

A new, first fossil species of *Ophioderma* Müller and Troschel, 1842 (Echinodermata: Ophiuroidea) (Late Miocene, Argentina)

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Abstract

A new species of *Ophioderma* Müller and Troschel, 1842 is described. The new species is the first fossil one of the genus, and the third ophiuroid described for the Tertiary of South America. It is characterized by its large size, proximal dorsal arm plates arched, entire or irregularly fragmented in two or three parts and lateral arm plates with four or five short, flat spines of similar length with a finger-like outline.

Key words: Ophiuroidea, *Ophioderma*, new species, Miocene, Argentina

Introduction

Except for *Ophioderma longicauda* (Retzius, 1805) (type species of the genus) that lives in the Mediterranean Sea and Northeastern Atlantic Ocean (Spain to Senegal), all the species of *Ophioderma* Müller and Troschel, 1842, presently occur on both littorals of America, most inhabiting the Western Atlantic Ocean (South Carolina, USA to São Paulo, Brazil), and some distributed on the Eastern Pacific Ocean (California to Perú). They mostly inhabit shelf environments, but there are also some records in deep waters (Abreu-Pérez *et al.* 2005; Albuquerque and Guille 1991; Barraza and Hasbún 2005; Brito 1962; Clark 1940; Durán-González *et al.* 2005; Hendler *et al.* 1995; Koehler 1914, 1927; Laguarda-Figueras *et al.* 2005; Manso 1993; Neira and Cantera 2005; Netto *et al.* 2005; Solís-Marín *et al.* 2005; Tommasi 1970, among others).

Generic placement of some proposed fossil representatives of *Ophioderma* is a matter of discussion. Chen and McNamara (2006) showed that some Triassic species formerly placed in *Ophioderma* do not belong in the genus, and Maastrichtian and Pliocene records of Kutscher and Jagt (2000) and Berry (1935) are based only on isolated arm plates, which makes a proper generic assignment difficult. Our material includes large disks covered by granules, and firmly fused subrounded arms, bearing short, flat, and addressed spines, and paired flat genital scales. Therefore, the new species described herein becomes the first undoubted fossil record of this genus, extending considerably its geographical range into high southern latitudes of the Southern Hemisphere.

Fossil ophiuroids from Tertiary strata of South America are scarce and only known (outside of Argentina) through the report of *Amphioplus venezuelanus* Berry, 1941 described from the Miocene of Venezuela, and the mention and illustration given by Kutscher *et al.* (2004) of *Ophiomusium* sp. (Miocene, Chile). Ophiuroids of Argentina are also poorly known, and are represented by *Ophiura elegantoides* Furque and Camacho, 1949, a late Middle Eocene taxon from the Leticia Formation (Tierra del Fuego), and by a recently described species of *Ophiocrossotta* (Caviglia, Martínez and del Río 2007), from the Early Miocene Chenque Formation. Other

records are only for “ophiuroids”, (Bertels 1965, Martínez *et al.* 2005) or without any factual basis (such as descriptions, illustrations or reference to any specimen, De Sáez, 1928).

Geological setting, taphonomy, and paleoecology

The material studied herein was found in the shoreface facies recorded from the regressive phase at the top of the Puerto Madryn Formation exposed at the cliffs of a new fossiliferous locality situated close to Estancia San Lorenzo, 18 km west to Punta Norte (southern coast of the San Matías Gulf, Península Valdés, Chubut Province) (figure 1).

