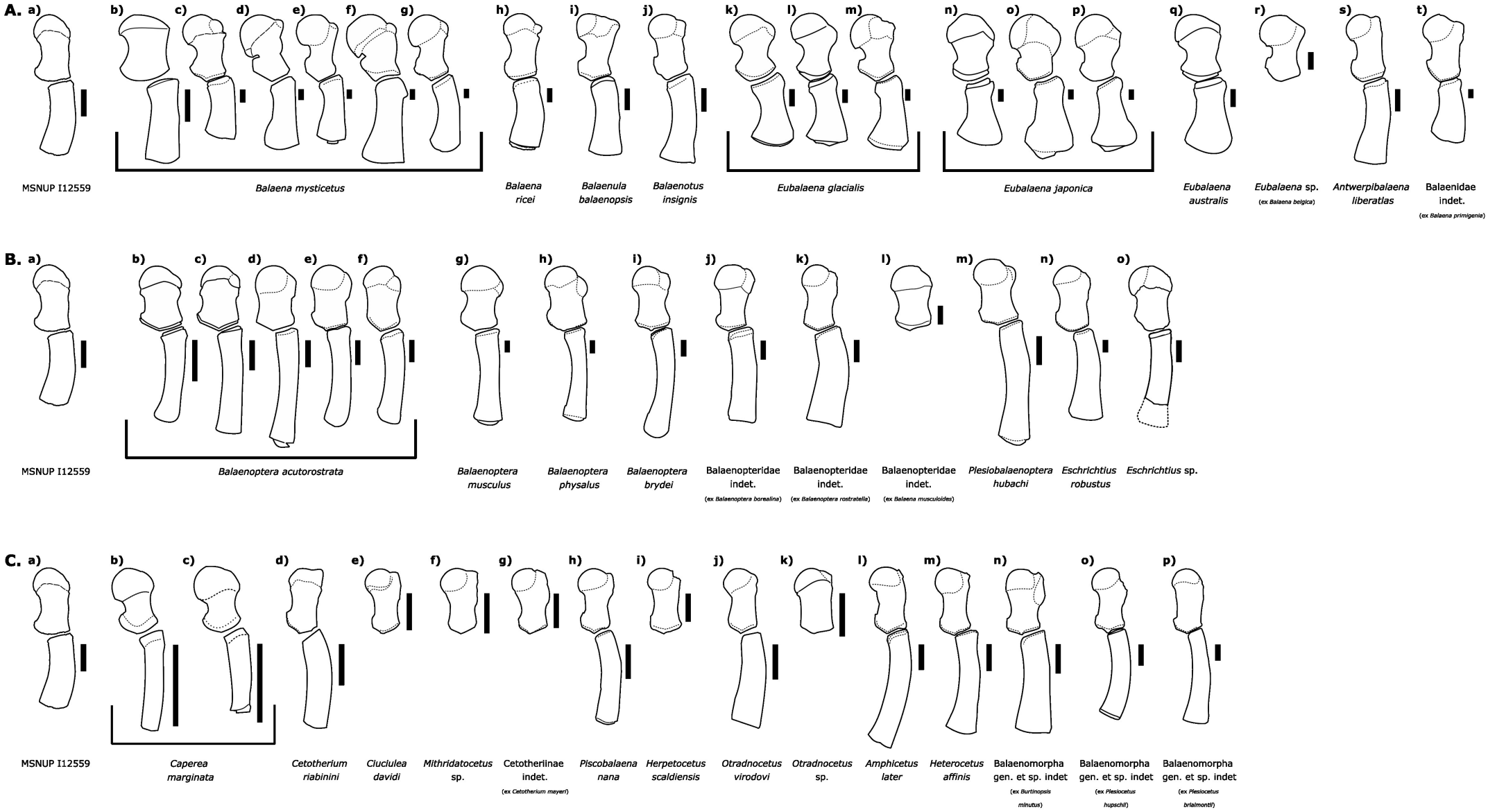
Supplementary File S3 for

A taphonomic cold case from Orciano Pisano (central Italy) reveals a distinctive trophic interaction in the Pliocene Mediterranean Sea

by Edoardo Terranova, Giovanni Bianucci, Marco Merella, Chiara Sorbini and Alberto Collareta

