

FIRST RECORD OF *CONCHODERMA AURITUM* (CIRRIPEDIA: LEPADIDAE)
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ABSTRACT

The carcass of an adult, male, Cuvier's beaked whale (*Ziphius cavirostris*, *Ziphiidae*) was found floating close to the coasts of Corfu Island, Greece, in July 2016. Many tens of copepods of the genus *Pennella* had infested the whale. Barnacles identified as *Conchoderma auritum* (*Cirripedia*, *Lepadidae*) and green algae were attached to the base of both teeth. We took standard measurements of the barnacles and found a mean capitulum length of 12.88 mm ($sd = 6.26$ mm, $n = 13$). Although this barnacle has been reported on several marine mammals and has a cosmopolitan distribution, this is the first report of the species in the Eastern Mediterranean Sea.

Key words: rabbit-ear barnacle, parasite, *Pennella*, Cuvier's beaked whale, cetacean, Mediterranean

PRIMO RITROVAMENTO DI *CONCHODERMA AURITUM* (CIRRIPEDIA: LEPADIDAE) SU
ZIPHIUS CAVIROSTRIS (CETACEA: ZIPHIIDAE) IN GRECIA

SINTESI

La carcassa di un maschio adulto di zifio (*Ziphius cavirostris*, *Ziphiidae*) è stata trovata galleggiante vicino alle coste dell'isola greca di Corfù nel luglio 2016. Decine di copepodi del genere *Pennella* avevano infestato la balena. Cirripedi identificati come *Conchoderma auritum* (*Cirripedia*, *Lepadidae*) e alghe verdi sono stati trovati fissati alla base di entrambi i denti. Gli autori hanno preso le misure standard dei cirripedi e stabilito una lunghezza, media del capitulum pari a 12,88 mm ($sd = 6,26$ mm, $n = 13$). Anche se questa specie di cirripedi è già stata trovata su diversi mammiferi marini e ha una distribuzione cosmopolita, questa è il primo ritrovamento della specie nel Mediterraneo orientale.

Parole chiave: cirripedi, parassiti, *Pennella*, zifio, cetacei, Mediterraneo

INTRODUCTION

Several species of cetaceans are known to host sessile and stalked barnacles (Crustacea: Cirripedia) (Fertl & Newman, 2008). Stalked barnacles of the genus *Conchoderma* can be considered generalists, since they occur on both living organisms and inanimate objects, such as ship hulls (Davidson *et al.*, 2009). Species of this genus have a highly reduced shell plate armature, which is correlated with an epibiotic mode of life (Anderson, 1993). The rabbit-ear barnacle *Conchoderma auritum* (Linnaeus, 1767) is one of the twenty living species of barnacles that use marine mammals as hosts (Newman & Ross, 1976). It is known to settle on slowly moving marine mammals (Aznar *et al.*, 2005) and requires hard surfaces for attachment (Clarke, 1966). It can be found attached on exposed and unprotected teeth or even on malformed parts of the jaw (such as a bone injury) (Clarke, 1966; Elorriaga-Verplancken *et al.*, 2015). It is considered as epizoic and commensal since it is hitchhiking on whales (Ralls & Mesnick, 2008).

Worldwide, *C. auritum* has been recorded on the teeth of seventeen toothed whales (e.g., Clarke, 1966; Mignucci-Giannoni *et al.*, 1998; Elorriaga-Verplancken *et al.*, 2015). It has also been found, less frequently, on damaged baleen plates in four mysticete species (Clarke, 1966; Ólafsdóttir & Shinn, 2013).

The Cuvier's beaked whale *Ziphius cavirostris* Cuvier, 1823 is characterized by a nearly cosmopolitan distribution, avoiding only high latitudes and polar waters (Heyning, 1989). It is the only ziphiid species that regularly occurs throughout the Mediterranean Sea

(Podestà *et al.*, 2016), with a local population likely small and isolated from that of the Atlantic (Dalebout *et al.*, 2005). From 1990 until the date of the stranding reported herein, at least 126 Cuvier's beaked whale strandings had been recorded along the Greek coasts (Frantzis, 2009; Frantzis, *unpublished data*).

