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Abadehella, A New Genus of Tetrataxid Foraminifera from the Late Permian

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Abstract

A new genus, *Abadehella* comprising three new species (*tarazi*, *coniformis*, and *biconvexa*) is proposed and described. So far as the morphologic features are concerned, the genus is considered to be a specialized genus in the family Tetrataxidae. This characteristic genus is found from the basal part of the Abadeh Formation in central Iran, the lowest member of the Zewan Formation in Kashmir, the *Palaeofusulina* limestone in Malaysia, *Lepidolina multiseptata* limestones in Cambodia and northeast Japan, the Takauchi and *Reichelina-Colaniella* limestones of the Maizuru belt, and the *Lepidolina kumaensis* zone of Shikoku in Japan.

The stratigraphic occurrence is limited to the Late Permian and the genus is considered to be useful for international correlation.

Introduction

During the summer of 1972 a party of Japanese geologists visited Iran and India with the purpose to make stratigraphic and paleontologic investigation of the strata adjacent to the Permian-Triassic boundary with a particular attention to a relationship between the lithology and the fossil contents.

Iranian-Japanese cooperation research group**** selected the Abadeh region, central Iran (Lat. 30° 55′ N, Long. 53° 15′ E) as one of suitable areas for the above purpose, where Dr. H. TARAZ of Geological Survey of Iran already described in detail the geological succession (TARAZ, 1969, 1971, and 1973).

The Abadeh section represents a complete sequence from the Guadalupian*****

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***** According to TARAZ (personal information to NAKAZAWA, June 1973), unit 1 contains *Pseudoschwagerina* sp. in the basal part, which indicates the lower limit of unit 1 extends to the Lower Permian.

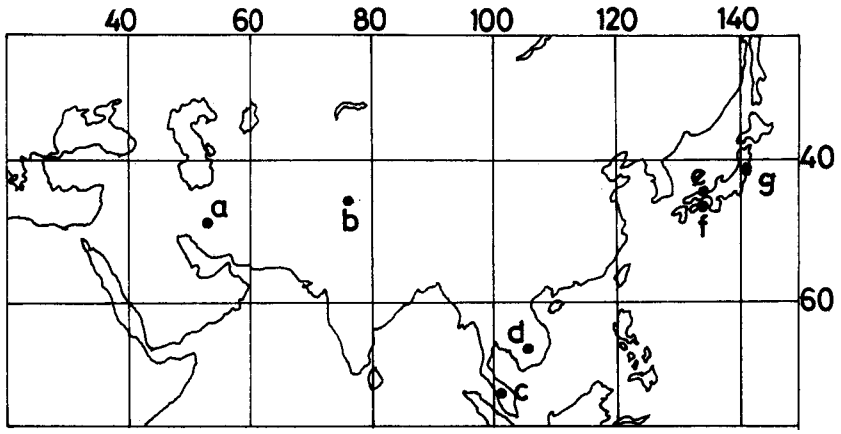

Figure 1. Locality-map of the genus *Abadehella*.
a: Abadeh region, Iran, b: Kashmir, India, c: south of Kota Bharu, Malaysia, d: Sisophon, Cambodia, e: Maizuru belt, f: Shikoku Is., g: Iwaizaki, e-g: Japan.

to probably the early Middle Triassic. Here, the strata consist of alternations of carbonate rocks and shale, predominant in the former. TARAZ (1969) divided the strata into twelve units, from unit 1 to unit 12. Unit 8 and the succeeding beds belong to the Triassic. Units 6 and 7 are safely correlated with the Dzhulfian including the Dorashamian of ROSTOVTSEV and AZARYAN (1973) in Armenian Dzhulfa and Julfa Beds to *Paratirolites* Limestone of STEPANOV *et al.* (1969) in Iranian Julfa. TARAZ named units 4 and 5 the Abadeh Formation. Analyzing the faunal assemblages of the formation he referred the age as pre-Dzhulfian and post-Guadalupian, and proposed the new Stage name, Abadehian for this part.

The laboratory works of the Japanese research group are going on at present. During the laboratory work, we discovered certain interesting foraminiferal specimens from the basal part of the Abadeh Formation. As a result of paleontologic examination a new generic name, *Abadehella,* is here proposed under the family Tetrataxidae. Three new species, *A. tarazi, A. coniformis,* and *A. biconvexa,* are discriminated under the genus. The genus has subsequently been discovered from Kashmir, Malaysia, Cambodia, and Japan (Fig. 1). In spite of its rather wide geographic distribution, it seems to be limited to a certain stratigraphic range of the Upper Permian, and is considered to be useful for international correlation.

Occurrence and age of *Abadehella*

Occurrence

The lowest part of unit 4 of the Abadeh Formation is rich in fossils characterized

by brachiopods (*Spinomarginifera* sp., *Leptodus nobilis, Krotovia jisuensiformis, Uncinunella timorensis, Reticularia* sp., Spiriferinacean species, etc.; identified by K. NAKAMURA), bryozoans (*Stenopora? kashmirensis* MS, *Fistulipora* sp., *Septopora lineata,* and *Polypora* sp.; identified by S. SAKAGAMI), ammonoid (*Xenodiscus?* sp.) and foraminifers. The new genus, *Abadehella* occurs abundantly at a horizon 2 m above the base of unit 4. From the basal limestone (about 10 m thick) the following foraminifers are discriminated.

Abadehella tarazi, gen. et sp. nov., *A. coniformis*, gen. et sp. nov., *A. biconvexa*, gen. et sp. nov., *Lunucammina* sp., *Baisalina* sp., *Palaeotextularia* sp., *Glomospira* spp., *Hemigordius* sp., *Climacammina* sp., *Nodosinella* sp., and *Schubertella?* sp.

