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PERMIAN BRACHIOPODS FROM KARAKORUM (PAKISTAN). Pt. 1
(With Appendix)

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Key-words: Brachiopods, New genera, New species, Biostratigraphy, Karakorum, Asselian, Sakmarian.

Riassunto. Cinque associazioni a Brachiopodi sono state riconosciute nelle successioni permiane del Karakorum settentrionale (Pakistan). Scopo del presente lavoro è di illustrare le due associazioni più antiche, di età rispettivamente Asseliano-Sakmariano inferiore e Sakmariano. L'associazione a Brachiopodi di età Asseliano-Sakmariano inferiore, denominata associazione a *Trigonotreta lyonsensis-Punctospirifer afghanus*, è stata campionata nella parte mediana della Fm. Gircha. Si tratta di un'associazione a bassa diversità faunistica, dominata dagli Spiriferidi, indicante condizioni climatiche fredde. L'associazione sakmariana, denominata associazione a *Hunzina electa* gen. n. sp. n., è stata campionata nella Fm. Lupghar, Mb. 1 dell'alta valle Hunza e nella Fm. Lashkargaz, Mb. 1 della zona Baroghil-Lashkargaz (Chitral). Questa associazione, più recente, è caratterizzata da una maggior diversità faunistica, indicante condizioni climatiche più calde rispetto alle precedenti. Inoltre la specie *Hunzina electa* gen. n. sp. n. costituisce un livello marker molto caratteristico, riconoscibile in quasi tutte le sezioni stratigrafiche eseguite nelle successioni permiane del Karakorum settentrionale. Nell'appendice a questo lavoro, vengono introdotti due nuovi generi, un nuovo sottogenere e nove nuove specie provenienti dal Boloriano al Murgabiano-Midiano del Karakorum settentrionale.

Abstract. Five brachiopod associations were collected in the Permian successions of N Karakorum (Pakistan). The aim of this work is to describe the two oldest brachiopod assemblages. The oldest association has been assembled in the Asselian-Early Sakmarian Gircha Fm. It has been named *Trigonotreta lyonsensis-Punctospirifer afghanus* assemblage and it is characterized by low diversity and dominance of spiriferids, indicating cold climate conditions. The second assemblage was collected in the Sakmarian Lupghar Fm., Mb. 1 of Upper Hunza valley and in the Sakmarian Lashkargaz Fm., Mb. 1 of Baroghil and Lashkargaz (Chitral). It has been named *Hunzina electa* gen. n. sp. n. assemblage and it is characterized by higher diversity than the oldest one, indicating warmer climate conditions. Furthermore *Hunzina electa* gen. n. sp. n. represents a marker in almost all the stratigraphic sections of N Karakorum. In the appendix two new genera, one new subgenus and nine new species of brachiopods collected in the Bolorian to Murgabian-Midian of Northern Karakorum, are named and described.

Introduction.

Large collections of Permian brachiopods were assembled during four Italian expeditions (1986, 1991, 1992a, 1992b) on the Pakistan side of Karakorum. The first three expeditions visited the Upper Hunza valley and its laterals, Chapursan valley, Abgarch valley and Shimshal valley. The last expedition was led in the western termination of the Karakorum, in the Chitral-Baroghil-Karambar sector (Fig. 1).

Permian brachiopods from western Karakorum (Baroghil pass) were first collected by Hayden (1915) and described by Reed (1925). A small collection of Permian brachiopods from Upper Hunza valley, collected by Desio in 1962, was described by Fantini Sestini (1965a).

At least five brachiopod assemblages have been recognized so far, from the Asselian-Sakmarian to the Murgabian-Midian (Angiolini, 1994). The aim of this paper is to describe the two oldest Permian brachiopod assemblages of Early Permian age.

Stratigraphy.

The Permian stratigraphy of Karakorum (Pakistan) has been extensively described by Gaetani et al. (1990) and Gaetani et al. (1995) (Fig. 2, 3). In the western termination of Karakorum (Baroghil-Karambar sector) the Lower Permian succession is represented at the base by the Gircha Fm., a terrigenous unit, mostly quartzarenitic. The Lashkargaz Fm. overlies the Gircha Fm. and consists of 4 members spanning the Sakmarian-Kubergandian time interval. The first two members are Early Permian in age. The first member of the Lashkargaz Fm. consists of hybrid arenites, siltites, marls and lenses of crinoidal limestones. The age is Sakmarian as testified by brachiopods and conodonts (Gaetani et al., 1995). The second member of the Lashkargaz Fm. is characterized at the base by fusulinid limestones, often dolomitized which pass to marly limestones and bioclastic limestones. The age of this member is Sakmarian to

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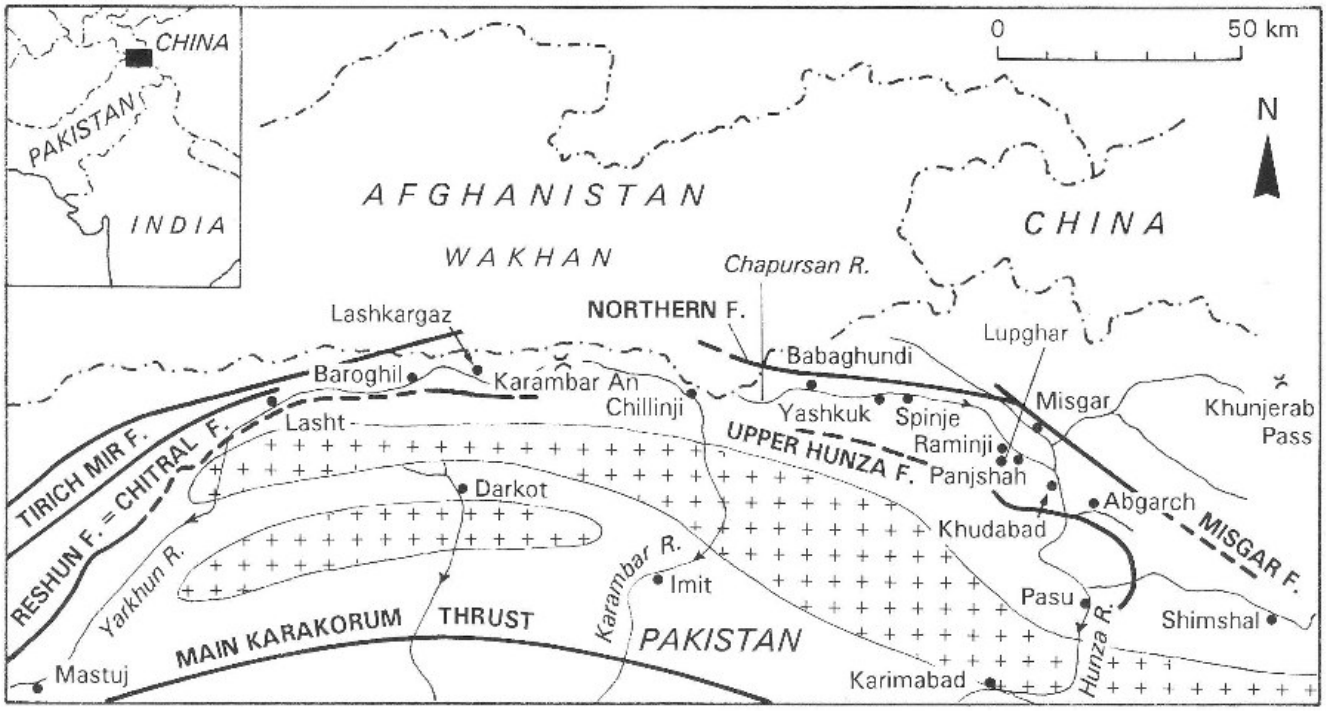


Fig. 1 - Geographic sketch map of Northern Pakistan with few details on general geology.

Bolorian on the basis of fusulinids and brachiopods (Gaetani et al., 1995).

In the Upper Hunza valley and its laterals the Lower Permian succession is characterized at the base by the terrigenous Gircha Fm., shaly in the lower part and arenaceous upward. The age of the Gircha Fm. is Asselian-Early Sakmarian, as testified by the brachiopod assemblage. The overlaying Lupghar Fm. is divisible in two members; the first member consists of hybrid arenites and bioclastic limestones with quartz and it is correlatable with the first member of the Lashkargaz Fm. The second member is characterized by fusulinid limestones, oolitic limestones and dolomites. The age of the Lupghar Fm. is Sakmarian-?Early Artinskian as testified by brachiopods and fusulinids (Gaetani et al., 1995).

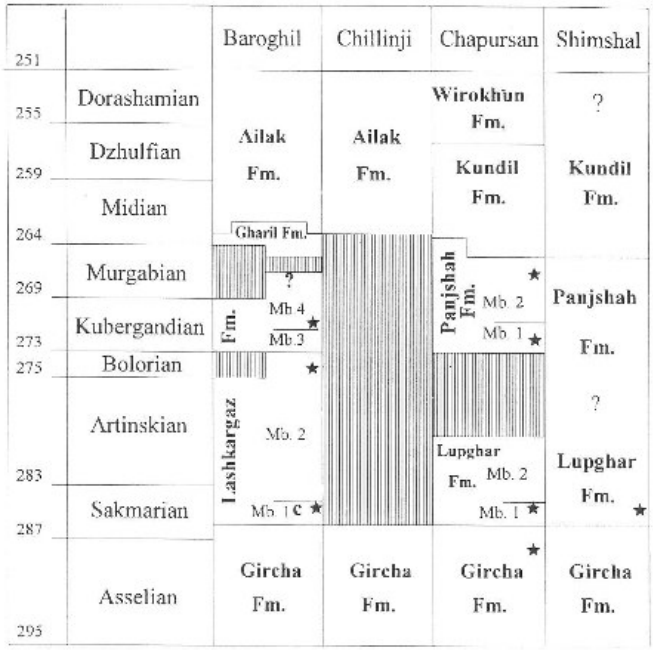


Fig. 2 - Chronostratigraphic scheme of the Permian successions of Karakorum. * Indicates the position of the brachiopod assemblages (from Gaetani et al., 1995).

The two brachiopod assemblages under examination were collected respectively: the lowest in the middle-upper part of the Gircha Formation in the Chapursan valley and the second in the upper part of the first member of the Lashkargaz Formation in the Baroghil-Karambar area and in the first member of the Lupghar Formation in the Upper Hunza valley and its laterals (Fig. 3, 4).

Composition of the assemblages.

The lowest brachiopod assemblage is characterized by the presence of *Lyonia* sp. ind., *Rhynchopora* sp. ind., *Punctospirifer afghanus* Termier, Termier, de Lapparent & Marin, *Trigonotreta lyonsensis* Archbold & Thomas, *Trigonotreta stokesi* Koenig, *Spirelytha petaliformis* (Pavlova), *Tomiopsis* cf. *bazardarensis* (Grunt) and by the bivalves *Etheripecten* sp., *Deltopecten* sp., *Eurydesma* sp. The assemblage is dominated by the spiriferid *T. stokesi*, *T. lyonsensis* and *S. petaliformis*. The two species of *Trigonotreta* represent the 80% of the assemblage. The other two spiriferids *P. afghanus*

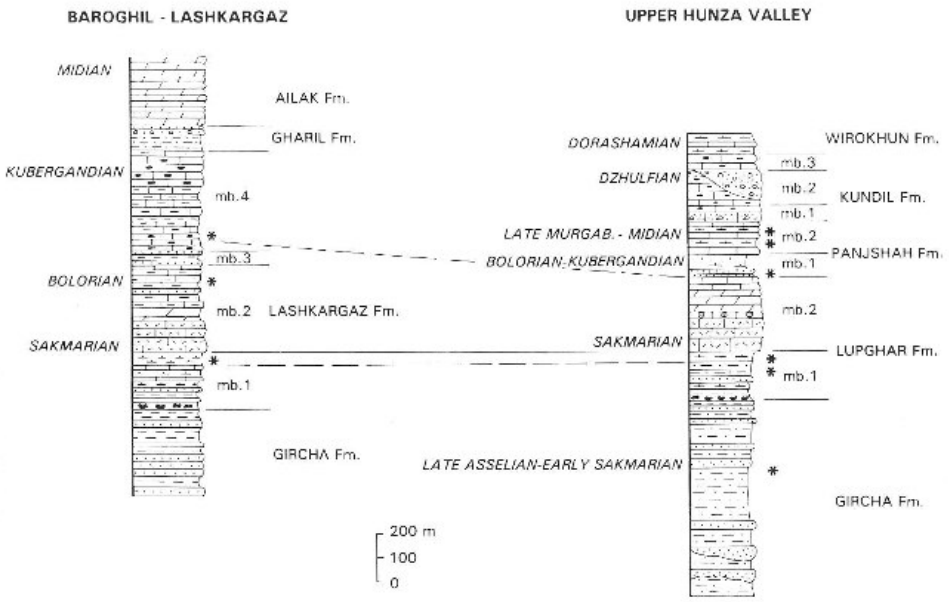


Fig. 3 - Synthetic stratigraphic successions of the Permian successions of Baroghil Lashkargaz (Chitral, W Karakorum) and Upper Hunza valley (Central Karakorum) (modified from Angiolini & Reuori, 1994). * Indicates the brachiopod assemblages.

and *T.* cf. *bazardarensis* are subordinated, whereas the Rhynchonellida and the Productida are represented only by respectively the genera *Rhynchopora* (1.4% of the total assemblages) and *Lyonia* (3% of the total assemblage). This association has been found in fine arkoses (Gaetani et al., 1995), suggesting deposition in a marine terrigenous platform in cold climate conditions, following the Gondwanian glaciation. Dickins (pers. comm., 1994) suggests that this association can be a slightly deeper water correspondent of the *Eurydesma* fauna.

The second assemblage is dominated by *Hunzina electa* gen. n. sp. n. and *Trigonotreta paucicostulata* (Reed). The species *Derbyia* cf. *baroghilensis* Reed, *Permochonetes pamiricus* Afanaseva, *Reticulatia* sp. ind., *Globiella* cf. *rossiae* (Fantini Sestini), *Costatumulus irwinensis* (Archbold), *Cleiothyridina ailakensis* Reed, *Cleiothyridina* aff. *semiconcava* (Waagen), *Cleiothyridina* sp., *Cleiothyridina globulina* (Waagen), *Spirigerella* sp. ind., *Cyrtella* cf. *nagmargensis* (Bion), *Hunzina tenuisulcata* (Merla) and *Gjelispinifera* aff. *cristata* (Schlotheim) are also present. Furthermore the bivalve *Parallelodon desioi* Fantini Sestini has been detected together with the brachiopod assemblage. The assemblage is dominated again by the spiriferids and by athyridids, but species of Chonetida and Productida are also present, enhancing the higher diversity of the association. However, the dominating species is *H. electa* gen. n. sp. n. which represents more than the 50% of the assemblages (numbering about 250 speci-

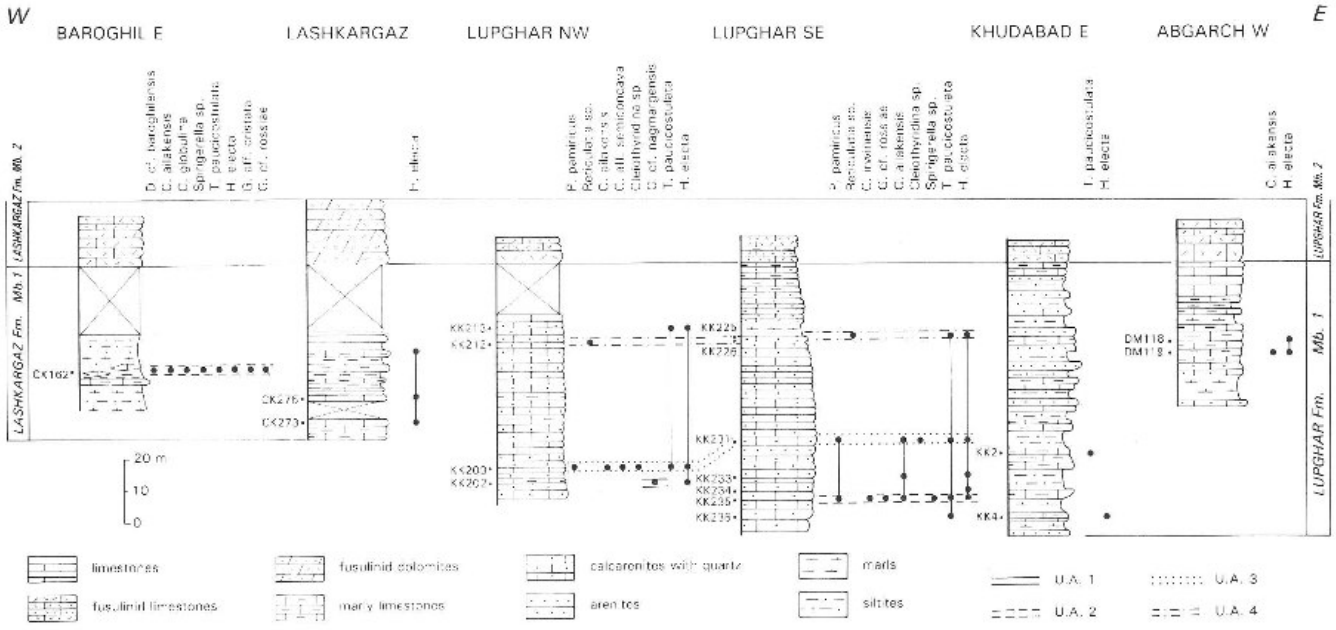


Fig. 4 - Correlation of the sections of Karakorum where the *H. electa* assemblage has been recognized with the stratigraphic occurrence of each species. The four Unitary Associations recognized with the method of Guex (1991) and Savary & Guex (1991) are also reported.

mens). *H. electa* gen. n. sp. n. is absent only in Shimshal valley where it is replaced, in the same stratigraphic position by *H. tenuisulcata*. The lithotype in which the second assemblage has been collected, is very variable consisting of shales with limestone lenses in the Baroghil E section, marly limestones in the Lashkargaz, Khudabad E and Abgarch W section, and arenaceous calcarenites in the Lupghar sections (Fig. 4). Thus the ecological control seems not to affect the distribution of the assemblage which is present over a large area at different depth, substratum and hydrodynamic conditions in an open marine shelf. The climate seems to be warmer than the previous one, as testified by the higher taxonomic diversity of the brachiopod assemblage and by the increasing deposition of limestones. Dickins (pers. comm., 1994) suggests this assemblage could be a deeper water correspondent of the *Oriocrassatella* fauna of Tibet.

Biostratigraphy.

The brachiopod assemblages of the Gircha Fm. and of the Mb. 1 of the Lupghar and Lashkargaz Fms. include more diagnostic species restricted to each interval, which do not show vertical recurrence. Furthermore the succession of the faunal assemblages seems not to be controlled by environmental parameters. In fact the same assemblage occurs in different lithofacies in the same stratigraphic position and different consecutive assemblages have been recognized in omogeneous lithofacies (Fig. 4).

On these bases, two biozones have been defined respectively in the Gircha Fm. and in the Mb. 1 of Lupghar and Lashkargaz Fms. of Karakorum: the lowest is an assemblage zone (Salvador, 1994) whereas the second is a range zone (Salvador, 1994). The lowest assemblage has been defined as the *T. lyonsensis-P. afghanus* assemblage zone from the two most characteristic species (Angiolini, 1994) (Fig. 5) and it has been recognized in the arkoses of the Gircha Fm. in the Ashtigar valley, at Spinje and above the Yashkuk glacier (Gaetani et al., 1995). The boundaries of this zone coincide with two barren intervals. This assemblage may also be interpreted as a Maximal Horizon (M.H.1), following the Unitary Association Method of Guex (1991) (Fig. 5).

The age of the *T. lyonsensis-P. afghanus* assemblage zone is Late Asselian-Early Sakmarian (Angiolini, 1994), as inferred by the known range of the following forms: *Lyonia*, a genus widespread in the Asselian-Early Sakmarian of W Australia (Archbold, 1983, 1992), *P. afghanus* from the Asselian of the Wardak (Termier et al., 1974), *T. lyonsensis* from the Asselian-Early Sakmarian of the Carnarvon Basin (Archbold & Thomas, 1986a) and *T. stokesi* from the Tamarian (Asselian-Early Sakmarian) of Tasmania (Clarke 1979, 1990; Archbold & Dickins, 1989; Archbold, 1992). Also the bivalve association (*Eurydesma*-like fauna) testifies for this age. Furthermore the occurrence of *T. bazardarensis* can confirm a Late Asselian-Sakmarian age. In fact this species has been originally collected from the lump-boulder member at the base of the Tashkazyk Fm. of the Bazardara Group in the south-east Pamir (Grunt, 1993; Grunt & Novikov, 1994). The age of this formation is still debated: Ruzhentsev (1978) suggested a Late Asselian age on the basis of ammonoids, whereas Grunt & Novikov (1994) proposed a Sakmarian-Early Artinskian age on the bases of the brachiopods occurring at the top of the formation, about 200 m above the lump-boulder assemblage. The lump-boulder brachiopod assemblage at the base of the Tashkazyk Fm. (Grunt & Novikov, 1994, p. 332) in the Kastanat-Djilga type section is very different from the brachiopod assemblage at the top of the formation, having only one species (*S. petaliformis*) in common. The lowest assemblage is also very similar to the *T. lyonsensis-P. afghanus* assemblage of Karakorum, except for the presence of *P. pamiricus*, which in Karakorum occurs higher; the assemblage at the top of the Tashkazyk Fm. is very similar to the *H. electa* assemblage of Karakorum. The brachiopod assemblage at the base of the Tashkazyk Fm. of the south-east Pamir is here interpreted as a mixed assemblage containing both reworked Late Asselian and Sakmarian species (see also the discussion on the lithology in Grunt & Novikov, 1994, p. 332), whereas the brachiopod assemblage at the top of the Tashkazyk Fm. is considered of Sakmarian-?Early Artinskian age.

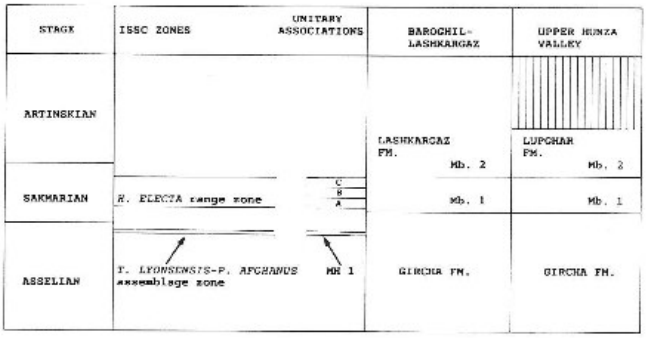
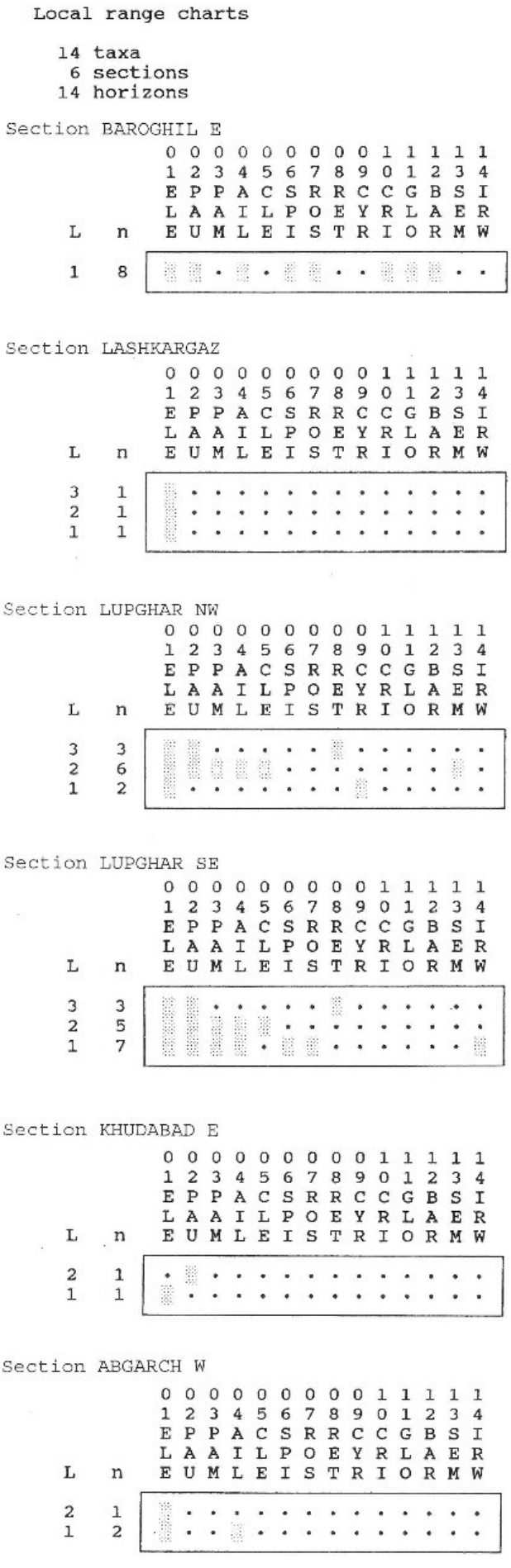


Fig. 5 - Brachiopod zones in the Lower Permian successions of Karakorum. Time Scale after Ross et al. (1994).

The second assemblage of Karakorum has been defined as the *H. electa* range zone (Fig. 5) and it occurs in the Lupghar Fm., Mb. 1 of Lupghar, Khudabad, Abgarch valley and Shimshal valley and in the Lashkargaz Fm., Mb. 1 of Lashkargaz and Baroghil. This zone is the body of strata representing



the stratigraphic and the geographic range of occurrence of *H. electa* gen. n. sp. n. and its boundary are the outermost limits of known occurrence of *H. electa* gen. n. sp. n. in each section.

According to the Unitary Association Method of Guex (1991) four Unitary Associations have been recognized with the Biograph 2.02 program (Savary & Guex, 1991) (Fig. 6, 7, 8). The lowest Unitary Association (U.A. 1) is characterized by the species *C.* cf. *nagmargensis*. The second one, U.A. 2, is characterized by the species *G.* cf. *rossiae* and *Spirigerella* sp. ind. The U.A. 3 is characterized by *Cleiothyridina* sp. ind., whereas the U.A. 4 is characterized by *Reticulatia* sp. ind.

H. electa and *T. paucicostulata* occur throughout the unitary associations, whereas *P. pamiricus* and *C. ailakensis* occur in U.A. 2 and U.A. 3 (Fig. 4). The reproducibility (R=2) is discrete for each U.A., except for U.A. 1 (R=1); the superpositional control is higher for the U.A. 3 (S.C.=3). Merging together the U.A. 2 and the U.A. 3, which show similarity of the fauna, the reproducibility increases (R=3) and the correlation is easier (Fig. 8), even if the union of the two unitary association is not "strictly identified" in any sections (Guex, 1991, pp. 16, 75-77). Three biochronozones may be recognized (Fig. 5):

1. Zone A = U.A. 1
2. Zone B = union of U.A. 2 and U.A. 3
3. Zone C = U.A. 4

The Unitary Association Method of Guex (1991) and Savary & Guex (1991) thus allows the establishment of a more detailed biozonation in the Mb. 1 of Lupghar and Lashkargaz Fms. with respect to the traditional method (at least 3 biozones versus 1) (Fig. 5).

The age of the *H. electa* zone is Sakmarian as suggested by the occurrence of *P. pamiricus* and *C. ailakensis* at the top of the Tashkazyk Fm. of SE Pamir (Sakmarian-Early Artinskian in Grunt & Dmitriev, 1973; Afanaseva, 1977; Grunt & Novikov, 1994), *G. rossiae* in the Late Sakmarian of Central Elburz (Fantini Sestini, 1966). Furthermore *T. paucicostulata* occurs in the Sakmarian of Central Elburz (Fantini Sestini, 1966), in the Sakmarian-Early Artinskian of SE Pamir (Grunt & Dmitriev, 1973; Grunt & Novikov, 1994) and in the Asselian-Early Sakmarian of Wardak (Termier et al., 1974). *H. tenuisulcata* occurs in the Early Permian of NE Karakorum (Merla, 1934) and of Shaksgam valley (Fantini Sestini, 1965b). The Sakmarian age of this zone is also supported by the occurrence of the conodont *A. paralautus* Orchard

Fig. 6 - Range charts for each section of Fig. 4, obtained with the Biograph 2.02 program (Savary & Guex, 1991).

