



Catalogue and bibliography of Recent and fossil *Botula* (Bivalvia: Mytilidae)

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Abstract

This annotated catalogue considers the names for species, subspecies and varieties of Recent and fossil bivalves that have been used for mytilid *Botula* Mörch, 1853, as a genus or subgeneric taxon in the literature or that are given herein for the first time. Information about types, including collection numbers, sizes, localities and geological ages are included when available. A bibliography with annotated listing of synonymies and chresonymies is presented for each of the about 50 names. The respective geographic and geologic distributions are summarized. A single-species concept for this group, put forward by earlier authors, is discussed. References to species as *Botula*, but now placed in other genera, are listed and discussed. The geologic record for *Botula* begins at least in the Cretaceous.

Key words: taxonomy, boring bivalves, marine bioerosion, fossil record, *Adula*, *Lithophaga* (Lithophaginae), *Gregariella*, *Lioberus* (Crenellinae), *Botulopsis* (Mysidiellidae)

Introduction

Mörch (1853: 55) introduced *Botula* as a subgenus of *Lithophaga* Röding, 1798, listing three (two named and one unnamed) species. Of these, only *B. fusca* (Gmelin, 1791) and its three noted synonyms can be regarded as *Botula* species. Dall (1898: 792) designated *M. cinnamomea* Lamarck, 1819, as type species of *Botula* (see type species problem). Wilson & Tait (1984) treated *B. fusca* as the only species of the genus, thus ignoring differences among specimens that other authors found important enough as a basis to describe and distinguish separate nominal species (e.g., *Botula cylista* Berry, 1959, by Keen 1971). This catalogue of Recent and fossil *Botula* was compiled to provide a comprehensive background for an unprejudiced evaluation of the taxonomic situation and adds further conclusions.

Material and methods

All taxa found somehow connected with *Botula* in the literature are listed below with their synonymies and chresonymies, geographical and, if fossil, geological distribution, followed by remarks. Questionable *Botula* species are marked by (?). For taxa actually being members of other genera, e.g. *Adula* H. Adams & A. Adams, 1857, these bibliographies are restricted to references as *Botula*.

Under the heading of each species, entries begin with the original citation: genus and species name, author(s), year, page(s), illustration(s). Then follows information about types (kind of type(s), collection number(s), size(s), type locality, and, if fossil, geologic age. The latter sometimes follows information by subsequent authors or is newly provided herein. The respective geographic and geologic distributions are summarized. Where possible and necessary, prior indications of geological age, particularly those in other languages, were converted to standard international age names. Later species citations, with different spelling of genus and or species name (including typographic errors) or the transfer to another genus, follow in chronological order and are separated from each other by semicolons. Citations include all pages and illustrations where names of the respective species occurred (pages merely mentioning the species are in parentheses). "Fide" refers to the author(s) of an entry that I could not confirm myself. Shell dimensions, some transformed from old measures like Viennese lines, are generally given in mm, and refer to length-height-width (diameter), respectively and in that order, e.g., 19.3-12.1-10.7 mm.

Abbreviations

ANSP Academy of Natural Sciences of Philadelphia, USA. AMNH American Museum of Natural History, New York, USA. AMS Australian Museum, Sydney, Australia. BMNH British Museum of Natural History (now Natural History Museum), London, UK. GBR Great Barrier Reef, Australia. GMC Egyptian Geology Museum in Cairo. ICZN International Commission on Zoological Nomenclature. IRSNB Institut Royal des Sciences Naturelles de Belgique, Belgium. KU Kansas University, USA. MHNG Muséum d'histoire naturelle de la Ville de Genève, Switzerland. MNHNP Musée National d'Histoire Naturelle de Paris, France. MPUC Museum of Paleontology, University of California, USA. NHMB Naturhistorisches Museum Basel, Switzerland. NHMW Naturhistorisches Museum Wien, Austria. NMVM Natural Museum of Victoria, Melbourne, Australia. RSME Royal Scottish Museum, Edinburgh, UK. SAM South Australian Museum, Adelaide, Australia. SDNHM San Diego Natural History Museum, USA. USNM United States National Museum, Washington, D. C., USA.

Taxonomy

Class Bivalvia Linnaeus, 1758

Oder Mytiloidea Férrusac, 1822

Superfamily Mytiloidea Rafinesque, 1815

Family Mytilidae Rafinesque, 1815

Subfamily Lithophaginae H. Adams & A. Adams, 1857

More or less elongate, cylindrical, beaks slightly behind anterior end, hinge margins generally smooth, perios-tracum commonly with calcareous incrustations (Soot-Ryen 1969). Hinge edentulous, extensible siphons rela-tively long. Ventral edges of incurrent or branchial siphon touch to form a tube, excurrent or anal siphon complete.

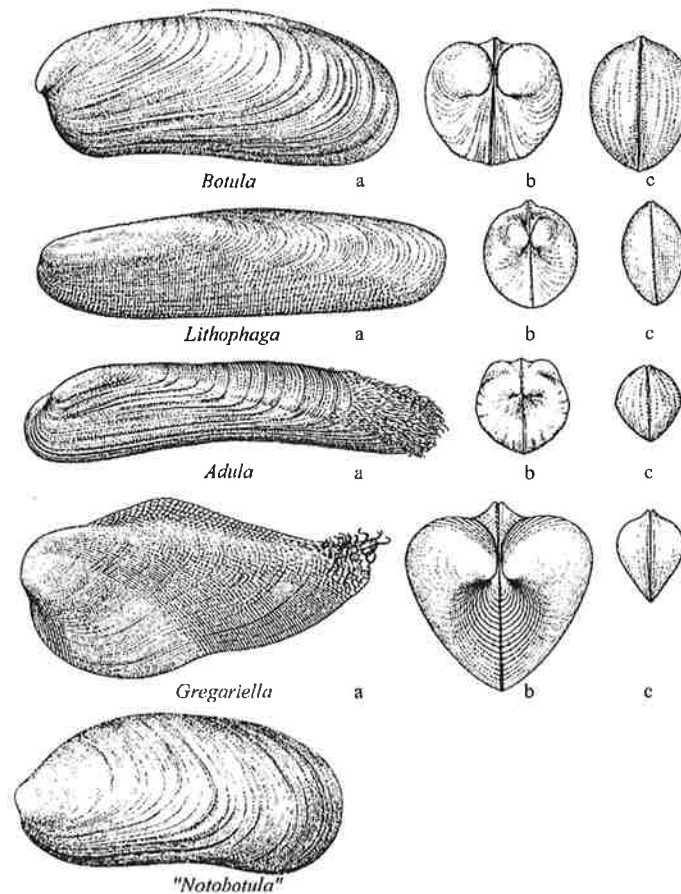


FIGURE 1. Shell characters of boring mytilid genera *Botula*, *Lithophaga*, *Adula*, *Gregariella*, and of non-boring "*Notobotula*". (a) left lateral view, (b) anterior view, (c) posterior view.

***Lithophaga* Röding, 1798**

(Fig. 1)

Type species. *L. mytuloides* Röding, 1798, by monotypy, referring to Gmelin's (1791: 3351) species 6, *Mytilus lithophagus* Linnaeus, 1758.

Diagnosis. Shell cylindrical, posteriorly more compressed, with vertical striae antero-ventrally and lacking any self-deposited calcareous incrustation (subgenus *Lithophaga*) or shell smooth and (partly) covered with own incrustations, particularly on the posterior half (subgenus *Leiosolenus* Carpenter, 1857). Umbones subterminal, ligament deep-set, along a toothless hinge.

Remarks. Anal and branchial siphons fused as in *Adula*, but the branchial part lacks papillae on its edge in *Lithophaga*. In *L. lithophaga*, there is a tonguelike structure, the valvular membrane, with minute papillae at the base of the branchial siphon (List 1902: pl. 7, fig. 6). Some examples of valvular siphonal membranes with central lappet and lateral digits in three *L. (Leiosolenus)* species are figured in Wilson (1985: figs. 5 and 7a, c), those of *B. fusca* by Wilson & Tait (1984: figs. 4, 5A, B). All seem to be quite variable and, therefore, of no help for species determination.

***Botula* Mörch, 1853**

(Fig. 1)

Type species. *Modiola cinnamomea* Lamarck, 1819, subsequent designation by Dall (1898: 792). Wilson & Tait (1984: 113), although referring to Dall (1898), incorrectly noted *Mytilus fuscus* Gmelin, 1791 as type species (see Discussion).

Diagnosis. Shell somewhat ovate to kidney-shaped, smooth; umbones terminal, prominent, somewhat coiled; siphons separate. The anterior retractor is fastened on the anterior thickened margin of the shell just below the umbones. The posterior adductor is small and the posterior retractor leaves a small scar above the adductor (Soot-Ryen 1955: text-fig. 70).

Remarks. Mörch (1853: 55) assigned to *Lithophaga (Botula)* three species: (1) *Tamarindiformes arenaria* Meuschen, 1787, with *Modiola vagina* Lamarck, 1819 and *M. castaneus* Gray (Rumphius 1705: pl. 46 fig. E) listed as synonyms, locality India Orientalis; (2) indet sp., no locality, and (3) *L. (B.) fusca* (Gmelin, 1791) referring to Lister's pl. 359 fig. 197, with *Mytilus brunneus* Solander, 1786 and *Modiola cinnamomea* var. Lamarck, 1819 and *M. favannii* Potiez & Michaud, 1844 listed as synonyms, locality Insulae Antillarum. Based on the subsequent type species designation (Dall 1898: 792), only *cinnamomea* and *fusca* are members of *Botula*. The question remains, whether they are separate species or conspecific (see species problem).

Soot-Ryen (1969) considered *Botula* to belong to Modiolinae, although the genus does not fit to the general characters he lists for the subfamily: modioliform, beaks slightly behind anterior end, hinge margin smooth or finely striated vertically, shell surface usually lacking radial sculpture, periostracum commonly hairy, free-living, often nestling. Compared with *Adula* and *Lithophaga*, the proportions of the valves are relatively shorter and higher, the umbones inflated, the convex anterior and posterior dorsal margins thickened and crenulate in *Botula* (Turner & Boss 1962), but there are definitely no crenulations in *Botula*. The only ornament of the shells, if present, results from growth lines or steps (Fig. 1).

***Lithophaga (Botula)* Mörch, 1853: 55**

Botulopa Iredale, 1939: 414. Type species (original designation), *Botulopa silicula infra* Iredale, 1939: (414), 415, pl. 6, fig. 26, Low Isles, Queensland (Pl. 1, Fig. 3a, b); Soot-Ryen 1969: (N279); Wilson & Tait 1984: (113)

Non *Botula (Notobotula)* Fleming, 1959: 170–171, (176). Type species (original designation), *Botula (Notobotula)*

molina Fleming, 1959, Lower Pleistocene, New Zealand. Castlecliff, Wanganui, pl. 14, figs. 18–24; = *Modiolula phaseolina* (Philippi, 1844), see Beu (2004: 144) and Fig. 1
Sootryenella Adegoke, 1977: 230–231. Type species (original designation), *Sootryenella ewekoroensis* Adegoke, 1977: 231, pl. 43, figs. 15–19

***Adula* H. Adams & A. Adams, 1857**

(Fig. 1)

Type species. *Mytilus soleniformis* Orbigny, 1846, by monotypy.

Diagnosis. Shell elongate, sub-cylindrical, umbones distinctly off anterior end, a diagonal line or shallow keel separating antero-ventral from postero-dorsal “triangle” of shell surface. Ventral margin usually concave, dorsal margin convex. Anterior byssal retractors fastened before the umbones. Siphonal prolongations of the posterior part of the mantle are similar like those found in *Lithophaga*, but with papillae on the rim of the branchial part (Soot-Ryen 1955: text-figs. 74–76).

Remarks. Anal and branchial part of siphons fused as in *Lithophaga*, while separated in *Botula*. The elongate form is similar to *Lithophaga* spp., which never develop a keel-like structure as in *Adula*. A concave ventral margin may occur only in *L. aristata* (Dillwyn, 1817) and *Botula*. *Adula* may be distinguished from *Lithophaga* by the umbones being distinctly off the anterior end, its lesser height in proportion to its length, and the somewhat inclined posterior half of the shell, the cross-section there being less oval but more diamond-shaped (Fig. 1).

Botula

Group names and bibliographies are listed below.

Botula* (?) *affinis (Gabb, 1862) = *Lithophaga ripleyana* (Gabb, 1862, Gabb 1876: 311) (Pl. 1, Fig. 7a, b)

Lithophagus affinis Gabb, 1862: 327, type: a curved tube (‘holotype’, ANSP 18802, 15.7–9.4–<10 mm, see remarks), type locality: exact locality unknown, probably Burlington County (fide Gabb 1862: 327), age: green marl of New Jersey, Cretaceous; Meek 1864: (10); Conrad 1868: (726); Twenhofel 1924: (74); Ruhoff 1980: (127, 608); Kleemann 1983: (1, 28, 31)

Lithodomus affinis Gabb - Stoliczka 1871: (375); Whitfield 1886: 66–67, (256, 267, 302), pl. 17, figs. 2, 3; Kleemann 1983: (21)

Lithophaga affinis Gabb - Gabb 1876: (311), = *L. ripleyana* Gabb, 1862: 326; Johnson 1905: (13); Gardner 1916: (619); Wade 1926: (70); Stephenson 1952: (86, 219, 222), possibly *Botula*

Lithophagus affinis Gabb ‘1861: 124’ - Whitfield 1886: (66) (misattributed, referring to a footnote of I. Lea, mentioning Gabb but no species)

Lithophagus affinis Gabb ‘1876’ - Whitfield 1886: (67), = *Lithodomus ripleyana* Gabb ‘1861: 124’; Weller 1907: (512, 513, = *Lithophaga ripleyana*)

Geographic distribution: ? Burlington County, New Jersey

Geologic distribution: green marls, Cretaceous

Remarks. Gabb (1862) stated that *L. affinis* is but a somewhat curved tube with unknown shell, shorter, more robust and more distinctly marked by the form of the shell than that of his previous species, *L. ripleyanus* Gabb, 1862: 326. The ‘holotype’ of *affinis*, ANSP 18802, is not a tube, but an interior cast of a probable *Botula* (Whitfield 1886, Kleemann 1983), 15.7–9.4–<10 mm (Pl. 1, Fig. 7a, b). Whitfield (1886) described and discussed both of Gabb’s 1862 species, considering *L. ripleyanus* sensu Gabb, 1876, as synonymous with *L. affinis* Gabb, ‘1861: 124’ (see above). On the other hand, Whitfield (1886) regarded *L. affinis* sensu Gabb, 1876, as synonymous with *L. ripleyanus* Gabb, ‘1861: 124’, although Gabb (1876: 311) had listed *affinis* and

Arcoperna carolinensis Conrad, 1875 as synonyms of *ripleyana*. The latter has priority (Gabb 1862: 326 versus 327).

Botula* (?) *archiaci (Deshayes, 1842)

Modiola archiaci Leymerie, 1841: (342), Maroles; (nomen nudum)

Modiola archiaci Deshayes (in Leymerie), 1842: 8, (25), pl. 10, fig. 2a–c, type: ?, type locality: Marolles, France, age: Neocomian; Kleemann 1983: (2, 28, 30), ? genus

Modiola archiacii (sic) Leymerie, 1842 - Orbigny 1845: (291), = *Lithodomus archiacii* Orbigny

Lithodomus archiacii (sic) Orbigny, 1845: 291, (295, 296, 297, 298, 791), pl. 344, figs. 10–12, size: 20.9.2-10 mm; Müller 1847: (36); Orbigny 1850, vol. 2: 81; Savi & Meneghini 1851: (43, 90, 163); Ryckholt 1852: (128); Cotteau 1855: 78; Cotteau 1853–57: 95; Raulin 1858: (425, 635); Kleemann 1983: (2), ? *Botula*

Lithodomus archiacii Leymerie - Gabb 1861a: (138)

Lithodomus archiaci, - Pictet & Campiche 1864–67: (514), 517–518, (523, 524, 549), pl. 134, fig. 8a–c; Stoliczka 1871: (375)

Mytilus (Modiola) archiaci Leymerie - Pictet & Campiche 1864–67: (514)

Mytili (Lithodomi) archiaci, - Mayer-Eymar 1891: (174)

Lithodomus (Botula) archiaci Deshayes – Gillet 1924: 26

L. (Botula) archiaci Orbigny - Gillet 1924: (tableau 4)

Geographic distribution: Marolles, Bettancourt-la-Ferrée (Haut-Marne), St-Sauveur, Moneteau, Tronchoy, Ligny, Wassy

Geologic distribution: Hauterivian (?), Neocomian, Upper Barremian, (Early Cretaceous)

Remarks. In my view, the figures of *Modiola archiaci* Deshayes, 1842, resemble somehow *Gregariella* because of a sulcus, drawn in figure 2a, while those of *Lithodomus archiacii* Orbigny, 1845, resemble *Botula* in general outline (Text-fig. 1). As no types are known, in my view only Orbigny's species may be a member of *Botula*. Gillet (1924: 26) noted *L. (Botula) archiaci* (Deshayes, 1842) from the Barremian, while on table 4 he listed *L. (Botula) archiaci* Orbigny (sic!) from the Hauterivian (most likely in error).

Botula arcuata 'Lamarck' of authors (= *cinnamomea* var., see below)

Non *Modiola arcuata* Lamarck, 1807, (237), pl. 18 (16), fig. 1a, b, fossil, Grignon, near Paris, France (see Remarks)

Modiola arcuata, - Dufo 1840: 215; Martens 1880: 318, ? *cinnamomea* (fide Lamy 1937: 183)

Modiola arcuata of authors - Lamy 1937: (183), = *L. (B.) cinnamomina* Chemnitz var. *b*

Geographic distribution: Mahé, Seychelles

Remarks. Lamy (1937: 182–183) described how the word “arquée”, used for variety *b* of *M. cinnamomea* Lamarck, led to the use of *M. arcuata* by Dufo (1840) and Martens (1880) for Recent material. In a footnote, Lamy (1937: 183) noted that the name for the fossil species from Grignon was transferred by Deshayes to the genus *Hindsia* Deshayes (1858, non H. Adams & A. Adams, 1853, fide Lamy 1937). Clapp & Kenk (1963: 330) considered Dufo's (1840) *M. arcuata* (non Lamarck) from coral rock from the Seychelles as possibly *L. cinnamomea* (Lamarck).

Botula* (?) *arenaria (Meuschen) - Mörch, 1853

Tamarindiformes arenarius Meuschen, 1787: 412; Mörch 1853: (55), = *Lithophaga (Botula) arenaria*; Kleemann 1983: (2, 27, 30), ? genus, nomen dubium

Lithophaga (Botula) arenaria Meuschen - Mörch 1853: 55; H. Adams & A. Adams 1858: (519)

Botula arenaria Meuschen - Wilson & Tait 1984: (113)

Botula arenarius Meuschen - Paetel 1890: (199)

Geographic distribution: India Orientalis, Indo-Pacific

Remarks. Wilson & Tait (1984) noted that "*arenaria*, a large, thin-shelled, siphonate mytilid which burrows in soft substrates of the central Indo-Pacific, is not congeneric with *fusca* (as Mörch 1853 suggested, see below), although its correct generic affinity is yet to be determined". Meuschen (1787) was rejected for nomenclatural purposes because the work was not properly published and the author did not apply the principles of binominal nomenclature (ICZN 1987: 319).

Botula argentina (Deshayes, 1824)

Modiola argentina Deshayes, 1824: 256–257, (258), pl. 15, fig. 15a–c, type: ?, size (of figure): 18-7-? mm, type locality: Valmondois, France, age: Eocene (grès marin inférieur); Deshayes 1830: 269–270, pl. 42, figs. 1–3; Grateloup 1838: (61); Deshayes 1861: 19; Pictet 1855, vol 3: (584); Sherborn 1923: (457); Kleemann 1983: (2, 27, 30), = *Botula mytilus argentinus*, - Deshayes 1832: 571; Deshayes 1836: 32 (fide Bronn 1848: 660; Deshayes 1861: 19)
Lithodomus argentina Deshayes - Bronn 1848: (659–660); Kleemann 1983: (3)
Lithodomus argenteus Orbigny - Orbigny 1850: (424); Deshayes 1861: (19) = *Modiola argentina*
Modiola argentea (sic) Deshayes - Orbigny 1850: (424), = *Lithodomus argenteus* Orbigny '1847'; Deshayes 1861: (10)
Lithodomus argentinus Deshayes - Cossmann 1887: 152, (156); Cossmann & Pissarro 1904–06: (5), pl. 38, fig. 116-3; Cossmann & Peyrot 1914: (23); Cossmann 1922: (156).
Lithophaga argentina (Deshayes) - Panteleev 1974: (102)
Botula argentina, - Kleemann 1990: (118)

Geographic distribution: Valmondois, Saucats, Auvers, le Fayel, Dax, le Guépelle, Seine-et-Oise, France

Geologic distribution: Bartonian, Eocene, Paleogene (grès marin inférieur et supérieur, Falunien, Sables moyens, Auversien, Parisien)

Remarks. Types are not known. The figured specimens in Deshayes (1824) and Cossmann & Pissarro (1906: pl. 38, fig. 116-3) all are members of *Botula*.

Botula (?) brabantica (Vincent, 1930)

Lithophagus (Botula) brabanticus Vincent, 1930: 2–3, text-fig. 1A–C, lectotype: IRSNB CI17, size: 14.5-4-4 mm, paratype: IRSNB CI18, type locality: Neder-over-Heembeek, Belgium, age: Upper Eocene, sands at Wemmel; Glibert 1936: (42); Kleemann 1983: (4, 27, 32)
Lithophaga (Botula) brabantica Vincent - Glibert 1936: 42–43, fig. 23 (paratype)
Lithophaga brabantica Vincent - Glibert 1936: (42), (text-)fig. 23 (two views of paralectotype, right valve x 6)

Geographic distribution: Neder-over-Heembeek, Belgium

Geologic distribution: Upper Eocene

Remarks. The figures, both in Vincent (1930) and Glibert (1936) from the lecto- and paratype respectively, look like oddly elongated, stretched *Botula* specimens.

Botula brevis (Tate, 1887)

Lithodomus brevis Tate, 1887: 186, type: lost?, size: 21-11-11 mm, type locality: Hallet's Cove, St. Vincent Gulf, Australia, habitat: in coral *Plesiastrea vincenti* T. Woods (n.n.), age: older Tertiary; Tate 1892: (130); Pritchard 1903: (88), Kleemann 1983: (4, 27, 32)

Geographic distribution: Hallet's Cove, St. Vincent Gulf, Australia

Geologic distribution: Paleogene

Remarks. The type of *Lithodomus brevis* Tate, 1887, was not found at the South Australian Museum and may be considered lost (R. Hamilton-Bruce, pers. comm.). Here, *L. brevis* is considered a *Botula* with very high probability due to its description, reported dimensions, and boring habit. Further, both *L. cuneiformis* Tate, 1892, (Pl. 1, Fig. 4) and *L. projectans* Tate, 1892 (Pl. 1, Fig. 5a, b) are *Botula* species and Tate (1892) referred to *bevis* as having a near alliance to *projectans* (see below).

***Botula (?) carolinensis* (Conrad, 1875)**

Arcoperna carolinensis Conrad, 1875: 5, pl. 1, fig. 6, type: lost, type locality: Snow Hill, North Carolina, age: Black Creek Formation; Gabb 1876: (311) = *Lithophaga ripleyana* Gabb, 1862; Weller 1907: (512), = *L. ripleyana*; Kleemann 1983: (5, 27, 32), *Botula* ?
Lithophaga carolinensis (Conrad) - Stephenson 1923: (38, 39, 41, 45), 243–244, pl. 62, figs. 4–9; Stephenson 1941: (30), 155–156, (478), pl. 22, figs. 18, 19; Turner & Boss 1962: (90); Sundberg 1981: (901); Bottjer 1982: (79); Tichy 1982: (288); Bien *et al.* 1999: (307)
Botula carolinensis (Conrad) ? - Stephenson 1952: 87, (220, 222), pl. 21, fig. 18; Scott 1970: 62, (66), pl. 1, fig. 18; Scott 1981: (469).

Geographic distribution: Snow Hill, Greene County, the Gohram place, 6 miles NW of Greenville, North Carolina; Chattahoochee River, opposite Woolridge Landing, Georgia; Onion Creek, 2.5 miles west of old Garfield, Travis County, Navarro group, and Aquilla Creek, 1.6 miles of Peoria, Hill County Locality 4, boring in rather soft, impure, ferruginous limestone, both Texas

Geologic distribution: Snow Hill calcareous member of Black Creek Formation (Campanian, North Carolina), lower part of Ripley Formation (Georgia), both, upper part of *Exogyra ponderosa* zone, and Corsicana marl (Texas), Lewisville member of Woodbine Formation, all Cretaceous

Remarks. Conrad's originally figured specimen can be regarded as lost (Stephenson 1923, 1941, 1952). The figure of it, about 11.5 mm long and 6 mm high, probably depicts a *Botula* (Kleemann 1983: 5). Scott (1970) also noted "disposition of original specimens unknown". Further, he regarded the syntype KU 500069 of *Lithophagus interrogatum* Twenhofel, 1924 (p. 74, pl. 7, fig. 15), as synonymous with *B. carolinensis*, although no shells but only tubes, diameters 1–5 mm, were found in *Gryphaea corrugata* (in *Gryphaea* horizons of the Kiowa shales, Kansas, Zone 14, Champion Draw). Stephenson (1923) figured three specimens, USNM 31713–31715, found in borings in the thick shells of *Cyprimeria gabbi* Stephenson, 1923. USNM 31713, measuring ~ 8-4-4 mm (figs. 5, 6) and USNM 31714 (figs. 7, 8) likely members of *Botula*. USNM 31715 (fig. 9), resembles *Botula*, but its posterior is less high than its anterior part (Pl. 2, Fig. 4), thus it remains questionable in its correct generic affinity. Stephenson (1941) figured USNM 76498, a *Botula* measuring 12.6-6-6 mm, which was boring in the shell of *Exogyra costata* Say, 1820. Stephenson (1952) added USNM 105287a (fig. 18), a left valve of 7 mm length, as *B. carolinensis*?