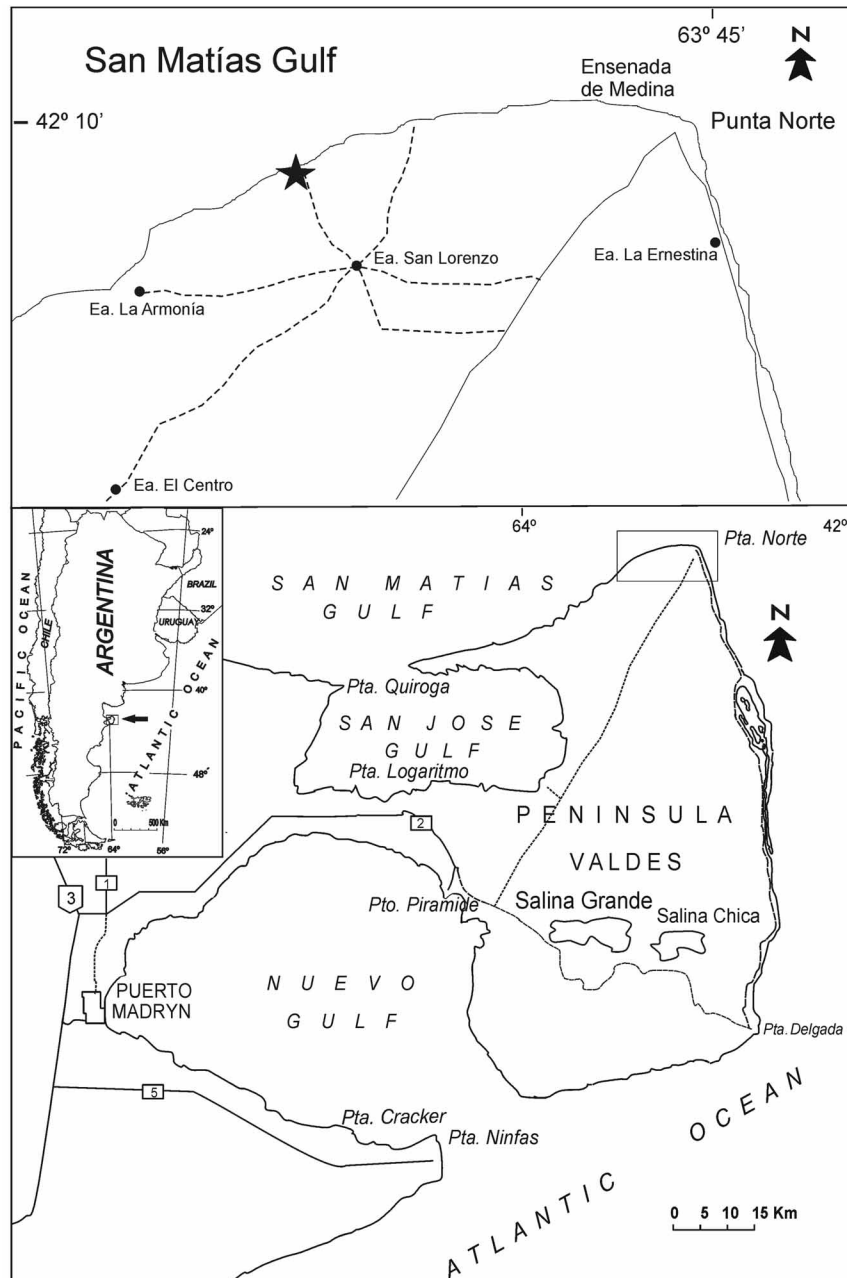


FIGURE 1. Geographic location (star) where the specimens of *Ophioderma bonaudoae* n.sp. were collected.

The Puerto Madryn Formation (Haller, 1978) consists of a 200 m thick, sandy sequence with intercalated highly fossiliferous shell-beds deposited in midshelf to foreshore environments (del Río *et al.*, 2001), around 10 million years ago (Tortonian, early Late Miocene) according to $^{87}\text{Sr}/^{86}\text{Sr}$ isotope ratios (Scasso *et al.*, 2001).

The studied outcrop (figure 2) consists of a 20 m thick sedimentary sequence composed of grey-white heterolithic tidal flat and shoreface tongue deposits with their upper part intensively bioturbated (ichnofabric consists mainly of *Ophiomorpha* and *Skolithos*), intercalated with numerous yellowish massive, fine sandstones shell- beds.