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Maximal residual horizons
sorted by cardinality

14 taxa
 6 sections
 5 maximal residual horizons

1.  1 [  8]: 01ELE 02PAU 04AIL 06SPI 07ROS 10CRI 11GLO 12BAR
4.  1 [  7]: 01ELE 02PAU 03PAM 04AIL 06SPI 07ROS 14IRW
3.  2 [  6]: 01ELE 02PAU 03PAM 04AIL 05CLE 13SEM
4.  3 [  3]: 01ELE 02PAU 08RET
3.  1 [  2]: 01ELE 09CYR
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A

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SORTED UNITARY ASSOCIATIONS

 14 taxa
  4 unitary associations

          1 2 3 4
09CYR     •
01ELE     • • • •
06SPI       •
07ROS       •
10CRI       •
11GLO       •
12BAR       •
14IRW       •
03PAM       • •
04AIL       • •
02PAU       • • •
05CLE         • •
13SEM         •
08RET           •
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B

```
Adjacency matrix of L

14 taxa
 4 unitary associations

                0 0 0 0 0 0 0 0 0 1 1 1 1 1
                1 2 3 4 5 6 7 8 9 0 1 2 3 4
                E P P A C S R R C C G B S I
                L A A I L P O E Y R L A E R
UA    n         E U M L E I S T R I O R M W
4     3         ▒ ▒ • • • • • ▒ • • • • • •
3     6         ▒ ▒ ▒ ▒ • • • • • • ▒ ▒ •
2    10         ▒ ▒ ▒ • ▒ ▒ • • ▒ ▒ ▒ • ▒
1     2         ▒ • • • • • • ▒ • • • • •
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C

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REPRODUCIBILITY OF THE UA

 6 sections
 4 unitary associations

                B L L L K
                A A U U H A
                R S P P U B
                O H G G D G
                G K H H A A
                H A A A B R
                I R R R A C
                L G N S D H
                _ A _ _ _ _
UA    n         E Z W E E W
4     2         • • ▒ ▒ • •
3     2         • • ▒ ▒ • •
2     2         ▒ • • ▒ • •
1     1         • • ▒ • • •
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D

Fig. 7 - Output of the Biograph program 2.02 (Savary & Guex, 1991). A) Maximal residual horizons in the 6 sections of Fig. 4. B) Sorted Unitary Associations. C) Adjacency matrix of L. D) Reproducibility of the Unitary Associations.

(Gaetani et al., 1995) about 4 m below the brachiopod assemblage. This association has three genera (*Hunzina, Costatumulus* and *Cyrtella*) in common with the Sakmarian association of the Callytharra Fm. (W Australia). Furthermore the *H. electa* range zone of Karakorum is very similar to the Sakmarian brachiopod assemblage of the middle part of the Mushirebuca Group of the Gegyai County (NW Tibet), described by Sun (1991). Finally Sakmarian-Early Artinskian fusulinids, dominated by the genus *Pseudofusulina*, have been detected at the base of the second member of the Lupghar Fm., above the brachiopod assemblage (Gaetani et al., 1995).

Collections and localities.

All specimens are housed at the Museo di Paleontologia (MPUM) del Dipartimento di Scienze della Terra dell'Università degli Studi di Milano (Italy). Specimens were found both in levels of measured sections and in isolated localities (for details refer to Gaetani et al., 1995) (Fig. 1,4).

Sections.

Baroghil E section

CK162, CK172 - Baroghil pass, Lashkargaz Fm., Mb. 1, Baroghil E section.

Lashkargaz section

CK273, CK276 - Lashkargaz, Lashkargaz Fm., Mb. 1, Lashkargaz section.

Ashtigar section

KP171 - Ashtigar, Gircha Fm.

Lupghar sections

KK202, KK203, KK212, KK213 - Chapursan valley, Lupghar Fm., Mb. 1, Lupghar NW section.

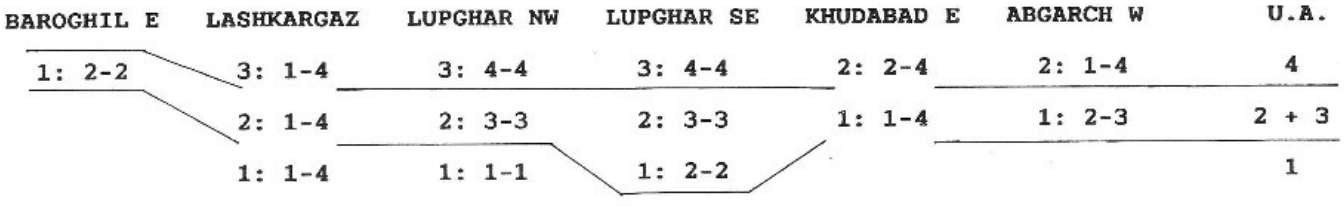


Fig. 8 - Correlation table. The distribution of Unitary Associations for each section is obtained with the Biograph 2.02 program (Savary & Guex, 1991), whereas the correlation lines have been drawned by the author.

KK236, KK235, KK234, KK233, KK231, KK226, KK225 - Chapursan valley, Lupghar Fm., Mb. 1, Lupghar SE section.

Khudabad section

KK2, KK4 - Chapursan valley, Lupghar Fm., Mb. 1, Khudabad E section.

Abgarch section

KL26 (=DM119), KL28 (=DM118), KL29 (=DM118) - Abgarch valley, Lupghar Fm., Mb. 1, Abgarch N section.

Shimshal section

KL17, KL19 - Shimshal valley, Lupghar Fm., Mb. 1, Shimshal section.

Localities.

DM35 - Hunza valley, Lupghar Fm., Mb. 1

KL21, KL22 - Shimshal valley, Yazghil glacier, Lupghar Fm., Mb. 1, in the screw.

CK409 - Yarkhun valley, gulley North of Showar Sur, Lashkargaz Fm., Mb. 1.

KK26 - Chapursan valley, 3560 m a.s.l. in the valley south of Spinji, Gircha Fm.

KL2 - Chapursan valley, 4000 m a.s.l. above left side of Yashkuk Glacier, Gircha Fm.

KK289 - Shimshal valley.

Systematic descriptions

Phylum **Brachiopoda**

Order **Strophomenida** Opik, 1934

Superfamily *Derbyiacea* Stehli, 1954

Family *Derbyidae* Stehli, 1954

Subfamily *Derbyinae* Stehli, 1954

Genus *Derbyia* Waagen, 1884

Type-species: *Derbyia regularis* Waagen, 1884

Comments. For the diagnosis of the genus *Derbyia* and its junior synonym *Wardakia* Termier, Termier, de Lapparent & Marin (1974, p. 95, pl. 9, fig. 2-5; pl. 10, fig. 1-3), refer to Grant (1976, 1993).

Derbyia cf. **baroghilensis** Reed, 1925

Pl. 1, fig. 1, 2

Material. 3 Dorsal valves: MPUM 7272 (DM35-1bis); MPUM 7270 (CK172-116); MPUM 7271 (CK172-156).

Description. Large sized, convex dorsal valve, subelliptical in outline. Hinge line less than maximum width, which is at about mid-length. The convexity of the valve decreases towards the cardinal margin. Umbo recurved; interarea lacking. A median sulcus begins anteriorly to the umbo, widening and deepening anteriorly.

Ornamentation of thin costellae, which increase in number anteriorly by intercalation, up to 14-16 per 10 mm at the anterior margin. The interspaces between costellae are larger than the costellae and are ornamented by thin concentric striae. Locally the costellae widen into small knots.

Interior of dorsal valve with strong socket plates.

Dimensions (in mm):

	Width	Length
DM35-1	49	41
CK172-116	42.3	37.7
CK172-156	60	45

Discussion. *D. baroghilensis* Reed, 1925 (p. 22, pl. 3, fig. 8) has been established on a single ventral valve from the Baroghil section of Hayden (1915). The specific identification of the dorsal valves here examined is based on the ornament affinity with *D. baroghilensis.*

D. eusarkos (Abich, 1878) described by Renz (1940) from the Early Permian of Karakorum (E of Shaksgam pass) and *D. diversa* Reed, 1944 from the top of the Tashkazyk Fm. (Sakmarian-Early Artinskian) of SE Pamir (Grunt & Dmitriev, 1973) are very similar to the analysed specimens.

Geographic and stratigraphic distribution. *D. baroghilensis* occurs in the Sakmarian of Karakorum (Baroghil pass and Hunza valley).

Order **Chonetida** Nalivkin, 1979

Suborder *Chonetidina* Muir-Wood, 1955

Family *Anopliidae* Muir-Wood; 1962

Genus *Permochonetes* Afanaseva, 1977

Type-species: *Permochonetes pamiricus* Afanaseva, 1977

Comments. *Permochonetes* Afanaseva is a distinctive genus of Anopliidae which shows external characters similar to *Neochonetes* Muir-Wood, 1962 (Rugosochonetidae), differing from it by absence of the median septum and the lateral septa in the dorsal valve.

Permochonetes pamiricus Afanaseva, 1977

Pl. 1, fig. 3-12

1965a *Neochonetes carboniferus* - Fantini Sestini, p. 140.
1977 *Permochonetes pamiricus* Afanaseva, p. 148, fig. 1, 2.

Material. 20 Ventral valves: MPUM 7274 (KL21-56); MPUM 7275 (KL21-57); MPUM 7276 (KL21-55); MPUM 7280 (KL21-34); MPUM 7283 (KK203-15); MPUM 7284 (KK231-20,-37,-39); MPUM 7285 (KK235-60,-61); MPUM 7286 (KL21-17,-19,-30,-33,-34bis,-35,-38,-39,-45,-47).

11 Partially decorticated ventral valves: MPUM 7287 (KK203-74); MPUM 7288 (KK231-16,-21,-36,-52); MPUM 7289 (KK235-59); MPUM 7290 (KL21-23,-24,-26,-31,-48).

22 Internal moulds of ventral valves: MPUM 7273 (KL21-16); MPUM 7277 (KL21-54); MPUM 7278 (KL21-53); MPUM 7279 (KL21-21); MPUM 7281 (KL21-25); MPUM 7282 (KL21-40); MPUM 7291 (KK231-8,-9,-22,-26,-28,-34); MPUM 7292 (KK235-47); MPUM 7293 (KL21-13,-18,-22,-27,-32,-37,-41,-46,-50).

4 Dorsal valves: MPUM 7294 (KL21-10,-14,-14bis,-29).

Description. Medium-sized, concavo-convex shell, subrectangular in outline. Maximum width slightly anterior to the hinge line. Cardinal extremities rectangular to obtuse.

Ventral valve very convex with small and slightly recurved umbo. Umbonal slopes diverge at about 120° and flatten towards the ears. Median sulcus, if present, wide and low. Dorsal valve concave, subcircular in outline. Ornamentation of bifurcating capillae, numbering 4-5 per 1 mm at a distance of 4 mm from the umbo. Growth lamellae occur at the anterior margin.

Interior of the ventral valve with a short median septum, 1-2 mm long. Adductor scars small, raised, oval in outline. Vascular trunks begin anteriorly to the septum and extend to 1/3 of the length of the valve; they are parallel to the plane of symmetry. Papillae are radially aligned.

Dimensions (in mm):

	Width	Length
KK235-47	11.8	7.3
KK235-59	15.8	9
KL21-40	16.6	10.5
KL21-14	18.1	8
KL21-16	16.8	9
KL21-19	15	9.3
KL21-33	14.8	6.7
KL21-34	19.4	10
KL21-45	7	5.2
KL21-50	16.9	8.7
KL21-53	16.2	8.5
KL21-55	13.4	6.8
KL21-14	13.3	9.5
KL21-14bis	14	9.3

Discussion. Diagnostic characters of *Permochonetes pamiricus* Afanaseva, 1977 are the subrectangular outline, the high convexity of the ventral valve, the low or absent ventral median sulcus, the short median septum and the shape of the vascular trunks.

Neochonetes carboniferus (Keyserling, 1846), as described by Fantini Sestini (1965a) from the Chapursan valley (Karakorum), shows the diagnostic features of *P. pamiricus*.

Stratigraphic and geographic distribution. *P. pamiricus* occurs at the base and the top of the Tashkazyk Fm. of the SE Pamir (Afanaseva, 1977) and in the Sakmarian of Karakorum (Chapursan and Shimshal valleys).

Order **Productida** Sarycheva & Sokolskaya, 1959

Suborder **Productidina** Waagen, 1883

Superfamily *Productacea* Gray, 1840

Family *Dictyoclostidae* Stehli, 1954

Genus *Reticulatia* Muir-Wood & Cooper, 1960

Type-species: *Productus huecoensis* King, 1831

Reticulatia sp. ind.

Pl. 1, fig. 13, 29, 30

Material. 1 Complete specimen: MPUM 7295 (DM35-6).

9 Ventral valves: MPUM 7481 (KK212-5); MPUM 7482 (KK212-3); MPUM 7483 (KK212-1); MPUM 7484 (KK212-2,-4,-6,-7,-8,-9,-11).

2 Dorsal valves: MPUM 7480 (KK225-1); MPUM 7484 (KK212-30).

Description. Medium sized concavo-convex, geniculated shell, subsquare in outline. Maximum width at the hinge line. Ventral valve with convex visceral disc and long spirally enrolled trail. Umbo pointed and recurved. Median sulcus rather deep and narrow. Dorsal valve concave, geniculated, with quite a long trail. Median fold rather prominent.

Ornamentation strongly reticulated. Costae fine, numerous, converging in the ventral sulcus, numbering 4-5 per 5 mm on the trail. Rugae fine, prominent on the visceral disc. Dorsal valve with dimples.

Dimensions (in mm):

	Width	Length
KK212-3	27	25.5
KK212-4	41	31
KK212-9	30.4	28.4
KK225-1	31.5	21

Discussion. The specimens from Karakorum are very similar to *Reticulatia pamirica* Grunt, 1973 from the top of the Tashkazyk Fm. (Sakmarian-Early Artinskian) of SE Pamir, but their bad state of preservation prevents a specific determination.

Geographic and stratigraphic distribution. *Reticulatia* sp. ind. occurs in the Sakmarian of Karakorum (Hunza valley).

Superfamily *Linoproductacea* Stehli, 1954

Family *Linoproductidae* Stehli, 1954

Subfamily *Linoproductinae* Stehli, 1954

Genus *Lyonia* Archbold, 1983

Type-species: *Linoproductus cancriniformis* var. *lyoni* Prendergast, 1943

Comments. *Lyonia* is a monotypic genus erected by Archbold (1983) for a species, *L. lyoni* (Prendergast, 1943), from the Lyons Group (Carnarvon Basin)

and Fossil Cliff Member (Perth Basin). *Lyonia* differs from *Costatumulus* Waterhouse, 1983 by means of its larger size, lower convexity of the ventral valve, presence of dorsal spines; from *Cancrinella* Fredericks, 1928 by means of its larger size and the cardinal process, which is not supported by septum and does not project beyond the hinge; from *Bandoproductus* Jing & Sun, 1981 by means of the presence of dorsal spines and the lower cardinal process and longer median septum.

Lyonia sp. ind.

Pl. 1, fig. 21

Material. 4 Ventral valves: MPUM 7296 (KK26-166); MPUM 7297 (KK26-139,-167,-168).

Description. Ventral valve gently convex, subcircular in outline, wider than long. Maximum width at the hinge line or just anterior to it. Umbo small and pointed. Ears large and flattened. Ornamentation of thin costellae, concentric rugae and spines. Costellae number 5-7 per 5 mm. Rugae are thin and low, but distinct. The spines arise from swollen costellae and their bases are about 0.8-1 mm in diameter.

Dimensions (in mm):

	Width	Length
KK26 166	26	25.4
KK26-168	22	20.1

Discussion. A comparison with *L. lyoni* (Prendergast, 1943) of Western Australia is not possible because of the poor preservation of the material and the lack of dorsal valves.

Geographic and stratigraphic distribution. *L. lyoni* has been described for the Asselian-Sakmarian of Western Australia (Archbold, 1983; Archbold & Dickins, 1989) and from the Asselian of Afghanistan (de Lapparent et al., 1971). *Lyonia* sp. ind. occurs in the Late Asselian-Early Sakmarian of Karakorum (Chapursan valley).

Subfamily *Auriculispininae* Waterhouse, 1986

Genus *Costatumulus* Waterhouse, 1983

Type-species: *Auriculispina tumida* Waterhouse, 1983

Comments. The relationship of *Costatumulus* with allied genera have been fully discussed by Trilochoan Singh & Archbold (1993) and by Archbold (1993).

Costatumulus irwinensis (Archbold, 1983)

Pl. 1, fig. 20

1973 *Cancrinella altissima* - Grunt & Dmitriev, p.106, pl. 8, fig. 1, 2.
1983 *Cancrinella irwinensis* Archbold, p. 239, fig. 1C-P.
1990 *Cancrinella irwinensis* - Archbold, p. 8, fig. 4F-G.

Material. 1 Ventral valve: MPUM 7298 (KK235-63).

Description. Ventral valve very convex with elongate outline. Maximum width anterior to the hinge line. Umbo recurved on hinge. Ornamentation of thin costellae, concentric rugae and spines. Costellae number 8-10 per 5 mm. Rugae are large and low but distinct, strongest on ears and lateral slopes. The spines arise from thicker costellae.

Dimensions (in mm):

	Width	Length
KK235-63	15	17.8

Discussion. Diagnostic characters of *Costatumulus irwinensis* (Archbold, 1983) are the variable size, the strong convexity of the ventral valve, the pointed umbo and the distinct, fine rugae. *Cancrinella altissima* King, 1938 described by Grunt & Dmitriev (1973) and Grunt & Novikov (1994) from the top of the Tashkazyk Fm. (Sakmarian-Early Artinskian) of the SE Pamir, shows the distinct features of *C. irwinensis*.

Geographic and stratigraphic distribution. *C. irwinensis* occurs in the Perth Basin (Fossil Cliff Member), Carnarvon Basin (Callytharra Fm.) and Canning Basin (Cuncudgeric Sandstones) of Western Australia (Archbold, 1983) and its age is Late Sakmarian.

C. irwinensis is also present in the Sakmarian-Early Artinskian of SE Pamir (Grunt & Dmitriev, 1973) and in the Sakmarian of Karakorum (Chapursan valley).

Subfamily *Stepanoviellinae* Waterhouse, 1975

Genus *Globiella* Muir-Wood & Cooper, 1960

Type-species: *Productus hemisphaerium* Kutorga, 1844

Comments. *Globiella* has usually been treated as a junior synonym of *Stepanoviella* Zavadovsky, 1960 (Grigorieva, 1962; Muir-Wood, 1965, in Williams et al., 1965; Waterhouse, 1970). Archbold (1983) has pointed out the differences between the two genera, *Stepanoviella* showing a finer ornamentation, two types of ventral spines and the occurrence of spines also in the dorsal valve. Furthermore *Stepanoviella* has been up to now known only from the Late Permian of Siberia. *Globiella* seems to be a widespread Peri-Gondwanian genus, mostly of Early Permian age.

The present writer suggests to include in *Globiella* also *Productus* cf. *waagenianus* Girty, 1909, as described by Merla (1934) for the Permian of Rimu (N Karakorum).

Two species of the genus *Globiella* characterize the Sakmarian middle part of the Mushirebuca Group of NW Tibet (Sun, 1991).

Globiella cf. **rossiae** (Fantini Sestini, 1966)

Pl. 1, fig. 14-19

1966 *Stepanoviella rossiae* Fantini Sestini, p. 28, pl. 4, fig. 1a-6.
non 1973 *Globiella? rossiae* - Grunt & Dmitriev, p. 107, pl. 7, fig. 6-8.

Material. 24 Ventral valves: MPUM 7299 (KK235-30); MPUM 7300 (KK235-29); MPUM 7301 (KK235-45); MPUM 7302 (KK235-24); MPUM 7303 (KK235-22); MPUM 7304 (KK235-23); MPUM 7305 (KK235-25,-26,-27,-31,-32,-34,-35,-38,-40,-41,-42,-50,-51,-52,-53,-54,-55,-56); MPUM 7306 (CK162-0).

Description. Medium sized, hemispherical, thin shelled *Globiella*. Hinge line slightly inferior to the maximum width. Ventral valve convex, with tiny umbo. Ears small. Ornamentation of fine, flexuous costellae, bifurcating and numbering 10-12 per 5 mm at 10 mm from umbo. The costellae increase in width anteriorly. Spines occur only near the cardinal margin. Low rugae may develop on the lateral flanks, but they never cross the venter.

Dimensions (in mm):

	Width	Length	Thickness
KK235-29	21	12.8	10.5
KK235-34	10	12.8	
KK235-41	13.9	12.3	6
KK235-52	19.5	15	9.5
CK162-0	19	14.5	9.6

Discussion. The fine and numerous costellae and the maximum width anterior to the hinge line refer the examined specimens to the species *Globiella rossiae* (Fantini Sestini, 1966). *Globiella ? rossiae* described by Grunt & Dmitriev (1973) from the Bolorian of SE Pamir belongs to a different species, being characterized by stronger ornamentation and bigger size.

Geographic and stratigraphic distribution. *Globiella rossiae* occurs in the Sakmarian of Central Elburz (Fantini Sestini, 1966) and in the Sakmarian of Karakorum (Chapursan valley and Baroghil pass).

Order Rhynchonellida Kuhn, 1949

Superfamily *Rhynchoporacea* Muir-Wood, 1955

Family *Rhynchoporidae* Muir-Wood, 1955

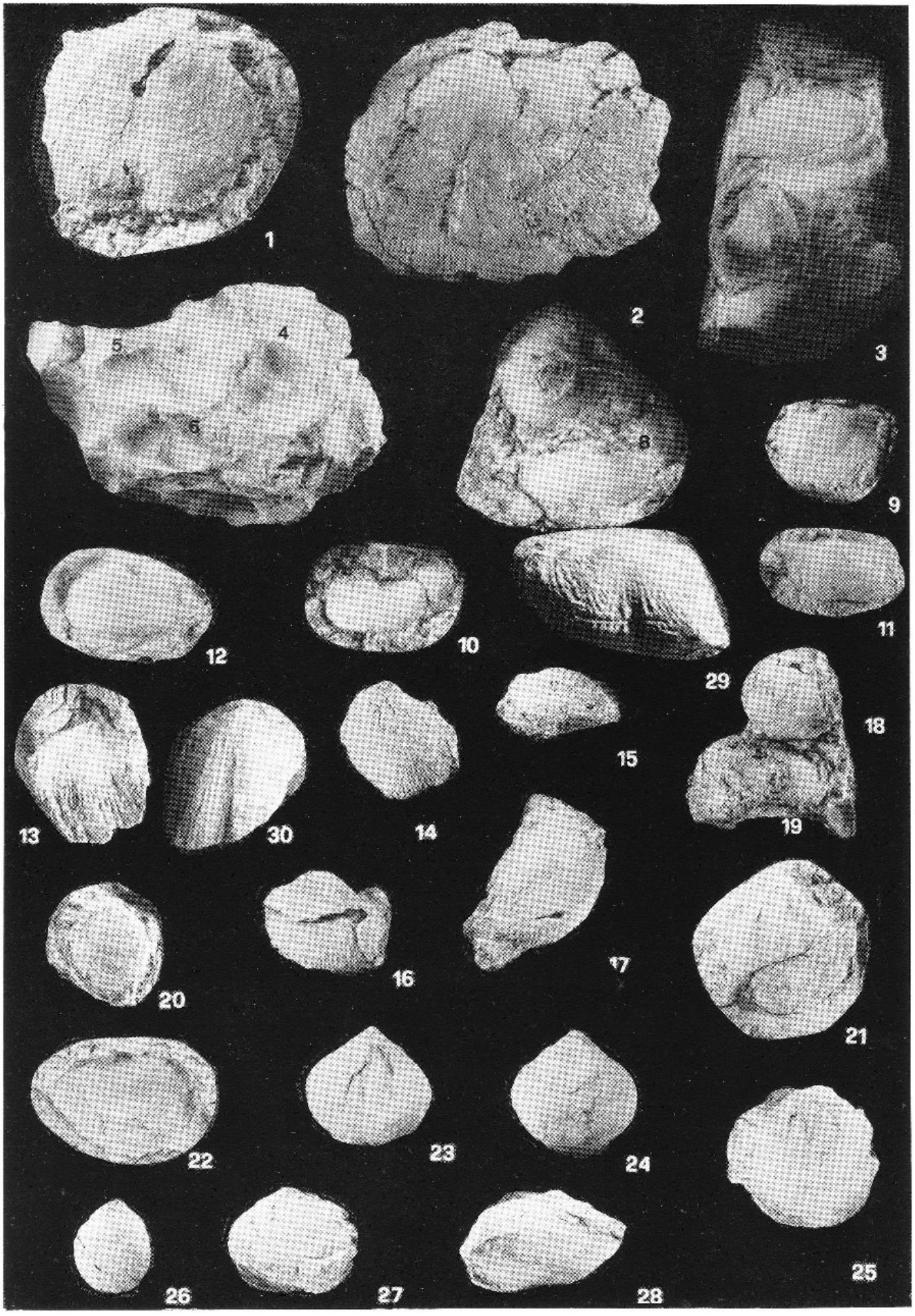
Genus *Rhynchopora* King, 1865

Type-species: *Terebratula geinitziana* Verneuil, 1845

PLATE 1

Fig. 1 - *Derbyia* cf. *baroghilensis* Reed, 1925. Dorsal valve. Specimen MPUM 7270 (CK172-116).
Fig. 2 - *Derbyia* cf. *baroghilensis* Reed, 1925. Dorsal valve. Specimen MPUM 7271 (CK172-156).
Fig. 3 - *Permochonetes pamiricus* Afanaseva, 1977. Ventral valve internal mould. Specimen MPUM 7273 (KL21-16); X 1.5.
Fig. 4 - *Permochonetes pamiricus* Afanaseva, 1977. Interior of ventral valve. Specimen MPUM 7274 (KL21-56); X 1.5.
Fig. 5 - *Permochonetes pamiricus* Afanaseva, 1977. Interior of ventral valve. Specimen MPUM 7275 (KL21-57); X 1.5.
Fig. 6 - *Permochonetes pamiricus* Afanaseva, 1977. Interior of ventral valve. Specimen MPUM 7276 (KL21-55); X 1.5.
Fig. 7 - *Permochonetes pamiricus* Afanaseva, 1977. Ventral valve internal mould. Specimen MPUM 7277 (KL21-54); X 1.5.
Fig. 8 - *Permochonetes pamiricus* Afanaseva, 1977. Ventral valve internal mould. Specimen MPUM 7278 (KL21-53); X 1.5.
Fig. 9 - *Permochonetes pamiricus* Afanaseva, 1977. Ventral valve internal mould. Specimen MPUM 7279 (KL21-21); X 1.5.
Fig. 10 - *Permochonetes pamiricus* Afanaseva, 1977. Ventral valve. Specimen MPUM 7280 (KL21-34).
Fig. 11 - *Permochonetes pamiricus* Afanaseva, 1977. Ventral valve internal mould. Specimen MPUM 7281 (KL21-25); X 1.5.
Fig. 12 - *Permochonetes pamiricus* Afanaseva, 1977. Ventral valve internal mould. Specimen MPUM 7282 (KL21-40); X 1.5.
Fig. 13 - *Reticulatia* sp. ind. Dorsal valve. Specimen MPUM 7295 (DM35-6).
Fig. 14 - *Globiella* cf. *rossiae* (Fantini Sestini, 1966). Ventral valve. Specimen MPUM 7299 (KK235-30); X 1.5.
Fig. 15 - *Globiella* cf. *rossiae* (Fantini Sestini, 1966). Ventral valve. Specimen MPUM 7300 (KK235-29); X 1.
Fig. 16 - *Globiella* cf. *rossiae* (Fantini Sestini, 1966). Ventral valve. Specimen MPUM 7301 (KK235-45); X 1.5.
