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A new species of *Strepsodiscus* KNIGHT (Gastropoda, Bellerophontoidea) from the Upper Cambrian of Argentina

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With 2 figures and 1 table

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Abstract: *Strepsodiscus austrinus* sp. nov. (Gastropoda, Bellerophontoidea) from the Lampazar Formation at Angosto de la Quesera locality (Salta Province, Argentina) is described. The new species is characterized by having a laterally compressed smooth shell. The spire is composed of three tangent whorls slightly coiled to the left, and the final 1/4 whorl free. *Strepsodiscus* KNIGHT is reported in South America for the first time. The specimens studied were collected in association with trilobites of the *Parabolina (Neoparabolina) frequens argentina* Zone (uppermost Cambrian).

Key words: Gastropoda, Bellerophontoidea, *Strepsodiscus*, Upper Cambrian, Argentina.

1. Introduction

The Lower Paleozoic faunas of northwestern Argentina have been intensively studied during the last decades. Although such analyses are mainly based on the most common groups of the fossil record (e.g. trilobites, graptolites, brachiopods), descriptions of subordinate taxa (e.g. Conulariida, Hyolitha, Rostroconchia, Echinodermata) have also been provided (e.g. HARRINGTON 1938; ACEÑOLAZA 1986, 1999; SÁNCHEZ 2000; GUTIÉRREZ MARCO & ACEÑOLAZA 2002; ACEÑOLAZA et al. 2003; LEME et al. 2003; PAGANI et al. 2005; GARCÍA BELLIDO & ACEÑOLAZA 2005), thus greatly contributing to reveal the complete composition of the Cambrian-Ordovician paleocommunities from SW Gondwana.

The aim of this paper is to describe a new species of *Strepsodiscus* KNIGHT (Gastropoda, Bellerophontoidea) from the Angosto de La Quesera, a classical fossil locality of Salta Province. *Strepsodiscus* is reported in South America for the first time. The specimens studied were collected from the Lampazar Formation (HARRINGTON in HARRINGTON & LEANZA 1957) in association with trilobites of the lower part of the *Parabolina (Neoparabolina) frequens argentina* Zone (uppermost Cambrian).

2. Stratigraphy

The Lampazar Formation was originally described by HARRINGTON (in HARRINGTON & LEANZA 1957) as dark gray to olive-green shales with intercalated sandstones from the Lampazar/Incamayo area. Subsequently, it was identified in other localities of the western Cordillera Oriental and eastern Puna (Salta and Jujuy Provinces), being Sierra de Cajas (ACEÑOLAZA 1968; TORTELLO & ESTEBAN 2003) and

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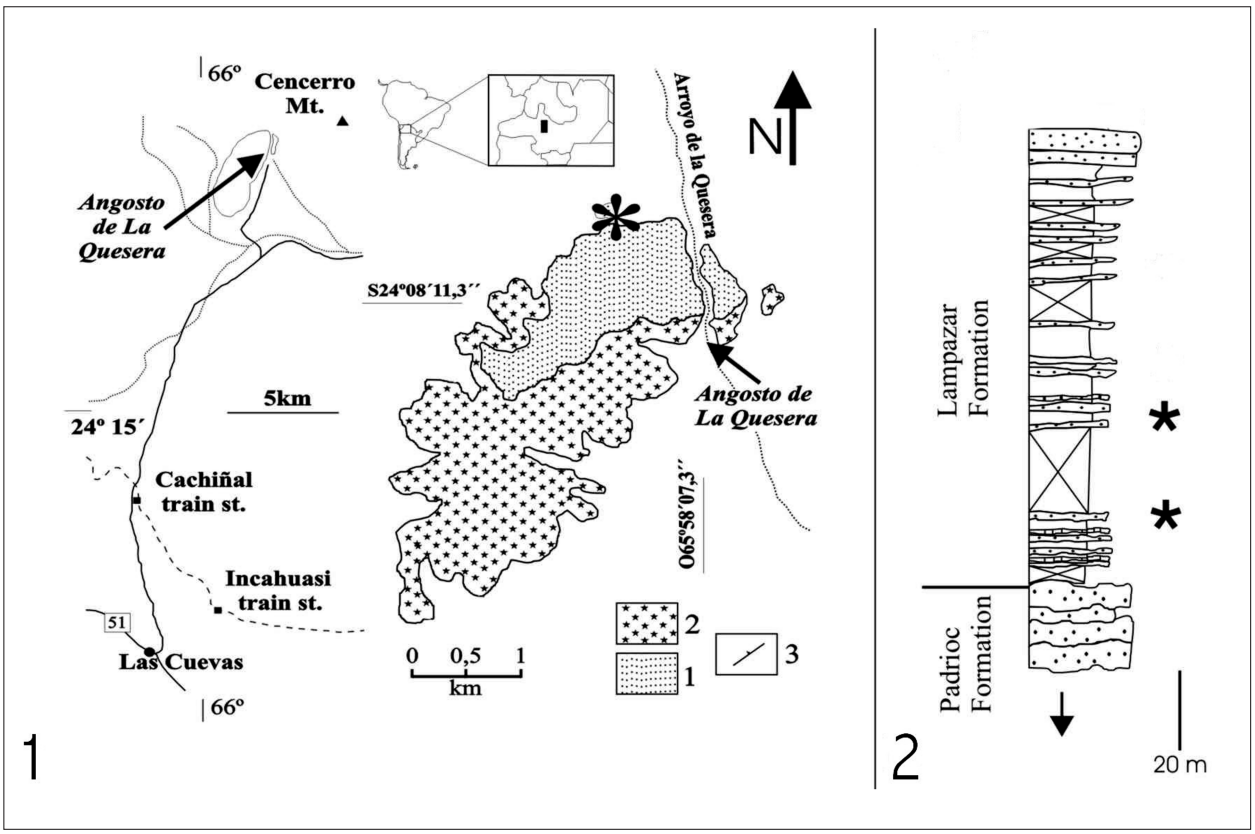

