NEW RUGOSOCHONETIDAE (BRACHIOPODA) FROM THE UPPER BASHKIRIAN AND MOSCOVIAN OF THE CANTABRIAN MOUNTAINS (N SPAIN)

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ABSTRACT

The Rugosochonetidae are widely spread in the Carboniferous of the Cantabrian Mountains and they have often been described or cited by previous authors. In this paper we present a study of the Rugosochonetidae found in upper Bashkirian and Moscovian (Pennsylvanian) rocks from the Cantabrian Mountains. The diagnosis of the family is modified in order to accommodate forms with a typical rugosochonetid ornamentation but without a dorsal median septum, which are included in the new genus *Riosanetes*, type genus of the new subfamily Riosanetinae. The new species *Riosanetes fernandezi* (type species of the new genus), *Neochonetes (Neochonetes) villamaninensis*, *N. (N.) saenzi, N. (N.) asturianus,* and *N. (N.) babianus* are described. The latter species is based on material previously described by us as *Neochonetes acanthophorus* (Girty, 1934).

Keywords: Brachiopods, chonetids, Rugosochonetidae, Bashkirian, Moscovian, Carboniferous, Cantabrian Mountains, Spain.

RESUMEN

Los chonétidos de la familia Rugosochonetidae están ampliamente difundidos en el Carbonífero de la Cordillera Cantábrica, por lo que han sido descritos o citados frecuentemente en trabajos previos de distintos autores. El presente trabajo se ocupa del estudio de una parte de los rugosochonétidos hallados en rocas del Bashkiriense superior y Moscoviense (Carbonífero superior, Pensilvaniense) de la Cordillera Cantábrica. Este estudio nos ha llevado a modificar la diagnosis de la familia Rugosochonetidae, fundamentalmente para que puedan incluirse en ella los chonétidos con exterior típico para la familia pero sin septo medio dorsal. Para este grupo de Rugosochonetidae se establece la nueva subfamilia Riosanetinae, con el nuevo género *Riosanetes* como género tipo. También se describe la nueva especie *Riosanetes fernandezi*, especie tipo del género, así como las especies *Neochonetes (Neochonetes) villamaninensis*, *N. (N.) saenzi, N. (N.) asturianus* y *N. (N.) babianus* también nuevas. Esta ultima especie se basa sobre material descrito previamente por nosotros como *Neochonetes acanthophorus* (Girty, 1934).

Palabras clave: Braquiópodos, chonétidos, Rugosochonetidae, Bashkiriense, Moscoviense, Carbonífero, Cordillera Cantábrica, España.

INTRODUCTION

The family Rugosochonetidae is with its 50 odd genera the largest family of the superfamily Chonetoidea. The most important of the nine subfamilies included in the Rugosochonetidae by Racheboeuf (1998) is the subfamily Rugosochonetinae with its global distribution and ranging throughout the Carboniferous and Permian. The Rugosochonetidae are well represented in the Carboniferous of the Cantabrian Mts, although at most localities they are few in number of specimens; occasionally, however, they dominate a fauna. In strata of late Bashkirian and Moscovian age, representatives of the following genera were found sofar: *Chonetinella,*

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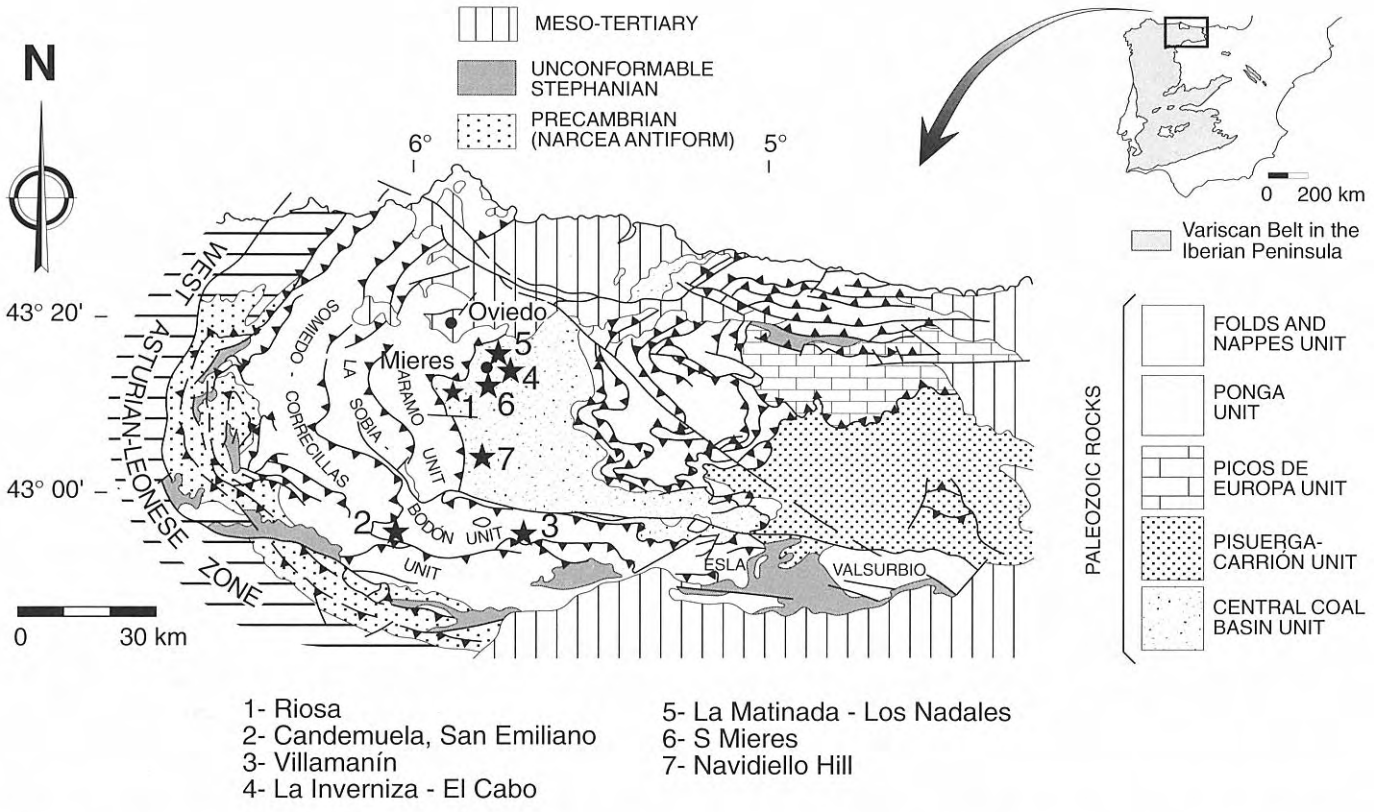


Figure 1. Simplified geological map of the Cantabrian Zone (after Pérez Estaún *et al.*, 1988), showing the collecting localities.

Isochonetes?, Lissochonetes?, Neochonetes, Rugosochonetes, and *Sokolskya* (Barrois, 1882; Delépine, 1943; Winkler Prins, 1968, 1983; van Amerom *et al.*, 1970; Martínez Chacón, 1979, 1990; Wagner *et al.*, 1983; Wagner and Winkler Prins, 1985; Luque *et al.*, 1985; Río García and Martínez Chacón, 1988; Villa *et al.*, 1988; Río García, 1993).

The material described has been collected from upper Baskirian and Moscovian rocks at various localities in Asturias and León (Fig. 1), situated in the Sobia-Bodón Unit (Candemuela Member of the San Emiliano Formation and Villamanín Beds), and in the Central Coal Basin Unit (Canales Formation, and Generalas and San Antonio Beds). The word "Beds" as applied to the Central Coal Basin is used here as a translation of the Spanish word "Paquetes", used by previous authors as an informal lithostratigraphic unit in that area.

