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ALBERTO COLLARETA (\*)

## FOSSIL TURTLE AND WHALE BARNACLES (CRUSTACEA: CIRRIPEDIA: CORONULOIDEA) KEPT AT THE NATURAL HISTORY MUSEUM OF PISA UNIVERSITY: AN ANNOTATED CATALOGUE

**Abstract** - *Fossil turtle and whale barnacles (Crustacea: Cirripedia: Coronuloidea) kept at the Natural History Museum of Pisa University: an annotated catalogue.* In this short paper the collection of fossil coronuloid barnacles kept at the Natural History Museum of Pisa University is presented and briefly commented. It consists of one hundred and twenty-seven catalogued specimens and features one species of turtle barnacle (*Chelonibia testudinaria*) and three species of whale barnacles ( $\dagger$ *Cetopirus fragilis*, represented in this collection by the holotype and only known specimen,  $\dagger$ *Coronula bifida*, and *Coronula diadema*). The paleontological collection of fossil turtle and whale barnacles kept at the Natural History Museum of Pisa University stands out as one of the most important collections of coronuloid barnacles in Italy and all over Europe. doi: 10.2424/ASTSN.M.2016.18

**Key words** - *Chelonibia, Cetopirus, Coronula, Invertebrate Paleontology, Museology, Museo di Storia Naturale (Calci, Pisa)*

**Riassunto** - *Cirripedi fossili simbionti dei vertebrati marini (Crustacea: Cirripedia: Coronuloidea) nelle collezioni del Museo di Storia Naturale dell'Università di Pisa: un catalogo annotato.* In questa breve nota viene presentato e brevemente commentato il catalogo relativo alla collezione paleontologica di crostacei coronuloidi del Museo di Storia Naturale dell'Università di Pisa. Essa consiste di centoventisette reperti catalogati, qui riferiti a una specie di Chelonibiidae (*Chelonibia testudinaria*) e a tre specie di Coronulidae ( $\dagger$ *Cetopirus fragilis*, rappresentato in questa collezione dall'olotipo e unico esemplare noto,  $\dagger$ *Coronula bifida* e *Coronula diadema*). La collezione di coronuloidi fossili del Museo di Storia Naturale dell'Università di Pisa è sicuramente tra le più importanti d'Italia e d'Europa. doi: 10.2424/ASTSN.M.2016.18

**Parole chiave** - *Chelonibia, Cetopirus, Coronula, Paleontologia degli Invertebrati, Museologia, Museo di Storia Naturale (Calci, Pisa)*

### INTRODUCTION

Cirripedes assigned to the superfamily Coronuloidea are known as epizoic phoronts of various marine vertebrates (including toothed and whalebone whales, sea turtles, and sirenians; as such, they are also called “turtle and whale barnacles”) and invertebrates (crabs and horseshoe crabs). These crown-shaped, suspension-feeding barnacles attach on a motile, long-living substrate, thus exploiting a continuous flow of seawater and nutrients. Generally speaking, turtle and whale barnacles are uncommon as fossil remains, and their

paleontological record is therefore still fragmentary and scattered. Nevertheless, fossil and subfossil coronuloid barnacles help to find answers to open questions dealing with the origin and evolution of this unusual group of cirripedes (e.g., Ross & Newman, 1967; Harzhauser *et al.*, 2011; Collareta *et al.*, 2016a), the origin and history of cetacean migrations (e.g., Bianucci *et al.*, 2006a, b; Collareta *et al.*, 2016b; Bosselaers & Collareta, 2016), and the relationship of ancient human populations with marine trophic resources (e.g., Marean *et al.* 2007; Blick *et al.* 2011; Álvarez-Fernández *et al.* 2014; Collareta *et al.*, 2017).

In this short paper I provide an annotated catalogue of the fossil turtle and whale barnacles kept at the Museo di Storia Naturale dell'Università di Pisa (hereinafter: MSNUP) and briefly discuss the importance of this rich paleontological collection.

### NOMENCLATURAL REMARKS

There is some confusion in literature regarding the nomenclature of the wall plates of coronuloids, and especially turtle barnacles. Here I follow Blick *et al.* (2011) in discriminating the lateral compartments of Chelonibiidae between latera (singular: latus) and carinolatera (singular: carinolatus) as commonly done when dealing with Coronulidae (e.g., Buckeridge, 1983). The rostrum of Blick *et al.* (2011) is here referred as rostrum sensu stricto (hereinafter: rostrum s.s.), whereas the shell element constituted by the partial fusion of the rostrum s.s. with the two adjacent rostralatera is here referred as compound rostrum.