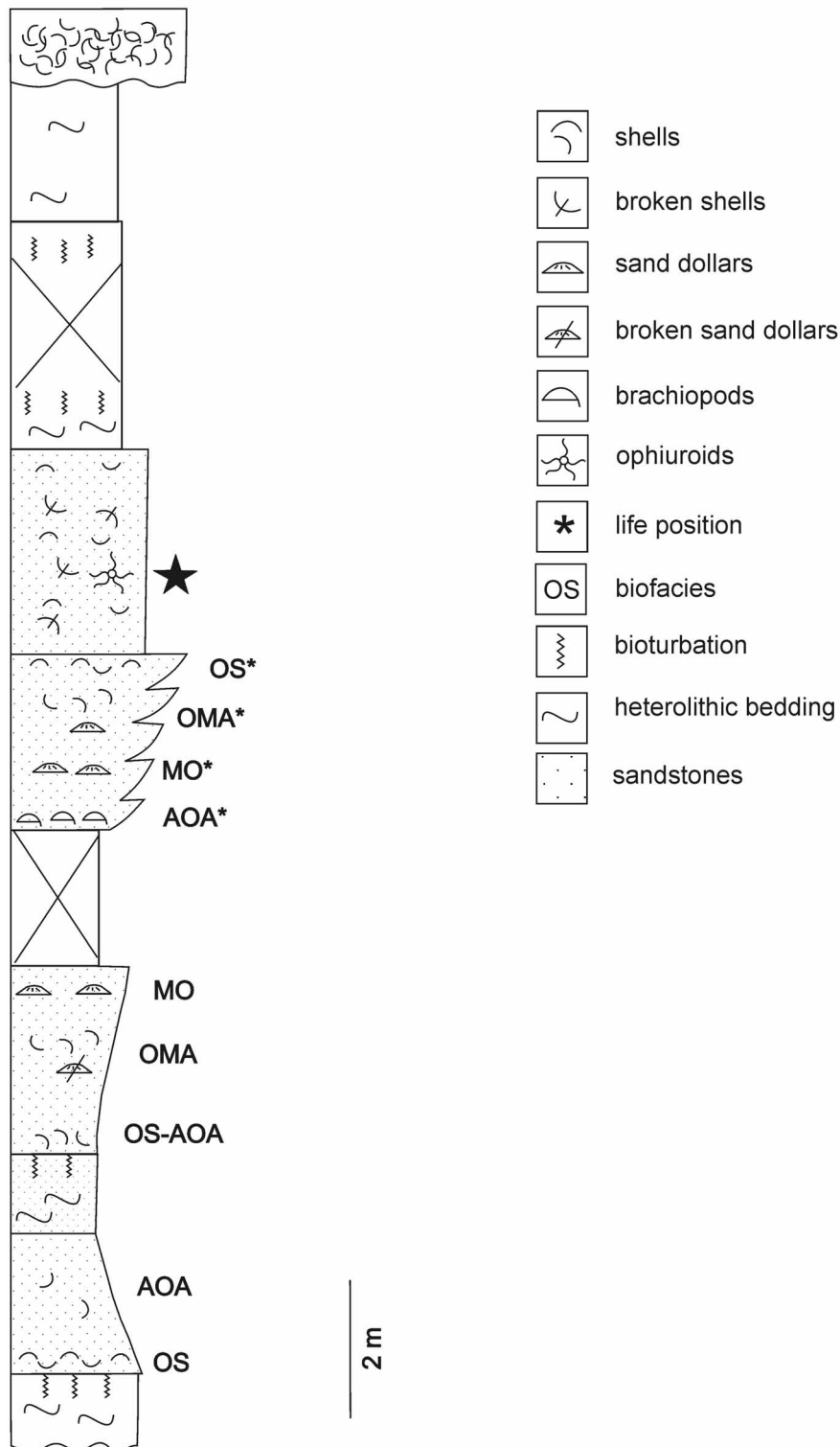


FIGURE 2. Stratigraphic section at Estancia San Lorenzo. Location of the specimens of *Ophioderma bonaudoae* **n.sp.** indicated by the star.