Besides, the new species *Neochonetes babianus* is introduced for material from the La Majua Member of the San Emiliano Formation and from the Cuera Limestone previously described by us as *Neochonetes acanthophorus* (Girty, 1934).

The specimens are deposited in the Geology Department of the University of Oviedo (numbers prefixed DPO) and the National Museum of Natural History of The Netherlands at Leiden (numbers prefixed RGM).

SUBORDER CHONETIDINA Muir-Wood, 1955
SUPERFAMILY **CHONETOIDEA** Bronn, 1862
Family **Rugosochonetidae** Muir-Wood, 1962

Emended diagnosis

Shell small to big, costate, costellate, capillate, smooth, or lamellose, plano- to concavo-convex; ventral sulcus absent or variably developed, with a corresponding dorsal fold; spines orthomorph, oblique to perpendicular, symmetrically placed; pseudodeltidium and chilidium normally present. Ventral median septum variably developed, always high in its posterior part. Dorsal interior with a large median septum, except in the new subfamily Riosanetinae, in which it is absent; without accessory septa; anderidia always well developed, anteriorly moderately divergent; cardinal process tetralobed externally and bilobed internally, anteriorly delimited by a cardinal process pit.

Subfamilies included: See Racheboeuf (1998); and Riosanetinae subfam. nov.

Discussion

We have modified the family diagnosis, as developed by Archbold (1982a), Martínez Chacón (1990) and Racheboeuf (1998), to accommodate the new subfamily Riosanetinae without a dorsal median septum, also, to add the costellate ornamentation (in the sense of Williams and Brunton, 1997: shell radially ornamented by costae and costellae; costella is a radial ridge on external surface of shell, which originates later than costae by bifurcation of existing costae or costellae or by intercalation between earlier formed ribs; see also Racheboeuf, 1998), which is very frequent in representatives of this family.

Subfamily **Rugosochonetinae** Muir-Wood, 1962

Diagnosis

Rugosochonetidae with a costate, costellate or capillate external ornamentation; ventral sulcus absent or variably developed, dorsal fold may be present; orthomorph spines normally oblique forming a low to moderate angle with the hinge. Dorsal interior with high median septum; brachial ridges normally well developed.

Genera included: See Racheboeuf (1998).

Neochonetes Muir-Wood, 1962

Type species: *Chonetes dominus* King, 1938; by original designation.

Diagnosis

Small to large rugosochonetids with a weakly to moderately concavo-convex shell, external radial ornamentation costellate, median sulcus weak to strongly developed, orthomorph spines forming a low to moderate angle with the hinge. Ventral interior with prominent median septum; parallel vascular ridges elevated. Dorsal interior with high median septum and brachial ridges; inner socket riges well developed; outer socket ridges may be present.

Discussion

In previous papers by one of us (Martínez Chacón, 1979, 1990), the difficulty of separating the genera *Rugosochonetes* Sokolskaja, 1950 and *Neochonetes* has been discussed, and the Bashkirian and Moscovian species from the Cantabrian Mountains were attributed to *Rugosochonetes*, since the criteria to differentiate the two genera were not clear and *Rugosochonetes* has priority. In the present paper we use as criteria to differentiate between the two genera the development of a pair of strong, parallel vascular ridges in the interior of the ventral valve of *Neochonetes*, which are absent or very weakly developed in *Rugosochonetes*; although, as already observed, the degree of development of the vascular ridges depends on the age of the individual, and their presence has been mentioned in species included in both genera (Martínez Chacón, 1990: 96). Therefore, if one admits these criteria as distinctive between both genera (as indicated by Archbold, 1981 and Racheboeuf, 1998), some species with strong vascular ridges have to be excluded from *Rugosochonetes*, e.g. *R. hindi* Muir-Wood, 1962 and *R. distinctus* Afanasjeva, 1976.

Neochonetes (Neochonetes) Muir-Wood, 1962

Discussion

The subgenus *Neochonetes (Sommeriella)* Archbold, 1982b [= *N. (Sommeria)* Archbold, 1981] was established for forms with an interior like *N. (Neochonetes)* and an exterior with a well developed ventral sulcus and dorsal fold, a more convex ventral valve, cardinal spines forming an angle of 40-45° with the hinge and maximum width situated anterior of the hinge. The *Neochonetes* species from the upper Bashkirian and Moscovian of the Cantabrian Mts are included in the subgenus *N. (Neochonetes).*

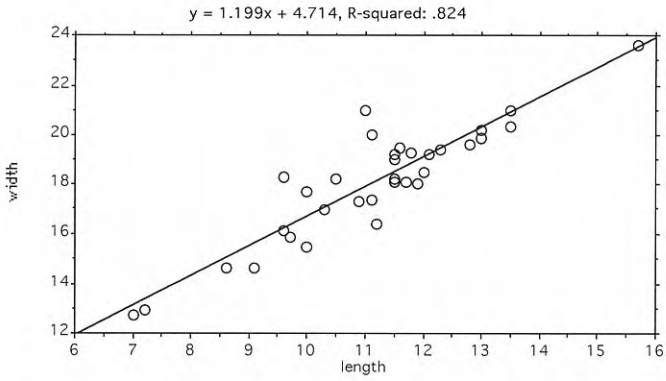


Figure 2. Length-width diagram of *Neochonetes (Neochonetes) villamaninensis* sp. nov.

Archbold (1981) described two lineages (stocks) within the subgenus *Neochonetes (Neochonetes)*, one based on *N. (N.) granulifer* (Owen, 1852) and including a.o. the type species *Chonetes dominus*, the other based on *N. (N.) carboniferus* (Keyserling, 1846) and including a.o. *Neochonetes acanthophorus* of Winkler Prins (1968). Whilst studying the differences between both groups, we found that in the first group the costulation is more weakly developed, the costulae often becoming obsolete towards the anterior margin. Since Archbold (1981: 111) did not list *Neochonetes acanthophorus* (Girty, 1934) with either stock, we studied the description of *Chonetes granulifer* var. *armatus* Girty, 1911 by Dunbar and Condra, 1932 more carefully and realised that its ornamentation was quite different from our Spanish material and that it belonged to the other group, thus forcing us to create a new species for our Spanish material: *N. (N.) babianus* sp. nov. (see below). Our new species *N. (N.) villamaninensis* and *N. (N.) saenzi* belong in our view to the lineage of *N. (N.) granulifer*, whilst *N. (N.) asturianus* and *N. (N.) babianus* belong to the lineage of *N. (N.) carboniferus*.

Neochonetes (Neochonetes) villamaninensis sp. nov.

Figs. 2-3

1983 Rugosochonetes acutus (Demanet, 1938); Winkler Prins, in Wagner *et al.*, fig. 17.
1988 Rugosochonetes n. sp. 1; Villa *et al.*, 339.

Derivatio nominis: The species is named after Villamanín (León), the area from which the material originates.

Locus typicus and stratum typicum

Railway cutting S of Villanueva de la Tercia (León), at 2-3 m S of km 48 (Fig. 1) (2-3 m above a bed with *Diplocraterion).* Sandstone layer in the Villamanín Beds of Early Moscovian (late Vereisky) age (Moore *et al.*, 1971; Wagner *et al.*, 1983, figs. 13-17; Villa *et al.*, 1988).

Material

Holotype, DPO 38058, internal moulds of ventral and dorsal valves united at the hinge (Fig. 3a) and many other specimens from the type locality and horizon (DPO 38059-38080, 38095-38107; RGM 292504-292508, 292517-292578), some with the shell preserved but the majority are external or internal moulds of one or the other valve.

Some 30 specimens, largely moulds but again some with the shell preserved (DPO 38081-38094), from sample T-296, W of Candemuela (León), mudstone 100 m below the top of the Candemuela Member of the San Emiliano Formation (Carballeira *et al.*, 1985), Early Moscovian in age.