Abadehella was also discovered by us in samples from Guryul ravine near Srinagar in Kashmir, India. The investigation of the Permian-Triassic sequence at Guryul ravine was made in detail by nearly same members of Japanese team in 1969. The preliminary report near the systemic boundary was published in 1970 by NAKAZAWA *et al.* The Permian Zewan Formation (about 96 m thick), which is conformably succeeded by the Lower Triassic beds, includes a number of marine fossils such as foraminifers, bryozoans, brachiopods, gastropods, bivalves, conodonts, algae, ammonoids, and others, and is divided into four members, from A to D in ascending order. Member A (26.6 m thick), which represents the lowest Zewan Formation, contains various kinds of foraminifers, bryozoans, and brachiopods as enumerated below in addition to indeterminable crinoid-stems and algae.

Bryozoa: *Fistulipora* sp., *Dyscritella tenuirama, Polypora transiens, Acanthocladia anceps, Stenopora kashmirensis* MS, etc. (identified by S. SAKAGAMI)

Brachiopoda: *Spirigerella* cf. *grandis, Linoproductus* cf. *lineatus, Lissochonetes morahensis, Waagenoconcha purdoni*, and *Chonetina?* sp. (identified by D. SHIMIZU)

Foraminifera: *Abadehella coniformis*, gen. et sp. nov., *Ammonidiscus* spp., *Glomospira* spp., *Nodosinella* spp., *Lunucammina* cf. *grandis, L.* spp., *Pachyphloia* spp., *Colaniella* cf. *minima, C. cylindrica, C.* sp., *Agathammina* sp., *Permodiscus* sp., *Hemigordius* sp., *Endothyra* cf. *miassica*, Palaeotextulariid, and *Staffella* sp. (identified by Y. OKIMURA)

Very recently *Abadehella* was found from the Takauchi limestone and the Kashiwadani limestone of the Upper Permian Maizuru Group in southwest Japan during the course of paleontologic and stratigraphic re-examination of the group by ISHII, OKIMURA, NAKAZAWA, and SHIMIZU. SHIMIZU (1961) once described the following brachiopod fossils from the Takauchi limestone and pointed the close affinity to those of the Lopingian (probably lower Lopingian) in China and the Middle Productus Limestone of the Salt Range.

Leptodus richthofeni, Neophricadothyris indica, N. cf. *calori, N. elegantula, Streptorhynchus semiplanus, Martinia elegans, Kiangsiella deltoides, Strophalosia tibetica,*

and *Neospirifer* sp.

WATERHOUSE (1972b) also correlated the Takauchi limestone with the Kalabagh Member (upper Middle Productus Limestone) based on the brachiopods described by SHIMIZU.

The following foraminiferal species are newly determined together with *Abadehella coniformis*.

Schubertella? sp., *Colaniella minima*, *Nodosaria* sp., *Lunucammina grandis*, *L.* sp., and *Tetrataxis* sp.

Abadehella cf. *coniformis* in the Kashiwadani limestone occurs in association with many kinds of foraminifers as follows, which represent the *Reichelina matsushitai-Colaniella minima* fauna of the Maizuru Group.

Reichelina matsushitai, *R.* spp., *Colaniella minima*, *C. nana*, *C.* sp., *Lunucammina* cf. *longissima*, *L. postcarbonica*, *L. grandis*, *Climacammina* sp., *Glomospira* spp., *Tetrataxis* sp., *Pachyphloia* spp., *Lasiodiscus irregularis*, *Endothyra*? sp., *Flondicularia* sp., *Permodiscus* sp., *Hemigordius* sp., *Dagmarita*? sp., *Agathammina*? sp., *Nodosaria* sp., *Monotaxinoides* sp., *Globovaluvulina* cf. *cyprica*, *Palaeofusulina*? sp., and *Codonofusiella*? sp.

Other occurrences of *Abadehella* are confirmed by OKIMURA and ISHII from the following places.

Shikoku Island, southwest Japan (Haigyu Formation)

Abadehella cf. *coniformis* in association with the *Lepidolina kumaensis* fauna.

Iwaizaki, northeast Japan

Abadehella coniformis from the *Lepidolina kumaensis* zone, and *Abadehella* sp. from the *Richthofenia* bed, that is, member h of Iwaizaki limestone. The latter horizon is in between the *Lepidolina kumaensis* zone and the *L. multiseptata shiraiwensis* zone, and contains many brachiopods, bryozoans, ostracods, and others along with smaller forminifers that are identified as *Codonofusiella* sp., *Colaniella* aff. *nana*, *Neoendothyra* sp., *Pachyphloia* sp., and *Schubertella* sp.

Sisophon, Cambodia (D horizon of Ishii *et al.*, 1969)

Abadehella coniformis in association with the *Lepidolina multiseptata multiseptata* fauna and *Wanganella* sp.

South of Kota Bharu, Malaysia

Abadehella coniformis, *Palaeofusulina* aff. *sinensis*, and *Colaniella parva*.

Age

In Iran the genus *Abadehella* is confined to the basal part of the Abadeh Formation, the stratotype of the Abadehian that is defined as post-Guadalupian and pre-Dzhulfian by TARAZ as already stated. It is out of question that the Abadeh Formation is pre-Dzhulfian in age from the geological succession. However, as to the

lower boundary further paleontologic and biostratigraphic studies will be required coupled with units 1–3.

