ONUSTUS PLIOEXTENSUS (SACCO 1896) (GASTROPODA: CAENOGASTROPODA): A MEDITERRANEAN PLIOCENE XENOPHORID WITH WESTERN ATLANTIC RELATIONSHIPS?

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Abstract Onustus plioextensus *(Sacco 1896) is a Mediterranean Pliocene xenophorid characterized by a large fragile shell with wide thin peripheral flange, porcellanous below. It is only known from the Piacenzian (Middle Pliocene) of central northern Italy and is very similar to the west Atlantic* Onustus longleyi *(Bartsch 1931). If the morphological similarity between these two xenophorids is not a result of convergent evolution and testifies to real affinity, then they constitute a group of closely related species with amphi-Atlantic distribution, a biogeographical pattern suggested for certain gastropod species mainly belonging to the tonnoideans.*

Key words *Xenophorids,* Onustus plioextensus, *taxonomy, palaeontology, biogeography, Pliocene*

INTRODUCTION

Manganelli *et al.* (2004) recently revised the Euro-Mediterranean Pliocene xenophorids, re-examining a species established by Sacco (1896), *Xenophora plioextensa*, on the basis of such bad material that he was not sure whether it actually belonged to a xenophorid. Unfortunately the redescription was also based on specimens which were fragmentary or still partly embedded in shale.

An entire shell and other material recently became available, making it possible to complete the description of this rare and little known fossil xenophorid. The new material also confirms the similarity between the Euro-Mediterranean Pliocene species and the west Atlantic *Onustus longleyi* (Bartsch 1931), raising an interesting biogeographical case.

MATERIALS AND METHODS

Morphological nomenclature Morphological nomenclature is usually that used by Ponder (1983), including the term "spire" for the upper parts of whorls, adapical to the periphery or peripheral flange; aperture terms are according to Manganelli *et al.* (2004).

Material examined No examined specimen has a registration number. Acronyms for the collections in which the material is kept are: AFMSN, Museo di Storia Naturale dell'Accademia dei Fisiocritici di Siena; FPC, F. Pizzolato collection, Arezzo; GMC, G. Manganelli collection, Siena; MMAS, Museo del Mare Antico, Salsomaggiore; VSC, V. Spadini collection, Lucignano. Other acronyms: fr fragments; sh shell.

Collecting sites These are from Siena and Radicofani Pliocene basins (southern Tuscany). For each site the nearest toponym, municipality and kilometric UTM references are given with a short description. Locality names and UTM references are according to the *Carta Topografica Regionale* (Scala 1:25.000, Edizione 1ª, anno 1980) of Tuscany. For site descriptions we used the Italian terms *biancane* and *calanchi* because they are used in the geomorphological literature (e.g. Phillips, 1998).

Finerri (Asciano, 32TQN1287): road-bed of the country road between Finerri and Pecorile; grey clays of Middle Pliocene (Piacenzian).

Fontanelle (Asciano, 32TQN0394): badlands (*biancane*) along the road between Arbia and Asciano, west of Fontanelle; grey clays of Middle Pliocene (Piacenzian).

I Sodi (Asciano, 32TQN0198, 0298): quarry of the brick factory "Laterizi Arbia" near Stazione di Castelnuovo Berardenga; grey clays of Middle Pliocene (Piacenzian).

Montepollini (Asciano, 32TQN1188): badlands (*biancane*) south of Montepollini; grey clays of Middle Pliocene (Piacenzian).

Mucigliani (Asciano, 32TQN0196): bed of the country road between Stazione di Castelnuovo

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Berardenga and Mucigliani, northwest of Mucigliani; grey clays of Middle Pliocene (Piacenzian).
Orsina Vecchia (Asciano, 32TQN1188): badlands (*biancane*) south of Orsina Vecchia; grey clays of Middle Pliocene (Piacenzian).
Poggetti (Asciano, 32TQN1092): ex-quarry of the brick factory "Fornaci di Rapolano"; grey clays of Middle Pliocene (Piacenzian). This site is reported as "Fornaci di Rapolano" by Manganelli *et al.* (2004).
Poggiodarno (Asciano, 32TPN9996): badlands (*biancane*) along the road between Monte Sante Marie and Asciano, northwest of Poggiodarno; grey clays of Middle Pliocene (Piacenzian).
Poggio Vangelo (Asciano, 32TPN9996): bed of the country road between Casacce and Fiorentine di sopra; grey clays of Middle Pliocene (Piacenzian).
San Vittorio (Asciano, 32TQN0793): section exposed on the left side of the Siena – Asciano railway between Ombrone River and San Vittorio (now covered by vegetation); grey clays of Middle Pliocene (Piacenzian).
Turnoff to Castelnuovo Berardenga (Castelnuovo Berardenga, 32TQN0399): outcrop exposed on left side of the Siena – Bettolle State Road (no. 326), at turnoff to Castelnuovo Berardenga; grey clays of Middle Pliocene (Piacenzian).
Vescona (Asciano, 32TQN0294): badlands (*biancane*) along the road between Arbia and Asciano, west of Fontanelle, at turnoff to Podere Sant'Anna; grey clays of Middle Pliocene (Piacenzian).