The MO, OS, AOA and OMA assemblages (biofacies) defined by del Río *et al.* (2001) dominate the fossiliferous beds, and were deposited by storm events in upper shoreface environments. Several recurrent census assemblages of *Pachymagas piramidesia* (AOA), *Monophoraster darwini* and “*Ostrea*” *patagonica* (MO, OS Assemblages) are recorded and indicate shallow depth associations situated just behind the surf zone in a high energy environment with a strong wave action. AO and OMA Assemblages constitute autochthonous-parautochthonous thin beds distributed throughout the sequence.

On the basis of the abundant molluscan fauna recorded in the Puerto Madryn Formation, Martínez and del Río (2002) defined the Valdesian Province, a biogeographic entity mostly characterized by the presence of paratropical warm-water elements with Caribbean affinities. The present record of *Ophioderma* is a confirmation of this assertion, since this genus is at present restricted to warm to warm-temperate waters, with its southernmost distribution placed at São Paulo (Brazil) in the Southwestern Atlantic coast, where the warm Brazilian Current that moves from north to south influences surficial water temperatures (figure 3).

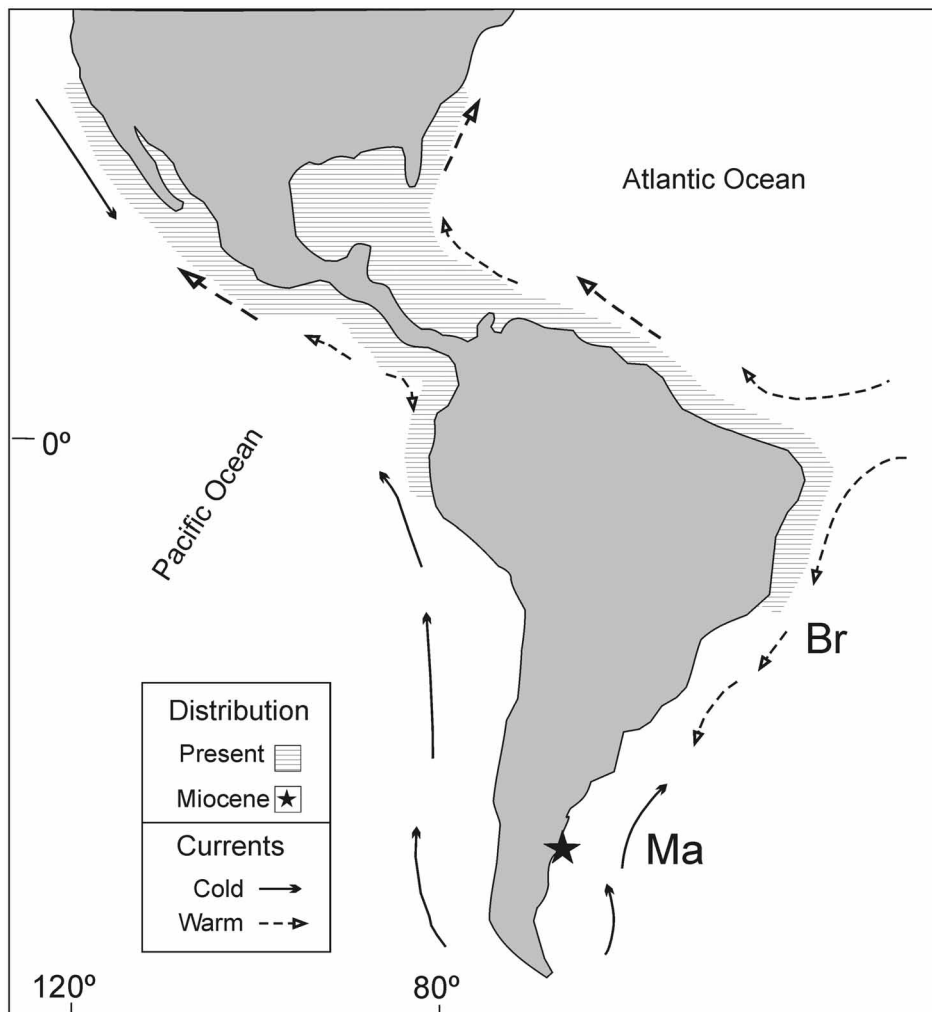


FIGURE 3. Present and Miocene geographic distribution of *Ophioderma* in the Americas. According to Martínez and del Río (2002) in the Miocene the influence of the proto Brazilian Current (Br) reached the present Península Valdés area, where now the Malvinas (Falkland Current) is operating..

According to autecologic information, some ophiuroids coil the arms when disturbed (i.e. *Amphipholis squamata* (Delle Chiaje, 1828), and *Ophiolepis paucispina* (Say, 1825); Hendler 1979, Emson and Wilkie 1982, Hendler and Turner, 1987, Hendler *et al.* 1995), and this is the position in which the holotype of *Ophioderma bonaudoae* new species was found (arm coiling is around and below the disk), indicating the typical very rapid burial after death characteristic of storm events.

Abbreviations: CNP-PIIc, Centro Nacional Patagónico, Paleontological Collection

Suprageneric classification follows Smith *et al.* (1995).

Class Ophiuroidea Gray, 1840

Subclass Ophiuridea Gray, 1840