The Zewan Formation is as a whole correlated to the upper Middle and Upper Productus Limestones, that is, the Kalabagh Member (upper Wargal) and the Chhidru Formation in Salt Range (Diener, 1899, 1903), and the lowest Zewan, from which *Abadehella* has been obtained, is most probably coeval with the Kalabagh Member. The age of the Zewan and Kalabagh-Chhidru is not unanimous among the authors. GRANT (1970) and WATERHOUSE (1972a, b) insist the Guadalupian age of the Kalabagh and Chhidru mainly on the basis of brachiopod fossils, while FURNISH and GLENISTER (1970) and FURNISH (1973) claim the post-Guadalupian age based on the ammonoids, especially *Cyclolobus*. GRANT and COOPER's opinion (1973) that the Zewan Series is older than the Productus Shale in the Himalayas and the latter is missing at Guryul ravine, is untenable judging from the close similarity of the Zewan fauna to that of the Kalabagh-Chhidru and the Productus Shale.

Under such circumstances the occurrence of *Abadehella* accompanied by *Colaniella, Lepidolina* and *Palaeofusulina* in Kashmir, Malaysia, Cambodia, and Japan has a special importance. The Upper Permian Maizuru Group in the Maizuru belt, southwest Japan contains three different faunae, such as *Palaeofusulina sinensis-Colaniella parva* in the limestone lenses, *Reichelina matsushitai-Colaniella minima* also in the limestone lenses, and *Lepidolina kumaensis* fauna in the coarse-grained clastic rocks and rarely limestones. The first fauna is recently confirmed to be stratigraphically higher than the latter two, while the latter two are contemporaneous but heteropic with each other (SHIMIZU, 1962; KANMERA and NAKAZAWA, 1973). The *Palaeofusulina-Colaniella* fauna is almost identical with the *Palaeofusulina* fauna in south China and Cambodia, which characterizes the uppermost Permian (Changhsingian) *Palaeofusulina* zone in China. The *Paleofusulina* zone is safely correlated to the upper Dzhulfian (or Dorashamian) by the ammonoid fauna of *Pseudotirolites-Pleuronodoceras* (CHAO, 1965; TEICHERT *et al.*, 1973).

On the other hand, the *Reichelina-Colaniella* fauna is similar to the *Codonofusiella* fauna which occupies the *Codonofusiella* zone below the *Palaeofusulina* zone. The former zone is correlated to the lower Dzhulfian (or Araxian) by means of the ammonoid fauna of *Prototoceras-Araxoceras* from the correlative Laoshan shale (CHAO, 1965).

Furthermore, the *Lepidolina kumaensis* fauna in Japan occurs at higher horizon than the *Lepidolina multiseptata shiraiwensis* fauna which is considered to be contemporaneous with the *Yabeina golobosa* fauna in Japan and that of "*Yabeina*" zone in China* (TORIYAMA, 1967, 1973). The "*Yabeina*" zone occupies the highest part of the

* *Yabeina* zone in south China is characterized by *Y. gubleri, Y. hayasakai, Neoschwagerina douvillei*, etc. (SHENG, 1963), which are referred to *Lepidolina multiseptata gigantea, L. m. multiseptata*, and *Colania douvillei*, respectively. All are found from *L. multiseptata shiraiwensis* zone in Japan.

Maokouan. The absence of *L. kumaensis* zone in China may be explained by the time-lack represented by the regional disconformity between the *Yabeina* zone and the *Codonofusiella* zone, that is, the Maokouan and the Wuchiapingian and/or earlier disappearance of *Lepidolina* in China (KANMERA and NAKAZAWA, 1973). It is also noted that the genus *Colaniella* is limited in range to the upper part of the Late Permian (from *Lepidolina multiseptata* zone up to *Palaeofusulina sinensis* zone) so far known*. This will be discussed by the authors in another paper.

The Takauchi limestone is correlated to the *Reichelina-Colaniella* limestones (the Kashiwadani and other limestones) in the common occurrence of *Colaniella minima, Abadehella coniformis* and *Lunucammina grandis,* and in the stratigraphic position. The former is, on the other hand, comparable to the lowest member of the Zewan in the similarity of brachopods in addition to the common occurrence of the above-mentioned foraminifers.

Many schemes have been presented by various workers for the international classification of the marine Permian since SPATH (1934) (GERTH, 1951; GLENISTER and FURNISH, 1961; FURNISH, 1966; FURNISH and GLENISTER, 1970; WATERHOUSE, 1972, etc.). Whatever the scheme is, however, it is reasonable to consider that the lowest member of the Zewan in Kashmir, the Takauchi limestone, the *Reichelina matsushitai-Colaniella minima* limestone and the *Lepidolina kumaensis* zone of the Maizuru Group in Japan, the Kalabagh Member in the Salt Range, and probably the lowermost part of the Abadeh Formation are correlated with each other. All these strata may be compared to the lower Wuchiapingian or the missing part between the latter and the Maokouan in China, although the possibility of the correlation of the lower Zewan-Kalabagh with the uppermost Maokouan-Sisophon C and D cannot be excluded because of the lack of fusulines in the former.

The genus *Abadehella* is known at present from the *Lepidolina multiseptata* zone to the *Palaeofusulina sinensis* zone and their correlatives, and it may have been generated and died out within a short range in the Late Permian.

Acknowledgement and repository

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* According to KUMMEL and TEICHERT (1973), the genus *Colaniella* commonly occurs in the Wargal Limestone, and more rarely in the Chhidru Formation, but it has not been described yet.

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All the specimens described and figured in this paper are kept in the Institute of Geology and Mineralogy, Faculty of Science, Hiroshima University. Their register numbers are indicated within the brackets in the explanation of plates.

Systematic description

Family Tetrataxidae GALLOWAY, 1933

Genus *Abadehella* OKIMURA and ISHII, gen. nov.

Type-species:—*Abadehella tarazi*, gen. et sp. nov.