Content: Supplementary Figure, Supplementary Abbreviations and Supplementary Reference list


A.
a)
b)
c)
d)
e)
f)
g)
h)
i)
j)
k)
l)
m)
n)
o)
p)
q)
r)
s)
t)
MSNUP I12559
Balaena mysticetus
Balaena ricei
Balaenula balaenopsis
Balaenotus insignis
Eubalaena glacialis
Eubalaena japonica
Eubalaena australis
Eubalaena sp. (ex Balaena belgica)
Antwerpibalaena liberatlas
Balaenidae indet. (ex Balaena primigenia)
B.
a)
b)
c)
d)
e)
f)
g)
h)
i)
j)
k)
l)
m)
n)
o)
MSNUP I12559
Balaenoptera acutorostrata
Balaenoptera musculus
Balaenoptera physalus
Balaenoptera brydei
Balaenopteridae indet. (ex Balaenoptera borealina)
Balaenopteridae indet. (ex Balaenoptera rostratella)
Balaenopteridae indet. (ex Balaena musculoides)
Plesiobalaenoptera hubachi
Eschrichtius robustus
Eschrichtius sp.
C.
a)
b)
c)
d)
e)
f)
g)
h)
i)
j)
k)
l)
m)
n)
o)
p)
MSNUP I12559
Caperea marginata
Cetotherium riabinini
Cluciulea davidi
Mithridatocetus sp.
Cetotheriinae indet. (ex Cetotherium mayeri)
Piscobalaena nana
Herpetocetus scaldiensis
Otradnocetus virodovi
Otradnocetus sp.
Amphicetus later
Heterocetus affinis
Balaenomorpha gen. et sp. indet (ex Burtinopsis minutus)
Balaenomorpha gen. et sp. indet (ex Plesiocetus hupschli)
Balaenomorpha gen. et sp. indet (ex Plesiocetus brialmontii)