Fig. 17 - *Globiella* cf. *rossiae* (Fantini Sestini, 1966). Ventral valve. Specimen MPUM 7302 (KK235-24); X 1.5.
Fig. 18 - *Globiella* cf. *rossiae* (Fantini Sestini, 1966). Ventral valve. Specimen MPUM 7303 (KK235-22); X 1
Fig. 19 - *Globiella* cf. *rossiae* (Fantini Sestini, 1966). Ventral valve. Specimen MPUM 7304 (KK235-23).
Fig. 20 - *Costatumulus irwinensis* (Archbold, 1983). Ventral valve. Specimen MPUM 7298 (KK235-63).
Fig. 21 - *Lyonia* sp. ind. Ventral valve. Specimen MPUM 7296 (KK26-166).
Fig. 22 - *Cleiothyridina ailakensis* Reed, 1925. Ventral valve external mould. Specimen MPUM 7309 (CK162-A).
Fig. 23 - *Cleiothyridina ailakensis* Reed, 1925. Ventral view of a complete specimen. Specimen MPUM 7310 (CK162-6).
Fig. 24 - *Cleiothyridina ailakensis* Reed, 1925. Dorsal view of a complete specimen. Specimen MPUM 7310 (CK162-6).
Fig. 25 - *Cleiothyridina ailakensis* Reed, 1925. Ventral valve. Specimen MPUM 7311 (CK162-7).
Fig. 26 - *Cleiothyridina globulina* (Waagen, 1883). Dorsal view of a complete specimen. Specimen MPUM 7312 (CK162-22).
Fig. 27 - *Cleiothyridina* aff. *semiconcava* (Waagen, 1883). Ventral view of a complete specimen. Specimen MPUM 7313 (KK203-48).
Fig. 28 - *Cleiothyridina* sp. ind. Dorsal valve. Specimen MPUM 7314 (KK231-31).
Fig. 29 - *Reticulatia* sp. ind. Dorsal valve external mould. Specimen MPUM 7480 (KK225-1).
Fig. 30 - *Reticulatia* sp. ind. Ventral valve. Specimen MPUM 7483 (KK212-1).

All x 1, except when specified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Comments. The genus *Rhynchopora* King has been redescribed and discussed in great detail by Cooper & Grant (1976).

Rhynchopora sp. ind.

Pl. 2, fig. 21, 22

Material. 2 Ventral valves: MPUM 7308 (KK26-45,-46).
1 Dorsal valve: MPUM 7307 (KK26-73).

Description. Biconvex shell with subpentagonal outline. Ventral valve with straight and long beak. Median sulcus low, extending forward as a tongue. Dorsal valve strongly convex; median fold not prominent. Ornamentation of fine costae starting at the umbo, slightly increasing in width anteriorly, with narrow intertrough. The costae number 20-22 for each valve. Interior of ventral valve with dental plates.

Dimensions (in mm):

	Width	Length
KK26-45	15.4	14.6
KK26-73	19.3	14.2

Discussion. *Rhynchopora* sp. ind. is similar to *Rhynchopora culta* Waterhouse, 1982 from the Asselian of S Thailand, differing from it by the more numerous and finer costae. A species of *Rhynchopora* is known from the Asselian-Tastubian Lyons Group (Archbold, 1992). It is a larger species with coarser costae (Archbold, pers. comm.).

Geographic and stratigraphic distribution. *Rhynchopora* sp. ind. occurs in the Asselian-Early Sakmarian of Karakorum (Chapursan valley).

Order Athyridida Dagys, 1974

Suborder Athyrididina Boucot, Johnson & Staton, 1964

Superfamily *Athyridacea* M'Coy, 1844

Family *Athyrididae* McCoy, 1844

Genus *Cleiothyridina* Buckman, 1906

Type-species: *Atrypa pectinifera* Sowerby, 1840

Comments. The genus *Cleiothyridina* has been extensively revised and discussed by Brunton (1972).

Cleiothyridina ailakensis Reed, 1925

Pl. 1, fig. 22-25; Pl. 6, fig. 1-9; Pl. 7, fig. 1-4; Text-fig. 9

1925 *Athyris (Cleiothyridina) ailakensis* Reed, p. 52, pl. 6, fig. 15-17; pl. 7, fig. 1.
1925 *Athyris (Cleiothyridina) gerardi?* - Reed, p. 51.
1925 *Athyris (Cleiothyridina) capillata?* - Reed, p. 54, pl. 7, fig. 2-3a.
1973 *Cleiothyridina ailakensis* - Grunt & Dmitriev, p. 148, pl. 13, fig. 1-5; pl. 15, fig. 4.

Material. 55 Complete specimens: MPUM 7310 (CK162-6); MPUM 7311 (CK162-7); MPUM 7315 (KK231-30); MPUM 7316 (CK162-20); MPUM 7317 (CK162-27); MPUM 7318 (CK162-21); MPUM 7319 (DM35-5); MPUM 7320 (CK162-28); MPUM 7322 (KK203-9,-24,-33,-73,-76,-79,-86); MPUM 7323 (KK231-5,-13,-17,-31,-32,-35,-40,-44,-48); MPUM 7324 (KK233-3); MPUM 7325 (KK235-4,-14,-16,-21); MPUM 7326 (CK162-B,-C,-5,-8,-9,-11,-12,-15,-16,-17,-18,-23,-24,-24bis,-25,-26); MPUM 7327 (KL21-1,-2,-3); MPUM 7328 (KL26-1,-2,-7,-8,-12,-17,-18).
1 External mould: MPUM 7309 (CK162-A).
2 Ventral valves: MPUM 7329 (KK231-19); MPUM 7330 (CK162-21).

Description. Biconvex shell, subpentagonal to subtriangular in outline. Hinge short and curved. Maximum width equal or slightly greater than length, at half the length of the shell. Cardinal extremities rounded. Anterior commissure rectimarginate, rarely weakly uniplicate.

Ventral valve slightly convex. Ventral umbo pointed, overhanging dorsal umbo. No ventral sulcus occurs. Dorsal valve strongly convex, without median fold. Ornamentation of concentric growth lamellae bearing flat and long spines. Interior of ventral valve with well developed dental plates and adminicula; muscle scars oval in outline with a myophragm. Interior of dorsal valve with a thin, triangular, apically perforated cardinal plate and a low median septum.

Dimensions (in mm):

	Width	Length	Thickness	Hinge Line
KK203-33	20.5	21.5	10	
KK203-73	26.2	23.2	11.3	11
KK203-76	22.9	22.7	7.3	9.7
KK203-79	12.1	9.3	6.1	
KK231-30	26	17.9	9.4	
KK231-48	25.2	18.9	10.5	12
KK235-21	12.7	12.4	5.7	
KL21-2	28.7	29.5	15.3	14.3
KL26-1	29.4	25.2	11.5	
KL26-8	29	26.6	14	
CK162-7	26	26.5	8	
CK162-8	19.7	17	10.2	9.3
CK162-16	23.6	23.3	12.6	11.2
CK162-17	17	16	7.9	
CK162-20	22.3	18.3	11.4	
CK162-24	17.6	17	6.2	
CK162-25	22.2	20.4	11.1	9.5

Ultrastructure (Pl. 7, fig. 1-4). Primary layer not preserved. Secondary layer consisting of long fibres, showing an irregular keel and saddle profile in transverse cross section. The width of fibres is 9-11 μm; their thickness is 4-6 μm.

Discussion. Diagnostic characters of *Cleiothyridina ailakensis* Reed, 1925 are the absence of median sulcus and fold, the subpentagonal outline of the shell and the greater convexity of the dorsal valve with respect to the ventral valve.

C. ailakensis differs from *Cleiothyridina royssiana* (Keyserling, 1846) by means of its smaller size and

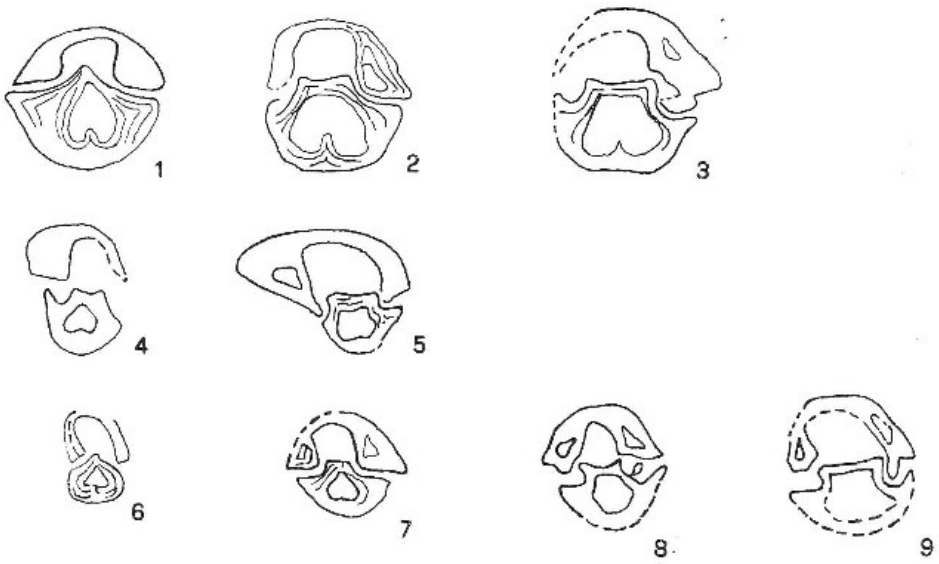


Fig. 9 - Serial sections of *C. ailakensis* (all 2 X). 1-3) Sections of specimen MPUM 7316 (CK162-20) at a distance of 1.8 mm, 2.2 mm and 2.4 mm from the umbo. 4-5) Sections of specimen MPUM 7315 (KK231-30) at a distance of 1.8 mm and 2 mm from the umbo. 6-9) Sections of specimen MPUM 7317 (CK162-27) at a distance of 2.3 mm, 2.6 mm, 3.5 mm and 3.9 mm from the umbo.

isometric dimensions; from *Cleiothyridina semiconcava* (Waagen, 1883) by means of its subpentagonal outline and the absence of a sulcal tongue; from *C. subexpansa* (Waagen, 1883) and *C. capillata* (Waagen, 1883) for the absence of ventral sulcus. The specimens of *Cleiothyridina seriata* Grant, 1976 described by Sun (1991) from the Sakmarian middle part of the Mushirebuca Group of NW Tibet are very similar to *C. ailakensis*.

Geographic and stratigraphic distribution. *C. ailakensis* is present at the top of the Tashkazyk Fm. (Sakmarian-Early Artinskian) of SE Pamir (Grunt & Dmitriev, 1973; Grunt & Novikov, 1994) and in the Sakmarian of Karakorum (Chapursan valley, Abgarch valley, Shimshal valley and Baroghil pass).

Cleiothyridina globulina (Waagen, 1883)

Pl. 1, fig. 26

1883 *Athyris globulina* Waagen, p. 474, pl. 41, fig. 1-3.
non 1934 *Cleiothyridina globulina* - Merla, p. 239.
1944 *Athyris (Cleiothyridina?) globulina* - Reed, p. 267, pl. 36, fig. 3-3b.
1965c *Cleiothyridina globulina* - Fantini Sestini, pp. 66-67, pl. 7, fig. 2a-c.

Material. 2 Complete specimens: MPUM 7312 (CK162-22); MPUM 7331 (CK162-13).

Description. Small, globular, biconvex shell longitudinally oval in outline. Hinge short and curved. Maximum width anterior to mid-length. Anterior commissure rectimarginate. Ventral valve convex, umbo tiny with small foramen. Lateral and anterior slopes are bent towards the dorsal valve. Dorsal valve convex as the ventral one. Median fold low in the umbonal region. Lateral and anterior slopes are bent towards the ventral valve. Ornamentation of growth lamellae closely spaced at the anterior and lateral slopes and spines.

Dimensions (in mm):

	Width	Length	Thickness
CK162-13	17.4	16.6	10.4
CK162-22	14.4	16.8	11.8

Discussion. The analysed specimens seem to belong to *Cleiothyridina globulina* (Waagen, 1883) on the basis of their globular shape, their banding flanks and ornamentation.

Geographic and stratigraphic distribution. *C. globulina* has been detected in the Lower Productus Limestones (= Amb Fm.) of Salt Range (Reed, 1944) which is Bolorian-Kubergandian according to Pakistanese-Japanese Research Group (1985). It is also present at the base of the Ruteh Lmst. (N Iran) which spans the late Early Permian-early Late Permian time interval (Fantini Sestini, 1965c). *C. globulina* occurs in the Sakmarian of Karakorum (Baroghil pass).

Cleiothyridina aff. **semiconcava** (Waagen, 1883)

Pl. 1, fig. 27; Pl. 7, fig. 5,6

Material. 4 Complete specimens: MPUM 7313 (KK203-48); MPUM 7321 (KK203-40); MPUM 7332 (KK203-22,-78).

Description. Medium sized, biconvex shell, transverse subelliptical in outline. Hinge quite long and curved. Maximum width at about mid-length. Anterior commissure uniplicate.

Ventral valve flat with straight umbo. Median sulcus occurs only in the anterior part, where it terminates in a "U" shaped sulcal tongue. Dorsal valve more convex than the ventral one. Median fold arises at the anterior margin. Ornamentation of growth lamellae with flat spines. Interior of ventral valve with dental plates and adminicula and with a tubercular myogliphe at a distance of 7.5 mm from the umbo.

Interior of the dorsal valve with a thin, triangular cardinal plate and a median septum.

Dimensions (in mm):

	Width	Length	Thickness	Hinge Line
KK203-78	24	18.3	12.1	13.2
KK203-22	24.5	20.4	14.2	10.5
KK203-40	26.6	16.5	16	
KK203-48	20.3	26	20	

Ultrastructure (Pl. 7, fig. 5, 6). The secondary layer fibres show an irregular shape due to the dissolution and coalescence of adjacent fibres. The width of the fibres in transverse cross section seems to be greater than 12 μm.

Discussion. The analysed specimens are similar to *Cleiothyridina semiconcava* (Waagen, 1883) (p. 481, pl. 41, fig. 4-6) in the transversally elliptical outline and in the dorsal valve more convex than the ventral one. However *C. semiconcava* is a very variable species characterized by a strongly uniplicate anterior commissure. The material under exam is too poor to confirm the attribution to *C. semiconcava*.

Geographic and stratigraphic distribution. *C. semiconcava* has been erected by Waagen from the Lower Productus Limestone (=Amb Fm.) of Salt Range. *C.* aff. *semiconcava* occurs in the Sakmarian of Karakorum (Chapursan valley).

Cleiothyridina sp. ind.

Pl. 1, fig. 28

Material. 2 Complete specimens: MPUM 7314 (KK231-31); MPUM 7333 (KK203-13).

Description. Medium sized, biconvex shell, transverse oval in outline. Hinge line long, slightly curved. Cardinal extremities rounded. Maximum width at mid-length, greater than the length of the shell. Anterior commissure slightly uniplicate.

Ventral valve slightly less convex than the dorsal one, with broad and shallow median sulcus. Dorsal valve swollen in the umbonal region.

Dimensions (in mm):

	Width	Length	Thickness	Hinge Line
KK231-31	31.4	18.4	14.7	20

Discussion. Diagnostic characters of this species are the transverse outline, the long hinge line and the subequal convexity of the two valves. *Cleiothyridina* sp. ind. is similar to *Pinegathyris roissyana* (Keyserling, 1846) as described by Reed (1944, p. 265, pl. 36, fig. 1, 2) from the Salt Range and to *Athyris aviformis* Grabau (1936) from the Maping Limestone of S China.

Geographic and stratigraphic distribution. *Cleiothyridina* sp. ind. occurs in the Sakmarian of Karakorum (Chapursan valley).

Family *Spirigerellidae* Grunt, 1980

Genus *Spirigerella* Waagen, 1883

Type-species: *Spirigerella derbyi* Waagen, 1883

Spirigerella sp. ind.

Material. 2 Complete specimens: MPUM 7334 (KK235-13); MPUM 7335 (CK162-23bis).

Description. Biconvex, swollen shell with longitudinally oval outline. Hinge line short and curved. Cardinal extremities rounded. Anterior commissure slightly uniplicate.

Ventral valve with high, slender, recurved umbo. Median sulcus narrow and shallow, starting from the umbo. Dorsal valve with small umbo, hidden by the recurved ventral umbo. Dorsal median fold evident in the umbonal region. Ornamentation of growth lamellae.

Dimensions (in mm):

	Width	Length	Thickness
CK162-23bis	11	27.4	14.8

Discussion. Diagnostic characters of this species are the elongate longitudinally oval outline and the strongly recurved ventral umbo. It is similar to *Spirigerella longa* Reed, 1944 as described by Termier et al. (1974) from the Sakmarian of Wardak, Central Afghanistan. However it differs from the original *S. longa* Reed, 1944 (Lower Productus Limestone) by means of its larger dimensions and absence of sulcal tongue and sinuation at the front margin.

Geographic and stratigraphic distribution. *Spirigerella* sp. ind. occurs in the Sakmarian of Karakorum (Chapursan valley and Baroghil pass).

Order Spiriferida Waagen, 1883

Superfamily *Spiriferacea* King, 1846

Family *Syringothyrididae* Fredericks, 1926

Genus *Cyrtella* Fredericks, 1924

Type-species: *Cyrtia kulikiana* Fredericks, 1916

Comments. The relationship of *Cyrtella* to other genera has been fully discussed by Thomas (1971) and Archbold (1990). The genus is considered to be a senior synonym of *Punctocyrtella* Plodowsky, 1968 by Thomas (1971), Waterhouse (1987) and Archbold & Gaetani (1993). In the present work it is considered to

be also a senior synonym of *Asyrinx* Hudson & Sudbury, 1959 from the Metalegoceras Lmst. and the Lusaba Lmst. (Oman).

Large species of *Cyrtella* are characteristic of Gondwanian Early Permian faunas from Oman to Tasmania, as pointed by Archbold (1987) and Archbold & Gaetani (1993). They also characterise the Sakmarian Cimmerian faunas (Karakorum, Afghanistan).

Cyrtella cf. **nagmargensis** (Bion, 1928)

Pl. 2, fig. 1, 19, 20

Material. 5 Dorsal valves: MPUM 7336 (KK202-25); MPUM 7337 (KK289-1); MPUM 7338 (KK289-3); MPUM 7339 (KK289-2,-4).

Description. Large sized species, maximum width at the hinge line. Shell substance punctate. Dorsal valve with trigonal outline. Interarea very low with open notothyrium. Median fold very high, showing steep flanks and bearing a median furrow which widens only slightly anteriorly. Ornamentation of simple costae with rounded crests, 10 in number on each flank, broadening anteriorly.

Dimensions (in mm):

	Width	Length
KK202-25	30	10.8
KK289-1	70	37.8

Discussion. It is very similar to *C. nagmargensis* (Bion, 1928, p. 27, pl. 2, fig. 2-5; pl. 4, fig. 15; pl. 5, fig. 1) differing from it only by the furrow on the dorsal fastigium which widens only slightly anteriorly. However, this difference is not significant. Furthermore the state of preservation of Karakorum material is not very good.

Geographic and stratigraphic distribution. *C. nagmargensis* occurs in the Agglomeratic Slate of Kashmir (Bion, 1928; Reed, 1932), in the Early Permian of Wardak (Termier et al., 1974), in the Sakmarian Chumik Fm. of Zanskar, NW Himalaya (Archbold & Gaetani, 1993) and in the Haushi fauna of Oman (Hudson & Sudbury, 1959).

C. cf. *nagmargensis* occurs in the Sakmarian of Chapursan and Shimshal valleys (Karakorum).

Family *Spiriferidae* King, 1846

Subfamily *Trigonotretinae* Schuchert, 1893

Genus *Trigonotreta* Koenig, 1825

Type-species: *Trigonotreta stokesi* Koenig, 1825

Comments. The genus *Trigonotreta* Koenig, 1825 has been described and discussed in detail by Armstrong (1968), Clarke (1979), Archbold & Thomas (1984a, 1986a), Clarke (1990), Archbold (1991).

Armstrong (1968) and Clarke (1979) considered *Grantonia* Brown, 1953 (pl. 6, fig. 1-9) a junior synonym of *Trigonotreta*.

Archbold & Thomas (1984a, 1986a) have fully discussed the relationship between *Trigonotreta* and *Neospirifer* Fredericks, 1924. *Trigonotreta* seems to be characterized by coarse bundles of unequal costae, with the primary costa coarser than the secondary ones. Furthermore the costae branch later in ontogeny than in *Neospirifer*. The delthyrial structures are also different in the two genera, *Trigonotreta* being characterized by the occurrence of a bulbous apical callosity. Archbold & Thomas (1984a) and Clarke (1990) have pointed out the similarity of *Brachythyrinella* Waterhouse & Gupta (1977, p. 6) with *Trigonotreta*. In fact *Brachythyrinella* does not lack ventral adminicula (Thomas, 1971), contrary to what stated by Waterhouse & Gupta (1977). Archbold (1991) has suggested to place *Brachythyrinella* in junior synonymy with *Trigonotreta*.

Trigonotreta stokesi Koenig, 1825

Pl. 2, fig. 2-9, 14; Pl. 8, fig. 1-3; Text-fig. 10

1825 *Trigonotreta Stokesii* Koenig, p. 3, pl. 6, fig. 70.
1872 *Spirifera dubia* Etheridge, pl. 16, fig. 6.
1953 *Trigonotreta stokesii* - Brown, pl. 5, fig. 1.
1965 *Trigonotreta stokesi* - Pitrat (in Williams et al.), fig. 574, 1a (non 1b,c,d).
1968 *Trigonotreta stokesi* - Armstrong, pl. 6, fig. 1,2,4,5,6 (non fig. 3).
1976 *Trigonotreta stokesi* - Roberts, Hunt & Thompson, fig. 17a-e.
1979 *Trigonotreta stokesi* - Clarke, pl. 1, fig. 1-6, 8, 9; pl. 2, fig. 1-9.
1984a *Trigonotreta stokesi* - Archbold & Thomas, fig. 3-H.
1990 *Trigonotreta stokesi* - Clarke, fig. 7A-H.
1993 *Trigonotreta stokesi* - Angiolini, p. 290, pl. 3, fig. 3-7.
non 1845 *Spirifer stokesi* Morris in Strzelecki, p. 280, pl. 15, fig. 1,1a.
non 1892 *Spirifer stokesii* - Etheridge jr., pl. 10, fig. 2-4.
non 1928 *Spirifer stokesii* - Bion, pl. 1, fig. 7a-c; pl. 5, fig. 6-8.
non 1932 *Spiriferina (Spiriferella?)* cf. *Stokesi* - Reed, pl. 6, fig. 8.

Material. 3 Complete specimens: MPUM 7347 (KK26-148); MPUM 7348 (KK26-55,-156).

59 Ventral valves: MPUM 7340 (KK26-61); MPUM 7341 (KK26-135); MPUM 7342 (KK26-113); MPUM 7343 (KK26-64); MPUM 7346 (KK26-71); MPUM 7349 (KK26-A,-2,-8,-9,-13,-16,-17,-24,-27,-29,-31,-36,-47,-48,-50,-54,-58,-65,-67,-72,-74,-78b,-79,-83,-86,-87,92,-94,-102,-114,-122,-124,-125,-126,-130,-132,-133,-143,-145,-150,-151,-155,-157,-158,-161,-163,-165,-169,-170,-174,-182,-184; MPUM 7351 (KK26-55); MPUM 7352 (KK26-37); MPUM 7357 (KK26-78).

12 Dorsal valves: MPUM 7344 (KK26-35); MPUM 7345 (KK26-4); MPUM 7350 (KK26-26,-30,-38,-53,-90,-120,-127,-131,-181,-183).

Description. Biconvex shell, semicircular in outline, with straight hinge line. Maximum width anterior to the hinge and greater than the length of the shell. Apical angle of 170°-175° in the immature speci-

mens and of 130°-160° in the mature ones. Cardinal extremities rounded (60°-100°).

Ventral valve with high, triangular interarea, with open delthyrium. Umbo pronounced and pointed. Median sulcus shallow, arising from the umbo. Dorsal valve with pointed umbo. Median fold quite high with triangular section. The width of the dorsal fold at the anterior commissure is about 1/3 of the total width.

Ornamentation of bundles of three costae which branch at a distance of 7-11 mm from the umbo. The primary costa is larger than the secondary ones. The width of each bundle at 1.5 cm from the umbo is about 2.5-3.3 mm. The bundles number 5-6 for each flank. The ventral sulcus is ornamented by 5-7 rounded, simple costae. The costae are poorly expressed on valve interior. Growth lamellae occur in both valves.

Interior of the ventral valve with dental plates and adminicula. Ventral muscle scars narrow, parallel-sided and long, extending to 1/3-1/2 of the length of the valve.

Dimensions (in mm).

	Width	Length	Thickness
KK26-55	50.4	28	11.6
KK26-A	7.4	5.1	
KK26-61	50	30.3	11
KK26-64	46	25.3	13
KK26-71	49	35	
KK26-78	35.3	21	
KK26-83	20	12	
KK26-184	47.2	23	7
KK26-169	21	14	8.4
KK26-35	53	30	