Diagnosis:- Test conical or subconical, trochoid, consisting of 10–20 whorls; ventral side deeply concave. 1.5–2 chambers of crescent-shape for each whorl, low in height, subdivided into three or more small chamberlets by the plates like septa and septula on the floor. These plates developed parallel and radially arranged to the coiling axis. Chamberlets oblong, and the apertural end unclosed. Wall calcareous, consisting of double layers, outer, dark, microgranular calcitic layer, and inner, light, fibrous one. Septa and septula composed of a single layer, clacareous, and microgranular. An aperture for each chamber opens into umbilicus on ventral side under valvular flaps.

Remarks:- This new genus is defined only from the thin section study, because there is no isolated, free specimen exhibiting the outer characters as a result of the occurrence in the rigid, micritic limestone. However, it may be sure that this new genus belongs to the family Tetrataxidae by such morphologic characters as conical shell, trochopsiral coiling and two-layered, calcareous wall.

In the axial section, the plates like septa and septula are not observable owing to the development parallel to the coiling axis. Accordingly, so far as the morphologic characters in the section are concerned, this genus is similar to the genus *Tetrataxis* in the shell-shape and coiling form. On the other hand, in the sagittal section the radial arrangement of septal plate, which developes from the circular outer wall to the central part, resembles transverse section of small rugose corals, and this feature is wholly dissimilar to that of *Tetrataxis*. Moreover, in both of lateral and parallel sections, the characteristic fretwork structures consisting of the wall and the plates is observable. Consequently, the new genus is clearly distinguished from *Tetrataxis* by above-mentioned morphologic characters.

The fretwork structure shown in the lateral and parallel sections of *Abedehella* is comparable with that of the genus *Valvulinella* which also belongs to the family Tetratxidae. However, *Abadehella* clearly differs from the latter, because the wall and septal plates of the latter are characterized by a calcareous, microgranular,

single layer, and the interior is horizontally and vertically subdivided into numerous tiny partitions.

The species belonging to this genus may be classified by the differences of shell-shape, size, apical angle in the early and later stages, the characters of lateral slopes and apertural depression, a number of whorls, a number of septa and septula of each chamber, and apertural character.

Geologic age and occurrence:- Late Permian. The materials of this genus occur abundantly from the lowest part of the Abadeh Formation, central Iran, the lowest Zewan Formation of the Guryul ravine, Kashmir, India, and the Takauchi limestone of the Maizuru Group, southwest Japan. The genus is commonly accompanied with *Colaniella minima* WANG, *C. cylindrica* M-MAKLAY, *Lunucammina grandis* (LIPINA), *Nodosinella* sp., *Glomospira* sp., *Pachyphloia* sp., and species of *Lepldolina.*

Abadehella tarazi OKIMURA and ISHII, gen. et sp. nov.

Pl. 1, Figs. 3 and 4; Pl. 3, Fig. 2

Materials:- The holotype specimen (axial section, reg. no. IGH: Ab-C-001, pl. 1, fig. 3), the paratype specimen (apertural section, reg. no. IGH: Ab-C-002, pl. 3, fig. 3), 4 axial and 5 nearly axial sections, 4 nearly sagittal and 11 other sections were examined. All the specimens came from the lowest part of the Abadeh Formation, central Iran.

Description:- Test relatively large, subconical, weakly depressed on both lateral sides, trochospirally coiled with 15–19 whorls. Each whorl consists of 1.5–2 chambers. Arrangement of chamber fairly synmetric. Chamber subdivided into 20 or more chamerlets by septal plates running parallel to the coiling axis, and a septulum commonly developed between septa on the floor of chamberlet. Lateral slope smooth in the early stage and slightly uneven with sutural compression. Apertural depression subconical. Chamber broadly low. Wall calcareous, consists of very thin, dark, microgranular, outer layer, and moderately thick, light, fibrous, inner layer. Septa and septula calcareous, consist of microgranular, single layer. An aperture for each chamber opens beneath valvular, short projection.

Dimensions:- In the axial section of the holotype, maximum width, 1.35 mm.; maximum height, 0.65 mm.; and apical angle, 70 degrees in the early stage, and it shows an equilateral triangle with 30 degrees in basal ange of the later stage.

Remarks:- The axial section of this species closely resembles that of *Tetrataxis conica* EHRENBERG, but the latter is easily distinguished from the former in its narrow, deeper depression in ventral side, and much lower chambers in height. This species can be distinguished from *Abadehella coniformis*, gen. et sp. nov. in its more concave lateral sides, and also differs from *A. biconvexa*, gen. et sp. nov. in its less convave lateral dises.

This new species is named in honour of Dr. H. TARAZ who clarified the important Permian-Triassic sequence in central Iran.

Horizon:- Late Permian. This species occurs only from the lowest part of the Abadeh Formation, the type of Abadehian, in central Iran.

Abadehella coniformis OKIMURA and ISHII, gen. et sp. nov.
Pl. 2, Figs. 1–5, 7 and 8; Pl. 1, Fig. 3; Pl. 4, Figs. 2–4

Materials:- The holotype specimen (axial section, reg. no. IGH: Ab-C-011, pl. 2, fig. 4), the paratype specimen (apertural section, reg. no. IGH: Ab-C-012, pl. 3, fig. 1), 5 axial and 5 nearly axial, 5 nearly sagittal and 13 other sections were examined. Among these materials, though the majority came from the lower part of the Abadeh Formation of Iran, 2 nearly axial and 2 oblique sections are obtained from the Zewan Formation in India, and one nearly axial, 2 sagittal and 5 oblique sections from the Takauchi limestone, Japan.