Description of species

Onustus plioextensus (Sacco 1896)

Primary reference [*Xenophora*] (*Tugurium*) *plioextensum* Sacco, 1896: p. 27, pl. 4, figs 3–3^{b}.

Type material No type material exists in the Bellardi – Sacco collection at the Museo Regionale di Scienze Naturali of Turin (Ferrero Mortara *et al.*, 1984).

Type locality "*Piacenziano*: Monte Castello presso Alessandria (poco frequente)", Italy.

Material examined Siena basin: Finerri (fr GMC), Fontanelle (fr GMC), I Sodi (fr GMC, 1 sh FPC, fr VSC), Montepollini (fr GMC), Mucigliani (fr GMC), Poggetti (fr VSC), Orsina Vecchia (fr GMC), Poggiodarno (fr GMC), Poggio Vangelo (fr GMC), San Vittorio (fr GMC), Vescona (fr GMC), turnoff to Castelnuovo Berardenga (fr GMC).

In addition to Sienese material, we studied a fine shell from the Pliocene of Campore di Salsomaggiore (Quarantelli collection, MMAS) and a badly preserved whole specimen, still partly embedded in shale, without collection data (AFMSN).

Diagnosis A species of *Onustus*, characterized by large size, trochiform shell with wide thin peripheral flange, porcellanous below; teleoconch with about six nearly flat and irregular whorls; most of spire surface free of attached objects or their scars, with very small delicate wavy vermiculate opisthocline riblets; attached objects (shells and fragments of shells) small to medium in size; base convex; basal sculpture consisting of robust collabral growth lines and very thin spiral lines; basal margin of peristome curved and initially thickened and reflexed; umbilicus round and deep.

Description Shell large, usually fragile (but some largest specimens robust), trochiform with pointed apex and wide thin peripheral flange, porcellanous below, spire conical; protoconch multispiral; teleoconch with about six regularly growing whorls; last whorl large, dilated; whorls nearly flat and irregular; sutures very shallow; most of spire surface exposed (i.e. free of attached objects or their scars), with very small, delicate wavy vermiculate opisthocline riblets intersected by weak prosocline growth lines and some prosocline rugae; attached objects only along sutures of last whorls and peripheral flange, widely spaced, small to medium in size and consisting of shells and shell fragments of gastropods (*Turritella spirata*, *Onustus plioextensus*, *Galeodea echinophora*, *Nassarius striatulus*, *Sveltia lyrata*, *Gemmula rotata*, *Gemmula contigua*, *Stenodrillia allionii* and *Comitas dimidiata*), bivalves (*Nucula placentina*, *Anadara diluvii*, *Korobkovia oblonga*, *Tellina serrata* and some others unidentified) and scaphopods (*Dentalium sexangulum*); scars of attached objects shallow to deep; base robust, convex with robust collabral growth and very fine wavy spiral lines; growth lines originate from umbilicus where they are disposed diagonally, then collabrally

cross base, becoming lamellate and terminating abruptly, slightly raised, at junction between base and peripheral flange or, sometimes, continuing on peripheral flange beyond junction between base and peripheral flange; aperture small; basal margin of peristome curved, initially thickened and well reflected; umbilicus wide, round and deep, perhaps slightly covered by peristome.

Dimensions Estimated diameter of largest specimens around 15 cm.

Geographic and stratigraphic distribution At present the species is known only from some localities of the Italian Pliocene (Monte Castello near Alessandria, Piedmont: Sacco (1896), Salsomaggiore: Manganelli *et al.* (2004), Siena Basin: Manganelli *et al.* (2004)), but its distribution is probably wider. In the Crete Senesi it is widespread in many outcrops consisting mainly of clayey sediments of deep facies dating back to the Piacenzian (Middle Pliocene), together with *Korobkovia oblonga* (Philippi 1844), *Aporrhais peralata* (Sacco 1893) and *Leucosyrinx angelonii* (De Stefani 1875).