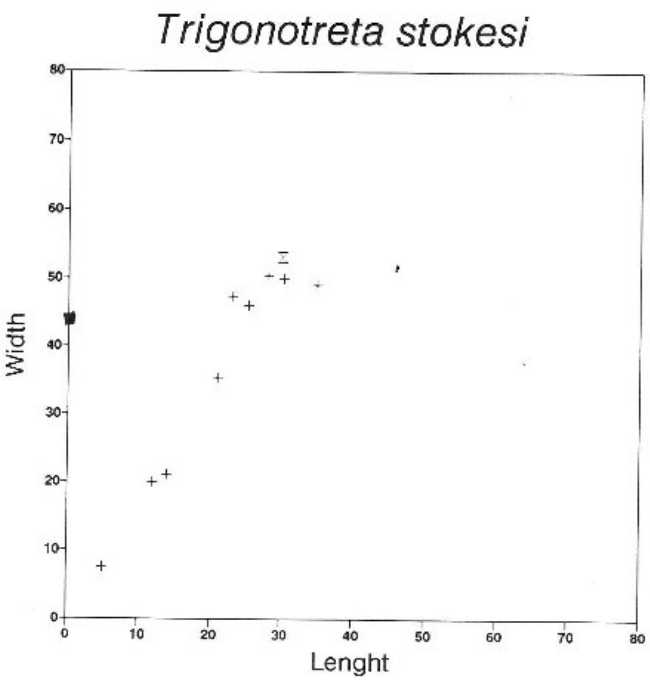


Fig. 10 - Width versus length diagram of *T. stokesi*, showing a regular increase in width during the growth of the shell. The plus indicates the ventral valves, whereas the hourglass indicates the dorsal valves.

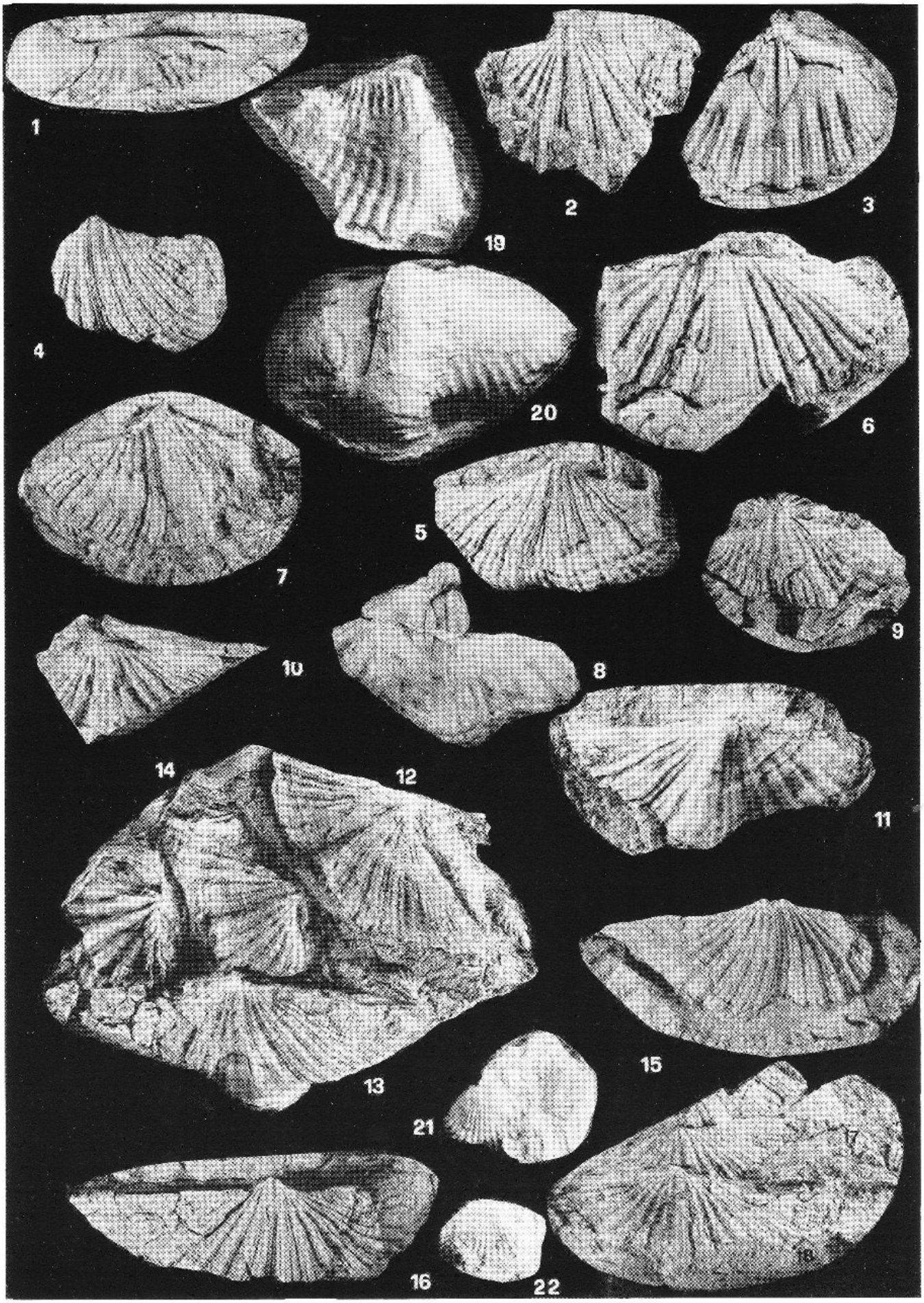
Ultrastructure (Pl. 8, fig. 1-3). The ultrastructure of *T. stokesi* has been previously described by Angiolini (1993)

The secondary layer is very thick near the umbo (1900 μm) decreasing in thickness anteriorly (236 μm). The fibres of the secondary layer are close-packed and are rather irregular in profile, probably due to diagenesis. In fact sometimes they show smooth keel

PLATE 2

Fig. 1 - *Cyrtella* cf. *nagmargensis* (Bion, 1928). Dorsal valve. Specimen MPUM 7336 (KK202-25).
Fig. 2 - *Trigonotreta stokesi* Koenig, 1825. Ventral valve. Specimen MPUM 7340 (KK26-61).
Fig. 3 - *Trigonotreta stokesi* Koenig, 1825. Ventral valve internal mould. Specimen MPUM 7341 (KK26-135).
Fig. 4 - *Trigonotreta stokesi* Koenig, 1825. Ventral valve. Specimen MPUM 7342 (KK26-113).
Fig. 5 - *Trigonotreta stokesi* Koenig, 1825. Ventral valve. Specimen MPUM 7343 (KK26-64).
Fig. 6 - *Trigonotreta stokesi* Koenig, 1825. Dorsal valve. Specimen MPUM 7344 (KK26-35).
Fig. 7 - *Trigonotreta stokesi* Koenig, 1825. Dorsal valve. Specimen MPUM 7345 (KK26-4).
Fig. 8 - *Trigonotreta stokesi* Koenig, 1825. Ventral valve internal mould. Specimen MPUM 7346 (KK26-71).
Fig. 9 - *Trigonotreta stokesi* Koenig, 1825. Dorsal view of a complete specimen. Specimen MPUM 7347 (KK26-148).
Fig. 10 - *Trigonotreta lyonsensis* Archbold & Thomas, 1986. Dorsal valve. Specimen MPUM 7353 (KK26-93).
Fig. 11 - *Trigonotreta lyonsensis* Archbold & Thomas, 1986. Dorsal valve internal mould. Specimen MPUM 7354 (KK26-63).
Fig. 12 - *Trigonotreta lyonsensis* Archbold & Thomas, 1986. Ventral valve. Specimen MPUM 7355 (KK26-76).
Fig. 13 - *Trigonotreta lyonsensis* Archbold & Thomas, 1986. Dorsal valve. Specimen MPUM 7356 (KK26-77).
Fig. 14 - *Trigonotreta stokesi* Koenig, 1825. Ventral valve. Specimen MPUM 7357 (KK26-78).
Fig. 15 - *Trigonotreta lyonsensis* Archbold & Thomas, 1986. Ventral valve. Specimen MPUM 7358 (KK26-134).
Fig. 16 - *Trigonotreta lyonsensis* Archbold & Thomas, 1986. Ventral valve. Specimen MPUM 7359 (KK26-117).
Fig. 17 - *Trigonotreta lyonsensis* Archbold & Thomas, 1986. Dorsal valve. Specimen MPUM 7360 (KK26-32).
Fig. 18 - *Trigonotreta lyonsensis* Archbold & Thomas, 1986. Dorsal valve. Specimen MPUM 7361 (KK26-33).
Fig. 19 - *Cyrtella* cf. *nagmargensis* (Bion, 1928). Dorsal valve. Specimen MPUM 7338 (KK289-3).
Fig. 20 - *Cyrtella* cf. *nagmargensis* (Bion, 1928). Dorsal valve internal mould. Specimen MPUM 7337 (KK289-1).
Fig. 21 - *Rhynchopora* sp. ind. Ventral valve. Specimen MPUM 7308 (KK26-45).
Fig. 22 - *Rhynchopora* sp. ind. Ventral valve. Specimen MPUM 7307 (KK26-73).

All x 1, except when specified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and saddle shape in transverse section. The width of the fibres is 13-20 μm and their thickness is 4-5 μm.

Ontogenetic variation. The immature specimens of *T. stokesi* (KK26-A,-83,-169) show a quite deep, "U" shaped ventral sulcus bounded by a pair of costae. In the mature specimens the sulcus becomes larger and less deep and the costae are clearly grouped into fascicles. The mature specimens show a thicker shell.

Discussion. The species under examination seems to belong to *Trigonotreta stokesi* Koenig, 1825 on the basis of ornamentation, shape of the ventral muscle field and intraspecific variability. It is also similar to *Trigonotreta victoriae* Archbold, 1991 from the Asselian-Early Tastubian of Victoria, differing from it by means of its finer and less rounded costae and greater variability. In the present paper the synonymy of Clarke (1979, 1990) is followed, with the inclusion of the specimens described by Armstrong (1968) in pl. 6, fig. 1,2,4,5,6 not considered in the synonymy of Clarke. Finally Clarke (1990) has suggested that the specimen described as *Brachythyrinella* cf. *narsarhensis* (Reed, 1928) by Waterhouse & Gupta (1978, pl. 4, fig. 5) from the Bijni Tectonic Unit (Garhwal Himalaya) may belong to *T. stokesi*.

Geographic and stratigraphic distribution. *Trigonotreta stokesi* is widespread in the Tamarian (Asselian-Early Sakmarian) of Tasmania (Swifts Jetty Sandstones, Glencoe Fm., Inglis Fm., Bundella Fm, Fossil Cliffs). In Karakorum *T. stokesi* occurs in the Late Asselian-Early Sakmarian Gircha Fm. of Karakorum (Chapursan valley).

Trigonotreta lyonsensis Archbold & Thomas, 1986

Pl. 2, fig. 10-13, 15-18; Pl. 8, fig. 4-6; Text-fig. 11

1959 *Neospirifer* sp. Dickins & Thomas, pp. 70, 71, 72, 74, 76.
1965a *Neospirifer fasciger nitiensis* - Fantini Sestini, pl. 20, fig. 1.
1967 *Neospirifer* sp. ind. Condon, pp. 35, 42.
1969 *Neospirifer* sp. nov. Thomas, p. 220.
1971 *Neospirifer* sp. Waterhouse, p. 391.
1975 *Neospirifer* sp. Playford et al., p. 279.
1986a *Trigonotreta lyonsensis* Archbold & Thomas, fig. 15A-G.
1993 *Trigonotreta lyonsensis* - Angiolini, p. 290, pl. 3, fig. 8; pl. 4, fig. 1-4.

Material. 9 Complete specimens: MPUM 7353 (KK26-93); MPUM 7363 (KK26-1,-56,-70,-81,-97,-118,-149,-154).

29 Ventral valves: MPUM 7355 (KK26-76); MPUM 7358 (KK26-134); MPUM 7359 (KK26-117); MPUM 7362 (KK26-88); MPUM 7364 (KK26-10,-11,-12,-15,-19,-22,-51,-62,-63b,-66,-80,-95,-96,-98,-101,-106,-110,-111,-128,-141,-153,-172,-179,-180,-185.

18 Dorsal valves: MPUM 7354 (KK26-63); MPUM 7356 (KK26-77); MPUM 7360 (KK26-32); MPUM 7361 (KK26-33); MPUM 7365 (KK26-4b,-23,-25,-28,-60,-68,-85,-91,-100,-105,-112,-146,-173,-176).

Description. Biconvex shell, transversely trigonal in outline. Maximum width at the hinge, long as twice the length. Apical angle of 150°-180°. Cardinal extremities acute (30°-40°).

Ventral valve with high, concave interarea with open delthyrium. Dental ridges and grooves distinct. Median sulcus shallow with rounded section. Dorsal valve with low interarea. Median fold high and sharp. The width of the fold at the anterior commissure is about 1/4-1/3 of the total width.

Ornamentation of bundles of 3 costae which branch at a distance of 7-10 mm from the umbo. The primary costa is larger than the secondary ones. The width of each bundle at a distance of 1.5 cm from the umbo is 2-3 mm. The ventral sulcus is ornamented by 2 bundles, whereas the dorsal fold is ornamented by 2-4 bundles. The number of bundles for each flank is 5, with the fifth pair weekly developed. The costae are poorly expressed on the valve interior. Growth lamellae are very prominent.

Interior of ventral valve with elongate oval muscle scars, extending to 1/2 the length of the shell.

Dimensions (in mm):

	Width	Length	Thickness
KK26-56	54.7	21.6	11.2
KK26-66	62	21.6	
KK26-80	62.5	30	7
KK26-111	49.4	23.4	
KK26-117	66.6	26	
KK26-128	62.7	26.7	16
KK26-4b	39.2	17.3	
KK26-32	53.6	19.8	
KK26-60	39.2	17.7	
KK26-63	54	24.6	15
KK26-68	62.6	30.7	
KK26-77	72	29.6	17

Ultrastructure (Pl. 8, fig. 4-6). The ultrastructure of *T. lyonsensis* has been previously described by Angiolini (1993). The primary layer consists of crystallites oriented with their long axes normal to the boundary with the secondary layer. Its thickness is about 18 μm. The secondary layer, 150-450 μm thick, consists of long, orthodoxly stacked fibres, aligned subparallel to the external surface of the valve. In transverse section the fibres of the secondary layer show an irregular, platy profile with two keels both on the inner and outer surfaces. The width of the secondary layer fibres is about 8-10 μm and their thickness is 4-6 μm. Convolutions of the secondary fibres have been observed away from the margins of the shell.

The occurrence of a tertiary layer, 40-56 μm thick, can be inferred by the local presence of an inner irregular layer.

Discussion. The specimens under examination belong to *Trigonotreta lyonsensis* Archbold & Thomas, 1986 on the basis of transversely trigonal outline, the bundles of 3 costae and the sharp dorsal fold. Arch-

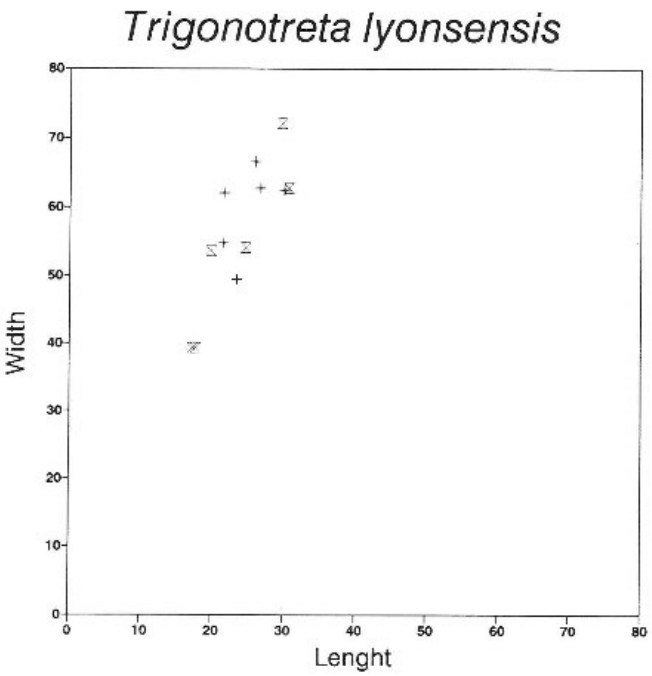

Fig. 11 - Width versus length diagram of *T. lyonsensis*, showing the high W/L ratio and the sharp increase of the width during the growth of the shell. The plus indicates the ventral valves, whereas the hourglass indicates the dorsal valves, which are comparatively less transverse than the ventral ones.

bold & Thomas (1986a) based *T. lyonsensis* only on 6 specimens, stating that its characters are stable. The population from Karakorum numbers at least 57 specimens, showing a greater variability with respect to the Australian specimens.

Geographic and stratigraphic distribution. *T. lyonsensis* occurs in the Late Asselian-Early Sakmarian of Lyons Group (Carnarvon Basin, W Australia). In Karakorum *T. lyonsensis* occurs in the Late Asselian-Early Sakmarian Circha Fm. of Chapursan valley.

Trigonotreta paucicostulata (Reed, 1925)

Pl. 3, fig. 1-10; Pl. 9, fig. 1-4; Text-fig. 12

1925 *Spirifer fasciger* var. *paucicostulata* Reed, p. 43, pl. 6, fig. 1.
1925 *Spirifer fasciger* var. *musakheilensis* - Reed, p. 42, pl. 6, fig. 2.
1930 *Neospirifer fasciger paucicostulatus* - Reed, p. 32, pl. 2, fig. 1, 1a.
1966 *Neospirifer fasciger paucicostulatus* - Fantini Sestini, p. 37, pl. 5, fig. 2a-3b.
1968 *Neospirifer fasciger* - Legrand-Blain, pl. 3, fig. 1a-b, 2, 3, 4a-b.
1973 *Neospirifer joharensis* - Grunt & Dmitriev, p. 132, pl. 9, fig. 10-13; pl. 16, fig. 1.
1974 *Neospirifer paucicostulatus* - Termier et al., p. 82, pl. 6, fig. 6; text-fig. 9.
1993 *Trigonotreta* sp. - Angiolini, p. 291, pl. 4, fig. 5-8.

Material. 3 Complete specimens: MPUM 7372 (CK162-3); MPUM 7378 (KK226-16); MPUM 7379 (KL22-4).

24 Ventral valves: MPUM 7366 (KK203-97); MPUM 7367 (KL21-8); MPUM 7370 (KK203-99); MPUM 7373 (KL19-49); MPUM 7374 (KL17-1); MPUM 7376 (KK213-2); MPUM 7377 (KK203-98); MPUM 7380 (KK2-2,-4,-5); MPUM 7381 (KK203-50,-53); MPUM 7382 (KK226-12); MPUM 7383 (KK231-2); MPUM 7384 (KK235-1,-2,-3,-10); MPUM 7385 (KK236-5); MPUM 7386 (KL22-3); MPUM 7387 (CK162-4); MPUM 7388 (KL21-5,-7,-11).

13 Dorsal valves: MPUM 7368 (KK226-15); MPUM 7369 (KK203-11); MPUM 7371 (KL21-9); MPUM 7375 (KL22-5); MPUM 7389 (KK203-54,-96); MPUM 7390 (KK226-2,-6,-28,-29,-30); MPUM 7391 (KK235-8,-11).

Description. Biconvex, medium to large sized shell, transverse in outline. The longitudinal curvature of the two valves is high. Maximum width anterior to the hinge and greater than the length of the shell. Cardinal extremities at right angle. Anterior commissure uniplicate with prominent fold.

Ventral valve with pointed, prominent umbo, overhanging the interarea which is low and concave. Median sulcus deep and "V" shaped in cross section. It deepens and broadens anteriorly. Dorsal valve less transverse in outline than the ventral valve. Median fold narrow, high, angular.

Ornamentation of the ventral valve of 4 pair of costae branching at a distance of 0.4-1 cm from the umbo, forming bundles, each of 3 costae. The external bundle is very feeble. Anteriorly each costa of the bundle bifurcates, so that at the anterior margin the bundle consists of 5-6 costae. The costae are fine and angular, the primary costa being always coarser than the secondary ones. The ventral sulcus is ornamented by a median costa and, along its flanks, by fine costae deriving from the branching of the principal pair of costae delimiting the sulcus. Growth lamellae are feeble.

Ornamentation of the dorsal valve of thin angular costae, branching at a distance of 1.2-1.4 cm from the umbo, forming fascicles of 3 costae. Dorsal fold ornamented by a couple of costae branching anteriorly.

Interior of the ventral valve with dental plates, adminicula and long and stout teeth.

Dimensions (in mm):

	Width	Length	W/L	Thickness	d(v.v.)	d(d.v.)
KK226-16	23.4	15.5	1.5	11.7		8.2
CK162-3	31.5	20		13.6		8.4
KK2-4	32.9	24.5	1.3	9.3		
KK203-53	35.5	26.3	1.3	12.9		
KK203-97	41.2	22.7	1.8	13	7.7	
KK213-2	30		2.4	9.6	9	
KK231-2	46.6	26.5	1.7	16.2	10	
KK235-1	42.6	29.1	1.4	9.8		
KL17-1	43	30.5		12.5		
KL19-49	44.5	30		11		
KK203-96	24.4	14.4	1.7			8
KK226-6	27	24.5	1.1	12		13.4
KK226-15	29.2	25	1.2	11		10
KK226-28	30.7	24	1.3	12		13.5
KL21-9	21.4	14.4				
KL22-5	46	39				

d (v.v.) = distance of beginning of fasciculation from the umbo in ventral valve;
d (d.v.) = same for dorsal valve.

Ultrastructure (Pl. 9, fig. 1-4). The ultrastructure of *T. paucicostulata* has been previously described by Angiolini (1993). The primary layer has not been observed. The secondary layer, 600 μm to 1400 μm-thick, consists of orthodoxly stacked fibres subparallel to the external surface of the valve. The fibres show a sub-rhomboidal profile in transverse section. The width of the fibres is 13-15 μm, their thickness is about 6-10 μm.

Intraspecific variability. *Trigonotreta paucicostulata* (Reed) shows variability in the width/length ratio. Some of the specimens are very transverse with respect to others which show a lower width/length ratio.

Discussion. Diagnostic characters of *Trigonotreta paucicostulata* are the fine, angular costae, forming bundles of up to 6 costae in the ventral valve and branching far from the umbo in the dorsal valve, the low number of bundles (three plus a feeble fourth), the "V" shaped ventral sulcus, the high angular dorsal fold and the cardinal extremities at right angle.

T. paucicostulata differs from *Trigonotreta neoaustralis* Archbold & Thomas, 1986 by means of the less pointed umbo, right angled cardinal extremities, feeble growth lamellae and the ornamentation of the dorsal valve; from *T. stokesi* Koenig, 1825 by means of the more angular dorsal fold and the ornamentation of bundles of 5-6 fine, acute costae.

After studying the collections of Grunt & Dmitriev (1973) at the Museum of Paleontology of the Russian Academy of Sciences in Moscow, the present author places the specimens of *Neospirifer joharensis* (Diener, 1897) from the top of the Tashkazyk Fm. (Sakmarian-Early Artinskian) of SE Pamir in synonymy with *T. paucicostulata*.

The specimens described as *Neospirifer fasciger* (Keyserling, 1846) by Legrand-Blain (1968) from the

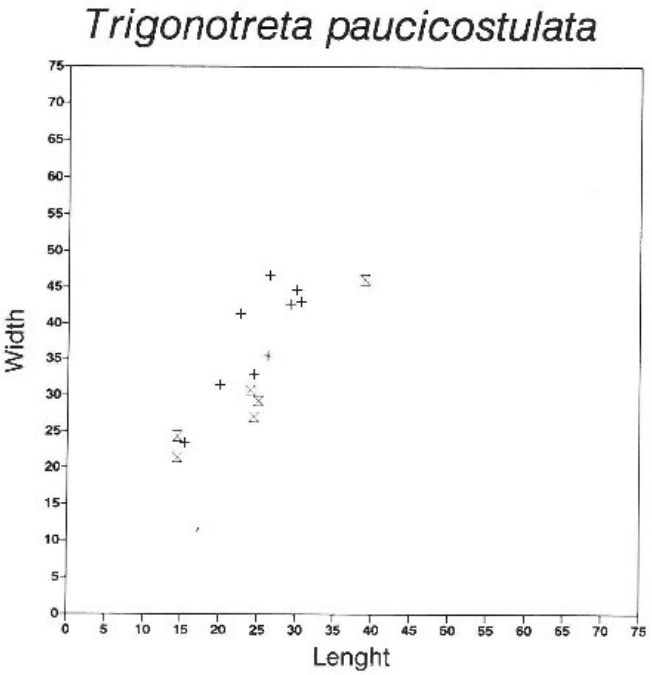

Fig. 12 - Width versus length diagram of *T. paucicostulata*, showing the less transverse outline of the dorsal valves (hourglass) with respect to the ventral ones (plus). Furthermore the outline of this species is less transverse than the outline of the other two species of *Trigonotreta*.

PLATE 3

Fig. 1 - *Trigonotreta paucicostulata* (Reed, 1925). Ventral valve. Specimen MPUM 7366 (KK203-97).
Fig. 2 - *Trigonotreta paucicostulata* (Reed, 1925). Ventral valve internal mould. Specimen MPUM 7367 (KL21-8).
Fig. 3 - *Trigonotreta paucicostulata* (Reed, 1925). Dorsal valve internal mould. Specimen MPUM 7368 (KK226-15).
Fig. 4 - *Trigonotreta paucicostulata* (Reed, 1925). Dorsal valve internal mould. Specimen MPUM 7369 (KK203-11).
Fig. 5 - *Trigonotreta paucicostulata* (Reed, 1925). Ventral valve internal mould. Specimen MPUM 7370 (KL203-99).
Fig. 6 - *Trigonotreta paucicostulata* (Reed, 1925). Dorsal valve internal mould. Specimen MPUM 7371 (KL21-9).
Fig. 7 - *Trigonotreta paucicostulata* (Reed, 1925). Ventral valve internal mould. Specimen MPUM 7372 (CK162-3).
Fig. 8 - *Trigonotreta paucicostulata* (Reed, 1925). Ventral valve. Specimen MPUM 7373 (KL19-49).
Fig. 9 - *Trigonotreta paucicostulata* (Reed, 1925). Ventral valve. Specimen MPUM 7374 (KL17-1).
Fig. 10 - *Trigonotreta paucicostulata* (Reed, 1925). Dorsal valve. Specimen MPUM 7375 (KL22-5).
Fig. 11 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7392 (CK172-6).
Fig. 12 - *Hunzina electa* sp. n. Ventral valve lateral view. Specimen MPUM 7393 (CK172-110).
Fig. 13 - *Hunzina electa* sp. n. Ventral valve lateral view. Holotype MPUM 7394 (CK172-64).
Fig. 14 - *Hunzina electa* sp. n. Ventral valve. Holotype MPUM 7394 (CK172-64).
Fig. 15 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7395 (KK203-67).
Fig. 16 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7396 (KK203-49).
Fig. 17 - *Hunzina electa* sp. n. Dorsal valve. Specimen MPUM 7397 (CK172-74).
Fig. 18 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7398 (CK172-39).
Fig. 19 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7399 (KK226-4).
Fig. 20 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7400 (KK203-30).
Fig. 21 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7401 (KK203-102).
Fig. 22 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7402 (KK203-25).
Fig. 23 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7479 (CK172-21).

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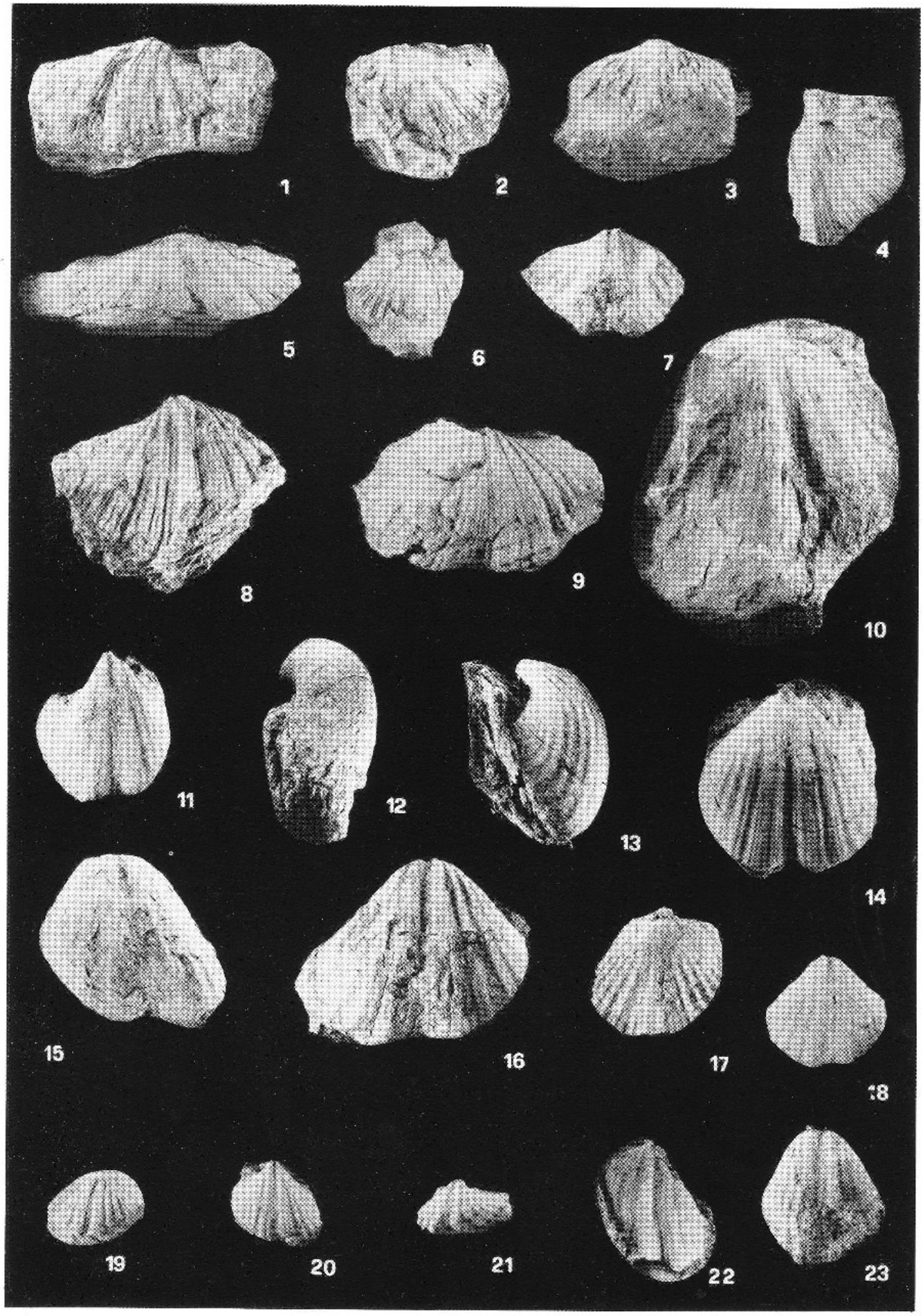
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Early Permian of Wardak and Tezak, seem to belong to *T. paucicostulata*. Also the Central Afghanistan specimen described as *Neospirifer paucicostulatus* by Termier et al. (1974, p. 82, pl. 6, fig. 6) and housed at the Office National des Collections Fossiles, Université Claude Bernard, Lyon, clearly belongs to *T. paucicostulata*.

Finally the specimens described by Merla (1934) as *Spirifer musakheilensis* Davidson, 1862 and housed in the Museum of Paleontology of Firenze, are morphologically close to *T. paucicostulata*, but are discriminated by a very high interarea.

Geographic and stratigraphic distribution. *T. paucicostulata* was firstly described by Reed (1925) from the Baroghil pass (Chitral). It occurs in the Agglomeratic Slates of Kashmir (Reed, 1930), in the Upper Sakmarian Geirud Fm., member D of Iran (Fantini Sestini, 1966), in the Sakmarian-Early Artinskian of SE Pamir (Grunt & Dmitriev, 1973; Grunt & Novikov, 1994), in the Sakmarian of Central Afghanistan (Legrand-Blain, 1968; Termier et al., 1974).

T. paucicostulata occurs in the Sakmarian of Karakorum (Baroghil pass, Chapursan valley and Shimshal valley).

Subfamily *Spiriferellinae* Waterhouse, 1968

Genus *Hunzina* gen. n.

Type-species: *Hunzina electa* sp. n.

Derivatio nominis. *Hunzina* from the Upper Hunza valley, where specimens representing the genus were collected.

Diagnosis. Spiriferellinae with elongate oval to subtriangular outline. Hinge line short. Ventral valve with thick shell, triangular interarea with open delthyrium. Ventral sulcus present. Dorsal valve subcircular in outline, with median fold. Ornamentation of fine to coarse costae, bifurcating and only few fasciculating. Interior of ventral valve with short dental plates and adminicula, deeply buried in the apical callosity. Micrornamentation of pustules and capillae, when preserved.

Discussion.

A) Suprageneric position.

The new genus has been placed in the subfamily Spiriferellinae, fitting very well with the diagnosis of the subfamily given by Archbold & Thomas (1985). In the present paper the subfamily Spiriferellinae is placed in the family Spiriferidae *sensu* Thomas (1971) according to Carter (1974) and Archbold & Thomas (1985).

Pitrat (1965, in Williams et al.) placed *Spiriferella* Tschernyschew, 1902 and allied genera in the Family Brachythyrididae, but these genera show dental plates and adminicula, the presence of which is not included in the diagnosis of Brachythyrididae.

Waterhouse (1978) placed the Spiriferellinae in the Family Licharewiidae on the basis of micrornamentation. Termier et al. (1974) suggested to elevate the Spiriferellinae to family rank.

B) Definition of the genus.

After studying the type-species of the allied genera *Elivina* Fredericks, 1924 and *Spiriferella* Tschernyschew, 1902 housed in V.S.E.G.E.I. of S. Petersbourgh (respectively in the Diener collection (1897) and in the Tschernyschew collection (1902)), the present author decided to introduce a new genus for the Karakorum specimens, named *Hunzina* gen. n.