***Botula cinnamomea* (Lamarck, 1819) (Pl. 1, Fig. 1)**

Mytilus cinnamominus Chemnitz, 1785: (124), 152, pl. 82, fig. 731 (A name in a rejected work, ICZN 1944, opinion 184), in *Strombus gigas* Linnaeus, 1758; Schröter 1788: (68); Dillwyn 1817: (303), = *Mytilus lithophagus* var.; Lamarck 1819: (115), = *Modiola cinnamomea*; Dall 1898: (797), = *Modiolus (B.) cinnamomeus* Lamarck; Lamy 1937: (187 footnote); Soot-Ryen 1955: (86), = *B. fusca*; Kleemann 1983: (5, 6); Wilson & Tait 1984: (114), = *B. fusca* (Gmelin, 1791)
Mytilus cinnamomeus Gmelin 1791: 3352, = *M. lithophagus* β , Chemnitz pl. 82, fig. 732 (in error for 731); Schreibers 1793: 293–294, = *M. lithophagus* var. *a*, (referring to) Martini (in error for Chemnitz) Conchylien (part) 8, pl. 82, fig. 732 (in error for 731, probably copying Gmelin, 1791); Schröter 1788: (68); Dillwyn 1817: (303); Savigny 1817: pl. 11, fig. 2; Deshayes 1832: 566; Dunker 1883: (25), = *Lithophaga fusca* - Sherborn 1924: (1316); Kleemann 1983: (5, 27, 30), = *B. cinnamomea*; Wilson & Tait 1984: (114), = *B. fusca*
Modiolus cinnamomeus Chemnitz - Link 1807: (147); Iredale 1939: (415); Kleemann 1983: (5); Wilson & Tait 1984: (114)
Mytilus cinnamominus Chemnitz - Dillwyn 1817: 303, synonym of *M. lithophagus* var.
Modiola cinnamomea Lamarck, 1819: 114–115, types: MNHNP (Pl. 1, Fig. 1), size: 37 mm, type locality: Mauritius, age: (Cenozoic -) Recent; Gould 1833: (43); Carpenter 1864: (577); Melvill & Standen 1899: 184, Torres Straits; Iredale 1939: (415); Clapp & Kenk 1963: (566), = *Lithophaga cinnamomea*
Modiola cinnamomea (b) Lamarck, 1819: 115, re Lister (1685) pl. 359, fig. 197, variety (*b*) in stony corals, fossil near Rome; Deshayes 1832: (566); Deshayes 1836: (25); Iredale 1939: (415)
Modiola cinnamomea Lamarck - Bory de St Vincent 1824: (149), pl. 221, fig. 4; Dubois 1825: (103); Audoin 1826: (52); Deshayes 1832: (571); Deshayes 1836: 25; Deshayes 1837: (268); Jay 1839: (29); Potiez & Michaud 1844: 130;

- Catlow & Reeve 1845: (72); Jay 1850: (76); Hanley 1843: 238, (239); Deshayes 1861: (10); Deshayes 1863: (23); Mabile & Mesle 1866: (118); Fischer 1871: (213); Martens 1879: (741); Martens 1880: (318); Grasset 1884: (300); (Küster &) Clessin 1889: (160); Dall 1916b: (1); Lamy 1920: 233–234; Sherborn 1924: (1315); Gardner 1926: (58); Johnson 1934: (28), = *B. fusca*; Iredale 1939: (415); Gardner 1950: (668, 687); Rios 1970: (159); Wilson & Tait 1984: (114, 120), fig. 1A, B, = *B. fusca*
- Modiola cinnamomea* var. Lamarck - Deshayes 1836: (28), = *M. fusca*; Mörch 1853: (55), = *B. fusca* Gmelin; Etera 1896: (793); Kleemann 1983: (6)
- Mytilus cinnamomeus* Chemnitz - Potiez & Michaud 1844: (130), = *Modiola cinnamomea* Lamarck
- Lithodomus cinnamomeus* Lamarck - Orbigny 1845: 333; Petit de la Saussaye 1856: (151); Beau 1857: 500; Schramm 1867: 22; Mayer 1872: (492); Mayer 1873: (16); Melvill & Standen 1906: (802); Melvill 1909: 74, 123; Cossmann & Peyrot 1914: (18); Teppner 1914: (102), 114, (116)
- Lithodomus cinnamomeus* Orbigny - Orbigny 1853: 333 (re *Mytilus cinnamomeus* Chemnitz and *Modiola cinnamomea* Lamarck)
- Lithophagus ? cinnamomea*, - Carpenter 1857: (234)
- Lithophagus cinnamomeus*, - Carpenter 1857: (174); Carpenter 1864: (586); Soot-Ryen 1955: (19, 86), = *B. fusca*
- Lithophagus cinnamomeus* Chemnitz - Carpenter 1857: (127), 129–130, (131); Carpenter 1857: 234, 249, 309, 363 (fide Lamy 1937: 180); Carpenter 1863: (26/200); Carpenter 1872b: (26/200); Strong & Hanna 1930: (fide Soot-Ryen 1955: 86); Olsson 1961: (131), = *B. fusca*
- Lithodomus cinnamominus* Chemnitz - Reeve 1858: sp. 5, pl. 1, fig. 5a, b; Reeve 1860: (73); Carpenter 1864: (564, 586); Stoliczka 1871: (371); Brazier 1885: (802); Smith 1903: (623); Hidalgo 1905: 21, (365, 366); Kühnelt 1930: (72, footnote)
- Lithophagus cinnamomeus* L. (non Linnaeus) - Carpenter 1860: (4)
- Adula cinnamomea*, - Carpenter 1864: (425), Vancouver District; Lamy 1937: (187); Kleemann 1983: (6)
- Adula cinnamomea* var., - Carpenter 1864: (552)
- Lithophaga cinnamomea* var. Lamarck - MacAndrew 1870: (448)
- Lithodomus cinnamomeus* Chemnitz - Mayer 1872: (492); Mayer 1873: (16); Cooke 1886: (141); Crosse & Fischer 1889: (291); Fischer 1891: 129, (181); Mayer-Eymar 1894: (124)
- Lithophaga cinnamomea* Lamarck - Mörch 1878: (16); Poulson 1878: (16); Küster & Clessin 1889: (162, 167), pl. 2, fig. 3; Sturany 1899: (288, 294); Dautzenberg 1900: (232); Sturany 1905: (140); Hedley 1906: (464); Hedley 1910: (346); Hedley 1916: (159); Satyamurti 1956: (37, 38), 41, pl. 4, fig. 10a, b; Starmühlner 1974: (66).
- Lithodomus (Botula) cinnamomeus* Lamarck - Fischer 1886: (969); Martens 1887: (207); Kleemann 1983: (6)
- Botula cinnamomea* (Lamarck) - Jousseume 1888: 216; Maury 1920: 68; Kuroda 1933: 141; Taylor 1968: (203); Warmke & Abbott 1961: (163) = *B. fusca*; Appukuttan, 1972: 380; Appukuttan 1973: 428; Nielsen 1976a: 3, fig. 16; Nielsen 1976b: (142), 145–146, text-figs. 3A–C, 4B; Kay 1979: (509); Sharabati 1984: pl. 40, fig. 3, 3a; Sheppard 1984: (49); Glayzer *et al.* 1984: (325); Sheppard 1984: (49); Taylor & Reid 1984: (206); Nielsen 1986: (5), 7, (20, 21), fig. 21; Arnaud & Thomassin 1990: (339, 340, 342)
- Modiola (Botula) cinnamomea* Lamarck - Dall 1889: (38); Verrill & Bush 1900: 517
- Modiolaria cinnamomea* Bruguière - Simpson 1887–89: 69*; Clapp & Kenk 1963: (894) ? *Lithophaga fusca* (Gmelin)
- Modiolus (Botula) cinnamomeus* Lamarck - Dall 1898: 792–798, (801), type of *Botula*; Ihering 1900: (88), type of *Botula*; Dall & Simpson 1902: 470; Dall 1915: 128, type of *Botula*; Gardner 1926: (6), 58–59; Dall *et al.* 1938: (59); Iredale 1939: (415); Gardner 1950: (668, 687); Vokes 1986: (159, 172)
- Mytilus cinnamomeus* Schreibers - Sherborn 1902: (216)
- Lithodomus cinnamomina* (sic) Lamarck - Shopland 1902: (178)
- Lithodomus (Botula) cinnamomea* (Lamarck) - Jukes-Browne 1905: (221)
- Lithodomus (Botula) cinnamomina* Chemnitz - Lamy 1906: (312); Lamy 1909: 399.
- Lithodomus (Botula) cinnamomea* Chemnitz - Lyngø 1909: 138/42–139/43
- Modiolus (Botula) cinnamomea* Lamarck - Mayzyck 1913: 22
- Lithophaga (Botula) cinnamomina* Chemnitz - Lamy 1919: 348–350; Pallary *et al.* 1926: 115, pl. 15, fig. 2.1–2.3; Dautzenberg 1932: 95, Diego-Suarez; Lamy 1937: (104, 173), 179–184, (187 footnote, 313 index); OBIS Indo-Pacific Molluscan Database, 2004, = *B. cinnamomea* (Gmelin)
- Mytilus cinnamomeus* Lamarck - Oldroyd 1924a: (70), type of *Botula*
- Lithophagus cinnamominus* Chemnitz - Faustino 1928: (41)
- Lithodomus (Botula) cinnamominus* Chemnitz - Lamy 1929: (204)
- Modiolus cinnamomeus*, - Stephenson *et al.* 1931: (60); Yonge 1955: (403, 409); Goreau *et al.* 1969: (192)
- Lithophaga (Botula) cinnamomea* (Chemnitz) Schröter - Dautzenberg 1932: 95, Diego Suarez; Dautzenberg & Bouge 1933: 436
- Lithophaga (Botula) cinnamomea* (Lamarck) - Prashad 1932: (76); McLean 1951: 42–43, pl. 8, fig. 5 (fide Clapp & Kenk 1963: 635)
- Lithodomus cinnamomeus*, - Kühnelt 1933: (383)

- Botula cinnamomea*, - Kuroda & Kikuchi 1933: (fide Clapp & Kenk 1963: 561); Fankboner 1971: (33, 42); Scott 1980: (130); Morton 1983: (143, 174); Vine 1986: (175); Mastaller 1987: (211); Morton 1990: (18); Peyrot-Clausade & Brunel 1990: (135, 136, 137, 139); Kleemann 1996: (149)
- Modiolus cinnamomeus* [sic] Bruguière – Bertram 1936: (1020)
- Modiolus cinnamomeus* Bruguière - Otter 1937: (325), 339, (344, 348); Gohar & Soliman 1963: (205), 206–211, (217), text-figs. 1, 2, pl. 1, figs. 1 (upper specimen), 2, 3
- Modiolus cinnamomeus* Bruguière [sic] - Wilson & Tait 1984: (114)
- Modiolus cinnamomeus* Bruguière [sic] – Otter 1937: (352), pl. 1, fig. 1.9
- Lithophaga (Botula) cinnamomina* var. *silicula* Lamarck - Lamy 1937: (184); Kleemann 1983: (6)
- Botulopa cinnamomea*, - Allan 1950: (293), re *Botulopa* Iredale, 1939, see *B. silicula infra* Iredale, 1939
- Modiolus (Botula) cinnamomeus*, - Gardner 1950: (687)
- Modiola cinnamomea antiqua*, - Serres 1954: 367; Kleemann 1983: (6)
- Lithophaga cinnamominus*, - Salvat & Rives 1975: (367)
- Modiolus cinnamomeus* Otter - Wilson 1979: (457)
- Modiola cinnamomea* var. *minor* Lamarck - Kleemann 1983: (6)
- Modiolus cinnamomea* Lamarck - Wilson & Tait 1984: (116)
- Botulina* (error for *Botula*) *cinnamomea*, - Peyrot-Clausade & Brunel 1990: (139).
- Mytilus cinnamomeus* Lamarck - Oldroyd 1924a: (70), type of *Botula*
- Botula cinnamomea* (Gmelin) - Kleemann 1983: (5, 14); Kleemann 1990a: (112, 113, 115, 116), pls. 4, 5; Kleemann 1990b: (106, 107, 112, 121, 122, 124, 125, 126, 128, 140, 144, 145, 150), fig. 8; Oliver 1992: (46), 53–54, fig. 21
- Typographic errors:
- Modiolam cinnamomeam*, - Philippi 1847: (113)
- Modiola (Lithodomus) cinnamomea*, - Hanley 1856: 23, pl. 24, fig. 24
- Lithodomus cinamomeus*, - Mayer (in Hartung) 1864: (219)
- Modiola cinnamomila* Lamarck – Lienard 1877: 66 (fide Clapp & Kenk 1963: 605)
- Lithodomus cinnamomeus* Chemnitz - Tate 1892: (130)
- Lithodomus cinnamomeanus*, - Shoplund 1896: 233 (fide Clapp & Kenk 1963: 890)
- Lithodomus sennamuncus* Chenu - Bordaz 1899: 181; Kleemann 1983: (22)
- Lithodomus cinnamomens* Chemnitz - Fanck 1929: (51)
- Modiolus cinnamomeus*, - Rees 1967: (226); Warne 1975: (213)
- Lithohoga cinnamomea*, - Starmühlner 1974: (76)
- Lithophaga cinnamomimus* Schreibers - Salvat & Rives 1975: (367), fig. 406
- Modiola cinamomea* Lamarck - Dall 1916b: (1)
- Modiola cinnamomea antiqua*, - Serres 1954: 367

Geographic distribution: Red Sea (Suez, Obock, Harvey, Sudan, Massouah, Dahlak, Djibouti, Aden), N Arabian Sea, Persian Gulf, Karachi, Indo-Pacific (Mauritius, SE and S Africa, Natal, Zanzibar, Bourbonne, Tular, Madagascar, Nicobar Islands, Seychelles, Laccadive and Maldiva Islands, Chagos, Gulf of Mannar, Gulf of Kutch, Mandapam and Minicoy Island, Ceylon, Madras Coast, Pamban, Andaman Isles, Malay Peninsula, Querimba Islands, Phuket, Thailand, Cape Liant to Koh Chang, Siam, China, Tuamotu, Mangareva, Luzon, Marinduque, Philippines, New Caledonia, Annam (Vietnam), Poulo-Condor, Cochinchine, Society Islands, Raiatea, Tuamutu Islands, Hikueru, Marutea du Sud, Taku, Tearia, Tokaerero, Tahiti, Gambier, Polynesia, West Australia, Low Isles, GBR, Mast Head Reef, Capricorn Group, Queensland, Mazatlán (Mexico)

West Indies Cape Fear to Guadeloupe, W Florida, SE coast of US, South Carolina, Bermudas, Owen Island, Grand Cayman Islands, Antilles, Cuba, Martinique, Dominica, Jamaica, Porto Rico, Trinidad, Virgin Islands, Rio Hacha (Columbia), Testigos (Venezuela), Brazil

Fossil: Switzerland (Cenozoic), Tampa, Florida (Oligocene); Italy (var. b)

Remarks. The syntypes, as photographed by P. Richens (BMNH) in 1977, consisted of a single left valve (Pl. 1, Fig. 1, left side) and a complete specimen (Pl. 1, Fig. 1, right side). Wilson & Tait (1984: fig. 1A, B) reproduced the single left valve as “left valve of the whole specimen”. Starting with Gmelin (1791), several authors regarded Chemnitz’s species as a variety of *L. lithophaga* (L.), while Deshayes 1836: 28 regarded *M. cinnamomea* var. Lamarck as *M. fusca*, and Mörch (1853: 55) as *L. (B.) fusca*. Dunker (1883) was first in considering *cinnamomea* as a synonym of *fusca*, although under the generic affinity to *Lithophaga*, while Johnson (1934: 28), Soot-Ryen (1955: 86) and Wilson & Tait (1984: 114) synonymized it with *B. fusca*. See discussion

on species problem below. The somewhat cosmopolitan geographic distribution, as listed above, is based on a single-species concept (Wilson & Tait 1984).

Botula conchafodentis (Gardner, 1916) (Pl. 2, Fig. 3a, b)

Lithophaga conchafodentis Gardner, 1916: (618), 619–620, (932), pl. 36, figs. 7–9, Holotype: USNM 131769, size: 13-5-7 mm (actually 8.9-4.0-? mm, Kleemann 1983: 6), type locality: Brightseat, Prince George's County, Maryland, age: Upper Cretaceous, Monmouth Formation; Wade 1926: 71, pl. 23, figs. 4, 8; Stephenson 1952: (86, 220, 222); Kleemann 1983: (6, 27, 32), = *Botula*

Lithophaga conchafodentis (sic) Gardner - Stephenson 1952: (86), = *Botula*; Carter 1979: (85); typographic error *Botula conchafodentis*, - Kleemann 1990: (118)

Geographic distribution: Brightseat, Prince George's County, Maryland, Dave Weeks place on Coon Creek, McNairy County, Tennessee

Geologic distribution: Monmouth Formation, Ripley Formation, Mastrichtian, Upper Cretaceous

Remark. Stephenson (1952) attributed *conchafodentis* correctly to *Botula* (Pl. 2, Fig. 3a, b).

Botula* (?) *contorta (Dujardin, 1837)

Modiola contorta Dujardin, 1837: 225, (309), pl. 15, fig. 12a, b, type: ?, size (of figure): 14-7.5-8.5 mm, type locality: France, age: Cretaceous (craie et faluns); Archiac & Haime 1853: (268); Kleemann 1983: (6, 17, 28, 30), ? *Botula Lithodomus contortus*, - Orbigny 1850, vol. 2: 247, re *Modiola contorta* Dujardin, 1837; Coquand 1859: (983, 1021); Mourlon 1881: (111); Kleemann 1983: (6, 17)

Lithodomus contortus Dujardin - Gabb 1861a: (138)

Mytilus (Modiola) contorta Dujardin - Pictet & Campiche 1864-67: (514, 525)

Geographic distribution: France: Tours, Roxan, Vendôme, Malberchie; India (?)

Geologic distribution: Santonian, Senonian, Upper Cretaceous, ? Miocene, Neogene,

Remarks. The type specimen has not been located. In my view, the figures can be attributed to *Botula* and Archiac & Haime (1853: 268) had pointed out that it resembled their *Mytilus subobtusus*, the holotype of which is a member of *Botula* (Pl. 2, Fig. 5a, b).

Botula cordata (Lamarck, 1807)

Modiola cordata Lamarck, 1807: pl. 18, fig. 2a–c, type: ?, type locality: near Paris, age: Eocene; Lamarck 1819, vol. 6: 117; Defrance 1824: 516 (fide Cossmann 1922: 155, = *Lithodomus (Botula) cordata* Lamarck); Deshayes 1824: (268); non Basterot 1825: (16), 79; Keferstein 1829: (86); Serres 1829: (142); Deshayes 1830: 268–269, pl. 39, figs. 17–19; Deshayes 1836, vol. 7: 29; Archiac 1843: (132) 260, (266) 394; Potiez & Michaud 1844: 130; Leymerie 1846: (369); Archiac 1850, vol. 3: (268); Serres 1854, vol. 2: 368; Deshayes 1861, vol. 2: (10), 19–20; Fischer 1866: (275); Benoist 1873: 66; Vasseur 1882: 57, 234; Marinelli 1902: 202 (fide Savazzi 1982: 173); Teppner 1914: (107), = *Lithodomus cordata*; Lamy 1920: (61); Sherborn 1925: (1519); Abbass 1973: (97); Kleemann 1983: (7, 27, 30), = *Botula*; Darga 1992: (88)

Modiola cordata (b) var. ?, - Lamarck 1819, vol. 6: 117; Deshayes 1836, vol. 7: 29; Lamy 1920: (61)

Modiola cordata Lamarck - Basterot, 1825: 79 (fide Lozouet *et al.* 2003: 4, = *B. subcordata* (Orbigny, 1852))

Mytilus cordatus Lamarck - Deshayes 1830–32: 571; Potiez & Michaud 1844: 130; Sherborn 1925: (1519), = *Modiola Non Modiola cordata* Basterot - Grateloup 1838: (61); Pictet 1855: (582, 584); Fischer 1866: (275), = *Lithodomus subcordatus* Orbigny; Cossmann & Peyrot 1914: (22); Lozouet *et al.* 2003: (4), = *B. subcordata* (Orbigny, 1852)

Lithodomus cordata Deshayes - Bronn 1848: (660); Sherborn 1925: (1519), = *Modiola*

Lithodomus cordatus, - Orbigny 1850, vol. 2: 391; Sherborn 1925: (1519), = *Modiola*; Sherborn 1932: (654); (typographic error)

Modiola cordiformis (Nobis) Serres, 1854: (368); (nomen nudum)

Lithodomus cordatus Lamarck - Bellardi 1855: 25 (fide Teppner 1914: 107); Fuchs 1870: (5)141, (32)168, (45)181; Reil 1870: (107); Benoist 1874: (141); Mayer 1876: (79); Cossmann 1887: 142(156)–153(157), (214(218)); Mayer-

Eymar 1894: (124); Vinassa de Regny 1898: (184(142)); Oppenheim 1900: 264 (fide Savazzi 1982: 173); Oppenheim 1901: (147); Oppenheim 1903: (78), 79; Cossmann & Pissarro 1904–06: (6), pl. 38, fig. 115-4 (2 figs.); Teppner 1914: (102), 107–108, (117); Dainelli 1915: 450, pl. 49, fig. 6 (fide Savazzi 1982: 173); Fabiani 1915: (258, 262, 271)

Lithophagus cordatus Lamarck - Frauscher 1886: 118(82)-119(83), tab. 2, pl. 6, fig. 11a, b

Mytilus (Lithodomus) cordatus Lamarck - Mayer-Eymar 1891: 174

Lithodomus cf. *cordatus* Lamarck - Dreger 1903a: 262, (282); Dreger 1903b: (348)

Lithodomus cf. *cordatus* Lamarck - Dreger 1903a: 262, (282); Dreger 1903b: 348

Lithodomus aff. *cordatus* Lamarck - Schubert 1905: (165(13))

Lithodomus cordata Lamarck - Cossmann & Peyrot 1914: (23)

Lithodomus (Botula) cordata (Lamarck) - Cossmann 1922: 155–156, pl. 9, figs. 13–15

Lithophaga (Botula) cordata (Lamarck) - Abbas 1973: 97, (98, 195), pl. 21, figs. 10, 11

Lithophaga cordata Lamarck - Panteleev 1974: (102)

Botula cordata (Lamarck) - Dolin *et al.* 1980: 36 (fide Savazzi 1982: 173); Savazzi 1982: (165–172), 173–174, figs. 3–9, 14, 17, 18; Seilacher 1984: (234); Wilson & Tait 1984: (119); Kleemann 1990: (118); Morton 1990: (22); Darga 1992: 88, (106); Zibrowius & Arnaud 1995: (236, 242); Kleemann 1996: (151)

Geographic distribution: Paris Basin, Meudon, St-Jean-d'Assé, Chaufour, Domfront (Sarthe), Saucats, Grignon, Parnes, Courtagon, Meudon, Montmirail, Bordeaux, Mérignac, Vaugirard, Montrouge, Brasles, Damery, Boursault, Arton near Nantes, Couiza, Corbières, Larriey, Sarthe, Cambon, Hérouval, Chaussy, Fillerval, Bretagne, Saint-Gilles, Ponchon, Blaye, Pyrenes, France; Bois-Gouet, Belgium; Berchtesgaden, Germany; Northern Alps, Häring near Kirchbichl (Tyrol), Guttenstein (Lower Austria), Sauerbrunn (Burgenland), Austria; Gomberto, Laverda, Sangonini, Monte Grumi, Possagno, Luteziano, Buttrio, Rupeliano, Venetian region, Northern Italy; Abu Zabel Cairo, Egypt; India ?

Geologic distribution: Lower Lutetian (Eocene), Oligocene

Remarks. Lamarck (1807) gave no description of *Modiola cordata*, an Eocene *Botula*, and pl. 18 is actually pl. 16 of Coquilles fossils des environs de Paris. No type could be located. Sizes mentioned are 29-15(?) mm (Dreger 1903) and 30-15-15 mm, for specimen GMC L.505, from Cairo Building Stone, Middle Eocene, noted as “holotype” in error for hypotype (Abbas 1973). Savazzi (1982) reported on commensalism between *B. cordata* and a solitary coral (see discussion).

***Botula cretacea* (Gabb, 1861)**

Modiola cretacea Gabb, 1861b: 198, pl. 3, fig. 3, type: lost?, size (of figure): ~16-8-? mm, type locality: S America, age: Cretaceous; Gardner 1926: (58); Gardner 1950: (671, 687); Kleemann 1983: (7, 28, 31), = *Botula*; Kleemann 1990: (116)

Modiolus cretaceus, - Gardner 1926: (58); Gardner 1950: (671)

Botula cretacea, - Kleemann 1990: (118), Middle Cretaceous

Geographic distribution: S America

Geologic distribution: Cretaceous

Remarks. The type disposition is not known. The attribution to *Botula*, with regard to figure 3, is renewed.

***Botula cuneiformis* (Tate, 1892) (Pl. 1, Fig. 4)**

Lithodomus cuneiformis Tate, 1892: 131, pl. 1, fig. 4, holotype: SAM D13045/1, size: 17-8-7 mm, habitat: consolidated shell-ooze, in ~14.5-50 m, type locality: Port Victoria, Spencer Gulf, Kangaroo Islands, Australia; Adcock 1893: (13); Verco 1908: (17); Cotton 1931: (340); Kleemann 1983: (7, 27, 32), = *Botula*

Lithophaga cuneiformis Tate - Cotton & Godfrey 1938: (116), 117, text-fig. 107; Allan 1950: (295); Cotton 1961: (124), 125, (328), text-fig. 111; Clapp & Kenk 1963: (69, 266, 267, 962, 999)

“*Lithophaga*” *cuneiformis* (Tate) - Beu 2004: (149), ? *Zelithophaga* Finlay, 1927

Botula cuneiformis (Tate) - Kleemann 1990: (112, 113, 114), pl. 1

Geographic distribution: Port Victoria, St. Vincent and Spencer Gulf, also Kangaroo Island, Flindersian region, S Australia

Remarks. The holotype is figured in Kleemann (1990), the paratype, SAM D13045/2, herein (Pl. 1, Fig. 4). As noted by Kleemann (1983), Tate's species is a junior homonym of the unrelated Bathonian *L. cuneiformis* Gourret, 1887.

***Botula cylista* Berry, 1959**

Botula cylista Berry, 1959: 108, types and size: see remarks, type locality: Punta Cameron, Mazatlán, Sinaloa, Mexico; Keen 1971: 74, fig. 155; Bernard 1983 (19), = *B. fusca*, Wilson & Tait 1984: 114, 116, fig. 1L, M, = *B. fusca*; Paredes & Cardoso 2003: 54–55, fig. 2; Hertz 1999: 18, fig. 33

Geographic distribution: Mazatlán, Mexico, to Manta, Ecuador, Tumbes (El Rubio), Peru (in stone coral, ? *Astrangia* sp.)

Remarks. The holotype CAS 043975 was figured by Hertz (1999), who gives paratype numbers as SBMNH 34010 (19 specimens) and SDNHM 42803 [sic] (1 specimen), measuring 19.3-12.1-10.7 mm (Wilson & Tait 1984). Keen (1971: 74) noted a size of 26-14-12 mm, and "A dark brown to black shell with a smooth periostracum. This has been identified by authors as *B. fusca* (Gmelin, 1791) because of its similarity to that West Indian form, from which it differs by being higher for its length, with a somewhat more arched dorsal margin." See discussion on species problem below.

***Botula ewekoroensis* (Adegoke, 1977)**

Pholad, n. sp., - Adegoke 1972: pl. 1, fig. 8

Sootryenella ewekoroensis Adegoke, 1977: 230–231, (360), pl. 43, figs. 15–19, holotype: UIMG 125, size: 22.0-11.5-13 mm, type locality: SW Nigeria, age: Ewekoro Formation (Paleocene)

Geographic distribution: SW Nigeria

Geologic distribution: Ewekoro Formation (Paleocene)

Remarks. The holotype is the only specimen of the species, stored at the University of Ife, Ile-Ife, Nigeria, and is a member of *Botula* as shown in the figures.

***Botula favannii* (Potiez & Michaud, 1844)**

Modiola favannii Potiez & Michaud, 1844: 130–132, pl. 54, fig. 9, type: ?, type locality: exotic; Mörch 1853: (55)

Modiola favanii (sic) Potiez & Michaud – Wilson & Tait 1984: (113), = *B. fusca*

Modiole favanni (sic) Potiez & Michaud – Wilson & Tait 1984: (116)

Remarks. The disposition of the type is unknown. The figure of *favannii* is a member of *Botula*.