Description:- Test moderate in size, typically conical shape of trochospiral coiling with 10–15 whorls; lateral slope straight or very slightly concave on one side, and smooth in the early stage but slightly uneven in the later stage. 1.5–2 chambers increased gradually in size, and its arrangement slightly asymmetric. Chamber subdivided into small chamberlets not exceeding 20 by septal plates. Septula poorly developed. Apertural depression narrow and deep. Chamber-height moderate and larger than the type species. Wall calcareous, consisting of thin, dark, microgranular, outer layer, and thick, fibrous, inner layer; septa and septula made of calcareous, microgranular, single layer. Aperture opens into umbilicus beneath valvular projection.

Diemensions:- In the axial section of the holotype, maximum width, 1.1 mm.; maximum height, 0.61 mm.; apical angle 75–85 degrees.

Remarks:- This new species and type species are closely alike in their shell-form, but the former is clearly distinguished from the latter in its small size, less number of chamberlets, and invariable apical angle through the growth stage. It is also distinuished from *A. biconvexa*, gen. et sp. nov. in its straight, smooth lateral slope and less number of chmberlets.

Horizon and occurrence:- Late Permian. This species occurs from Member A of the Zewan Formation at Guryul ravine, Kashmir and the Takauchi and Kashiwadani limestones of the Maizuru Group in association with *Reichelina matsushitai, Colaniella minima, C. nana, C. cylindrica, Lunucammina grandis, Endothyra miassica,* etc. This speies is yielded abundantly from the micritic limestone of the basal part of the Abadeh Formation in Iran. In Malaysia it occurs from the *Palaeofusulina* aff. *sinensis-Colaniella parva* limestone, while it comes from the *Lepidolina kumaensis* zone in Shikoku, Japan.

Abadehella biconvexa OKIMURA and ISHII, gen. et sp. nov.
Pl. 1, Figs. 1,2,6,7 and 9; Pl. 3, Fig. 8

Materials:- The holotype specimen (axial section, reg. no. IGH: Ab-C-021, pl. 1, fig. 6), the paratype specimen (apertural section, reg. no. IGH: Ab-C-022, pl. 3, fig. 8), 4 nearly axial, one nearly apertural and 8 other sections were examined. All the specimens came from the lowest part of the Abadeh Formation, central Iran.

Description:- Test relatively large, subconical in shape with broad base and low or high mammillate spire, trochospirally coiled with 15 or less whorls; consisting of 1–1.5 chambers for each whorl. Arrangement of chambers slightly asymmetric. Chambers of the early stage increasing gradually in size, but in the later stage fairly inflated and added to the outside, accordingly lateral slopes draw sigmoid curve. Apertural depression conical. Chambers low, subdivided into numerous small chamberlets by septal plates. Septula well developed on the floor between the septa. Wall calcareous, consists of thin, dark, microgranular, outer layer and thick, light, fibrous, inner layer. An aperture for each chamber opens beneath valvular projection.

Dimensions:- Maximum width, 1.41 mm., maximum height, 0.69 mm.; apical angle, 85 degrees in the early stage of the holotype, and 55 degrees in the figured specimen (pl. 1, fig. 9) of highly mammillate, conical form.

Remarks:- The species can be distinguished from other two species of *Abadehella* in its sigmoid curves on both lateral sides of the test that are caused by outward expansion of chambers in adult stage.

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Postscript

The assemblage of *Lepidolina multiseptata shiraiwensis*, *Abadehella coniformis*, and *Pachyphloia* sp. is recently discovered by one of us (ISHII) in a limestone slab collected by Dr. M. Murata of Tohoku University at the south of Iwaizaki, northeast Japan (see Text-figure 1).

Explanation of plate 1

Abadehella biconvexa OKIMURA and ISHII, gen. et sp. nov. (× 50)

Fig. 1. Lateral section, showing the numerous chamberlets.
Fig. 2. Oblique section, showing the fretwork and septula.
Fig. 6. Axial section (holotype, IGH: Ab-C-021).
Fig. 7. Oblique section.
Fig. 9. Nearly axial section.

Abadehella tarazi OKIMURA and ISHII, gen. et sp. nov. (× 85)

Fig. 3. Axial section (holotype, IGH: Ab-C-001).
Fig. 4. Axial section.

Abadehella sp. (× 50)

Fig. 5. Nearly axial section, showing the apertural projection.
Fig. 8. Lateral section, showing the fretwork and septula.

(All the illustrated specimens are from the Abadeh Formation, Iran)

Explanation of plate 2

(All figs., × 50, except for Figs. 1, 7 and 8, × 85)

Abadehella coniformis OKIMURA and ISHII, gen. et sp. nov.

Figs. 1 and 2. Nearly axial section.
Fig. 3. Parallel section, showing the apertural projection.
Fig. 4. Axial section (holotype, IGH: Ab-C-011).
Fig. 5. Lateral section, showing the fretwork.
Fig. 7. Oblique section.
Fig. 8. Parallel section.

Abadehella sp.

Fig. 6. Oblique section.

Glomospira sp.

Fig. 9. Horizontal axial section.
Fig. 10. Vertical axial section.

Lunucammina sp.

Fig. 11. Longitudinal section.

Glomospirella? sp.

Fig. 12. Vertical axial section.

Colaniella cf. *minima* WANG

Fig. 13. Longitudinal section.

(The specimens of Figs. 7–13 are from Member A of the Zewan Formation, Kashmir, India. Others are from the Abadeh Formation.)

Explanation of plate 3

(All figs. × 50)

Abadehella coniformis OKIMURA and ISHII, gen. et sp. nov.

Fig. 1. Apertural section (paratype, IGH: Ab-C-012).

Abadehella tarazi OKIMURA and ISHII, gen. et sp. nov.

Fig. 2. Apertural section (paratype, IGH: Ab-C-002).

Abadehella spp.

Figs. 3–5. Apertural, oblique sections, showing the arrangement of the chambers, chamberlets and septula.

Fig. 6. Sagittal section of the early stage.

Fig. 7. Lateral section, showing the fretwork and the feature of chamber arrangement.

