.** *Oistodus triangularis* (Furnish), lateral views of oistodiform and acodiform elements, Dumugol Sh., sample Cd 5, $\times 133$ and $\times 147$. **Fig. 19, 21.** *Drepanoistodus basiovalis* (Sergeeva), lateral views of drepanodiform and oistodiform elements, Dumugol Sh., samples Hd 1 and Cd 5, $\times 133$ and $\times 112$. **Fig. 22.** *Scolopodus quadruplicatus* Branson & Mehl, Dumugol Sh., sample Cd 5, $\times 58$.

PLATE 1



The limestone samples for conodont study were concentrated to the stratigraphic interval of the Hwajeol and Dumugol formations in order to refer to the lithostratigraphic classification as noted above. Three biostratigraphic zones were recognised in the Upper Cambrian of eastern Danyang area, including the *Proconodontus muelleri*, *Eoconodontus notchpeakensis*, and *Cordylodus proavus* zones in ascending order, and one Lower Ordovician conodont zone, *Rossodus manitouensis* – *Scolopodus quadraplicatus* Zone, was recognized in the lower part of the Dumugol Shale based on 321 identifiable conodont specimens from 33 samples within five measured sections and three spot localities.

This biostratigraphic zonation of the eastern Danyang area is analogous to that of the Duwibong, and the Ogdong – Yeongchun areas, resulting in identical correlation data. This biostratigraphic data support our proposal on lithostratigraphic classification of the eastern Danyang area.

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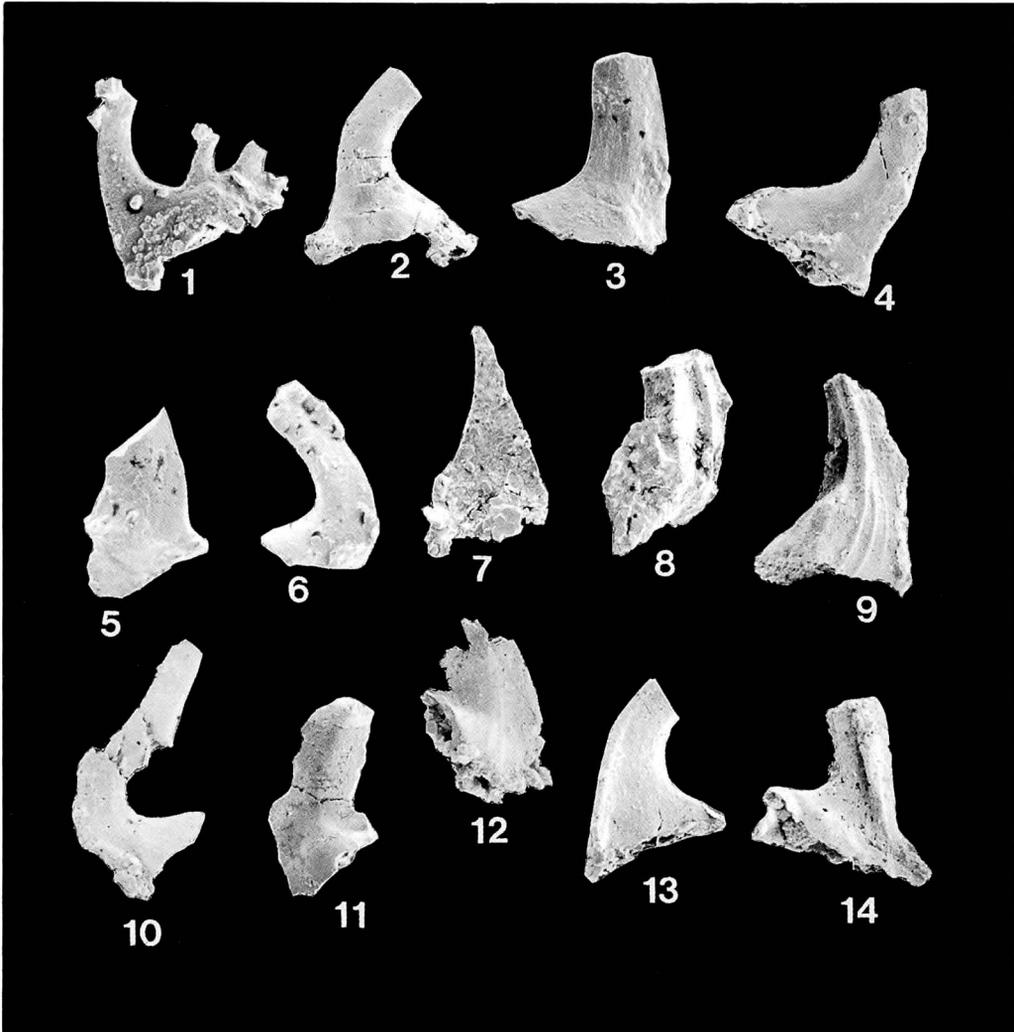
Fieldwork was carried out several times : in middle August and early October 1993, in middle April and late September 1994, in late May and late June 1995, and in late February and late April 1996. Most of our laboratory work have been carried out at Department of Earth Science, Chonbuk National University, Jeonju.

