

## Middle Permian ammonoids from the Takakurayama area, Abukuma Mountains, northeast Japan, and their stratigraphical significance

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### Abstract

Four ammonoid species, *Propinacoceras* sp., *Agathiceras* sp., *Mexicoceras?* sp. and *Roadoceras* sp., are described from the upper Takakurayama Formation in the Takakurayama area, Abukuma Mountains, northeast Japan. These ammonoids indicate a Middle Permian (Wordian) age. The Takakurayama ammonoid specimens are reworked fossils, probably derived from shallow marine continental shelf to a deep-sea basin by sediment-gravity flows in Late Permian.

*Key words:* Abukuma Mountains, ammonoid, Middle Permian, reworked fossil, Takakurayama Formation.

### Introduction

Permian rocks consisting chiefly of black shale with sandstone and conglomerate are distributed in the Takakurayama area, eastern Abukuma Mountains, i.e., Yaguki, Yotsukuramachi, Iwaki City, Fukushima Prefecture, northeast Japan (Fig. 1). The Permian section of the Takakurayama area was studied first by Iwao and Matsui in 1961 during mapping of the Taira 1: 50,000 Sheet, published by the Geological Survey of Japan. They recognized the occurrence of some Permian marine invertebrate fossils from around Mt. Takakurayama, and

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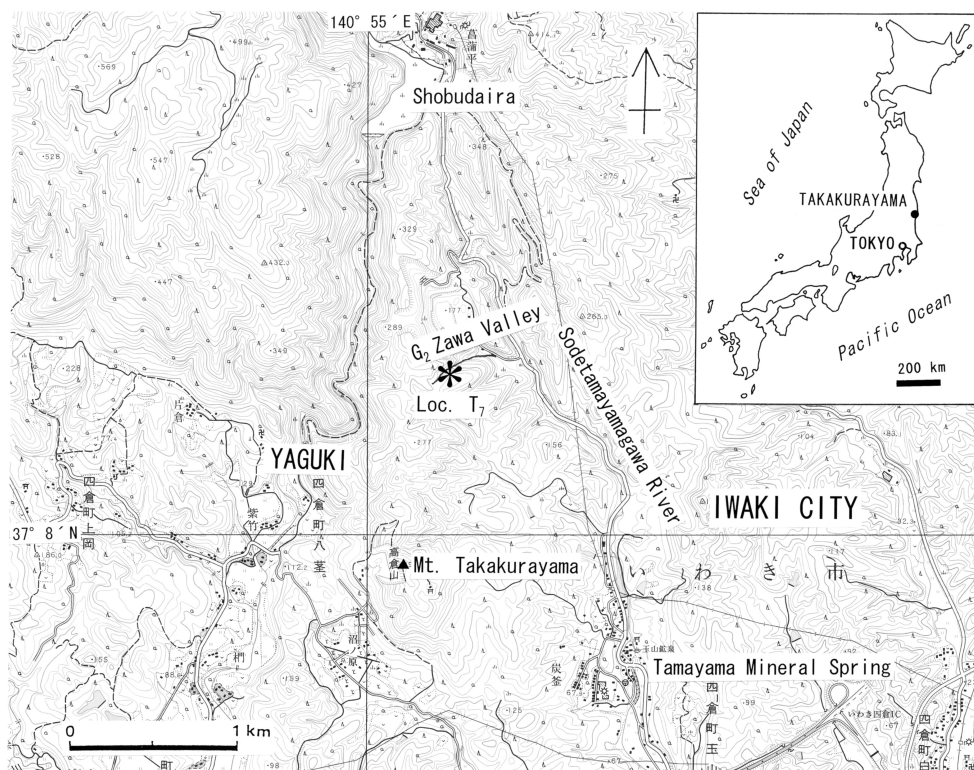
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**Fig. 1.** Index map showing the fossil locality T<sub>7</sub>, in the Takakurayama area, eastern Abukuma Mountains. Using the topographical map of “Yotsukura” scale 1: 25,000 published by the Geographical Survey of Japan.

