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SHELLY FOSSILS FROM THE MACHARI FORMATION (LATE CAMBRIAN), YEONGWOL

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ABSTRACT

Diverse shelly fossils from the lower part of the Machari Formation, Yeongwol, are first reported. The Machari Formation has previously been assigned to the Late Cambrian age, based on time-sensitive trilobites, conodonts, and molluscs etc. The fauna recovered consists of a number of problematic phosphatic sclerites, including diverse cone-shaped forms (=coniform conodont-like) such as smooth, spiny, arched, and longitudinally furrowed ones and other enigmatic forms which resemble bamboo joint or dumbbell in outline, and genal spine of trilobite. All taxa are preliminarily described due to uncertain taxonomic status.

INTRODUCTION

The Cambrian small shelly and problematic fossils were initiated to study in 1970's at some western countries, and then gradually have a valuable position through the cumulative studies in the Lower Paleozoic biostratigraphy and paleoenvironment. In Korea, some reports on shelly and problematic fossils were published on the Lower to Middle Cambrian of Munkyeong, Yeongwol and Paegunsan synclinal areas (Lee, H.Y., 1987 ; Lee, B.S. *et al.*, 1991 ; Lee, H.Y. *et al.*, 1992).

This report is a part of the paleontological study on the Machari Formation in the Yeongwol area. Previously, the senior writer has studied conodonts (1991) and macrofossils including mollusks, trilobites and others (1992).

The purpose of this study is to describe shelly and problematic fossils from the Machari Formation in the Yeongwol area, and then evaluate them in view of biostratigraphic and paleoenvironmental applications.

STRATIGRAPHIC SUMMARY

The Machari Formation was proposed by Yoshimura, I. (1940) for the peculiar banded limestone beds between the lower clastic sediments (Sambangsan Formation) and the upper dolomitic limestones (Wagok Formation) in the Yeongwol area.

Recently, Lee, B.S. *et al.* (1991) classified the Machari Formation in the study area into two members : the lower dark-grey to black shale member and the upper dark-grey thin-bed-

ded limestone (so-called banded limestone) member. The lower part of the formation in the Konggi-ri (Eodungol) area consists of black shales with several limestone interbeds, and the basal part was not exposed (Fig. 2).

The Eodungol section from which shelly fossils were only recovered herein is fairly well exposed along a road for forest conservancy in southern slope of Mt. Sambang, Konggi-ri, Puk-myeon, Yeongwol-gun. the section measured herein amounts to 69 m in thickness, starting about 23 m above the thick greenish-grey shale beds of the underlying Sambangsan Formation, and consists of alternation of black shales and limestones. Sample horizon is marked on Fig. 2. See Lee, B. S. *et al.* (1991) in detail concerning associated fauna and correlation.