Fig. 1. 1 – Location map of the Angosto de la Quesera, Cordillera Oriental of Salta Province, northwestern Argentina. References: 1: Cambrian/Ordovician strata; 2: La Quesera Granite; 3: strata deep and orientation. **2** – Stratigraphic sketch of the Lampazar Formation exposed at the locality studied; asterisks show the location of the samples.

Angosto del Moreno (e.g. Moya et al. 2003) its most representative sections. The formation is interpreted as having formed in an outer shelf environment with some transitions towards inner shelf conditions. The lower part of the unit is generally composed of gray and black shales deposited in a low energy, dysaerobic setting, whereas the middle to upper intervals show higher proportions of sandstone beds, suggesting progressively high energy, shallow conditions (e.g. Sierra de Cajas, see Tortello & Esteban 2003).

At the Angosto de la Quesera, the Cambrian-Ordovician sediments (Padrioc, Lampazar, Cardonal and Saladillo Formations) overlie the "Granito Rojo La Quesera" (517 and 526 MY) of the Tastil Granite (Keidel 1943; Hongn et al. 2001; Aceñolaza et al. 2003; Astini 2005). The Lampazar Formation crops-out on the northwestern flank of the Angosto (Fig. 1.1), forming a slope partially covered by abundant debris (Aceñolaza et al. 2003). The succession is characterized by greenish, yellowish and reddish fine- to medium-grained sandstones and subordinate shales, which concordantly rest on the thick quartzites of the Padrioc Formation (Cambrian) (Fig. 1.2). The middle and upper parts of the section display gutter casts associated with hummocky cross stratification, a common feature of storm-dominated shelf environments. Reddish-yellowish, fine-grained sandstone beds contain gastropods in association with numerous specimens of Hyolitha and *Palaeophycus* isp., as well as with well-preserved cranidia of the olenid trilobites *Parabolina (Neoparabolina) frequens* (Barrande) and *Angelina hyeronimi* (Kayser).

Based on the trilobite content, the succession is referred to the lower part of the *Parabolina frequens argentina* Zone (uppermost Cambrian; Harrington

& LEANZA 1957; RUSHTON 1982; LUDVIGSEN 1982; ACEÑOLAZA 1983; SALFITY et al. 1984; RAO 1999; TORTELLO & ESTEBAN 1999, 2003; ESTEBAN & TORTELLO, in press). *Parabolina frequens* possesses a valuable potential for correlation (SHERGOLD 1988). RUSHTON (1982) and ŻYLIŃSKA (2001) reported it in the *Acerocare* Zone (Uppermost Cambrian) of Wales and Poland, respectively, whereas ROBISON & PANTOJA-ALOR (1968) illustrated fragmentary material from Mexico, associated with conodonts of the *Cordylodus proavus* Zone (LANDING et al. 2007).

