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NOTA PALEONTOLÓGICA

Revision of the brachiopod *Eoorthis grandis* Harrington, 1938, from the Lower Ordovician of Northwestern Argentina

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Introduction

Lower Ordovician brachiopods from NW Argentina have been known since the 19th century, from the descriptions of Kayser (1876), and since the 1930s from those of Kobayashi (1937) and Harrington (1937, 1938). The original collections forming the basis for these descriptions, many of them new species, commonly cannot be located, and in some cases are definitively lost. This is the case for the Steinman collection, containing the types of the Kobayashi's (1937) paper; these collections, deposited in Freiburg University were destroyed during World War II (Kuss and Tobien in Havlíček and Branisa, 1980: p. 6). This compounds the difficulty in recognising and revising these superficially described and poorly illustrated species. Perhaps because of these difficulties, only a few of those previously defined species have already been revised and they remain very poorly known.

Ulrich and Cooper (1938) reassigned *Orthis saltensis* Kayser, 1876 and *Eoorthis*? *putilliformis* Kobayashi to the genus *Nanorthis*. Castellaro (1963) followed Ulrich and Cooper (1938) and included also *Eoorthis grandis* Harrington, 1938 within *Nanorthis*. Havlíček and Branisa (1980) in their study of the Ordovician brachiopods of Bolivia also revised one of those previously described species from Argentina, reassigning *Orusia saltensis* (Kayser) determined by Kobayashi (1937) within *Notorthisina*. The latest revision of one of those previously defined species was by Benedetto (*in* Benedetto and Carrasco, 2002) in his study of some Tremadoc brachiopods from NW Argentina; Benedetto (in Benedetto and Carrasco, 2002) placed in synonymy with his new species *Nanorthis purmamarcaensis*, the shells identified as *Eoorthis christianiae* (Kjerulf) and *Eoorthis andina* sp. nov. by Harrington (1937 and 1938, respectively). Nevertheless, Benedetto (p. 656) commented on the difficulty of making comparisons with *N. andina* (Harrington) (*sic*), due to a lack of information on the latter species. Certainly, if that comparison could be confirmed and Harrington's species proved to be the same as *Nanorthis purmamarcaensis* Benedetto, this name would be a junior synonym of *Nanorthis andina* (Harrington).

Eoorthis grandis Harrington, 1938 is one such poorly known brachiopod species from the Lower Ordovician of NW Argentina that has not yet received a thorough revision. The shells studied and illustrated by Harrington (1938) were collected by G. Bonarelli from a brown-yellowish sandstone at Portezuelo de Salta; this is the name of the eastern entrance to the town of Salta from the Road 34, placed immediately south of Cerro San Bernardo. The Lower Ordovician outcrops at Portezuelo de Salta are a continuation of those of Cerro San Bernardo. Harrington (1938) also identified *E. grandis* in clay-slates and sandstones, with *Kayseraspis brackebuschi* and *Didymograptus nitidus*, collected by P. Sgrosso and J. Frenguelli from Cerro San Bernardo, as well as in brown-yellowish sandstones from Cerro Purma (Jujuy Province). Harrington (1938) dated the horizons yielding *E. grandis* as Lower Skiddawian and identified tentatively the lithostratigraphic unit as the upper part of the Saladillo Group. Harrington (*in* Harrington and Leanza, 1957) identified more precisely the beds yielding *E. grandis* in the Cerro San Bernardo Section as the horizon 3 of the San Bernardo Formation. According to Moya *et al.* (1994) this unit is almost entirely early Arenig in age, with the Tremadoc-Arenig boundary lying close to the base of the formation, and the lower-middle Arenig boundary in its uppermost part. The fossiliferous horizon would be within the graptolite *nitidus* Biozone and the trilobite *asaphelloides* Biozone. Thus it can be correlated with the British Whitlandian.