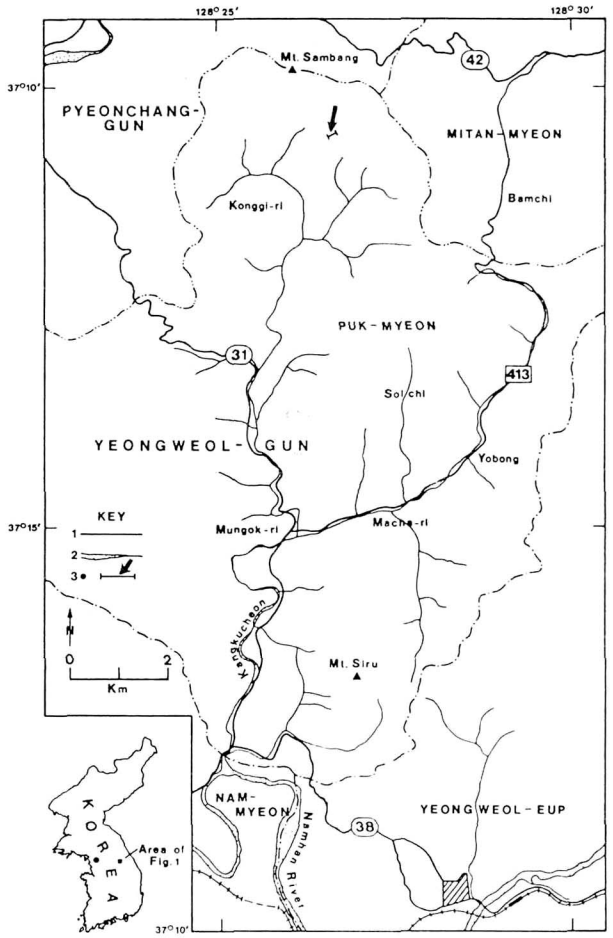

Fig. 1. Location map for Eodungol section of the Machari Formation in the Yeongwol area 1 : National and provincial roads. 2 : Rives and streams. 3 : Measured section.

SHELLY FAUNA

Diverse shelly fossils were recovered from the lower part of the Machari Formation in the Eodungol section, Konggi-ri, Puk-myeon, Yeongwol-gun, Kangweon-do.

Previously, the sample Eo 188 also yielded a fairly diverse fauna such as conodonts, including *Furnishina triangulata, F. furnishi, Gapparodus bisulcatus, G.* cf. *bisulcatus, G.* n. sp., *G.* sp., *Phakelodus tenuis, Westergaardodina matsushitai* and *W. moessebergensis* (Lee, B. S. *et al.*, 1991), mollusks (*Costipelagiella* n. sp.) and trilobites (*Leijopyge armata*).

The shelly fauna occurs as phosphatised or recrystallized sclerites, and includes cone-shaped forms (=coniform conodont-like) with smooth and spiny surfaces, longitudinally furrowed form, bamboo joint or dumbbell-like form, and genal spine-like form.

Isolated coniform sclerites with smooth surface (pl. 1, figs. 1–4, ? 5) resemble some Late Cambrian proconodontiid conodonts and Lower to Middle Cambrian tubular fossils such as *Conotheca* Missarzhevsky, *Salanacus* Grigorieva or *Koksodus* Missarzhevsky in outline, respectively.

Multisclerites fused on a plate (pl. 1, figs. 8, 9, ? 12) have a strong resemblance to *Paracardiniachites* Quian and Jiang, and *Brushenodus* Jiang reported respectively from the Lower Cambrian of China.

Spinous cap-shaped sclerite (pl. 1, fig. 17) closely resembles the lowermost Ordovician conodont species *Clavohammulus*, but precise affinity is uncertain.

Serrate coniform sclerites (pl. 1, fig. 13) also resemble *Proconodontus posterocostatus* Miller or *P. serratus* Miller of conodont, but the conodont taxa have small sharp lateral edges.

The biostratigraphic correlation of all shelly taxa described herein is unclear at the present level. But, the stratigraphic position of the shelly fauna strongly suggests that the fossil-bea-

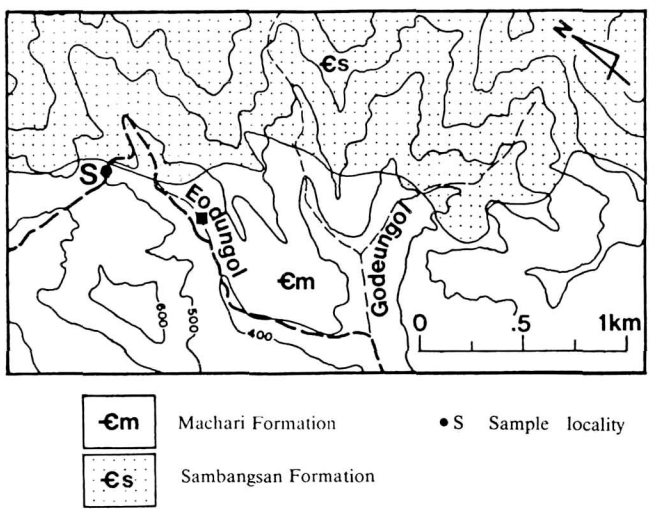

Fig. 2. Geological map around the Eodungol section (S), southern slope of Mt. Sambang.

ring bed was deposited in the Late Cambrian, in view of the geologic age of the common species such as conodont (*Gapparodus bisulcatus* and *Westergaardodina matsushitai*), trilobite (*Leijopyge armata*), and mollusk (*Costipelagiella* n. sp.).