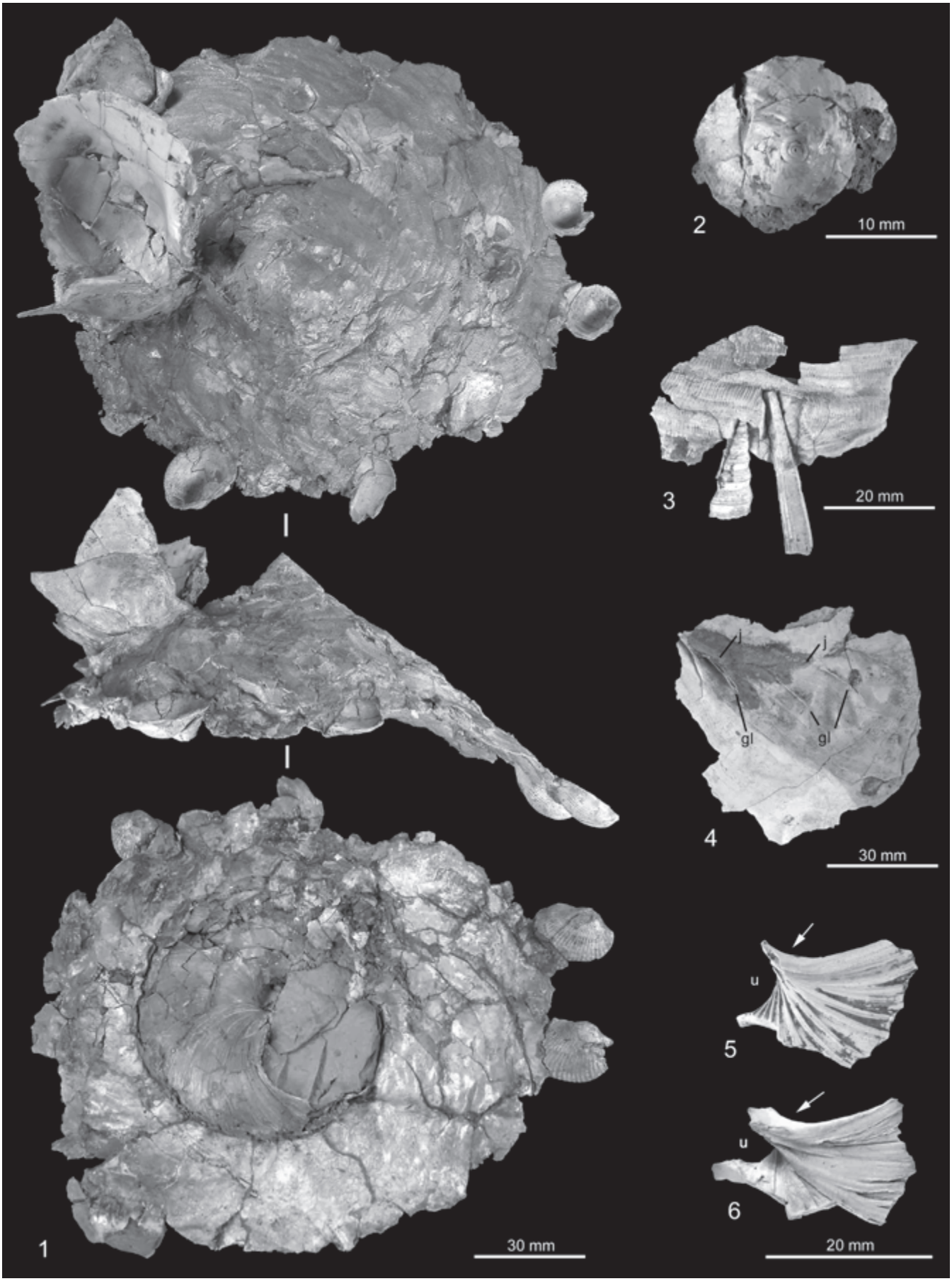
Etymology The specific epithet *plioextensa,* formed by the suffix "*plio*" from Pliocene and the adjective "*extensa*", wide, from the binomial *Trochus extensus* Sowerby 1821, expresses Sacco's opinion that the two species were similar.