***Botula fusca* (Gmelin, 1791)**

Musculus exiguus fuscus (etc.) Lister, 1685: pl. 359, fig. 197; Prashad 1932: (79), = *L. (B.) cinnamomea* (Lamarck)

Mytilus fuscus Gmelin, 1791, vol. 1 (6): 3359–3360, type: ?, type locality: Venezuela (fide Lozouet *et al.* 2003: 4), re Lister, 1685: pl. 395, fig. 197; Bosc, 1801, vol. 3: 166 (fide Clapp & Kenk 1963: 166); Dillwyn 1817: 306; Wood 1818: (57); Wood 1825: (57), pl. 12, fig. 12; Hanley 1842–56: 239 (1843); Hedley 1901: 707; Sherborn 1902: (405); Lamy 1906: 312, = *Lithodomus (B.) cinnamomina* Chemnitz; Lyngø 1909: 42/138, = *L. (B.) cinnamomea* Chemnitz; Lamy 1919: 349; Lamy 1920: 233, 234; Glibert 1936: (42); Lamy 1937: 179–183; Dall *et al.* 1938: 59, type of *Botula*; Stephensen 1952: 86, = *Botula*; Soot-Ryen 1955: (83); Soot-Ryen 1969: (N278); Habe 1977: 63; Kleemann 1983: (10, 27, 30); Wilson & Tait 1984: (114), = *B. fusca*; Oliver 1992: (53); Lozouet *et al.* 2003: (4), type of *Botula*

- Modiola fusca* Gmelin - Deshayes (in Lamarck *et al.*), 1836: 28; Catlow & Reeve 1845: (72); Jay 1850: (76); Deshayes 1861 vol. 2: 10; Dall 1916b: (1); Iredale 1939: (415)
- Mytilus (Modiola) fusca*, - Anton 1838: (16), = *Modiola fusca* Deshayes
- Lithodomus fuscus* Gmelin - Forbes & Hanley 1848–53 vol. 2 (1849): (213); List of British Animals 1851: (164, 165); Orbigny 1853: 332; Wood & Hanley 1856: 67, pl. 2, fig. 13; Hidalgo 1905: (366), = *L. cinnamominus*; Kühnelt 1930: (72)
- Lithophaga (Botula) fusca* Gmelin - Mörch 1853: 55, including *Modiola cinnamomea* var. Lamarck, *M. favannii* Potiez & Michaud and *Mytilus brunneus* Solander; Prashad 1932: (80); Thiele 1934: (800); McLean 1951: 43, pl. 8, fig. 3 (fide Clapp & Kenk 1963: 635); Abbass 1973: (96)
- Lithophagus fuscus* Gmelin - Krebs 1864: 130 (fide Clapp & Kenk 1963: 553)
- Lithophaga fusca* Gmelin - Mörch 1878: 16 (fide Clapp & Kenk 1963: 716); Dunker 1882: pl. 6, figs. 8, 9; Dunker 1883: 25; Küster & Clessin 1889: 160, pl. 2, figs. 2, 3 (1889); Satyamurti 1956: (41)
- Botula fuscus* Gmelin - Paetel 1890: (199); Morton 1983: (174)
- Modiolus fuscus* Gmelin - Dall 1898: 797; Dall 1915: (128); Gardner 1926: (59); Iredale 1939: (415); Gardner 1950: (678, 687)
- Modiolus (Botula) fuscus* Gmelin - Thiele & Jaekel 1931: 169, fide Lamy 1937: 182, = *Lithophaga (Botula) cinnamomina* Chemnitz
- Botula fusca*, - Dautzenberg 1932: (95), = *L. (B.) cinnamomina* (Chemnitz); Kuroda 1933: (141), = *B. cinnamomea* (Lamarck); Lermond 1936: (6), Florida; Dall *et al.* 1938: 59; Iredale 1939: (415); Bales 1940: (40); Perry 1940: 47, pl. 7, fig. 42; Abbott 1954: 356; Poirier 1954: (150); Franc 1960: 2080; Olsson 1961: 131, pl. 16, fig. 5-5c; Bales 1966: (3, 4); Soot-Ryen 1969: N279; Rios 1970: 159; Keen 1971: 74; Zankl & Schroeder 1972: 530; Ginsburg & Schroeder 1973: 588; Abbott 1974: 436; Humfrey 1975: 215, (241, 340), pl. 24, fig. 3; Rios 1975: 200, pl. 64, fig. 973; Warme 1975: 213; Emerson & Jacobson 1976: 359, pl. 38, fig. 11; Carter 1978: 13, 80; Carter 1980: 636, 638; Morton 1983: (157); Carter & Clark 1985: 63; Vokes 1986: (162), 172, pl. 1, figs. 12, 13a, b; Kobluk & Lysenko 1986: (658, 661, 662, 667, 668, 669); Kleemann 1990: (112), = *B. cinnamomea*; Morton 1990: (18)
- Lithophaga fusca* Dunker (ex parte) - Prashad 1932: (79), = *L. (B.) cinnamomea* (Lamarck)
- Lithophagus fuscus* (sic), - Clench *et al.* 1948: (39), typographic error
- Botula fusca* (Gmelin) - Soot-Ryen 1955: 86, text-figs. 70–72, pl. 9, fig. 52; Warmke & Abbott 1961: 163, pl. 31d; Porter & Wolfe 1971: (99); Macintyre & Glynn 1976: (1069); Bernard 1983: 19; Kleemann 1983: (6); Wilson & Tait 1984: 114–122, fig. 1G–K, N; Studenka *et al.* 1998: (294); Beu 2004: (146)

Geographic distribution: East Indies, Indian Ocean; N Carolina to SE Florida, Southeast U.S., Porto Rico, Virgin Islands, Jamaica, West Indies (Antilles), N of Isla Tortuga, Venezuela, Caribbean; Pacific coast from Mexico to Ecuador, Manta; Indo-Pacific region; Sligo (Forbes & Hanley 1849); Paratethys (Studenka *et al.* 1998)

Geologic distribution: Middle Miocene (Studenka *et al.* 1998)

Remarks. Gmelin (1791) referred to Lister's (1685, pl. 395, fig. 197) figured specimen, of about 18-8-? mm. Soot-Ryen (1955: 86) noted that this species is *cinnamomea* of authors, not Lamarck, 1819. Wilson & Tait (1984) considered *Botula* to contain but a single species, *B. fusca*, which is questioned herein (see species problem).

***Botula hawaiiensis* Dall, Bartsch & Rehder, 1938**

Botula hawaiiensis Dall, Bartsch & Rehder, 1938: 59, pl. 12, figs. 1–4, type: USNM 484180, size: 15.0-7.8-9.2 mm, habitat: on sand, pebble and shell bottom, in 110–117 (-1170 ?) m (60-64-0 fathoms), type locality: Station 3845 off south coast of Molokai, Hawaii; Olsson 1961: (131); Clapp & Kenk 1963: (284), = *Lithophaga hawaiiensis*; Kay 1979: (509), = *B. silicula* (Lamarck, 1819); Kleemann 1983: (11, 27, 33), = *B. ? cinnamomea* (Gmelin, 1791); Wilson & Tait 1984: (114, 116), fig. 1D, E, = *B. fusca*

Geographic distribution: Hawaii

Remarks. Dall *et al.* (1938) noted three more specimens from the type locality, USNM 335613, and a single one, USNM 335615, from off the northeast coast of Hawaii in 532–347 m, cracked out of a lump of lava.

***Botula hispaniolae* Maury, 1917**

Botula hispaniolae Maury, 1917: 357(193), (413(249), 464(48)), pl. 35, fig. 11, type: not selected, size: 16-7-9 mm, habitat: quite common boring in coral, type locality: Rio Cana at Caimito, age: Miocene (blue clays, zone H)

Botula hispaniola, - Kleemann 1990: (118), typographic error

Geographic distribution: Dominican Republic

Geologic distribution: Miocene

Remarks. No type specimen was selected by Maury (1917), who noted that they were uniform in size, resembling both *B. cinnamomea* Lamarck and *B. incurva* Gabb, but very much smaller and apparently distinct. The type locality is near Santo Domingo. The whereabouts of the specimens is unknown.

***Botula hortensis* (Vinassa de Regny, 1898)**

Lithodomus hortensis Vinassa de Regny, 1897: (21); Vinassa de Regny, 1898: 184(142), pl. 20(7), figs. 9, 10, type: ?, localities: Priabona, Orti, Valle Organa, Venetian Alps, age: Priabonian; Oppenheim 1901: 147, pl. 16, figs. 9, 10; Lörenthey 1905: (189); Vadász 1906: 276, pl. 10, fig. 10a, b; Teppner 1914: (102), 115, (117); Fabiani 1915: (265); Cossmann 1922: (156); Piccoli & Macellini 1962: (55, 96); Piccoli & Massari Degasperis 1968: (249); Savazzi 1982: (173, 174), = *B. cordata* (Lamarck, 1805), in error for 1807; Kleemann 1983: (11, 27, 32), ? *Botula*

Botula hortensis, - Savazzi 1982: (166)

Botula hortensis (Lamarck) - Savazzi 2001: (59), fig. 1AC

Geographic distribution: Priabona, Possagno, Treviso province, NE Italy; Budapest, Hungary

Geologic distribution: Priabonian (blue marls), Upper Eocene

Remarks. Oppenheim (1901, pl. 16, fig. 10) was first to figure a *Botula* specimen in a solitary, turbinate coral, *Pattalophyllia subinflata* (Catullo, 1856), showing the bivalve in dorsal view, crossing the coral skeleton close to and somewhat along its periphery, and not in direction or proximity of the coral center. The figures of *B. hortensis*, shell length 19 mm, in Savazzi (2001: fig. 1A-C) are the same as figures 3, 6, and 4, respectively, of *B. cordata* in Savazzi (1982) (see above).

***Botula incurva* (Gabb, 1881) (Pl. 1, Fig. 8a-d)**

Lithophaga incurva Gabb, 1881: 377, pl. 47, fig. 80, holotype: ANSP 3447, size: 23-9-12 mm, type locality: Limon and Moen, Costa Rica, age: Pliocene clay beds; Dall 1898: (801), = *Botula*; Kleemann 1983: (12), = *Botula*

Botula incurva Gabb - Maury 1917: (357); Kleemann 1990: (118)

Geographic distribution: Costa Rica

Geologic distribution: Pliocene

Remark. The species is represented only by the holotype, being a slender, strongly arched specimen (Pl. 1, Fig. 8a-d).

***Botula inflata* (Whitfield, 1886), = *B. subinflata* (Whitfield, 1899)**

Modiola (*Lithodomus* ?) *inflata* Whitfield, 1886: 197-198, pl. 26, figs. 1, 2, type: lost, size: ~ 15-7.5-7.5 mm, type locality: Mr. Ware's pits, near Mullica Hill, New Jersey, age: Middle marls; Whitfield 1899: (160), = *M. subinflata*, new name; Weller 1907: (507) = *M. subinflata*; Kleemann 1983: (12)

Remark. See *B. subinflata* Whitfield, 1899 (new name for *inflata*).

Botula laysana Dall, Bartsch & Rehder, 1938 (Pl. 1, Fig. 6a, b)

Botula laysana Dall, Bartsch & Rehder, 1938: (59), 60, pl. 12, fig. 5. Type: USNM 335614, size: 9.5-5.4-6.9 mm, type locality: Station 3936, near Laysan Island, habitat: on small broken shell and coralline bottoms in 145–238 m; Kay 1979: (509), = *B. silicula* (Lamarck, 1819); Kleemann 1983: (13, 27, 33), = *Botula*; Wilson & Tait 1984: (114, 116), fig. 1F, = *B. fusca*; Kleemann 1990: (118)
Lithophaga laysana, - Clapp & Kenk 1963: (284)

Geographic distribution: Laysan Island, Hawaii Islands

Geologic distribution: Pleistocene ?

Remarks. This species is only represented by the holotype, a very inflated, probably sub-fossil specimen with the shell lacking any periostracal remains (Pl. 1, Fig. 6a, b).

Botula* (?) *lesbarritzensis (Cossmann, 1922)

Lithodomus (*Botula*) *lesbarritzensis* Cossmann, 1922: 156, pl. 9, figs. 29–30, 58, holotype: lost ?, size: 11-5.5-5 mm, type locality: Lesbarritz, age: Oligocene (Stampien); Kleemann 1983: (13, 27, 32), ? *Botula*

Geographic distribution: Lesbarritz, France

Geologic distribution: Oligocene, Late Paleogene

Remarks. The whereabouts of the holotype and only specimen is unknown. The figures are not good enough to allow a definite statement about the generic affinity.

Botula mcknighti (Hanna, 1927) (Pl. 2, Fig. 1a, b)

Lithophaga mcknighti Hanna, 1927: 279, pl. 33, figs. 2, 7, 8, 10, 11, holotype: MPUC 31151, size: 18.8-9.2-9.1 mm, paratypes: MPUC 31152-53, size: 11.7-6.6-5.2 and 11.5-5.1-4.4 mm respectively, type locality: La Jolla Quadrangle, California, age: Eocene; Kleemann 1983: (16, 27, 32), = *Botula*; Wilson & Tait 1984: (119), *B. fusca* ?

Geographic distribution: La Jolla Quadrangle, California

Geologic distribution: Eocene

Remarks. Only the holotype (figs. 10, 11) represents *Botula*, the paratypes probably are members of *Coralliophaga* Blainville, 1824.

Botula* (?) *minuscula (Dollfus, 1863)

Mytilus minusculus Dollfus, 1863: 75, pl. 16, figs. 4, 5, type: ?, size: ?, type locality: Le Havre, age: Kimmeridgian (fide Chavan 1952: 22)

Mytilus minusculus, - Lennier 1870: 100 (fide Chavan 1952: 22)

Botula minuscula (Dollfus) - Chavan 1952: 22–23, (121), text-fig. 10, pl. 1, figs. 36–38

Geographic distribution: Le Havre, Cordebugle, France

Geologic distribution: Kimmeridgian (Malm, Jurassic)

Remarks. The disposition of the type is unknown. Chavan (1952) reported *B. minuscula* from coral *Goniastrea*. Figures 36 and 38 resemble *Botula*, not so fig. 37 and text-fig. 10.

Botula* (?) *mixta (Borissjak, 1906)

Lithodomus mixtus Borissjak, 1906: 14–16, (17), 31–32, pl. 2, figs. 8–11, types: ?, size: from 11-5-5 mm to 17-7.5-7.5 mm, type locality: Kremenez, age: horizon 7 and 8 (etc.), limestone series of the Jurassic Donez; Kleemann 1983:

(16, 28, 32), ? *Lithophaga*

Lithodomus mixtus Borissjak 1917 (?) - Chavan 1952: (23, footnote), = *Botula*

Geographic distribution: Kremenez (Ukraine)

Geologic distribution: Jurassic

Remarks. Borissjak (1906) noted 187 specimens for *mixtus* but without type designation. The disposition of the material is unknown. The footnote of Chavan (1952) says "est certainement aussi une *Botula*, mais plus courte en avant, plus oblique en arrière". Kleemann (1983) regarded *mixtus* as a probable *Lithophaga*, which is likely, due to the more oval outline of the figures presented by Borissjak (1906) and his statement of the umbos not reaching the anterior end.

Non *Botula* (*Notobotula*) *molina* Fleming, 1959, = *Modiolula phaseolina* (Philippi, 1844)

Botula (*Notobotula*) *molina* Fleming, 1959, (170), 171, text-fig. 5, pl. 14, figs. 18–24, age: Lower Pleistocene, type locality: Castlecliff, Wanganui, New Zealand, holotype: TM2124, right valve, size: 17-9-4 mm, four paratypes: TM21-25-2128, the largest 18 mm long, in the New Zealand Geological Survey; Stilwell & Zinsmeister 1992: (59); Beu (2004: 111, 144, 146, fig. 8A, B, H), = *Modiolula phaseolina* (Philippi, 1844)

Geographic distribution: Castlecliff, Wanganui, New Zealand

Geologic distribution: Pleistocene

Remarks. Beu (2004) noted *B. (N.) molina* as new synonym of the North Atlantic – Mediterranean *Modiolula phaseolina* (Philippi, 1844). (See *B. pirriei*)

Botula (?) *obesa* (Pictet & Campiche, 1867)

Lithodomus obesus Pictet & Campiche, 1867: 521, (524), pl. 135, fig. 1a, b, type: MHNG 9593, size: 40-24-34 mm, type locality: Villiers-le-Lac, age: Valanginian; Ruhoff 1980: (402, 608); Kleemann 1983: (17, 31), ? genus.
Lithodomus (*Botula*) *obesus* Pictet & Campiche - Gillet 1924: (26)

Geographic distribution: Villiers-le-Lac, Doubs, France

distribution: Valanginian (Neocomian) to Aptian, Cretaceous

Remarks. The figures 1a, b show affinity to *Modiolus* as well as the casts and images of the 'holotype', MHNG 9593 (2 specimens), provided by courtesy of D. Decrouez. *Lithodomus obesus* Pictet & Campiche has nothing to do with *Modiola* (*Lithophagus*) *obesa* Philippi, 1847a, = *Lithophaga obesa* (Philippi) (Kleemann 1983: 17).

Botula obtusa (Orbigny, 1845)

Lithodomus obtusus Orbigny, 1845: 296, (297, 298, 792), pl. 345, figs. 11–13, type: ?, size: 15-6.8-7.5 mm, type locality: Royan, age: Senonian, Upper Cretaceous; Orbigny 1850: (247) = *L. contortus* Orbigny, 1847; Coquand 1859: (1001); Guéranger 1867: 17, pl. 23, fig. 17; Kleemann 1983: (17), ? *Botula*

Geographic distribution: Mars (Sarthe), Royan, France

Geologic distribution: Turonian, Senonian, Upper Cretaceous

Remarks. Orbigny (1850); regarded *L. obtusus* as the same as "his" *L. contortus*, referring to *Modiola contorta* Dujardin, 1837. Thus, we may consider *B. obtusa* to be synonymous with *B. contorta* (see above). Guéranger (1867) figured a *Botula* under the name of *L. obtusus*.

***Botula oolithica* (Merian, 1840)**

Venerupis oolithica Merian, 1840: 75, holotype: NHMB 2300, size: < 27 mm, habitat: in coral, type locality: near Langenbruck, border between Kanton Basel and Solothurn, age: Bathonian ferruginous layers; Strübin 1913: (36, 39, 40, text-fig. 3, = *Lithodomus bathonicus* Rollier, 1911)

? *Lithodomus bathonicus* Rollier, 1911: (42, 160), text-fig. 49, nomen dubium

Lithodomus bathonicus Rollier - Strübin 1913: (34, 35), 39–42, text-figs. 3–6

Non *Lithodomus bathonicus* Rollier, 1914: 322–424, pl. 21, fig. 6, 6a–d; Kleemann 1983: (3, 28, 32); Kleemann 1990a: (119, 120), = *Lithophaga*

Geographic distribution: Langenbruck, Ramlinsburg, Wittinsburg, Basler Jura, Switzerland

Geologic distribution: Bathonian (Movelierschichten, Dogger, Jurassic)

Remarks. The original description of *Venerupis oolithica* (in my translation from the German): “The bivalve is elongated oval, inflated, quite thick, and gaping a little at the anterior end. Its length is not quite a French inch (<27 mm). It has the general shape of Lamarck’s lithophages, but the nature of the ligament of the existing specimens cannot be recognized.” A gaping anterior would rather indicate a *Gastrochaena*, but the only available specimen, the holotype, is partly embedded in oolithic rock, thus hiding its anterior part. Nevertheless, the visible parts (digital images, courtesy of Arne Ziemis) support my view to regard it as a *Botula*. Its size is stated as 20-11-<10 mm by Strübin (1913), who attributed *V. oolithica* and his own described and figured specimens, to *L. bathonicus* Rollier, 1911. Rollier (1911: 42) had only mentioned *L. bathonicus* sp. nov. in coral *Thamnastrea*, presenting just a line drawing of the cobble with several boreholes and two shell outlines in it, but no description. Rollier (1914) described and figured *L. bathonicus* as new species and the holotype, at ETH Zürich, represents a small-sized *Lithophaga* of about 13-6-5 mm. While Strübin’s specimens, particularly those two measuring 20-11-10.5 mm and 19.5-11.5-10 mm respectively (1913: figs. 4, 4a and 5, 5a), clearly are members of *Botula*. Figure 3 in Strübin (1913) illustrates the original specimen of *V. oolithica* in its borehole. Rollier (1914) noted *L. bathonicus* sensu Strübin as non synonymous with his species, but with Merian’s *L. oolithicus*. I agree with this view.

***Botula (?) orbignyanus* (Peron, 1906)**

Lithodomus orbignyanus Peron, 1906: 139/171, (262), pl. 5, fig. 9, type: fig. 9, size: ~15 mm, habitat: in coral, type locality: Chatel-Censoir, Yonne, age: Oxfordian (Rauracien blanc); Kleemann 1983: (18, 28, 32), ? *Botula*

Geographic distribution: Chatel-Censoir, Yonne, France

Geologic distribution: Oxfordian, Early Malm, Late Jurassic

Remarks. The type specimen has not been located. The figure caption in Peron (1906, pl. 5, fig. 9) reads *Lithodomus orbignyanus* Cotteau in coll.

***Botula (?) oviformis* (Gabb, 1864)**

Lithophagus oviformis Gabb, 1864: 185, pl. 25, fig. 168, type: embedded in oyster (Gabb, 1864: fig. 191), type locality: Cow creek, Shasta County, age: Division A, Cretaceous; Ruhoff 1980: (414, 608); Kleemann 1983: (18) ? *Botula*
Lithophaga oviformis Gabb - Stephenson 1952: (86), = *Botula*

Geographic distribution: Shasta County, California

Geologic distribution: Cretaceous

Remarks. The disposition of Gabb’s type is unknown. *Mytilus (Lithodomus) oviformis* Buvignier (1852) is definitely no *Botula* species (Kleemann 1983), while Stephenson (1952) considered Gabb’s (1864) species to be a member of *Botula*.

Non *Botula pirriei* Stilwell & Zinsmeister, 1992, ? *Modiolula* Sacco, 1897

Botula pirriei Stilwell & Zinsmeister, 1992: 59, pl. 2, fig. f, holotype: USNM 441602, size: 35.5-20.5-11.5 mm, type locality: PU loc. 1097, Seymour Island, Antarctic Peninsula, age: Lower Tertiary, La Meseta Formation

Geographic distribution: Seymour Island, Antarctic Peninsula

Geologic distribution: La Meseta Formation, Paleogene

Remark. This species was compared with *B. (Notobotula) molina* (= *Modiolula phaseolina*, and may be also attributed to *Modiolula*, explaining the erroneous attribution to *Botula* (see above).

Botula plumosa Stephenson, 1952 (Pl. 2, Fig. 7a, b)

Botula plumosa Stephenson, 1952: (29), 87, (219 index), pl. 21, figs. 15–17, fig. 15 (x3), right side of holotype: USNM 105288, size: 13.8-6.6-6.5 mm, figs. 16, 17 (both x4), paratype: USNM 105289, 3 unfigured paratypes: USNM 105290, type locality: all from locality 137, a small stream cut, 0.2 miles south, 0.5 mile west of Star School, about 5 miles southeast of the center of Denison, northeastern Grayson County, Texas, age: Woodbine Formation from Lewisville member, Upper Cretaceous.

Geographic distribution: Denison, northeastern Grayson County, Texas

Geologic distribution: Upper Cretaceous

Remarks. I have seen all the types. The holotype has some resemblance to *Modiolus* as the posterior is a little higher than the anterior, but that may be tectonically influenced. It lacks prominent beaks and the usually rather evenly rounded shells (Pl. 2, Fig. 7a, b). The paratypes, USNM 105289, 8.1-4.0-4.0 mm, and USNM 105290/1-3, measuring 11.3-6.5-6.2, 9.6-6.2-6.2, and 7.8-4.8-4.4 mm respectively, can be assigned to *Botula* confidently.

Botula (?) prestensis (Pictet & Campiche, 1867)

Lithodomus prestensis Pictet & Campiche, 1867, vol. 3: 522–523, (524, 549), pl. 136, figs. 2a–c, 3a, b, 4a, b, types: MHNG 9608 (2 specimens), size: (of one) 9-5-5 mm, type locality: La Presta, Neuchâtel, age: Lower Aptian; Stoliczka 1871: (357); Ruhoff 1980: (443, 608); Kleemann 1983: (20, 28, 31)

Lithodomus (Botula) prestensis Pictet & Campiche - Gillet 1924: (26)

Geographic distribution: La Presta, Val de Travers, Neuchâtel, Switzerland

Geologic distribution: Lower Aptian, Cretaceous

Remarks. The images and casts of the types (courtesy of D. Decrouez, MHNG) are lacking any radial shell ornament, being striking in the original figures 2 and 3. The casts, measuring 7.3-4.3-4.4 and 6.5-4.2- >3.2 mm respectively, thus less than what Pictet & Campiche (1867) stated. They both resemble small *Botula* specimens with inflated posterior end, whereas figures 2 and 3 resemble *Brachidontes*, and figure 4 may be from a *Lithophaga* borehole cast.

Botula projectans (Tate, 1892) (Pl. 1, Fig. 5a, b)

Lithodomus projectans Tate, 1892: 130–131, pl. 1, fig. 1, holotype: SAM D.14615, size: 28-12.5-12 mm, type locality: Port Darwin, Australia; Iredale 1939: (416); Clapp & Kenk 1963: (961); Kleemann 1983: (20, 27, 32), = *Botula*; Wilson & Tait 1984: (114, 116), = *B. fusca*.

Geographic distribution: Port Darwin, Australia

Remarks. Tate (1892) stated that *projectans* differs from *cinnamoneus* (sic) Chemnitz (1785) by its less arched dorsal line, straighter ventral margin and by the absence of decussated sculpture. In his description,

Tate (1892) noted the interior shell being of a violet-brown colour, of which no trace is remaining in the holotype (Pl. 1, Fig. 5a, b).

Botula ripleyana (Gabb, 1862)

Lithophagus ripleyanus Gabb, 1862: 326–327, type: ?, size: 14–9–6.5 mm, length of tube 23 mm, type locality: the point where the West Jersey railroad crosses Big Timber Creek, between Gloucester and Red Bank, New Jersey, age: “Ripley Group”, Cretaceous marls; Meek 1864: (10); Twenhofel 1924: (74); Ruhoff 1980: (468, 608); Kleemann 1983: (21, 27, 31), ? *Botula*

Lithodomus ripleyana Gabb - Stoliczka 1871: (375); Whitfield 1885: 67–68, (256, 267, 302), pl. 17, figs. 4, 5

Lithophaga ripleyana Gabb - Gabb 1876: 311–312; Johnson 1905: (13); Weller 1907: 512–513, (863), pl. 56, figs. 9–12; Stephenson 1914: (24), 35, (77); Gardner 1916: 618–619, (620, 621, 623), pl. 36, figs. 4–6; Wade 1926: 70, (71), pl. 23, fig. 5, 6; Stephenson 1941: (155, 156, 633) ? *L. carolinensis* (Conrad, 1875); Stephenson 1952: (86, 222, 224), probably *Botula*; Richards 1958: (fide Bien *et al.* 1999: 300); Carter 1978: (85); Kleemann 1983: (5); Bien *et al.* 1999: (300, 301)

Lithophagus ripleyanus Gabb 1876, non 1862 - Whitfield 1885: (66), = *Lithodomus affinis* Gabb; Pl. 1, Fig. 7a, b

Lithodomus repleyanus - Whitfield 1885: (67) (typographic error)

Geographic distribution: New Jersey (Big Timber Creek, between Gloucester and Red Bank, New Egypt, Ware’s pits near Mullica Hill, Hunt’s pits at Manalapan, Monmouth County, Westville, Crawfords Corner, Marlboro, Crosseicks Creek, near Walnford), Tennessee (Dave Week’s place on Coon Creek, McNairy County) Northern Mississippi (2 miles S of New Albany), Maryland, N. America

Geologic distribution: Mississippian, Upper Cretaceous (Cretaceous marls, Ripley Formation, *Exogyra costata* zone, lower green marls, Merchantville clay-marl, Wenonah sand, Navesink marl, Maryland: Matawan Formation, Monmouth Formation)

Remarks. No type material of the species is known. Gabb (1876) listed his *L. affinis* and *Arcoperna carolinensis* Conrad, 1875 (see above), as synonyms of *ripleyana*. Gabb (1876) noted “some bedded partially or entirely in fossil wood”. These specimens cannot belong to *Botula*, but specimens of *ripleyana* in the USNM do: USNM121679, 2 connected borings, 18.4–~7–7.8 mm and ~13–?–6 mm, preserved as a steinkern, from S side of the canal between St. George’s and Lorwood Grove, Delaware, Mt. Laurel-Navesink formation, Cretaceous, USNM 131745, 15.0–6.6–~6.5 mm (Gardner 1916, pl. 36, figs. 4, 5; Pl. 2, Fig. 8a, b), and USNM 131746, ~12 borings as clustered steinkerne in dissolved mollusk shell (Gardner 1916, pl. 36, fig. 6). While USNM 32768, measuring 19–9.9–6.2 mm, looks like a tectonically compressed specimen (Wade 1926, pl. 23, figs. 5, 6), those figured by Weller (1907: pl. 56, figs. 9–12) can hardly be attributed to *Botula*, as he stated “these shells burrow (bore) into various substances, usually wood (never *Botula*), ... and ... burrowing (boring) in the shells of *Gryphaea vesicularis* at Mullica Hill.”