SYSTEMATIC DESCRIPTION

The species assignments are temporally uncertain, and our groupings are highly speculative. Some other enigmatic fossils such as arched sclerites (pl. 1, figs. 10, 11), bamboo joint-like sclerites (pl. 1, fig. 14, 15) are not described further.

All figured specimens are deposited in the repository of the Department of Earth Science Education, Chonbuk National University, Jeonju.

Genus and species indet. A

(Isolated coniform sclerites with smooth surface)

Pl. 1, figs. 1–4, ? 5

Description : Isolated, slender to robust (approximately 0.7–3.05 mm in length), erect to slightly proclined (partially twisted), recrystallized phosphatic steinkerns, gently to rapidly tapering away from a round to weakly elliptical aperture (proximal outline). Internal sides preserved as rather excavated in some specimens, but infilled with coarse materials in many specimens. Distal cross section round to oval, lacking any surfacial structure.

Discussion : The sclerites are slightly different from each other, but they are tentatively grouped herein based on gross outer morphology. All forms are closely similar in outline to the Cambrian proconodontiid conodonts (*Proconodontus gallatini* (Müller) and *P. rotunda-*

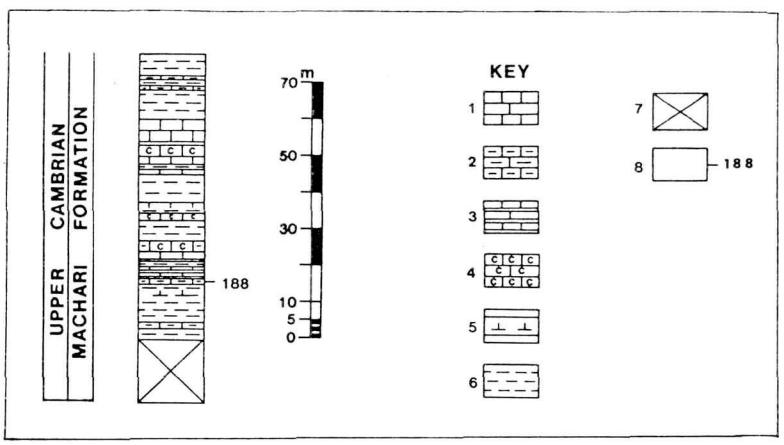

Fig. 3. Stratigraphic section for the fossil horizon at the Eodungol section. 1 : massive limestone. 2 : laminated or clayey limestone. 3 : banded limestone 4 : crystalline limestone. 5 : calcareous shale. 6 : non-calcareous shale. 7 : no outcrop. 8 : sample with fossils

tus (Druce and Jones)). The relatively large (mainly 7–20 times over), however, recrystallized steinkern, and extremely shallow cavity can be distinguished from the conodont forms. Although they may be taxonomically separated, the present isolated sclerites may be component elements (all but pl. 1, fig. 4) forming an independent apparatus as shown in conodonts. Multisclerites fused on a plate (pl. 1, figs. 8, 9, ? 12) serve as a clear evidence of this interpretation.

This forms, also, resemble in outline, tubular fossil such as *Conotheca* Missarzhevsky, but the latter has a aperture perpendicular to the longitudinal axis and dense growth lines.

Particularly, one form (pl. 1, fig. 4) is probably regarded as isolated element of *Salanacus* Grigorieva or *Koksodus* Missarzhevsky. Rozanov (1986) tentatively assigned these conical teeth on a plate to gastropod radula.

Genus and species indet. B
(Multisclerites fused on plates)
Pl. 1, figs. 8, 9, ? 12

Description : Fused, 2.25 mm in max. length and 3.0 mm in max. width, recrystallized, phosphatic serrate sclerite, consisting of a basal supporting plate and up to 4 cone-shaped spines. Basal plates comprise both nearly straight-solid and undulatory-slightly excavated morphs. Spines are reclined to one lateral side, fused or discrete, inequidimensional, gently tapering, and round in cross section.