Supplemental figure: Schematic comparison between the humeral and radial morphologies of extant and extinct mysticete species. A) Balaenidae; B) Balaenopteridae and Eschrichtiidae; and C) other mysticetes (including Cetotheriidae s.s. and *Caperea marginata*); humerus and radius are in lateral view in all panels; scale bars equal 10 cm for all panels. Aa,Ba,Ca) MSNUP I12559; Ab) very young *Balaena mysticetus*, reversed (after Nishiwaki and Kasuya, 1970); Ac) UAM-15988, adult *Balaena mysticetus* (drawing after the Idaho Virtual Museum); Ad) sexually mature *Balaena mysticetus* (after Thewissen et al., 2021); Ae) NSB-DWM 1987B6, sexually mature (60 year old) *Balaena mysticetus* (after Thewissen et al., 2021); Af), NHMD, sexually mature *Balaena mysticetus*, reversed (after Daniel Hillmann, in Thewissen et al., 2021); Ag) ZMUC 1596, *Balaena mysticetus* (after de Lavigerie et al., 2020); Ah) USNM 22553, *Balaena ricei* (after Westgate and Frank, 2002); Ai) *Balaenula balenopsis*, reversed (after Van Beneden, 1878); Aj) *Balaenotus insignis* (after Van Beneden, 1878); Ak) MZUN Z731, juvenile *Eubalaena glacialis* (ph Edoardo Terranova); Al) MSNUP C-264, *Eubalaena glacialis*, reversed (reversed after the MSNUP Sketchfab profile); Am) ZMUC 13.9.1891, *Eubalaena glacialis* (after the Rigsters Sketchfab profile); An) NMNZ MM002239, young *Eubalaena australis* (after de Lavigerie et al., 2020); Ao) 61A, adult *Eubalaena japonica* (after Omura et al., 1969); Aq) 61B, adult *Eubalaena japonica* (after Omura et al., 1969); Ar) RBINS M. 2280, *Eubalaena* sp., reversed (after Bisconti et al., 2017); As) IRSNB M2325, *Antwerpibalaena liberatlas* (after de Lavigerie et al., 2020); At) Balaenidae indet, reversed (after Van Beneden, 1878); Bb) very young *Balaenoptera acutorostrata*, reversed (after the Flickr profile of John Rochester); Bc) QM JM 10961, immature *Balaenoptera acutorostrata* (after Paterson et al., 1997); Bd) MZUN Z732, juvenile *Balaenoptera acutorostrata* (ph Edoardo Terranova); Be) MTUM-DW273, *Balaenoptera acutorostrata*, reversed (after Kato et al., 2021); Bf) QM JM11761, adult *Balaenoptera acutorostrata* (after Paterson et al., 2000); Bg) physically mature *Balaenoptera musculus* (after Omura et al., 1970); Bh) MZB 83-308, adult *Balaenoptera physalus* (Carrillo et al. 2014); Bi) 77N62, mature *Balaenoptera brydei* (after Omura et al., 1981); Bj) Balaenopteridae indet., reversed (after Van Beneden, 1882); Bk) Balaenopteridae indet. (after Van Beneden, 1882); Bl) Balaenopteridae indet. (after Van Beneden, 1882); Bm) MB.Ma. 28570, *Plesiobalaenoptera hubachi*, reversed (after Bisconti, 2010); Bn) *Eschrichtius robustus*, reversed (after Andrews, 1914); Bo) HMT-F-1, *Eschrichtius* sp. (after Ichishima et al., 2006); Cb) NMNZ MM2959, newborn *Caperea marginata* (after Müller M.K., 2020); Cc) NMNZ MM2904, juvenile *Caperea marginata*, reversed (after Müller M.K., 2020); Cd) NMNH-P 668/1, *Cetotherium riabinini*, reversed (after Gol'din et al., 2014); Ce) ZIRMV28/1, *Ciuciulea davidi* (after Gol'din, 2018); Cf) SPMI GG 77/114, *Mithridatocetus* sp. (after Gol'din and Startsev, 2016); Cg) ONU 3966, Cetotheriinae indet. (after Gol'din and Startsev, 2016); Ch) MNHN SAS 1617, *Piscobalaena nana*, reversed (after Bouetel and Muizon, 2006); Ci) *Herpetocetus scaldiensis*, reversed (after Van Beneden, 1886). Cj); GNM CO-5–12, *Otradnocetus virodovi*, reversed (after Gol'din, 2018); Ck) VSEGEI 2401, *Otradnocetus* sp., reversed (after Gol'din and Startsev, 2016); Cl) *Amphicetus later*, reversed (after Van Beneden, 1886); Cm) *Heterocetus affinis* (after Van Beneden, 1882); Cn) RBINS M707-709, Balaenomorpha gen. et. sp. indet. (after Van Beneden, 1882); Co) RBINS M671, Balaenomorpha gen. et. sp. indet., reversed (after Van Beneden, 1885); Cp) RBINS M659, Balaenomorpha gen. et. sp. indet., reversed (after Van Beneden, 1885).

Supplementary Abbreviations:

GNM: Georgian National Museum, Tbilisi, Georgia
HMT-F: The Historical Museum of Teshio River, Hokkaido, Japan
IRSNB: Institut royal des Sciences naturelles de Belgique, Brussels, Belgium
MB: Museum für Naturkunde in Berlin, Berlin, Germany
MNHN: Muséum national d'Histoire naturelle, Paris, France
MSNUP: Museo di Storia Naturale dell'Università di Pisa, Calci, Italy
MTUM: Museum of Marine Science, Tokyo University of Marine Science and Technology, Tokyo, Japan
MZB: Museu de Ciències Naturals de Barcelona, Barcelona, Spain
MZUN: Museo Zoologico dell'Università di Napoli, Università Federico II Napoli, Napoli, Italy
NHMD: Natural History Museum Denmark, Copenhagen, Denmark
NMNH-P: Academician V.A. Topachevsky Paleontological Museum of the National Museum of Natural History of the National Academy of Sciences of Ukraine, Kiev, Ukraine
NMNZ: Museum of New New Zealand Te Papa Tongarewa, Wellington, New Zealand
NSB-DWM: North Slope Borough Department of Wildlife Management, Barrow, Alaska, USA
ONU: Odessa National University, Odessa, Ukraine
QM: Queensland Museum (mammal Collection), Brisbane, Queensland, Australia
RBINS: Royal Belgian Institute of Natural Sciences, Brussels, Belgium
SPMI: National University of Mineral Resources, St. Petersburg, Russia
UAM: University of Alaska Museum, Fairbanks, Alaska, USA
USNM: National Museum of Natural History, Smithsonian Institution, Washington DC, USA
VSEGEI: Central Scientific Research Geological Survey Museum, Karpinsky Russian Geological Research Institute, St Petersburg, Russia
ZIRM: Museum of Fossil Faunistic Complexes of Moldova, Institute of Zoology of Academy of Sciences of Republic of Moldova, Chisinău, Moldova
ZMUC: Zoological Museum of the University of Copenhagen, Denmark