Abadehella biconvexa OKIMURA and ISHII, gen. et sp. nov.

Fig. 8. Apertural section (paratype, IGH: Ab-C-022).

Lunucammina sp.

Fig. 9. Longitudinal section.

Hemigordius sp.

Fig. 10. Horizontal axial section.

Fig. 11. Vertical axial section.

(All the illustrated specimens are obtained from the Abadeh Formation, Ab-C-c horizon.)

Explanation of plate 4

(All figs. × 80, except for Fig. 1, × 50)

Abadehella sp.

Fig. 1. Oblique section. This specimen is closely resemble the one of plate 2, fig. 6 from the Abadeh Formation.

Abadehella coniformis OKIMURA and ISHII gen. et sp. nov.

Figs. 2, 4. Oblique sections.

Fig. 3. Axial section.

Schubertella? sp.

Fig. 5. Nearly axial section.

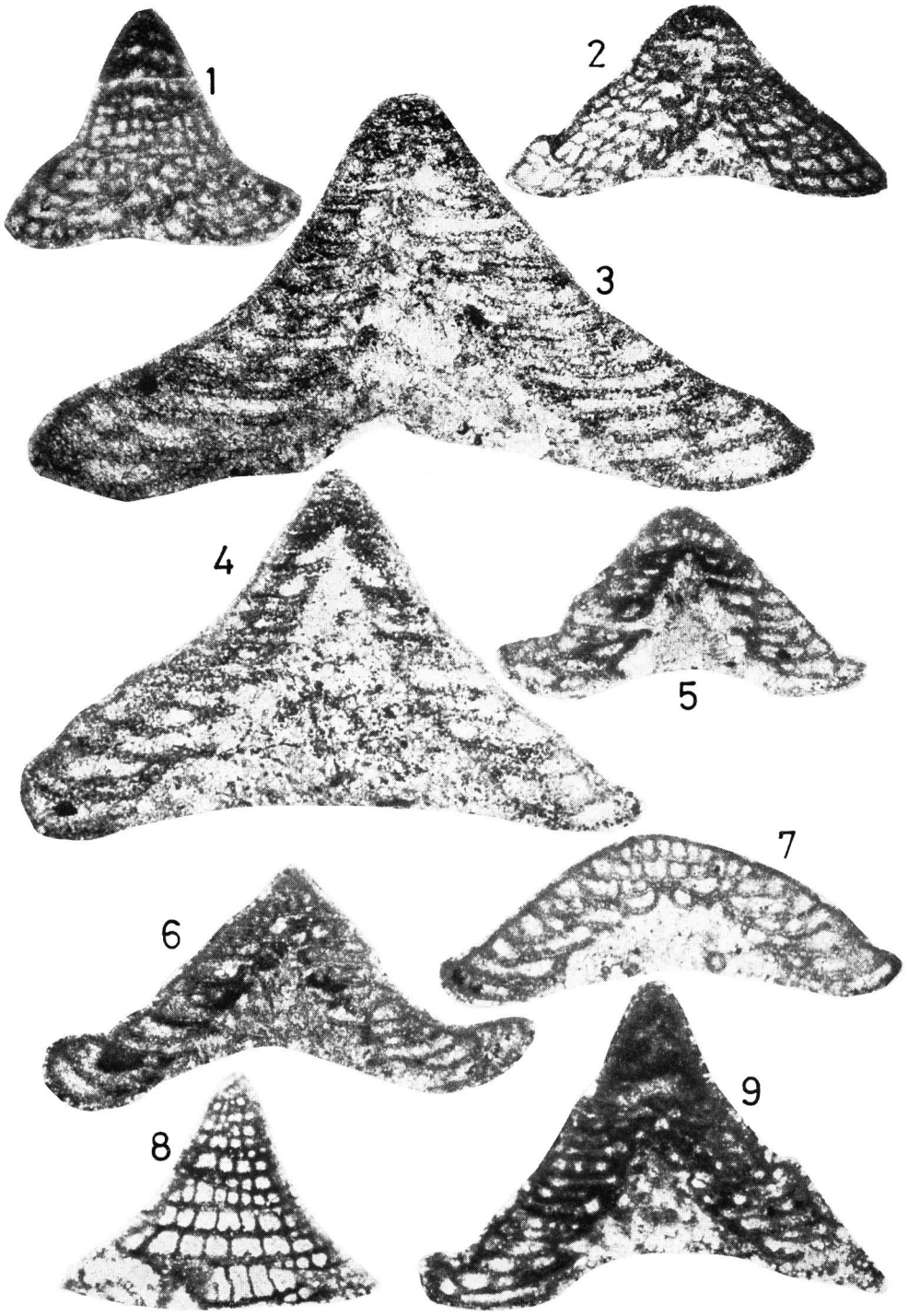
Colaniella minima WANG

Fig. 6. Transverse section.

Fig. 7. Longitudinal section.

Nodosaria sp.

Fig. 8. Longitudinal section.
Lunucammina sp.
Fig. 9. Longitudinal section.
Lunucammina grandis (LIPINA)
Fig. 10. Longitudinal section.
Tetrataxis sp.
Fig. 11. Nearly axial section.
Fig. 12. Oblique section.
(All the specimens came from the Takauchi Limestone of the Maizuru Group, Japan.)