Spiriferella was introduced by Tschernyschew (1902) with *S. saranae* de Verneuil, 1845 from the Early Permian of the Urals as type-species. The genus *Spiriferella* was largely used to include a large spectrum of species which do not share the general characters of the type-species.

Elivina was introduced by Fredericks, 1924 with type-species *Spirifer tibetanus* Diener, 1897 as described by Tschernyschew (1902) from the Asselian of the Urals. Waterhouse (1966) pointed out that *Elivina* is based on an ambiguous species, i.e. on *S. tibetanus sensu* Tschernyschew from the Urals which is not conspecific with the original *S. tibetanus* introduced by Diener (1897) for the Late Permian of Chitichum 1. Waterhouse (1966, p. 53) proposed the specimen GSI6112 figured by Diener (1897, pl. 6, fig. 1a-c) as lectotype of *E. tibetana* Diener.

The direct study of the paratypes of *Spiriferella saranae* from the Urals and *Spirifer tibetanus* from Chitichum and *S. tibetanus* from the Urals at V.S.E.G.E.I. (S. Petersbourgh) led the author to point out that:

- *S. saranae*, type-species of the genus *Spiriferella*, is characterized by fasciculate ornamentation, delthyrium closed by a large and convex pseudodeltidium, short dental plates and adminicula apically included in the umbonal callus, depressed rhomboidal muscle scars.

- *S. tibetanus* as described by Tschernyschew (1902) from the Asselian of the Urals belongs to the genus *Spiriferella*, as described above.

- *S. tibetanus* Diener from the Late Permian of Chitichum is the type-species of the genus *Elivina* and is characterized by ornamentation of platy, large costae, poorly fasciculated and by thin dental plates diverging towards the venter of the valve.

The genus *Hunzina* gen. n. is here introduced to include those forms characterized by ornamentation only partially fasciculated, open delthyrium, short and parallel dental plates and adminicula, both included in the apical callus.

C) Relationships with allied genera.

Hunzina gen. n. differs from *Spiriferella* by means of the open delthyrium, lower dorsal fold, less fasciculated ornamentation, shorter dental plates which are strongly embedded in the apical callus; from *Elivina* by means of the ornamentation and of thicker and parallel dental plates and adminicula, which do not diverge.

The genus *Eliva* Fredericks, 1924 differs from the above mentioned genera by means of the ornamentation of simple costae and of the absence of dental plates. *Eridmatus* Branson, 1966 is distinguished by its long hinge line, high, sulcate dorsal fold and deep ventral sulcus.

Composition of the genus. *H. electa* sp. n., from the Sakmarian of Karakorum; *H. tenuisulcata* (Merla, 1934) from the Sakmarian of Shimshal valley and from the Permian of N. Karakorum (Rimu); *H. elegantula* (Hu, 1983) from the Early Permian of Duoma district, Rutog, Xizang (Tibet); *H. mushirebucaensis* (Sun, 1991) from the Sakmarian middle part of the Mushirebuca Group of Gegyai County (NW Tibet).

Besides these species, *Spiriferella?* sp. from Central Afghanistan (Legrand-Blain, 1968, p. 247, text-fig. 19-21, pl. 4, fig. 10-13), *Spiriferella* sp. from SE Pamir (Grunt & Dmitriev, 1973, p. 133, text-fig. 37, pl. 9, fig. 9) and *Spiriferella tibetana* as described by Termier et al. (1974) from the Murgabian of Wardak probably belong to the genus *Hunzina*.

Interesting discussions with T.A. Grunt (Russian Academy of Sciences, Moscow), to whom the present writer showed part of the collection from Karakorum, have pointed out that the specimens from the Late Permian of Mongolia described by Pavlova (in Pavlova et al., 1991, pp. 124-127, fig. 17-18, pl.30, fig. 1-8) as *Spiriferella ovata* Lee & Gu, 1976, *S. keilhaviformis* Fredericks, 1916 and *S. mugunica* Pavlova, 1991 may be included in the genus *Hunzina*.

Finally the species of *Spiriferella* from the Artinskian-Kungurian of W Australia [*S. cundlegoensis* Archbold & Thomas, 1985, *S. australasica* (Etheridge, 1889) and *S. etheridgei* Archbold & Thomas, 1985] could belong to the genus *Hunzina* gen. n. on the basis of the absence of pseudodeltidium and the dental plates embedded in the apical callus.

Hunzina electa gen. n. sp. n.

Pl. 3, fig. 11-23; Pl. 4, fig. 1-14; Pl. 6, fig. 10-30, 41-43; Pl. 10, fig. 1-4; Text-fig. 13, 14

1925 *Spiriferella rajah* - Reed, p. 45, pl. 6, fig. 3-5.
1925 *Spiriferella vercherei* - Reed, p. 45, pl. 6, fig. 6-8a.
1934 *Spirifer tibetanus occidentalis* - Merla, p. 229, pl. 21, fig. 21, 22.
1934 *Spirifer tibetanus* var. *lata* Merla, p. 230, pl. 21, fig. 25.
1939 *Spirifer tibetanus* - Renz, p. 36.
1940 *Spirifer tibetanus occidentalis* - Renz, p. 187, pl. 6, fig. 4, 8.
1965a *Elivina tibetana* - Fantini Sestini, p. 142, pl. 20, fig. 2-5.
1993 *Elivina tibetana* - Angiolini, p. 293, pl. 5, fig. 1-3.

Material. 8 Complete specimens: MPUM 7397 (CK172-74); MPUM 7416 (KK203-29,-35,-66); MPUM 7417 (CK172-86); MPUM 7423 (CK172-87,-146); MPUM 7479 (CK172-21).

225 Ventral valves: MPUM 7392 (CK172-6); MPUM 7393 (CK172-110); MPUM 7394 (CK172-64); MPUM 7395 (KK203-67); MPUM 7396 (KK203-49); MPUM 7398 (CK172-39); MPUM 7399 (KK226-4); MPUM 7400 (KK203-30); MPUM 7401 (KK203-102); MPUM 7402 (KK203-25); MPUM 7403 (CK172-2); MPUM 7404 (KK203-47); MPUM 7405 (CK172-120); MPUM 7406 (CK172-95); MPUM 7407 (CK172-84); MPUM 7408 (KK203-62); MPUM 7409 (CK172-155); MPUM 7410 (CK172-87); MPUM 7413 (CK172-4); MPUM 7414 (CK172-22); MPUM 7415 (CK172-50); MPUM 7418 (KK203-1); MPUM 7419 (DM35-10); MPUM 7420 (KK203-106); MPUM 7421 (CK172-1); MPUM 7422 (KK203-95); MPUM 7424 (KK4-1); MPUM 7425 (KK203-2,-6,-8,-10,-13-14,-34,-36,-37,-38,-43,-45,-46,-55,-57,-59,-61,-63,-64,-65,-68,-69,-70,-71,-91,-92,-94,-101,-103,-104,-105,-107); MPUM 7426 (KK213-1); MPUM 7427 (KK226-1,-7,-13,-14,-17); MPUM 7428 (KK231-1,-3,-6,-25); MPUM 7429 (KK233-1,-2); MPUM 7430 (KK234-1); MPUM 7431 (KK235-7); MPUM 7432 (DM35-1,-4,-7,-8,-9,-11); MPUM 7433 (KL 26-4,-5,-13,-14,-20); MPUM 7434 (KL28-4,-6,-7); MPUM 7435 (KL29-1,-2,-3,-4,-5,-7,-10); MPUM 7436 (CK162-1,-2); MPUM 7437 (CK172-3,-5,-7,-8,-9,-10,-11,-12,-13,-14,-16,-17,-18,-19,-20,-23,-24,-25,-26,-27,-28,-29,-30,-31,-32,-32bis,-33,-35,-36,-37,-38,-40,-41,-42,-43,-44,-45,-46,-47,-48,-49,-50bis,-51,-52,-53,-54,-55,-56,-57,-58,-59,-60,-61,-62,-63,-65,-66,-67,-68,-69,-70,-71,-72,-75,-76,-77,-78,-79,-80,-81,-82,-83,-85,-88,-89,-90,-91,-92,-93,-94,-96,-96bis-98,-99,-100,-101,-102,-103,-104,-105,-106,-107,-108,-109,-111,-112,-113,-114,-115,-122,-121,-123,-124,-125,-126,-127,-128,-129,-130,-131,-132,-133,-134,-135,-137,-138,-139,-140,-141,-142,-143,-144,-145,-147,-148,-149,-150,-153,-154); MPUM 7438 (CK409).

9 Dorsal valves: MPUM 7411 (KK226-5); MPUM 7412 (KK226-6); MPUM 7439 (KK203-3, 56,-93); MPUM 7440 (KK226-27); MPUM 7441 (KK231-41); MPUM 7442 (CK172-151,-152).

Holotype. MPUM 7394 (CK172-64) (Pl. 3, fig. 13, 14).

Type-locality. Baroghil pass, Upper Yarkhun valley, Karakorum, Pakistan.

Type-level. CK172, Lashkargaz Fm., Mb. 1, Sakmarian.

Derivatio nominis. *Electa* from the latin chosen to represent the new genus.

Description. Biconvex shell, with elongate oval outline. Hinge line short, comprised between 1/3 and 1/2 of the maximum width, which is at mid-length. Cardinal extremities rounded. Anterior commissure uniplicate, with high fold.

Ventral valve strongly convex, with thickened shell in the posterior region. Umbo pointed, pronounced and curved on the interarea which is narrow, high, triangular with open delthyrium. Ventral sulcus angular, deepening and widening anteriorly. Dorsal

valve less convex than the ventral one, with oval to sub-rounded outline. Dorsal fold low and acute.

Ornamentation of the ventral valve of 5-6 rounded costae on each flank, bifurcating at the umbo and, more rarely, anteriorly. The principal pair of costae, flanking the ventral sulcus, bifurcate firstly at a distance of 5-8 mm from the umbo and later at mid-length forming fascicles of 3-4 costae. The lateral costae are generally simple; only in few cases they may bifurcate forming low bundles. The costae become coarser anteriorly. The ventral sulcus is ornamented by a central fine costa; its flanks may be bold or ornamented by the internal bifurcation of the principal pair of costae. Ornamentation of dorsal valve of costae irregularly bifurcating, forming bundles of 3 costae each. The dorsal fold is ornamented by a couple of costae. Micrornamentation of lirae and very weak growth lamellae.

Interior of ventral valve with apical callus extending to a distance of 4-7 mm from the umbo and thick and short dental plates and adminicula totally embedded in the apical callosity. The equidimensional, triangular teeth are not supported directly by the dental plates, but by the external wall of the interarea. Ventral muscle scars depressed, oval to sub-rounded in outline, weekly striated, terminating against a narrow platform. The width of the muscle scars is 1/3 the maximum width of the shell and its length is about 1/3 of the length.

Dimensions (in mm):

	Width	Length	Thickness		Hinge Line	H. Int.
KK203-29	15.3	13.1	11	3.9		1.7
KK203-35	22.1	44	30.3	9		

	Width	Length	Thickness	Hinge Line	H. Int.
CK172-21	23.2	26.1	13.8	11.6	
CK172-86	39	52.5	19.3	19.2	4.2
CK172-146	17.4	18	6.9	7.5	1.5
KK203-6	26	48	18		
KK203-14	24.1	35	16.5		
KK203-34	25	37	18.5	9	
KK203-49	41.4	33.4	22.4	17.6	
KK203-55	33.8	28.3	17		
KK203-62	21.5	29.5	15.6	7	
KK203-67	35.4	31.9	22.3	13.3	
KK203-68	29.3	29.5	16.9		
DM35-4	34	43	15	16.6	
KL29-3	29.8	39.2			
CK162-1	38.5	46.3	15	12	
CK162-2	27	31.2	15	9.5	
CK172-4	34.8	42.5	15.5	15.3	
CK172-17	28	30.1			
CK172-18	23.4	30.4	8.8		
CK172-26	27	34.5	16	11	
CK172-53	33	37.1	18	12.5	
CK172-54	25.4	30.3	11.5	8.5	
CK172-64	33.4	33.9	15.2		
CK172-65	24	27.5	13.5	8.9	
CK172-72	23.4	29.1			
CK172-89	27	32.5	13.7	12	
CK172-90	28.2	30.4			
CK172-96	24.7	32.5	12	9.6	
CK172-103	24.5	32.4	13.7	10.3	6.3
CK172-125	17.8	23	12.3	8.4	
CK172-129	30.6	33.5	16		
CK172-137	25.2	34			
CK172-145	19.2	22.4	9.1	7.8	
CK172-148	25.1	33.1	14.6	11.8	3.1
KK203-3	28	43	12		
KK203-56	21	21.5	10.4		
KK226-6	23.4	27.2	9.5	8	
KK226-5	21	24	8		
CK172-151	31.3	29			
CK172-152	16.9	17.6			

H. Int.: Height of interarea

PLATE 4

Fig. 1 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7404 (KK203-47).
Fig. 2 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7405 (CK172-120).
Fig. 3 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7406 (CK172-95).
Fig. 4 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7407 (CK172-84).
Fig. 5 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7408 (KK203-62).
Fig. 6 - *Hunzina electa* sp. n. Ventral valve internal mould. Specimen MPUM 7409 (CK172-155).
Fig. 7 - *Hunzina electa* sp. n. Ventral valve anterior view. Specimen MPUM 7410 (CK172-87).
Fig. 8 - *Hunzina electa* sp. n. Dorsal valve. Specimen MPUM 7411 (KK226-5).
Fig. 9 - *Hunzina electa* sp. n. Dorsal valve. Specimen MPUM 7412 (KK226-6).
Fig. 10 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7413 (CK172-4).
Fig. 11 - *Hunzina electa* sp. n. Ventral valve dorsal view. Specimen MPUM 7414 (CK172-22); X 1.5.
Fig. 12 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7415 (CK172-50).
Fig. 13 - *Hunzina electa* sp. n. Ventral valve. Specimen MPUM 7405 (CK172-120); X 1.5.
Fig. 14 - *Hunzina electa* sp. n. Ventral view of a complete specimen. Specimen MPUM 7417 (CK172-86).
Fig. 15 - *Hunzina tenuisulcata* (Merla, 1934). Ventral valve. Specimen MPUM 7443 (KL19-30).
Fig. 16 - *Hunzina tenuisulcata* (Merla, 1934). Ventral valve. Specimen MPUM 7444 (KL17-5).
Fig. 17 - *Hunzina tenuisulcata* (Merla, 1934). Ventral valve. Specimen MPUM 7445 (KL17-11).
Fig. 18 - *Hunzina tenuisulcata* (Merla, 1934). Dorsal valve. Specimen MPUM 7446 (KL19-12).
Fig. 19 - *Hunzina tenuisulcata* (Merla, 1934). Dorsal valve. Specimen MPUM 7447 (KL19-32).
Fig. 20 - *Hunzina tenuisulcata* (Merla, 1934). Ventral valve. Specimen MPUM 7448 (KL17-26).

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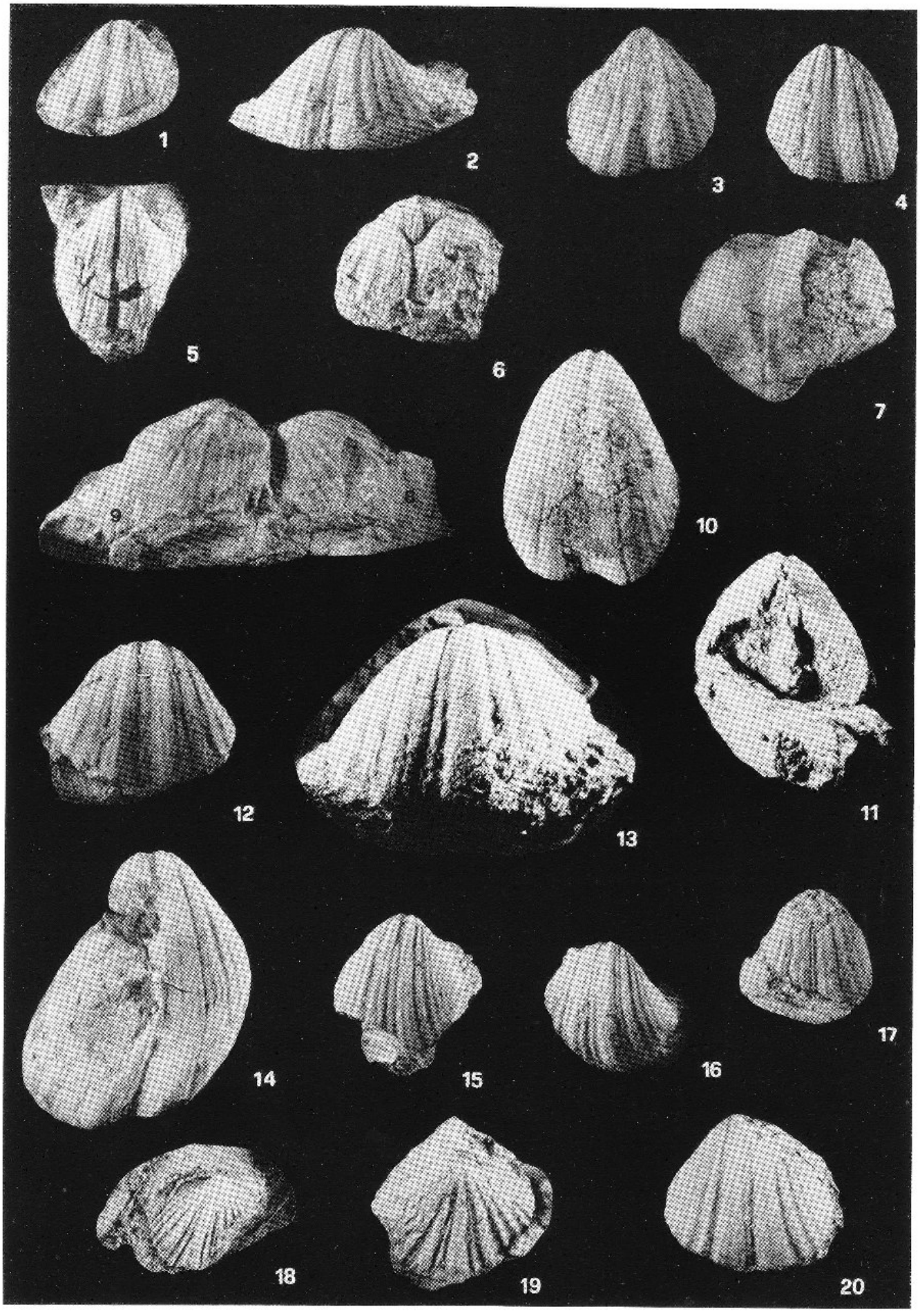
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Ultrastructure (Pl. 10, fig. 1-4). The ultrastructure of *H. electa* sp. n. has been previously described by Angiolini (1993).

The primary layer is not preserved. The secondary layer is about 300 μm thick and it consists of thin, platy, orthodoxly stacked fibres, sub-parallel to the external surface of the valve. The secondary layer fibres show a platy, sub-rectangular profile in cross and oblique section. No keel has been observed on the fibres. The thickness of the fibres is 2-3 μm and their width in transverse section is 13-16 μm, when not affected by recrystallization. Partial fusion of adjacent fibres in some parts of the shell is attributed to recrystallization.

Towards the interior and away from the lateral margins a coarse, prismatic calcite layer has been detected. It is more probably related to recrystallisation of secondary fibres than to the occurrence of a tertiary layer.

Discussion. Diagnostic characters of the new species are the oval outline, short hinge line, convex and strongly enrolled ventral valve, large and deep ventral sulcus, poorly fasciculated flanks of ventral valve and low dorsal fold ornamented by a couple of costae.

Hunzina electa sp. n. differs from *Hunzina tenuisulcata* (Merla, 1934) by means of its larger ventral sulcus and different ornamentation; from *Hunzina elegantula* (Hu, 1983) by its larger ventral sulcus, less strong fasciculation and less angular costae, from *H. mushirebucaensis* (Sun, 1991) by its stronger fasciculation and larger sulcus.

The specimens described by Reed (1925) as *S. rajah* Salter, 1925 and *S. vercherei* (De Verneuil, 1867) from Baroghil pass (Hayden, 1915) belong to the same species, according to Waterhouse (1966, p. 52) and are here included in *H. electa* sp. n. on the basis of the material collected at Baroghil pass in 1992.

After studying the collection of Merla (1934) from Rimu (NE Karakorum), housed at the Museum of Palcontology of the University of Firenze, the present author includes the specimens described by Merla as *S. tibetanus*, *S. tibetanus occidentalis* and *S. tibetanus* var. *lata* in *Hunzina electa* sp. n.

Finally the specimens from Shaksgam described by Renz (1939, 1940) as *S. tibetanus* and *S. tibetanus occidentalis* seem to belong to *H. electa* sp. n.

Geographic and stratigraphic distribution. *H. electa* sp. n. occurs in the Early Permian of NE

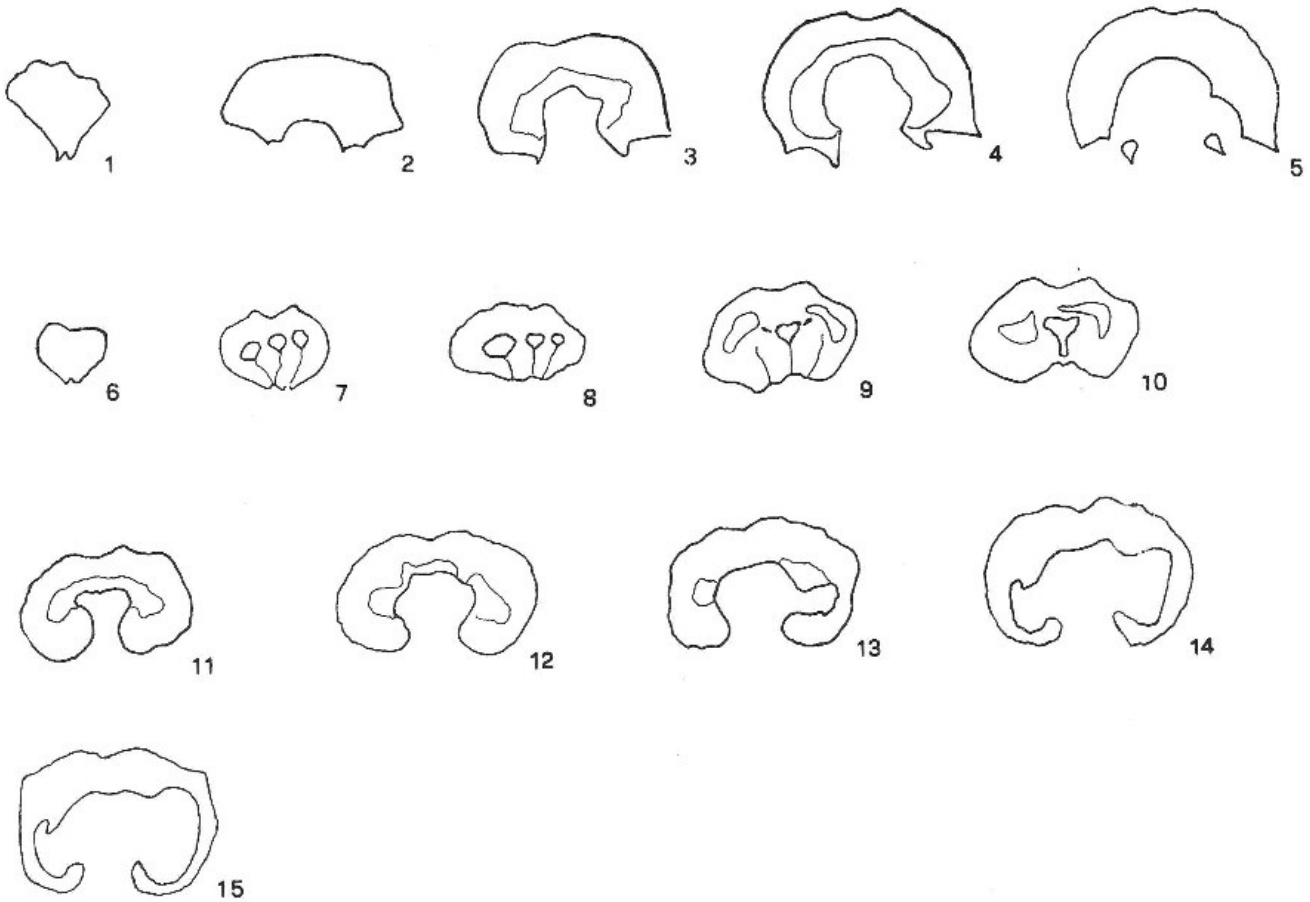


Fig. 13 - Serial sections of the ventral valves of *H. electa* (1-5) and of *H. tenuisulcata* (6-15) (all 1.2 X). 1-5) Sections of specimen MPUM 7418 (KK203-1) at a distance of 3.3 mm, 7 mm, 8.8 mm, 10.8 mm and 12.1 mm from the umbo. 6-15) Sections of specimen MPUM 7452 (KL17-7) at a distance of 1.2 mm, 1.8 mm, 2.9 mm, 4.8 mm, 9.4 mm, 9.9 mm, 13.2 mm, 13.9 mm, 14.2 mm and 15.5 mm from the umbo.

Karakorum (Merla, 1934) and of Shaksgam (Renz, 1939, 1940).

In Western and Central Karakorum it is present respectively in the Sakmarian Lashkargaz Fm., Mb. 1 of Baroghil pass, Lashkargaz and North of Showar Sur and in the Sakmarian Lupghar Fm., Mb. 1 of Chapursan and Abgarch valleys.

Hunzina tenuisulcata (Merla, 1934)

Pl. 4, fig. 15-20; Pl. 5, fig. 1-3; Pl. 6, fig. 31-40; Pl. 9, fig. 5,6; Text-fig. 13, 15

1934 *Spirifer tibetanus* var. *tenuisulcata* Merla, p. 273, pl. 26, fig. 14-21.
1948 *Elivina tibetana tenuisulcata* - Branson, p. 356.
1965b *Elivina* cf. *tibetana tenuisulcata* - Fantini Sestini, p. 198.

Lectotype. IGF17090, coming from Campo IV of Rimu (NE Karakorum), housed in Museum of Paleontology of Firenze.

Material. 1 Complete specimen: MPUM 7454 (KL19-11).

67 Ventral valves: MPUM 7443 (KL19-30); MPUM 7444 (KL17-5); MPUM 7445 (KL17-11); MPUM 7448 (KL17-26); MPUM 7449 (KL19-1); MPUM 7450 (KL19-2); MPUM 7451 (KL17-35); MPUM 7452 (KL17-7); MPUM 7453 (KL19-13); MPUM 7455 (KL17-2,-3,-4,-6,-12,-13,-14,-17,-18,-18bis,-19,-21,-22,-23,-24,-27,-29,-30,-31,-32,-33,-34,-35,-38,-40); MPUM 7456 (KL19-3,-4,-5,-6,-8,-9,-10,-14,-15,-15bis,-17,-19,-20,-21,-22,-23,-24,-27,-28,-29,-31,-33,-34,-35,-36,-37,-38,-39,-40,-41,-43,-44,-46).

9 Dorsal valves: MPUM 7446 (KL19-12); MPUM 7447 (KL19-32); MPUM 7457 (KL17-9,-12,-15,-20,-37,-39); MPUM 7458 (KL19-48).

Description. Biconvex shell with longitudinally oval outline. Hinge line very short, less than 1/2 the maximum width, which lies at about 2/3 of the length of the shell. Cardinal extremities quite rounded. Anterior commissure uniplicate.

Ventral valve strongly convex with thicker shell in the umbonal region. The curvature of the ventral valve is pronounced both longitudinally and transversely. Ventral umbo pointed, recurved on interarea which is low and concave. Ventral sulcus narrow and shallow. Dorsal valve less convex than the ventral one, with subrounded outline. Dorsal median fold very shallow.

Ornamentation of ventral valve of rounded costae, branching at the umbo. Ventral sulcus bounded by a pair of thick, rounded costae, bifurcating at a distance of 4-6 mm from the umbo, forming fascicles of 2 costae. In the mature specimens each costa of the couple can bifurcate anteriorly, forming fascicles of 4 costae. In any case the width of the couple of costae is larger than the ventral sulcus itself. The lateral costae number 4-5 for each flank of the valve and may branch anteriorly, forming fascicles of 2, rarely 3, costae. The ventral sulcus is ornamented by a coarse median costa. Ornamentation of dorsal valve of rounded costae which branch only in the

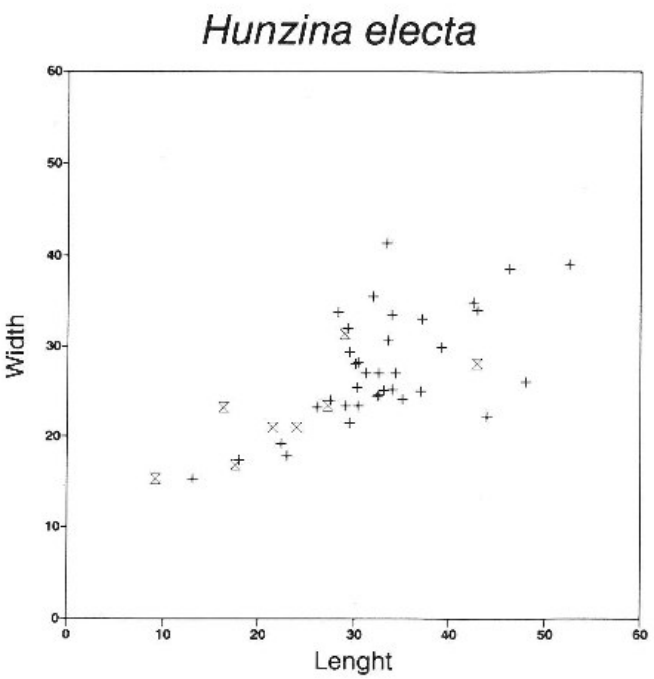


Fig. 14 - Width versus length diagram of *H. electa*, showing the dispersion of the data due to the state of preservation of the specimens. The juveniles seem to be more transverse in outline than the mature specimens which are longitudinally elongated. In fact only a slight increase in width during growth has been observed. The plus indicates the ventral valves, whereas the hourglass indicates the dorsal valves.

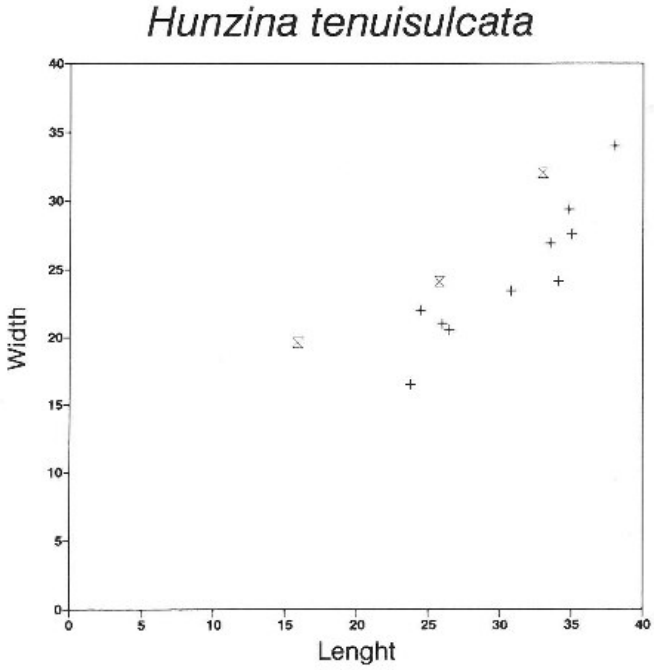


Fig. 15 - Width versus length diagram of *H. tenuisulcata*, showing the more transverse outline of the dorsal valves (hourglass) with respect to the ventral ones (plus). The general outline of this species seems to be more transverse with respect to *H. electa*.

anterior region, forming fascicles of 3 costae at the anterior margin. The dorsal fold is ornamented by a costa branching near the umbo and near the anterior margin.

Interior of ventral valve with short dental plates and adminicula embedded in the umbonal callus. Muscle scars with subrounded outline, abruptly terminating against a subrectangular platform.

Dimensions (in mm):

	Width	Length	Thickness	Hinge Line	H. Int.
KL19-11	24.1	34.1	21.4	12	
KL17-2	30			11.9	4.9
KL17-4	20.5	26.5		10	4.8
KL17-14	21	24.4	12		
KL17-19	27.5	35			
KL17-30	26.9	33.5	17	13	5
KL19-1	34	38	15		
KL19-5	21	26	13		
KL19-6	23.4	30.8	17		
KL19-8	30	34.8	15.6		
KL19-28	16.5	23.7	12		
KL19-33	21.7			13.1	5
KL17-9	34	33			
KL19-32	19.6	15.9		10	

H. Int: Height of interarea

Ultrastructure (Pl. 9, fig. 5,6). The analysed specimens resulted very recrystallized. Locally the secondary layer consists of long, thin fibres, parallel to the external surface of the shell. The secondary layer fibres show a platy subrectangular outline in transverse cross section. Their width is about 12-14 μm and their thickness is 2.5-5 μm.

Ontogenetic variation. The immature specimens show a less elongate outline and are ornamented by simple costae. Only the principal pair of costae, bounding the ventral sulcus, show fasciculation.