Order Ophiurida Müller and Troschel, 1840

Suborder Ophiurina Müller and Troschel, 1840

Infraorder Ophiodermatina Smith, Paterson and Lafay 1995

Family Ophiodermatidae Ljungman, 1867

Subfamily Ophiodermatinae Ljungman, 1867

***Ophioderma* Müller and Troschel, 1842**

Type species. *Asterias longicauda* Retzius, 1805, by subsequent designation, Clark, 1915.

Although the most conspicuous characteristic of the genus, i.e. the genital slits, are not visible, the presence of large disks with very small scales covered by granules, firmly fused subrounded arms, very short, flat, and addressed arm spines, and two flat genital scales, lead us to include the fossils in *Ophioderma*.

***Ophioderma bonaudoae* new species**

Plate 1, figs. A–G

Diagnosis. Large *Ophioderma* with proximal dorsal arm plates arched, entire or irregularly fragmented in two or three parts; lateral arm plates with four or five short, flat spines of similar length with a finger-like outline.

Description. Disk outline pentagonal, interbrachial outline straight. Ventral surface not fully preserved. Dorsal surface with very small scales, larger distally, covered by small rounded granules. Radial shields ovate, granules do not cover them but taking into account the preservation, radial shields could have been covered. Arms broadly rounded near the disk, more rounded distally; ventrally flat, and with dorsal midline angular to rather sharply angular proximally, becoming flatter distally. At base, arm diameter is around 1/4 of disk diameter, and taper gently. Proximal dorsal plates sometimes irregularly fragmented in two or three parts. Ventral arm plates pentagonal, wider proximally (visible as hexagons) than distally (visible as quadrangles). Convex lateral plates bear five (four distally) small, not reaching the next distal joint, flattened, addressed spines, with a finger-like outline. Spines are of similar length, or the dorsal one is a little smaller. Two flat tentacle scales, the ventral one largest. Buccal elements not preserved, except the hemi-mandibles and an oral shield (paratype). The oral shield is broadly rounded, the lateral margins converge gently to the mouth, and the proximal side is nearly straight.