Diagnosis

Neochonetes (Neochonetes) of the lineage of *N. (N.) granulifer* with a transverse shell of rounded subrectangular shape, hinge line equal to the greatest width or nearly so; sulcus inappreciable; flat to very weakly concave dorsal valve; ornamentation of weak costae and costulae, 5-6 per mm at the anterior margin. Near the internal border of the ventral valve the tubercles are numerous and form a kind of rim.

Description

Shell of small to medium size [L = 7.0-15.7 mm (medium 11.1), W = 12.7-23.6 mm (medium 18.0); dimensions of holotype: L = 11.7 mm, Ld = 10.8 mm, W = 18.0 mm; Fig. 2], plano-convex to very weakly concavo-convex, transverse (L/W = c. 0.6), of rounded subrectangular shape, with rounded cardinal extremities and the maximum width at the hinge or just in front of it. No sulcus or fold.

Ventral valve weakly and uniformly convex, with umbo hardly protruding. On both sides of the umbo at least 7 spine bases, the farthest away forming an angle of 50-60° with the hinge. Costellate ornamentation with weak, fine costae and costellae, partly disappearing towards the front, with a density of 5-6 per mm; they are absent on the ears; on the anterior third of the valve growth lamellae appear which are densely stacked near the border.

Dorsal valve practically flat with a similar ornamentation.

Ventral valve interior with a very high median septum in its posterior part between the adductor scars, continuing in front of them as a low ridge at least to mid length but occasionally reaching the anterior margin. Adductor scars small and oval, clearly impressed; the diductor scars are large flabelliform and poorly defined, they can be recognised by the absence of tubercles. In front of the adductors originate a pair of strong vascular ridges, parallel to the median septum, which continue almost to the anterior margin. The internal surface, apart from the muscle scars, is covered with radially arranged rows of tubercles; these are stronger in the posterolateral regions and are densely packed near the front, forming an elevated rim.

Interior of dorsal valve with bilobed cardinal process (externally tetralobate), separated from the median septum by a cardinal process pit. The septum is strong and rather long, more than half the valve length; at its anterior end normally two parallel rows of 2-3 elevated, thick tubercles occur. Anderidia short, finer and lower than the median septum, diverging at an angle of 30-45°. Adductor scars poorly defined. Inner socket ridges elevated, forming an angle of 20° with the hinge; outer socket ridges also developed. Brachial ridges prominent, with stronger tubercles than the remainder of the valve. Internal surface, apart from the posterior central part, covered with radially arranged rows of tubercles.

Comparison

The new species resembles the type species in its shape, dimensions and internal characteristics; it is differentiated from it by its less convex ventral valve and flat dorsal valve.

From *Rugosochonetes acutus* (Demanet, in Demanet and van Straelen, 1938), which can be externally rather similar (see also Winkler Prins, 1968) and to which part of the material was originally referred by one of us (C.F.W.P.), it is distinguished by its stronger developed internal structures and the flatter dorsal valve.

A comparison with the new species *N. (N.) saenzi, N. (N.) asturianus* and *N. (N.) babianus* follows below at the descriptions of those species.

Distribution

The species is only known from the upper part of the Candamuela Member of the San Emiliano Formation and the Villamanín Beds, both of Vereisky age.

Neochonetes (Neochonetes) saenzi sp. nov.

Figs. 4-5

±*1985 Rugosochonetes* cf. *dalmanoides*; Luque *et al.*, 294 (pars).

Derivatio nominis: The species is dedicated to José Antonio Sáenz de Santa María, geologist of HUNOSA, who knows the geology of the Central Coal Basin very well and who sampled the La Matinada-Los Nadales and La Inverniza-El Cabo sections.

Locus typicus and stratum typicum

La Matinada-Los Nadales section at some 4 km NE of Mieres, on the road from Mieres to Sama at the Santo Emilano Hill, Central Coal Basin (Fig. 1). Generalas Beds, gray mudstone, sample N13,M16, at 65 m above the base of the beds, i.e. above the La Torala Limestone (Leyva and Gervilla, 1983; Luque *et al.*, 1985).

Material

Holotype (DPO 38146) incomplete specimen with both valves (Fig. 5a) and five other specimens from the type locality and horizon (DPO 38145, 38147), all with the shell preserved.

From the same section and also from the Generalas Beds, sample N-13,M-13 are some 10 specimens (DPO 38139-38144, 38153-38154) and from sample N-13,M-17, 5 specimens (DPO 38148-38152); most of these specimens have their shell preserved but some are moulds.