Discussion. After studying the type-series of *Hunzina tenuisulcata* (Merla, 1934), housed at the Museum of Palcontology of Firenze, the present author established the specimen (a ventral valve) IGF17090 as lectotype of *H. tenuisulcata.*

Diagnostic characters of *H. tenuisulcata* are the narrow and shallow ventral sulcus, ornamented by a coarse costa and bounded by a pair of large fascicles of 2-4 costae; the low dorsal fold and the ornamentation of the dorsal valve of simple costae branching only at the anterior margin.

Geographic and stratigraphic distribution. *H. tenuisulcata* occurs in the Early Permian of NE Karakorum (Merla, 1934) and of Shaksgam (Fantini Sestini, 1965b).

In Central Karakorum it is present in the Sakmarian Lupghar Fm., Mb. 1, of Shimshal valley.

Superfamily *Spiriferinacea* Davidson, 1884

Family *Spiriferinidae* Davidson, 1884

Genus *Punctospirifer* North, 1920

Type-species: *Punctospirifer scabricosta* North, 1920

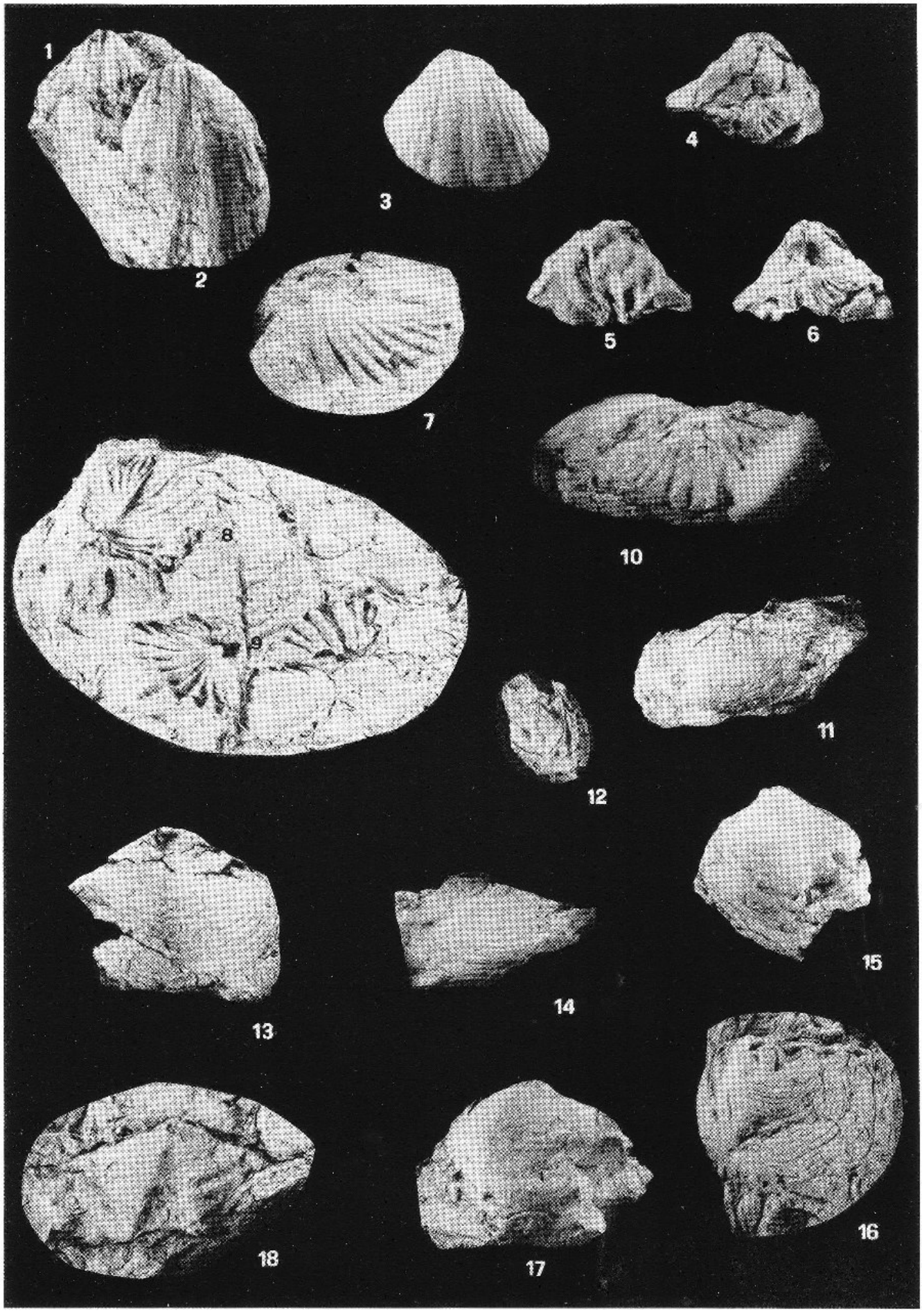
Comments. The genus *Punctospirifer* has been introduced by North (1920) for those septate and punctate spiriferids, showing high ventral interarea and rounded ventral sulcus and dorsal fold, which are larger than the lateral costae.

Punctospirifer differs from *Spiriferellina* Fredericks, 1924 by means of greater number of lateral

PLATE 5

Fig. 1 - *Hunzina tenuisulcata* (Merla, 1934). Ventral valve. Specimen MPUM 7449 (KL19-1).
Fig. 2 - *Hunzina tenuisulcata* (Merla, 1934). Ventral valve. Specimen MPUM 7450 (KL19-2).
Fig. 3 - *Hunzina tenuisulcata* (Merla, 1934). Ventral valve. Specimen MPUM 7451 (KL17-35).
Fig. 4 - *Punctospirifer afghanus* Termier, Termier, de Lapparent & Marin, 1974. Posterior view of a complete specimen. Specimen MPUM 7459 (KK26-44).
Fig. 5 - *Punctospirifer afghanus* Termier, Termier, de Lapparent & Marin, 1974. Anterior view of a complete specimen. Specimen MPUM 7459 (KK26-44).
Fig. 6 - *Punctospirifer afghanus* Termier, Termier, de Lapparent & Marin, 1974. Dorsal view of a complete specimen. Specimen MPUM 7459 (KK26-44).
Fig. 7 - *Gjelispinifera* aff. *cristata* (Schlotheim, 1816). Ventral valve external mould. Specimen MPUM 7463 (CK162-33).
Fig. 8 - *Gjelispinifera* aff. *cristata* (Schlotheim, 1816). Complete specimen, external mould. Specimen MPUM 7464 (CK162-32).
Fig. 9 - *Gjelispinifera* aff. *cristata* (Schlotheim, 1816). Complete specimen, external mould. Specimen MPUM 7465 (CK162-31).
Fig. 10 - *Punctospirifer afghanus* Termier, Termier, de Lapparent & Marin, 1974. Ventral valve. Specimen MPUM 7460 (KL2-4bis).
Fig. 11 - *Spirelytha petaliformis* (Pavlova, 1973). Dorsal valve internal mould. Specimen MPUM 7467 (KL2-9).
Fig. 12 - *Spirelytha petaliformis* (Pavlova, 1973). Dorsal valve internal mould. Specimen MPUM 7468 (KL2-12).
Fig. 13 - *Spirelytha petaliformis* (Pavlova, 1973). Ventral valve. Specimen MPUM 7469 (KL2-11).
Fig. 14 - *Spirelytha petaliformis* (Pavlova, 1973). Dorsal valve. Specimen MPUM 7470 (KL2-5).
Fig. 15 - *Spirelytha petaliformis* (Pavlova, 1973). Ventral valve. Specimen MPUM 7471 (KL2-4).
Fig. 16 - *Spirelytha petaliformis* (Pavlova, 1973). Dorsal valve. Specimen MPUM 7472 (KL2-15).
Fig. 17 - *Tomiopsis* cf. *bazardarensis* (Grunt, 1993). Dorsal valve. specimen MPUM 7478 (KL2-1).
Fig. 18 - *Tomiopsis* cf. *bazardarensis* (Grunt, 1993). Ventral valve. Specimen MPUM 7477 (KL2-18).

All x 1, except when specified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costae, larger ventral sulcus and dorsal fold and ventral interarea sharply differentiated from the lateral flanks of the valve; from *Gjelispinifera* Ivanova, 1975 for the absence of spines, higher and well differentiated interarea and higher median septum of the ventral valve.

Punctospirifer afghanus Termier, Termier, de Lapparent & Marin, 1974

Pl. 5 , fig. 4-6, 10

1974 *Punctospirifer afghanus* Termier et al., p. 80, pl. 6, fig. 1; pl. 16, fig. 1.

Material. 1 Complete specimen: MPUM 7459 (KK26-44).
2 Ventral valves: MPUM 7460 (KL2-4bis); MPUM 7461 (KL2-3).
1 Dorsal valve: MPUM 7462 (KL2-2bis).

Description. Biconvex shell with trigonal outline. Maximum width at the hinge line. Cardinal extremities acute. Anterior commissure uniplicate. Shell substance punctate.

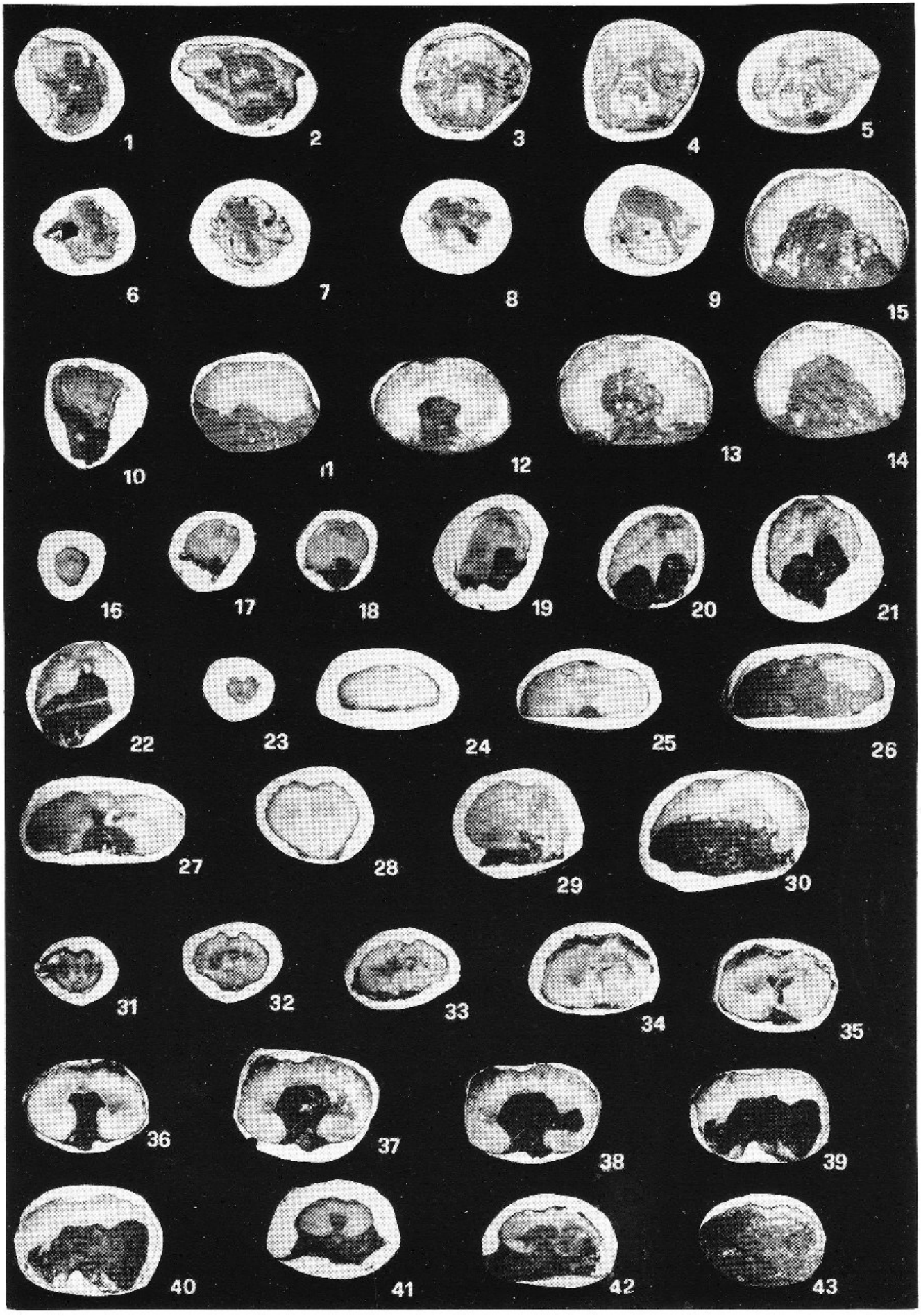
Ventral valve with high, striated interarea, concave below the umbo and flat towards the cardinal margin, lying normal to the plane of commissure. The interarea is sharply distinct from the flanks of the valve. Delthyrium narrow with cylindrical deltidial ridges. Ventral sulcus large, shallow and rounded. Dorsal valve with pronounced median fold, larger than lateral costae.

Ornamentation of simple, coarse, rounded costae, numbering 5-6 for each flank. Growth lamellae and faint radial capillae are also present.

Interior of ventral valve with thick dental plates and adminicula and high and strong median septum, thickened at its base.

PLATE 6

Fig. 1 - *Cleiothyridina ailakensis* Reed, 1925. Specimen MPUM 7315 (KK231-30), section at 1.8 mm from the umbo; X 2.
Fig. 2 - *Cleiothyridina ailakensis* Reed, 1925. Specimen MPUM 7315 (KK231-30), section at 2 mm from the umbo; X 2.
Fig. 3 - *Cleiothyridina ailakensis* Reed, 1925. Specimen MPUM 7316 (CK162-20), section at 1.8 mm from the umbo; X 2.
Fig. 4 - *Cleiothyridina ailakensis* Reed, 1925. Specimen MPUM 7316 (CK162-20), section at 2.2 mm from the umbo; X 2.
Fig. 5 - *Cleiothyridina ailakensis* Reed, 1925. Specimen MPUM 7316 (CK162-20), section at 2.4 mm from the umbo; X 2.
Fig. 6 - *Cleiothyridina ailakensis* Reed, 1925. Specimen MPUM 7317 (CK162-27, section at 2.3 mm from the umbo; X 2.
Fig. 7 - *Cleiothyridina ailakensis* Reed, 1925. Specimen MPUM 7317 (CK162-27), section at 2.6 mm from the umbo; X 2.
Fig. 8 - *Cleiothyridina ailakensis* Reed, 1925. Specimen MPUM 7317 (CK162-27), section at 3.5 mm from the umbo; X 2.
Fig. 9 - *Cleiothyridina ailakensis* Reed, 1925. Specimen MPUM 7317 (CK162-27), section at 3.9 mm from the umbo; X 2.
Fig. 10 - *Hunzina electa* sp. n. Specimen MPUM 7418 (KK203-1), section at 3.3 mm from the umbo; X 1.2.
Fig. 11 - *Hunzina electa* sp. n. Specimen MPUM 7418 (KK203-1), section at 7 mm from the umbo; X 1.2.
Fig. 12 - *Hunzina electa* sp. n. Specimen MPUM 7418 (KK203-1), section at 8.8 mm from the umbo; X 1.2.
Fig. 13 - *Hunzina electa* sp. n. Specimen MPUM 7418 (KK203-1), section at 10.8 mm from the umbo; X 1.2.
Fig. 14 - *Hunzina electa* sp. n. Specimen MPUM 7418 (KK203-1), section at 12.1 mm from the umbo; X 1.2.
Fig. 15 - *Hunzina electa* sp. n. Specimen MPUM 7418 (KK203-1), section at 12.6 mm from the umbo; X 1.2.
Fig. 16 - *Hunzina electa* sp. n. Specimen MPUM 7419 (DM35-10), section at 2.2 mm from the umbo; X 1.2.
Fig. 17 - *Hunzina electa* sp. n. Specimen MPUM 7419 (DM35-10), section at 3.7 mm from the umbo; X 1.2.
Fig. 18 - *Hunzina electa* sp. n. Specimen MPUM 7419 (DM35-10), section at 5.2 mm from the umbo; X 1.2.
Fig. 19 - *Hunzina electa* sp. n. Specimen MPUM 7419 (DM35-10), section at 6.6 mm from the umbo; X 1.2.
Fig. 20 - *Hunzina electa* sp. n. Specimen MPUM 7419 (DM35-10), section at 8 mm from the umbo; X 1.2.
Fig. 21 - *Hunzina electa* sp. n. Specimen MPUM 7419 (DM35-10), section at 9.7 mm from the umbo; X 1.2.
Fig. 22 - *Hunzina electa* sp. n. Specimen MPUM 7419 (DM35-10), section at 13.4 mm from the umbo; X 1.2.
Fig. 23 - *Hunzina electa* sp. n. Specimen MPUM 7420 (KK203-106), section at 1.5 mm from the umbo; X 1.2.
Fig. 24 - *Hunzina electa* sp. n. Specimen MPUM 7420 (KK203-106), section at 6.8 mm from the umbo; X 1.2.
Fig. 25 - *Hunzina electa* sp. n. Specimen MPUM 7420 (KK203-106), section at 10.1 mm from the umbo; X 1.2.
Fig. 26 - *Hunzina electa* sp. n. Specimen MPUM 7420 (KK203-106), section at 13.4 mm from the umbo; X 1.2.
Fig. 27 - *Hunzina electa* sp. n. Specimen MPUM 7420 (KK203-106), section at 15.7 mm from the umbo; X 1.2.
Fig. 28 - *Hunzina electa* sp. n. Specimen MPUM 7403 (CK172-2), section at 4.3 mm from the umbo; X 1.2.
Fig. 29 - *Hunzina electa* sp. n. Specimen MPUM 7403 (CK172-2), section at 6.2 mm from the umbo; X 1.2.
Fig. 30 - *Hunzina electa* sp. n. Specimen MPUM 7403 (CK172-2), section at 11.6 mm from the umbo; X 1.2.
Fig. 31 - *Hunzina tenuisulcata* (Merla, 1934). Specimen MPUM 7452 (KL17-7), section at 1.2 mm from the umbo; X 1.2.
Fig. 32 - *Hunzina tenuisulcata* (Merla, 1934). Specimen MPUM 7452 (KL17-7), section at 1.8 mm from the umbo; X 1.2.
Fig. 33 - *Hunzina tenuisulcata* (Merla, 1934). Specimen MPUM 7452 (KL17-7), section at 2.9 mm from the umbo; X 1.2.
Fig. 34 - *Hunzina tenuisulcata* (Merla, 1934). Specimen MPUM 7452 (KL17-7), section at 4.8 mm from the umbo; X 1.2.
Fig. 35 - *Hunzina tenuisulcata* (Merla, 1934). Specimen MPUM 7452 (KL17-7), section at 9.4 mm from the umbo; X 1.2.
Fig. 36 - *Hunzina tenuisulcata* (Merla, 1934). Specimen MPUM 7452 (KL17-7), section at 9.9 mm from the umbo; X 1.2.
Fig. 37 - *Hunzina tenuisulcata* (Merla, 1934). Specimen MPUM 7452 (KL17-7), section at 13.2 mm from the umbo; X 1.2.
Fig. 38 - *Hunzina tenuisulcata* (Merla, 1934). Specimen MPUM 7452 (KL17-7), section at 13.9 mm from the umbo; X 1.2.
Fig. 39 - *Hunzina tenuisulcata* (Merla, 1934). Specimen MPUM 7452 (KL17-7), section at 14.2 mm from the umbo; X 1.2.
Fig. 40 - *Hunzina tenuisulcata* (Merla, 1934). Specimen MPUM 7452 (KL17-7), section at 15.5 mm from the umbo; X 1.2.
Fig. 41 - *Hunzina electa* sp. n. Specimen MPUM 7421 (CK172-1), section at 3.8 mm from the umbo; X 1.2.
Fig. 42 - *Hunzina electa* sp. n. Specimen MPUM 7421 (CK172-1), section at 5.4 mm from the umbo; X 1.2.
Fig. 43 - *Hunzina electa* sp. n. Specimen MPUM 7421 (CK172-1), section at 7.9 mm from the umbo; X 1.2.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Dimensions (in mm):

	Width	Length	Thickness	H. Int.
KK26-44	30.5	17.9	18.1	7.4
KL2-4bis	33	19		

Discussion. The specimens of Karakorum have been included in *Punctospirifer afghanus* Termier, Termier, de Lapparent & Marin, 1974 on the basis of the high interarea, large ventral sulcus, number of lateral costae and high ventral median septum.

The specimens of *P. afghanus* Termier, Termier, de Lapparent & Marin (1974) from Central Afghanistan (Termier et al., 1974), housed at the Office National des Collections Fossiles, Université Claude Bernard, Lyon, consist only of two ventral valves. No direct comparison between the dorsal valves is thus possible.

Geographic and stratigraphic distribution. *P. afghanus* occurs in the Asselian of Wardak (Central Afghanistan) (Termier at al., 1974).

In Karakorum it is present in the Asselian-Early Sakmarian Gircha Fm. of Chapursan valley.

Genus *Gjelispinifera* Ivanova, 1975

Type-species: *G. gerasimovi* Ivanova, 1975

Comments. *Gjelispinifera* Ivanova, 1975 is similar to *Reticulariina* Fredericks, 1916 differing from it by means of more acute cardinal extremities, shape of ventral median septum and micrornamentation. *Gjelispinifera* differs from *Spiriferellina* Fredericks, 1924 by its larger dimensions, more acute cardinal extremities and micrornamentation.

Archbold (1988) suggests to include the specimens from Timor described by Broili (1916) as *Spiriferina cristata* (Schlotheim, 1816) in the genus *Gjelispinifera*. In the present paper the specimens from Karakorum described by Merla (1934) as *S. cristata* are included in the genus *Gjelispinifera*.

Gjelispinifera aff. **cristata** (Schlotheim, 1816)

Pl. 5, fig. 7-9

1925 *Spiriferina cristata* (Schlotheim) var. - Reed, p. 49, pl. 6, fig. 10.

Material. 2 Complete specimens: MPUM 7464 (CK162-32); MPUM 7465 (CK162-31).

3 Ventral valves: MPUM 7463 (CK162-33); MPUM 7466 (CK162-34,-35).

Description. Biconvex shell with semicircular outline. Hinge line straight, corresponding to the maximum width of the shell. Cardinal extremities subangular. Shell substance strongly punctate. Ventral valve with pointed umbo overhanging the interarea, which is low and concave. Ventral sulcus narrow, deep, with flat floor, widening anteriorly. Dorsal valve with narrow fold with flat top.

Ornamentation of subrounded, simple costae, 1.8-2 mm wide at the anterior margin, numbering 5-6 for each flank. The costae flanking the ventral sulcus are larger than the lateral ones. Growth lamellae and hollow spines are also present.

Dimensions (in mm):

	Width	Length
CK162-31	26.4	17.5
CK162-34	14.6	10.4

PLATE 7

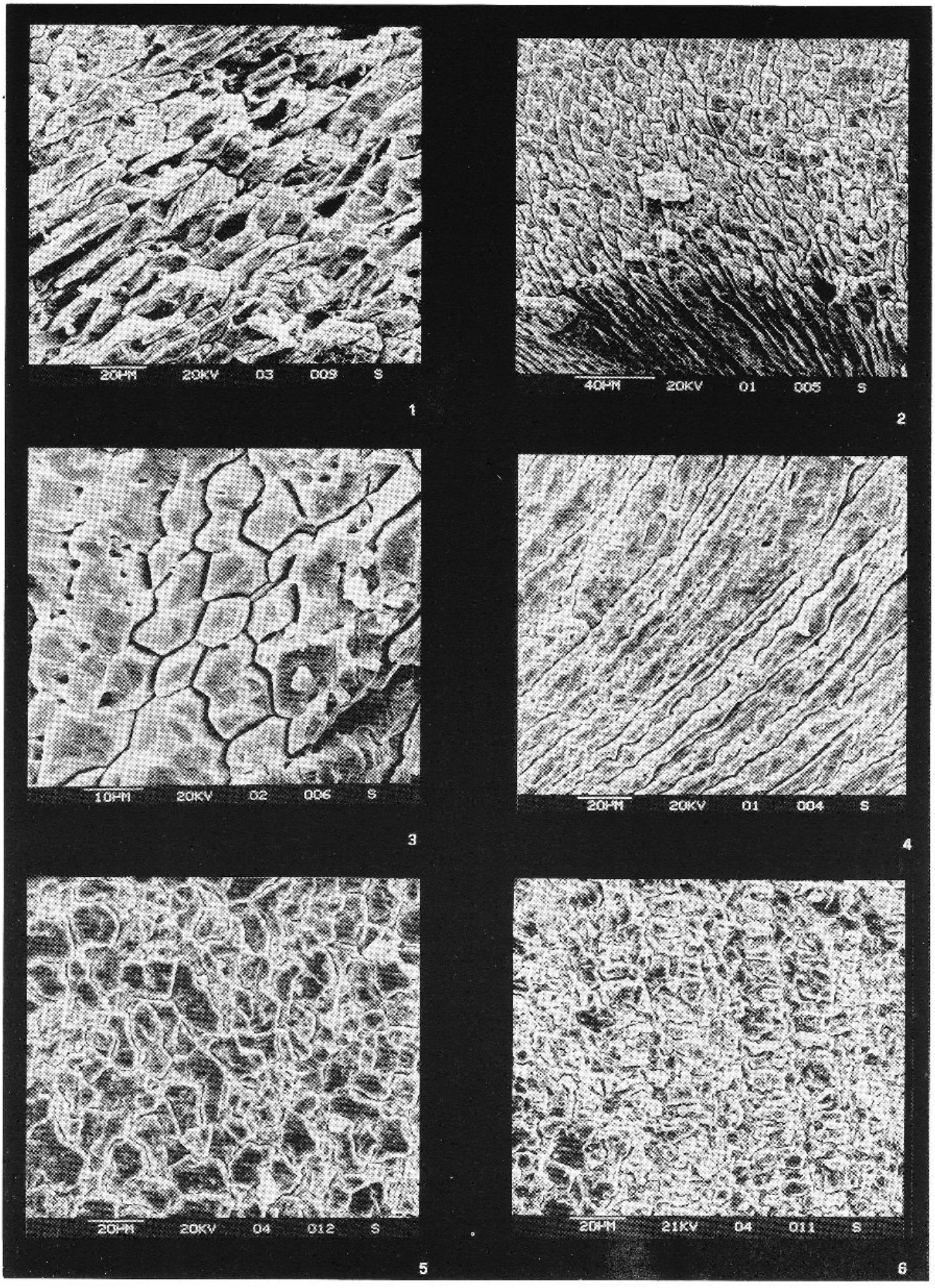
Fig. 1 - *Cleiothyridina ailakensis* Reed, 1925 Transverse-oblique section of ventral valve. Specimen MPUM 7318 (CK162-21).
Fig. 2 - *Cleiothyridina ailakensis* Reed, 1925. Longitudinal section of ventral valve. Specimen MPUM 7319 (DM35-5).
Fig. 3 - *Cleiothyridina ailakensis* Reed, 1925. Longitudinal section of ventral valve. Specimen MPUM 7320 (CK162-28).
Fig. 4 - *Cleiothyridina ailakensis* Reed, 1925. Longitudinal section of ventral valve. Specimen MPUM 7319 (DM35-5).
Fig. 5 - *Cleiothyridina* aff. *semiconcava* Waagen, 1883. Longitudinal section of ventral valve. Specimen MPUM 7321 (KK203-40).
Fig. 6 - *Cleiothyridina* aff. *semiconcava* Waagen, 1883. Longitudinal section of ventral valve. Specimen MPUM 7321 (KK203-40).

PLATE 8

Fig. 1 - *Trigonotreta stokesi* Koenig, 1825. Transversal section of ventral valve. Specimen MPUM 7351 (KK26-55).
Fig. 2 - *Trigonotreta stokesi* Koenig, 1825. Longitudinal section of ventral valve. Specimen MPUM 7352 (KK26-37).
Fig. 3 - *Trigonotreta stokesi* Koenig, 1825. Longitudinal section of ventral valve. Specimen MPUM 7352 (KK26-37).
Fig. 4 - *Trigonotreta lyonsensis* Archbold & Thomas, 1986. Transversal section of ventral valve. Specimen MPUM 7362 (KK26-88).
Fig. 5 - *Trigonotreta lyonsensis* Archbold & Thomas, 1986. Transversal section of ventral valve. Specimen MPUM 7362 (KK26-88).
Fig. 6 - *Trigonotreta lyonsensis* Archbold & Thomas, 1986. Transversal section of ventral valve. Specimen MPUM 7362 (KK26-88).

PLATE 9

Fig. 1 - *Trigonotreta paucicostulata* (Reed, 1925). Longitudinal section of ventral valve. Specimen MPUM 7376 (KK213-2).
Fig. 2 - *Trigonotreta paucicostulata* (Reed, 1925). Longitudinal section of ventral valve. Specimen MPUM 7376 (KK213-2).
Fig. 3 - *Trigonotreta paucicostulata* (Reed, 1925). Transversal section of ventral valve. Specimen MPUM 7377 (KK203-98).
Fig. 4 - *Trigonotreta paucicostulata* (Reed, 1925). Transversal section of ventral valve. Specimen MPUM 7377 (KK203-98).
Fig. 5 - *Hunzina tenuisulcata* (Merla, 1934). Transversal section of ventral valve. Specimen MPUM 7453 (KL19-13).
Fig. 6 - *Hunzina tenuisulcata* (Merla, 1934). Transversal section of ventral valve. Specimen MPUM 7453 (KL19-13).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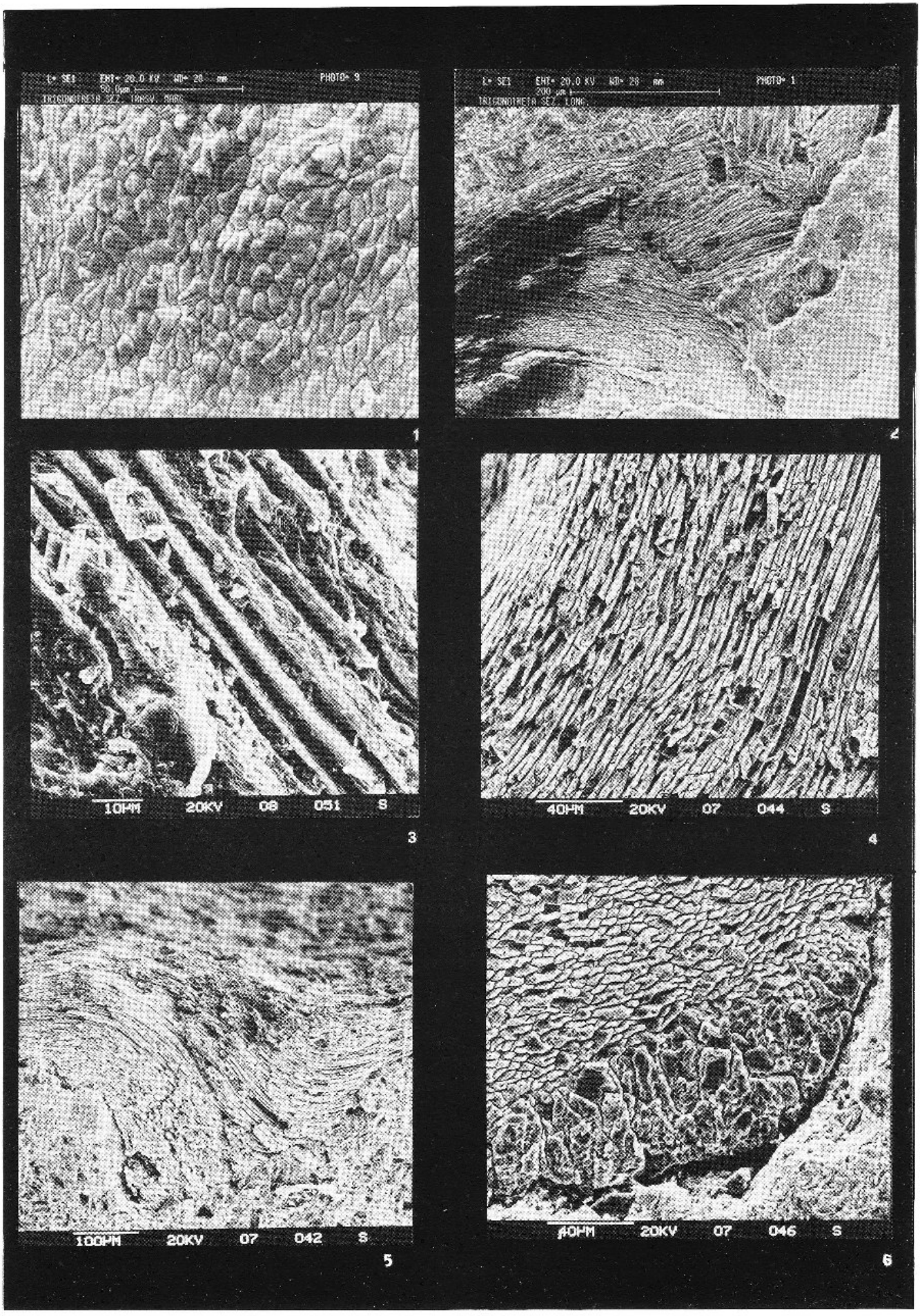
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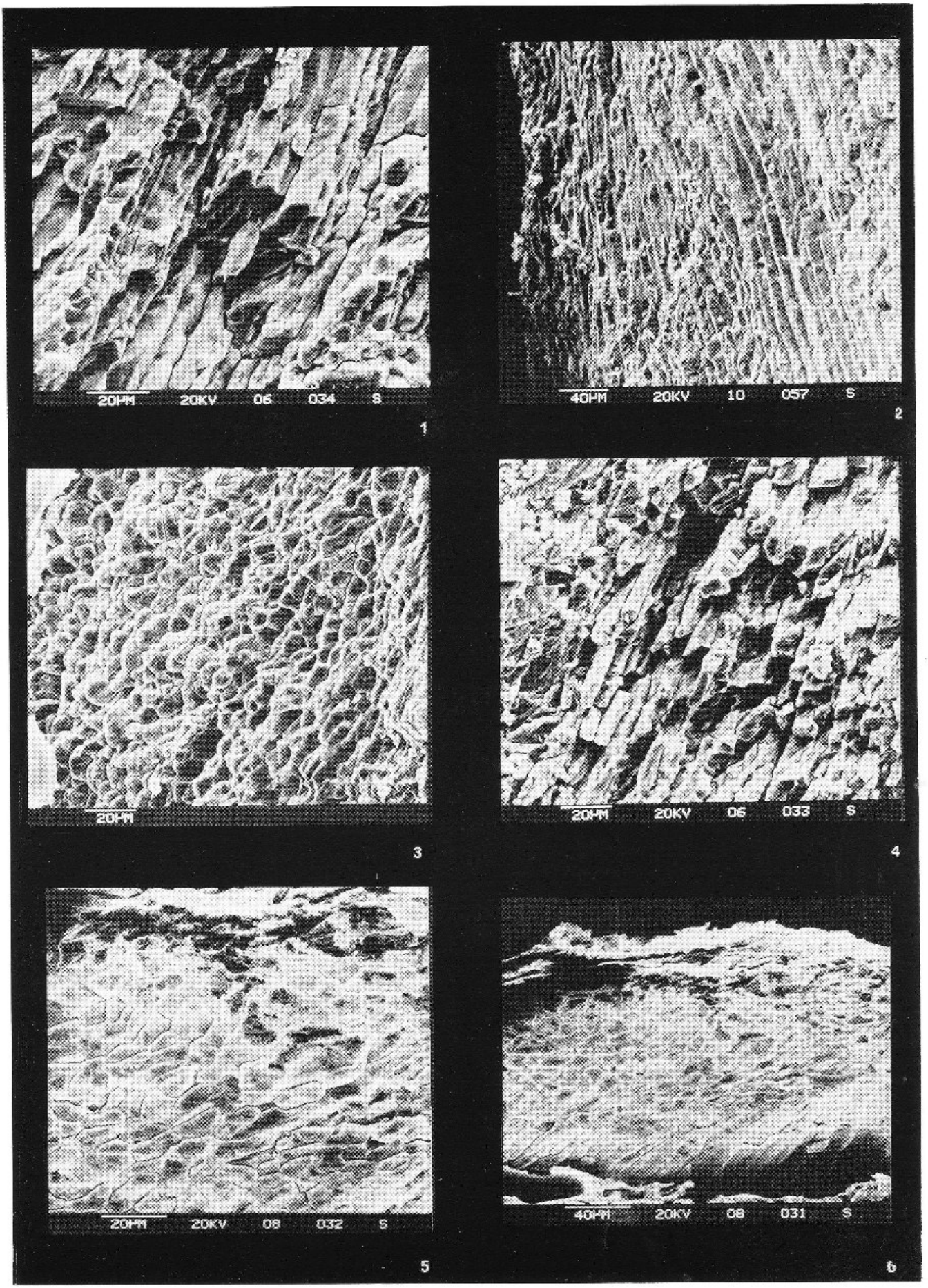
40µM 20KV 07 046 S
6


20µM 20KV 06 034 S
1
40µM 20KV 10 057 S
2
20µM
3
20µM 20KV 06 033 S
4
20µM 20KV 08 032 S
5
40µM 20KV 08 031 S
6

Discussion. The specimens from Karakorum are similar to *G. cristata* (Schlotheim, 1816), differing from it by means of the narrow, flat bottomed ventral sulcus and dorsal fold and the fine, numerous lateral costae. The specimens described by Merla (1934) as *S. cristata* differs from *G.* aff. *cristata* by the larger ventral sulcus and lower number of costae (3-4 for each flank).

Geographic and stratigraphic distribution. *G.* aff. *cristata* occurs in the Sakmarian of Karakorum (Baroghil pass).

Superfamily *Reticulariacea* Waagen, 1883
Family *Elythidae* Fredericks, 1924
Genus *Spirelytha* Fredericks, 1919

Type-species: *Spirelytha pavlovae* Archbold & Thomas, 1984

Comments. Archbold & Thomas (1984b) and Klets (1987) have exhaustively revised the genus *Spirelytha*. *Spirelytha* differs from *Kitakamithyris* Minato, 1951 by the presence of dorsal median septum and absence of pseudodeltidium.

Spirelytha petaliformis (Pavlova, 1973)

Pl. 5, fig. 11-16; Pl. 10, fig. 5, 6

1973 *Kitakamithyris petaliformis* Pavlova in Grunt & Dmitriev, p. 136, pl. 10, fig. 2-5.
1993 *Spirelytha petaliformis* - Angiolini, p. 294, pl. 5, fig. 7, 8; pl. 6, fig. 1, 2.

Material. 2 Complete specimens: MPUM 7474 (KL2-13,-25).
11 Ventral valves: MPUM 7469 (KL2-11); MPUM 7471 (KL2-4); MPUM 7475 (KL2-2,-6,-7,-8,-14,-21,-23,-24,-26).
7 dorsal valves: MPUM 7467 (KL2-9); MPUM 7468 (KL2-12); MPUM 7470 (KL2-5); MPUM 7472 (KL2-15); MPUM 7473 (KK26-82); MPUM 7476 (KL2-19,-22).

Description. Large sized, biconvex shell, with fan outline. Hinge line straight and short. Maximum width anterior to the hinge. Anterior commissure uniplicate.

Ventral valve with pointed, pronounced, high umbo, giving a subpentagonal outline to the valve. Interarea high, striated, with open delthyrium. Ventral sulcus large, shallow, rounded, starting at a distance of 3-5 mm from the umbo and widening anteriorly. Dorsal valve with transversely oval outline. Dorsal fold large, shallow, rounded, bounded by depressed areas.

Ornamentation of regularly spaced growth lamellae, 1-1.4 mm high, bearing double-barrelled spines, numbering 3 per 1 mm. The base of the double-barrelled spines is triangular.

Interior of valves with fine vascular channels. Interior of ventral valve with coarse median septum, extending to 2/3 the length of the valve, strong ventral adminicula and rhomboidal, depressed, longitudinally striated muscle scars. Interior of dorsal valve with thin median septum.

Dimensions (in mm):

	Width	Length	Thickness	A	H. Int.	Hinge Line
KL2-13	24.2	19.7	7	98°		
KL2-25	32.9	25.3	13.2		9.3	
KL2-11	41	30.6		100°	9.4	22.2
KL2-14	25.1	21		87°	6.5	15.3
KL2-4	34	27.4		95°	6.4	19.9
KL2-7	36.6			102°	7.6	
KL2-9	33.7	22.1				

A = apical angle.

Ultrastructure (Pl. 10, fig. 5, 6). The ultrastructure of *S. petaliformis* has been previously described by Angiolini (1993). The primary layer has not been observed. The secondary layer is 350 μm thick. It consists of long fibres subparallel to the external surface of the valve which show a platy profile or a subrhomboidal shape. The width of fibres is 8-11 μm and their thickness is 4-7 μm. The scars of attachment of the double-barrelled spines consist of fine secondary layer fibres. Towards the interior the fibres of the secondary layer pass to irregular, poorly defined crystals inferred to represent a tertiary layer, 50-60 μm thick.

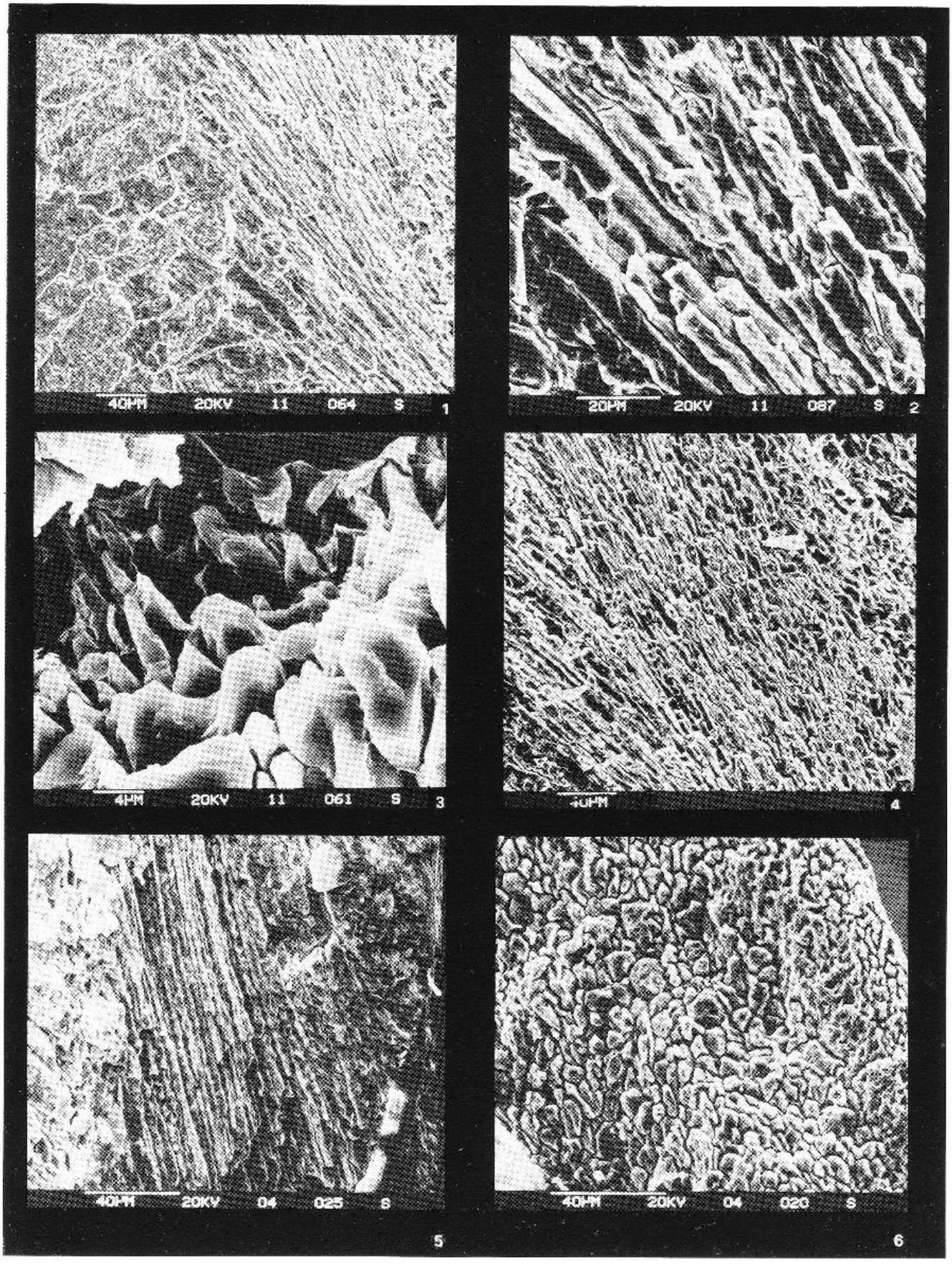
Discussion. Diagnostic characters of *Spirelytha petaliformis* (Pavlova, 1973) are the large size, the "petal" outline of the shell, the shallow ventral sulcus and dorsal fold.

S. petaliformis is similar to *S. fredericksi* Archbold & Thomas, 1984, from the Callytharra Fm. (Carnarvon Basin) and Fossil Cliff member (Perth Basin), differing from it by means of its pointed ventral outline and shorter ventral adminicula.

Geographic and stratigraphic distribution. *S. petaliformis* occurs at the base and the top of the Tashkazyk Fm. of SE Pamir (Grunt & Dmitriev, 1973; Grunt & Novikov, 1994) and in the Asselian-Early Sakmarian Gircha Fm. of Chapursan valley (Karakorum).

PLATE 10

Fig. 1 - *Hunzina electa* sp. n. Longitudinal section of ventral valve. Specimen MPUM 7422 (KK203-95).
Fig. 2 - *Hunzina electa* sp. n. Longitudinal section of ventral valve. Specimen MPUM 7422 (KK203-95).
Fig. 3 - *Hunzina electa* sp. n. Longitudinal section of ventral valve. Specimen MPUM 7422 (KK203-95).
Fig. 4 - *Hunzina electa* sp. n. Longitudinal section of ventral valve. Specimen MPUM 7422 (KK203-95).
Fig. 5 - *Spirelytha petaliformis* (Pavlova, 1973). Transverse-oblique section of dorsal valve. Specimen MPUM 7473 (KK26-82).
Fig. 6 - *Spirelytha petaliformis* (Pavlova, 1973). Transverse-oblique section of dorsal valve. Specimen MPUM 7473 (KK26-82).


40µM 20KV 11 064 S 1
20µM 20KV 11 087 S 2
4µM 20KV 11 061 S 3
40µM 4
40µM 20KV 04 025 S 5