In this short note, we report the first record of *C. auritum* in the Eastern Mediterranean basin.

MATERIAL AND METHODS

On 12 July 2016, a carcass of a Cuvier's beaked whale was found floating close to the coast of Santa Barbara beach (Fig. 1), SW Corfu Island, Greece (39°24'42"N, 019°59'14"E). Several photographs were taken (Fig. 2), but no necropsy was conducted. Green algae (Chlorophyta) and barnacles that were found attached to the base of both teeth (Fig. 3a) were collected, preserved in 70% ethanol for further analysis and deposited at the Pelagos Cetacean Research Institute in Athens, Greece.

We identified all the barnacles collected from both teeth following Darwin (1852, p. 141, pl. III, fig. 4). Apart from the order level (Buckeridge & Newman, 2006), the classification of the barnacles followed Martin and Davis' (2001) scheme to family level. We also took the following measurements to the nearest 0.01 mm with a digital Vernier caliper: capitulum length (CL), total length (TL, without "ears") and scutum maximal length and width (SL & SW, respectively). Specifically for SL and SW, we measured these without removing the scutum.

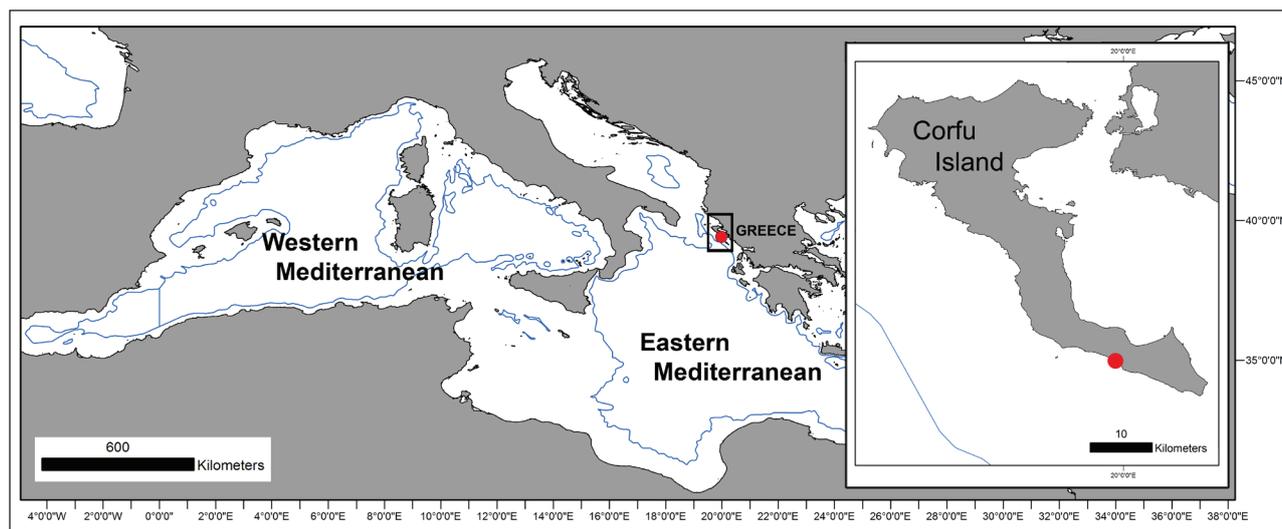


Fig. 1: Map of the Mediterranean Sea and Corfu Island (magnification) showing the stranding position in Santa Barbara Beach (red dot). The 1000 m contour appears as a blue line in both maps.

Sl. 1: Zemljevid Sredozemskega morja in otoka Krfa (povečano) z označeno lokaliteto, kjer je naplavilo kita na plaži Sv. Barbare (rdeča pika). Kontura, ki označuje 1000 m, je označena z modro črto.

RESULTS

The stranded whale was a recently dead male with erupted teeth (Fig. 3a) and a total length of 5.15 m. Based on several of the available photographs, it seemed emaciated, although no definitive conclusion can be drawn as the photographs were taken while the whale was in the water.

Many *Pennella* sp. copepods had infested the whale. At least one hundred of them were counted on the available photographs, which only showed the right side of the whale's body. These copepods were spread all over the head, body and tail-stock (Fig. 2).