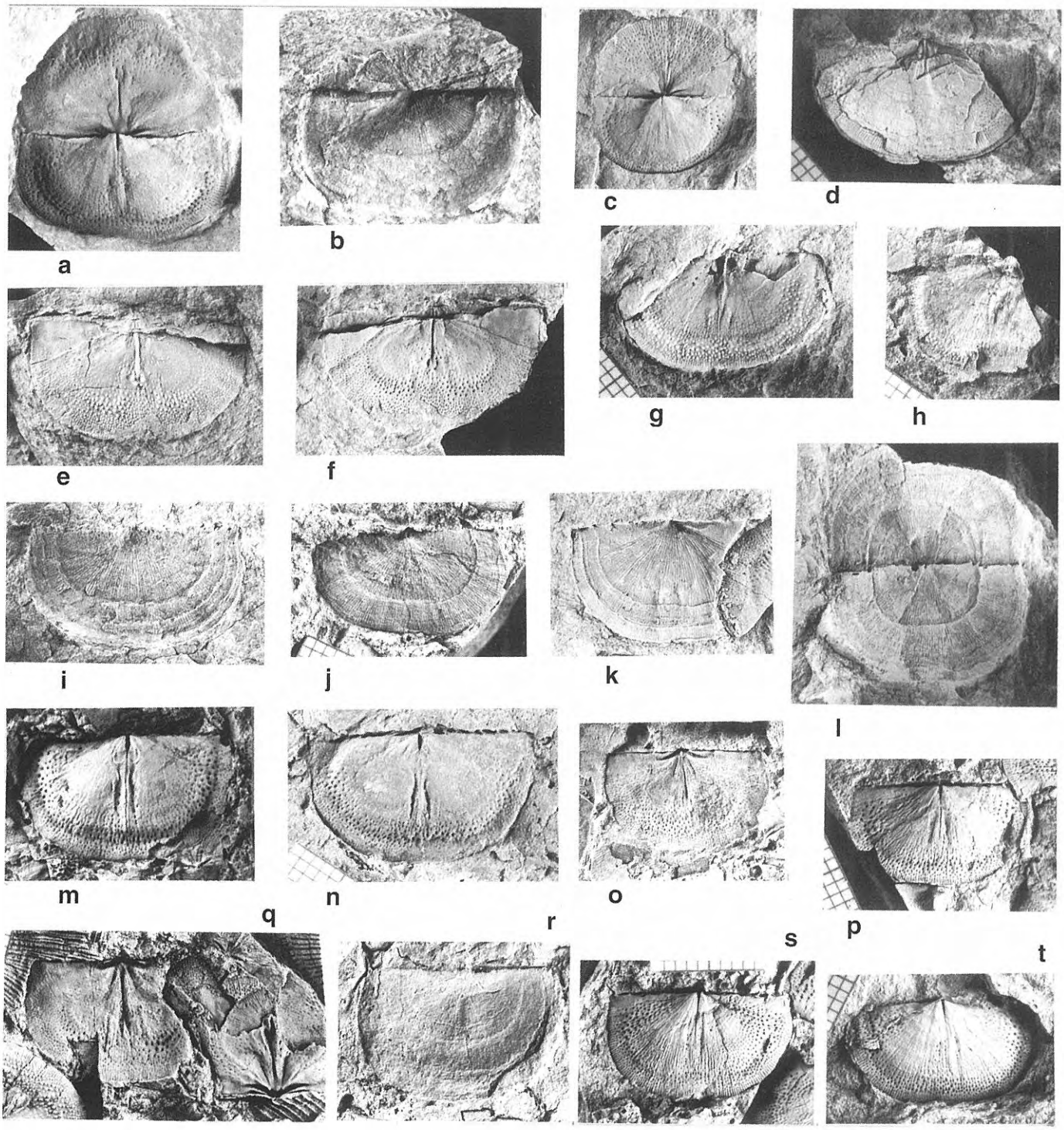


Figure 3. *Neochonetes (Neochonetes) villamaninensis* sp. nov., railway cutting S of Villanueva de la Tercia (León), Villamanín Beds; all x 2. **a**. Holotype, DPO 38058, internal mould of both valves united at the hinge. **b**. DPO 38059, external mould of both valves united at the hinge; the dorsal one is incomplete. **c**. DPO 38060, juvenile specimen, internal mould of both valves united at the hinge. **d**. DPO 38061, damaged specimen, in ventral view, showing part of the dorsal interior and of the external moulds of the dorsal and ventral valves. **e-f.** DPO 38062, dorsal interior with part of the ventral valve preserved and mould of the same specimen. **g**. DPO 38063, ventral interior. **h**. DPO 38075, fragmentary ventral interior. **i**. DPO 38073, external mould of ventral valve. **j**. DPO 38068, external mould of dorsal valve. **k**. DPO 38074, external mould of incomplete ventral valve. **l**. DPO 38072, external mould of both valves united at the hinge. **m**. DPO 38079, internal mould of ventral valve. **n**. DPO 38076, internal mould of ventral valve. **o**. DPO 38080, internal mould of dorsal valve. **p**. DPO 38066, internal mould of ventral valve. **q.** internal moulds of dorsal valves, DPO 38070 (at left) and DPO 38071 (incomplete, at right). **r**. DPO38077, external mould of dorsal valve. **s.** DPO 38065, internal mould of ventral valve. **t**. DPO 38064, internal mould of ventral valve.

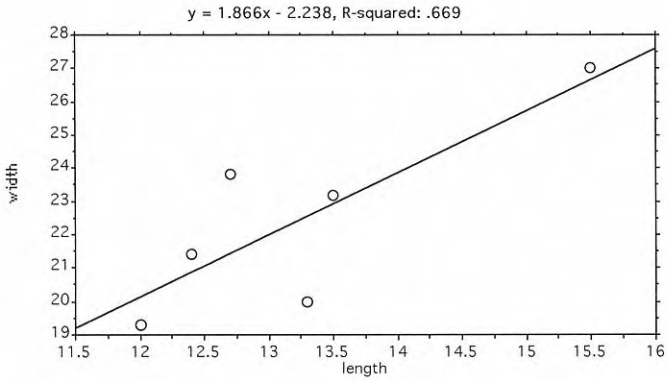


Figure 4. Length-width diagram of *Neochonetes (Neochonetes) saenzi* sp. nov.

About 10 moulds (some with a small part of the shell preserved) (DPO 38135-38138) from the San Antonio Beds, La Inverniza-El Cabo section, c. 10 km E of Mieres (Fig. 1) (Leyva and Gervilla, 1983), sample C-12,M-1, are assigned to the species with some doubts.

Diagnosis

Medium-sized *Neochonetes (Neochonetes)* of the lineage of *N. (N.) granulifer* with the ventral valve weakly but regularly convex; hinge line equal to the greatest width or nearly so; sulcus and fold weakly developed or may even be absent; ornamentation of weak costae and costellae, c. 4 per mm in the anterior part; occasionally becoming obsolete towards the anterior margin. Ventral interior with poorly delimited muscular field and marginal rim. Dorsal interior with strong anderidia.

Description

Shell of medium size [L = 12.0-15.5 mm (medium 13.2), W = 19.3-27.0 mm (medium 22.7); dimensions of holotype: L = 15.5 mm, W ~ 27 mm; Fig. 4], concavo-convex or plano-convex, transverse (L/W = c. 0.6), with rounded cardinal extremities and the maximum width at the hinge or just in front of it. Sulcus and fold weakly developed or absent.

Ventral valve weakly convex, with umbo hardly protruding. On both sides of the umbo 5 spines have been observed, forming a rather large angle with the hinge; ears hardly delimited. Costellate ornamentation with fine costae and costellae, occasionally disappearing towards the front, with 4 per mm in the anterior region; on the anterior third of the valve growth lamellae appear which become closer near the border.

Dorsal valve weakly concave or flat, with a similar ornamentation.

Ventral valve interior with a very high median septum in its posterior part; a pair of strong, parallel vascular ridges; muscle field poorly delimited; marginal rim. The internal surface, apart from the muscle scars, is covered with radially arranged rows of tubercles; those in front of the marginal rim are very fine and densely packed.

In the interior of the dorsal valve only the cardinal process, cardinal process pit, median septum, strong anderidia, and tubercles were observed.

Comparison

The new species is distinguished from *N. (N.) villamaninensis* and *N. (N.) asturianus* by its flattened shell and large size. Also, unlike *N. (N.) villamaninensis,* it normally has a sulcus, although weakly developed, and stronger anderidia.

A comparison with the new species *N. (N.) asturianus* and *N. (N.) babianus* follows below at the descriptions of those species.

Its flat shell and relatively large size compare well with *N. dalmanoides* (Nikitin, 1890), but the Russian species has normally small pointed ears, a distinct sulcus and fold, and is larger. Also, the costulation apparently continues to the front of the shell in *N. dalmanoides*.

Distribution

The species is known from Upper Moscovian strata of the Generalas Beds and possibly also the San Antonio Beds of the Central Coal Basin.

Neochonetes (Neochonetes) asturianus sp. nov.

Figs. 6-7

±*1985 Rugosochonetes* cf. *dalmanoides*; Luque *et al.*, 294 (pars).

Derivatio nominis: From Latin *asturianus*, inhabitant of Asturias, the province from which our material has derived.

Locus typicus and stratum typicum

Section of the trail to the Navidiello Hill, some 4 km E of Puente de los Fierros, Pontones syncline, Central Coal Basin (Fig. 1). Generalas Beds, sample N-6, at 6 m above the base of a 19 m thick lutite at the base of the section, Podolsky (Upper Moscovian).

Material

Holotype (DPO 38108) an internal mould of a ventral valve (Fig. 7a), and 25 specimens, external and internal moulds of one valve or the other from the type locality and horizon (DPO 38109-38126).

The remaining specimens are also from the Generalas Beds of Podolsky age in the Central Coal Basin: La Inverniza-El Cabo section at 10 km E of Mieres (Leyva and Gervilla, 1983), sample L-9,M-4: 4 moulds (DPO 38127-38130) and sample L-9,M-5: 5 moulds (DPO 38131-38134).

Diagnosis

Neochonetes (Neochonetes) of the lineage of *N. (N.) carboniferus* having a convex ventral valve with a strongly curved postero-median region and well delimited, flattened ears; hinge line equal to the greatest width or nearly so; sulcus and fold variably developed; ornamentation of fine, but distinct costae and costellae, 4-7 per mm at the anterior margin. Ventral interior with pronounced adductor scars, posteriorly limited by strong ridges; near the internal border there is an elevated rim. Dorsal interior with strong anderidia forming an angle of c. 50°.