Opercular plates of Coronuloidea are overly rare in the fossil record (e.g., Harzhauser *et al.*, 2011), and no opercular plate has been detected to date in the paleontological collection of turtle and whale barnacles of the MSNUP. Nevertheless, here I describe as complete those shells which preserve all the wall elements, that is: rostrum (compound rostrum in Chelonibiidae), right latus, right carinolatus, carina, left carinolatus, and left latus.

(\*) Dipartimento di Scienze della Terra, Università di Pisa, via S. Maria 53, 56126 Pisa, Italy. Email: alberto.collareta@for.unipi.it Dottorato Regionale in Scienze della Terra Pegaso, via S. Maria 53, 56126 Pisa, Italy.

## CATALOGUE

Class MAXILLOPODA Dahl, 1956  
 Subclass CIRRIPEDIA Burmeister, 1834  
 Order SESSILIA Lamarck, 1818

Suborder BALANOMORPHA Pilsbry, 1916  
 Superfamily CORONULOIDEA Newman & Ross, 1976  
 Family CHELONIBIIDAE Pilsbry, 1916  
 Genus *Chelonibia* Leach, 1817  
*Chelonibia testudinaria* (Linnaeus, 1758)

**Material.** MSNUP I-16914, complete and articulated shell; MSNUP I-16915, articulated compound rostrum and right latus; MSNUP I-16916, articulated shell lacking the right carinolatus, having an incomplete, very juvenile shell (MSNUP I-16917) attached to the rostrum and right latus; MSNUP I-16918, incomplete articulated compound rostrum, right latus, and left latus; MSNUP I-16919, incomplete articulated shell, constituted by part of the compound rostrum, right latus, and part of the left latus, right carinolatus, and carina; MSNUP I-16920, MSNUP I-16921, MSNUP I-16922, MSNUP I-16923, four incomplete compound rostra; MSNUP I-16924, isolated rostrum s.s.; MSNUP I-16925, MSNUP I-16926, two isolated right rostrolatera; MSNUP I-16927, MSNUP I-16928, two isolated left rostrolatera; MSNUP I-16929, MSNUP I-16930, MSNUP I-16931, three right lateral compartments (latera or carinolatera); MSNUP I-16932, MSNUP I-16933, MSNUP I-16934, MSNUP I-16935, MSNUP I-16936, MSNUP I-16937, MSNUP I-16938, MSNUP I-16939, eight left lateral compartments (latera or carinolatera); MSNUP I-16940, MSNUP I-16941, two carinae; MSNUP I-16942, anatomically indeterminable fragment.

**Notes.** The fossil specimens of *Chelonibia testudinaria* kept at the MSNUP were collected by Giovanni Bianucci from upper Pliocene (Piacenzian) shallow-marine deposits exposed at Casenuove (Empoli municipality, Tuscany, Italy) in association with a partial skeleton of a baleen-bearing whale belonging to an indeterminate species of the family Balaenidae (Bianucci, 1996; Collareta et al., 2016a). On the basis of biostratinomic, functional, and actualistic considerations, Collareta et al. (2016a) proposed that the cirripedes were hosted on the baleen whale. This record indicates that mysticete cetaceans can be added to the list of the possible hosts of the barnacles of the genus *Chelonibia*, thus suggesting that the whale barnacles could have originated from an ancient event of dispersal of *Chelonibia* (or a similar ancestor) on baleen whales (Collareta et al., 2016a). The record from Casenuove represents one of the largest accumulations of fossil or subfossil remains of turtle barnacles reported to date from a single taphonomic scenario.

Family CORONULIDAE Leach, 1817  
 Genus *Cetopirus* Ranzani, 1817  
 $\dagger$ *Cetopirus fragilis* Collareta et al., 2016b  
 (Fig. 1)

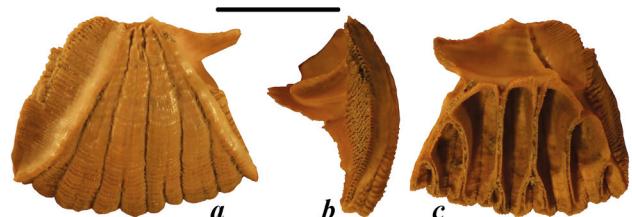


Fig. 1 - MSNUP I-16903,  $\dagger$ *Cetopirus fragilis* (holotype), single left compartment (latus or carinolatus) collected in the town of Otranto (Apulia region, South Italy) in Lower Pleistocene deposits. a: external view, b: radial view, c: internal view. Scale bar = 10 mm. Modified after Collareta et al. (2016b).