Dimensions. Holotype, disk diameter: 29 mm, arm base diameter: 7 mm; Paratype, disk diameter : 24 mm, arm base diameter : 6 mm.

Type material: Holotype CNP-PIIc 00233, Paratype CNP-PIIc 00234

Etymology. Dedicated to María Sol Bonaudo, who collected both specimens.

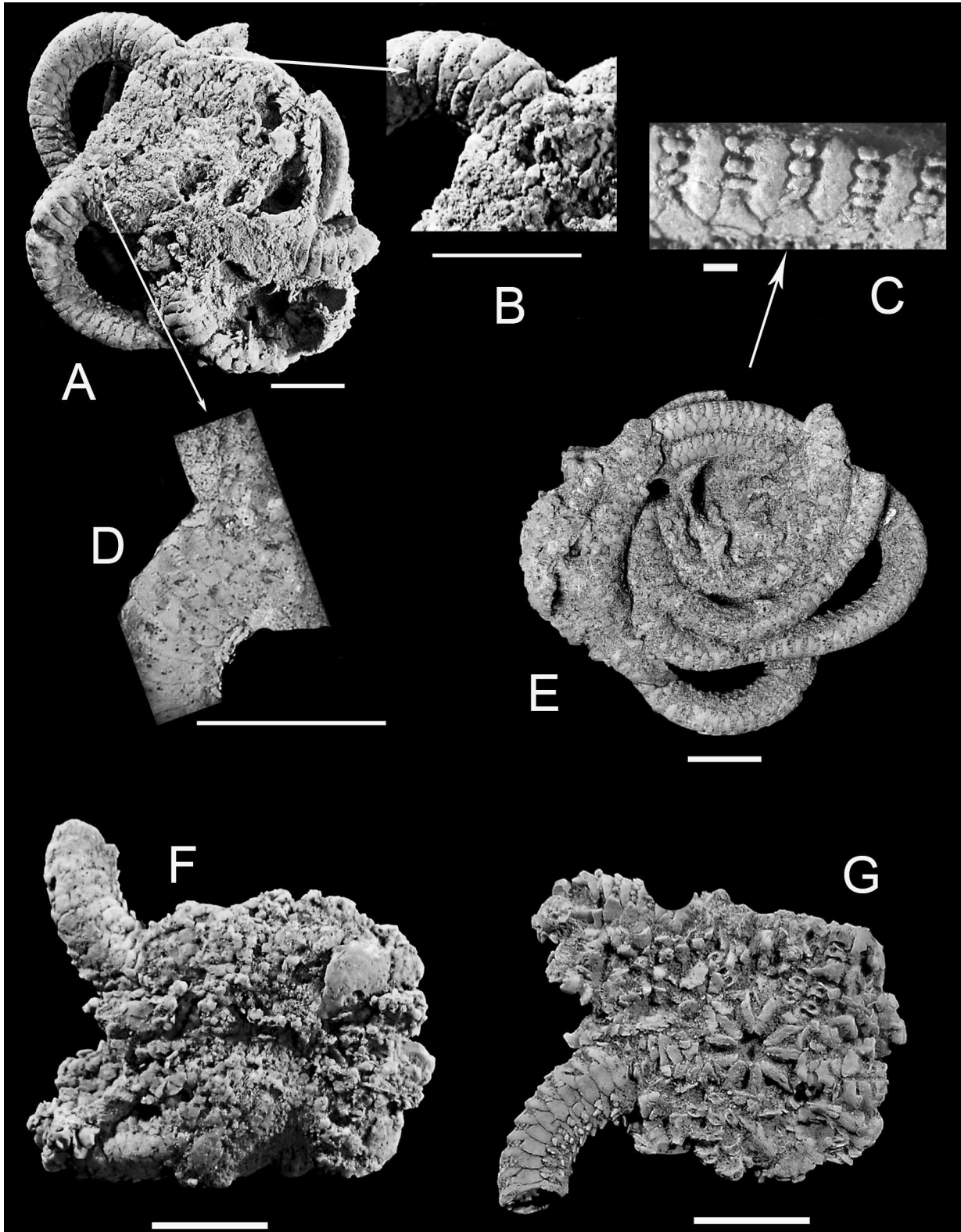


PLATE 1. *Ophioderma bonaudoae* n.sp. A. Dorsal view of Holotype CNP-PIIc 00233. . Scale bar: 10 mm. B. Arm base of Holotype CNP-PIIc 00233. Scale bar: 10 mm C. Lateral view of arm of Holotype CNP-PIIc 00233. Scale bar: 1 mm. D. Arm base Holotype CNP-PIIc 00233. Scale bar: 10 mm. E. Ventral view of Holotype CNP-PIIc 00233. Scale bar: 10 mm F. Dorsal view of Paratype CNP-PIIc 00234 Scale bar: 10 mm. G. Ventral view of Paratype CNP-PIIc 00234. Scale bar: 10 mm.

Discussion

Ziesenhenné (1955) recognized 21 species of *Ophioderma*; since this time, five more have been described, but there is no modern revision of the genus, and probably there are some synonyms. Hence, comparisons are done with the best-recognized species. As can be noted, although the preservation of the new species prevents comparison of some of the commonly used characters, the recent species of *Ophioderma* can be distinguished from *Ophioderma bonaudoae* n. sp. on the basis of the disk size and shape, transverse dimension and shape of the arm, arm plate architecture, and number, size and shape of the arm spines.

O. longicauda (Retzius, 1805) (Mediterranean Sea, Atlantic Ocean from Iberian Peninsula to Senegal), type species of the genus, is similar in size, but differs from *O. bonaudoae* n.sp. in having thinner arms, 8–10 arm spines, the ventralmost being larger.