Discussion : The forms described may be interpreted as individual elements of the multisclerites, but the idea is, temporally, in status of speculation.

This morphologic group has a strong resemblance to *Paracariniachites* Quian and Jiang, and *Brushenodus* Jiang reported respectively from the Lower Cambrian of China.

Genus and species indet. C
(Spinous cap-shaped sclerites)
Pl. 1, fig. 17

Description : Bilaterally subsymmetrical (slightly bended to one lateral side), cap-shaped with spines, hollow sclerite, rapidly tapering away from round aperture to sharp distal tip. Ratio of width/height is 1 : 1 (both 2.05 mm). Outer surface covered with numerous, uprightly projected tiny spines.

Discussion : This specimen closely resembles the lowermost Ordovician conodont species *Clavohamulus* Miller, but precise affinity is unclear.

Genus and species indet. D
(Serrate coniform sclerites)
Pl. 1, fig. 13

Description : Bilaterally symmetrical, straight, up to 3.3 mm long, weakly tapering, hollow, fragmentary coniforms with regularly-spaced tiny spines on inner lateral margin. The cone is flattened, forming oval to elliptical cross section. The surface of the cone is smooth.

Discussion : The appearance of regularly denticulated cone resembles *Proconodontus posterocostatus* Miller or *P. serratus* Miller of conodont, but the conodont taxa have small, sharp lateral edges.

Genus and species indet. E
(Furrowed tubular sclerites)
Pl. 1, figs. 6, 7

Description : Uniform (no divergence angle), 2.75 mm in length, 0.2−0.35 mm in diameter, nearly straight, fragmentary tubes with one longitudinal furrow (groove). Neither proximal nor distal ends preserved. Two tubular morphs are discriminable based on the dimension and orientation of furrow ; straight, broadly furrowed, slender morph (pl. 1, fig. 6) and slightly sinuous, narrowly furrowed, thick morph (pl. 1, fig. 7). Other surface except furrowed region is smooth, lacking of growth lines.

Discussion : Our specimens are similar to other tubular form hitherto reported such as *Anabarites* Missarzhevsky. The three longitudinal sulci of the latter, however, differentiate from the present specimens.