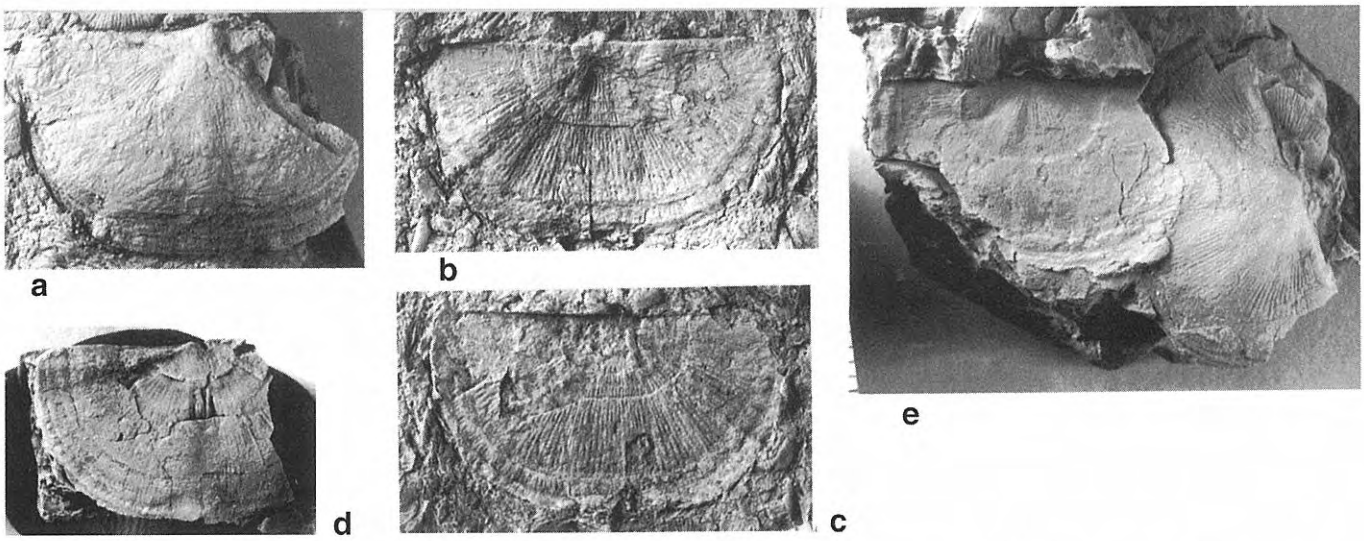


Figure 5. *Neochonetes (Neochonetes) saenzi* sp. nov. Central Coal Basin, La Matinada-Los Nadales section, Generalas Beds, Upper Moscovian (probably Podolsky); all x 2. **a-c**. Sample N-13:M-16. a. Holotype, DPO 38146, damaged specimen in ventral view. b-c. DPO 38145, dorsal valve exterior and external mould of the same. **d-e**. Sample N-13:M-17. d. DPO 38148, incomplete specimen in ventral view, showing part of internal mould of ventral valve. e. DPO 38149, ventral view of a somewhat damaged specimen (at right), and DPO 38150, external mould of dorsal valve (at left).

Description

Shell of small to medium size [L = 5.9-13.8 mm (medium 10.2), W = 10.8-24.0 mm (medium 17.4); dimensions of holotype: L = 10.3 mm, W ~ 19 mm; Fig. 6], concavo-convex to plano-convex, transverse (L/W = c. 0.6), with rounded cardinal extremities and the maximum width at the hinge or just in front of it. Sulcus and fold variably developed.

Ventral valve convex, with an elevated postero-median region and well delimited, flattened ears. On both sides of the umbo up to 9 spine bases were counted. Costellate ornamentation with fine costae and costellae, with 4-7 per mm at the anterior border; on the anterior third of the valve some growth lamellae appear which are more closely spaced near the border.

Dorsal valve weakly concave or flat with a similar ornamentation.

Ventral valve interior with a high median septum in its posterior part between the adductor scars, continuing in front of them to mid length as a low ridge. Adductor scars small and oval, strongly impressed, and postero-laterally bordered by strong ridges; the diductor scars are large, flabelliform and poorly delimited. In front of the adductors originate a pair of strong vascular ridges, parallel to the median septum and close to it, which continue almost to the anterior margin. Close to the margin and parallel to it there is an elevated rim. The internal surface, apart from the muscle scars, is covered with tubercles; these are fine and densely packed near the front.

Interior of dorsal valve with bilobed cardinal process (externally tetralobate), separated from the median septum by a cardinal process pit. The median septum is strong and about half the valve length; at its anterior end normally two parallel rows of 2-3 elevated, thick tubercles occur. Anderidia as strong as the median septum, diverging at an angle of c. 50°. Inner socket ridges elevated, forming a low angle with the hinge. Brachial ridges weakly developed. Internal surface, apart from the posterior central part, covered with tubercles.

Comparison

The new species resembles *N. (N.) villamaninensis* closely, but is distinguished by its more convex ventral valve with variably developed sulcus and better delimited ears, well separated from the remainder of the valve. There are also some internal differences, such as the ridges posterior to the adductors, which are more marked, and the more elevated anterior rim. The main differences in the dorsal interior are the stronger anderidia forming a larger angle in *N. (N.) asturianus*.

Our new species is distinguished from *N. (N.) saenzi* by its rather more convex ventral valve and ears that are well differentiated from the remainder of the valve.

A comparison with the new species *N. (N.) babianus* follows below at the description of that species.

The species has been previously identified as *Rugosochonetes* cf. *dalmanoides* (Nikitin, 1890) by one of us (M.L.M.Ch.). It is, however, differentiated from that species (now included in the genus *Neochonetes*) from the Upper Carboniferous of the Moscow Basin by its more convex ventral valve with better delimited ears, and by its smaller size.

Distribution

The species is only known from Upper Moscovian (Podolsky) strata of the Generalas Beds of the Central Coal Basin.

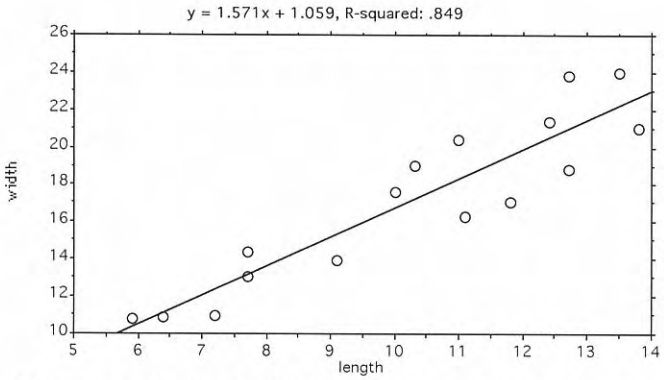


Figure 6. Length-width diagram of *Neochonetes (Neochonetes) asturianus* sp. nov.

Neochonetes (Neochonetes) babianus sp. nov.

1968 *Neochonetes acanthophorus* (Girty, 1934); Winkler Prins, 119, pl. 9: 11-16.
1977 *Rugosochonetes acanthophorus* (Girty); Martínez Chacón, 42.
1979 *Rugosochonetes acanthophorus* (Girty, 1934); Martínez Chacón, 91, pl. 7: 19-22, pl. 8: 1-9.
1985 *Rugosochonetes acanthophorus* (Girty, 1934); Martínez Chacón and Winkler Prins, 236, pl. 1: 1-2.
1990 *Rugosochonetes acanthophorus* (Girty, 1934); Martínez Chacón, 96, pl. 1: 19.
1993 *Rugosochonetes acanthophorus*; Martínez Chacón, in Sánchez de Posada *et al.*, 94.

Derivatio nominis: From "babiano", inhabitant of the region La Babia (León), from which our material has derived.

Locus typicus and stratum typicum

Locality at the outskirts of San Emiliano on the road to La Majua, León province (Winkler Prins, 1968, loc. 20; Fig. 1). Basal part of the lowermost limestone of the La Majua Member of the San Emiliano Formation, of late Bashkirian age (cf. Wagner *et al.*, 1983: fig. 20).