The barnacles were in two large clusters attached to both teeth. All ten barnacles found on the right tooth and three out of six from the left tooth were collected.

The species was readily identified as the rabbit-ear barnacle *Conchoderma auritum* by the obvious ear-like appendages (tubes) on the capitulum, and the small bilobed scutum (Darwin, 1852; Fig. 3b & 3c). The chlorophytes were not identified to species level. The barnacle species' classification is the following:

Phylum ARTHROPODA

Infraclass CIRRIPEDIA Burmeister, 1834

Order LEPADIFORMES Buckeridge & Newman, 2006

Family LEPADIDAE Darwin, 1852

Genus *Conchoderma* von Olfers, 1814

Conchoderma auritum (Linnaeus, 1767)

The mean (\bar{x}), standard deviation (s), minimum and maximum ($min-max$) values (in mm) of CL, TL, SL and SW for all sampled barnacles ($n=13$) were, respectively:

CL: $\bar{x} = 12.88$, $s = 6.26$, $min-max = 2.04-25.08$

TL: $\bar{x} = 13.92$, $s = 6.90$, $min-max = 4.17-50.40$

SL: $\bar{x} = 4.39$, $s = 1.83$, $min-max = 1.28-7.45$

SW: $\bar{x} = 1.96$, $s = 0.85$, $min-max = 0.51-3.40$

DISCUSSION

Today, the barnacle genus *Conchoderma* is represented by three living species according to Chan *et al.*, (2009). *Conchoderma virgatum* Spengler, 1789 and *C. auritum* are present in the Mediterranean Sea (Koukouras & Matsa, 1998). The rabbit-ear barnacle *C. auritum* had only been reported from the western Mediterranean basin (Koukouras & Matsa, 1998) before our observation, and it is somewhat surprising that no other reports were available for the eastern Mediterranean basin, since the species has a cosmopolitan distribution (Chan *et al.*, 2009). Throughout the cetacean fauna of the Mediterranean Sea, it was reported to have been found on a Cuvier's beaked whale stranded in Algiers (Monod, 1938 in Clarke, 1966) and on the left mandible of a striped dolphin *Stenella coeruleoalba* (Meyen, 1833) that stranded in Sicily (Sampieri) in 1991 (Insacco *et al.*,



Fig. 2: Body parts of the Cuvier's beaked whale stranded in Santa Barbara Beach, Corfu Island, Greece, on 12 July 2016. More than 35 specimens of the parasitic copepod *Pennella balaenoptera* are visible in the photograph of the head area.

Sl. 2: Telesni deli Cuvierjevega kljunatega kita, ki ga je naplavilo na plaži Sv. Barbare na Krfu 12. julija 2016. Več kot 35 primerkov zajedalskega raka ceponožca *Pennella balaenoptera* je vidno na fotografiji glave.

2014; G. Insacco, *personal communication*, 2016). The latter, recorded at the Strait of Sicily, was the easternmost record of the species in the Mediterranean Sea.

The barnacles we found on the teeth of the stranded whale were in two clusters, one on each tooth. The presence of the rabbit-ear barnacle in clusters is probably facilitating cross-fertilization, since this species is hermaphrodite (Ruppert *et al.*, 2004). According to Rasmussen (1980), the rabbit-ear barnacle reaches sexual maturity at a scutum length of 7 mm. If these growth measurements taken at sea water temperatures of 16 - 19 °C were also valid for the hotter Eastern Mediterranean basin, only one of the specimens we sampled was sexually mature. Similarly, all barnacles would have been attached on the whale for much less than 150 days, according to the same author.

There are only three known records of rabbit-ear barnacles on Cuvier's beaked whales: from the Galápagos Islands (Palacios *et al.*, 1994), the Caribbean (Mignucci-Giannoni *et al.*, 1998), and the western Mediterranean basin (Monod, 1938 in Clarke, 1966), with the first record considered doubtful by the authors. In the first two cases, as in the current study, the whale was a male with a total length exceeding 5 m, and the barnacles were only attached to its teeth.