Nomenclature Although Sacco (1896) listed this species as "*Tugurium plioextensum*", in the text and in the legend of Plate 4, the original combination is *Xenophora (Tugurium) plioextensa* because he regarded *Tugurium* as a subgenus of *Xenophora* (see p. 25). This equivocal treatment is not exclusive to this genus, but the rule whenever there are subgenera throughout Sacco's text of Bellardi and Sacco's *I Molluschi dei terreni terziari del Piemonte e della Liguria*.

Systematics Ponder (1983) marked the modern starting point for the systematics of the xenophorids. He assigned all living species to the genus *Xenophora* Fischer von Waldheim 1807, split into three subgenera: *Xenophora* (s.s.), *Stellaria* Möller 1832, and *Onustus* Swainson 1840. Although his systematics was widely adopted in the '80s and '90s, certain recent authors have preferred to regard *Stellaria* (Kreipl *et al.*, 1999; Kreipl & Alf, 1999; Nielsen & De Vries, 2002; Landau *et al*., 2004; Manganelli *et al.*, 2004) and *Onustus* (Kreipl *et al.*, 1999; Kreipl & Alf, 1999; Simone, 2005) as distinct genera as well. We also use this approach.

Remarks Manganelli *et al*. (2004) tentatively assigned this species to *Xenophora plioextensa* Sacco 1896. In fact, although Sacco's diagnosis is defective (*"Testa crassula, conica. Anfractus primi et medii laeves, laeviter convexuli, sublucidi, corpora aliena non colligentes. Umbilicus latus, profundus sublaevis"*) and based on such bad material that he was not sure whether it belonged to a xenophorid, it is consistent with a species of *Onustus*, especially in view of the large umbilicus. Unfortunately the type material in the Bellardi-Sacco collection at the Museo Regionale di Scienze Naturali of Turin no longer exists (Ferrero Mortara *et al*., 1984). Sacco's figures are of no help because they illustrate two internal moulds, and new material from the type locality is not yet available.

After its description, this species was subsequently recorded by Cossmann (1916), Ponder (1983), Manganelli *et al*. (2004) and Chirli (2008). Cossmann (1916) regarded it as a valid species, occurring "dans le Plaisancien d'Italie et dans le Scaldisien d'Anvers" and illustrated a fine shell (Cossmann, 1916: pl. 11, figs 20–21), without giving the locality of collection. This shell does not belong to an *Onustus* species and seems to have a base, aperture and umbilicus similar to the shell figured by Marquet (1997: pl. 1, fig. 7) as *Xenophora scaldensis* Glibert 1958, from the Pliocene of Kallo (Belgium). Ponder (1983) briefly discusses its relationships, stating that it probably belonged to the lineage that began with *Trochus extensus* Sowerby 1821, together with the Italian Miocene *Phorus borsoni* Sismonda 1847, and *Xenophora depressa* Pantanelli 1887. Manganelli *et al.* (2004) redescribed the species on the basis of new Pliocene material from localities in Emilia Romagna and Tuscany, stating that *O. plioextensus* was very similar to *O. longleyi* (Bartsch 1931), because both have the porcellanous lower surface of the peripheral flange and a curved basal peristome (other *Onustus* species with porcellanous lower surface of peripheral flange have a wavy inner basal margin of peristome; see Kreipl & Alf, 1999: pls 26–28). Finally Chirli (2008: pl. 8,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figs 8–9) illustrated a specimen from the Tuscan Pliocene misidentifying it as *Xenophora plioitalica* (Sacco 1896).

The new material confirms the similarity between fossil species from the Italian Pliocene and Recent species from the western Atlantic. Besides the porcellanous lower surface of the wide peripheral flange and the curved basal peristome, the two species also share the robust collabral growth lines which become lamellate before terminating abruptly, slightly raised, at the junction between the base and peripheral flange or continuing on the peripheral flange beyond junction between base and peripheral flange; they differ in spire angle, width of peripheral flange and perhaps inner basal peristome (spire angle more acute, peripheral flange less wide and inner basal peristome less thickened and reflexed in *O. longleyi*) (for *O. longleyi*, see: Ponder, 1983: figs 31 g, 31h; Goud & Kronenberg, 1988–89: figs 20B, 43; Kreipl & Alf, 1999: text fig. 44, pl. 28, figs 26, 26a, 26b; Simone, 2005: 384–386, as *O. caribaeus*).