Material

Holotype (RGM 291437, Winkler Prins, 1968, pl. 9, fig. 11; a complete specimen) and many additional specimens from the type locality (cf. Winkler Prins, 1968; Martínez Chacón, 1979).

Diagnosis

Neochonetes (Neochonetes) of the lineage of *N. (N.) carboniferus* having a markedly convex ventral valve with small, poorly delimited ears; hinge line equal to the greatest width or nearly so; sulcus and fold variably developed; ornamentation of fine but prominent costae and costellae, 5-6 per mm at the anterior margin, growth lamellae and numerous scattered spinule apertures; 7 or 8 spines occur on each side of the umbo forming an angle of c. 50° with the hinge. Ventral interior with pronounced adductor scars and moderately developed vascular ridges; surface covered with endospines, becoming very small near the anterior border. Dorsal interior with strong anderidia forming an angle of c. 40°.

Description

For a full description the reader is referred to previous papers of the authors cited in the synonymy, notably Winkler Prins (1968) and Martínez Chacón (1979, 1990).

Comparison

From the true *N. (Neochonetes) acanthophorus* (Girty, 1934), originally described as *Chonetes granulifer* var. *armatus* by Girty (1911; see also Dunbar and Condra, 1932) and to which our new species has been referred in the past, *N. (N.) babianus* is differentiated by its pronounced costulation, which does not become obsolete towards the anterior margin (see discussion of the subgenus above).

The new species is distinguished from *N. (N.) villamaninensis* by the presence of a variably developed sulcus and fold, its concave brachial valve, more pronounced costellation with numerous spinule apertures, and some internal differences, especially its less strongly developed vascular ridges.

From *N. (N.) saenzi* our new species is distinguished by its better developed sulcus and fold, its more concave brachial valve, and more pronounced costellation with numerous spinule apertures.

The new species is distinguished from *N. (N.) asturianus* by its less demarcated and weakly developed ears, its more concave brachial valve, more pronounced costellation with numerous spinule apertures, and its less strongly developed vascular ridges.

Distribution

The species is known from the San Emiliano Formation (Upper Bashkirian) of León, and the Levinco Beds of the Central Coal Basin and the Cuera Limestone (E Asturias) (Lower Moscovian: Vereisky).

Subfamily **Riosanetinae** subfam. nov.

Type genus: *Riosanetes* gen. nov.

Diagnosis

Small to medium-sized rugosochonetids with costellate ornamentation; oblique orthomorph spines. Dorsal interior without median septum.

Genera included

Apart from the type genus: *Permochonetes* Afanasjeva, 1977, Lower Permian of the Pamirs.

Discussion

The new subfamily is established to include in it the chonetids with an exterior like the representatives of the subfamily Rugosochonetinae, but without a dorsal median septum or traces of lateral septa.

The lophophore of the members of this subfamily is considered to have been schizolophe, as normally found in the Rugosochonetidae, and not ptycholophe as

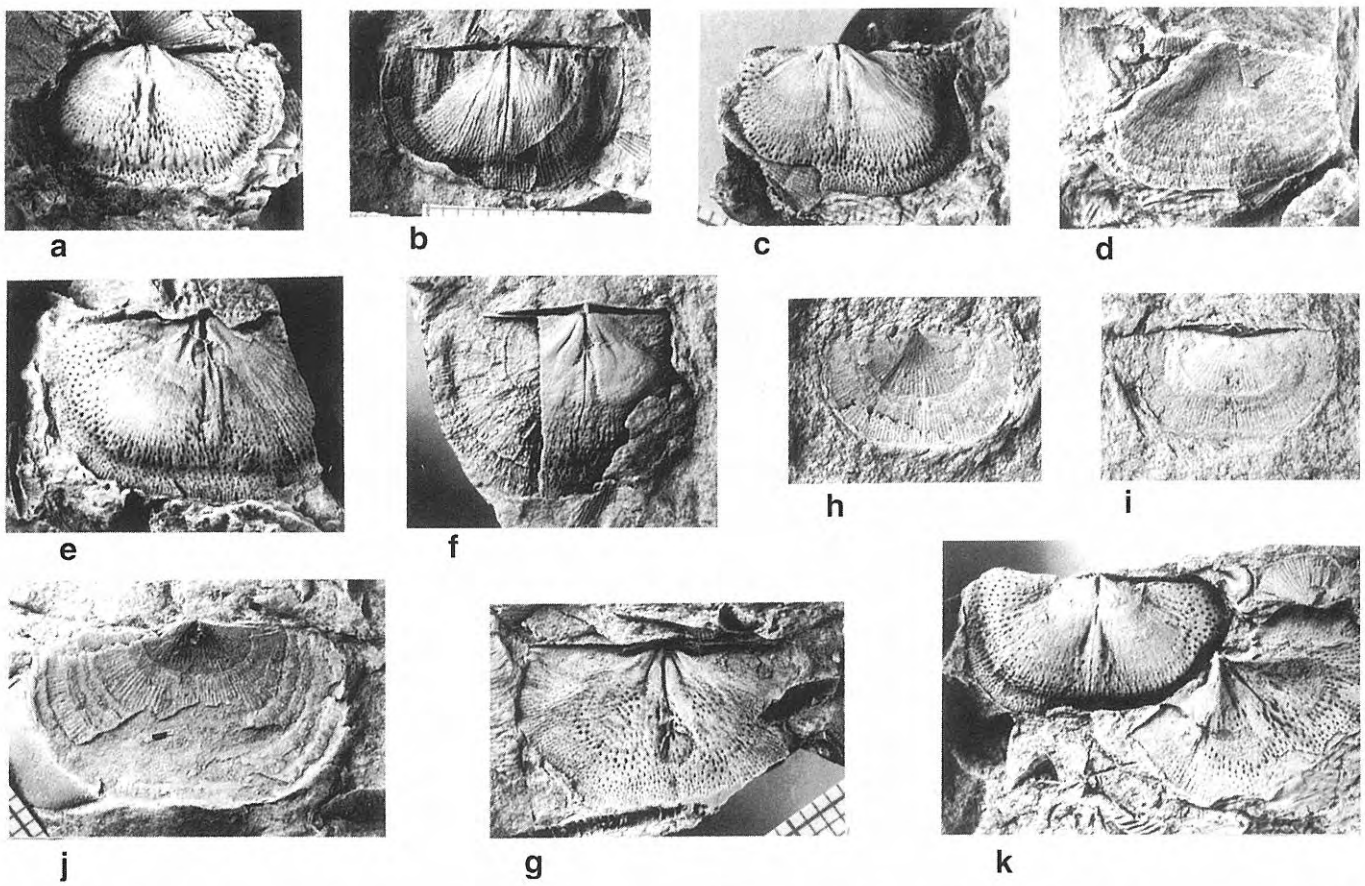


Figure 7. *Neochonetes (Neochonetes) asturianus* sp. nov. Central Coal Basin, Generalas Beds, Upper Moscovian (probably Podolsky); all x 2. **a-g.** Navidiello Hill (Puente de los Fierros), sample N-6. a. Holotype, DPO 38108, internal mould of ventral valve. b. DPO 38117, internal mould of ventral valve, less convex than usual. c-d. DPO 38119, internal mould of ventral valve and fragment of the external mould. e. DPO 38121, internal mould of ventral valve. f. DPO 38115, damaged internal mould of ventral valve with part of dorsal external mould. g. DPO 38118, internal mould of dorsal valve. **h-j**. La Inverniza-El Cabo section, sample L-9:M-5. h-i. DPO 38133, external moulds of ventral and dorsal valves. j. DPO 38131, external mould of ventral valve. **k**. La Inverniza-El Cabo section, sample L-9:M-4, DPO 38127, internal mould of ventral valve (at left) and DPO 38128, internal mould of dorsal valve (at right).

considered typical for the Anopliidae (cf. Afanasjeva, 1984, fig. 2).