proposed the Takakurayama Series for the Permian rocks distributed in this area. In the same year but shortly later, Yanagisawa and Nemoto (1961) published their detail stratigraphical work on the Permian, in which they named the Permian as the Takakurayama Group and subdivided it into three formations, the Iriishikura, Motomura and Kashiwadaira Formations, in ascending order. Subsequently Onuki (1966) called the whole Permian rocks of the Takakurayama area as the Takakurayama Formation because of the predominance of black shale with some sandstone and conglomerate intercalations throughout the sequence. We follow the Onuki's opinion and use the term, Takakurayama Formation for the Permian sequence in the Takakurayama area.

Yanagisawa and Nemoto (1961) correlated the Takakurayama Group (=Takakurayama Formation) with the Lower to Middle Permian, lower to middle Maiya Group (Tachibana, 1952) of the Nagasaki area in the southern Kitakami Mountains. Onuki (1966) correlated the Takakurayama Formation with the Middle Permian Kanokura Formation (Onuki, 1937) of the

southern Kitakami Mountains. Yanagisawa (1967) correlated the Takakurayama Group with the Lower Permian Sakamotozawa Formation (Onuki, 1937) to the Upper Permian Toyoma Formation (Mabuti and Noda, 1934) in the southern Kitakami Mountains. Moreover, Ueno (1992) correlated the Takakurayama Group with the Middle Permian (upper Murgabian). The disagreement among the above four opinions is owing to their overlooking the nature of fossils, namely, the reworked fossils from the Takakurayama Formation.

Recently the fourth author (SH) studied the Permian section and made a 1: 10,000 scale geological map of the Takakurayama area in the course of his graduate thesis under supervision of the first author (JT). During the field survey, he collected some ammonoid specimens from sandy shale of the upper part of the Takakurayama Formation, cropped out at the locality T<sub>7</sub> (of Yanagisawa, 1967) in the G<sub>2</sub> Zawa Valley (named by Yanagisawa and Nemoto, 1961), a tributary of the Sodontamayamagawa River in the Takakurayama area. Then the second and third authors (MF and YZ) studied the systematics of the Hasegawa's collection and another ammonoid specimen, collected from the same locality and housed in the Tohoku University, Sendai.

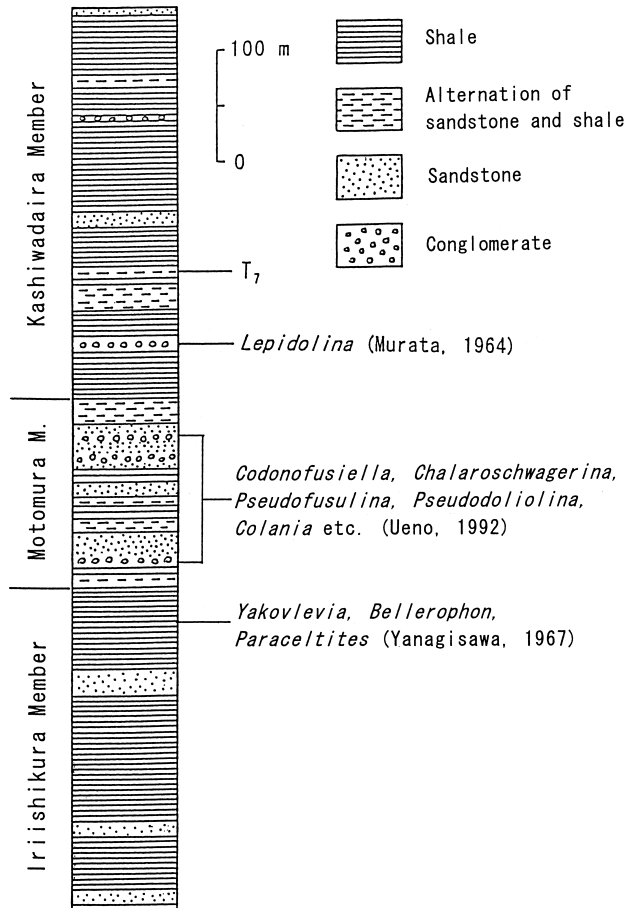
In this paper we describe four species of ammonoid from the locality T<sub>7</sub>, and discuss the ages of the ammonoid fauna and the Takakurayama Formation. The ammonoid specimens treated in this paper are reworked fossils, probably derived from shallow marine continental shelf to a deep-sea basin by sediment-gravity flows in Late Permian.