O. cinereum Müller and Troschel, 1842 (Florida to São Paulo, Brazil) is similar to *O. bonaudoae* n.sp. in size, but the former has the proximal dorsal plates of the arm irregularly fragmented in small parts, the size of the around 8 spines gradually increase towards the ventral side, the most ventral one nearly reaching the next distal joint.

The disk of *O. bonaudoae* n.sp. is rather larger than that of *O. appressum* (Say, 1825) (north of the State of São Paulo, Brazil, to North Carolina), and they also differ in *O. appressum* having the dorsal arm plates undivided, and 8 to 10 spines, the largest being the most ventral one, that nearly reaches the next distal joint.

O. brevicaudum Lütken, 1856 (North Carolina to northeastern Brazil, Ascension Island) is smaller than *O. bonaudoae* n.sp., has polygonal granules near the edge of the disk, and arm spines, although the most similar in shape to those of *O. bonaudoae* n.sp., are more numerous, triangular in outline and nearly reach the base of the next distal joint.

O. brevispinum (Say, 1825) (North Carolina to northeastern Brazil) differs from *O. bonaudoae* n.sp. in having the former 7–9 thin, blunt tipped and peg-like arm spines.

O. januarii Lütken, 1856 (Antilles to São Paulo, Brazil) is smaller than *O. bonaudoae* n.sp., has octagonal ventral arm plates, unfragmented dorsal arm plates, and 7 to 9 brachial spines.

O. guttatum Lütken, 1859 (Caribbean Sea) is larger than *O. bonaudoae* n.sp., has flattened granules, dorsal arm plates irregularly fragmented in many pieces, and more numerous arm spines, of different shape and size.

O. phoenium H. L. Clark, 1918 (Caribbean Sea) is smaller than *O. bonaudoae* n.sp., and has 9–10 arm spines, of different shape and size.

O. rubicundum Lütken, 1856 (Caribbean Sea) is smaller than *O. bonaudoae* n.sp., has the dorsal arm plates not fragmented, and has 7–9 arm spines, the most ventral noticeably larger than the others.