From the original material on which Harrington (1938) based *E. grandis*, a single sample of Bonnarelli's collection from Portezuelo de Salta has been located. It is housed in the SEGEMAR repository, under the number 11060 (535). Within this sample, a medium

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grained sandstone, all the internal and external moulds illustrated by Harrington (1938: pl. 2, figs 12, 15, 17 and 18) are preserved. Five samples from Frenguelli's collection, housed in La Plata Museum, have also been studied; they come from the same locality as Bonnarelli's collection; they were also referred to by Harrington (1938) among the material considered to define the species. Although most of the valves of this collection are only preserved as fragmentary exteriors, their observable features closely coincide with those in Bonnarelli's collection.

Palaeontology

Order ORTHIDA Schuchert and Cooper, 1932
Suborder DALMANELLIDINA Moore, 1952
Superfamily DALMANELLOIDEA Schuchert, 1913
Family HETERORTHIDAE Schuchert & Cooper, 1931

Genus ***Tarfaya*** Havlíček, 1971

Type species. *Tarfaya marocana* Havlíček, 1971 from the Upper Fezouata Formation (Arenig) of the Moroccan Anti-Atlas.

Emended diagnosis. Shell ventribiconvex, with ribs incurved posterolaterally to intersect hinge line, short suboval to subpolygonal ventral muscle field, ridgelike cardinal process continuous with short median septum, quadripartite dorsal muscle field with bilobed anterior pair; postero-lateral vascula terminalia strongly incurved postero-medianly, intersecting hinge line to form cardinal canals on the interarea.

Discussion. This genus was assigned by Havlíček (1971) to the Productorthinae, noted its similarity with the genera *Panderina* and *Prantlina* in the lobate anterior margins of the anterior pair of the dorsal adductor scars. Nevertheless he noted its strong resemblance to the heterorthids in the disposition of the vascula terminalia and the posterior ribs, that incurve postero-laterally to intersect the hinge line. The lack of traces of endopunctation in the type material, made up of internal and external moulds, must have suggested its inclusion within the Orthoidea. In spite of this, Harper (2000) included *Tarfaya* among the punctate family Heterorthidae. Although in the studied Argentine specimens is not possible to determine the shell substance type, Harper's (2000) proposal is accepted herein, considering that the ornamentation and vascula terminalia disposition of the Moroccan genus is a strong enough hint for a reassignment of the taxon.

Until *Tarfaya* shells with well-preserved endopunctae are described, its inclusion within the heterorthids remains uncertain; but some clues about the shell substance of *Tarfaya* are evident from the revision of *Nanorthis brachymyaria* Benedetto and *Nanorthis purmamarcaensis* Benedetto (both in Benedetto and Carrasco, 2002) from the Tremadoc of Argentina. According to Benedetto (written communication, 26/7/2003) these species belong to the same genus as *Eoorthis grandis*, here included within *Tarfaya*. Nevertheless, if Benedetto is correct or if those species belong to closely related genera, the type material of *N. purmamarcaensis* is the first evidence of a punctate shell substance for these early Ordovician Argentine brachiopods. Although Benedetto (in Benedetto and Carrasco, 2002) assigned *Nanorthis purmamarcaensis* to the impunctate orthidines, several of the internal moulds illustrated (in Benedetto and Carrasco, 2002: figures 4-19, 4-20, 5-6 and 5-7) display radially arranged tiny knobs following the internal impressions of the ribs on the valve margins. If these knobs are the infillings of endopunctae, *N. purmamarcaensis* should be assigned to the punctate dalmanellidines, and possibly to the heterorthid *Tarfaya*. Thus it would become the first evidence of a very early Ordovician origin for the family Heterorthidae as well as the punctate shell substance type seen in *Tarfaya*.

Besides the type species and *T. grandis*, the only other species ascribed to this genus are *Tarfaya intercalare* (Chang) and *Tarfaya zanzhangenis* Xu and Liu from the Arenig of Southwestern China (Xu and Liu, 1984). Nevertheless, none of these two taxa displays the incurved ribs intersecting the hinge line, typical of *Tarfaya* and of the family Heterorthidae. They neither display the peculiar bilobed posterior pair of the dorsal muscle field, present in both *T. marocana* and *T. grandis*. Thus both Chinese species are rejected herein from *Tarfaya*.

Tarfaya grandis (Harrington, 1938)
Figures 1.A-J.