Apart from the rabbit-ear barnacles that we found on the whale, there was a large number of parasitic copepods spread along the body. They were determined as *Pennella balaenoptera* Koren & Danielssen, 1817, since this is the only species of the genus that uses marine

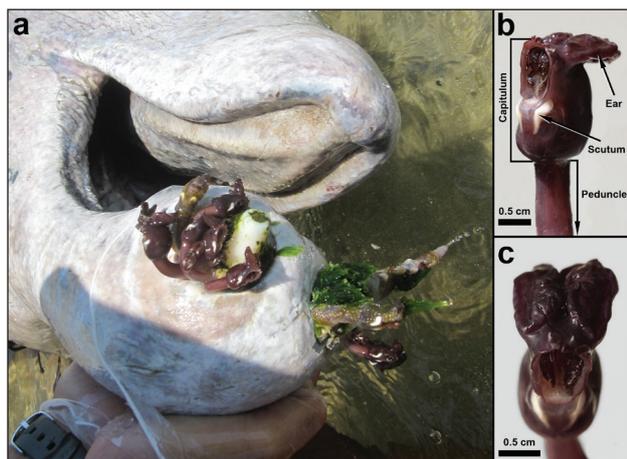


Fig. 3: a) Close view of the whale's jaws with the rabbit-ear barnacles *Conchoderma auritum* and green algae attached to the teeth; b) and c) upper part of a rabbit-ear barnacle specimen. Scale bar = 0.5 cm.

Sl. 3: a) Bližinski posnetek kitove čeljusti z raki vitičnjaki *Conchoderma auritum* in zelenimi algami, pritrjenimi na zobeh; b) in c) zgornji del raka vitičnjaka. Merilo = 0,5 cm.

mammals as hosts (Hogans, 1987). The heavy infestation by parasitic copepods in this case might not have been independent from the presence of the rabbit-ear barnacle. However, no physical connection between the two parasites could be observed from the available

photographs, as in other reported cases of fish infestation by *Pennella* sp. and *Conchoderma* sp. (e.g., Pradeep *et al.*, 2016). Infestation of cetaceans by *P. balaenoptera* can be a signal of an extended period of weakness (Aznar *et al.*, 2005), while a heavy infestation can cause substantial depletion of lymphoid tissue, resulting in ineffective immune responses (Cornaglia *et al.*, 2000). Moreover, an extensive epizootic crustacean infestation might be associated with the immunosuppressive effects of a viral infection (cetacean morbillivirus, CeMV) and abnormally heavy loads of polychlorinated biphenyls (Aznar *et al.*, 2005). Although CeMV is rarely reported in Cuvier's beaked whales (Jacob *et al.*, 2016), parasitosis of *P. balaenoptera* can be seen as an indicator of cetacean health (Vecchione & Aznar, 2014).

The available evidence suggests that the Cuvier's beaked whale studied here was probably weakened and unable to feed. The infestation with the copepods and the settlement of the barnacles was likely the result of the whale's gradual debilitation that eventually led to its death.

ACKNOWLEDGEMENTS

The authors thank Hercules, Marilena and Theofanis Dimitriadis for sending the whale's photographs and the samples of barnacles and algae. They are also grateful to Asst. Prof. Teresa Paula Gonçalves Cruz (Department of Biology, University of Évora, Portugal) for her advice on barnacle measurements. Ultimately, they thank Miss Heather Margaret Vance for her helpful comments to improve the manuscript.

PRVI ZAPIS O POJAVLJANJU RAKA VITIČNJAKA VRSTE *CONCHODERMA AURITUM*
(CIRRIPEDIA: LEPADIDAE) NA CUVIERJEVEM KLJUNATEM KITU *ZIPHIUS CAVIROSTRIS*
(CETACEA: ZIPHIIDAE) V GRČIJI

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POVZETEK

Truplo odraslega samca Cuvierjevega kljunatega kita (Ziphius cavirostris, Ziphiidae) je julija 2016 naplavilo blizu obale otoka Krfa (Grčija). Na kitu se je zaredilo nekaj deset ceponožcev iz rodu Pennella, medtem ko so bili na bazi zob pritrjeni raki vitičnjaki Conchoderma auritum (Cirripedia, Lepadidae) in zelene alge. Avtorji so opravili standardne meritve na rakah vitičnjakih in izmerili povprečno dolžino glavičastega dela (capitulum), ki je meril 12,88 mm (sd = 6,26 mm, n = 13). Čeprav so o tem raku vitičnjaku že poročali, da je bil najden na mnogih morskih sesalcih in je tudi sicer kozmopolit, gre za prvi zapis o pojavljanju te vrste v vzhodnem Sredozemskem morju.