Supplementary References

1. Andrews, R. C. Monographs of the Pacific Cetacea, The California Gray Whale (*Rhachianectes glaucus* Cope). *Mem. Am. Mus. Nat. Hist.* **1914**, *I* (V), 227-287.
2. Bisconti, M. New Description of *"Megaptera" hubachi* Dathe, 1983 Based on the Holotype Skeleton Held in the Museum für Naturkunde, Berlin. *Quad. Mus. St. Nat. Livorno* **2010**, *23*, 37-68.
3. Bisconti, M.; Lambert, O.; Bosselaers, M. Revision of *"Balaena" belgica* Reveals a New Right Whale Species, the Possible Ancestry of the Northern Right Whale, *Eubalaena glacialis*, and the Ages of Divergence for the Living Right Whale Species. *PeerJ* **2017**, *5*, e3464, 1-50.
4. Bouetel, V.; de Muizon, C. The Anatomy and Relationships of *Piscobalaena nana* (Cetacea, Mysticeti), a Cetotheriidae s.s. from the Early Pliocene of Peru. *Geodiversitas* **2006**, *28* (2), 319-395.
5. Carrillo, M.; Alcántara, E.; Taverna, A.; Paredes, R.; García-Franquesa, E. Descripción Osteológica del Rorcual Común (*Balaenoptera physalus*, Linnaeus, 1758) del Museo de Ciencias Naturales de Barcelona. *Arx. Misc. Zool.* **2014**, *12*, 93-123. https://doi.org/10.32800/amz.2014.12.0093.
6. de Lavigerie, G. D.; Bosselaers, M.; Goolaerts, S.; Park, T.; Lambert, O.; Marx, F. G. New Pliocene Right Whale from Belgium Informs Balaenid Phylogeny and Function. *J. Syst. Palaeontol.* **2020**, *18* (14), 1141-1166. https://doi.org/10.1080/14772019.2020.1746422.
7. Gol'din, P.; Startsev, D. A Systematic Review of Cetothere Baleen Whales (Cetacea, Cetotheriidae) from the Late Miocene of Crimea and Caucasus, with a New Genus. *Pap. Palaeontol*. **2016**, 1-20.
8. Gol'din, P.; Startsev, D.; Krakhmalnaya, T. The Anatomy of the Late Miocene Baleen Whale *Cetotherium riabinini* from Ukraine. *Acta Palaeontol. Pol.* **2014**, *59*(4), 795-814.
9. Gol'din, P. New Paratethyan Dwarf Baleen Whales Mark the Origin of Cetotheres. *PeerJ* **2018**, *6*, e5800, 1-33. https://doi.org/10.7717/peerj.5800.
10. Ichishima, H.; et al. The Oldest Record of Eschrichtiidae (Cetacea, Mysticeti) from the Late Pliocene, Hokkaido, Japan. *J. Paleontol.* **2006**, *80* (2), 367-379.
11. Idaho Virtual Museum. Available at https://virtual.imnh.iri.isu.edu/Osteo/View/Bowhead_Whale/789 (accessed 5 August 2024).
12. Flickr - Rochester, J. Minke Whale Skeleton album, available at: https://www.flickr.com/photos/jrochester/albums/72157662614490885/ (accessed 5 August 2024).
13. Kato, H.; Fujise, Y.; Nakamura, G.; Hakamada, T.; Luis A. Pastene, L. A.; Best, P. B. Dwarf Minke Whales: Morphology, Growth and Life History Based on Samples Collected from the Higher Latitudes in the Southern Hemisphere. *Cetacean Popul. Stud.* **2021**, *3*, 93-128.
14. Müller, M. K. Comparative Anatomy and Functional Morphology of the Forelimb in Cetaceans from New Zealand. Ph.D. Thesis, Geology Department, University of Otago, New Zealand, 2020.
15. Nishiwaki, M.; Kasuya, T. A Greenland Right Whale Caught at Osaka Bay. *Sci. Rep. Whales Res. Inst.* **1970**, *22*, 45-62.
16. Omura, H.; Ohsumi, S.; Nemoto, T.; Nasu, K.; Kasuy, T. Black Right Whales in the North Pacific. *Sci. Rep. Whales Res. Inst.* **1969**, *21*, 1-78.
17. Omura, H.; Ichihara, T.; Kasuya, T. Osteology of Pygmy Blue Whale with Additional Information on External and Other Characteristics. *Sci. Rep. Whales Res. Inst.* **1970**, *22*, 1-27.