1938 *Nanorthis saltensis* (Kayser); Ulrich and Cooper, p. 91, pl. 12E, figs. 15-18.
1938 *Eoorthis grandis* sp. nov.; Harrington, p. 129, pl. 2, figs. 12, 15, 17 and 18.
1963 *Nanorthis grandis* (Harrington); Castellaro, p. 140-141.

Types. Lectotype: internal mould of dorsal valve SEGEMAR 11060-e, figured in Harrington (1938: plate II, figs. 12 and 17), re-figured herein as figures 1.D, E.

Material. Twenty ventral and dorsal valves, preserved as moulds, mostly externals, including SEGEMAR 11060 a-h, and Museo de La Plata 3122, 3151, 3153, 3240 and 3241.

Diagnosis. *Tarfaya* species with transversely elongated suboval outline, ventral and dorsal muscle fields large for the genus, and ribs of rounded cross-section.

Stratotype and type locality. San Bernardo Formation (Whitlandian); Portezuelo de Salta, at the eastern outskirts of Salta town and the foothills of Cerro San Bernardo.

Description. Shell ventribiconvex with suboval out-

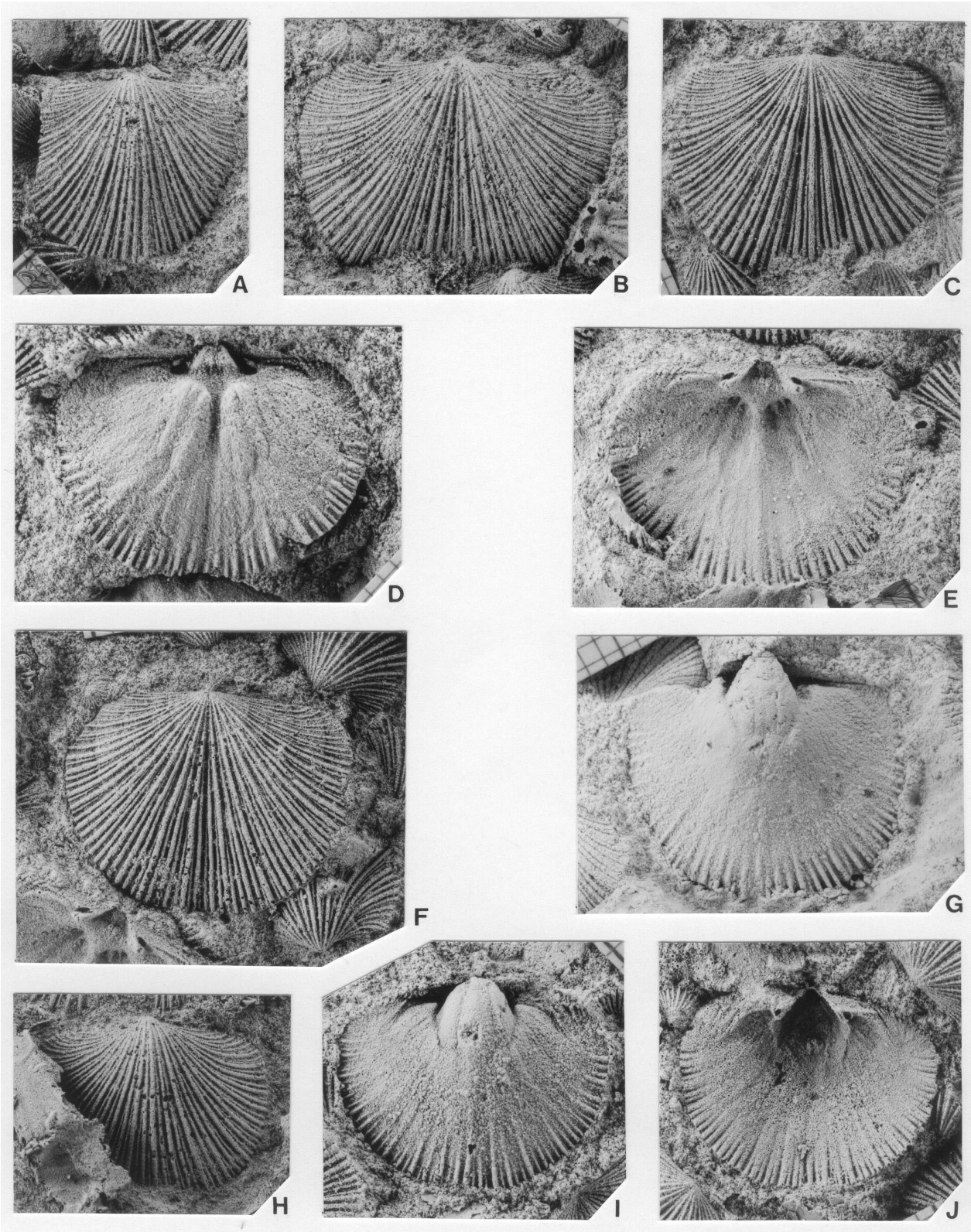

Figura 1. ***Tarfaya grandis*** (Harrington, 1938), San Bernardo Formation, Portezuelo de Salta (Salta, Argentina), all x 3.5. **A,** latex cast of exterior of ventral valve, SEGEMAR11060-a / *réplica en látex del exterior de una valva ventral*. **B,** latex cast of exterior of dorsal valve, SEGEMAR 11060-g / *réplica en látex del exterior de una valva dorsa*l. **C,** latex cast of exterior of dorsal valve, SEGEMAR 11060-f / *réplica en látex del exterior de una valva dorsal*. **D-E,** lectotype, internal mould (D) and latex cast of interior (E) of dorsal valve, SEGEMAR 11060-e/ *molde interno* (D) *y réplica en látex del interior* (E) *de una valva dorsal*). **F,** latex cast of exterior of dorsal valve, SEGEMAR 11060-h / *réplica en látex del exterior de una valva dorsal*. **G,** internal mould of ventral valve, SEGEMAR 11060-b. **H,** latex cast of exterior of ventral valve, SEGEMAR 11060-d / *réplica en látex del exterior de una valva ventral.* **I-J,** internal mould (I) and latex cast of interior (J) of ventral valve, SEGEMAR 11060-a / *molde interno (I) y réplica en látex del interior* (J) *de una valva ventral*.