O. squamosissimum Lütken, 1856 (Caribbean Sea) is larger than *O. bonaudoae* n.sp., has flattened granules, and the dorsal arm plates subdivided transversely. Although the number of arm spines can be sometimes equal to that of *O. bonaudoae* n.sp., in this species are all of similar size, and in *O. squamosissimum* size increases ventrally.

O. bonaudoae n.sp. is larger than *O. panamense* Lütken, 1859 (California to Peru), and the latter has the upper arm plates undivided. Arm spines in *O. panamense* are more numerous, increase ventrally in size, and are more pointed.

O. variegatum Lütken, 1856 (California to Panama) is clearly distinguished from *O. bonaudoae* n.sp. by its very narrow arms, and more numerous and robust arm spines.

O. teres (Lyman, 1860) (Gulf of California to Peru), although rather similar in size, can be differentiated from *O. bonaudoae* n.sp. because the adults have the upper arm plates always broken in two or more irregular fragments, and 8–10 spines of more triangular shape, not all of equal size.

O. devaneyi Hendler and Miller, 1984 (North Carolina to Straits of Florida, Gulf of Mexico) is similar in size to *O. bonaudoae* n.sp., but has the dorsal arm plates subdivided (except near tip), and bear up to nine spines whose length increase ventrally.

O. ensiferum Hendler and Miller, 1984 (Caribbean Sea) is smaller than *Ophioderma bonaudoae* n.sp., has dorsal arm plates not fragmented, and up to seven pointed arm spines with length increasing ventrally, the most ventral covering the tentacle scale and reaching the base of the next ventral spine.

TABLE 1. Comparison of some characters of the species of *Ophioderma*. Size and arm width are considered when differing significantly from those of *Ophioderma bonaudoae* n.sp. pdap: proximal dorsal arm plates, laps: lateral arm plates spines, -: not significantly different.

	Disk size	Disk granules	Fragm pdap	Number laps	Relative size and shape laps	Arm width
<i>O. bonaudoae</i> n.sp.	-	rounded	No, or 2–3 parts	4–5	Flat, finger-like outline short, all similar	-
<i>O. longicauda</i>	-	rounded	no	8–10	Straight sided, blunt tip, ventralmost larger	thinner
<i>O. cinereum</i>	-	rounded	Yes (small)	ca. 8	straight sided, blunt tip, increase ventrally, ventralmost tapered and pointed	-
<i>O. appressum</i>	smaller	rounded	no	8–10	increase ventrally, ventralmost tapered	-
<i>O. brevicaudum</i>	smaller	some polygonal	rarely	7–9	Short, finger-like outline to almost triangular, all similar	-
<i>O. brevispinum</i>	smaller	rounded	no	7–9	straight sided, blunt tip, short, all similar	-
<i>O. januarii</i>	smaller	rounded	no	7–9	Increase at the middle or ventrally, blunt tip dorsally, more acute ventrally	-
<i>O. guttatum</i>	larger	flattened	yes	9–10	small, acute, dorsal slender	-
<i>O. phoenium</i>	smaller	rounded	no	9–10	dorsals pointed, ventrally larger	-
<i>O. rubicundum</i>	smaller	rounded	no	7–9	straight sided, blunt tip, short, ventral most larger	-
<i>O. squamosissimum</i>	larger	flattened	yes	5–7	straight sided, blunt tip, size increase ventrally	-
<i>O. panamense</i>	smaller	rounded	no	10–12	Size increase ventrally, almost triangular	-
<i>O. variegatum</i>	-	rounded	yes	7–10	robust, blunt tip	Thinner
<i>O. teres</i>	-	rounded	yes	8–10	ventralmost larger	-
<i>O. devaneyi</i>	-	rounded	yes	Up to 9	Blunt, truncated tip, size increase ventrally	-
<i>O. ensiferum</i>	-	rounded	no	Up to 7	Pointed, size increase ventrally	-

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