We have transferred the genus *Permochonetes*, formerly included in the family Anopliidae, to the Rugosochonetidae, and to the new subfamily in particular, because its form and ornamentation coincides with that of the Rugosochonetidae, it lacks a dorsal median septum and is considered to have had a schizolophe lophophore (cf. Afanasjeva, 1984, fig.3; 1988, fig. 48). In our view it seems unlikely that a schizolophe has developed from a ptycholophe, as suggested by Afanasjeva (1984, p. 101 = 92), since the former is a more primitive stage. Afanasjeva (1977) recognised that *Permochonetes* resembles *Neochonetes* externally, from which it is distinguished by the absence of a median septum in the interior of the dorsal valve.

Distribution

Pennsylvanian (Upper Moscovian) of Asturias (N Spain) and Lower Permian of the Pamirs.

Genus *Riosanetes* gen. nov.

Derivatio nominis: After "Riosa", a region in Asturias from which the type species of the genus is derived, and "netes", termination of *"Chonetes"*.

Type species: *Riosanetes fernandezi* gen. et sp. nov.

Diagnosis

Small, thin shell, plano-convex to slightly concavo-convex, with a subrectangular outline, cardinal extremities rounded; costellate ornamentation with fine costae and costellae, apart from the ears, which are smooth. Ornamentation internally as prominent as externally, suggesting a very thin shell. Ventral interior with a short median septum, posteriorly elevated; without vascular ridges. Dorsal interior with very thin anderidia, high and strong inner socket ridges, without median septum; tubercles placed in rows along the intercostal sulci, occasionally the tubercles of the central rows are

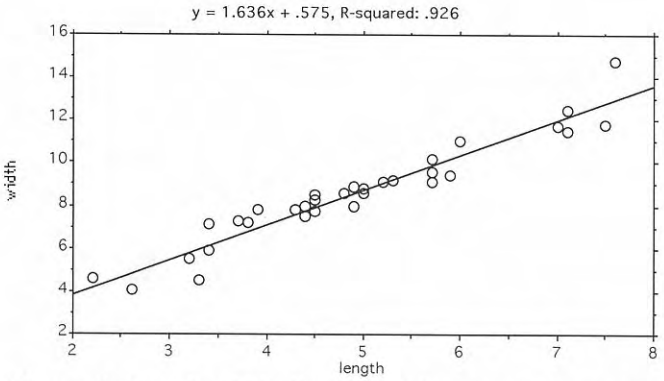


Figure 8. Length-width diagram of *Riosanetes fernandezi* gen. et sp. nov.

more marked, but they never form septa; brachial ridges not developed.

Species included: Type species only.

Discussion

The new genus is included in the family Rugosochonetidae because of its form, ornamentation and the characteristics of the ventral valve. The exterior is similar to the representatives of the subfamily Rugosochonetinae, but is distinguished from them, fundamentally, by the absence of a median septum in the dorsal interior. This lack of a dorsal median septum is what brought us to modify the diagnosis of the family to include the genus and to establish the new subfamily Riosanetinae.

The ornamentation and the interior of the dorsal valve are like those of *Permochonetes*, which we have included also in the new subfamily, but which is fundamentally differentiated from it by its ventral interior, the Permian genus having a much better developed muscular field and a pair of vascular ridges; besides, *Permochonetes* has a larger size and thicker shell.

Riosanetes resembles the Permian genus *Fanichonetes* Xu y Grant, 1994, a lot by its external characteristics and those of the ventral interior. The dorsal interior of *Fanichonetes* is poorly known, and therefore it is uncertain whether it has a median septum. If it is lacking, it should also be included in the new subfamily Riosanetinae.

Alatochonetes Liang, 1990 is another Permian genus, included in the subfamily Rugosochonetinae and which dorsal interior is poorly known. However, it is differentiated from *Riosanetes* by its ornamentation of thick costae crossed by strong rugae with prominent tubercles at the intersections. The ornamentation, by the way, makes it rather doubtful whether this genus belongs to the Chonetoidea, let alone the Rugosochonetidae. The figured material of the type species *Alatochonetes alata* (Liang, 1990, pl. 15, figs. 15-16) appears to be insufficiently preserved to decide this matter.

Arctochonetes Ifanova, 1968 has a poorly defined dorsal median septum, but, contrary to *Riosanetes*, has a pair of accessory septa (and thus cannot be included in the family Rugosochonetidae) and a pair of vascular truncs in the ventral interior.

The form, ornamentation and the caracteristics of the ventral interior of *Riosanetes* suggest the genus *Rugosochonetes* Sokolskaja, 1950, from which it is differentiated by the lack of a median septum in the dorsal interior.

The new genus resembles *Caenanoplia* Carter, 1968 (Family Anopliidae, Subfamily Caenanopliinae) by its lack of a median septum and accessory septa in the dorsal interior, but *Caenanoplia* is clearly differentiated by its form and ornamentation, which is very distinct from that of the Rugosochonetidae.

Subglobosochonetes Afanasjeva, 1976 resembles the new genus in having a well developed costellate ornamentation, though not as strongly developed as in

Figure 9. *Riosanetes fernandezi* gen. et sp. nov.; all x 2.5, except a, which is x 5. **a-p**. Villamerí, Riosa (Asturias), sample Ri-3, Canales Fm., Upper Moscovian. a. Holotype, DPO 38155, internal mould of dorsal valve. b. Holotype, DPO 38155, external mould of dorsal valve (lower left) and DPO38158, internal mould of dorsal valve (upper right). c. DPO 38158, external mould of dorsal valve. d-e. Two moulds of ventral valves (the larger, DPO38163) both external and internal. f. Internal mould of ventral valve (DPO 38156, upper right), external mould of dorsal valve (DPO38161, lower right), external mould of ventral valve (center) and external mould of dorsal valve (DPO 38184, left). g. Countermould of specimes shown in f: dorsal interior (DPO 38184), ventral interior, ventral exterior (DPO 38156) and dorsal interior somewhat eroded (DPO 38161). h. Two external moulds of dorsal valves, DPO 38159 (lower) and DPO 38160 (upper left). i. Internal moulds of the preceding specimens. j. External mould of dorsal valve, DPO 38162 (upper part of foto), and internal mould of dorsal valve (lower right) and external mould of dorsal valve (lower left) of two other specimens. k. Countermoulds of preceding specimens. l. DPO 38177, internal mould of ventral valve. m-n. DPO 38178, external and internal moulds of ventral valve. o. Moulds of various specimens with part of the shell preserved; e.g. DPO 38176, internal mould of ventral valve (at left) and dorsal interior with high internal crests (bottom center). p. DPO38157, internal mould of ventral valve. **q-s**. Candemuela (León), sample T-296, Candemuela Member of the San Emiliano Fm., Lower Moscovian. q-r. DPO 38196, dorsal exterior, somewhat decorticated, showing part of the internal mould, and external mould of the same specimen with part of the interior of the dorsal valve. s. DPO38194, internal mould of dorsal valve (lower part of foto) and DPO 38195, external mould of ventral (upper part). **t-u.** Mieres, probably Caleras Beds, Upper Moscovian. t. DPO 38185, internal mould of both valves united at the hinge. u. DPO 38186, internal mould of both valves united at the hinge. **v**. La Matinada-Los Nadales section, sample N-13:M-16, Generalas Beds, Upper Moscovian. DPO 38192, external mould of both valves united at the hinge.