**Material.** MSNUP I-16903, single left compartment (latus or carinolatus), holotype and only referred specimen.

**Notes.** This isolated compartment was collected by Angelo Varola in the port of Otranto (Apulia, Italy) from a Lower Pleistocene shallow-marine deposit of the Uggiano La Chiesa Formation attributed to the Mediterranean Neogene Nannoplankton (MNN) zone 19a of Rio et al. (1990), that is, to the 1.95 Ma - 1.73 Ma time span (according to Raffi et al., 2006) (Collareta et al., 2016b). The type horizon of  $\dagger$ *Cetopirus fragilis* features also remains of  $\dagger$ *Coronula bifida* Bronn, 1831 (including specimen MSNUP I-16904). MSNUP I-16903 represents the geologically oldest record of the genus *Cetopirus*. As *Cetopirus* is currently known as an exclusive symbiont of the right whales (i.e., members of the balaenid genus *Eubalaena* Gray, 1864), MSNUP I-16903 strongly suggests the presence of Balaenidae in the Mediterranean basin during the early Pleistocene, as well as the  $\dagger$ *Coronula bifida* remains suggest with regard to Balaenopteridae (Collareta et al., 2016b). Moreover, the find of MSNUP I-16903 evokes an ancient mysticete migratory route running from the central Mediterranean to the Northeastern Atlantic during the early Pleistocene (and, possibly, late Pliocene) (Collareta et al., 2016b).

Genus *Coronula* Lamarck, 1802

$\dagger$ *Coronula bifida* Bronn, 1831

**Material.** MSNUP I-16900, MSNUP I-16901, MSNUP I-16902, complete and articulated shells; MSNUP I-16904, isolated right compartment; MSNUP I-16905, two articulated partial compartments, including a left lateral compartment; MSNUP I-16906, isolated left compartment; MSNUP I-16907, one almost complete and articulated shell; MSNUP I-16908, seven compartments, including two rostra, three left lateral

compartments, one right lateral compartments, and one indeterminable compartment; MSNUP I-16909, disarticulated rostrum, right lateral compartment, and left lateral compartment; MSNUP I-169010, isolated rostrum; MSNUP I-16911, isolated carina; MSNUP I-16912, isolated left compartment; MSNUP I-16913, isolated right compartment.

**Notes.** The fossil remains of †*Coronula bifida* kept at the MSNUP were collected by Angelo Varola (specimens MSNUP I-16900 to MSNUP I-1692 and MSNUP I-16904 to MSNUP I-16906) and the late Elena Menesini (specimens MSNUP I-16907 to MSNUP I-16913) from shallow-marine deposits belonging to the Plio-Pleistocene Uggiano La Chiesa Formation. These specimens come from various localities of the eastern coast of Salento, including Sant'Andrea (MSNUP I-16900 to MSNUP I-16902), Otranto (MSNUP I-16904), Uggiano La Chiesa (MSNUP I-16905), Rocca Vecchia (MSNUP I-16906 to MSNUP I-1698 and MSNUP I-16910), Santa Foca (MSNUP I-16909), and an unknown locality "southwest to Otranto" (MSNUP I-16911 and MSNUP I-16912). In particular, MSNUP I-16904 was found in a marly horizon which features also the holotype of †*Cetopirus fragilis*, MSNUP I-16903. Menesini (1968) described and figured some of the specimens she collected, recognizing among them representatives of two subspecies: the nominotypical †*Coronula bifida bifida* Bronn, 1831 and †*Coronula bifida barbara* Darwin, 1854. However, this subspecific taxonomy had no following in subsequent works. Considering that extant *Coronula diadema* (Linnaeus, 1767) preferentially attaches on humpback whales (the balaenopterid *Megaptera novaeangliae* (Borowski, 1781)) and detachment of whale barnacles from extant baleen whales has been mainly observed in breeding areas, the abundance of fossil remains of †*Coronula bifida* in the inner neritic lower Pleistocene deposits of eastern Salento was recently interpreted as an indirect evidence of an ancient breeding ground of Balaenopteridae (Bianucci *et al.*, 2006b; Collareta *et al.*, 2016b). Interestingly, the coexistence of *Coronula* and *Cetopirus* observed at Otranto suggests that Balaenopteridae and Balaenidae shared the same breeding ground during the cold season (Collareta *et al.*, 2016b).

#### *Coronula diadema* (Linnaeus, 1767)

**Material.** MSNUP I-13793, MSNUP I-13942, MSNUP I-13943, three complete and articulated shells; MSNUP I-13944, isolated rostrum; MSNUP I-13945, three indeterminable fragmentary compartments; MSNUP I-13946, three fragmentary compartments (rostrum, right latus, and left latus); MSNUP I-13949, MSNUP I-13950, two complete and articulated shells; MSNUP I-13951, articulated rostrum and right latus; MSNUP I-13952, indeterminable isolated compart-