### **Stratigraphy**

(by JT and SH)

The Takakurayama Formation is exposed in the northeastern slope of Mt. Takakurayama, dipping 30-45° W and striking in a general NNE-SSW direction, and occupying the area of about 3 km<sup>2</sup>. It consists mostly of black shale with subordinate sandstone and conglomerate, more than 805 m in total thickness. This formation is subdivided into three members, 1) the Iriishikura Member, consisting mostly of shale with some sandstone beds, 290 m thick, 2) the Motomura Member, consisting mostly of sandstone and conglomerate with some shale beds, 167 m thick and 3) the Kashiwadaira Member, consisting mostly of shale with some sandstone and conglomerate beds, 348 m thick, in ascending order (Fig. 2). These three members are approximately equal to the Iriishikura, Motomura and Kashiwadaira Formations, established by Yanagisawa and Nemoto (1961), respectively. The ammonoid fossils studied herein were collected from sandy shale of the upper Takakurayama Formation (Kashiwadaira Member), about 570 m above the base of the formation at the locality T<sub>7</sub>. The Takakurayama Formation is intruded by the Cretaceous granitic rocks on the northeast, unconformably overlain by the Upper Cretaceous Futaba Group on the southeast, and contacts with fault the Lower Cretaceous intermediate volcanic rocks on the west.

It is noteworthy that the black shales of the Takakurayama Formation are quite similar in lithology to those of the Toyoma Formation (=Toyoma Series, Minato et al., 1979); and the



**Fig. 2.** Generalized columnar section of the Takakurayama Formation in the Takakurayama area.

conglomerates resemble the Usuginu-type conglomerate (Iwai and Ishizaki, 1966; Kano, 1971). Both of them are developed in the Upper Permian of the southern Kitakami Mountains, northeast Japan.

Permian marine invertebrates, such as fusulinaceans, smaller foraminifers, brachiopods, pelecypods, cephalopods and trilobites, furthermore land plants also have been described from the Takakurayama Formation, mostly from sandy shale of the upper part, the Kashiwadaira Member, at the locality T<sub>7</sub> by many authors (Hayasaka, 1957, 1965; Endo and Matsumoto, 1962; Yanagisawa, 1967; Nakazawa and Newell, 1968; Nakamura, 1972; Asama, 1974; Kobayashi and Hamada, 1984; Ueno, 1992; Tazawa, 1999).