Riosanetes, and in lacking a median septum, but it shows traces of lateral septa in the form of weak ridges in the brachial valve interior and thus in our view is rightly included in the subfamily Caenanopliinae of the Anopliidae.

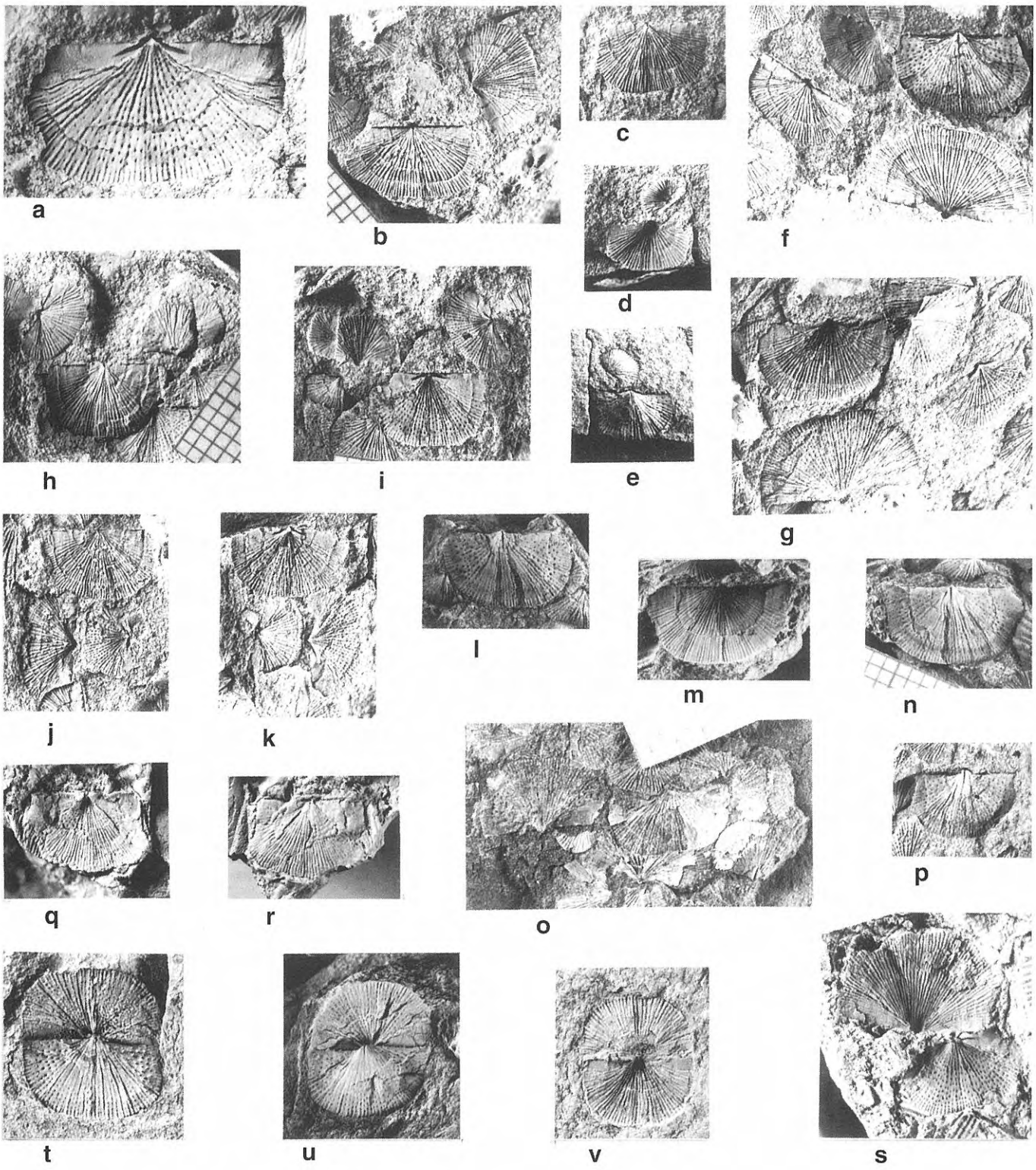
Distribution

Moscovian of Asturias and León.

Riosanetes fernandezi gen. et sp. nov.

Figs. 8-9

Derivatio nominis: The species is dedicated to Dr Luis Pedro Fernández González (Geology Department, University of Oviedo), who studied the Carboniferous stratigraphy of the Riosa area.



Locus typicus and stratum typicum

Upper trail from Villamerí, Riosa. Canales Formation (Upper Moscovian), sample Ri-3, mudstones from bed 19 of the log "Montsacro 2 (superior)" of Fernández González (1990), some 6.5 m above a covered part.

Material

Holotype (DPO 38155) internal and external mould of a dorsal valve (Fig. 9a-b), and some 40 additional specimens (DPO 38156-38184, 38187-38190), some with their shell preserved, but the majority are external or internal moulds of one valve or the other, originated from the type locality and layer.

La Matinada-Los Nadales section at some 4 km NE of Mieres, on the road from Mieres to Sama by the Santo Emilano Hill, Central Coal Basin (Fig. 1). Generalas Beds, gray mudstone bed, sample N13,M16, at 65 m above the base, i.e. above the La Torala Limestone, some 30 specimens, some with their shell preserved, others as moulds (DPO 38191-38193).

S of Mieres, on the road to Rozaes de Bazuelo (Central Coal Basin), probably Caleras Beds, 2 internal moulds of both valves united at the hinge (DPO 38185-38186).

W of Candemuela (León), mudstone 100 m below the top of the Candemuela Member of the San Emiliano Formation (Carballeira *et al.*, 1985), Lower Moscovian, sample T-296, 4 moulds, some with their shell preserved (DPO 38194-38197).

Diagnosis

As for the genus.

Description

Very thin, small shell [L = 2.2-7.6 mm (medium 4.9), W = 4.1-14.8 (medium 8.7); dimensions of the holotype: Ld = 5.2; W = 10.5; see Fig. 9], plano-convex or weakly concavo-convex, transverse (L/W = 0.5-0.7), with a subrectangular to semi-elliptic outline, cardinal extremities rounded, the maximum width coinciding with the hinge or slightly in front of it. Sulcus and fold absent or only slightly developed.

Ventral valve weakly convex, with a small beak slightly curved over the interarea. On each side of the umbo a maximum of 6 spine bases is observed; the angle of the spines with the hinge could not be observed. Ornamentation costellate, except on the ears, which are smooth, at least in the posterior part; costae and costellae thin, numbering 15-18 at 3 mm width at the anterior margin; they multiply by bifurcation.

Dorsal valve flat or slightly concave, less curved than the ventral one; with a similar ornamentation.

Interior of ventral valve with short median septum, posteriorly elevated; ornamentation the reverse of the exterior, with tubercles placed in rows along the external intercostal sulci. In mature specimens, a weak rim can be observed near the margin (Fig. 9n,p).

Interior of dorsal valve with deep cardinal process pit; internal socket ridges strong, straight and short, forming an angle of c. 20° with the hinge; anderidia very thin, no median septum; ornamentation as in the ventral valve; some specimens with more marked tubercles on the central rows, but without forming a septum.

Comparison

Externally, the species resembles the species of *Rugosochonetes* found in the Cantabrian Mts in strata of the same age (see Winkler Prins, 1968; Martínez Chacón, 1979), especially *R. skipseyi* (Currie, 1937, in Currie *et al.*). It is mainly differentiated by the absence of a dorsal median septum. Also, *Riosanetes fernandezi* is less transverse than *Rugosochonetes skipseyi.*

Distribution

The species is known from the Canales Fm. (Riosa, Asturias) and the Generalas Beds and probably also from the Caleras Beds (Central Coal Basin), Upper Moscovian; also from the Candemuela Member of the San Emiliano Fm. (Candemuela, León), Lower Moscovian.

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