Botula* (?) *semen (Reeve) Simpson, 1889

Non *Modiola semen* Lamarck, 1819: 115, size: 16 mm; Lyngø 1909: (45/141), = *Modiolaria (Gregariella) coralliophaga* (Chemnitz) Gmelin; Kleemann 1983: (22), = *Gregariella*

Botula semen (Reeve) Simpson 1887–89: 69* (fide Clapp & Kenk 1963: 894, ? *Modiolaria coralliophaga* (Gmelin)); Kleemann 1983: (22)

Remarks. This is a very questionable species perhaps synonymous with *Gregariella semen* (Lamarck, 1819) or *G. coralliophaga* (Gmelin, 1791).

Botula silicula (Lamarck, 1819) (Pl. 1, Fig. 2)

Modiola silicula Lamarck, 1819: 115, holotype: MNHNP, size: 25 mm, type locality: Australia; Dubois 1825: (103); Deshayes (in Lamarck *et al.*) 1836: 25, = *Modiola cinnamomea* var. Lamarck; Hanley 1842–56: 238 (1843); Jay

1939: (30); Catlow & Reeve 1845: (73); Dunker 1883: 25, = *Lithophaga fusca* var. Gmelin; Gould 1833: (43); Lyngø 1909: 42/138, = *Lithodomus (Botula) cinnamomea* Chemnitz; Lamy 1919: 349; Lamy 1920: 234, = *M. cinnamomea* var.; Lamy 1937: 180, = *Lithophaga (B.) cinnamomina* Chemnitz var. *silicula* Lamarck; Iredale 1939: (415), = *Botulopa silicula infra* Iredale, 1939; Clapp & Kenk 1963: 303, 566, 570, 586, = *Lithophaga cinnamomea* (Lamarck); Kleemann 1983: (22, 27, 30), = *Botula*; Wilson & Tait 1984: (114), fig. 1C, = *B. fusca*

Non *Modiola silicula* Sowerby, 1830: fig. 2 (non Lamarck, fide Lamy 1920: 234 footnote); Reeve 1841: pl. 100, fig. 2 (non Lamarck, fide Lamy 1920: 234 footnote); Küster & Clessin 1889: 95, ? *M. vagina* Lamarck; Lamy 1919: (349 footnote), = *M. castanea* Gray, non Say

Mytilus silicula Lamarck - Satyamurti 1856: (41), = *Lithophaga cinnamomina* (sic)

Lithophaga silicula Lamarck - H. Adams & A. Adams 1858: 519

Lithodomus siliculus Lamarck - Paetel 1890: (200)

Botulopa silicula infra Iredale, 1939: 415, pl. 6, fig. 26, holotype: AMS C.60400, size: 26.5 - 12 - 12 mm (Pl. 1, Fig. 3a, b), type locality: Low Isles, Queensland; Allan 1950: 293, text-fig. 68/4; Clapp & Kenk 1963: 495; Soot-Ryen 1969: (N279); Habe 1977: 63; Kleemann 1983: (12, 22, 27) = *Botula*; Wilson & Tait 1984: (113), 114, 116, fig. 1O, P, = *B. fusca*

Botula silicula Lamarck - Habe 1951: 56, fig. 106–197, Japan (fide Clapp & Kenk 1963: 420, = *Lithophaga cinnamomea* (Lamarck)); Habe 1962: (113), pl. 50, fig. 13; Habe 1964: 167, pl. 50, fig. 13; Habe 1977: 63, pl. 10, figs. 3, 4; Kay 1979: 509, fig. 164E, F; Habe 1981: (fide Lee & Morton 1985: 60); Tsi & Ma 1982: (445); Wang 1983: (fide Lee & Morton 1985: 60); Matsukuma 1984: (7, 32), pl. 1, fig. 14; Lee & Morton 1985: (52) 60, (66, 67, 68, 69), pl. 5D

Botulopa silicula, - Maxwell 1968: 169, (239); Wilson 1979: 457, = *Modiolus cinnomemeus* (sic) of Otter; Scott 1980: (130)

Modiolus silicula Lamarck - Wilson & Tait 1984: (116)

Geographic distribution: Australia, Noto and Kii peninsulas, Tosa Bay, Palau Islands, coast of Guangdong to Hainan Island, Xisha Islands, South China Sea, Japan

Remarks. The disarticulated shells of the holotype of *Modiola silicula*, which have a blackish periostracum and thus may be attributed to *B. fusca*, are mounted on cardbord. The right valve is seen from outside, with part of the periostracum crumbled away, the left, incomplete valve is shown from inside (Pl. 1, Fig. 2). The holotype of *Botulopa silicula infra* is a light brown specimen (Pl. 1, Fig. 3a, b), probably being a member of *B. cinnamomea* Lamarck. From the two figures presented for *infra*, by Wilson & Tait (1984), only fig. 1–P is the left valve of the holotype, seen in lateral outer view. While the other, fig. 1–O, is from a different left valve in lateral inner view, lacking the writing of the number inside and being posteriorly more inflated.

Botula similis (Ryckholt, 1852)

Lithodomus similis Ryckholt, 1852: 128–129, (132, 172), pl. 7, figs. 3–5, type: ?, size, as taken from the figures: 13.5–2.4.2 mm, type locality: Cibly, age: Late Senonian; Stoliczka 1871: (375); Ruhoff 1980: (495, 608); Kleemann 1983: (22, 28, 31), ? *Botula*

Lithophagus (Lithodomus) similis Ryckholt - Murlon 1881 vol 2: (94, 111)

Botula similis (Ryckholt) - Pantelev 1974: (34, 44), 102–103, (150), pl. 25, fig. 10a, b; Kleemann 1983: (22)

Lithodomus similes, - Pantelev 1974: (102)

Lithophaga similis, - Pantelev 1974: (31, 59), text-fig. 12

Geographic distribution: Cibly, France; W. Turkmenistan

Geologic distribution: Maastrichtian, Late Senonian, uppermost Cretaceous, Danian, Lower Paleocene

Remarks. The disposition of the type is unknown, but I agree with Pantelev (1974) in considering *similis* a *Botula*.

Botula similoides Vokes, 1946

Botula similoides Vokes 1946: (155), 159, pl. 2, figs. 11, 12, holotype: AMNH 25999, size: 7.4–4.4–4.1 mm, type locality: "Olive Locality" at Abeih, Lebanon mountains, age: Aptian; Chavan 1952: (23); Kleemann 1990: (116, 117, 118)

Geographic distribution: Abeih, Lebanon

Geologic distribution: Aptian (Cretaceous)

Remarks. Apart from *B. cretacea*, *B. similoides* proves the geological range of the genus from at least the middle Cretaceous to Recent.

Botula* (?) *subalveata (Conrad, 1866)

Lithophaga subalveata Conrad, 1866: 73, pl. 4, fig. 4, type: single specimen penetrating *Ostrea percrassa* Conrad, type locality: Shiloh, Cumberland County, New Jersey, age: Miocene; Moore 1962: (98); Turner & Boss 1962: (90), = *Botula*; Ruhoff 1980: (513, 608); Kleemann 1983: (23, 27, 31), ? *Botula*

Geographic distribution: Cumberland County, New Jersey

Geologic distribution: Miocene

Remark. This is another questionable species, based on a single specimen.

Botula subcordata (Orbigny, 1852)

Modiola cordata Lamarck - Basterot, 1825: 79 (fide Lozouet *et al.* 2003: 4)

Mytilus subcordatus Orbigny, 1852, vol 3: (126), re *Modiola cordata* Basterot, 1825: 79, non Linnaeus (?), lectotype: MNHNP R63676 (Lozouet *et al.* 2003: pl. 6, fig. 3), type locality: Saucats (Gironde), France, age: Aquitanian (Falunien), Lower Miocene; Benoist 1873: (66), = *Modiola cordata* Lamarck; Ruhoff 1980: (515, 615); Kleemann 1983: (23–24, 27, 31); Lozouet *et al.* 2003: (4), = *B. subcordata*

Lithodomus subcordatus Orbigny - Fischer 1866: 275; Hörnes 1867a: (583); Hörnes 1867b: (353); Cossmann 1895: 19, pl. 5, figs. 23, 24 (fide Cossmann & Peyrot 1914: 22); Teppner 1914: (103, 116); Cossmann 1922: (156); Kühnelt 1931: (241); Kühnelt 1933: (372); Lozouet *et al.* 2003: (4)

Lithodomus (Botula) subcordata Orbigny - Cossmann & Peyrot 1914: 22–23, pl. 16, figs. 15–19; Kleemann 1983: (24), = *Botula*

Lithodomus (Botula) subcordata Orbigny mut. *lozesi* Cossmann & Peyrot, 1914: 23–24, pl. 15, fig. 23, pl. 21, fig. 19, type; Kleemann 1983: (24), = *Botula*; Lozouet *et al.* 2003: (4), = *B. subcordata*

Lithophagus subcordatus Orbigny - Dollfus & Dautzenberg 1920: (392)

Lithophaga subcordata (Orbigny) - Janakevich 1968: (38, 39, 40, 41), 42, (43), (pl.) fig. 3a–c

Lithophaga subordata (typographic error) (Orbigny) - Janakevich 1968: (pl.)

Botula ? subcordata (Orbigny) - Schultz 2001: (130–131), pl. 10, fig. 3a, b

Botula subcordata (Orbigny) - Lozouet *et al.* 2003: (1), 4, pl. 6, figs. 1–6.

Geographic distribution: France: Saucats (Gironde), Tarsous (Cilicie), Davas (Carie), Léognan (Le Thil infr.), Mérignac (Baour), Saucats (Lariev), Cabanac (Pouquet), Pessac (Lorient), Manciet (Gers); Austria: Kalksburg, Wöllersdorf, Burgenland

Geologic distribution: Miocene (Aquitanian, Badenian, Leithakalk) Helvetien

Remarks. The “original” species description by Orbigny “1847”, cited by Schultz (2001) was not found. As Cossmann & Peyrot (1914, pl. 16, figs. 15–19) published neotypes from the early Miocene, Aquitanian, the holotype can be regarded lost. Lozouet *et al.* (2003: 4) designated MNHNP R63676 as lectotype for *B. subcordata* (Orbigny, 1852).

Botula subinflata (Whitfield, 1899)

Modiola subinflata Whitfield, 1899: 160, new name for *M. inflata* Whitfield, 1886 (see there)

Modiola subinflata Whitfield - Weller 1907: 507–508, (992), pl. 55, figs. 20, 21 (after Whitfield)

Modiolus subinflatus (Whitfield) - Palmer & Brann 1965: (200); Kleemann 1983: (12)

Geographic distribution: New Jersey

Geologic distribution: Hornerstown marl, Latest Cretaceous

Remarks. According to Palmer & Brann (1965) the type was lost in 1963. The figures of *M. inflata* Whitfield, 1886 seem to depict a member of *Botula*.

Botula subobtusa (Archiac, 1850) (Pl. 2, Fig. 5a, b)

Mytilus subobtusus Archiac, 1850, vol. 3, 268, holotype: BMNH L98491, size: 40 - 20 - 24 mm, type locality: Hala (India), age: Paleogene (Calcaire blanc grisatre de la chaine d'Hala) fide Archiac & Haime 1853: 268, pl. 23, fig. 13, 13a; Mayer-Eymar 1891: (174), = *M. (Lithodomus) cordatus* Lamarck
Botula subobtusus, - Kleemann 1990: (118)

Geographic distribution: India

Geological distribution: Paleogene

Remark. I located the holotype at BMNH (Pl. 2, Fig. 5a, b).

Botula traversensis (Pictet & Campiche, 1867)

Lithodomus traversensis Pictet & Campiche, 1867: 523, (524), pl. 136, fig. 5a, b, type: MHNG 9609, size: 11-6-6.5 mm, type locality: La Presta, Neuchâtel, age: Aptian; Stoliczka 1871: (375); Ruhoff 1980: (542, 608); Kleemann 1983: (25, 28, 32), ? *Botula*

Geographic distribution: La Presta, Neuchâtel, Switzerland

Geologic distribution: Aptian (Cretaceous)

Remarks. The figures 5a, b look very much like *Botula*. Having seen images and a cast of the type and only specimen (through the courtesy of D. Decrouez, MHNG), no doubt is left.

Botula (?) tumidula (Stoliczka, 1871)

Lithodomus (? Botula) tumidula Stoliczka, 1871: 375-376, pl. 23, fig. 16, 16a, pl. 38, fig. 13, type: ?, size (of figures): ~ 13.5-10-8.5 mm, habitat: conglomeratic whitish sandstone, type locality: S. India, SE of Arrialoor, age: Cretaceous, Arrialoor group; Kleemann 1983: (25, 28, 32), ? genus

Geographic distribution: Arrialoor group, South India

Geologic distribution: Late Cretaceous

Remarks. The figures (16, 16a) depict a specimen with a prominent keel-like postero-dorsal elevation, which in lateral view results in a dorsal depression behind the anterior of the specimen, thus leaving considerable doubt about an affinity to *Botula*. The "corrected view of the same specimen", pl. 38, fig. 13 (x2, 27-20 mm), rules out *Botula* due to its general form and because sulci appear to run from the umbones ventrally. As the fossil is incomplete posteriorly and drawn in latero-dorsal view, the exact outline is difficult to imagine and I leave the interpretation of the drawing and generic determination open.

Botula twitchelli (Gardner, 1916) (Pl. 2, Fig. 2a, b)

Lithophaga twitchelli Gardner, 1916: (618), 622-623, pl. 36, figs. 12, 13, holotype: USNM 131744, size: 21.8 - 11.8 - 11.7 mm, type locality: railroad cut 1 mile west of Seat Pleasant, Prince George's County, Maryland, age: Monmouth Formation, Upper Cretaceous; Stephenson 1952: (86, 222, 225), = *Botula*; Sundberg 1981: (901); Kleemann 1983: (25, 27, 32), = *Botula*

Geographic distribution: Seat Pleasant, Prince George's County, Maryland, USA

Geologic distribution: Monmouth Formation, Maastrichtian, Upper Cretaceous

Remarks. Figures 12 and 13 depict the holotype and only specimen of the species in right lateral and anterior view, respectively. Herein, dorsal and left lateral view are given as well (Pl. 2, Fig. 2a, b).

Non *Botula vestita* (H. Adams & A. Adams, 1858)

Modiola vestita Philippi, 1844, = *Amygdalum agglutinans* (Cantraine, 1835), fide <http://www.somali.asso.fr/clemam/biotaxis.php?X=21529&header=1>

Lithophaga (Botula) vestita Philippi – H. Adams & A. Adams, 1858: (519); Kleemann 1983: (25), n. nudum, ? Philippi

Remark. According to www.somali.asso.fr/clemam/biotaxis.php?X=21529&header=1 this is a junior synonym of *Amygdalum agglutinans*.

Listings of other taxa, only as far as connected somehow with *Botula* in the literature, are given below.

Botula* references in *Lithophaga

Lithophaga* (?) *avellana (Orbigny, 1845)

Lithodomus avellana Orbigny, 1845, vol. 3: 291–292, (297), pl. 344, figs. 13–15, type: figured, size: 18–11.5–11.7 mm, type locality: Orgon (Vaucluse), age: Lower Neocomian; Archiac 1847: (307); Orbigny 1850: 107; Morris 1854: (207); Gabb 1861a: (138); Pictet & Campiche 1864–67: 520, (524, 549), pl. 137, figs. 2a, b, 3, 4a–c; Lorient in Pictet 1866: 37–38, Couche B; Stoliczka 1871: (375, 376); Böhm 1884: 27; Mayer-Eymar 1887: (24); Lorient 1888: (309); Rollier 1914: (334); Favre & Richard 1927: 26, pl. 3, figs. 32–34; Kleemann 1981: (52, 55); Kleemann 1983: (3, 28, 30)

Lithophagus avellana, - Pictet 1855, vol. 3: (584); Böhm 1883: 586, (664, 674, 678), pl. 66, figs. 6–10; Böhm 1884: (27)

Lithodomus cf. *avellana* Orbigny - Toula 1882: (43)

Lithodomus (Botula) avellana Orbigny - Gillet 1924: (26), pl. 1, fig. 3a, b

Lithophaga avellana (Orbigny) - Chernov & Yanin 1974: 38–39, (40, 41), figs. 1–5

Geographic distribution: Orgon (Vaucluse), Sainte-Croix, Arzier, Pierre-Chatel; Maidstone, Kent; Chlebowitz, Ignaziberg, Koniakau, Stramberg, Tieschan, *Willamowitz*

Geologic distribution: Upper Jurassic, Lower Cretaceous, Valangian (Neocomian) to Barremian

Remarks. The location of the figured type specimen is not known. The specimen MHNG 9601, described and figured in Pictet & Campiche (1867), is also ovoid and without prominent beaks, thus not a member of *Botula*, but probably a short inflated *Lithophaga*. Only Gillet (1924) mentioned *avellana* as *L. (Botula)*.

Lithophaga fabaeformis Cressin, 1926

Lithophaga fabaeformis Cressin, 1926: (105, 108), 118–119, (122, 124, 228), pl. 9, figs. 14, 15, holotype (cast): NMVM P13447 (fig. 14), size: 17–6.5–4.5 mm, paratype (fig 15): NMVM P13448, size: 12.5–6.8–7 mm (not 11.5–6 mm), type locality: Outcrop 1, Green Gully, age: Janjukian of Torquay, Tertiary of Australia, Ironstone beds, Keilor; Kleemann 1983: (10, 27.32)

Geographic distribution: Outcrop 1, Green Gully, Keilor, Torquay, SE Australia

Geologic distribution: Oligo-Miocene (Ironstone beds, Janjukian)

Remarks. The oblong holotype is a member of *Lithophaga*, but the shorter paratype, as the name suggests, a bean-shaped cast of a *Botula* (Pl. 1, Fig. 9a, b); therefore it is mentioned here.

Lithophaga* (?) *manuanensis (Newton, 1909) (Pl. 1, Fig. 12a, b)

Lithophaga manuanensis Newton, 1909: 43–44, pl. 4, figs. 1–3, holotype: BMNH L22035, size: 30–13–14 (29.3–12.9–14.2) mm, type locality: Zululand, Tributaries of the Manuan Creek, age: Cretaceous; Kleemann 1983: (15, 28, 32), holotype ? *Botula*

Geographic distribution: Manuan Creek, Zululand, South Africa

Geologic distribution: Late Cretaceous

Remarks. The fractured and deformed holotype is the only specimen. It was noted by Kleemann (1983: 12) as questionable *Botula* specimen, but due to observable lateral sulci, it cannot be a member of *Botula* (Pl. 1, Fig. 12a, b).

Botula* references in *Adula

***Adula californiensis* (Philippi, 1847)**

Modiola californiensis 'Eschscholtz' - Philippi, 1847: 113; Clapp & Kenk 1963: (784), = *Adula californiensis*

Botula californiensis (Philippi) - Dall 1916a: 18 (fide Clapp & Kenk 1963: 282, = *Adula californiensis*); Clemens 1933: 31 (fide Clapp & Kenk 1963: 242, = *Adula californiensis*); Keep 1935: (331, 333); Haas 1942: (110); Haas 1943: (8); Hirase 1936: (11), pl. 18, fig. 11 (fide Clapp & Kenk 1963: 464); Keen 1940: 480 (fide Clapp & Kenk 1963: 529, = *Adula californiensis*); La Roque 1953: 37 (fide Clapp & Kenk 1963: 590, = *Adula californiensis*); Light *et al.* 1954: (238), fig. 102d (fide Clapp & Kenk 1963: 605, = *Adula californiensis*); Nomura & Hatai 1935: 8, (fide Clapp & Kenk 1963: 741); Oldroyd 1924b: 24 (fide Clapp & Kenk 1963: 748, = *Adula californiensis*); Haderlie *et al.* 1974: (200)

Botula (Adula) californiensis Philippi - Keep 1935: (64); Oldroyd 1924a: 71–72, pl. 27, fig. 5; Clapp & Kenk 1963: (748, = *Adula californiensis*)

Botula californica (in error for *californiensis*), - Morris 1952: (60), pl. 7, fig. 10.

Geographic distribution: East Pacific, British Columbia, Vancouver Island to San Diego, California, also North Japan

***Adula diegensis* (Dall, 1911)**

Modiolus diegensis Dall, 1911: 110–111

Botula (Adula) diegensis (Dall) - Oldroyd 1924a: 71, pl. 11, figs. 1, 2; Lamy 1937: (196, = *Adula diegensis*); Clapp & Kenk 1963: (748, = *Adula diegensis*)

Geographic distribution: East Pacific, North America

***Adula falcata* (Gould, 1851)**

Lithodomus falcatus Gould, 1851: 92, about 70-12-12 mm; Gould 1853: 403–404, pl. 16, fig. 9

Adula falcata Gould - Carpenter 1864: (425), 644

Botula falcata Gould - Dall 1916b: 18 (fide Clapp & Kenk 1963: 282); Keep 1935: (333); Morris 1952: 23, (60, 212), pl. 7 (2 views); Fitch 1953: 51, fig. 17 (fide Clapp & Kenk 1963: 366); Light *et al.* 1954: 235, fig. 102e (fide Clapp & Kenk 1963: 605); Yonge 1955: (384–389), text-figs. 1B, 2–5, 6A; Yonge 1963: (16, 19), text-fig. 8A–C; Haderlie *et al.* 1974: (200, 202); Nielsen 1976b: (146); Pojeta & Palmer 1976: (167); Kleemann 1983: (10); Morton 1983: (174)

Botula (Adula) falcata (Gould) - Oldroyd 1924a: 71, pl. 21, figs. 8, 9; Johnson & Snook 1927: 431 (fide Clapp & Kenk 1963: 516); Keep 1935: (64); Hertlein & Strong 1946: 74 (fide Clapp & Kenk 1963: 454); Smith & Mackenzie 1948: 171 (fide Clapp & Kenk 1963: 899); Abbott 1954: 356, pl. 29; Franc 1960: (2080), fig. 1744A; Clapp & Kenk 1963: (748, = *Adula falcata*)

Adula (Botula) falcata Gould - Fankboner 1971: 28–49, 10 figs

Geographic distribution: Monterey, Coos Bay, Oregon to San Diego, California, Mexico

Botula references in Subfamily Crenellinae H. Adams & A. Adams, 1857

Round to modioliform, beaks more or less behind anterior end, anterior hinge margin thickened and vertically striated or with dysodont teeth, dorsal hinge margin usually finely vertically striated. Surface with radial sculpture commonly absent on median area or rarely smooth. Free living, nestling, rarely boring (Soot-Ryen, 1969).

Gregariella Monterosato, 1883 (Fig. 1)

Type species. *Modiolus sulcatus* Risso, 1826, by original designation, = *Modiola opifex* Say, 1825, non of authors.

Diagnosis. Elongate, inflated, beaks incurved, umbonal keel angulated, radially striated anteriorly and posteriorly where striae end along oblique line, median part concentrically striated, periostracum hairy along umbonal keel, anterior and posterior dysodont teeth, margins crenulated (Soot-Ryen, 1969).

Botulina Dall, 1889: 38, type *Modiola opifex* Say, 1825

Tibialectus Iredale, 1939: 424, type *T. otteri* Iredale, 1939

Gregariella splendida (Reeve, 1858)

Non *Volsella splendida* Dunker, 1857: 365, ? syntypes: BMNH 1967564/1-3, size: 21.2-13.3-10.1 mm, 18.8-11.3-9.8 mm, and 16.3-9.5-7.5 mm respectively, type locality: California; Kleemann 1983: (23), ? *Volsella*

Lithophaga (Botula) splendida 'Dunker' - H. Adams & A. Adams, 1858: (519); Kobelt 1881: (364), pl. 106, fig. 10, type of *Botula*; Kleemann 1983: (23)

Lithodomus splendidus 'Dunker' - Reeve 1858: sp. 31, pl. 5, fig. 31, ? syntype: BMNH 1984185, size: 12.4-6.1-7.7 mm, type locality: Sydney; Kleemann 1983: (23), = *Gregariella*

Lithodomus (Botula) splendida, - Chenu 1862: (156), fig. 775

Botula splendida Chenu - Lamy 1937: (46), = *Modiolaria (Gregariella) splendida* Reeve

Botula splendida Dunker - Stoliczka 1871: (370); Hedley 1901: (707), = *Modiolaria splendida*; Iredale 1939: (415)

Botula splendidus Dunker - Paetel 1890: (200)

Geographic distribution: Sydney

Remarks. The probable syntypes of *V. splendida* (BMNH 1967564/1-3, negative 1623) have nothing to do with *Gregariella* but *Volsella*. Although referring to Dunker (1857), Reeve's description and figure of his *Lithodomus splendidus* (1858: sp. 31, pl. 5, fig. 31), is a member of a hairy *Gregariella*. Chenu's figure (1862, fig. 775) is the same as Reeve's and Kobelt's figure (1881, pl. 106, fig. 10) is a redrawing of Reeve's. Thus, Kobelt's selection of *splendida* "Dunker" as type of *Botula* should be ruled out (see Type species problem). Keen (1971: 67, fig. 135) attributed Dunker's species to *Lioberus*, noting "three specimens from the type lot in the British Museum, not previously illustrated". BMNH 1967564/1, the largest, 21-12-? mm, is among the figured in Keen (1971), below the figure number 136.

Lioberus Dall, 1898

Type species. *Modiola castanea* Say, 1822, by monotypy.

Diagnosis. Beaks near anterior end, smooth or with obsolete radial sculpture, edentulous, periostracum smooth (Soot-Ryen 1969)

Lioberus castanea (Say, 1822)

Modiola castanea Say, 1822: 266 (fide Thiele 1934: 800); Lamy 1937: (49)

Lithophaga (Lioberus) castanea (Say) - Thiele 1934: (800); Kleemann 1983: (5)

Modiolaria (Lioberus) castanea Say - Lamy 1937: 49–50

Botula castanea (Say) – Perry 1940: 47, pl. 7, fig. 41; Clapp & Kenk 1963: (777), = *Modiolaria*

Lioberus castaneus Say - Poirier 1954: (150, formerly known as *Botula castanea* Say); Warmke & Abbott 1961: 163, pl. 31h; Humfrey 1975: 216

Geographic distribution: SW coast of Florida, West Indies

Remarks. Poirier (1954) gives no reference, but probably refers to Perry (1940).

***Botula* references in Family Mysidiellidae Cox, 1964**

Type genus. *Mysidia* Bittner, 1891 (non Westwood, 1840, nec Dana, 1850), renamed *Mysidiella* Cox, 1964: 44 (Waller 2005: 8).

For original and emended diagnosis see Waller (2005).

***Botulopsis* Reis, 1926**

Type species. *Botulopsis reisi* Waller, 2005 (= *Botulopsis cassiana* Reis, 1926 non *Botulopsis cassiana* (Bittner, 1895), by monotypy, Ladinian (Wettersteinkalk), Hochalpe, Karwendel, Austria (Waller 2005: fig. 4.8–4.10, reproduction of figures 1–3 in Reis 1926, pl. 8).

Diagnosis (emended by Waller 2005: 13). Mysidiellidae moderately inflated and rounded-oblong in shape, with umbones broad and rounded, beaks medially inturned and not extending beyond anteriormost point of anterior shell margin; byssal invagination very shallow.