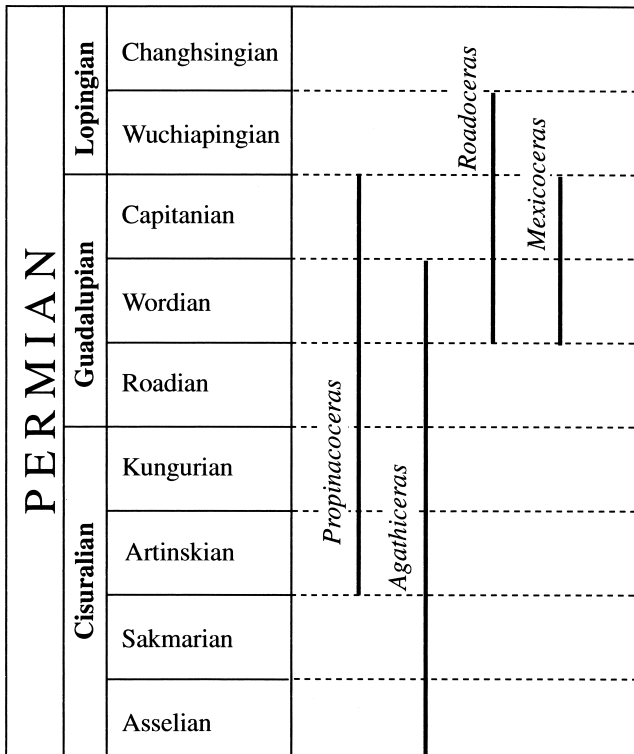
## Discussion

### 1. Age of the ammonoid fauna

The following four ammonoid species are described herein from the locality T<sub>7</sub>, sandy shale of the upper Takakurayama Formation (Kashiwadaira Member): *Propinacoceras* sp., *Agathiceras* sp., *Mexicoceras*? sp. and *Roadoceras* sp. These ammonoids are valuable for age determination, whereas their specific identifications are uncertain.

Figure 3 shows the stratigraphical distributions of the genera *Propinacoceras*, *Agathiceras*, *Mexicoceras* and *Roadoceras*. The genus *Propinacoceras* is known from the Artinskian to Capitanian (Ehiro and Araki, 1997; Ehiro, 1998; Zhou et al., 1999). *Agathiceras* has a long range from the Middle Carboniferous (Moscovian) to Wordian (Glenister et al., 1990; Zhou et al., 1999). The stratigraphical range of the genus *Roadoceras* is in controversy. We accept the opinion of Zhou et al. (1999), who consider it to be the Wordian-Wuchiapingian. *Mexicoceras* seems to be restricted to the Wordian-Capitanian (Zhou et al., 1999).

To sum up the Takakurayama ammonoid fauna from the locality T<sub>7</sub> indicates a Middle Permian (Wordian) age.



**Fig. 3.** Stratigraphical distribution of some ammonoid genera found from the locality T<sub>7</sub>, upper Takakurayama Formation.

## 2. Age and correlation of the Takakurayama Formation

Figure 2 shows the fossil horizons and their fossil contents. Yanagisawa (1967) reported the occurrence of a brachiopod *Linoproductus?* cf. *mammatus* (Keyserling) [= *Yakovlevia mammatiformis* (Fredericks) by Tazawa, 1999], a gastropod *Bellerophon* sp. and an ammonoid *Paracelites* aff. *elegans* Girty from shale of the Iriishikura Member at the locality T<sub>1</sub>, about 31 m below from the base of the Motomura Member. He correlated the Iriishikura Member with the Lower Permian Sakamotozawa Formation based on these fossils. The later two forms, however, occur also from the Kashiwadaira Member at the locality T<sub>7</sub> (Yanagisawa, 1967). Moreover, *Bellerophon* is common in the Upper Permian Toyoma Formation (Onuki, 1969, p. 68), and *Paracelites* has a stratigraphical range from the Roadian to Wuchiapingian (Zhou et al., 1999).

Ueno (1992) described 74 taxa of foraminifers including fusulinaceans, such as *Codonofusiella abukumaensis* Ueno, *Chalartoschwagerina vulgaris* (Schellwien), *Pseudofusulina fusiformis* (Schellwien), *Pseudodoliolina* cf. *ozawai* Yabe and Hanzawa and *Colania* sp., from limestone pebbles and sandy or muddy matrix of conglomerates in the Motomura Member, and correlated the conglomerates with the Middle Permian (upper Murgabian). However, the foraminifers indicating various ages from Artinskian to Wuchiapingian occur evidently as reworked fossils.