40µM 20KV 04 020 S 6

Family *Ingelarellidae* Campbell, 1959
Subfamily *Ingelarellinae* Campbell, 1959
Genus *Tomiopsis* Benediktova, 1956
Type-species: *Brachythyris kumpani* Yanishevskiy, 1935

Comments. The genus *Tomiopsis* Benediktova, 1956 has been discussed by Archbold & Thomas (1986b). *Tomiopsis* Benediktova, 1956 differs from *Notospirifer* Harrington, 1955 by means of the more developed dental plates and crural plates and by the micrornamentation. In fact in *Notospirifer* the micrornamentation consists of tiny upright microspines behind short grooves leading anteriorly into deep, globose and elongated pits (Clarke, 1992), whereas that of *Tomiopsis* is characterized by elongated grooves.

Tomiopsis cf. **bazardarensis** (Grunt, 1993)
Pl. 5, fig. 17, 18

1993 *Notospirifer bazardarensis* Grunt, p. 128, fig. 1, 4.

Material. 1 Ventral valve: MPUM 7477 (KL2-18).
1 Dorsal valve: MPUM 7478 (KL2-1).

Description. Medium sized, biconvex shell with subpentagonal outline. Anterior commissure uniplicate.

Ventral valve with distinct sulcus, widening anteriorly and bounded by two folds. Lateral folds numbering 2 for each flank, wide and shallow. Dorsal valve with distinct median fold.

Ornamentation of faint growth lamellae. Micrornamentation of very fine radial channels.

Interior of ventral valve with short dental plates.

Dimensions (in mm):

	Width	Length
KL2-1	32.2	25.2

Discussion. The specimens under examination are tentatively included in *Tomiopsis bazardarensis* (Grunt, 1993) on the basis of the micrornamentation and the shallow, poorly defined lateral folds.

Geographic and stratigraphic distribution. *T. bazardarensis* occurs in the lump-boulder member (Late Asselian-Early Sakmarian) at the base of the Tashkazyk Fm. in the SE Pamir (Grunt, 1993; Grunt & Novikov, 1994). *T.* cf. *bazardarensis* is present in the Asselian-Early Sakmarian Gircha Fm. of Chapursan valley (W Karakorum).

APPENDIX

NEW BRACHIOPOD TAXA FROM THE BOLORIAN-MURGABIAN/MIDIAN OF KARAKORUM

Introduction.

In order to avoid the use of nomina nuda in the general paper on the Permian stratigraphy of Northern Karakorum (Gaetani et al., 1995), issued contemporary to this article, I introduce here two new genera, one new subgenus and nine new species of brachiopods collected in the Bolorian to Murgabian of Northern Karakorum.

The brachiopod assemblages in which the new taxa have been discovered and the detailed biostratigraphy of the assemblages will be discussed in a complete monograph.

Of the eight taxa herein described, *Marginifera andreai* sp.n. and *Aldina exilis* gen. n. sp. n. have been collected in the Bolorian Lashkargaz Fm., Mb. 2 of the Lashkargaz section (Gaetani et al., 1995); *Transennatia reedi* sp. n., *Reticulatia chitralis* sp. n. and *Magniplicatina johannis* sp. n. have been found in the Kubergandian Lashkargaz Fm., Mb. 4 of the Lashkargaz and Baroghil E section (Gaetani et al., 1995), whereas *Neochonetes costellata* sp. n. is present in both the Mb. 2 and Mb. 4 of the Lashkargaz Fm. *Magniplicatina johannis* sp. n. is also present in the Panjshah Fm., Mb. 1 of Panjshah section. *Retimarginifera gaetanii* sp. n. and *Chapursania tatianae* gen. n. sp. n. occur in the Late Murgabian-Midian Panjshah Fm., Mb. 2 of Panjshah section (Gaetani et al., 1995).

Collections and localities.

All specimens are housed at the Museo di Paleontologia del Dipartimento di Scienze della Terra dell'Università degli Studi di Milano (Italy).

Specimens were found at the following localities (see Gaetani et al., 1995):

KK67, KK68, KK76, KK79, KK88 - Panjshah Fm., Mb. 2, Panjshah section, Chapursan valley.

KK93 - Panjshah Fm., Mb. 1, Panjshah section, Chapursan valley.

CK190, CK189, CK198 - Lashkargaz Fm., Mb. 4, Baroghil E section, Baroghil pass.

CK269, CK365, CK365bis, CK324 - Lashkargaz Fm., Mb. 4, Lashkargaz section, Lashkargaz.

CK315, CK319 - Lashkargaz Fm., Mb. 2, Lashkargaz section, Lashkargaz.

CAL4 - Yarkhun river, Hot Spring, 2 km W of Lashkargaz.

Order **Chonetida** Nalivkin, 1979

Suborder **Chonetidina** Muir-Wood, 1965

Family *Rugosochonetidae* Muir-Wood, 1962

Subfamily *Rugosochonetinae* Muir-Wood, 1962

Genus *Neochonetes* Muir-Wood, 1962

Type-species: *Chonetes dominus* King, 1938

Comments. The relationship of *Neochonetes* with allied genera and the recognition of different subgenera within the genus have been exhaustively discussed by Archbold (1981, 1982).

Archbold (1981) retains *Quadranetes* Sadlick, 1963 as a junior synonym of *Neochonetes*.

Subgenus *Neochonetes (Neochonetes)* Muir-Wood, 1962

Neochonetes (Neochonetes) costellata sp. n.

Fig. 16.1

1925 *Chonetes costata* Stuckenberg var. Reed, p. 38, pl. 3, fig. 6.

Material. 5 Ventral valves: CK189-1; CK190-3; CK319-3; CAL4-11,-75.

2 Dorsal valves: CK198-107; CK319-10bis.

Holotype. CK189-1 (Fig. 16.1).

Type-locality. Baroghil pass, Upper Yarkhun valley, Karakorum, Pakistan.

Type-level. CK189, Lashkargaz Fm., Mb. 4, Kubergandian.

Derivatio nominis. *Costellata* for the characteristic ornamentation of costellae.

Description. Concavo-convex shell with semicircular outline. Maximum width at the hinge line. Cardinal extremities at right angle; ears narrow and bald.

Ventral valve slightly convex. Umbonal slopes diverging at 100° and flattening towards the cardinal margin. Median sulcus absent. Dorsal valve concave.

Ornamentation of bifurcating costellae numbering 2 per mm at a distance of 5 mm from the umbo. The costellae bifurcate firstly at mid-length and a second time near the anterior margin. The intercostal troughs are angular and large as the costellae. Microornamentation of small pustules.

Interior of the ventral valve with a long median septum extending anteriorly to 1/3 the length of the valve.

Dimensions (in mm):

	Width	Length
CAL4-11	17.1	10.5

Discussion. Diagnostic characters of the new species are the long hinge line, the low convexity of the ventral valve, the ventral sulcus low or absent and the ornamentation of costellae. The first three characters indicate that the new species clearly belongs to the subgenus *Neochonetes (Neochonetes)*, whereas its coarse ornamentation is more typical for genera like *Waagenites* Paeckelmann, 1930.

The specimens from Baroghil described by Reed (1925) as *Chonetes costata* Stuckenberg var. are here included in *N. costellata* sp. n. In fact the types of *C. costata* Stuckenberg from the Late Carboniferous of the Russian platform, housed at the V.S.E.G.E.I. in S. Petersbourgh, show smaller dimensions, highly convex ventral valve and a deep median sulcus and may belong to the genus *Waagenites*.

Geographic and stratigraphic distribution. *N. (N) costellata* sp. n. occurs in the Bolorian Lashkargaz Fm., Mb. 2 of Lashkargaz and in the Kubergandian Lashkargaz Fm., Mb. 4 of Yarkhun river (2 km W of Lashkargaz) and of Baroghil Pass.

Order **Productida** Sarycheva & Sokolskaya, 1959

Suborder **Productidina** Waagen, 1883

Superfamily *Productacea* Gray, 1840

Family *Marginiferidae* Stehli, 1954

Genus *Marginifera* Waagen, 1884

Type-species: *Marginifera typica* Waagen, 1884

Comments. The genus *Marginifera* Waagen, 1884 has been revised by Muir-Wood & Cooper (1960) and by Grant (1968). The authors have restricted the definition of the genus to forms characterized by ornamentation of rugae, week costae and spines on the visceral disc and in two or three parallel rows along the flanks of the ventral valve, absent in the dorsal valve.

Marginifera andreai sp. n.

Fig. 16.2

Material. 37 Ventral valves: CK315-A,-6,-10,-14,-16,-21,-22,-25,-27,-30,-35,-36,-39,-40,-42,-44,-67,-72,-79,-84,-85,-86,-92,-103,-108,-112,-116,-117,-130,-131,-132,-134,-136,-137,-139,-140,-141.

5 Dorsal valves: CK315-23,-34,-107,-120,-132bis.

Holotype. CK315-67 (Fig. 16.2).

Type-locality. Lashkargaz, Upper Yarkhun valley, Karakorum, Pakistan.

Type-level. CK315, Lashkargaz Fm., Mb. 2, Bolorian.

Derivatio nominis. *Andreai* from the surname of Andrea Zanchi.

Description. Small sized, concavo-convex shell, with longitudinally oval outline. Hinge line straight, slightly less than the maximum width.

Ventral valve strongly geniculated, with convex visceral disc and long recurved trail. Umbo curved, overhanging the hinge line. Ears convex and triangular. Dorsal valve concave, geniculated, with short trail. Ventral sulcus and dorsal fold absent.

Ornamentation of low, irregular rugae on the visceral disc. Costae rounded, week, bifurcating and numbering 12-14 at the anterior margin. The width of the costae is 0.7-0.8 mm. The intercostal troughs are large. Coarse spines on the visceral disc and in two parallel rows on the ventral flanks. The number of spines for each valve is about 35 in the mature specimens. Dense and sinuous growth lines at the anterior margin.

Interior of the dorsal valve with strong median septum, extending to 2/3 the length of the valve, adductor scars raised on a platform, crenulated marginal ridge and endospines.

Dimensions (in mm):

	Width	Length	Length along the curvature
CK315-A	11.9	12.5	22
CK315-16	12.8	14.1	20.5
CK315-25	10	10.6	19.5
CK315-40	10	10.5	17.5
CK315-67	9.1	12.4	22
CK315-79	11.6	13.5	23
CK315-84	10.5	14.2	25
CK315-103	12.5	14.7	24.5
CK315-108	12.3	14.8	23.9
CK315-116	14	15.1	24
CK315-117	12.5	14.3	22
CK315-23	14.2	11.7	
CK315-107	15.5	13.1	

Discussion. The new species is characterized by longitudinal oval outline, long trail, absence of ventral sulcus, quite defined costae, low rugae and coarse spines.

M. andreai sp. n. is similar to *Marginifera spinosocostata* (Abich, 1878), differing from it by means of the less pointed umbo, absence of a sulcus delimiting the ears, longer trail, better defined costae and for the dimensions and the arrangement of the spines.

The direct study of the collection of Merla (1934), housed at the Museo di Paleontologia, Università di Firenze, has pointed out that the specimens described by Merla (1934) as *Productus typicus elongatus* Huang, 1933 are very similar to *M. andreai* sp. n. but differ from it for the presence of a ventral sulcus and stronger and more numerous costae.

M. andreai sp. n. differs from *Marginifera ovalis* Waagen, 1884 and from *Marginifera protracta* Reed, 1944 from the Salt Range by means of the absence of ventral sulcus; from *Marginifera banphotensis* Yanagida, 1964 from the Permian of Central Thailand, by means of the coarser spines, less numerous costae and longer trail.

Geographic and stratigraphic distribution. *M. andreai* sp. n. occurs in the Bolorian Lashkargaz Fm., Mb. 2 of Lashkargaz.

Genus *Retimarginifera* Waterhouse, 1970

Type-species: *Retimarginifera perforata* Waterhouse, 1970

Comments. The genus *Retimarginifera* Waterhouse, 1970 has been discussed by Grant (1976), Waterhouse (1981) and in details by Archbold (1984).

Retimarginifera differs from *Marginifera* Waagen, 1884 by means of the ornamentation (number and arrangement of spines, reticulation of visceral disc).

Retimarginifera gaetanii sp. n.

Fig. 16.3

Material. 5 Ventral valves: KK79-27,-31; KK88-9,-10,-11.

Holotype. KK79-31 (Fig. 16.3).

Type-locality. Panjshah, Chapursan valley, Upper Hunza valley, Karakorum, Pakistan.

Type-level. KK79, Panjshah Fm., Mb. 2, Late Murgabian-Midian.

Derivatio nominis. *Gaetanii* from the name of Prof. Maurizio Gaetani.

Description. Concavo-convex shell with subquadrate outline. Maximum width at the hinge line.

Ventral valve convex, geniculated with long trail. Umbo swollen; ears flat, triangular and pointed. Median sulcus large and deep starting at a distance of 5-6 mm from the umbo.

Ornamentation of rugae, costae and few spines. The rugae occur on the visceral disc and number about 12-13, producing distinctly reticulate visceral disc. The costae are thin (0.3 mm in width) and numerous, up to 14 for each flank on the ventral valve. The costae converge anteriorly into the median sulcus. The spines are few and occur on the lateral slopes beyond the sulcus and on the ears.

Dimensions (in mm):

	Width	Length
KK79-27	>13	12.7
KK79-31	24	16

Discussion. Diagnostic characters of the new species are the sub-quadrate outline, the thin and numerous costae and the deep ventral sulcus.

Retimarginifera gaetanii sp. n. is similar to *Retimarginifera lapparenti* Termier, Termier, de Lapparent & Marin, 1974 from the Murgabian of Central

Afghanistan (Termier et al., 1974) differing from it by means of the deeper ventral sulcus, less numerous costae and less extended reticulation.

The specimens of *Probolonia himalayensis* (Diener, 1899), described by Grunt & Dmitriev (1973) from the Darvasian of SE Pamir, differs from the new species by means of coarser costae which tend to fasciculate anteriorly.

Geographic and stratigraphic distribution. *R. gaetanii* sp. n. occurs in the Late Murgabian-Midian Panjshah Fm., Mb. 2 of Panjshah (Chapursan valley).

Genus *Transennatia* Waterhouse, 1975

Type-species: *Productus gratiosus* Waagen, 1884

Comments. The genus *Transennatia* has been introduced by Waterhouse (1975) and almost contemporaneously by Grant (1976), who named the new genus *Gratiosina*, recognizing in a note (Grant, 1976, p. 131) its junior synonymy with *Transennatia*. *Asioproductus* Chan, 1977 is also a junior synonym of *Transennatia* Waterhouse, 1975, as stated by Archbold & Bird (1989).

According to Grant (1976) *Transennatia* is placed in the Family Marginiferidae, on the basis of the internal characters. The inclusion of *Transennatia* in the Family Dictyoclostidae, as suggested by Archbold & Bird (1989) is not accepted, the only dictyoclostide feature of *Transennatia* being the semireticulate ornamentation.

Transennatia differs from *Retimarginifera* Waterhouse, 1970 by means of its less transverse outline, smaller ears, stronger costae, reticulated pattern of sharp points on the visceral disc and raised adductor platform in the ventral valve.

Transennatia reedi sp. n.

Fig. 16.4

1925 *Productus* aff. *tartaricus* - Reed, p. 31, pl. 3, fig. 9.

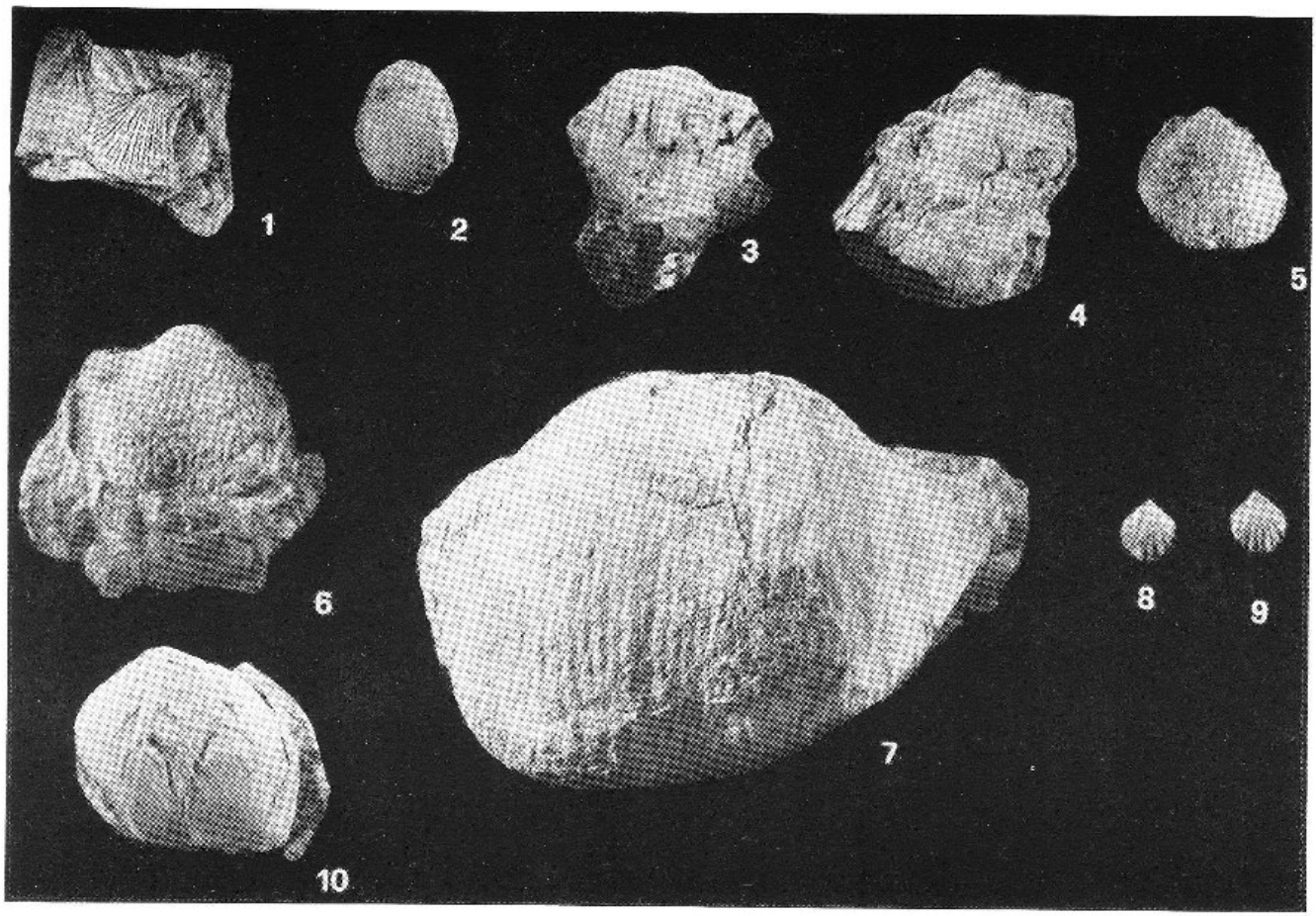


Fig. 16 - 1) *Neochonetes costellata* sp. n. Holotype. Ventral valve. Specimen CK189-1. 2) *Marginifera andreai* sp. n. Holotype. Ventral valve. Specimen CK315-67; X 1.5. 3) *Retimarginifera gaetanii* sp. n. Holotype. Ventral valve. Specimen KK79-31. 4) *Transennatia reedi* sp. n. Holotype. Dorsal valve. Specimen CK324-43. 5) *Magniplicatina johannis* sp. n. Holotype. Ventral valve. Specimen CK365-14. 6) *Waagenoconcha (Gruntoconcha) macrotuberculata* sp. n. Holotype. Ventral valve. Specimen CK365bis-12. 7) *Reticulatia chitralis* sp. n. Holotype. Ventral valve. Specimen CK269-10. 8) *Aldina exilis* sp. n. Holotype. Dorsal valve. Specimen CK319-34. 9) *Aldina exilis* sp. n. Holotype. Ventral valve. Specimen CK319-34. 10) *Chapursania tatianae* sp. n. Holotype. Ventral valve internal mould. Specimen KK67-19.

Material. 41 Ventral valves: CK324-1,-2,-3,-4,-5,-6,-7,-8,-9,-10,-11,-12,-13,-14,-15,-16,-17,-18,-19,-20,-21,-22,-23,-24,-25,-26,-27,-28,-29,-30,-31,-32,-33,-34,-35,-36,-37,-38,-39,-40,-41.

17 Dorsal valves: CK324-42,-43,-44,-45,-46,-47,-48,-49,-50,-51,-52,-53,-54,-55,-56,-57,-58.

Holotype. CK324-43 (Fig. 16.4).

Type-locality. Lashkargaz, Upper Yarkhun valley, Karakorum, Pakistan.

Type-level. CK324, Lashkargaz Fm., Mb. 4, Kubergandian.

Derivatio nominis. *Reedi* from the name of F.R.C. Reed.

Description. Medium sized, concavo-convex geniculated shell. Maximum width at the anterior margin.

Ventral valve geniculated, with convex visceral disc and long, longitudinally recurved trail. Umbo recurved, slightly overhanging the interarea. Ears small and flat, not distinct from the lateral slopes. Median sulcus deep and narrow with flat bottom. The lateral slopes beyond the sulcus are very convex. Dorsal valve geniculated, with concave visceral disc and short trail. Median fold narrow, distinct on the trail.

Ornamentation of the ventral valve of costae, rugae and spines. The rugae are thin and occur on the visceral disc, crossing the costae and producing a reticulated pattern. The costae bifurcate near the umbo giving origin to 2 costae within the sulcus, which become faint anteriorly, to 7-8 costae, 0.6-0.8 mm wide, on each flank of the valve and to 4-5 low lateral costae, which tend to recurve posteriorly towards the cardinal margin. The scars of attachment of the spines are numerous and occur on the trail and on the visceral disc. Ornamentation of the dorsal valve reticulated on visceral disc and costate on the trail.

Interior of the dorsal valve with bilobed "W" shaped cardinal process; raised, pear-shaped adductor pads; median septum extending over mid-length of visceral disc; marginal ridges extending sligthly anteriorly to the cardinal extremities.

Dimensions (in mm):

	Width	Length
CK324-15	19.1	16
CK324-21	18.4	16.2
CK324-23	18.5	17.2
CK324-28	18	17.2
CK324-31	19.3	15.5
CK324-34	21.2	16
CK324-37	18.7	16.2
CK324-42	19.4	13.5
CK324-43	18.5	12.7
CK324-44	18.2	13.7
CK324-49	21.9	15

Discussion. Diagnostic characters of the new species are the coarse costae which do not converge into the sulcus and the deep, uniformly wide ventral sulcus.

T. reedi sp. n. differs from *Transennatia gratiosa* (Waagen, 1884) from the Salt Range by means of its convex visceral disc, deeper sulcus, coarser costae not converging into the sulcus and less strongly reticulated visceral disc. *Transennatia insculpta* (Grant, 1976) from Thailand differs from the new species by its smaller dimensions, more transverse outline, fewer spines, costae increasing in width anteriorly and converging into the sulcus and sharper reticulation on the visceral disc.

The specimens from Baroghil described by Reed (1925) as *Productus* aff. *tartaricus* Tschernyschew, 1902 are included in *T. reedi* sp. n.

Geographic and stratigraphic distribution. *T. reedi* sp. n. occurs in the Kubergandian Lashkargaz Fm., Mb. 4 of Lashkargaz.

Family *Waagenoconchidae* Muir-Wood & Cooper, 1960

Genus *Waagenoconcha* Chao, 1927

Type-species: *Productus humboldti* d'Orbigny, 1842

Comments. The genus *Waagenoconcha* Chao, 1927 and its splitting in two subgenera have been fully discussed by Archbold (1993).

Subgenus *Waagenoconcha (Gruntoconcha)* subgen. n.

Type-species: *Waagenoconcha (Gruntoconcha) macrotuberculata* sp. n.

Derivatio nominis: *Gruntoconcha* from the name of Dr. T.A. Grunt.

Diagnosis. Medium sized *Waagenoconcha*, with short trail and coarse, elongate spine bases which decrease in dimensions anteriorly.

Discussion. The new subgenus differs from *Waagenoconcha (Waagenoconcha)* Chao, 1927 by means of coarser and less elongate spine bases; from *Waagenoconcha (Wimanoconcha)* Waterhouse, 1983 by its smaller dimensions, shorter trail and absence of radial crenulations on the ventral trail.

Composition of the subgenus. *Waagenoconcha (Gruntoconcha)* subgen. n. includes the species *Waagenoconcha* (*G.*) *abichi* (Waagen, 1884) and *W.* (*G.*) *macrotuberculata* sp. n.

Waagenoconcha (Gruntoconcha) macrotuberculata sp. n.

Fig. 16.6

1934 *Productus abichi* - Merla, p. 263

1940 *Productus (Waagenoconcha) abichi* - Renz, p. 161, pl.4, fig. 6.

Material. 1 Complete specimen: CK365-6.

20 Ventral valves: CK189-18; CK198-3,-111,-112; CK365-1,-11,-16,-19,-22; CK365bis-12,-17; CAL4-33,-34,-74,-83,-88,-89,-93,-97,-98.

8 Dorsal valves: CK189-20; CK198-28,-36,-107,-109; CK365-2,-17; CAL4-87.

Holotype. CK365 bis-12 (Fig. 16.6).

Type-locality. Lashkargaz, Upper Yarkhun valley, Karakorum, Pakistan.

Type-level. CK365, Lashkargaz Fm., Mb. 4, Kubergandian.

Derivatio nominis. *Macrotuberculata* from the greek macros=large and from the latin tuberculum=tubercle (base of spine).