***Botulopsis cassiana* (Bittner, 1895)**

Botula (?) cassiana Bittner, 1895: 49, (231), pl. 5, figs. 17, 18, types: 3 specimens at NHMW (see remarks), type locality: Sanct Cassian, age: Cordevol (*Trachyceras aon* zone), basal Carnian, Late Triassic; Bubnoff 1921: 335), = *Cardiomorpha* de Koninck, 1841 (fide Waller 2005); Reis 1926: (124), = *Botulopsis*; Soot-Ryen 1969: (N275), type of *Botulopsis*; Tichy 1970: (639); Kleemann 1983: (5, 28), ? *Arcoperna*, ? *Botulopsis*; Waller 2005: (13, 14)

Lithodomus (Botula ?) cassiana Bittner - Diener 1923: (139); Zapfe 1967: (436)

Botulopsis cassiana Bittner - "n.s." n.g., Reis 1926: 124, pl 8, figs. 1–3; Soot-Ryen 1969: N275, fig. C19.4a, b; Waller 2005: (12, 13, 14), fig. 4.7 (reproduction of Bittner's pl. 5, fig. 18)

Geographic distribution: St. Cassian, Northern Italy, Alpine Europe

Geologic distribution: San Cassiano Formation, Cordevol, basal Carnian, Late Triassic

Remarks. Bittner (1895) was quite uncertain about the generic affinity. Reis (1926) put *cassiana*, as type species, into his new genus *Botulopsis*. From the supposedly three syntypes, two are stored in the palaeontological collection of NHMW, Nr. D.2/3 1884. One left valve, filled with indurated sediment, is the larger specimen, 15.4-12.6x2 mm (figured in Soot-Ryen 1969), and the smaller is a right valve in sediment, 10.6-8.6x2 mm. A third syntype was not found. The attached label reads "*Sigaretus ?*" respectively "*? Botula cassiana* Bittner", St. Cassian, Stuares, Southern Tyrol, Alpine Triassic, *Trachyceras aon* zone, which is basal Carnian (Cordevol, L. Krystyn, pers. comm.).

Discussion

History of the taxonomic ranking and attribution to mytilid subfamilies

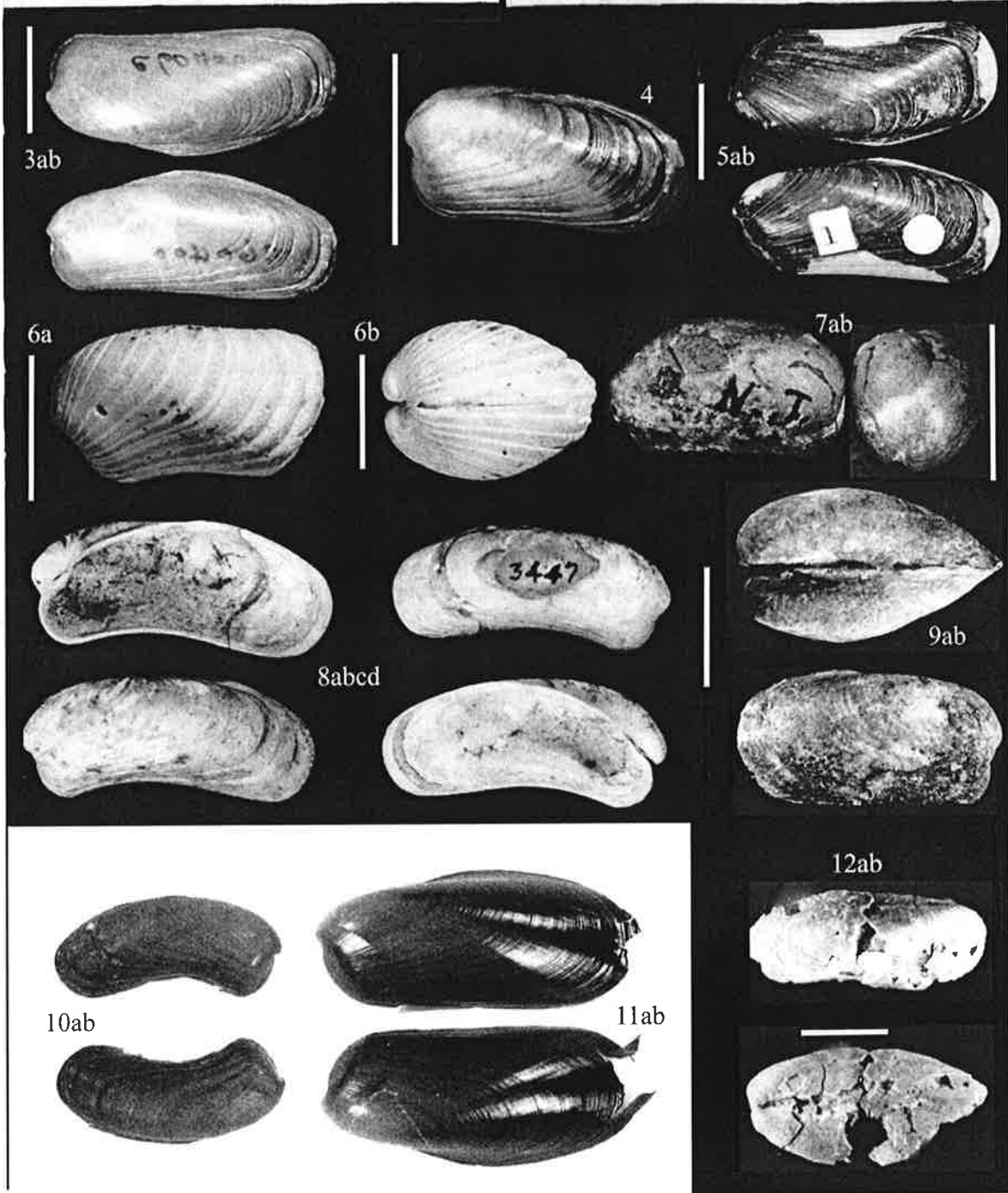
Botula was established as subgenus of *Lithophaga* (Mörch 1853). Jousseume (1888: 216), regarding *B. cinnamomea* (Lamarck), placed *Botula* in generic rank for the first time. Considering this very species, Dall



1
Modiola cinnamomea L.
 de l'Île de France. M^e Deshayes
 individu nommé par Lamarck 1817



2
Modiola silicula L.
 nelle Hollande. (type de Lamarck)



(1898) treated *Botula* as subgenus of *Modiolus*, while Lamy (1906, 1919) and Lynge (1909) returned to Mörch's opinion, which I share, as the shell is more subcylindrical as in *Lithophaga* (but with terminal not subterminal umbos) and not laterally compressed and with low anterior and high posterior outline as in *Modiolus*. Nevertheless, the separated siphons in *Botula* can be regarded as a feature of probably generic value (Wilson & Tait 1984). Later, some authors (e.g., Soot-Ryen 1969, Savazzi 1982, Morton 1982 fig. 11, Morton 1983 fig. 9, Arnaud & Thomassin 1990, and Darga 1992) put *Botula* in the subfamily Modiolinae Keen, 1958, instead of Lithophaginae, to which it belongs (e.g., Wilson & Tait 1984, Coan & al. 2000, herein, see Fig. 1).

The type species problem

Gmelin (1791: 3352), referring to Chemnitz's (1785) fig. 732 (in error for fig. 731, see *Mytilus vulgaris* Gmelin, 1791: 3358), regarded *Mytilus cinnamomeus* as *M. lithophagus* β . On page 3359, follows *Mytilus fuscus* Gmelin, 1791 (referring to Lister, 1685, pl. 359, fig. 197, *musculus exiguus fuscus* ...). According to opinion 184 of the ICZN 1944, Chemnitz (1785), like Lister (1685), is a non-binominal publication and invalid. Thus the earliest proper description is the one of *Botula fusca* by Gmelin (1791).

Lamarck (1819: 114–115), referring to Chemnitz's fig. 731, described *Modiola cinnamomea* (Pl. 1, Fig. 1), and for the smaller "var. *b*" referred to Lister's fig. 197. Dall (1898: 792, and again in 1915: 128) designated *M. cinnamomea* Lamarck as type species of *Botula*. Ihering (1900: 88) and Oldroyd (1924b; 70) confirmed this designation. But years later, Dall *et al.* (1938: 59) selected *Mytilus fuscus* Gmelin, 1791, as type species, ignoring the earlier designation of *cinnamomea* Lamarck which has priority, according to ICZN Code, 4th ed., article 70.2: "Type fixation overlooked. If it is found that an earlier type species fixation has been overlooked, the overlooked fixation is to be accepted and any later fixations are invalid. If this is considered to cause instability or confusion the case is to be referred to the Commission for a ruling." (Application submitted).



PLATE 1.

Fig. 1: Syntypes of *Modiola cinnamomea* Lamarck, 1819, MNHNP, from Mauritius, mounted on cardboard. Bar 1 cm.

Fig. 2: Type of *Modiola silicula* Lamarck, 1819, MNHNP, 24.9 mm in length, from Australia, mounted on cardboard. Probably a member of *B. fusca* (Gmelin, 1791). Bar 1 cm.

Fig. 3a, b: Holotype of *Botulopa silicula infra* Iredale, 1939, AMS C60400, Low Isles, GBR, 26.5-12.0-12.0 mm, (a) outer lateral view of right and (b) left valve. Probably a member of *Botula cinnamomea* (Lamarck, 1819). Bar 1 cm.

Fig. 4: Paratype of *Lithodomus cuneiformis* Tate, 1892, SAM D13045/2, length 14.3 mm, left lateral view. Note at least 7 distinct growth increments, which may be regarded as annual. Bar 1 cm.

Fig. 5a, b: Holotype of *Lithodomus projectans* Tate, 1892, SAM D14615, 28-12.5-12 mm, (a) right and (b) left lateral view. Port Darwin, Australia. Probably a member of *B. fusca* (Gmelin, 1791). Bar 1 cm.

Fig. 6a, b: Holotype of *Botula laysana* Dall, Bartsch & Rehder, 1938, USNM 335614, 9.5-5.4-6.9 mm, (a) left lateral and (b) ventral view. Station 3936, near Laysan Island in 79-130-0 fathoms (145-238 m) on small broken shell and coralline bottoms. Note at least 13 distinct growth increments, which may be regarded as annual. Bar 5 mm.

Fig. 7a, b: "Type" (see above) of *Lithophagus affinis* Gabb, 1862, ANSP 18802, 15.7-9.4-<10 mm, (a) right lateral and (b) anterior view. Cretaceous, green marl of New Jersey, ? Burlington County. Bar 1 cm.

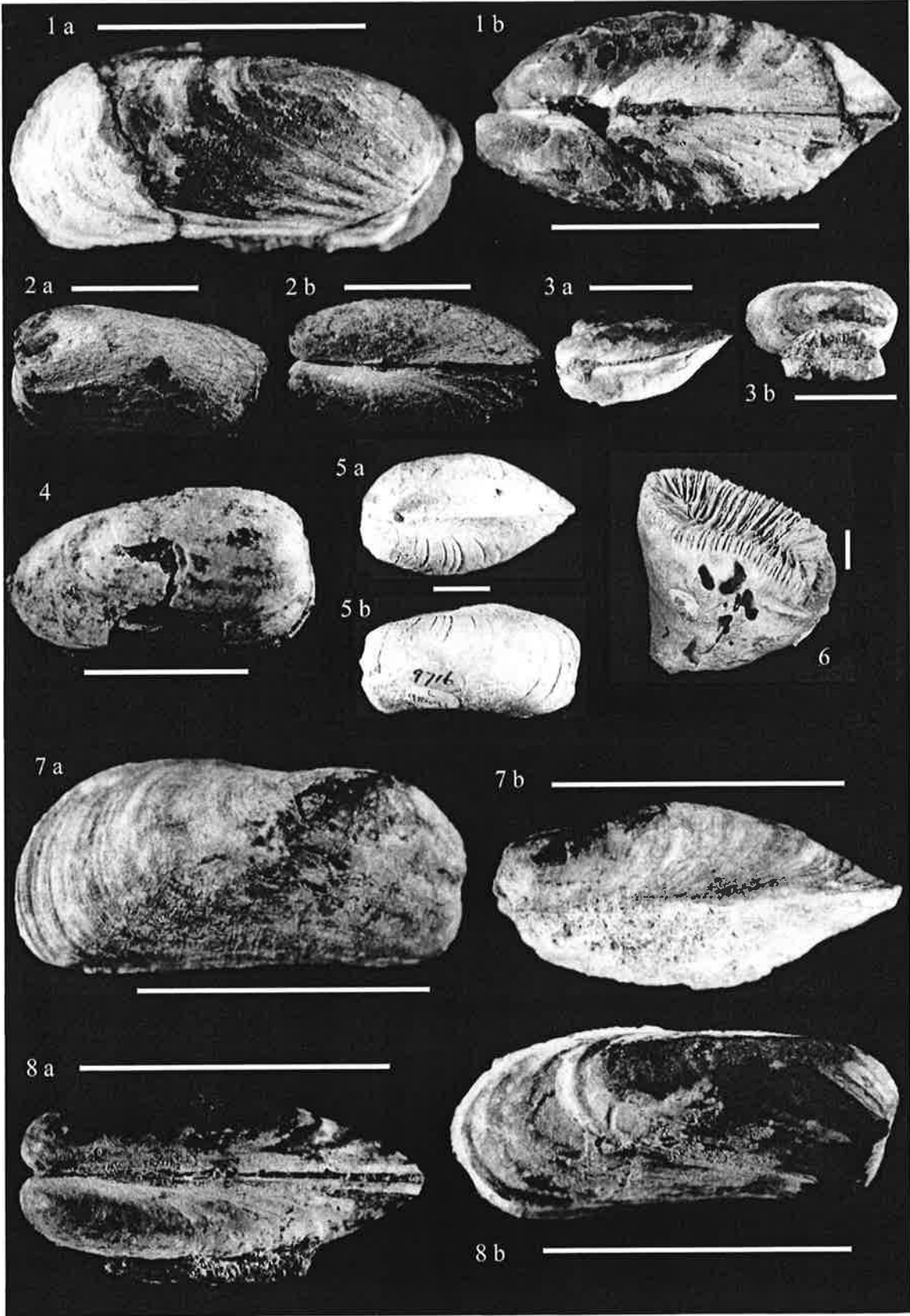
Fig. 8a-d: Holotype of *Lithophaga incurva* Gabb, 1881, ANSP 3447, 22.9-10.2-<12.5 mm, (a) inner and (b) outer lateral view of right valve, (c) outer and (d) inner lateral view of left valve. Pliocene clay beds between Limon and Moen, Costa Rica. Bar 1 cm.

Fig. 9a, b: Paratype of *Lithophaga fabaeformis* Cressin, 1926, NMVM P13448, 12.5-6.8-7.0 mm, (a) in dorsal and (b) right lateral view. Ironstone beds, Keilor, Janjukian of Torquay, Tertiary of Australia.

Fig. 10a, b: *Botula* sp., RSME 196161(part), 25.6-9.2-11.7 mm, outer lateral view of (a) right and (b) left valve. No locality, coll. A. E. Salisbury. Note similarity to *B. incurva*.

Fig. 11a, b: *Botula* sp., RSME 196161(part), 36.3-15.7-14.4 mm. No locality, coll. A. E. Salisbury. Note similarity to *B. projectans*.

Fig. 12a, b: Holotype of *Lithophaga manuanensis* Newton, 1909, BMNH L22035, Cretaceous, Zululand, tributaries of the Manuan creek, 29.3-12.9-14.2 mm, (a) right and (b) dorsal view. Note sulci in (a), specimen not a member of *Botula*.



The species problem

Gmelin (1791) regarded the cinnamon brown *Mytilus cinnamomeus* (*Botula cinnamomea*) as *M. lithophaga* β (*Lithophaga lithophaga* β), but described a new species, *M. fuscus* (dark, blackish), differing from *B. cinnamomea* mainly, if not exclusively, in periostracal colouration. In the first case, almost neglecting the obvious difference in shell morphology between *Lithophaga s.s.* and *Botula* (Fig. 1), and in the second, probably over-valuing shell colours. Lamarck (1819: 114–115) considered *M. fuscus* as a smaller variety of his *Modiola cinnamomea*.

Link (1807), had already shifted *Botula cinnamomea* from Lithophaginae to Modiolinae, although as *Modiolus cinnamomeus* instead of *Modiola*. In the past, many authors accepted one or the other subfamily attribution (see bibliographies, particularly of *cinnamomea* and *fusca*), but the closer affinity of *Botula* to *Lithophaga*, Lithophaginae, than to Modiolinae is out of question. Nevertheless, Arnaud & Thomassin (1990) considered *Botula* as member of Modiolinae (and *Gregariella* as belonging to Lithophaginae instead of Crenellinae).

Carpenter (1864: 425) stated “*Adula parasitica*, Deshayes, and the long-known *A. cinnamomea* appear to be congeneric.” Kleemann (1990: pl. 2) figured the syntypes of *Modiola parasitica* Deshayes, 1863, which by their slender, elongated shells and umbonal position clearly are members of *Adula*, while *cinnamomea* is a *Botula* species (Pl. 1, Fig.1)

Lynge (1909) can be regarded as the first author of a single-species concept in *Botula*. Referring to Chemnitz (1785), he included in the synonymy of *B. cinnamomea* not only *Modiola cinnamomea* Lamarck (Pl. 1, Fig. 1) and *Lithodomus cinnamominus* (Chemnitz) Reeve (1858), but also *Mytilus fuscus* Gmelin (1791), *Lithophaga fusca* (Gmelin) Dunker (1882), and *Modiola silicula* Lamarck (1819; Pl. 1, Fig. 2). Dautzenberg (1932: 95) too, included *B. fusca* in *B. cinnamomina* (Chemnitz, 1785, etc.), thus regarding the colour variations in *Botula* as not distinctive.

Wilson & Tait (1984) treated *B. fusca* as the only (Recent) species of the genus, being “widespread in tropical and sub-tropical seas of the Indian, Pacific and western Atlantic Oceans, apparently absent from the tropical eastern Atlantic”. They included in the synonymy *Mytilus cinnamominus* Chemnitz, 1785, *M. fuscus* Gmelin, 1791, *M. cinnamomeus* sensu Schreibers (1793), *Modiolus cinnamomeus* sensu Link (1807), *Modiola cinnamomea* Lamarck, 1819 (Pl. 1, Fig. 1), *M. silicula* Lamarck, 1819 (Pl. 1, Fig. 2), *Modiole favanni* Potiez & Michaud, 1844, *Lithodomus projectans* Tate, 1892 (Pl. 1, Fig. 5a, b), *Botula hawaiiensis* Dall, Bartsch & Rehder, 1938, *B. laysana* Dall, Bartsch & Rehder, 1938 (Pl. 1, Fig. 6a, b), *Botulopa silicula infra* Iredale,

← PLATE 2.

Fig. 1a, b: *Lithophaga mcknighti* Hanna, 1927, holotype, MPUC 5062/31151, 18.8-9.2-9.1 mm, (a)right lateral and (b) dorsal view of a *Botula*. La Jolla Formation, Eocene. Bar 1 cm.

Fig. 2a, b: *Lithophaga twitcheli* Gardner, 1916, holotype, USNM 131744, >21.8-11.7-11.8 mm, (a) left lateral and (b) dorsal view of a *Botula*. Monmouth Formation, U. Cretaceous, 1 mile W of Seat Pleasant, Prince George’s County, Maryland. Bar 1 cm.

Fig. 3a, b: *Lithophaga conchafodentis* Gardner, 1916, holotype, USNM 131769, 8.9-4-4 mm, (a)dorsal and (b) right lateral view of a probable *Botula*. Monmouth Formation, U. Cretaceous, Brightseat, Prince George’s County, Maryland. Bar 1 cm.

Fig. 4: *Lithophaga carolinensis* (Conrad) sensu Stephenson 1952, USNM 31715, 9.0-5.0-4.6 mm, ? *Botula*. Black Creek Formation (Snow Hill member), Snow Hill, North Carolina, Campanian, upper Cretaceous. Bar 5 mm.

Fig. 5a, b: *Mytilus subobtusus* Archiac, 1850, holotype, BMNH L98491, 40-20-24 mm, a member of *Botula* (a) dorsal and (b) right lateral view. Bar 1 cm.

Fig. 6: *Placosmilia*, part of USNM CK 34-5, with *Botula* borings, Santonian, Spain. Bar 1 cm.

Fig. 7a, b: *Botula plumosa* Stephenson, 1952, holotype, USNM 105288, 13.8-6.8-6.5 mm, (a) right lateral and (b) dorsal view, U. Cretaceous, Woodbine Formation. Bar 1 cm.

Fig. 8a, b: *Lithophaga ripleyana* (Gabb) - Gardner 1916, USNM 131745, 15-6.6-6.5 mm, (a) dorsal and (b) right lateral view of a *Botula*. Matawan Formation, U. Cretaceous, Delaware. Bar 1 cm.

1939 (Pl. 1, Fig. 3a, b), and *B. cylista* Berry, 1959, (Wilson and Tait 1984: 114). *Botula cylista*, according to Keen (1971: 74), is a dark brown to black species, occurring from Mazatlán, Mexico, to Manta, Ecuador, and differing from *B. fusca* by being higher for its length, with a somewhat more arched dorsal margin. Wilson & Tait (1984) only cited Schreibers (1793) and Link (1807) in the synonymy of their *B. fusca* (see bibliography), while omitting many references more worthy to quote (see bibliography of the synonymised *cinnamomea* and other species). From the two Australian species described by Tate in 1892, *Lithodomus cuneiformis* (Pl. 1, Fig. 4) and *L. projectans* (Pl. 1, Fig. 5a, b), Wilson & Tait (1984) left out *L. cuneiformis* from their single species concept, accepting a wide range in colouration, shell shape and even in siphon morphology, noting usually separated siphons but joined ones in odd individuals, which I can confirm for some GBR specimens. Up to now, malacologists have generally accepted the separation of mytilid species based solely on different colouration (and geographical distribution), e.g. related *Lithophaga nigra* (Orbigny, 1842) and *L. straminea* (Reeve, 1857) with intermittent Mediterranean *L. lithophaga* (Linnaeus, 1758). Gmelin (1791) gave no locality for *M. fuscus*. Therefore, we do not know whether it co-occurred with *M. cinnamomea* somewhere in the habitats (mari mediterraneo, indico, americano) given for the latter (together with *M. lithophagus*).

The holotypes of *Modiola silicula* (Pl. 1, Fig. 2) and *Lithodomus projectans* (Pl. 1, Fig. 5a, b) are *Botula* specimens with a dark brown to black periostracum. Based on colouration, both could be considered as *B. fusca*, while the holotype of *Botulopa silicula infra* (Pl. 1, Fig. 3a, b) has a light brown and translucent periostracum, thus being a member of *B. cinnamomea*. At Lizard Island, Great Barrier Reef, I found fair coloured as well as dark brown to posteriorly blackish, small and large specimens which may well belong to different species of *Botula* at the same locality. Striking morphological differences, as seen in the figured specimens, e.g. Pl. 1, Figs. 10, 11, are generally used for separating species.

Some "species" in the fossil record, where material is often scarce, were described from single specimens. This is the case even in Recent 'species', e.g., *B. hawaiiensis* and *B. laysana* (Pl. 1, Fig. 6a, b), although the specimens were dredged, dead and lacking periostracum. The probably subfossil, *B. laysana*, only 9.5 mm in length, 5.4 mm in height but inflated to an extreme width of 6.9 mm, has a rather heart-shaped outline in ventral (Pl. 1, Fig. 6b) view, thus resembling the related *Fungiacava* (Hoeksema & Kleemann 2002). The Pliocene *B. incurva*, 22.5-8.8-12.5 mm (Pl. 1, Fig. 8a-d), kidney-shaped in lateral view, has a shell size and proportions very much like a Recent specimen with dark brown periostracum from an unrecorded locality, RSME 1961.61 (part) 25.6-9.2-11.7 mm (Pl. 1, Fig. 10a, b). Considering the striking differences in *Botula*, not only between *B. laysana* and *B. incurva*, a single-species concept seems dubious. Before we accept such a concept, careful studies of soft parts and particularly DNA analyses of specimens from around the world, or at least the Caribbean, Eastern Pacific and Great Barrier Reef, should be carried out for judgement. (A similar investigation would be appropriate in the closely related *Lithophaga nigra* - *L. lithophaga* - *L. straminea* group, and probably many others.)

Erroneous attribution of species to *Botula*

Several authors reported on *Adula* species under the genus *Botula* (Dall 1916a, Keep 1935, Yonge 1955), or subgenus *Botula* (Oldroyd 1924ab, Fankboner 1971). The fossil *Lithodomus avellana* was noted only by Gillet (1924) as belonging to subgenus *Botula*, which is questionable. *Volsella splendida* was unfortunately selected as type species of *Botula* by Kobelt (1881), thus having priority versus Dall (1898).

Fossil record

Considering the known geological record and comparing the original descriptions and illustrations (including related small-sized *Lithophaga*), *Botula* seems to have developed in the Late Mesozoic (see Appendix 1). However, the oldest known record, *Botula* (?) *cassiana* Bittner, 1895, from the alpine Triassic, is not a member of *Botula* but mysidiellid *Botulopsis*. Bathonian *Venerupis oolithica* Merian (1840) and *Lithodomus bathonicus* Strübin (1913) are the earliest Jurassic records I can confirm as *Botula* in our present

understanding. Thus, its geologic range is at least from the Bathonian (Dogger, Jurassic) to Recent (see Appendix 1).

Several fossil "species" are based on single specimens, e.g., *Lithophagus affinis* (Pl. 1, Fig. 7a, b, a possible *Botula* steinkern), *Lithophaga incurva* (Pl. 1, Fig. 8a–d), and *Mytilus subobtusus* (Pl. 2, Fig. 5a, b). The latter, from the Paleogene of India, measures 40-20-24 mm and is probably the largest known fossil *Botula*. Its length is rarely approached and only minimally surpassed by recent, but more slender specimens, e.g., 39.0-16.7-17.2 mm, from Heron Island, GBR, and 40.6-17.8-18.1 mm, from St. Croix, Caribbean (own collection).

Habitat

All recent members of *Botula* bore in reef limestone, dead parts of coral and thick shells. Savazzi (1982), however, reported on commensalism between the upper Eocene species *B. cordata* (Lamarck), including *B. hortensis*, and a solitary soft bottom coral, *Pattalophyllia*, recording three adults and up to 20 juvenile specimens in about 300 coral individuals from the blue marls near Possagno, NE Italy. I do not agree with Savazzi's (1982) opinion that this "commensalism" can be compared with *L. lessepsiana* (Vaillant, 1865) and *Fungiacava eilatensis* Goreau *et al.*, 1968, in the sense of a true association between host coral and dweller (Hoeksema & Kleemann 2002, Kleemann 1980, 1995, Kleemann & Hoeksema 2002). In the solitary coral, *Placosmia* from the Santonian in Spain, several specimens, USNM CK 32-3, 34-5, 37-2, contained *Botula* borings. All borehole openings were located laterally in the unprotected epitheca of the coral (Pl. 2, Fig. 6), which was also observed in some extant "hosts", which means the veligers settled on dead parts of the coral skeleton. Savazzi (2001) repeated his opinion of an obligatory association with living solitary corals, now under the name of *B. hortensis* "Lamarck" (see *B. hortensis* above). If *Botula* was able to infest host corals through their tissue in the Eocene, why is such an obvious advantage not used also in the Recent? I find it difficult to believe that *Botula* should have lost the ability to settle on (selected) host species through live coral tissue, which, in my opinion, it never had. Yet, it had and still has the ability to settle on dead parts of live coral (Kleemann 1996; Pl. 2, Fig. 6).

Acknowledgements

This study is based on by-products of a more general research on chemically boring bivalves through many years, with travels abroad and facilitated by grants from the Australian European Exchange Programme, Royal Society London, Austrian Academy of Sciences, and a one-year US Max Kade fellowship. The USNM and particularly the BMNH gave me opportunity and support by their staff while working on collection material during my visits. Drawings of Fig. 1 by N. Frotzler, compilation by K.-U. Hochhauser. Photographs of figures 1–6 of plate 1 by P. Richens, courtesy of BMNH. Thanks for critical comments and corrections are due to D. L. Geiger, R. Bieler and an unknown reviewer.