The Kashiwadaira Member, especially the sandstone-shale alternation at the locality T<sub>7</sub>, is highly fossiliferous. Hayasaka (1957, 1965) described the following 3 nautiloid and 8 ammonoid species from sandy shale at the locality T<sub>7</sub>: *Tainoceras abukumaense* Hayasaka, *Tainoceras* aff. *unklesbayeri* Miller and Youngquist, *Tylonautilus permicus* Hayasaka, *Propinacoceras* sp., Medlicottidae gen. et sp. indet., ?*Pseudogastrioceras* sp., *Agathiceras* cf. *suessi* Gemmellaro, *Stacheoceras* aff. *grünwaldti* Gemmellaro, *Popanoceras* sp. and *Waagenoceras* cf. *richthofeni* Miller and Furnish. He considered the age of the cephalopod fauna to be a Middle Permian (Sosioian). Asama (1974) described 8 species of land plants, including *Bicoemphleopteris hallei* Asama and *Gigantopteris nicotianaefolia* Schenk, from sandy shale at the locality T<sub>7</sub>, and correlated the Takakurayama flora with the Northern Cathaysian-type flora of the Upper Shihhotse Formation (upper Maokouan-Wuchiapingian) of Shanxi, north China. In this study, we confirmed the occurrence of the middle Middle Permian (Wordian) ammonoid fauna consisting of four species from the horizon T<sub>7</sub>. It is remarkable that a late Middle Permian (Capitanian) fusulinacean *Lepidolina multiseptata* (Deprat) occurs from a redeposited limestone block or limestone pebble of conglomerate in the lower Kashiwadaira Member, about 70 m below from the horizon T<sub>7</sub> (Murata, 1964) (see Fig. 2).

We, judging from the age and nature of occurrence of the above-sited fossils and the lithostratigraphy of the Takakurayama Formation, concluded that this formation is correlated with the Upper Permian Toyoma Formation in the southern Kitakami Mountains. Consequently the ammonoid specimens from the locality T<sub>7</sub>, as well as the almost all of the fossils hitherto

reported from the Takakurayama Formation, are probably reworked fossils, derived from shallow marine continental shelf to a deep-sea basin by sediment-gravity flows in the Late Permian. Concerning this conclusion, Yoshida and Machiyama (1997, 1998) suggested a similar Late Permian sedimentary environment in the South Kitakami region on the basis of their lithological and sedimentological studies on the Toyoma Formation and the Usuginu-type conglomerate.

### **Systematic palaeontology**

(by MF and YZ)

In the following descriptions, NU-CP indicates cephalopod specimens housed in the Department of Geology, Faculty of Science, Niigata University; IGPS indicates the Department of Geology and Palaeontology (now changed the name to the Department of Geoenvironmental Science), Faculty of Science, Tohoku University, Sendai.

Class Cephalopoda Cuvier, 1797  
Subclass Ammonoidea Zittel, 1884  
Order Prolecanitida Miller and Furnish, 1954  
Superfamily Medlicottioidea Karpinsky, 1889  
Family Medlicottidae Karpinsky, 1889  
Genus *Propinacoceras* Gemmellaro, 1887

*Propinacoceras* sp.

Fig. 5A

*Material*.—One ventral mould specimen, NU-CP5.

*Remarks*.—A single ventral mould specimen is available. The venter is almost flat, but bears two rows of transversely elongate nodes separated by prominent median groove. The elongate nodes and median groove of the present specimen are similar to those of *Propinacoceras* sp., described and figured by Hayasaka (1965, p. 15, pl. 2, figs. 1-2) from the upper Takakurayama Formation. The ventral nodes of Capitanian *Propinacoceras* sp., from the Ochiai Formation, southern Kitakami Mountains (Ehiro and Araki, 1997, p. 64, figs. 9.1-9.4), look lower than those of the present specimen. However, the comparison of these specimens is difficult because of their ill state of preservation.

Order Goniaticida Hyatt, 1884  
Suborder Goniaticina Hyatt, 1884  
Superfamily Goniaticaceae de Haan, 1825

## Family Agathiceratidae Arthaber, 1911

Genus *Agathiceras* Gemmellaro, 1887*Agathiceras* sp.

Figs. 5B-D

*Agathiceras* cf. *suessi* Gemmellaro: Hayasaka, 1965, p. 19, pl. 2, figs. 3-4; text-fig. 2;  
Yanagisawa, 1967, p. 100, pl. 1, fig. 16; pl. 3, fig. 4.

*Material*.—Three specimens, NU-CP3, NU-CP6, NU-CP7.