ment; MSNUP I-13954, MSNUP I-13955, MSNUP I-13956, MSNUP I-13957, MSNUP I-13958, MSNUP I-13959, MSNUP I-13960, MSNUP I-13961, eight complete and articulated shells; MSNUP I-13962, three articulated compartments (right latus, right carinolatus, and fragmentary carina); MSNUP I-13963, MSNUP I-13964, MSNUP I-13965, MSNUP I-13966, four complete and articulated shells; MSNUP I-13967, three articulated compartments (left latus, left carinolatus, and fragmentary rostrum); MSNUP I-13969, MSNUP I-13970, MSNUP I-13971, MSNUP I-13972, MSNUP I-13973, MSNUP I-13974, MSNUP I-13975, MSNUP I-13976, MSNUP I-13977, MSNUP I-13978, MSNUP I-13979, MSNUP I-13980, MSNUP I-13981, MSNUP I-13982, MSNUP I-13983, MSNUP I-13984, MSNUP I-13985, MSNUP I-13986, MSNUP I-13987, MSNUP I-13988, MSNUP I-13989, MSNUP I-13990, MSNUP I-14392, MSNUP I-14393, MSNUP I-14393, MSNUP I-15762, twenty-six complete and articulated shells; MSNUP I-15763, indeterminable fragmentary compartment; MSNUP I-15764, isolated right latus or carinolatus; MSNUP I-15765, MSNUP I-15766, MSNUP I-15767, MSNUP I-15768, MSNUP I-15769, MSNUP I-15770, MSNUP I-15771, MSNUP I-15772, MSNUP I-15773, nine complete and articulated shells; MSNUP I-15774, two articulated compartments (rostrum and right latus); MSNUP I-15775, MSNUP I-15776, MSNUP I-15777, MSNUP I-15778, MSNUP I-15779, MSNUP I-15780, MSNUP I-15781, MSNUP I-15782, MSNUP I-15783, nine complete and articulated shells; MSNUP I-15784, two articulated compartments (carina and left carinolatus); MSNUP I-15785, two indeterminable fragmentary compartments; MSNUP I-15786, two indeterminable fragmentary compartments; MSNUP I-15787, two indeterminable fragmentary compartments; MSNUP I-15788, two articulated compartments (rostrum and right latus); MSNUP I-15789, MSNUP I-15790, MSNUP I-15791, MSNUP I-15792, MSNUP I-15793, MSNUP I-15794, MSNUP I-15795, MSNUP I-16943, eight complete and articulated shells.

**Notes.** The fossil shells of *Coronula diadema* kept at the MSNUP were collected in the early 2000s by Giovanni Bianucci, Chiara Sorbini, and colleagues from early Pleistocene (most likely Calabrian; personal communication by Claudio Di Celma, 2015) neritic sediments of the Canoa and Tablazo Formations (Canoa basin, Ecuador) (Bianucci *et al.*, 2006a, b). A detailed taphonomic, paleoecological and paleobiogeographical study of the outstanding fossil whale barnacle assemblage from the coastline of Ecuador was provided by Bianucci *et al.* (2006a, b). In the light of the preferential host-specificity of *Coronula diadema* on humpback whales, and considering that this mysticete species currently use the shallow-marine coastal waters in front of the emerged Canoa basin as a breeding ground, Bianucci

*et al.* (2006a, b) inferred that during the early Pleistocene the Canoa Basin was placed on the seasonal migration route of humpback whales (or related forms) and that these whales remained in the Canoa Basin for sufficient time (breeding?) for large accumulations of *Coronula diadema* to form. The record from the Canoa and Tablazo Formations represents one of the largest accumulations of fossil or subfossil remains of whale barnacles known worldwide.

## CONCLUDING REMARKS

The paleontological collection of Coronuloidea of the MSNUP, consisting of one hundred and twenty-seven catalogued specimens, features one species of turtle barnacle (*Chelonibia testudinaria*) and three species of whale barnacles ( $\dagger$ *Cetopirus fragilis*, represented in this collection by the holotype and only known specimen,  $\dagger$ *Coronula bifida*, and *Coronula diadema*).

The study of this material allowed significant progress in the systematics, taphonomy, phylogeny, paleoecology, and paleobiogeography of coronuloid barnacles, thus providing also insights on the paleobiology of their vertebrate hosts (Menesini, 1968; Bianucci, 1996; Bianucci *et al.*, 2006a, b; Collareta *et al.*, 2016a, b).

The collection of fossil turtle and whale barnacles kept at the MSNUP stands out as one of the most rich and diverse paleontological collections of Coronuloidea in Italy and all over Europe.

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This work is dedicated to the memory of the late Ludovico Galleni, distinguished biologist and supporter of the major role of paleontology in deciphering the dynamics of Evolution and envisioning Biosphere as a whole.

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Edizioni ETS  
Piazza Carrara, 16-19, I-56126 Pisa  
[info@edizioniets.com](mailto:info@edizioniets.com) - [www.edizioniets.com](http://www.edizioniets.com)  
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