영월지역 마차리층 (캄브리아 후기)의 각질화석

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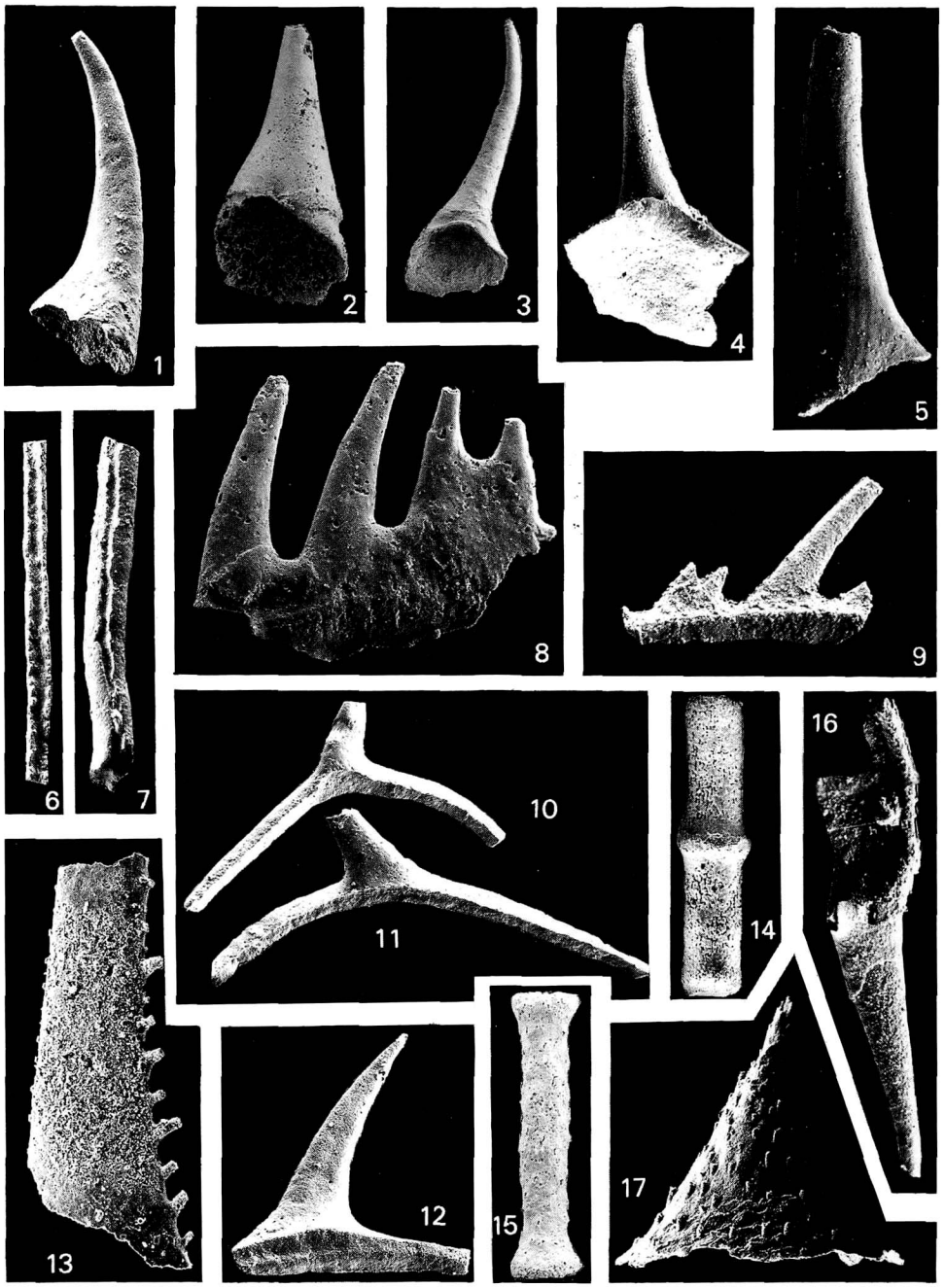
PLATE 1

1−4, ?5 : Isolated coniform sclerites with smooth surface. Eo 188, 1−3, 5, lateral views, 4, posterolateral view, 1.−×64, 2, 3, 5.−×18. **6, 7** : Furrowed tubular scleries. Eo 188, bottom (?) views, ×18 and ×18. **8, 9, ?12** : Multisclerites fused on plates. Eo 188, lateral views, all ×18. **10, 11** : Indeterminate arched sclerites. Eo 188, inner lateral views, ×36 and ×36. **13** : Serrate coniform sclerite. Eo 188, lateral view, ×18. **14, 15** : Indeterminate bamboo joint-like sclerites. Eo 188, lateral views, ×18 and ×18. **16** : ? Genal spine of trilobite. Eo 188, cranidium(?), ×36. **17** : Spinous cap-shaped sclerite. Eo 188, lateral view, ×18.

PLATE 1



요 약

영월의 마차리층 하부에서 다양한 각질화석이 산출되어 이를 처음으로 보고한다. 마차리층은 그간 삼엽충, 코노돈트와 연체동물 화석 등에 의해 캄브리아기 후기 지층으로 대비되어 왔다. 산출된 화석군은 많은 소속불명의 인산질 sclerites로서, 단순형 코노돈트와 흡사한 원추모양, 길게 홈이 파인 원통 모양, 아치형태에 돌기가 난 모양들과 외형이 대나무 마디와 흡사한 것, 그리고 삼엽충의 genal spine을 닮은 형태 등 기이한 유형들로 구성된다. 이들 화석은 분류상의 위치가 불명하므로 여기에서는 형태의 기재만을 하였다.

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