*Description*.—Shell medium in size, discoidal to subdiscoidal in outline, involute with narrow arched venter. Sides flattened. Umbilicus small, being 10 % or less of conch diameter; umbilicus border not distinct. Ornamentation represented by fine longitudinal lirae, with no marked radial constrictions. Both growth line and external suture-line absent.

*Remarks*.—*Agathiceras* is characterized by its discoidal conch, small umbilicus, fine longitudinal lirae and sinuous transverse constriction. Our specimens safely assigned to the genus *Agathiceras* in size, outline, and in having small umbilicus. These specimens are comparable with *Agathiceras* cf. *suessi* Gemmellaro, described by Hayasaka (1965) and Yanagisawa (1967) from the Kashiwadaira Member.

*Measurements*.—See Table 1.

**Table 1.** Measurements of *Agathiceras* sp., from the locality T<sub>7</sub>, upper Takakurayama Formation. Values in mm where applicable.

Register No.	<i>D</i>	<i>H</i>	<i>W</i>	<i>U</i>	<i>H/D</i>	<i>W/H</i>	<i>U/D</i>
NU-CP3	8.2	4.5		0.8	0.55		0.10
NU-CP6	16.2	7.3	>2.0	1.0	0.45	>0.27	0.06
NU-CP7	18.6	9.0		2.0?	0.48		0.11?

*D*: diameter of conch, *H*: height of whorl, *W*: width of conch, *U*: diameter of umbilicus.

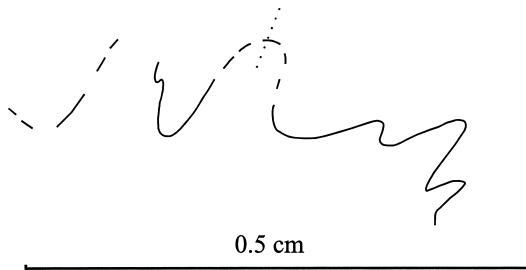
## Superfamily Cyclolobaceae Zittel, 1895

## Family Cyclolobidae Zittel, 1903

Genus *Mexioceras* Ruzhencev, 1955*Mexioceras*? sp.

Figs. 4, 5E





**Fig. 4.** Suture-line near the umbilical area of *Mexioceras?* sp., IGPS86629, from the locality T<sub>7</sub>, upper Takakurayama Formation in the Takakurayama area.

*Waagenoceras* cf. *dieneri* Böse: Yanagisawa, 1967, p. 100, pl. 3, fig. 13.

*Material.*—One specimen, IGPS86629.

*Description.*—Shell subglobular, involute. Umbilical shoulder abruptly rounded and vertical, with small umbilicus. Umbilicus being about 10% of conch diameter. Venter rounded. Concentric shallow groove on surface of shell. Both growth line and radial ornament absent. Suture-line near umbilical part consisting of series of small lobes and saddles (Fig. 4).

*Remarks.*—The present specimen was described and illustrated by Yanagisawa (1967, p. 100, pl. 3, fig. 13) as *Waagenoceras* cf. *dieneri* Böse. However, we review the morphological data and propose the specific name *Mexioceras?* sp. for this specimen. Identification with *Mexioceras* was made only in question on the basis of resemblance of the suture-line fragments from the near umbilical part of the shell, not for their characteristics as subglobular conch, fine concentric longitudinal lirae, and small umbilicus. Generally *Mexioceras* has involute, subglobular conch, therefore the conch proportion of our specimen also be close to the genus *Mexioceras*.

*Measurement.*—See Table 2.

**Table 2.** Measurement of *Mexioceras?* sp., from the locality T<sub>7</sub>, upper Takakurayama Formation. Values in mm where applicable.

Register No.	<i>D</i>	<i>H</i>	<i>W</i>	<i>U</i>	<i>H/D</i>	<i>W/H</i>	<i>U/D</i>
IGPS86629	37.0	17.1		4.1	0.46		0.11

*D*: diameter of conch, *H*: height of whorl, *W*: width of conch, *U*: diameter of umbilicus.