Ključne besede: rak vitičnjak, zajedalec, *Pennella*, Cuvierjev kljunati kit, kiti, Sredozemsko morje

REFERENCES

Anderson, D. T. (1993): Barnacles: Structure, function, development and evolution. Chapman & Hall, London, 376 pp.

Aznar, F. J., D. Perdiguero, A. Pérez del Olmo, A. Repullés, C. Agustí & J. A. Raga (2005): Changes in epizootic crustacean infestations during cetacean die-offs: The mass mortality of Mediterranean striped dolphins *Stenella coeruleoalba* revisited. Dis. Aquat. Organ., 67, 239-247.

Buckeridge, J. S. & W. A. Newman (2006): A revision of the Iblidae and the stalked barnacles (Crustacea: Cirripedia: Thoracica), including new ordinal, familial and generic taxa, and two new species from New Zealand and Tasmanian waters. Zootaxa, 1136, 1–38.

Chan, B. K. K., R. E. Prabowo & K. Lee (2009): Crustacean fauna of Taiwan: Barnacles, Volume I – Cirripedia: Thoracica excluding the Pyrgomatidae and Acastinae. National Taiwan Ocean University, Taiwan, 317 pp.

Clarke, R. (1966): The stalked barnacle *Conchoderma*, ectoparasitic on whales. Norsk Hvalfangsttid, 55, 153-168.

Cornaglia E., L. Rebora, C. Gili & G. Di Guardo (2000): Histopathological and Immunohistochemical Studies on Cetaceans Found Stranded on the Coast of Italy between 1990 and 1997. J. Vet. Med. A. Physiol. Pathol. Clin. Med., 47, 129-142.

Dalebout, M. L., K. M. Robertson, A. Frantzis, D. Engelhaupt, A. A. Mignucci-Giannoni, R. J. Rosario-Delestre & C. S. Baker (2005): Worldwide structure of mtDNA diversity among Cuvier's beaked whales

(*Ziphius cavirostris*): implications for threatened populations. *Mol. Ecol.*, 14, 3353-3371.

Darwin, C. R. (1852): A monograph on the sub-class Cirripedia, with figures of all the species. Volume 1. The Lepadidae; or, pedunculated cirripedes. The Ray Society, London, 400 pp.

Davidson, I. C., C. W. Brown, M. D. Sytsma & G. M. Ruiz (2009): The role of containerships as transfer mechanisms of marine biofouling species. *Biofouling*, 25, 645–655.

Elorriaga-Verplancken, F. R, S. Tobar-Hurtado, M. A. Medina-López, D. Bárcenas de la Cruz & R. J. Urbán (2015): Potential Morphological Contributions to a Live Stranding: Abnormal Snout and *Conchoderma auritum* Infestation in a Bottlenose Dolphin (*Tursiops truncatus*). *Aquat. Mamm.*, 41, 198-202.

Fertl, D. & W. A. Newman (2008): Barnacles. In: Perrin, W., B. Wursig & J. G. M. Thewissen (eds.): *Encyclopedia of marine mammals*. Academic, San Diego, pp. 89-91.

Frantzis, A. (2009): Cetaceans in Greece: present status of knowledge. Technical Report, Initiative for the Conservation of Cetaceans in Greece. Greece, 94 pp.

Heyning, J. E. (1989): Cuvier's beaked whale *Ziphius cavirostris* G. Cuvier, 1823. In: Ridgway S. H. & R. J. Harrison (eds.) *Handbook of marine mammals*, Vol. 4. River dolphins and the Larger Toothed Whales. Academic, London, pp. 289-308.

Hogans, W. E. (1987): Morphological variation in *Pennella balaenoptera* and *P. filosa* (Copepoda: Pennellidae) with a review of the genus *Pennella* Oken, 1816 parasitic on cetacea. *Bull. Mar. Sci.*, 40, 442-453.