References

- Abbass, H.L. (1973) A monograph on the Egyptian Paleocene and Eocene pelecypods. *Egyptian Journal of Geology*, 16, 69–200.
- Abbott, R.T. (1954) *American Seashells*, Van Nostrand Comp. Inc., New York, etc., xiv + 541 pp., 40 pls.
- Abbott, R.T. (1974) *American Seashells* (2nd ed.), Van Nostrand Reinhold Comp., New York, 663 pp., 24 pls.
- Adams, H. & Adams, A. (1853–58) *The Genera of Recent Mollusca, arranged according to their Organisation*, London, 2, 661 pp., 3, 138 pls. (Publ. dates on p. 661)
- Adcock, D.J. (1893) *A Handlist of the Aquatic Mollusca inhabiting South Australia*, Adelaide, 14 pp.
- Adegoke, O.S. (1972) Macrofauna of the Ewekoro Formation (Paleocene) of southwestern Nigeria. *African Geology*, 1972, 269–276, 3 pls.

- Adegoke, O.S. (1977) Stratigraphy and paleontology of the Ewekoro Formation (Paleocene) of southwestern Nigeria. *Bulletins of American Paleontology*, 71 (295), 5–379.
- Allan, J. (1950) *Australian Shells, with related Animals living in the Sea, in Freshwater and on Land*, Melbourne, xix + 470 pp., 44 pls.
- Anton, H.E. (1839) *Verzeichnis der Conchylien welche sich in der Sammlung von Hermann Eduard Anton befinden*, Halle, xvi + 110 pp.
- Appukuttan, K.K. (1973) Distribution of coral boring bivalves along Indian Coasts. *Journal of the Marine Biological Association of India*, 15, 427–430.
- Arango y Molina, R. (1880) *Contribucion a la Fauna Malacologia Cubana*, Habana, 280 + 35 pp.
- Archiac, E.J.A.D. de St.S., V. de' (1850) *Histoire des Progrès de la Géologie de 1834 à 1850, Tome Troisième. Formation Nummulitique. Roches ignées ou pyrogènes des époques quaternaire et tertiaire*, Paris, 3, 624 pp.
- Archiac, E.J.A.D. de St.S., V. d', & Haime, J. (1853) *Description des Animaux Fossiles du Groupe Nummulitique de l'Indes*, Paris, vii + 373 pp., 36 pls.
- Arnaud, P.M. & Thomassin, B.A. (1990) Habits and morphological adaptations of mytilids (Mollusca: Bivalvia) from coastal and reefal environments in southwest Malagasia (Indian Ocean). In: Morton, B. (Ed.) *The Bivalvia – Proceedings of a Memorial Symposium in Honour of Sir Charles Maurice Yonge, Edinburgh, 1986*, Hong Kong University Press, Hong Kong, 333–344 pp.
- Audoin, V. (1826) Explication sommaire des planches de Mollusques de l'Égypte et de la Syrie, publiées par Jules-César Savigny ... In: *Description de l'Égypte ...*, *Histoire Naturelle*, Paris, 1(4), 7–56. (fide Clapp & Kenk 1963: 105).
- Bales, B.R. (1940) The rock dwellers of the Florida Keys. *The Nautilus*, 54, 39–42.
- Bales, B.R. (1966, 3rd ed.) Shore and shallow water collecting. In: *How to collect Shells, a symposium*, American Malacological Union, Inc. Publ.
- Basterot, B. de (1825) Description géologique du Bassin tertiaire du sud-ouest de la France. *Mémoire de la Société Histoire Naturelle Paris*, 2, 1–100.
- Beau, J.P. (1857) Catalogue des coquilles recueillies à la Guadeloupe et ses dépendances. *Revue coloniale*, (ser. 2) 18, 479–505. (Also separately printed, Paris, 1858).
- Bellardi (1855) Catalogo ragionato dei foss. Num. D'Egitto etc. *Mem. del Acad. Reale Torino*, 15, (fide Teppner 1914: 107)
- Benoist, E.A. (1873) Catalogue synonymique et raisonné des Testacés fossils recueillis dans les faluns Miocènes des communes de La Brède et de Saucats. *Actes de la Société Liméenne de Bordeaux*, 29 (ser. 3, vol. 9), 5–78.
- Benoist, E.A. (1874) Note sur la constitution géologique du vallon de Moras, près La Brède. *Actes de la Société Liméenne de Bordeaux*, 29 (ser. 3, vol. 9), 139–142 (CXXXIX–CXLII).
- Bernard, F.R. (1983) Catalogue of the Living Bivalvia of the Eastern Pacific Ocean: Bering Strait to Cape Horn. *Canadian Special Publications in Fisheries and Aquatic Sciences*, 61, 1–102.
- Berry, S.S. (1959) Notices of new eastern Pacific Mollusca – III. *Leaflet of Malacology*, 1, 108–113.
- Bertram, G.C.L. (1936) Some aspects of the breakdown of coral at Ghardaqa, Red Sea. *Proceedings of the Zoological Society London*, 1936, 1011–1026.
- Beu, A.G. (2004) Marine Mollusca of oxygen isotope stages of the last 2 million years in New Zealand. Part 1: Revised generic positions and recognition of warm-water and cool-water migrants. *Journal of the Royal Society of New Zealand*, 34, 111–165.
- Beu, A.G. & Maxwell, P.A. (1990) Cenozoic Mollusca of New Zealand. *New Zealand Geological Survey, Paleontological Bulletin*, 58, 1–518.
- Beurlen, K. (1944) Beiträge zur Stammesgeschichte der Muscheln. *Sitzungsberichte der mathematisch-naturwissenschaftlichen Abteilung der Bayerischen Akademie der Wissenschaften zu München*, 1–2, 133–145.
- Bien, W.F., Wendt J.M. & Alexander, R.R. (1999) Site selection and behavior of sponge and bivalve borers in shells of the Cretaceous oysters *Exogyra candellata* and *Pycnodonte mutabilis* from Delaware, U.S.A. *Historical Biology*, 13, 299–315.
- Bittner, A. (1895) Lamellibranchiaten der Alpenen Trias. I. Theil. Revision der Lamellibranchiaten von Sect. Cassian. *Abhandlungen der K.K. geologischen Reichsanstalt Wien*, 18, 1–235.
- Bordaz, G. (1899) Liste des coquilles recueillies à la Martinique. *Société d'Histoire naturelle Autun Bulletin*, 12, 165–184.
- Borissjak, A., (1906) Die Pelecypoden der Jura-Ablagerungen im europäischen Russland. III. Mytilidae. *Trudy Geologicheskago Komiteta (Mém. Com. Géolog.)*, St. Petersburg, (n.s.), 29, 1–22 (in Russian), 23–35 (in German), 2 pls.
- Bory de Saint-Vincent, J.B.G.M. (1824) Mollusca. In: *Tableau Encyclopédique et Méthodique des trois Règnes de la Nature Histoire naturelle: Vers, Coquilles, Mollusques et Polypiers*, Paris, 1, 134–180. (Regarding the publication date see C. D. Sherborn & B.B. Woodward in *Proceedings of the Zoological Society of London*, for 1893: 582–584.)
- Bosc, L.A.G. (1801) *Histoire naturelle des Coquilles, contenant leur Description, les moers des Animaux qui les habitent et leurs usages ...*, Paris (fide Clapp & Kenk 1963: 166).

- Bottjer, D.J. (1982) Paleocology of epizoans and borings on some Upper Cretaceous chalk oysters from the Gulf Coast. *Lethaia*, 15, 75–84.
- Brazier, J. (1884) Critical list of Mollusca from north-west coast of Australia. *Proceedings of the Linnean Society of New South Wales*, 9, 793–803.
- Bronn, H.G. (1848) *Index Palaeontologicus, oder Übersicht der bis jetzt bekannten fossilen Organismen. 1 Abth. A Nomenclator palaeontologicus, in alphabetischer Ordnung, Erste Hälfte, A-M*, E. Schweizerbart, Stuttgart, lxxxix + 775 pp.
- Bubnoff, S.v. (1921) Die ladinische Fauna von Forno (Messovalle) bei Predazzo. *Verhandlungen des Naturhistorisch-medizinischen Vereins zu Heidelberg, neue Folge*, 14, 257–379.
- Carpenter, P.P. (1857) *Catalogue of the Reigen Collection of the Mazatlán Mollusca in the British Museum*, Warrington, lxvi + 552 pp. (Also) *Catalogue of the collection of Mazatlán Shells, in the British Museum. Collected by Frederick Reigen, described by Philip P. Carpenter*, British Museum of Natural History, London, xvi + 552 pp.
- Carpenter, P.P. (1857) Report on the present state of our knowledge with regard to the Mollusca of the west coast of North America. *Reports of the British Association for the Advancement of Science*, 26, 159–368.
- Carpenter, P.P. (1860) West Coast - Mexican and Panamic province. In: Lea, I., Carpenter, P. P., Simpson, W. M., Binney W. G. & Prime, T. (Eds.) *Check Lists of the Shells of North America prepared for the Smithsonian Institution. No. 2. Smithsonian Miscellaneous Collections*, 2(6), 1–13.
- Carpenter, P.P. (1864a) Supplementary report on the present state of our knowledge with regard to the Mollusca of the west coast of North America. *Reports of the British Association for the Advancement of Science*, 33, 517–686. (Also: *Smithsonian Miscellaneous Collections*, 10, 3–175).
- Carpenter, P.P. (1864b) Diagnosis of new forms of mollusca from the Vancouver district. *Annals and Magazine of Natural History*, (3) 14, 423–429.
- Carter, J.G. (1978) Ecology and evolution of the Gastrochaenacea (Mollusca, Bivalvia) with notes on the evolution of the endolithic habitat. *Peabody Museum of Natural History Yale University, Bulletin*, 41, vi + 92.
- Carter, J.G. & Clark, G.R.II. (1985) Classification and phylogenetic significance of molluscan shell microstructure. In: *Mollusks, notes for a short course. University of Tennessee, Department of Geological Sciences, Studies in Geology*, 13, 50–71.
- Catlow, A. & Reeve, L. (1845) *The Conchologist's Nomenclator. A catalogue of all the recent species of shells, included under the subkingdom 'Mollusca', with their authorities, synonyms, and references to works where figured or described*, London, 326 pp.
- Chavan, A. (1952) Les Pélécytopodes des Sables Astartiens de Cordebuga (Calvados). *Mémoires Suisses de Paléontologie*, 69, 1–132.
- Chemnitz, J.H. (1785): *Neues systematisches Conchylien-Cabinet*, G. N. Raspe, Nürnberg, 8, (xx +) 372 pp., pl. 70–102.
- Chenu, J. (1862) *Manuel de Conchyliologie et de Paléontologie Conchyliologique*, Paris, 2, 1–327.
- Clapp, W.F. & Kenk, R. (1963) *Marine Borers. An annotated Bibliography*, Office of Naval Research, Department of the Navy ACR 74, Washington, D.C., 1136 pp.
- Clemens, W.A. (1933) *A Check List of the marine Fauna and Flora of the Canadian Pacific Coast*, Ottawa National Research Council of Canada, 88 pp. (fide Clapp & Kenk 1963: 242).
- Clench, W.J., Aguayo, C.G. & Turner, R.D. (1947–48) The West Indian marine shells by Henry Krebs. *Revista de la Sociedad malacologia Carlos de la Torre*, 5, 23–40, (2) 59–80, (3) 91–116 (1947), 6, (1) 11–43, (2) 45–48, frontispiece (1948).
- (Küster, H.C. & Clessin, S. (1840–90) Die Familie der Mytilidae. In *Abbildungen nach der Natur mit Beschreibungen. Begonnen von Dr. H. Küster, fortgeführt und beendet von S. Clessin*. In: Martini, F. H. W. & Chemnitz, J. H. (Eds.) *Systematisches Conchylien Cabinet* (2nd ed), Nürnberg, 8(3), 1–170, col. pl. 1–36. (For publ. dates see Prashad 1932: 4).
- Coan, E.V., Scott, P.V. & Bernard, F.R. (2000) Bivalve Seashells of Western North America Marine Bivalve Mollusks from Arctic Alaska to Baja California. *Santa Barbara Museum of Natural History Monographs Number 2, Studies in Biodiversity Number 2*, Santa Barbara, CA, USA.
- Conrad, T.A. (1866) Illustrations of Miocene fossils with descriptions of new species. *American Journal of Conchology*, 2, 65–74.
- Conrad, T.A. (1868) Synopsis of the Invertebrate Fossils of the Cretaceous Formation of New Jersey. In: Cook, G. H. (Ed.): *Geology of New Jersey*, Newark, Appendix A, 721–731.
- Conrad, T.A. (1875) Descriptions of new genera and species of fossil shells of North Carolina, in the State Cabinet at Raleigh. *Report of the Geological Survey of North Carolina*, 1(appendix A), 1–13.
- Cooke, A.H. (1886) Report on the Testaceous Mollusca obtained during a Dredging- excursion in the Gulf of Suez in the Months of February and March 1869. By Robert Mac Andrew. Republished, with Additions and Corrections by Alfred Hands Cooke. Part IV. *Annals and Magazine of Natural History*, (5) 17(98), 128–142, 18(104), 92–109.
- Cossmann, M. (1887) *Calalogue illustré des coquilles fossils de l'éocène des environs de Paris*, Bruxelles, 2, 1–218, pl. 1–8. (extract des *Annales de la Société Royale Malacologique de Belgique*, 22, 3–214, pl. 1–8).

- Cossmann, M. (1921–22) Synopsis illustré des mollusques de l'Eocène et de l'Oligocène en Aquitaine. *Mémoires de la Société Géologique de France*, 55, 5–112, pl. 1–6 (1921), 113–220, pl. 1–7 (1922).
- Cossmann, M. & Peyrot, A. (1914) Conchologie Néogénique de l'Aquitaine. *Actes de la Société linnéenne de Bordeaux*, 68, 5–210.
- Cossmann, M. & Pissarro, G. (1904–1906) *Iconographie complete des coquilles fossiles de l'Éocène des environs de Paris. T. I Pelecypodes*, Paris, 5–12, 45 pls.
- Cotton, B. C. (1931) Pelecypoda of the Flinderian region, southern Australia. II. *Records of the South Australian Museum, Adelaide*, 4, 333–354.
- Cotton, B.C. (1961) *South Australian Mollusca. Pelecypoda*. Handbooks of the Flora and Fauna of South Australia, Government Printer, Adelaide, 363 pp.
- Cotton, B.C. & Godfrey, F.K. (1938) *The Mollusks of South Australia. Part I. The Pelecypoda*. Handbooks of the Flora and Fauna of South Australia, Government Printer, Adelaide, 314 pp.
- Cox, L.R. (1964) Notes concerning the taxonomy and nomenclature of fossil Bivalvia (mainly Mesozoic). *Proceedings of the Malacological Society of London*, 36, 39–48.
- Crosse, H. & Fischer, P.H. (1889) Note sur la faune Conchyliologique marin de l'Annam. *Journal de Conchyliologie*, 37, 281–296.
- Dainelli, G. (1915) L'Eocene friulano. *Memoire geografico, Firenze* (fide Savazzi 1982: 174).
- Dall, W.H. (1889) A preliminary catalogue of the shell-bearing marine mollusks and brachiopods of the south-eastern coast of the United States, with illustrations of many of the species. *Bulletin of the United States National Museum*, 37, 7–221, 74pls.
- Dall, W.H. (1898) Contribution to the Tertiary Fauna of Florida. IV. *Transactions of the Wagner Free Institute of Science Philadelphia*, 3, 571–947.
- Dall, W.H. (1911) Notes on California Shells (II.). *The Nautilus*, 24, 109–112 (fide Clapp & Kenk 1963: 282).
- Dall, W.H. (1915) A monograph of the molluscan fauna of the *Orthaulax pugnax* zone of the Oligocene of Tampa, Florida. *Bulletin of the United States National Museum*, 90, xv + 173, 26 pls.
- Dall, W.H. (1916a) *Checklist of the Recent bivalve mollusks (Pelecypoda) of the northwest coast of America from the Polar Sea to San Diego, California*, Southwest Museum Los Angeles, 44 pp.
- Dall, W.H. (1916b) Notes on the Californian species of *Adula*. *The Nautilus*, 30 (1), 1–3.
- Dall, W.H., Bartsch, P. & Rehder, H.A. (1938) A manual of the recent and fossil marine Pelecypod mollusks of the Hawaiian Islands. *Bulletin of the Bernice Pauahi Bishop Museum Honolulu*, 153, iv + 233 pp.
- Dall, W.H. & Simpson, C.T. (1902) The Mollusca of Porto-Rico. *Bulletin of the United States Fisheries Commission*, 20(for 1900), 351–524, pl. 53–58.
- Dana, J.D. (1850) Synopsis Generum Crustaceorum Ordinis "Schizopoda". *The American Journal of Science and Arts, second series*, 9, 17–133.
- Darga, R. (1992) Geologie, Paläontologie und Palökologie der SO-bayerischen unter-priabonen (O-Eozän) Riffkalkvorkommen des Eisenrichtersteins bei Hallthurn (N Kalkalpen) und des Kirchbergs bei Neubeuern (Helvetikum). *Münchener Geowissenschaftliche Abhandlungen*, A23, 1–66.
- Dautzenberg, P. (1900) Croisières du Yacht Chazalie dans l'Atlantique. *Mémoire de la Société Zoologique de France*, 13, 145–265.
- Dautzenberg, P. (1932) Mollusques testacés marins de Madagascar suppl. *Journal de Conchyliologie*, 76, 5–119.
- Dautzenberg, P. & Bouge, J.L. (1933) Les Mollusques testacés marins des établissements Française de l'océanie. III. *Journal de Conchyliologie*, 77(3), 351–469.
- Defrance, (1824): *Dictionnaires des Sciences Naturelles*, 31 (fide Cossmann 1922: 155).
- Deshayes, G.P. (1824) Mémoire Géologique sur les Fossils de Valmondois, et principalement sur les quoquilles perforantes découvertes dans le grès marin inférieur. *Mémoires de la Société d'Histoire Naturelle de Paris*, 1, 245–258.
- Deshayes, G.P. (1824–32) *Descriptions des Coquilles des Environs de Paris. I. Conchifères*, Paris, 392 + 28 pp., pl. 1–65.
- Deshayes, G.P. (1830–32) *Encyclopedie méthodique. Histoire naturelle des Vers*, Paris, 2 (1) vii + 256, (2) 1–144 (1830), (2) 145–594, (3) 595–1152 (1832).
- Deshayes, G.P. (1836) *Histoire naturelle des animaux sans vertèbres ... par J. B. P. A. de Lamarck*, Paris, 7, vi + 736 pp. (2nd augmented ed., see Lamarck, J.B.P.A. de M. de, Deshayes, G. P., & Edwards M.).
- Deshayes, G.P. (1861) *Description des Animaux sans Vertèbres découverts dans le bassin de Paris pour servir de supplément à la description des Coquilles Fossiles des Environs de Paris comprenant une revue générale de toutes les espèces actuellement connues. Tome 2, Texte. Mollusques Acéphales Monomyaires et Brachiopodes Mollusques céphalés. Premier Partie. Accompagné d'un Atlas de 64 planches*, Paris, London, New York, 968 pp.
- Deshayes, G.P. (1863) Catalogue des Mollusques de l'Île de la Réunion (Bourbon). – In: Maillard, L. (Ed.) *Notes sur l'Île de la Réunion (Bourbon)*, Paris, 2 (Annex E), 144 pp, 14 pls. (2nd ed.).
- Diener, C. (1923) Lamellibranchiata triadica. In: *Fossilium Catalogus I: Animalia Pars 19*, W. Junk, Berlin, 259 pp.
- Dillwyn, L.W. (1817) *A Descriptive Catalogue of Recent Shells, arranged according to the Linnean Method with particular attention to the synonymy (in two vol.)*, London, 1, xii + 580, 2, 581–1092+29 pp.

- Dolin, C., Dolin, L. & Le Renard, J. (1980) Inventaire systématique des mollusques de l'Auverisien à "facies charrié" de Baron (Oise) et remarques paléontologiques. *Bulletin Inf. Géol. Bass. Paris*, 17, 26–48. (fide Savazzi 1882: 174).
- Dollfus, A. (1863) La Faune kimméridgienne du Cap de la Hève, essai d'une révision paléontologique. Paris, Souy, 102 p., 18pl. (fide Chavan 1952: 22).
- Doncieux, (1911) *Numm. Corbières sept.* (fide Cossmann 1922: 155).
- Dreger, J. (1903a) Die Lamellibranchiaten von Häring bei Kirchbichl in Tirol. *Jahrbuch der k.k. geologischen Reichsanstalt Wien*, 53, 253(1)–284(32), pl. 11(1)–13(3).
- Dreger, J. (1903b) Ueber die unteroligocänen Schichten von Häring und Kirchbichl in Tirol mit einem Verzeichnis der bisher von dort bekannten Lamellibranchiaten. *Verhandlungen der k.k. geologischen Reichsanstalt, 1902*, 14–15, 345/1–351/7.
- Dubois, C. (1825) *An Epitome of Lamarck's arrangement of testacea: being a free translation of that part of his work, De l'Histoire Naturelle Des Animaux Sans Vertèbres, with illustrative observations and comparative and cynoptic tables of the systems of Linnaeus and Lamarck*, London, 317 pp. (A new edition, 1828).
- Dufo, H. (1840) Observations sur les Mollusques marins, terrestres et fluviatiles des îles Séchelles et des Amirantes. II. *Annales des Sciences Naturelles Seconde Serie Zoologie*, 14, 166–221.
- Dujardin, F. (1837) Mémoire sur les conches du sol en touraine, et description des coquilles de la craie et des faluns. *Mémoires de la Société géologique Française*, 2, 211–311.
- Dunker, G. (1857) *Mytilacea nova collectionis cumingianae, descripta a Guil. Dunker. Proceedings of the Zoological Society of London*, 24, 358–366. (Date fide Sclater, W. 1893: 435–440 in *Proceedings of the Zoological Society of London*)
- Dunker, W. (1880–83) Die Gattung *Lithophaga* in Abbildungen nach der Natur mit Beschreibungen. In: Martini, F. H. W. & Chemnitz, J. H. (Ed) *Systematisches Conchylien-Cabinet*, G. N. Raspe, Nürnberg, 8(3a), 32 pp, 6 pls. (For publ. dates see Oostingh 1925: 362).
- Elera, C. de (1896) *Catálogo sistemático de toda la fauna de Filipinas conocida hasta el presente ...*, Manila, 3 (fide Clapp & Kenk 1963: 345).
- Emerson, W.K. & Jacobson, M.K. (1976) *The American Museum of Natural History Guide to Shells Land, Freshwater, and Marine, from Nova Scotia to Florida*, A. A. Knopf, New York, 482 + xviii pp., 47 pls.
- Fabiani, R. (1915) Il Paleogene del Veneto. *Memorie dell' Istituto Geologico della R. Università di Padova*, 3, 1–336.
- Fanck, A. (1929) *Die bruchlose Deformation von Fossilien durch tektonischen Druck und ihr Einfluss auf die Bestimmung der Arten. Beobachtet und bearbeitet an den Pelecypoden der St. Galler Meeresmolasse*, Zürich, 59 pp, 16 pls.
- Faustino, L.A. (1928) *Summary of Philippine Marine and Fresh-water Mollusks*, Manila, 384 pp.
- Férrusac, A.E. de (1822) Tableaux Systématiques des Animaux Mollusques. A. Bertrand, Paris, 1–111.
- Fischer, P. (1866) Faune Tertiaire Moyenne. In: Tchihatcheff, P. de (Ed.) *Asie Mineure Quatrième Partie description physique de cette contrée*, Paris, 235–318.
- Fischer, P. (1871) Sur la Faune conchyliologique marine de la Baie de Suez. *Journal de Conchylogie*, 19, 209–226.
- Fischer, P. (1880–87) *Manuel de Conchyliologie et de Paléontologie Conchyliologique, Histoire Naturelle des Mollusques vivants et fossils*, Paris, xxiv + 1369 pp., 23 pls. (in 2 vols.).
- Fischer, P. (1891) Catalogue et Distribution Géographique des Mollusques Terrestres, Fluviatiles & Marins d'une partie de l'Indo-Chine (Siam, Laos, Cambodge, Conchinchine, Annam, Tonkin). *Bulletins de Société d'Histoire Naturelles Autun*, 4, 87–276.
- Fitch, J.E. (1953) Common marine bivalves of California. *California, Department of Fish and Game, Marine Fisheries Branch, Fishery Bulletin*, 90, 1–102. (fide Clapp & Kenk 1963: 366).
- Fleming, C.A. (1959) Notes on New Zealand Recent and Tertiary mussels (Mytilidae). *Transactions of the Royal Society of New Zealand*, 87, 165–178.
- Forbes, E. & Hanley, S. (1848–53) *A History of British Mollusca, and their shells*, London, 1, lxxx + 486, 2, viii + 480 (1849), 481–557 (1850), 4, vi + 302, (col. pls. 1–34 and A-O publ. in 1848, fide Clapp & Kenk 1963: 370–371).
- Frauscher, K.F. (1886) Das Unter-Eocän der Nordalpen und seine Fauna. I. Theil. Lamellibranchiata. *Denkschriften der kaiserlichen Akademie (Mathematisch-naturwissenschaftliche Classe) Wien*, 51, 37–270 (1–234).
- Fuchs, T. (1870) Beitrag zur Kenntnis der Conchylienfauna des Vincentinischen Tertiärgebirges. I. Abtheilung. Die obere Schichtengruppe, oder die Schichten von Gomberto, Laverda und Sangonini. *Denkschriften der kaiserlichen Akademie der Wissenschaften Wien*, 33, 137–216.
- Gabb, W.M. (1861a) *Synopsis of the Mollusca of the Cretaceous Formation, Including the Geographical and Stratigraphical Range and Synonymy*. Philadelphia, 201 pp.
- Gabb, W.M. (1861b) Descriptions of some new species of Cretaceous Fossils from South America, in the Collection of the Academy. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1860, 197–198.
- Gabb, W.M. (1862) Descriptions of new species of Cretaceous fossils from New Jersey, Alabama and Mississippi. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1861, 318–330.
- Gabb, W.M. (1864) Descriptions of Cretaceous fossils. *Geological Survey of California. Palaeontology*, 1, 57–217.