The occurrence of *Strepsodiscus* KNIGHT does not contradict a latest Cambrian age for the Lampazar Formation. The genus is especially represented in the Trempealeauan of North America (Quebec, New York, Missouri) (CALVIN 1892; WALCOTT 1912; KNIGHT 1948; RUNNEGAR 1981; YOCHELSON & NUELLE 1985), as well as the Dresbachian of Colorado (KNIGHT 1948) and the Cambrian-Ordovician transition interval of Iowa and Texas (see YOCHELSON & NUELLE 1985).

3. Systematic palaeontology

Superfamily Bellerophontoidea M'COY, 1851
Family Cyrtolitidae MILLER, 1889

Genus *Strepsodiscus* KNIGHT, 1948

Type species: *Strepsodiscus major* KNIGHT, 1948, from the Late Cambrian (Dresbachian) of Colorado, EE. UU. by original designation.

Other species included: *Strepsodiscus paucivoluta* (CALVIN 1892), from the Late Cambrian (Trempealeauan) of Missouri and the Cambrian-Ordovician transition of Iowa and Texas, EE. UU. (YOCHELSON & NUELLE 1985); *S. minutissimus* (WALCOTT 1912), from the Late Cambrian (Trempealeauan) of New York, EE. UU. (RUNNEGAR 1981); *S. praecursor* (KNIGHT 1948), from the Late Cambrian (late Franconian to Trempealeauan) of Quebec, Canada (YOCHELSON & NUELLE 1985).

Remarks: The shells of the bellerophonts are coiled in a close spiral. The whorl cavity is deep and two symmetrical retractor muscles are inserted one on each side deeply within the aperture, in such a position that their retraction would withdraw the cephalo-pedal mass within the aperture. The presence of a U- or V-shaped notch in the aperture suggests the development of two gills in the living animal. Although this primitive feature is shared with the pleurotomarians, the bellerophonts differs from the latter by having an isostrophic coiling and a symmetrical shell (Knight 1952).

Strepsodiscus is characterized by having a discus-like shell with a final whorl that is out of contact with the coil, a slight degree of asymmetry in the sinistral sense, a deep V-shaped sinus in the anterior lip, and a sharp dorsal crest (KNIGHT 1948). The genus represents the oldest record of late Cambrian gastropods (YOCHELSON & NUELLE 1985): *Strepsodiscus* precedes in the fossil record *Scaevogyra* WHITFIELD, the earliest hyperstrophic gastropod, and both precede the earliest pleurotomarian. KNIGHT (1952) suggested that *Strepsodiscus* could be the precursor of sinistral or hyperstrophic gastropods, supposing that asymmetry arose as an early genetic response to the mechanical difficulties of isostrophic coiling. However, YOCHELSON & NUELLE (1985) pointed out that *Strepsodiscus* and *Scaevogyra* do not seem to be closely related genera because the latter strongly differs in having a simple inclined apertural lip. Speculations about the origin of sinistral coiling and/or hyperstrophic coiling of shells are based on little evidence (YOCHELSON & NUELLE 1985). According to those authors, the slight uncoiling and the asymmetry in *Strepsodiscus* might be the result of a growth "programme" for coiling, which allowed for more individual variation in this early genus than is commonly found in younger gastropods (YOCHELSON & NUELLE 1985).

Strepsodiscus austrinus sp. nov.
Fig. 2

Etymology: Refers to the geographic location of the species.

Material: Twenty specimens, internal and external moulds. Holotype: PIL 15215 (Fig. 2.4). Paratypes: PIL 15216-15234 a-b. The material is housed in the Facultad de Ciencias Naturales e Instituto Miguel Lillo, Universidad Nacional de Tucumán (PIL), Argentina.

Type locality and horizon: Angosto de la Quesera, Salta Province, Argentina. Lampazar Formation, lower part of the *Parabolina (Neoparabolina) frequens argentina* Zone, latest Cambrian.

Diagnosis: Shell fairly large, laterally compressed; shell surface smooth; spire with three tangent whorls slightly coiled to the left, and the final 1/4 whorl free. Whorl width rapidly expanding. Circumumbilical angulation absent.

Description: Shell moderately large, laterally compressed, with a slight and varying degree of asymmetry in the sinistral sense. Early growth stages consisting of three coiled whorls before developing open coiling. Whorl width rapidly expanding. Umbilicus widely open. Circumumbilical angulation absent. Dorsum narrow, almost lanceolate in cross section, lacking selenizone. Shell surface smooth. Aperture and slit unknown. A few specimens show a weak circumdorsal depression.