line, transversely elongate, obtuse cardinal angles, maximum width at posterior third of shell, hinge line 64-84% as wide as shell, and anterior commissure slightly sulcate. Ventral valve moderately convex, about 20% as deep as long, slightly carinate; apsacline ventral interarea, about 10% as high as valve length, with open delthyrium. Dorsal valve slightly convex, 76-78% as long as wide, with shallow and wide median sulcus; dorsal interarea anacline with open notothyrium. Radial ornament ramicostellate to slightly fascicostellate, with, 6-7 ribs per 2 mm, 5 mm anteromedially from umbo, rounded in section and incurved posteriorly to intersect hinge line. Growth lines poorly preserved.

Ventral interior with short dental plates, continuous anteriorly with very low muscle delimiting ridges, converging anteriorly; ventral muscle field subpentagonal, 35-38% as long as valve, 26-28% as wide as valve, with triangular adductor scar, 32-49% as wide as muscle field, almost as long as diductor scars, not enclosed by these. Postero-lateral vascula terminalia strongly incurved postero-medialy, intersecting hinge line to form cardinal canals on the interarea.

Dorsal interior with high notothyrial platform, continuous anteriorly with strong median ridge, bounded laterally by ridge-like brachiophores, strongly diverging anteriorly, extending forward 13-19% of valve length and splaying laterally 28-35% of valve width; oblique dental sockets, excavated on valve floor; cardinal process low, ridge-like, nearly as long as notothyrial platform. Dorsal muscle field quadripartite, strongly impressed, 54-58% as long as valve, 40% as wide as valve, with bilobed anterior pair, larger and wider than posterior pair, and antero-lateral invaginations continuous posteriorly with radial ridges. Vascula media bifurcated, with anterior branches strongly incurved inwardly; posterior vascula terminalia incurved postero-medianly and continuous with cardinal canals, excavated on lateral sides of dorsal interarea.

No infillings of endopunctae can be observed in the studied moulds.