- Gabb, W.M. (1876) Notes on American Cretaceous fossils, with descriptions of some new species. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1876: 276–324.
- Gabb, W.M. (1881) Description of new species of fossils from the Pliocene clay beds between Limon and Moen, Costa Rica, together with notes on previously known species from there and elsewhere in the Caribbean area. *Journal of the Academy of Natural Sciences of Philadelphia*, (2) 8, 349–380.
- Gardner, J. (1916) Mollusca. In: *Systematic Paleontology of the Upper Cretaceous Deposits of Maryland*, 371–733.
- Gardner, J. (1926) The molluscan fauna of the Alum Bluff Group of Florida. *Professional Papers United States Geological Survey*, 142 A–D, 1–184, 28 pls.
- Gardner, J. (1950) The molluscan fauna of the Alum Bluff Group of Florida. Part IX, Index to chapters A–H. *United States Department of the Interior Geological Survey Professional Paper*, 142–I, 657–709.
- Gillet, S. (1924) Études sur les Lamellibranches Néocomiens. *Mémoires de la Société Géologique de France (n.s.)*, 3, 1–224.
- Ginsburg, R.N. & Schroeder, J.H. (1973) Growth and submarine fossilization of algal cup reefs, Bermuda. *Sedimentology*, 20, 575–614.
- Glazer, B.A., Glazer, D.T. & Smythe, K.R. (1984) The marine mollusca of Kuwait, Arabian Gulf. *Journal of Conchology*, 31, 311–330.
- Glibert, M. (1936) Faune malacologique des sables de Wemmel. I Pélécytopodes. *Mémoires du Musée Royal d'Histoire Naturelle de Belgique*, 78, 1–190 (208).
- Gmelin, J.F. (1791) Vermes. In: *Caroli a Linné Systema naturae per regna tria naturae, Ed. 13*, Lipsiae, 1(6), 3021–3910.
- Gohar, H.A.F. & Soliman, G.N. (1963) On two mytilids boring in dead coral. *Publications of the Marine Biological Station, Al Ghardaqa, Red Sea*, 12, 205–218.
- Goreau, T.F., Goreau, N.I., Neumann, Y. & Yonge, C.M. (1968) *Fungiacava eilatensis* n. gen., n. sp. (Bivalvia, Mytilidae) a boring bivalve commensal in reef corals. *American Zoologist*, 8(4), 799.
- Gould, A.A. (1833) *Lamarck's Genera of Shells, with a catalogue of species*, Boston, 110 pp.
- Gourret, P. (1887) Description de quelques espèces jurassiques de la Basse-Provence, avec les planches IX, X, et XI. *Recueil zoologique Suisse*, (1) 4, 241–267, pl. 9–11.
- Grasset, J.P.A. (1884) *Index Testaceorum Viventium quae in collectione J.-P.-A. Grasset extant*, Alger, Paris, 324 pp.
- Grateloupe, J.P.S. de (1838) *Catalogue zoologique, renfermant les débris fossiles des Animaux ... découverts dans les différents étages des terrains qui constituent les formations géognostique du bassin de la Gironde (environs de Bordeaux), précédé de la classification des terrains de ce basin*, Bordeaux, 77 pp.
- Guéranger, E.A.F. (1867) *Album Paléontologique du Département de la Sarthe représentant au moyen de la photographie les fossiles recueillis dans cette ciconscription*. Le Mans, 20 pp., 25 pls.
- Haas, F. (1942) The habits of life of some West Coast bivalves. *The Nautilus*, 55, 109–113.
- Haas, F. (1943) Malacological notes – III. The boring of *Lithophaga*. *Publications of the Field Museum of Natural History Chicago*, 29, 7–8.
- Habe, T. (1951–53) *Genera of Japanese Shells: Pelecypoda and Scaphopoda* (in Japanese). No place, 326 pp. (For publ. dates see Clapp and Kenk 1963: 419).
- Habe, T. (1962) *Coloured illustrations of the shells of Japan (II)*. Hoikusha, Osaka, xii + 182, App. 1–46, 66 pls.
- Habe, T. (1964) *Shells of the Western Pacific in Color*, Osaka, Japan, 2, 223 pp, 66 pls.
- Habe, T. (1977) Bivalvia and Scaphopoda (in Japanese). In: *Systematics of Mollusca in Japan*, xiii + 372, 72 pls.
- Haderlie, E.C., Mellor, J.C., Minter, III, C.S. & Booth, G.C. (1974) The sublittoral benthic fauna and flora off Del Monte Beach, Monterey, California. *The Veliger*, 17, 185–204.
- Hanley, S. (1842–56) *An illustrated and descriptive Catalogue of Recent Bivalve Shells*, London, xviii + 392 + 8 + 24, suppl. pl. 9–24.
- Hedley, C. (1901) Studies on Australian Mollusca, V. *Proceedings of the Linnean Society of New South Wales*, 1901, 700–708, pl. 34.
- Hedley, C. (1906) The Mollusca of Mast Head Reef, Capricorn Group, Queensland. I. *Proceedings of the Linnean Society of New South Wales*, 31, 453–479.
- Hedley, C. (1910) The marine fauna of Queensland. Appendix: Catalogue of the marine Mollusca of Queensland. *Reprints of the Australian Association for the Advancement of Science, Meeting 12(1909)*, 343–371.
- Hedley, C. (1916) A preliminary index to the mollusca of western Australia. *Journal and Proceedings of the Royal Society of Western Australia*, 1, 152–226.
- Hertlein, L.G. & Strong, A.M. (1946) Eastern Pacific expeditions of the New York Zoological Society XXXIV. Mollusks from the west coast of Mexico and Central America, part III. *Zoologica (New York)*, 31, 53–76.
- Hertz, C.M. (1999) Illustrations of the types named by S. Stillman Berry in his "Leaflets in Malacology" revised. *The Festivus*, 31 (Supplement): 1–43.
- Hidalgo, J.G. (1905) Catálogo de los moluscos testáceos de las islas Filipinas, Joló y Marianas. - *Revista de la real Academia de Ciencias exactas fis. y nat. Madrid*, 2, 233–312, 3, 9–64 (fide Clapp & Kenk 1963: 460).

- Hirase, S. (1936) *A Collection of Japanese Shells with Illustrations in natural Colours*. - (5th ed., Tokyo, also 6th ed., 1938)
- Hoeksema, B.W. & Kleemann, K. (2002) New records of *Fungiacava eilatensis* Goreau et al., 1968 (Bivalvia, Mytilidae) boring into Indonesian mushroom corals (Scleractinia, Fungiidae). *Basteria*, 66, 25–30.
- Hörnes, M. (1867) Die fossilen Mollusken des Tertiär-Beckens von Wien. *Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt Wien*, 17: 583–588.
- Hörnes, M. (1859–1870) Die fossilen Mollusken des Tertiär-Beckens von Wien. Band II: Bivalven. *Abhandlungen der Kaiserlich-Königlichen Geologischen Reichsanstalt Wien*, 4, 1–430.
- Humfrey, M. (1975) *A guide to the marine mollusks of the Caribbean*. Collins, London, 351 pp., 32 pls.
- ICZN (1944) Opinion 184. 3(3), 25–36.
- ICZN (1987) Opinion 260. 319.
- Ihering, H. von (1900) On the South American species of Mytilidae. *Proceedings of the Malacological Society, London*, 4, 84–98.
- Iredale, T. (1939) Mollusca I. *Great Barrier Reef Expedition 1928–29, Scientific Reports*, 5(6), 209–425.
- Janakevich, A.N. (1968) To the character of representatives of *Lithophaga* kind from Torton reef limestones of Moldavia. *Paleontologicheskii Sbornik*, 5, 38–44.
- Jay, J.C. (1839) *A Catalogue of the Shells, arranged according to the Lamarckian System; together with Descriptions of New or Rare Species*, New York, London, 126 pp, 10 pls.
- Jay, J.C. (1850) *A Catalogue of the Shells, arranged according to the Lamarckian System, with their authorities, synonyms, and references to works where figured or described, contained in the collection of J. C. Jay, M. D., member of the Lyceum of Natural History*, New York, New York, 460 pp.
- Johnson, C.W. (1905) Annotated list of the types of invertebrate Cretaceous fossils in the collection of the Academy of Natural Sciences, Philadelphia. *Proceedings of the Academy of Natural Sciences, Philadelphia*, 57, 4–28.
- Johnson, C.W. (1934) List of marine mollusca of the Atlantic Coast from Labrador to Texas. *Proceedings of the Boston Society of Natural History*, 40, 1–204.
- Johnson, M.E. & Snook, H. J. (1927) *Seashore Animals of the Pacific Coast*, New York. (fide Clapp & Kenk 1963: 516).
- Jousseume, F. (1888) Description des Mollusques recueillis par M. Le Dr. Faurot dans la mer Rouge et le golfe d'Aden. *Mémoires de la Société Zoologique de France*, 1, 165–223.
- Jukes-Browne, A.J. (1905) A review of the genera of the family Mytilidae. *Proceedings of the Malacological Society, London*, 6, 211–224.
- Kay, E.A. (1979) *Hawaiian Marine Shells*, xviii + 653 pp. ISBN 0-910240-28-4.
- Keen, A.M. (1940) Molluscan species common to western North America and Japan. *Proceedings of the Pacific Science Congress*, 3, 479–483 (fide Clapp & Kenk 1963: 529).
- Keen, A.M. (1971) *Sea Shells of Tropical West America*, Stanford University Press Stanford, California, 1064 pp, 22 pls. (2nd ed.).
- Keep, J. (1935) *West Coast Shells. A description in familiar terms of the principal marine, fresh-water, and land mollusks of the United States, British Columbia, and Alaska, found west of the Sierra*, Stanford University Press Stanford, California, xi + 350 pp.
- Kleemann, K.H. (1980) Boring bivalves and their host corals from the Great Barrier Reef. *Journal of molluscan Studies*, 46, 13–54.
- Kleemann, K.H. (1983) Catalogue of recent and fossil *Lithophaga* (Bivalvia). *The Journal of Molluscan Studies, Supplement* 12, 1–46.
- Kleemann, K. (1990a) Evolution of chemically-boring Mytilidae (Bivalvia). In: Morton, B. (Ed.) *The Bivalvia – Proceedings of a Memorial Symposium in Honour of Sir Charles Maurice Yonge, Edinburgh, 1986*, Hong Kong University Press, Hong Kong, 111–124.
- Kleemann, K. (1990b) Boring and growth in chemically boring bivalves from the Caribbean, Eastern Pacific and Australia's Great Barrier Reef. *Senckenbergiana maritima*, 21, 101–154.
- Kleemann, K. (1994) Associations of coral and boring bivalves since the Late Cretaceous. *Facies*, 31, 131–140.
- Kleemann, K. (1996) Biocorrosion by bivalves. *P.S.Z.N.I: Marine Ecology*, 17, 145–158.
- Kleemann, K. & Hoeksema, B.W. (2002) *Lithophaga* (Bivalvia, Mytilidae), including a new species, boring into mushroom corals (Scleractinia, Fungiidae) off South Sulawesi, Indonesia. *Basteria*, 66, 11–24.
- Kobelt, W. (1880–81) *Illustriertes Conchylienbuch. Elfte Lieferung*, Nürnberg, 2, 145–392, pl. 51–112.
- Kobluk, D.R. & Lysnki, M.A. (1986) Reef-dwelling molluscs in open framework cavities, Bonaire N. A., and their potential for preservation in a fossil reef. *Bulletin of Marine Science*, 39(3), 657–672.
- Krebs, H.J. (1864) *The West-Indian marine shells, with some Remarks. A manuskript printed for circulation between collectors*, Falster, Nykjøbing, (6+) 137 pp. (Republished by Clench et al. 1942).
- Kühnelt, W. (1930) Bohrmuschelstudien I. *Palaeobiologica*, 3, 53–91.
- Kühnelt, W. (1931) Über ein Massenvorkommen von Bohrmuscheln im Leithakalk von Müllendorf im Burgenland. *Paläobiologica*, 4, 239–250, pl. 22–24.

- Kuroda, T. (1933) An illustrated catalogue of the Japanese shells (15). *Venus*, 4(3), appendix 141–144.
- Kuroda, T. & Kikuchi, K. (1933) Studies on the molluscan fauna of Toyama Bay. *Venus*, 4(1), 1–14.
- Küster, H.C. & Clessin, S. (1840–90) Die Familie der Mytilidae. In *Abbildungen nach der Natur mit Beschreibungen. Begonnen von Dr. H. Küster, fortgeführt und beendet von S. Clessin. In: Martini, F. H. W. & Chemnitz, J. H. (Eds.) Systematisches Conchylien Cabinet (2nd ed), Nürnberg, 8(3), 170 pp, 36 col. pls. (For publ. dates see Prasad 1932: 4).*
- Lamarck, J.B.P.A. de M. de (1805) Genre LV. Modiole. *Modiola*. (In: Suite des Mémoires sur les fossils des environs de Paris). *Annales du Muséum d'Histoire Naturelle, Paris*, 6, 121–126.
- Lamarck, J.B.P.A. de M. de (1807) Explication des planches (pl. xv–xviii) Coquilles fossils des environs de Paris. *Annales du Muséum d'Histoire Naturelle*, 9, 236–240, pl. 17–19.
- Lamarck, J.B.P.A. de M. de (1819) *Histoire naturelle des animaux sans vertèbres*, Verdière, Paris, 6, 343 pp.
- Lamarck, J.B.P.A. de M. de, Deshayes, G.P. & Edwards M. (1836) *Histoire naturelle des animaux sans vertèbres*, Paris, 7, vi+736 pp.
- Lamy, É. (1906) Liste des Lamellibranches recueillis par M. L.-G. Seurat aux îles Tuamotu et Gambier (1902–1905). *Bulletins du Muséum Histoire Naturelle*, 12, 205–215, 308–318.
- Lamy, É. (1909) Coquilles marines recueillies par M. F. Geay à Madagascar (1905). *Mémoire de la Société Zoologique de France*, 22, 299–346.
- Lamy, É. (1919) Les Lithodomes de la Mer Rouge (d'après les matériaux recueillis par M. le Dr. Jousseume). *Bulletin du Muséum Histoire Naturelle*, 25, 252–257, 344–350.
- Lamy, É. (1920) Notes sur les espèces rangées par Lamarck dans son genre *Modiola*. *Bulletin du Muséum Histoire Naturelle*, 26, 61–67, 148–154, 231–238.
- Lamy, É. (1929) Notes sur quelques lamellibranches de la Martinique. *Bulletin du Muséum Histoire Naturelle de Paris*, 1, 201–208.
- Lamy, É. (1937) Révision des Mytilidae vivants du Muséum National d'Histoire Naturelle de Paris. *Journal de Conchyliologie*, 81, 99–132, 169–197.
- La Roque, A. (1953) Catalogue of the Recent Mollusca of Canada. *National Museum of Canada (Ottawa), Bulletin 129 (= Biological Series, 44)*, ix + 406.
- Lee, S.Y. & Morton, B. (1985) The Hong Kong Mytilidae. In: Morton, B. & Dudgeon, D. (Ed) *Proceedings of the Second International Workshop on the Malacofauna of Hong Kong and Southern China*, Hong Kong, 1983, 49–76.
- Lermond, N.W. (1936) *Check List of Florida Marine Shells*, N. W. Lermond, Gulfport, Florida, 54 pp.
- Leymerie, A. (1846) VIII. Mémoire sur le terrain à nummulites (épécrotacé) des corbières et de la montagne noire. *Mémoires de la Société géologie de la France*, (2) 1, 337–373.
- Light, S.F., Smith, R.I., Pitelka, F.A., Abbott, D.O. & Weesner, F.M. (1954) *Intertidal Invertebrates of the Central California Coast*, Berkeley & Los Angeles, xiv+466.
- Link, H.F. (1807) *Beschreibung der Naturalien-Sammlung der Universität zu Rostock. - 3. Abtheilung*, Rostock, 101–160.
- List of British Animals (1851) *Volume 7, Mollusca Acephala and Brachiopoda*, London.
- List, T. (1902) Die Mytiliden des Golfes von Neapel. *Fauna und Flora Golf von Neapel, Monograph 27*, 1–312, pl. 1–22.
- Lister, M. (1685) *Historia sive synopsis methodica conchyliorum quorum Omnium Pictura, ad vivum delineata, exhibetur. Liber Primus, qui est de Cochleis Terrestribus*, London.
- Lörenthey, I. (1905) (no title) *Földtani Közlöny, Budapest*, 35(4), 189–190.
- Lozouet, P., Lesport, J.-F., Favia, R., Renard, P. & Rocher, P. (2003) Les bivalvia de l'Aquitanién (Miocène inférieur) de Saucats <Larrey> (Gironde). I. – Pteriomorpha. *Cossmanniana, Paris*, 9, 1–45.
- Lyngé, H. (1909) The Danish expedition to Siam, 1899–1900, IV. Lamellibranchiata. *Danske Videnskaberne Selskabs Skrifter, Naturvidenskabelig og matematisk Afdelning*, (7) 5, 97–299.
- Mabille, J. & Mesle, G. le (1866) Observations sur la faune malacologique de la Conchinchine et fu Cambodje, comprenant la description des espèces nouvelles. *Journal de Conchyliologie*, 14, 117–138.
- MacAndrew, R. (1870) Report on the Testaceous Mollusca obtained during a Dredging Excursion in the Gulf of Suez in the months of February and March 1869. *Annals and Magazine of Natural History*, (4) 6, 429–450.
- Macintyre, I.G. and Glynn, P.W. (1976) Evolution of modern Caribbean fringing reef, Galeta Point, Panama. *The American Association of Petroleum Geologists Bulletin* 60, 1054–1072.
- Marinelli, O. (1902) Descrizione geologica dei dintorni di Tarento. *R. Ist. Stud. Super. Prat. Perf., sez. Scienze Fisiche Naturali Firenze* (fide Dainelli 1915; Savazzi 1982: 175).
- Martens, E. von (1879) Übersicht der von ihm (W. Peters) von 1843 bis 1847 in Mossambique gesammelten Mollusca, bearbeitet von Hrn. Prof. Dr. E. v. Martens. *Monatsberichte der königlich preussischen Akademie der Wissenschaften Berlin*, 1879, 727–749.
- Martens, E. von (1880) Mollusken. In: Möbius, K. A., Richters, F., & Martens, E. K. von (Eds.): *Beiträge zur Meeresfauna der Insel Mauritius und der Seychellen*, Berlin, 179–352.

- Martens, E. von (1887) List of the shells of Mergui and its archipelago, collected for the Trustees of the Indean Museum, Calcutta, by Dr. John Anderson, F.R.S., Superintendent of the Museum. *Journal of the Linnean Society of London (Zoology)*, 21, 155–219.
- Mastaller, M. (1987) Molluscs of the Red Sea. In: Edwards, A. J. & Head, S. M. (Eds.) *Red Sea Key Environments*, Pergamon Press, Oxford ..., 194–214.
- Matsukuma, A. (1984) Intertidal bivalved mollusca collected from the Eastern Caroline and Marshall Islands, Western Pacific. *Proceedings of the Japanese Society of Systematic Zoology*, 27, 1–34, pl. 1–5, map 1–4.
- Maury, C.J. (1917) Santo Domingo type sections and fossils. Part I. Mollusca. *Bulletins of American Paleontology*, 5, 165–215.
- Maury, C.J. (1920) Recent mollusks of the Gulf of Mexico and Pleistocene and Pliocene species from the Gulf states. I. Pelecypoda. *Bulletins of American Paleontology*, 8, 1–147.
- Maxwell, W.G.H. (1968) *Atlas of the Great Barrier Reef*, Elsevier Publishing Company, Amsterdam-London-New York, 258 pp.
- Mayer, K. (1864) Paläontologische Verhältnisse. Systematisches Verzeichnis der fossilen Reste von Madeira, Porto Santo und Santa Maria nebst Beschreibung der neuen Arten. In: Hartung, G. (Ed.) *Geologische Beschreibung der Inseln Madeira und Porto Santo*, Leipzig, 183–275.
- Mayer, K. (1872a) Verzeichnis der Versteinerungen des Helvetian der Schweiz und Schwabens. In: Kaufmann, F. J. (Ed.) *Rigi und Molassegebiet der Mittelschweiz*, Bern, 488–511.
- Mayer, K. (1872b) *Systematisches Verzeichnis der Versteinerungen des Helvetian der Schweiz und Schwabens*, Zürich, 35 pp.
- Mayer, K. (1876) Systematisches Verzeichnis der Versteinerungen des Parisian der Umgegend von Einsiedeln. In: *Beiträge zur geologischen Karte der Schweiz, 14 Lieferung*, Geologische Commission der schweizer naturforschenden Gesellschaft, Zürich, 1–100, pl. 1–4.
- Mayer-Eymar, C. (1891) Diagnoses Mytilorum ex agris Aegyptiae nummulitica. *Vierteljahrsschrift der Naturforschenden Gesellschaft in Zürich*, 36, 169–175.
- Mazyck, W.G. (1913) Catalog of Mollusca of South Carolina. *Contributions from the Charleston Museum*, 2, 1–39.
- McLean, R.A. (1951) The Pelecypoda or bivalve mollusks of Porto Rico and the Virgin Islands. *Scientific Survey of Porto Rico and the Virgin Islands*, 17, 1–183.
- Melvill, J.C. (1909) Report on the marine Mollusca obtained by Mr. J. Stanley Gardiner, F.R.S., among the islands of the Indian Ocean in 1905. *Transactions of the Linnean Society of London*, (2) 13, 65–138.
- Melvill, J.C. & Standen, R. (1899) Report on the marine Mollusca obtained during the first expedition of Prof. A. C. Haddon to the Torres Straits, in 1888–89. *Journal of the Linnean Society of London (Zoology)*, 27, 150–206.
- Melvill, J.C. & Standen, R. (1906) The mollusca of the Persian Gulf, Gulf of Oman, and Arabian Sea ... with descriptions of species. II. Pelecypoda. *Proceedings of Zoological Society of London*, 1906, 783–848.
- Meuschen, F.C. (1787) *Museum Geversianum sive Index rerum naturalium ...*, Rotterdami, iv + 659 pp.
- Mörch, O.A.L. (1852–53) *Catalogus Conchyliorum quae reliquit D. Alphonso D'Aguirra et Gadea Comes de Yoldi*, Copenhagen, Fasc. 2, iv + 74 pp.
- Mörch, O.A.L. (1878) Marine Shells. In: Poulsen, C. M. (Ed.) *Catalogue of West-India Shells in the Collection of Dr. C. M. Poulsen*, Copenhagen, 7–16 pp.
- Moore, E.J. (1962) Conrad's Cenozoic fossil marine Mollusk type specimens at the Academy of Natural Sciences Philadelphia. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 114 (2), 23–120.
- Morris, P.A. (1952) *A Field Guide to the Shells of our Atlantic and Gulf Coasts*, Boston, xiv + 236, pl. 1–45.
- Morton, B. (1983) Coral-associated bivalves of the Indo-Pacific. In: Wilbur, K. M. (Ed. in chief) *The Mollusca 6 Ecology*, 139–224.
- Morton, B. (1982) The mode of life and functional morphology of *Gregariella coralliophaga* (Gmelin 1791) (Bivalvia: Mytilacea) with a discussion on the evolution of the boring Lithophaginae and adaptive radiation in the Mytilidae. In: Morton, B. & Tseng, C. K. (Eds.) *The Marine Flora and Fauna of Hong Kong and Southern China*, Proceedings of the 1st International Marine Biological Workshop, Hong Kong 1980, 875–895.
- Morton, B. (1990) Corals and their bivalve borers – the evolution of a symbiosis. In: Morton, B. (Ed.): *The Bivalvia – Proceedings of a Memorial Symposium in Honour of Sir Charles Maurice Yonge, Edinburgh, 1986*, Hong Kong University Press, Hong Kong, 11–46;
- Mourlon, M. (1881) *Géologie de la Belgique*, Paris, Berlin, Bruxelles, 2, lxvi+392 pp.
- Nielsen, C. (1976a) An illustrated checklist of bivalves from PMBC beach with a reef-flat at Phuket, Thailand. *Research Bulletin Phuket marine biological Center*, 9, 1–7.
- Nielsen, C. (1976b) Notes on boring bivalves from Phuket, Thailand. *Ophelia*, 15 141–148.
- Nielsen, C. (1986) Fauna associated with the coral Porites from Phuket, Thailand. (Part 1): Bivalves with description of a new species of *Gastrochaena*. *Phuket Marine Biological Center, Research Bulletin*, 42, 1–24.

- Nomura, S. & Hatai, K. (1935) Catalogue of the shell-boring Mollusca collected from the Kesen and Motoyosi Districts, northeast of Honsyu, Japan, immediately after the Sanriku Tsunami, March 3, 1933, with the descriptions of five new species. *Saito Ho-on Kai Museum Research Bulletin (Sendai)*, 5, 1–47.
- Oldroyd, I.S. (1924a) The marine Shells of the West Coast of North America. *Stanford University Publications, University Series, Geological Sciences*, 1, 1–247, pl. 1–57.
- Oldroyd, I.S. (1924b) Marine shells of Puget Sound and vicinity. *Publications of the Puget Sound Biological Station, University of Washington*, 4, 1–271.
- Oliver, P.G. (1992) *Bivalved Seashells of the Red Sea*, National Museum of Wales, Cardiff, 330 pp. ISBN 3-925919-08-2
- Olsson, A.A. (1961) *Mollusks of the tropical eastern Pacific particularly from the southern half of the Panamic-Pacific faunal province (Panama to Peru)*. *Panamic-Pacific Pelecypoda*, Paleontological Research Institution, Ithaca N.Y., 574 pp., 86 pls.
- Oostingh, C.H. (1925) Report on a collection of recent shells from Obi and Halmahera (Molluscas). *Mededelingen van de Landbouw-Hoogeschool Wageningen*, 29, 1–362 + 1.
- Oppenheim, P. (1901) Die Priabonaschichten und ihre Fauna. *Palaeontographica*, 47, 137–348.
- Oppenheim, P. (1903) Zur Kenntnis alttertiärer Faunen in Ägypten. I. Lieferung: Der Bivalven erster Teil. *Palaeontographica*, 30 (3/1), 1–164.
- Orbigny, A.D. d' (1843–47) *Paléontologie Française. Description zoologique et géologique de tous les Animaux Mollusques et Rayonnés de France, Terrains Crétacés*, Paris, 3 Lamellibranchia: 1–288 (1844), 289–448 (1845), Atlas 3: pl. 237–489. (For publication dates see Sherborn, *Geological Magazine*, 1899: 223).
- Orbigny, A.D. d' (1847) Sur les mollusques vivants et fossiles. *Arch. Bibl. Univ.*, 6 (fide Schultz 2001: 131; not seen)
- Orbigny, A.D. d' (1841–53) Mollusques. In: Sagra, R. de la (Ed.) *Histoire physique, politique et naturelle de l'île de Cuba*, Paris, 2, 280 pp.
- Orbigny, A.D. d' (1850–52) *Prodrome de Paléontologie Stratigraphique Universelle des Animaux Mollusques and Rayonnés faisant suite au cours élémentaire de Paléontologie et de Géologie Stratigraphiques*, V. Masson, Paris, 1, lx + 394 pp., 2, 428 pp., 3, 196 + 189 (191) pp.
- Otter, G.W. (1937) Rock-destroying organisms in relation to coral reefs. *Great Barrier Reef Expedition, 1929–29, Scientific Reports*, 1, 323–352.
- Paetel, F. (1890) *Catalog der Conchylien Sammlung von Fr. Paetel. 3. Abtheilung: Die Acephalen und die Brachiopoden*, Berlin, (4. Neubearbeitung, 15. Lieferung) viii + 256 + xxxii pp.
- Pallary, P., Dautzenberg, P., Dupois, Joleaud, L., Koch, A., Lamy, E., Vayssière, A. & Vignal, L. (1926) Explication des planches de J. C. Savigny. *Mémoires présentés à l'institut d'Égypte et publiés sous les auspices de sa majesté Fouad Ier, Roi d'Égypte*, 11, viii + 139 pp., 18 pls.
- Panteleev, G.S. (1974) (*Stratigraphy and bivalve molluscs of Danian and Palaeocene deposits of the Zakaspien region. In Russian*), Nauka, Moscow, 152 pp.
- Paredes, C. & Cardoso, F. (2003) Adiciones a los moluscos bivalvos marinos del Perú. *Revistas Peru Biología*, 10, 53–58.
- Perry, L.M. (1940) Marine shells of the southwest coast of Florida. *Bulletin of American Paleontologists*, 26 1–260.
- Petit de la Saussaye, S. (1856) Deuxième Supplément au Catalogue des Coquilles trouvées à la Guadeloupe. *Journal de Conchyliologie*, 5, 149–158.
- Philippi, R.A. (1844) *Enumeratio molluscorum Siciliae cum viventium tum in tellure tertiaria fossilium, quae in itinere suo observavit*. Vol. 2, iv + 303 pp, pls. 13–28, [+] Eduard Anton, Halle [Halis Saxorum] fide www.somali.asso.fr/clemam/biotaxis.php?X=21529&header=1
- Piccoli, G. & Massari Degasperis, G. (1968) I molluschi dello stratotipo del Priaboniano e il loro significato paleoecologico. *Mémoires Bureau de Recherches Géologique et Minières, Lyon*, 58, 245–252. (fide Savazzi 1982: 175).
- Piccoli, G. & Mocellin, L.G. (1962) Studi sulla macrofauna priaboniana di Priabona. *Memorie degli Istituti Geologia e Mineralogia dell' Università di Padova*, 33, 1–120. (fide Savazzi 1982: 175).
- Pictet, F.-J. (1855) *Traite de Paléontologie ou Histoire Naturelle des Animaux Fossiles considérés dans leurs rapports Zoologiques et Géologiques*, Paris, 3, 654 pp.
- Pictet, F.-J. & Campiche, G. (1864–67) Description des fossiles du terrain crétacé des environs de Sainte-Croix. In: *Matériaux pour la Paléontologie Suisse ou recueil de monographies sur les fossiles du Jura et des Alpes*, Geneve, 3, 1–558, pl. 99–139.
- Poirier, H. (1954) *An up-to-date systematic list of 3200 seashells from Greenland to Texas: translation, explanation and gender of their names*, New York, 215 pp.
- Pojeta, J.jr. & Palmer, T.J. (1976) The origin of rock boring in mytilacean pelecypods. *Alcheringa*, 1, 167–179.
- Porter, H.J. & Wolfe, D.A. (1971) Mollusca from the North Carolina commercial fishing grounds for the calico scallop, *Argopecten gibbus* (Linné). *Journal de Conchyliologie*, 109, 91–109.
- Potiez, V.L. & Michaud, A.L.G. (1844) *Galerie des Mollusques, ou Catalogue méthodique, descriptif et raisonné des Mollusques et Coquilles du Muséum de Donai*, Paris, 2, xxxvii–xliv + 307 (+2) pp., Atlas: 57–79, pl. 38–70.