Measurements (in mm): Length: 7.5-27, width: 4-6.3.

Comparisons: *Strepsodiscus austrinus* sp. nov. mostly resembles the type species *S. major* KNIGHT (1948: 3, pl. 1, fig. 1.a-m) in having similar dimensions and degree of

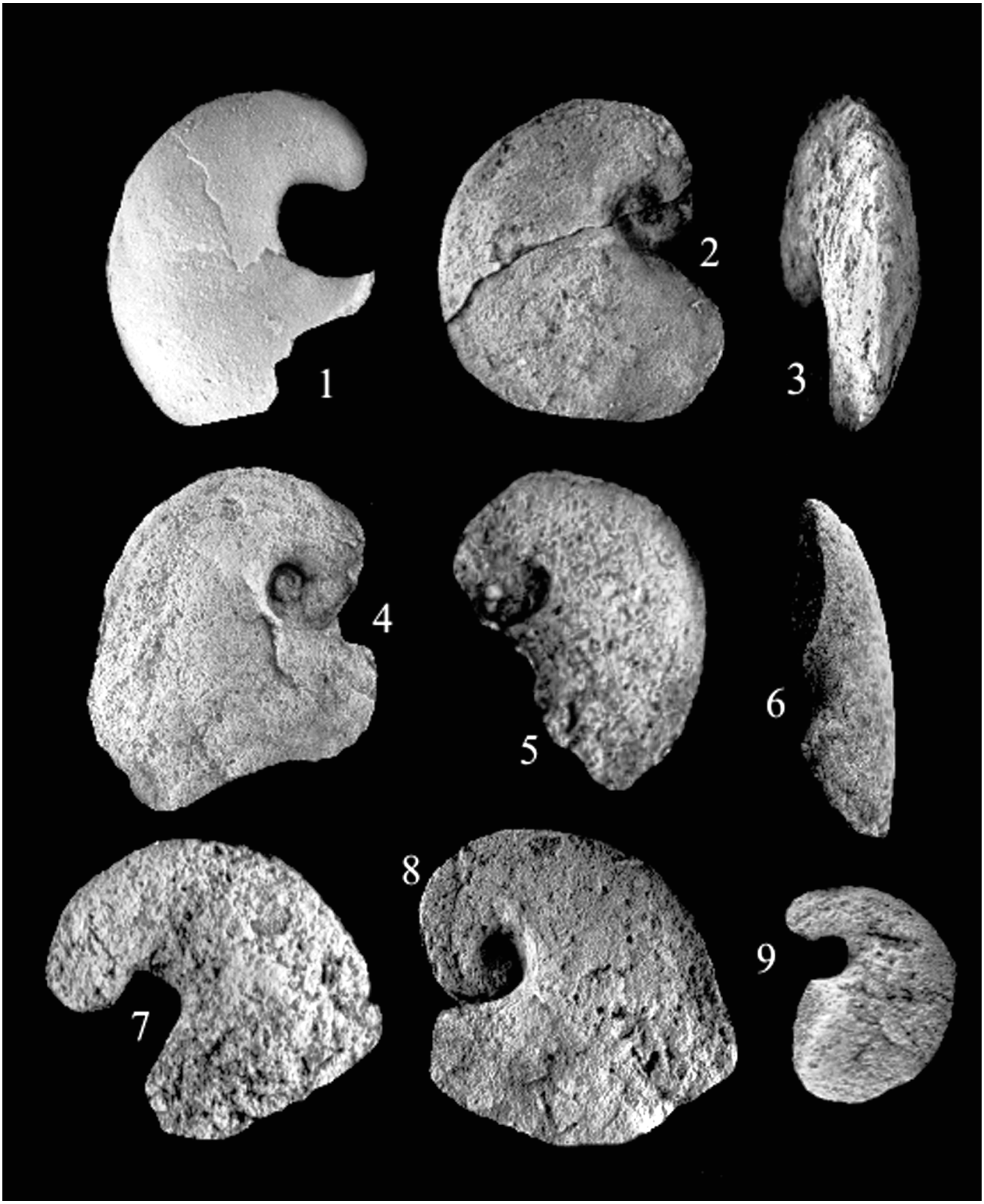

Fig. 2. *Strepsodiscus austrinus* sp. nov. **1** – PIL 15233 (latex mould), x2.5; **2** – PIL 15222, x3.1; **3** – PIL 15218, x2.5; **4** – PIL 15215 (holotype), x1.8; **5** – PIL 15225, x2.5; **6** – PIL 15223, x2; **7** – PIL 15219, x3; **8** – PIL 15234b, x2; **9** – PIL 15230, x3.4.