Description. Concavo-convex shell. Hinge line straight, less than maximum width, which lies at mid-length.

Ventral valve uniformly convex; umbo large, slightly incurved; ears small and flat, distinct from the lateral sloped which are steep. Median sulcus low, starting anteriorly from the umbonal region. Dorsal valve concave, showing a slight geniculation at the anterior margin; ears large and flat; median fold low.

Ornamentation of coarse spine bases, resembling tubercles, showing a quincunxial, sometimes irregular arrangement. The spine bases are 0.6-0.8 mm wide and oval-shaped. They decrease in width anteriorly to 0.4 mm. Low growth rugae occur anteriorly, whereas sinuous growth lines cover all the surface of the valves.

Interior of dorsal valve with marginal ridges and median septum.

Dimensions (in mm):

	Width	Length
CK189-18	31	26.7
CK198-3	29.1	25
CK365-16	30.6	25.7
CK365bis-12	24.8	21.7
CAL4-74	23.1	20.3
CAL4-83	40.5	30.3
CAL4-88	35	30
CAL4-98	24.6	20
CK198-28	33	27.3
CK365-2	33.6	22.6
CAL4-87	33.8	25.1

Discussion. Diagnostic characters of the new species are the slightly prominent umbo, very steep ventral flanks, low ventral sulcus, coarse spine bases showing oval outline, low growth rugae.

After having studied the topotypes of *Waagenoconcha (Gruntoconcha) abichi* (Waagen, 1884) from the Salt Range, housed at the V.S.E.G.E.I. of S. Petersbourgh, I can affirm that it is similar to *W. (G.) macrotuberculata* sp. n., but differs from it by the more swollen umbo, less steep ventral flanks, less coarse and more regularly arranged spine bases. Furthermore *W. (G.) macrotuberculata* sp. n. does not show the two rounded folds separating the ears from the visceral disc in the dorsal valve, described by Waagen (1884, p. 698) and illustrated by Muir-wood & Cooper (1960, pl. 89, fig. 4) for *W. (G.) abichi* (Waagen).

The specimens described by Merla (1934) as *Productus abichi* Waagen, housed at the Museo di Paleontologia, Università di Firenze, consist of two external casts of dorsal valves and of one fragment of ventral valve and seem to belong to *W. (G.) macrotuberculata* sp. n. Also the specimens from Shaksgam described by Renz (1940) as *Productus (Waagenoconcha) abichi* Waagen may be included in *W. (G.) macrotuberculata* sp. n.

The specimen from Shaksgam, described by Fantini Sestini (1965b, p. 184) as *W.* cf. *abichi* (Waagen) may belong to *W. (G.) macrotuberculata* sp. n. for the steepness of its ventral flanks. However the bases of spines are not preserved, preventing a specific determination.

On the contrary the specimen described by Termier et al. (1974) as *W. abichi* is characterized by very fine spine bases, being very different from the species from Karakorum.

Geographic and stratigraphic distribution. *W. (G.) macrotuberculata* sp. n. occurs in the Permian of NE Karakorum (Merla, 1934) and in Shaksgam (Renz, 1940).

In Western Karakorum it is present in the Kubergandian Lashkargaz Fm., Mb. 4 of Baroghil-Lashkargaz area.

Family *Dictyoclostidae* Stehli, 1954

Subfamily *Dictyoclostinae* Stehli, 1954

Genus *Reticulatia* Muir-Wood & Cooper, 1960

Type-species: *Productus huecoensis* King, 1831

Comments. *Reticulatia* Muir-Wood & Cooper, 1960 differs from *Callytharrella* Archbold, 1985 by means of the absence of costae on the ears, no fasciculation of costae on the trail, presence of a marginal ridge in the brachial valve and anteriorly bilobed cardinal process.

Reticulatia chitralis sp. n.

Fig. 16.7

1925 *Productus transversalis* - Reed, p. 33, pl.4, fig. 8; pl.5, fig. 1, 2.
1932 *Productus transversalis* - De Terra, p. 161, pl.13, fig. 13.
1932 *Productus semireticulatus* - De Terra, p. 161, pl.14, fig. 4.
1940 *Productus semireticulatus* - Renz, pp. 21, 144, pl.2, fig. 8.
1940 *Productus semireticulatus* var. *transversalis* - Renz, pp. 22, 145.
1965b *Reticulatia* cf. *transversalis* - Fantini Sestini, p. 188, pl. 22, fig. 4.

Material. 35 Ventral valves: CK189-13,-38,-41,-45; CK269-0,-5,-10,-11,-12,-14,-15,-17,-24,-27,-29,-30,-32; CAL4-1,-5,-6,-19,-20,-35,-39,-40,-45,-48,-49,-53,-54,-55,-69,-83,-84,-85.

21 Dorsal valves: CK189-33,-39,-154; CK269-1,-2,-6,-13,-22,-25,-26,-28,-31; CAL4-17,-21,-22,-31,-51,-59,-71,-73,-81.

Holotype. CK269-10 (Fig. 16.7).

Type-locality. Lashkargaz, Upper Yarkhun valley, Karakorum, Pakistan.

Type-level. CK269, Lashkargaz Fm., Mb. 4, Kubergandian.

Derivatio nominis. *Chitralis* from the geographic region of Chitral.

Description. Large-sized, concavo-convex, strongly geniculated shell with transverse outline. Maximum width at the hinge-line.

Ventral valve with convex visceral disc and long, spirally enrolled trail. Umbo large and recurved on a concave ginglymus. Ears triangular, slightly recurved, demarcated by a curve cut line. Lateral flanks steep. Median sulcus very low or absent. Dorsal valve concave, geniculated with transverse outline. Visceral disc long, flat or concave; trail quite long. Median fold very low or absent.

Ornamentation of costae, rugae and spines. The rugae occur on the ears and on the visceral disc, where, crossing the costae, they produce a reticolated ornamentation. The costae are thin (1.5-2.5 mm wide at the anterior margin), rounded, bifurcating anteriorly. The intercostal troughs are narrower than the costae. The costae are lacking on the ears. The spines are long and hollow, with 1.6-2 mm diameter; they occur on the ears and along the cardinal margin and rarely on the trail. Growth lamellae occur anteriorly.

Interior of the ventral valve with large striated adductor scars. Interior of dorsal valve with high trilobed, anteriorly bilobed cardinal process; short lateral ridge; median septum thinning anteriorly and extending to 2/3 the length of visceral disc.

Dimensions (in mm):

	Width	Length	l (d.v.)	l(t)	Thickness
CK269-10	84.3	>52			33
CK269-12	>67	>70			26
CK269-29	66	40			30.5
CK269-30	69.2	57			37
CAL4-5	>57	63			29
CAL4-20	80	57			37
CAL4-40	61	52			27.3
CAL4-48	60	60			26
CAL4-53	57	>48			31
CAL4-69	>61.5	71			37
CK269-1	69.5		31	38	
CK269-2	67		29	30.5	
CK269-13	>76		28.7	32	
CK269-31	>72		31.5	>21	
CAL4-17	69.8		38.5	31	
CAL4-22	>82		33	32	
CAL4-31	55		24	>22	
CAL4-51	66.8	40.4	33	30.8	
CAL4-71	>58		24	>23	
CAL4-73	65	45.7	31.8	25	
CAL4-81	61		38		

l (d.v.) : visceral disc length.
l (t) : dorsal trail length.

Intraspecific variability. Inside the population a few specimens show a more longitudinally elongated ventral valve with low and narrow sulcus, thus differing from the more transverse individuals without ventral sulcus.

Discussion. *Reticulatia chitralis* sp. n. differs from the Uralian specie *R. transversalis* (Tschernyschew, 1902) by its larger dimensions, shallower sulcus and finer ornamentation. The specimens from KunLun described by De Terra (1932) as *P. transversalis* Tschernyschew and those from Shaksgam described by Renz (1939, 1940) as *P. semireticulatus* and *P. s. transversalis* may belong to *R. chitralis* sp. n. The same is true for the Shaksgam specimens described by Fantini Sestini (1965b) as *R.* cf. *transversalis*.

The longitudinally elongated specimens of *R. chitralis* sp. n. are very similar to the specimens described by De Terra (1932) for KunLun and Renz (1939, 1940) for Shaksgam as *P. semireticulatus* Martin, 1809. The latter has been largely used to include a variety of forms characterized by large dimensions and reticulated ornamentation, thus loosing taxonomic validity. Also *P. semireticulatus* Martin described by Broili (1916, p. 8, pl.2, fig. 14-16) for the Permian of Timor could belong to *R. chitralis* sp. n. The specimen described by Merla (1934) as *P. semireticulatus* is an undeterminable fragment of shell.

R. chitralis sp. n. differs from *R. pamirica* Grunt, 1973 from the Sakmarian of SE Pamir by means of the maximum width at the hinge line, less enrolled ears, shallower sulcus, coarser and less spaced ornamentation.

Geographic and stratigraphic distribution. *R. chitralis* sp. n. occurs in the Permian of KunLun (De Terra, 1932) and of Shaksgam (Renz, 1939; Fantini Sestini, 1965b).

In Western Karakorum it is present in the Kubergandian Lashkargaz Fm., Mb. 4 of Baroghil-Lashkargaz area.

Superfamily *Linoproductacea* Stehli, 1954

Family *Linoproductidae* Stehli, 1954

Subfamily *Auriculispininae* Waterhouse, 1986

Genus *Magniplicatina* Waterhouse, 1983

Type-species: *Cancrinella magniplica* Campbell, 1953

Comments. *Magniplicatina* Waterhouse, 1983 differs from *Cancrinella* Fredericks, 1928 by means of less convex visceral disc, shorter and less enrolled trail, stronger rugae, coarser spines which are totally lacking on the dorsal valve (Grigorieva et al., 1977; Archbold, 1993).

Magniplicatina johannis sp. n.

Fig. 16.5

1925 *Productus cancriniformis* - Reed, p. 24, pl. 5, fig. 7, 8.
1939 *Productus cancriniformis* - Renz, p.18, pl. 3, fig. 6, 7.
1965b *Cancrinella cancriniformis* - Fantini Sestini, p. 190.

Material. 1 Complete specimen: KK93-79.

17 Ventral valves: KK93-14,-25,-53,-88; CK189-26,-53; CK 269-8; CK365-3,-14,-15; CK365bis-5,-7,-8,-15,-16; CAL4-29,-60.

5 Dorsal valves: CK189-112,-126; CK365-12,-21; CK365bis-4.

Holotype. CK365-14 (Fig. 16.5).

Type-locality. Lashkargaz, Upper Yarkhun valley, Karakorum, Pakistan.

Type-level. CK365, Lashkargaz Fm., Mb. 4, Kubergandian.

Derivatio nominis. *Johannis* from the surname of Giovanni Angiolini.

Description. Medium sized, concavo-convex shell with transverse outline. Maximum width anterior to the hinge line.

Ventral valve convex with sub-triangular outline. Umbo swollen, pointed and recurved. Ears quite large and flat. Dorsal valve concave, geniculated, with sub-circular outline.

Ornamentation of ventral valve with rugae, costellae and spines. The rugae are coarse (1-1.3 mm in width), prominent and irregular on the trail and number 15-16 for each valve. In the mature specimens the width of the rugae is up to 1.7 mm. The costellae are thin and numbers 9-12 per 5 mm at the anterior margin. The spines are recumbent with distinct elongated spine ridges, 1.3-1.6 mm long. The diameter of spines is about 0.4 mm. The spines are extended posteriorly as thin channels inside the shell substance for 3 mm. Ornamentation of dorsal valve finer, without spines, rarely with dimples.

Interior of dorsal valve with sessile, bilobed cardinal process, with diverging lobes; median septum low, extending to 2/3 the length of visceral disc

Dimensions (in mm):

	Width	Length	Thickness
KK93-14		29	
KK93-88	27	26	
CK269-8	23	22	
CK365-14	20	19.2	10.6
CK365bis-15	21.9	17.6	8.7
CAL4-60	24.3	16	
CK189-112	16.4	11.2	
CK189-126	13.1	11.9	
CK365-12	25.5	15	

Discussion. Diagnostic characters of the new species are the elongated spine ridges, prominent and irregular rugae and not numerous costellae.

Cancrinella cancriniformis (Tschernyschew, 1889) as described by Renz (1939) and by Fantini Sestini (1965b) for the Permian of Shaksgam seems to belong to *Magniplicatina johannis* sp. n.

The specimens figured by Termier et al. (1974) in pl. 27, fig. 7, 8 and described by the authors as *Permundaria sisophonensis* Nakamura, Kato & Choi, 1970 may belong to *Magniplicatina johannis* sp. n. for their convex ventral valve and ornamentation of costellae and spines ridges.

Geographic and stratigraphic distribution. *M. johannis* sp. n. occurs in the Permian of Shaksgam (Renz, 1939; Fantini Sestini, 1965b).

In Western and Central Karakorum it is present in the Kubergandian Lashkargaz Fm., Mb. 4 of Baroghil-Lashkargaz area and in the Kubergandian Panjshah Fm., Mb. 1 of Chapursan valley.

Order Rhynchonellida Kuhn, 1949

Superfamily *Rhynchonellacea* Gray, 1848

Family *Allorhynchidae* Cooper & Grant, 1976

Genus *Aldina* gen. n.

Type-species: *Aldina exilis* sp. n.

Derivatio nominis: *Aldina* from the surname of Prof. Alda Nicora.

Diagnosis. Small sized, globular shell with sub-triangular to sub-pentagonal outline. Anterior commissure strongly uniplicate. Ventral valve with strongly recurved umbo; delthyrium closed by deltidial plates delimiting a small foramen. Ornamentation of costae in the anterior half of the valves. Interior of ventral valve with long dental plates. Interior of dorsal valve with flat, divided hinge plate; median septum absent.

Discussion. The new genus is here included in the Family Allorhynchidae on the basis of its internal characters (i.e. dental plates in the ventral valve and divided hinge plate in the dorsal valve).

Aldina gen. n. differs from *Hemileurus* Cooper & Grant, 1976 by the absence of socket ridges, the flat hinge plate, the strongly plicate anterior commissure, the more recurved ventral umbo and the ornamentation.

Aldina gen. n. is externally similar to *Gerassimovia* Likharev, 1956 and *Pontisia* Cooper & Grant, 1969 but differs from the first by the presence of dental plates and from the second by the divided hinge plate.

Composition of the genus: *Aldina exilis* sp. n.

Aldina exilis sp. n.

Fig. 16.8, 16.9; Fig. 17

Material. 27 Complete specimens: CK315-29,-46,-63,-93; CK319-25,-26,-27,-30,-32,-33,-34,-35,-36,-37,-38,-39,-40,-41,-42,-43,-44,-46,-47,-48,-49,-50,-56.

Holotype. CK319-34 (Fig. 16.8, 16.9).

Type-locality. Lashkargaz, Upper Yarkhun valley, Karakorum, Pakistan.

Type-level. CK319, Lashkargaz Fm., Mb. 2, Bolorian.

Derivatio nominis. *Exilis* from the latin small.

Description. Small sized, globular shell with sub-triangular to sub-pentagonal outline. Maximum width anterior to mid-length. Anterior commissure strongly uniplicate with trapezoidal outline. Lateral commissure sinuous.

Ventral valve less convex than dorsal valve. Ventral umbo strongly recurved; foramen small. Median sulcus starting at mid-length, projecting as a trapezoidal tongue towards the dorsal valve in the mature specimens. Dorsal valve very convex with a median fold evident at the anterior margin.

Ornamentation of coarse, angular costae starting anteriorly to mid-length. The costae number 2-3 in the ventral sulcus, 3-4 on the dorsal fold and 2-3 on each flank.

Interior of ventral valve with long, sub-parallel dental plates. Interior of dorsal valve with flat, divided hinge plate; median septum absent (Fig. 17).

Dimensions (in mm):

	Width	Length	Thickness
CK315-93	9.7	9.3	7.2
CK319-25	6	6.4	5.6
CK319-26	8.2	8.7	4.5
CK319-27	9.5	8.4	4.8
CK319-32	7	5.9	4
CK319-34	6.8	7.2	4.7
CK319-36	8.4	6.6	6
CK319-38	6.6	5.7	4.5
CK319-39	6.6	6.4	4.6
CK319-41	6	6.4	5.4
CK319-42	6.3	4.9	4.2
CK319-43	5.1	5.8	4.6
CK319-44	6.7	5.2	4.8
CK319-47	6.1	6	4.7
CK319-50	6.1	6.6	4.2
CK319-56	6.8	7	4

Discussion. Diagnostic characters of the new species are the strongly recurved ventral umbo, the trapezoidal ventral tongue and the coarse ornamentation.

Geographic and stratigraphic distribution. *A. exilis* sp. n. is present in the Bolorian Lashkargaz Fm., Mb. 2 of Lashkargaz.

Order Spiriferida Waagen, 1883

Suborder Spiriferidina Waagen, 1883

Superfamily *Reticulariacea* Waagen, 1883

Family *Martiniidae* Waagen, 1883

Genus *Chapursania* gen. n.

Type-species. *Chapursania tatianae* sp. n.

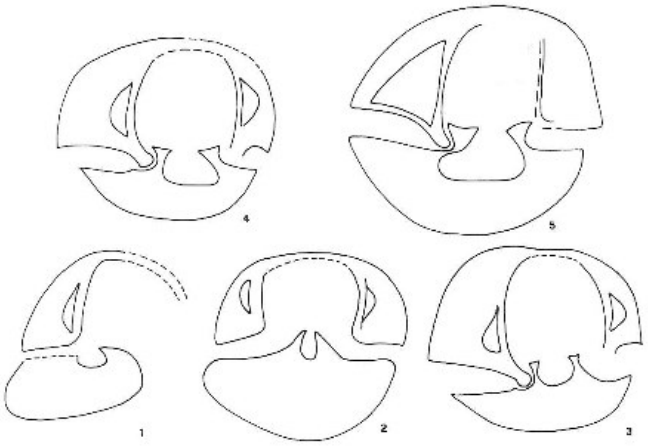


Fig. 17 - Serial sections of *Aldina exilis* sp. n. Specimen CK319-56. 1) Section at 0.9 mm from the umbo; 2) section at 1.1 mm from the umbo; 3) section at 1.3 mm from the umbo; 4) section at 1.6 mm from the umbo; 5) section at 1.8 mm from the umbo.

Derivatio nominis. *Chapursania*, from Chapursan valley, Pakistan.

Diagnosis. Large sized, biconvex shell with distinct fold and sulcus. Hinge line shorter than maximum width. Macro-ornament lacking. Interior of ventral valve lacking apical plates, with large muscle field. Vascular channels coarse, very sinuous, connected by transverse channels.

Discussion. *Chapursania* gen. n. is externally very similar to *Martinia* McCoy, 1844, differing from it for its peculiar vascular system, consisting of sinuous, coarse and connected vascular channels, and for its large muscle field.

Chapursania gen. n. differs from *Tiramnia* Grunt, 1977 which is characterized by arcuate vascular channels and smaller muscle field.

Composition of the genus: *Chapursania tatianae* sp. n.

Chapursania tatianae gen. n.

Fig. 16.10; Fig. 18

Material. 6 Complete specimens: KK67-19,-20,-48,-63; KK79-13,-25.

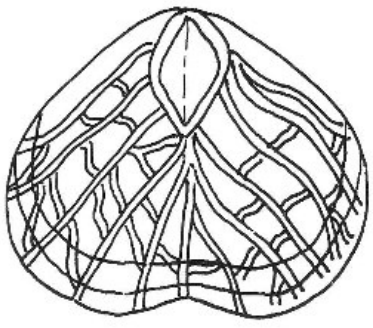


Fig. 18 - Vascular system in the ventral valve of *Chapursania tatianae* sp. n.

9 Ventral valves: KK67-1,-28,-46,-61; KK68-8; KK79-29; KK76-5; KK88-3,-6.

1 Dorsal valve: KK68-1.

Holotype: KK67-19 (Fig. 16.10).

Type-locality. Panjshah, Chapursan valley, Upper Hunza valley, Pakistan.

Type-level. KK67, Panjshah Fm., Mb. 2, Late Murgabian-Midian.

Derivatio nominis. *Tatianae* from the surname of Dr. Tatiana A. Grunt.

Description. Large sized, biconvex shell with transversally sub-elliptical outline. Hinge line short, long as 1/3-1/2 of the maximum width. Cardinal extremities rounded. Maximum width anterior to mid-length and greater than the length of the shell. Anterior commissure strongly uniplicate.

Ventral valve convex, longitudinally recurved with sub-pentagonal to sub-elliptical outline. Umbo pointed, not overhanging the interarea which is triangular, concave, distinct from the lateral flanks. Median sulcus shallow, widening anteriorly, projecting as a tongue into the dorsal valve. The anterior margin results thus raised, forming a ridge higher than the convexity of the dorsal valve. Dorsal valve less convex than the ventral valve, with sub-circular to sub-elliptical outline. Median fold absent.

Shell bald, with growth lamellae becoming sinuous anteriorly.

Interior of ventral valve with coarse sinuous vascular channels which are connected by shorter transverse ones (Fig. 18). The central vascular channel extends inside the sulcus towards the anterior margin. Ventral muscle field large, depressed, rhomboidal in outline, extending to 1/3 the length of the valve.

Dimensions (in mm):

	Width	Length	Thick	Hinge line
KK67-19	29.5	29	23.9	13
KK67-20	41.4	35	27.3	
KK67-63	44.5	36	29	23.4
KK79-13	18	14	9.1	
KK79-25	33.2	25	21.3	13.2
KK67-28	25	20.3	8	
KK79-29	40.5	31.4	11.4	
KK68-1	39	33.7	9	

Ontogenetic variation. The juvenile specimens are characterized by a more transverse outline and by a less enhanced sulcal tongue with respect to the mature ones.

Ultrastructure. The shell resulted almost completely recrystallized. Only locally subrhomboidal secondary layer fibres inclined at large angle to the shell surface have been detected. Depositional banding of fibres has also been observed.

Discussion. Diagnostic characters of the new species are the transversely elongated outline, the sulcal tongue, the absence of the dorsal fold, the large and rhomboidal muscle field and the vascular system.

Externally *Chapursania tatianae* sp. n. is very similar to *Martinia nucula* Rothpletz, 1892, differing from it by the absence of dorsal fold and of fine punctuation of the shell. In any case Rothpletz (1892) did not describe the vascular system. The specimens described as *M. nucula* by Termier et al. (1974) for the Murgabian of Central Afghanistan show straight, fine and radial vascular channels, characteristic of the genus *Martinia*.

Chapursania tatianae sp. n. is also similar to *Martinia subtriquetra* Merla (1934) differing from it only by the more transverse outline, the more longitudinally recurved and convex ventral valve and the more swollen ventral umbo. Unfortunately the vascular system of *M. subtriquetra* is not displayed neither on the specimens of Merla (1934) nor on the specimens described as *M. subtriquetra* by Fantini Sestini (1965b).

Geographic and stratigraphic distribution. *C. tatianae* sp. n. is present in the Late Murgabian-Midian Panjshah Fm., Mb. 2 of Panjshah.

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