Discussion. This species is assigned to *Tarfaya* Havlíček, 1971 since its most important features are coincident with the diagnostic ones of that genus, especially the ornamentation, the peculiar posteriorly incurved postero-lateral ribs and posterior vascula terminalia, as well as the ventral and dorsal muscle fields, with a peculiar bilobed anterior pair in the latter. *Tarfaya grandis* (Harrington, 1938) can be easily distinguished from the type and only other known species of the genus, *Tarfaya maroccana* Havlíček, 1971 for its transversely elongated suboval outline, that is subcircular in the Moroccan species, and its much larger ventral and dorsal muscle fields. The ornamentation is also different with angulose to subangulose ribs in *T. maroccana*, slightly thicker than the rounded ribs of *T. grandis*.

Ulrich and Cooper (1938) illustrated four valves from the Ozarkian of northwestern Argentina, stored in the United States National Museum, which they ascribed to *Nanorthis saltensis* (Kayser), proposing them as hypotypes for the species. Since these valves closely coincide with *T. grandis* in all those features that can be observed in Ulrich and Cooper's (1938: pl. 12E, figs. 15-18) photographs, it is necessary to reconsider the priority of the two names applied to the material from the different collections; many probably belong to a single species. The original description of *Orthis saltensis* Kayser, 1876 was based on an assemblage of shells from the town of Salta and the Nevado del Castillo, both in the Argentine Salta Province. Firstly, the ascription of the specimens illustrated by Ulrich and Cooper (1938) to *Orthis saltensis*, can not be justified either with the extremely brief and superficial description of the Salta specimens or with their generalized hand-drawings in Kayser's original paper. Actually, the morphological description and hand made illustration of the shells by Kayser (1876) are not enough to identify in any case the species defined by this author, and thus *O. saltensis* must be considered a *nomen dubium*. The same conclusion can be drawn from the discussion by Havlíček and Branisa (1980: 29). Furthermore, there is no trace of the original shells studied by Kayser and it is not possible to identify the exact localities and horizons where his shells were collected from, in order to define a neotype among possible topotypes. Moreover, since it is possible to distinguish shells with two very different ornamentation patterns on the illustrations of *O. saltensi* by Kayser (1876: pl 1, fig. 16), this is also a *nomen confusum*. Therefore, while the original collection studied by Kayser (1876) cannot be located and his types re-described, it is proposed herein to consider the name *Orhis saltensis* invalid.

In spite of the nomenclatorial problems surrounding Ulrich and Cooper's (1938) determination of *Nanorthis saltensis*, the valves that they studied are of considerable importance. Their illustrations allowed Havlíček and Branisa (1980: p. 29) to suggest for the first time the close relationships of those valves to the Moroccan genus *Tarfaya*, something corroborated herein.

Conclusions

Our revision has suggested the reassignment of *E. grandis* to *Tarfaya* Havlíček, 1971, a problematic genus known up to now exclusively from the Arenig of Morocco. The assignment to *Tarfaya* of two species from the Lower Ordovician of Southwestern China (Xu and Liu, 1984) is not accepted herein. *Tarfaya* is thus, besides *Incorthis* (Havlíček and Branisa, 1980;

Mergl, 1988; Benedetto, 1998), an example of the biogeographical links during the Arenig between the N and W Gondwana margins, as well as one of the few endemic brachiopods within the Early Ordovician Mediterranean Province (Spjeldnaes, 1961). Isolation from other zoogeographical provinces was not marked until the Mid and Late Ordovician (Havlíček and Branisa, 1980; Havlíček, 1989).

Orthis saltensis Kayser, 1876 is a confusing species; its type material is lost and it is known exclusively from an extremely imprecise description and generalized hand drawings. Herein it is designated *nomen dubium* as well as a *nomen confusum*. Thus, in order to avoid further incorrect determinations it is proposed to consider the name invalid. An example of such problems is the assignment of Argentinian material to *O. saltensis* by Ulrich and Cooper (1938), in the same year as the definition of *Eoorthis grandis* by Harrington (1938), a species into which that material can be clearly assigned.

Although the re–description and discussion on the type collection made herein should allow in the future the ready recognition of *E. grandis*, new specimens from the type locality of the species are required, in order to precisely determine its stratigraphic range and describe more carefully its shell substance type and morphological variability.

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