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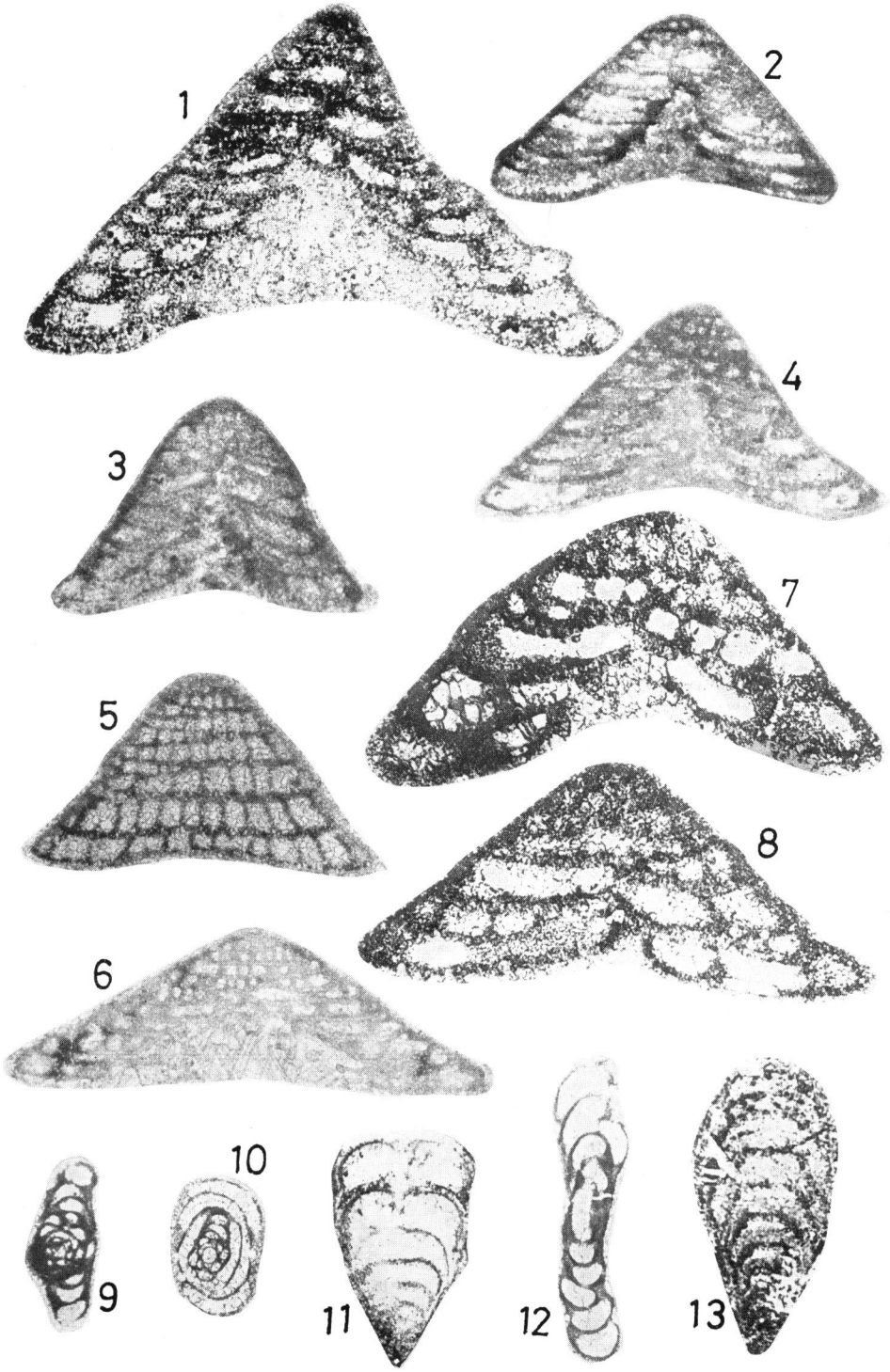
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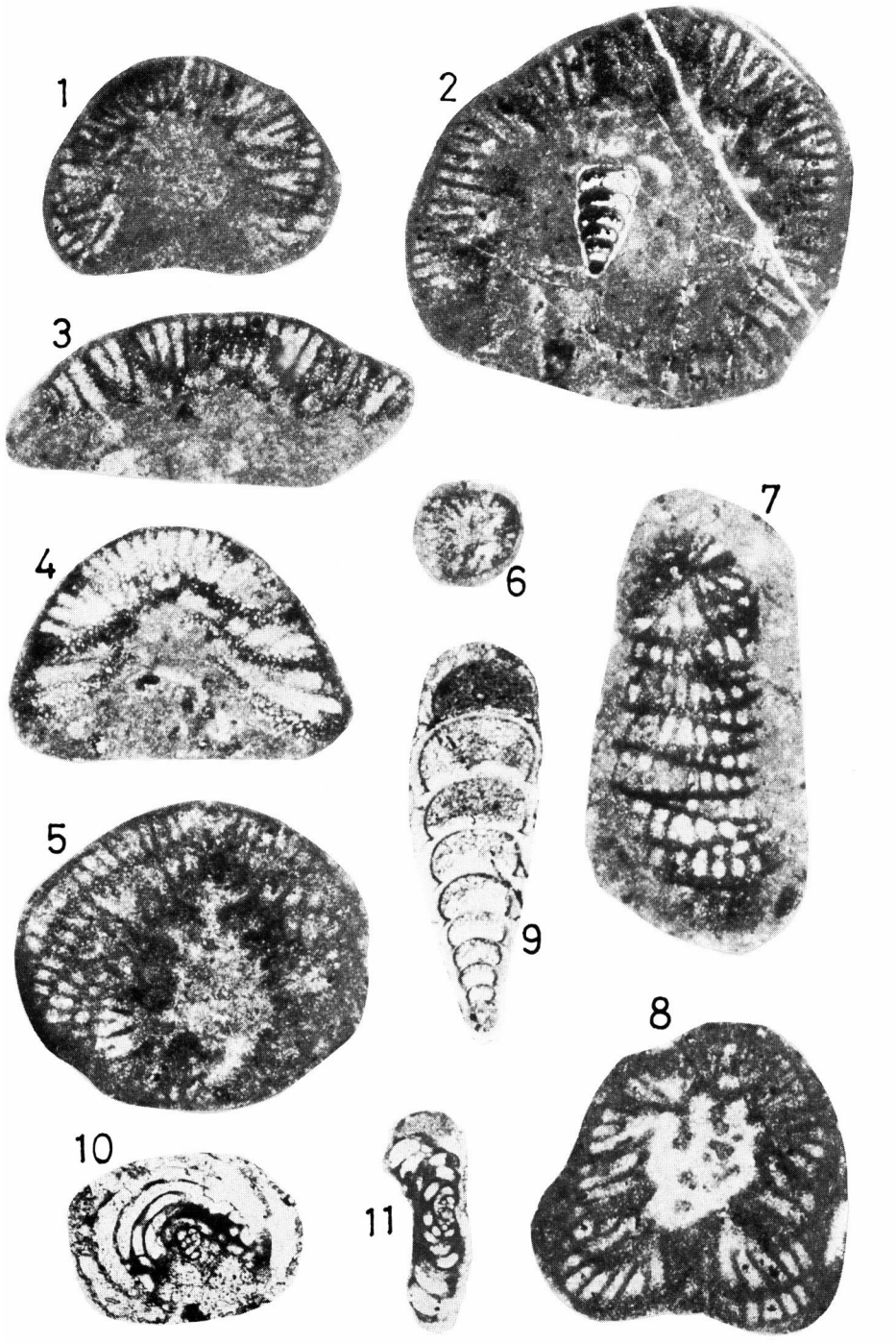