If the morphological similarity between the Euro-Mediterranean Pliocene *Onustus plioextensus* and the Recent West Indian *Onustus longleyi* is not the result of convergent evolution and testifies real affinity between the two taxa, then this raises an interesting biogeographical problem. The biogeographical relationships between malacofaunas on opposite sides of the Atlantic have received some attention, especially from a western Atlantic perspective (see, for example: Scheltema, 1992, 1995; Briggs, 2003; Vermeij, 2005). Recent amphi-Atlantic molluscan species are very common in cold and temperate waters (Franz, 1970; Vermeij, 2005), but rare in the tropical sector, although examples of tropical amphi-Atlantic species are known, especially among the tonnoideans: *Phalium granulatum* (Born 1778), *Eudolium crosseanum* (Monterosato 1869) *Cypreocassis testiculus* (Linnaeus 1758), *Cymatium parthenopeum* (von Salis 1793) and so on (Laursen, 1981; Marshall, 1992; Landau *et al*., 2004). The issue was recently tackled for Euro-Mediterranean Neogene molluscs by Landau *et al.* (2004) while discussing the evolutionary history and biogeography of the tonnoideans of the Early Pliocene of Estepona in southern Spain. According to Landau *et al*. (2004), the fossil record of these molluscs suggests that certain species crossed the Atlantic: some species, for example *Cypreocassis testiculus* and *Cymatium parthenopeum*, originated in the western Atlantic and migrated to the eastern Atlantic and Europe during the Late Miocene (*C. parthenopeum*) or more recently (*C. testiculus*); whereas others, such as *Ranella olearium* (Linnaeus 1758) and *Charonia lampas* (Linnaeus 1758), originated in the Euro-Mediterranean area and migrated to the western Atlantic. This pattern may not be exclusive to the tonnoideans but also applicable to other molluscs such as the xenophorids and possibly others as well.

Teleplanic larvae are thought to have been involved in the tropical amphi-Atlantic distribution (Scheltema, 1995). Although no xenophorid larvae are known, the small multispiral protoconch suggests (long) larval life which would account for the wide distribution of certain species, such as *Xenophora cerea* (Reeve 1845), *Xenophora mekronensis* (Newton 1905) and so on (Ponder, 1983; Ponder & De Keyzer, 1998). If so, it is not clear whether this group of xenophorids (*O. plioextensum, O. longleyi*) originated in the western Atlantic and migrated to the Euro-Mediterranean area or vice-versa. Although the fossil record is abundant, it unfortunately does not help to reconstruct the history and relationships of this group. A number of fossil nominal taxa related to *Onustus* have been described or reported from the Eocene to Miocene of the West Indies and from the Eocene to Pliocene of the Euro-Mediterranean area (Ponder, 1983; Manganelli *et al*., 2004). Regrettably, many are

Figures 1–6 1. An almost complete shell from I Sodi; it only lacks the peristome. Due to its state it was prepared with fixing glue making it shiny. Note the shells attached to its peripheral flange (*Anadara diluvii*, *Galeodea echinophora*, *Korobkovia oblonga*, *Nassarius striatulus*) and the two gryphaeid oysters *Neopycnodonte navicularis* growing on its spire. 2. A shell apex from Mucigliani: note the multispiral protoconch. 3. A dorsal view of a peripheral flange fragment from I Sodi, with two attached shells (*Turritella spirata* and *Dentalium sexangulum*). 4. A basal view of a peripheral flange fragment from turnoff to Castelnuovo Berardenga, with scars of the junction (j) between base and peripheral flange and basal growth-lines (gl) continuing on the peripheral flange beyond the junction between base and peripheral flange. 5–6. Two base fragments from San Vittorio: note thickened inner basal peristome (arrow) and basal growth lines departing from the umbilicus (u).

based on badly preserved material and their status and relationships are therefore difficult to evaluate. The only one based on well preserved material is *Phorus borsoni* which Ponder (1983) regarded as "somewhat similar" to *O. longleyi*. Indeed they share a convex base and curved growth lines, but are distinguished by characters of the umbilicus and peripheral flange (umbilicus wide and peripheral flange very wide in *O. longleyi*; umbilicus very small or closed and peripheral flange very short in *P. borsoni* – Sacco, 1896: p. 27, pl. 4, figs 4–4; Ferrero Mortara *et al.*, 1984: pl. 42, figs 12a-12c).

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