



## Phylum Brachiopoda\*

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### Abstract

The number of living brachiopod genera and species recorded to date, are 116 and 391, respectively. The phylum Brachiopoda is divided into three subphyla: Linguliformea, Craniiformea and Rhynchonelliformea. Although they were extremely common throughout the Paleozoic, today they are considered a minor phylum, and only five orders have extant representatives: Lingulida, with two families, 6 genera and 25 species; Craniida, with one family, 3 genera and 18 species; Rhynchonellida, with 6 families, 19 genera and 39 species; Thecideida, with two families, 6 genera and 22 species; and Terebratulida, with 18 families, 82 genera, and 287 species.

**Key words:** Brachiopoda, classification, diversity

### Introduction

Brachiopods are exclusively marine, sessile invertebrates with a soft body enclosed in a shell consisting of two unequal valves. They are recorded since the Lower Cambrian and were extremely common fossils throughout the Paleozoic; altogether about 30,000 fossil species have been described. Since the Mesozoic, the diversity and abundance of brachiopods have been dramatically reduced, and today they are considered a minor phylum. Only extant taxa are recorded in this synopsis.

The classification of Phylum Brachiopoda follows the revision published in the *Treatise on Invertebrate Paleontology, Part H Brachiopoda*, revised (Kaesler 1997–2006; Selden 2007), with recent additions and amendments published online at *Brachnet* (<http://paleopolis.rediris.es/BrachNet/>) and at the *Brachiopoda World Database* (Emig *et al.* 2013). The phylum is divided into three subphyla: Linguliformea, Craniiformea and Rhynchonelliformea. The name of each subphylum derives from its most ancient living order, i.e., Lingulida, Craniida, Rhynchonellida. Only five orders have extant representatives. Linguliformea and Craniiformea, whose valves are joined only by soft tissues, have one living order each. The living representatives of Lingulida belong to two families, 6 genera and 25 species, while those of Craniida belong to one family, 3 genera and 18 species.

The subphylum Rhynchonelliformea is represented in modern seas by three orders: Rhynchonellida, Thecideida and Terebratulida. All rhynchonelliform brachiopods have calcitic shells with valves joined at a mineralized hinge. The 39 extant species of order Rhynchonellida belong to 6 families and 19 genera. The order Thecideida includes two living families, 6 genera and 22 species. Terebratulida is the most diverse order in Recent seas, being represented by 18 families (+ one family uncertain and one superfamily without family),

82 genera, and 287 species. In total, the extant brachiopod fauna comprises 391 species in 116 genera; however, of these about 5% may be considered as synonymous.

Lists of Brachiopoda species are available in Logan (2007) and at WoRMS (World Register of Marine Species, <http://www.marinespecies.org>). Since volume 6 of the Treatise was published (Selden, 2007), five new extant genera have been described: *Neoemula* by MacKinnon *et al.* (2008), *Joania* by Álvarez *et al.* (2008), *Minutella* by Hoffmann & Lüter (2010), *Oceanithyris* and *Simpliciforma* by Bitner & Zezina in Bitner *et al.* (2013). Several reviews on living brachiopods have also been published: these include Bitner (2008, 2009, 2011), Emig (2009, 2012), Zezina (2010), Cohen *et al.* (2011), Simon & Hoffmann (2013).

Brachiopods are widely distributed geographically, living in all oceans, at depths ranging from intertidal down to more than 5000 m.

## Classification

Phylum **BRACHIOPODA** Duméril, 1805

Subphylum **LINGULIFORMEA** Williams, Carlson, Brunton, Holmer et Popov, 1996

Class **Lingulata** Gorjansky et Popov, 1985

Order **Lingulida** Waagen, 1885

Superfamily **Linguloidea** Menke, 1828 [Lower Cambrian - Holocene]

Family **Lingulidae** Menke, 1828 (2 genera, 12 species)

Superfamily **Discinoidea** Gray, 1840 [Ordovician - Holocene]

Family **Discinidae** Gray, 1840 (4 genera, 13 species)