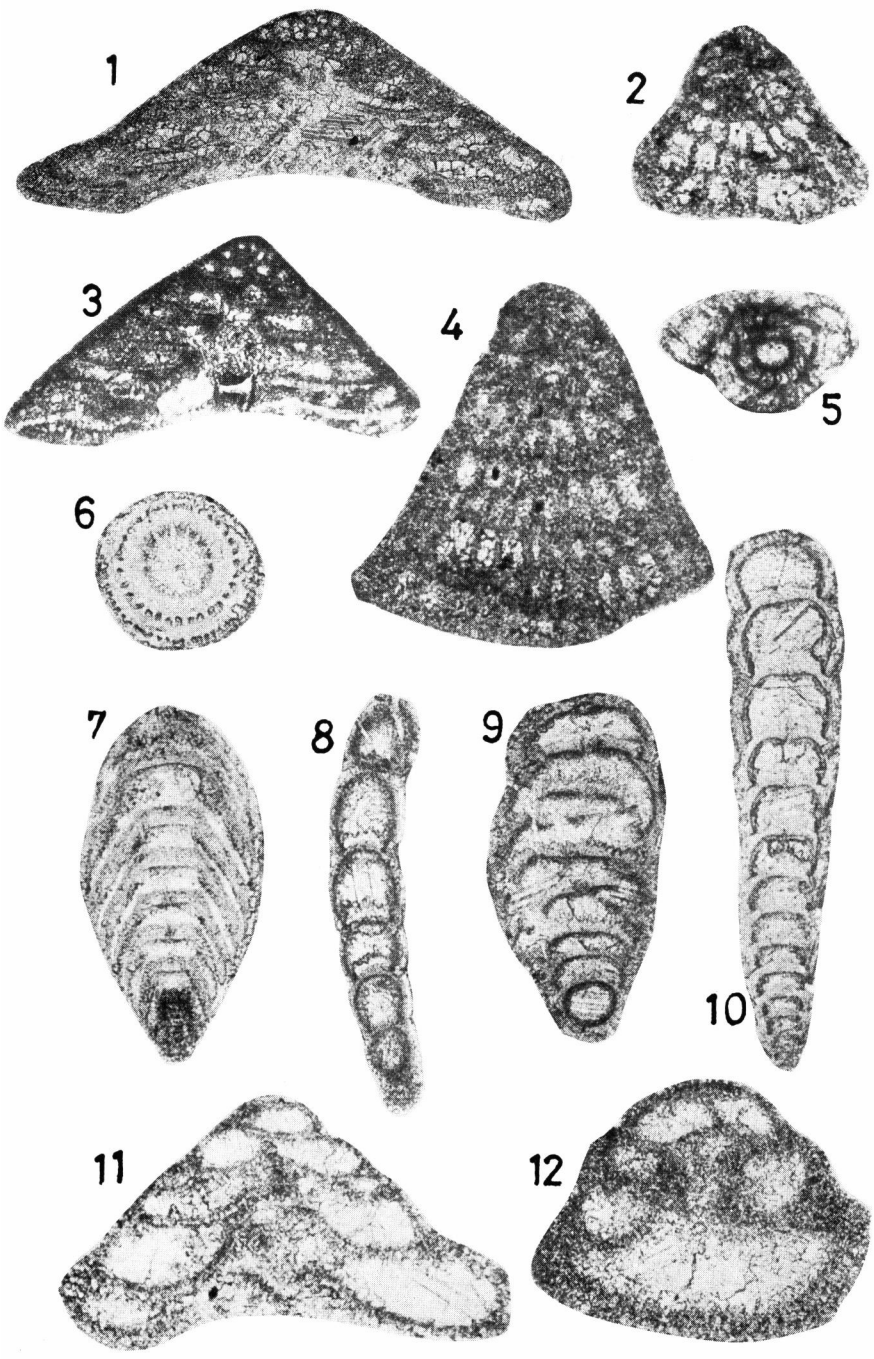


OKIMURA, ISHII, and NAKAZAWA: *Abadehella* from the Late Permian



OKIMURA, ISHII, and NAKAZAWA: *Abadehella* from the Late Permian