18. Omura, H.; Kasuya, T.; Kato, H.; Wada, S. Osteological Study of the Bryde's Whale from the Central South Pacific and Eastern Indian Ocean. *Sci. Rep. Whales Res. Inst.* **1981**, *33*, 1-26.
19. Paterson, R. A.; Janetzki H. A.; Williams, S. C. Osteology of Immature Dark Shoulder Minke Whales *Balaenoptera acutorostrata* from Southern Queensland. *Mem. Queensl. Mus.* **1997**, *42* (1), 315-325.
20. Paterson, R. A.; Cato, D. H.; Janetzki H. A.; Williams, S. C. An Adult Dwarf Minke Whale *Balaenoptera acutorostrata* Lacepède, 1804 from Fraser Island, Queensland. *Mem. Queensl. Mus.* **2000**, *45* (2), 557-568.
21. Sketchfab - Natural History Museum University of Pisa, *Eubalaena glacialis*, available at: https://sketchfab.com/3d-models/north-atlantic-right-whale-4cc3ebebb63b4c81a87388fd977c7b47 (accessed 5 August 2024).
22. Sketchfab - Rigsters. *Eubalaena glacialis* - 3D Scanning project by Icelandic Museum of Natural History and Natural History Museum of Denmark, available at https://sketchfab.com/3d-models/eubalaen-glacialis-north-atlantic-right-whale-3858008a8bf94ff599228e998fc9d397 (accessed 5 August 2024).
23. Thewissen, J. G. M.; Hillmann, D. J.; George, J. C.; Tarpley, R. J.; Sheffield, G.; Stimmelmayr, R.; Suydam, R. Postcranial Skeleton and Musculature. In *The Bowhead Whale:* Balaena mysticetus*: Biology and Human Interactions*; 2021; pp 137-149. https://doi.org/10.1016/B978-0-12-818969-6.00010-8.
24. Van Beneden, P. J. Description des Ossements Fossiles des Environs d'Anvers, Troisième Partie, Cétacés, Genres: *Balaena*, *Balaenula* et *Balaenotus*. *Ann. Mus. R. Hist. Nat. Belg., Sér. Paléontol.* **1880**, *4*, 1-83.
25. Van Beneden, P. J. Description des Ossements Fossiles des Environs d'Anvers, Troisième Partie, Cétacés, Genres: *Megaptera*, *Balaenoptera*, *Burtinopsis*, et *Erpetocetus*. *Ann. Mus. R. Hist. Nat. Belg., Sér. Paléontol*. **1882**, *7*, 1-87.
26. Van Beneden, P. J. Description des Ossements Fossiles des Environs d'Anvers, Troisième Partie, Cétacés, Genres: *Plesiocetus*. *Ann. Mus. R. Hist. Nat. Belg.*, *Sér. Paléontol*. **1885**, *9*, 1-40.
27. Van Beneden, P. J. Description des Ossements Fossiles des Environs d'Anvers, Troisième Partie, Cétacés, Genres: *Amphicetus*, *Heterocetus*, *Mesocetus*, *Idiocetus* et *Isocetus*. *Ann. Mus. R. Hist. Nat. Belg., Sér. Paléontol.* **1886**, *13*, 1-139.
28. Westgate, J. W.; Frank, C. W., Jr. *Balaena ricei*, a New Species of Bowhead Whale from the Yorktown Formation (Pliocene) of Hampton, Virginia. *Cenozoic Mamm*. *Land Sea* **2002**, *93,* 295-312.