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PLATE 2

Fig. 1. *Cordylodus angulatus* Pander, lateral view, Dumugol Sh., sample Gj 1, $\times 147$. **Fig. 2.** *Drepanodus* sp. cf. *D. arcuatus* (Lindström), lateral view, Dumugol Sh., sample Gj 1, $\times 70$. **Fig. 3.** *Drepanodus suberectus* Bransom & Mehl, lateral view, Dumugol Sh., sample Cd 2, $\times 168$. **Fig. 4–6, 11.** *Drepanoistodus basiovalis* (Sergeeva), lateral views of drepanodiform, suberectiform and oistodiform elements, Dumugol Sh., sample Cd 5, $\times 127$, $\times 147$, $\times 168$ and $\times 100$. **Fig. 7.** *Acontiodus* (?) sp. (Flattened element), posterior view, Dumugol Sh., sample Gj 1, $\times 86$. **Fig. 8.** *Scolopodus* n. sp., posterolateral view, sample Ki 1, $\times 70$. **Fig. 9, 14.** *Paltodus quinquecostatus* Müller, Dumugol Sh., samples Cd 1 and Cd 2, $\times 98$ and $\times 70$. **Fig. 10.** *Drepanodus homocurvatus* (Lindström), lateral view, Dumugol Sh., sample cd 5, $\times 88$. **Fig. 12.** *Paroistodus proteus* (Lindström), lateral view of oistodiform element, Dumugol Sh., sample Cd 5, $\times 74$. **Fig. 13.** *Scandodus* sp., lateral view, Dumugol Sh., sample Cd 2, $\times 70$.

PLATE 2



단양 동부지역 조선누층군 (캄브리아-오르도비스계)의 암층서와 코노돈트 생층서

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요 약

단양 동부지역의 조선누층군, 특히 캄브리아-오오도비스계 경계부의 층서 범위에 대한 그간의 암층서분류를 평가하고, 코노돈트 화석군을 기재, 대비하기 위하여 이 연구를 실시하였다. 이 지역의 층서는 다소의 횡적 변화가 있으나 암상, 층서 관계 및 화석군을 고려해 볼 때, 표식지인 두위봉지역의 층서와 거의 유사하다. 연구지역 8개 층서 단면 33개 표점에서 선별된 321 개체의 코노돈트에 대한 생층서 연구 결과, 화절층 중상부 구간에서 하부로부터 *Proconodontus muelleri*, *Eoconodontus notchpeakensis* 및 *Cordylodus proavus* 대 등 3개 생층서대와, 두무골세일 하부에서 *Rossodus manitouensis* - *Scolopodus quadraplicatus* 대가 잠정 인지되었다. 이러한 생층서 분대는 근본적으로 표식지의 그것과 일치하는 것이어서 층서 대비에 있어서도 같은 결과가 나왔다.

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