Table 1. Comparison of morphological characters in described species of *Strepsodiscus*. Length and width (in mm) correspond to the holotypes.

Species	Shell shape	Profile	Early growth stages	Body whorl	Dorsum	Growth lines	Selenizone	Slit	Umbilicus		Length	Width
S. major	Compressed	Asymmetric sinistral	Coiled	½ whorl free	Narrow	Present	Probable pseudo selenizone	Deep V-shape	Slightly deeper at right side		24.3	12.8
S. praecursor	Compressed	Symmetric	Coiled	¾ whorl free	Sharply rounded	Present	Convex	½ whorl deep	Widely open		11	4.3
S. minutissimus		Sub-elliptical	Coiled	Unknown	Carinate	Faint striae	---	---	Widely open	Circum-dorsal depression	4	---
S. paucivoluta	Strongly compressed	Symmetric lanceolate	Unknown	Wide, compressed	Narrow Knife-like	Present	Probably not	---	---	Circum-umbilical angulation	35	7
S. austrinus sp. nov.	Compressed	Asymmetric sinistral	Coiled	¼ whorl free	Narrow Knife-like	Absent	Absent	unknown	Widely open	Circum-dorsal depression	27	4

coiling; however, the latter differs by its circumumbilical angulation (Table 1). Both *S. austrinus* sp. nov. and *S. praecursor* (KNIGHT, 1948: 5, pl. 1, fig. 2.a-c) lack circumumbilical angulation, but the latter can be distinguished by possessing a symmetric shell, a more rounded dorsum, well defined growth lines and a selenizone. *Strepsodiscus paucivoluta* (CALVIN, 1892) (YOCHELSON & NUELLE 1985: 734 ff., figs. 1-2) differs from *S. austrinus* sp. nov. in showing a more open coiled shell.

Strepsodiscus minutissimus (WALCOTT, 1912: 266, pl. 41, figs. 15-16; RUNNEGAR 1981: figs. 3.N-Q) was described on the basis of small specimens, which show no evidence of open coiling. Because such change in shape is an ontogenetic feature, the species cannot be properly compared with other species of the genus until larger specimens are obtained (YOCHELSON & NUELLE 1985: 736 f.). The illustrated material of *Strepsodiscus minutissimus* seems to differ from *S. austrinus* sp. nov. in having striae on the shell surface.

Strepsodiscus austrinus sp. nov. and "Bellerophontida gen. et sp. indet. 1" from the latest Cambrian (Payntonian) of Tasmania (JAGO & CORBETT 1990, fig. 2.F) share similar dimensions and coiling degree. However, the material from Tasmania consists of a unique internal mould (only illustrated in lateral view), so it is not possible to provide a more complete comparison of both taxa.

4. Remarks on palaeoecology and functional morphology

The bellerophontids were benthic forms that developed different modes of life. Analyses of functional morphology are mainly based on key features such as the general shape of the shell, coiling degree, type of umbilicus and aperture, depth of the slit, and development of ornamentation and inductural deposits.

LINSLEY (1978: 202) proposed that the open coiled gastropods were especially adapted for a sedentary life in unconsolidated substrates. HARPER & ROLLINS (oral communication, 1982 in YOCHELSON & NUELLE 1985) suggested that some of the bellerophontaceans may have been semi-infaunal, possessing a relatively large foot that partly covered the shell.

The disposition of the early whorls and the slight uncoiling in the sinistral sense are features of palaeoecological significance in *Strepsodiscus.* The early growth stages of the genus consist of three coiled whorls, while the last whorl expands rapidly. The aperture is somewhat unusual, it seems drop-like then we can infer that the cephalopedal mass could have partially expanded out of it. By this way, the weight of the shell could have been distributed, the slight sinistral deviation counteracted, and the gravity centre compensated.

Strepsodiscus austrinus sp. nov. may have been a sedentary, semi-infaunal form adapted to live in unconsolidated sea bottoms. The co-occurrences of Hyolitha and the spiny trilobite *Parabolina (Neoparabolina) frequens argentina* (Kayser), as well as *Palaeophycus ichnosp.*, provide additional evidence in favour of soft sea bottom conditions (Aceñolaza & Aceñolaza 2002; Tortello & Clarkson 2006).

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