Superfamily Gastriocerataceae Hyatt, 1884  
 Family Paragastrioceratidae Ruzhencev, 1951  
 Subfamily Pseudogastrioceratinae Furnish, 1966  
 Genus *Roadoceras* Zhou, 1985

*Roadoceras* sp.

Figs. 5F-G

*Material*.—Two specimens, NU-CP4, NU-CP13.

*Description*.—Shell discoidal, evolute, with arched venter and flattened sides. Umbilical border narrowly rounded, but distinct; umbilical wall steep and comparatively high; umbilicus reasonably wide. Ornamentation consisting of numerous strong spiral ribs. External suture-line not expressed.

*Remarks*.—The genus *Roadoceras* is characterized by its involute and discoidal shell, surface ornamentation of coarse spiral lines, and transverse ribs lacking in the early stage. Our fragment specimens are safely referred to *Roadoceras*, but the specific identification is difficult owing to their ill preservation. This genus is distributed in the Wordian and Capitanian of North America, Sicily, Far East Russia, China and Japan (Takakurayama). *Roadoceras subroadense* Zakharov and Pavlov, 1986 from the Capitanian Barabash Formation of western Primorye, Far East Russia differs from the Takakurayama species in having wider umbilicus and more flattened shell sides.

*Measurement*.—See Table 3.

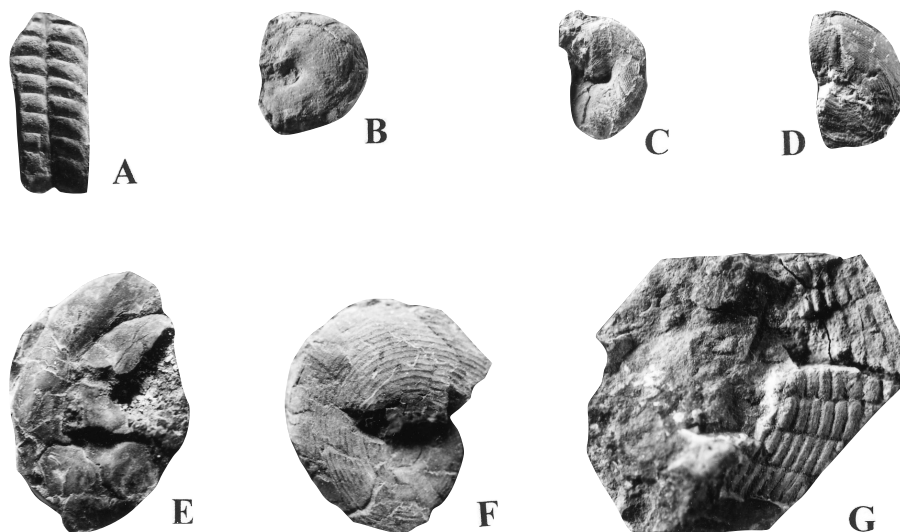
**Table 3.** Measurement of *Roadoceras* sp., from the locality T<sub>7</sub>, upper Takakurayama Formation. Values in mm where applicable.

Register No.	<i>D</i>	<i>H</i>	<i>W</i>	<i>U</i>	<i>H/D</i>	<i>W/H</i>	<i>U/D</i>
NU-CP4	30.0	15.0	>8.0	8.0	0.5	>0.53	0.27

*D*: diameter of conch, *H*: height of whorl, *W*: width of conch, *U*: diameter of umbilicus.

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**Fig. 5.** Permian ammonoids from the locality T<sub>7</sub>, upper Takakurayama Formation in the Takakurayama area. A: *Propinacoceras* sp., NU-CP5; B-D: *Agathiceras* sp., B: NU-CP3, ×2, C: NU-CP6, D: NU-CP7, E: *Mexioceras*? sp., IGPS86629, F, G: *Roadoceras* sp., F: NU-CP4, G: NU-CP13. All figures are in natural size unless otherwise indicated.

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