Subphylum **CRANIIFORMEA** Popov, Basset, Holmer et Laurie, 1993

Class **Craniata** Williams, Carlson, Brunton, Holmer et Popov, 1996

Order **Craniida** Waagen, 1885

Superfamily **Cranioidea** Menke, 1828 [Ordovician - Holocene]

Family **Craniidae** Menke, 1828 (3 genera, 18 species)<sup>1</sup>

Subphylum **RHYNCHONELLIFORMEA** Williams, Carlson, Brunton, Holmer et Popov, 1996

Class **Rhynchonellata** Williams, Carlson, Brunton, Holmer et Popov, 1996

Order **Rhynchonellida** Kuhn, 1949

Superfamily **Pugnacoidea** Rzhonsnitskaia, 1956 [Lower Devonian - Holocene]

Family **Basiliolidae** Cooper, 1959 (3 subfamilies, 5 genera, 11 species)

Superfamily **Dimerelloidea** Buckman, 1912 [Upper Devonian - Holocene]

Family **Cryptoporidae** Muir-Wood, 1955 (2 genera, 9 species)

Superfamily **Norelloidea** Ager, 1959 [Lower Triassic - Holocene]

Family **Frieleidae** Cooper, 1959 (3 subfamilies, 8 genera, 13 species)

Family **Tethyrhynchiidae** Logan *in* Logan & Zibrowius, 1994 (1 genus, 1 species)

Superfamily **Hemithiridoidea** Rzhonsnitskaia, 1956 [Middle Triassic - Holocene]

Family **Hemithirididae** Rzhonsnitskaia, 1956 (2 genera, 3 species)

Family **Notosariidae** Manceñido et Owen, 2002 (1 genus, 2 species)

Order **Thecideida** Elliot, 1958

Superfamily **Thecideoidea** Gray, 1840 [Upper Triassic - Holocene]

Family **Thecidellinidae** Elliot, 1958 (2 subfamilies, 3 genera, 13 species)<sup>2</sup>

Family **Thecideidae** Gray, 1840 (1 subfamily, 3 genera, 9 species)

Order **Terebratulida** Waagen, 1883

Suborder **Terebratulidina** Waagen, 1883

1. *Novocrania japonica* was previously reported as *Craniscus japonicus* (see Robinson & Lee 2011). Also the genus *Novocrania* Lee et Brunton, 2001 needs revision as the status of at least three species remain uncertain.
2. Recently the genus *Minutella* Hoffmann et Lüter, 2010 has been placed in a new subfamily Minutellinae proposed by Logan & Baker (2013).