Insacco, G., G. Buscaino, G. Buffa, M. Cavallaro, E. Crisafi, R. Grasso, F. Lombardo, G. Lo Paro, N. Parrinello, M. Sarà & F. Spadola (2014): Il patrimonio delle raccolte cetologiche museali della Sicilia. *Museologia Scientifica Memorie*, 12, 391-405 [in Italian].

Jacob, J. M., K. L. West, G. Levine, S. Sanchez & B. A. Jensen (2016): Initial characterization of novel beaked whale morbillivirus in Hawaiian cetaceans. *Dis. Aquat. Organ.*, 117, 215-227.

Koukouras, A. & A. Matsa (1998): The Thoracican Cirriped Fauna of the Aegean Sea: New Information, Check List of the Mediterranean Species, Faunal Comparisons. *Senck. Marit.*, 28, 133-142.

Martin, J. W. & G. E. Davis (2001): An Updated Classification of the Recent Crustacea. *Contr. Sci. Mus. Nat. His. Los Angeles*, 39, 1-124.

Mignucci-Giannoni, A. A., E. P. Hoberg, D. Siegel-Causey, E. H. Jr. Williams (1998): Metazoan parasites and other symbionts of cetaceans in the Caribbean. *J. Parasitol.*, 84, 939-946.

Monod, T. (1938): *Conchoderma auritum* (L. 1767) Olfers 1814 sur un *Ziphius* cf. *cavirostris* (?) G. Cuvier 1823. *Bull. Trav. Sta. Aquicult. Pêche Castiglione*, 1937, 205-210 [in French].

Newman, W. A. & A. Ross (1976): Revision of the balanomorph barnacles; including a catalog of species. *Mem. San. Diego Soc. Nat. Hist.*, 9, 1-108.

Ólafsdóttir, D. & A. P. Shinn (2013): Epibiotic macrofauna on common minke whales, *Balaenoptera acutorostrata* Lacépède, 1804, in Icelandic waters. *Parasit Vectors*, 6. doi: 10.1186/1756-3305-6-105

Palacios, D. M., P. Rodriguez, B. Brennan & K. Marshall (1994): Notes on the Cuvier's beaked whale (*Ziphius cavirostris*), with observations of a dead specimen. *Noticias de Galápagos*, 54, 29-31.

Podestà, M., A. Azzellino, A. Cañadas, A. Frantzis, A. Moulins & M. Rosso (2016): Cuvier's Beaked Whale, *Ziphius cavirostris*, Distribution and Occurrence in the Mediterranean Sea: High-Use Areas and Conservation Threats. In: Notarbartolo di Sciara, G., M. Podestà & B. E. Curry (eds.): *Adv. Mar. Biol.*, 75, pp. 103-140.

Pradeep H. D., S. S. Shirke & S. M. Devi (2016): Report of Epizootic Cirripede, *Conchoderma virgatum* (Spengler, 1790) on *Pennella instructa* (Wilson, 1917) parasitic on Indo-Pacific Sailfish *Istiophorus platypterus* caught from Andaman Sea. *J. Entomol. Zool. Stud.*, 4, 1208-1210.

Ralls, K. & S. Mesnick (2008): Sexual dimorphism. In: Perrin, W., B. Wursig & J. G. M. Thewissen (eds.): *Encyclopedia of marine mammals*. Academic, San Diego, pp. 1005-1011.

Rasmussen, T. (1980): Notes on the biology of the shipfouling gooseneck barnacle "*Conchoderma auritum*" Linnaeus, 1776 (Cirripedia: Lepadomorpha). *Papers of the Fifth International Congress on Marine Corrosion and Fouling*, Barcelona, pp. 37-44.

Ruppert, E. E., R. S. Fox & R. D. Barnes (2004): *Invertebrate Zoology: A functional evolutionary approach*. Brooks/Cole Thompson Learning, Belmont, 1008 pp.

Vecchione, A. & F. J. Aznar (2014): The mesoparasitic copepod *Pennella balaenopterae* and its significance as a visible indicator of health status in dolphins (Delphinidae): a review. *J. Mar. Anim. Ecol.*, 7, 4-11.