- Superfamily **Terebratuloidea** Gray, 1840 [?Upper Jurassic, Lower Cretaceous - Holocene]  
 Family **Terebratulidae** Gray, 1840 (4 subfamilies, 12 genera, 52 species)<sup>1</sup>
- Superfamily **Dyscolioidea** Fischer et Oelhart, 1891 [Lower Jurassic - Holocene]  
 Family **Dyscoliidae** Fischer et Oelhart, 1891 (3 subfamilies, 6 genera, 15 species)
- Superfamily **Cancellothyridoidea** Thomson, 1926 [Lower Jurassic - Holocene]  
 Family **Cancellothyrididae** Thomson, 1926 (1 subfamily, 4 genera, 28 species)  
 Family **Chlidonophoridae** Muir-Wood, 1959 (3 subfamilies, 7 genera, 24 species)  
 Family **Cnismatocentridae** Cooper, 1973 (1 subfamily, 1 genus, 2 species)
- Suborder **Terebratellidina** Muir-Wood, 1955
- Superfamily **Zeillerioidea** Allan, 1940 [Lower Triassic - Holocene]  
 Family **Zeilleriidae** Allan, 1940 (1 subfamily, 1 genus, 6 species)
- Superfamily **Kingenoidea** Elliot, 1948 [Middle Triassic - Holocene]  
 Family **Kingenidae** Elliot, 1948 (1 subfamily, 1 genus, 2 species)  
 Family **Aulacothyropsidae** Dagens, 1972 (1 subfamily, 2 genera, 6 species)
- Superfamily **Laqueoidea** Thomson, 1927 [Upper Triassic - Holocene]  
 Family **Laqueidae** Thomson, 1927 (2 subfamilies, 2 genera, 15 species)  
 Family **Frenulinidae** Hatai, 1938 (3 subfamilies, 4 genera, 12 species)  
 Family **Terebrataliidae** Richardson, 1975 (1 subfamily, 5 genera, 9 species)
- Superfamily Uncertain  
 Family Uncertain (2 genera, 3 species)
- Superfamily **Megathyridoidea** Dall, 1870 [Lower Cretaceous - Holocene]  
 Family **Megathyrididae** Dall, 1870 (3 genera, 27 species)  
 Family **Thaumatosiidae** Cooper, 1973 (1 genus, 1 species)
- Superfamily **Bouchardioidea** Allan, 1940 [Lower Cretaceous - Holocene]  
 Family **Bouchardiidae** Allan, 1940 (1 genus, 1 species)
- Superfamily **Platidioidea** Dall, 1870 [Upper Cretaceous - Holocene]<sup>2</sup>  
 Family **Platidiidae** Dall, 1870 (2 subfamilies, 6 genera, 16 species)<sup>2</sup>
- Superfamily **Terebratelloidea** King, 1850 [Paleogene - Holocene]  
 Family **Terebratellidae** King, 1850 (4 subfamilies, 14 genera, 28 species)  
 Family **Dallinidae** Beecher, 1893 (2 subfamilies, 4 genera, 21 species)
- Superfamily **Kraussinoidea** Dall, 1870 [Miocene - Holocene]  
 Family **Kraussinidae** Dall, 1870 (4 genera, 16 species)
- Suborder Uncertain  
 Superfamily **Gwynioidea** MacKinnon, 2006 [Middle Jurassic - Holocene] (2 genera, 3 species)

## Cited References

- Álvarez, F., Emig, C.C., Roldán, C. & Viéitez, J.M. (2005) Lophophorata, Phoronida, Brachiopoda. Fauna Ibérica, CSIC, Madrid, vol. 27, 276 pp.
- Álvarez, F., Brunton, C.H.C. & Long, S.L. (2008) Loop ultrastructure and development in Recent Megathyridoidea, with description of a new genus, *Joania* (type species *Terebratula cordata* Risso, 1826). *Earth and Environmental Science Transactions of the Royal Society of Edinburgh*, 98, 391–403.  
<http://dx.doi.org/10.1017/s1755691008075130>
- Bitner, M.A. (2008) New data on the recent brachiopods from the Fiji and Wallis and Futuna islands, South-West Pacific. *Zoosystema*, 30 (2), 419–461.
- Bitner, M.A. (2009) Recent Brachiopoda from the Norfolk Ridge, New Caledonia, with description of four new species.

1. The genus *Tichosina* Cooper, 1977 needs to be revised, as most of the species appear to be synonymous.
2. Although the family Platidiidae is commonly attributed to Thomson (1927), this name was already made available by Dall (1870) (*cf.* Álvarez & Emig, 2005 in Álvarez *et al.* 2005)

*Zootaxa*, 2235, 1–39.

- Bitner, M.A. (2011) *Xenobrochus norfolkensis* (Brachiopoda: Dyscoliidae), a new species from the Norfolk Ridge, New Caledonia, South-West Pacific. *Carnets de Géologie / Notebooks on Geology*, Article 2011/5 (CG2011\_A05), 203–211.  
<http://dx.doi.org/10.4267/2042/45792>
- Bitner, M.A., Melnik, V.P. & Zezina, O.N. (2013) New paedomorphic brachiopods from the abyssal zone of the north-eastern Pacific Ocean. *Zootaxa*, 3613, 281–288.  
<http://dx.doi.org/10.11646/zootaxa.3613.3.6>
- Cohen, B.L., Bitner, M.A., Harper, E.M., Lee, D.E., Mutschke, E. & Sellanes, J. (2011) Vicariance and convergence in Magellanic and New Zealand long-looped brachiopod clades (Pan-Brachiopoda: Terebratelloidea). *Zoological Journal of the Linnean Society*, London, 162, 631–645.  
<http://dx.doi.org/10.1111/j.1096-3642.2010.00682.x>
- Dall, W.H. (1870) A revision of the Terebratulidæ and Lingulidæ, with remarks and descriptions of some Recent forms. *American Journal of Conchology*, 6 (1), 88–168, pl. 6–8.
- Emig, C.C. (2009) Chapter IV. Part 35. Brachiopods. In: Wehrtmann, I.S. & Cortés, J. (Eds.), *Marine Biodiversity of Costa Rica, Central America. Monographiae Biologicae*, 86, 417–420 et CD-Species List 35.1 et 35.2, pp. 389–391. Springer Verlag, Berlin, 538 pp. & CD-Rom 500 pp.
- Emig, C.C. (2012) Révision des espèces de brachiopodes décrites par A. Risso. *Carnets de Géologie* [Notebooks on Geology], Article 2012/02 (CG2012\_A02), p. 15–30.  
<http://dx.doi.org/10.4267/2042/45933>
- Emig, C.C., Álvarez, F. & Bitner, M.A. (2013) Brachiopoda World Database. Available online at <http://www.marinespecies.org/brachiopoda>. Consulted on 2013-08-20.
- Hoffmann, J. & Lüter, C. (2010) Shell development in the Thecidelline brachiopods with description of a new recent genus. *Special Papers in Palaeontology*, 84, 137–160.
- Kaesler, R.L. (Ed.) (1997–2006) *Treatise on Invertebrate Paleontology, Part H, Brachiopoda (revised)*, vol. 1–5. Geological Society of America, Boulder, Colorado, and University of Kansas Press, Lawrence, Kansas.
- Logan, A. (2007) Geographic distribution of extant articulated brachiopods. In: *Treatise on Invertebrate Paleontology, Part H, Brachiopoda (revised)*, vol. 6, 3082–3115. Geological Society of America, Boulder, Colorado, and University of Kansas Press, Lawrence, Kansas.
- Logan, A. & Baker, P. (2013) The development and shell microstructure of the pseudodeltidium and interarea in thecideide brachiopods. *Palaeontology*, 56, 433–455.  
<http://dx.doi.org/10.1111/pala.12001>
- MacKinnon, D.L., Hiller, N., Long, S.L. & Marshall, B.A. (2008) *Neoaemula*, a new genus of platidiid brachiopod, with new observations on species referred to the Recent platidiid brachiopod genus *Amphithyris* Thomson. *Fossils and Strata*, 54, 321–331.
- Robinson, J.H. & Lee, D.E. (2011) Spine formation in *Novocrania* and *Danocrania* (Brachiopoda, Craniata). *Memoirs of the Association of Australasian Palaeontologists*, 41, 25–37.
- Selden, P.A. (Ed.) (2007) *Treatise on Invertebrate Paleontology, Part H, Brachiopoda (revised)*, vol. 6. Geological Society of America, Boulder, Colorado, and University of Kansas Press, Lawrence, Kansas.
- Simon, E. & Hoffmann, J. (2013) Discovery of Recent thecideide brachiopods (Order: Thecideida, Family: Thecideidae) in Sulawesi, Indonesian Archipelago, with implications for reproduction and shell size in the genus *Ospreyella*. *Zootaxa*, 3694 (5), 401–433.
- Thomson, J.A. (1927) Brachiopod morphology and genera (Recent and Tertiary). *New Zealand Board Science and Art, Manual* 7, 1–338, 2 pl.
- Zezina, O.N. (2010) Check list of Holocene brachiopods annotated with geographical ranges of species. *Paleontological Journal*, 44 (9), 1176–1199.  
<http://dx.doi.org/10.1134/s0031030110090030>