- Prashad, B. (1932) The Lamellibranchia of the Siboga Expedition: systematic part. II. Pelecypoda (exclusive the Pectinidae). *Siboga-Expeditie 1899–1900, Monograph*, 53c, 1–353. (Leiden).
- Pritchard, G.D. (1903) Contributions to the paleontology of the Older Tertiary of Victoria. Lamellibranchs. Part 3. *Proceedings of the Royal Society of the Victoria (new series)*, 15, 87–103, pl. 12–15.
- Raulin, V. (1858) Statistique Générale par V. Raulin avec la carte géologique du département per A. Leymerie et V. Raulin. In: *Statistique Géologique du département de l'Yonne*, Auxerre, 23 + 8 + xvi + 863 pp., pl. 3–4.
- Rees, W.J. (1967) A brief survey of the symbiotic-associations of cnidaria with mollusca. *Proceedings of the Malacological Society London*, 37, 213–231.
- Reeve, L.A. (1857–58) Monograph of the genus *Lithodomus*. In: *Conchologia Iconica: or, illustrations of the shells of molluscous animals*, Reeve Brothers, London, 10, 5 pls. (+ descriptions).
- Reeve, L.A. (1860) *Elements of Conchology: an introduction to the natural history of shells and of the animals which form them*, London, 2, vi + 203 pp., pl. I–Q, 22–46. (1859, fide Clapp & Kenk 1963: 823)
- Reil, W. (1870) Tertiärpetrefakten aus Egypten. *Verhandlungen der k.k. geologischen Reichsanstalt Wien*, 1870(6), 107–108.
- Reis, O.M. (1926) Die Fauna des Wettersteinkalks. III. Teil: Gastropoden, Bivalven, Brachiopoden, etc. *Geognostische Jahreshefte München*, 39, 87–138.
- Rios, E.C. (1970) *Coastal Brazilian Seashells*, Rio Grande, 255 pp., 60 pls.
- Rios, E.C. (1975) *Brazilian Marine Mollusks Iconography*, Rio Grande, 331 pp., 91 pls.
- Rollier, L. (1911) *Les Facies du Dogger ou Ooolithique dans le Jura et les Régions Voisines*. Mémoire publié par la fondation Schnyder von Wartensee à Zurich, 352 p., Zurich.
- Rollier, L. (1914) Fossiles Nouveaux ou peu connus des terrains secondaires (Mésozoïques) du Jura et des contrés environnements. *Mémoires de la Société Paléontologique Suisse*, 40, 321–440, pls. 21–28.
- Ruhoff, F.A. (1980) Index to the species of Mollusca introduced from 1850 to 1870. *Smithsonian Contributions to Zoology*, 294, 1–640.
- Rumphius, G.E. (1705) *D'Amboinsche Rariteitkamer*. Amsterdam, F. Halma. 340 pp, 60 pls. (not seen)
- Ryckholt, P. de (1852) *Mélanges Paléontologiques*. 1^{re} Partie. 176 pp, 10 pls. (extracted from *Mémoires couronnés et Mémoires des Savants Étrangers par l'Académie Royale des sciences, des lettres et des beaux-arts de Belgique*, 24)
- Sacco, F. (1897) *I molluschi dei terreni terziarii del Piemonte e della Liguria. Parte XXV. (Spondylidae, Radulidae, Aviculidae, Vulsellidae, Pernidae, Pinnidae, Mytilidae, Dreissensidae)*. Torino, Carlo Clausen. 76 p., 12 pls.
- Salvat, B. & Rives, C. (1975) *Coquillages de Polynésie*, Les éditions du pacifique, 393 pp.
- Satyamurti, S.T. (1956) The mollusca of Krusadai Island (in Gulf of Manaar). Scaphopoda, Pelecypoda and Cephalopoda. *Bulletin of the Madras Government Museum, New Series*, 1(2), part 7, 1–202, pl. 1–30.
- Savazzi, E. (1982) Commensalism between a boring mytilid bivalve and a soft bottom coral in the Upper Eocene of northern Italy. *Paläontologische Zeitschrift*, 56(3/4), 165–175.
- Savazzi, E. (2001) A review of symbiosis in the Bivalvia, with special attention to macrosymbiosis. *Paleontological Research*, 5, 55–73.
- Savi, P. & Meneghini, G. (1851) Osservazione Stratigrafiche e Paleontologiche concernenti la Geologia della Toscana e dei paesi limitrofi. Firenze, 249 pp.
- Savigny, J.C. (1817) (Coquilles) In: *Description de l'Égypte ...*, Histoire naturelle, Atlas, Coquilles, Paris, 14 pls. (Pls. reproduced in Pallary et al. 1926)
- Say, T. (1825) On a new species of *Modiola*. *Journal of the Academy of Natural Sciences Philadelphia*, 4, 368–380.
- Schramm, A. (1867) Catalogues des coquilles et des Crustacés de la Guadeloupe. – 1–27; Basse-Terre. (2nd ed. 1869).
- Schreibers, K. (1793) *Versuch einer vollständigen Conchylienkenntnis nach Linnes System. Von den Muscheln*, Wien, 2, 416 pp.
- Schröter, J.S. (1788) *Vollständiges alphabetisches Namen-Register über alle zehn Bände des, von dem seel. Herrn D. Martini in Berlin angefangenen, und vom Herrn Pastor Chemnitz in Kopenhagen fortgesetzten und vollendeten systematischen Conchylien-Cabinets*, Nürnberg, 124 pp.
- Schubert, R.J. (1905) Zur Stratigraphie des istrisch – norddalmatinischen Mitteleocäns. *Jahrbuch der k.k. geologischen Reichsanstalt, Wien*, 55, 153(1)–188(36).
- Schultz, O. (2001) Bivalvia neogenica (Nuculacea-Unionacea). *Catalogus Fossilium Austriae*, 1(1), xlviii + 379 + 56. ISBN 3-7001-2982-3
- Scott, P.J.B. (1980) Associations between scleractinians and coral-boring molluscs in Hong Kong. In: Morton, B. (Ed.) *Proceedings of the First International Workshop on the Malacofauna of Hong Kong and Southern China*, Hong Kong University Press, Hong Kong, 121–128.
- Scott, R.W. (1970) Palaeoecology and paleontology of the Lower Cretaceous Kiowa Formation, Kansas. *The University of Kansas Paleontological Contributions*, 52, 1–94.
- Scott, R.W. (1981) Biotic relations in Early Cretaceous coral-algal-rudist reefs, Arizona. *Journal of Paleontology*, 55, 463–478.

- Seilacher, A. (1984) Constructional morphology of bivalves: evolutionary pathways in primary versus secondary soft-bottom dwellers. *Palaeontology*, 27, 207–237.
- Serres, M. de (1829) *Géognosie des terrains tertiaires ou Tableau des principaux Animaux Invertébrés des terrains marins tertiaires, du midi de la France*, Montpellier, Paris, v–xcii + 277, pl. 1–6.
- Serres, M. de (1854) De l'action exercée sur les roches par les mollusques perforants, et des moyens de distinguer cette action des effets produits par les agents extérieurs. *Mémoires de l'Académie des Sciences et Lettres de Montpellier*, 2, 341–376.
- Sharabati, D. (1984) *Red Sea Shells*, London..., 128 pp. ISBN 0-7103-0103-0
- Sheppard, A.L.S. (1984) The molluscan fauna of Chagos (Indian Ocean) and an analysis of its broad distribution patterns. *Coral Reefs*, 3, 43–50.
- Sherborn, C.D. (1902) *Index Animalium 1758–1800*, Cambridge, lix + 1195 pp.
- Shopland, E.R. (1896) List of shells collected at Aden in 1892–95... *Journal of the Bombay Natural History Society*, 10, 217–235. (fide Clapp & Kenk 1963: 890)
- Shopland, E.R. (1902) List of marine shells collected in the neighbourhood of Aden between 1892 and 1901. *Proceedings of the Malacological Society London*, 5, 171–179.
- Simpson, C.T. (1887–89) Contributions to the Mollusca of Florida. *Proceedings of the Davenport Academy of Natural Sciences*, 5, 45–72, 63*–72*.
- Smith, A.G. & Mackenzie, G. (1948) The marine mollusks and brachiopods of Monterey Bay, California, and vicinity. *Proceedings of the California Academy of Sciences*, 26, 147–245.
- Smith, E.A. (1903) Marine Mollusca. In: Gardiner, J. S. (Ed.): *The Fauna and Geography of the Maldive and Laccadive Archipelagos. Being the Account of the Works ed. By John Stanley Gardiner*, Cambridge, 2(7), 589–630, pl. 35–36.
- Solander, (1786) *Cat. Portland Museum* (fide Lamy 1937: 179).
- Soot-Ryen, T. (1955) A report on the family Mytilidae (Pelecypoda). *Allan Hancock Pacific Expeditions*, 20, 1–175.
- Soot-Ryen, T. (1969) Superfamily Mytilacea Rafinesquae, 1815. In: Moore, R. C. (Ed.) *Treatise on Invertebrate Paleontology. Part N1, Mollusca 6, Bivalvia*, The Geological Society of America and University of Kansas Press, Lawrence, Kansas, N271–N280.
- Starmühlner, F. (1974) Beiträge zur Kenntnis der Mollusken-Fauna im Litoral von Südindien und Ceylon. *Journal of the Marine Biological Association of India*, 16 (1), 49–82.
- Stephenson, L.W. (1923) The Cretaceous formation of North Carolina. Part I. Invertebrate fossils of the Upper Cretaceous formations. *North Carolina Geologic and Economic Survey*, 5, 1–604.
- Stephenson, L.W. (1941) The larger invertebrate fossils of the Navarro Group of Texas (Exclusive of corals and crustaceans and exclusive of the fauna of the Escondido formation). *The University of Texas Publications*, 4101, 1–641.
- Stephenson, L.W. (1952) Larger invertebrate fossils of the Woodbine formation (Cenomanian) of Texas. *Geological Survey Professional Paper*, 242, iv + 211 pp., 58 pls.
- Stephenson, T.A., Stephenson, A. & Tandy, G. (1931) The Ecology of Low Isles. *Great Barrier Reef Expedition, 1928–29, Scientific Reports*, 3(2), 35–68, pl. 4–17.
- Stilwell, J.D. & Zinsmeister, W.J. (1992) Molluscan systematics and biostratigraphy. Lower Tertiary, La Meseta Formation, Seymour Island, Antarctic Peninsula. *Antarctic Research Series*, 55, xii + 192 pp.
- Stoliczka, F. (1870–71) The Pelecypoda, with a review of all known Genera of this class, fossil and recent. In: Cretaceous Fauna of Southern India. *Memoirs of the Geological Survey of India, Palaeontologia Indica*, 3, xxii + 537 pp.
- Studenka, B., Gontsharova, I. & Popov, S., (1998) The bivalve faunas as a basis for reconstruction of the Middle Miocene history of the Paratethys. *Acta Geologica Polonica*, 48, 285–342.
- Sturany, R. (1899) Lamellibranchiaten des Rothen Meeres. In: *Expedition S. M. Schiff "Pola" in das Rothe Meer, nördliche und südliche Hälfte, 1895/96 und 1897/98. XIV. Zoologische Ergebnisse*, Wien, 41 pp., 7 pls. (Also: *Denkschriften der mathematisch-naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften Wien*, 69 (1901), 255–295.)
- Sturany, R. (1905) Beiträge zur Kenntnis der Molluskenfauna des Roten Meeres und des Golfes von Aden. *Nachrichtsbblatt der deutschen malakologischen Gesellschaft*, 37, 132–146.
- Sundberg, F.A. (1981) Cretaceous *Lithophaga* (Mollusca: Bivalvia) from the West coast of North America. *Journal of Paleontology*, 55, 901–902.
- Tate, R. (1887) The lamellibranchs of the Older Tertiary of Australia (Part II). *Transactions and Proceedings and Report of the Royal Society of South Australia, Adelaide*, 9, 142–189.
- Tate, R. (1892) Descriptions of some new species of marine mollusca from Australia. *Transactions and Proceedings and Report of the Royal Society of South Australia, Adelaide*, 15, 125–132.
- Taylor, J.D. (1968) Coral reef and associated invertebrate communities (mainly molluscan) around Mahé, Seychelles. *The Royal Society, Series B, Biological Sciences* 793, 254, 129–206.
- Taylor, J.D. & Reid, D.G. (1984) The abundance and trophic classification of mollusks upon coral reefs in the Sudanese Red Sea. *Journal of Natural History*, 18, 175–209.

- Thiele, J. (1934) *Handbuch der Systematischen Weichtierkunde, Scaphopoda, Bivalvia, Cephalopoda*, 2(3), 779–1022, Jena.
- Thiele, J. & Jaeckel (1931) *Muscheln der Deutschen Tiefsee-Expedition* (fide Lamy 1937: 182).
- Tichy, G. (1970) Typen-Katalog. Verzeichnis der in der Geologisch-Paläontologischen Abteilung des Naturhistorischen Museum aufbewahrten Typen sowie der Abbildungsoriginale. *Annalen des Naturhistorischen Museum Wien*, 74, 607–655.
- Tichy, G. (1982) (re) Sundberg (1981) Cretaceous *Lithophaga* (Mollusca: Bivalvia) from the West coast of North America. *Zentralblatt für Geologie und Paläontologie Teil II Paläontologie*, 1981, p. 288.
- Tsi, C.Y. & Ma, S.T. (1982) A preliminary check list of the marine Gastropoda and Bivalvia (Mollusca) of Hong Kong and Southern China. In: Morton, B. & Tseng, C. K. (Eds.) *Proceedings of the First International Workshop on the Malacofauna of Hong Kong and Southern China*, Hong Kong University Press, Hong Kong, 1982, 431–458;
- Turner, R.D. & Boss, K.J. (1962) The genus *Lithophaga* in the Western Atlantic. *Johnsonia*, 4 (41), 81–116.
- Turton, W. (& daughter) (1819) *A conchological dictionary of the British Islands*, London, xxv + 272 pp., 28 pls.
- Vadász, M.E. (1906) Budapest-Rákos felsőmediterránkovi faunája. *Földtani Közlöny, Budapest*, 36, 323–351.
- Vaillant, L. (1865) Recherches sur la faune malacologique de la baie de Suez. *Journal de Conchyliologie, Paris*, 13 (2), 97–127, pl. 6.
- Vasseur, G. (1882) Recherches géologiques sur les terrains tertiaires de la France occidentale Stratigraphie. *Annales des Sciences Géologiques, Paris*, 13, 1–432.
- Verco, J.C. (1908) *Catalogue of Marine Mollusca of South Australia*, Adelaide, 24 pp.
- Verrill, A.E. & Bush, K.J. (1900) Additions to the marine mollusca of the Bermudas. *Transactions of the Connecticut Academy of Arts and Sciences*, 10, 513–544.
- Viader, R. (1937) Revised catalogue of the testaceous mollusks of Mauritius and its dependencies. *Mauritius Institute Bulletin*, 1, xiii + 110 pp.
- Vincent, E. (1930) Les Mytilidées des sables de Wemmel (Eocène supérieur). *Bulletin du Musée royal d'Histoire naturelle de Belgique*, 6, 1–9.
- Vine, P. (1986) *Red Sea Invertebrates*, Immel Publishing, London, 224 pp.
- Vinassa de Regny, P.E. (1897) La posizione stratigrafica del Piano di Priabona. *Rivista Italiana di Paleontologia*, 3, 21–23.
- Vinassa de Regny, P.E. (1898) Synopsis dei Molluschi terziari delle Alpi venete. Parte seconda: Strati oligocenici. - VI. Via degli Orti, Valle Orgagna, Priabona ecc. *Palaeontographia Italica*, 3, 145(103)–200(158), pls. 19(6)–20(7).
- Vokes, H.E. (1946) Contributions to the paleontology of the Lebanon mountains, Republic of Lebanon. Part 3. The pelecypod fauna of the "Olive Locality" (Aptian) at Abeih. *Bulletin of the American Museum of Natural History New York*, 87, 139–214.
- Waller, T.R. & Stanley, G.D.Jr. (2005) Systematic Paleontology. Middle Triassic pteriomorphian Bivalvia (Mollusca) from the New Pass Range, West-Central Nevada: Systematics, biostratigraphy, paleoecology, and paleobiogeography. *The Paleontological Society Memoir 61, supplement to Journal of Paleontology*, 79(1), 1–64.
- Wang, Z.R. (1983) Studies on the Mytilidae of the Xisha Islands, Guangdong Province, China. *Studia Marina Sinica*, 20, 213–222. (fide Lee & Morton 1985: 60)
- Warne, J.E. (1975) Borings as trace fossils, and the processes of marine bioerosion. In: Frey, R. W. (Ed.) *The Study of Trace Fossils*, Springer Verlag, New York, 181–227.
- Warmke, G.L. & Abbott, R.T. (1961) *Caribbean Seashells*, Livingston Publications, Narbeth, Pennsylvania, 346 pp., 44 pls.
- Weller, S. (1907) A report on the Cretaceous Paleontology of New Jersey (Based upon the stratigraphic studies of George N. Knapp). *New Jersey Geological Survey, Palaeontology*, 4, 1–871.
- Westwood, J.O. (1840) Observations on the genus *Derbe* of Fabricius. *Proceedings of the Linnean Society of London*, 1, 82–85.
- Whitfield, R.P. (1886) Brachiopoda and Lamellibranchiata of the Raritan clays and greensand marls of New Jersey. *Monographs of the United States Geological Survey*, 9, xx + 338 pp., 34 pls.
- Wilson, B.R. (1979) A revision of Queensland lithophagine mussels (Bivalvia, Mytilidae, Lithophaginae). *Records of the Australian Museum*, 32, 435–489.
- Wilson, B.R. (1985) Sibling species of *Leiosolenus* (Bivalvia, Mytilidae, Lithophaginae) boring in living corals in the Indo-West Pacific region. *Proceedings of the 5th International Coral Reef Congress, Tahiti, 1985*, 5, 183–190.
- Wilson, B.R. & Tait, R. (1984) Systematics, anatomy and boring mechanisms of the rock-boring mytilid bivalve *Botula*. *Proceedings of the Royal Society of Victoria*, 96, 113–125.
- Wood, W. (1818) *Index Testaceologicus; or a Catalogue of Shells, British and Foreign, arranged according to the Linnean System; with the latin and english names, references to figures, and places where found*, London, viii + 188 (+2) pp., 8 pls.

- Wood, W. (1824–25) *Index Testaceologicus; or a Catalogue of Shells, British and Foreign, arranged according to the Linnean System; with the latin and english names, references to figures, and places where found*, London, xxxii + 188 (+2) pp., 8 pls. (2nd ed.).
- Wood, W. & Hanley, S. (1856) *Index Testaceologicus, an illustrated Catalogue of British and Foreign Shells, containing about 2800 figures accurately coloured after nature. A new and entirely revised edition, with ancient and modern appellations, synonyms, localities, etc. etc. by Silvanus Hanley*, London, 234 pp., 38 + 8 pls.
- Yonge, C.M. (1951) Marine boring organisms. *Research (London)*, 4, 162–167.
- Yonge, C.M. (1955) Adaptations to rock boring in *Botula* and *Lithophaga* (Lamellibranchia, Mytilidae) with a discussion on the evolution of this habit. *Quarterly Journal of Microscopical Science*, 96, 383–410.
- Zankl, H. & Schroeder, J.H. (1972) Interaction of genetic processes in Holocene reefs off North Eleuthera Island, Bahamas. *Geologische Rundschau*, 61, 520–541.
- Zapfe, H. (1967) Beiträge zur Paläontologie der nordalpinen Riffe. Die Fauna der Zlambach-Mergel der Fischerwiese bei Aussee, Steiermark (exkl. Coelenterata und Mikrofossilien). In: *Kühn Festschrift*, Österreichische Paläontologische Gesellschaft, Wien, 413–480, pl. 1–9.

Appendix 1. Geologic record of species names

(Names in bold appear to be true *Botula*)

Mesozoic

Triassic

Botula (?) *cassiana* Bittner, 1895, Cordevol, Carnian, St. Cassian, = mysidiellid *Botulopsis*

Jurassic

Venerupis oolithica Merian, 1840, Bathonian, Dogger

Lithodomus bathonicus Rollier - Strübin 1913, Bathonian, Dogger (= *oolithica*)

Lithodomus orbignyianus Peron, 1906, Oxfordian, Early Malm

Mytilus minusculus Dollfus, 1863, Kimmeridgian

Cretaceous

Lithophagus affinis Gabb, 1862, green marl of New Jersey

Lithodomus archiacii Orbigny, 1845, Neocomian

Lithodomus (Botula) avellana Orbigny – Gillet 1924, Valanginian, Barremian, Aptian

Arcoperna carolinensis Conrad, 1875, Snow Hill, Black Creek Formation, Campanian, Upper Cretaceous, North Carolina

Lithophaga conchafodentis Gardner, 1916, Monmouth Formation, Brightseat, Prince George's County, Maryland

Modiola contorta Dujardin, 1837

Modiola cretacea Gabb, 1861, S America

Lithodomus obesus Pictet & Campiche, 1864–67, Valanginian of Villiers-le-Lac, Neocomian, Aptian of Orgon

Lithodomus obtusus Orbigny, 1845, Turonian, Mars (Sarthe), Senonian, Royan

Lithophaga oviformis Gabb - Stephenson 1952, Cenoman

Botula plumosa Stephenson, 1952, Cenoman

Lithophagus ripleyanus Gabb, 1862, marls of New Jersey

Lithodomus similis Ryckholt, 1852, Upper Senonian, Ciply

Botula similoides Vokes, 1946, Aptian, Lebanon

Lithodomus (?) *Botula* *tumidula* Stoliczka, 1871, Arrialoor group, SE of Arrialoor, S India

Lithophaga twitchelli Gardner, 1916, Monmouth Formation, Seat Pleasant, Prince George's County, Maryland

Cenozoic

Paleogene

Lithodomus brevis Tate, 1887, Paleogene

Sootryenella ewekoroensis Adegoke, 1977, Paleocene

Mytilus subobtusus Archiac, 1850, Archiac & Haime, 1853, Paleogene, Hala, India

Lithophaga fabaeformis Crespin, 1926, Ironstone beds, Keilor, Janjukian of Torquay, Australia

Modiola argentina Deshayes, 1824, Eocene, Valmondois, France

Modiola cordata Lamarck, 1807, Eocene, near Paris

Lithophaga mcknighti Hanna, 1927, Eocene, La Jolla Quadrangle, California

Lithophagus (Botula) brabanticus Vincent, 1930, Upper Eocene

Lithodomus (Botula) lesbarritzensis Cossmann, 1922, Oligocene, Stampian, Lesbarritz, France

Neogene

Botula pirriei Stilwell & Zinsmeister, 1992, Neogene, La Meseta Formation, Seymour Island, Antarctic Peninsula, =
Modiola
Lithodomus hortensis Vinassa de Regny, 1898, Miocene, Priabona, Orti, Valle Organa, Italy
Mytilus subcordatus Orbigny, 1852, Miocene, Falunian, Saucats (Gironde), France
Lithophaga incurva Gabb, 1881, Pliocene, clay beds between Limon and Moen, Costa Rica, (Pl. 1, Figs. 8a–d)

Quaternary
Pleistocene ?

Botula hispaniolae Maury, 1917

Holocene

Lithophaga (Botula) arenaria Meuschen - Mörch, 1853

Modiola cinnamomea Lamarck, 1819, Mauritius, (Pl. 1, Fig. 1)

Lithodomus cuneiformis Tate, 1892, Port Victoria, Spencer Gulf, Kangaroo Islands, Australia, (Pl. 1, Fig. 4)

Botula cylista Berry, 1959, Punta Cameron, Mazatlán, Sinaloa, Mexico

Mytilus fuscus Gmelin, 1791

Botula hawaiiensis Dall, Bartsch & Rehder, 1938 Hawaii

Botula laysana Dall, Bartsch & Rehder, 1938, Laysan Island, Hawaii, (Pl. 1, Figs. 6ab)

Lithodomus projectans Tate, 1892, Port Darwin, Australia (Pl. 1, Figs. 5ab)

Modiola silicula Lamarck, 1819, Australia, (Pl. 1, Fig. 2)

Botulopa silicula infra Iredale, 1939, Low Isles, Queensland (Pl. 1, Figs. 3ab).

Appendix 2. “*Botula*” names in chronological order

(1685 *Musculus exiguus fuscus* Lister)
(1785 *Mytilus cinnamominus* Chemnitz)
(1791 *Mytilus cinnamomeus* Chemnitz - Gmelin)
1791 *Mytilus fuscus* Gmelin
1807 *Modiola arcuata* Lamarck
1807 *Modiola cordata* Lamarck
1819 *Modiola cinnamomea* Lamarck
1819 *Modiola silicula* Lamarck
1824 *Modiola argentina* Deshayes
1835 *Modiola contorta* Dujardin
1840 *Venerupis oolithica* Merian
1842 *Modiola archiaci* Deshayes (in Leymerie)
1845 *Lithodomus archiacii* Orbigny
1845 *Lithodomus obtusus* Orbigny
1850 *Mytilus subobtus* Archiac
1852 *Lithophagus ripleyanus* Gabb
1852 *Mytilus subcordatus* Orbigny
1852 *Lithodomus similis* Ryckholt
1862 *Lithophagus affinis* Gabb
1863 *Mytilus minusculus* Dollfus
1864 *Lithophaga oviformis* Gabb
1867 *Lithodomus obesus* Pictet & Campiche
1867 *L. traversensis* Pictet & Campiche
1871 *Lithodomus* (? *Botula*) *tumidula* Stoliczka
1875 *Arcoperna carolinensis* Conrad
1881 *Lithophaga incurva* Gabb
1886 *Modiola (Lithodomus ?) inflata* Whitfield
1887 *Lithodomus brevis* Tate
1892 *Lithodomus cuneiformis* Tate
1892 *Lithodomus projectans* Tate
1895 *Botula* (?) *cassiana* Bittner
1898 *Lithodomus hortensis* Vinassa de Regny
1906 *Lithodomus orbignyanus* Peron
1909 *Lithophaga manuanensis* Newton

1913 *Lithodomus bathonicus* Rollier - Strübin
1916 *Lithophaga conchafodentis* Gardner
1916 *Lithophaga twitchelli* Gardner
1917 *Botula hispaniolae* Maury
1922 *Lithodomus (Botula) lesbarritzensis* Cossmann
1926 *Lithophaga fabaeformis* Crespin
1927 *Lithophaga mcknighti* Hanna
1930 *Lithodomus (Botula) brabanticus* Vincent
1938 *Botula hawaiiensis* Dall, Bartsch & Rehder
1938 *Botula laysana* Dall, Bartsch & Rehder
1939 *Botulopa silicula infra* Iredale
1946 *Botula similoides* Vokes
1952 *Botula plumosa* Stehenson
1959 *Botula cylista* Berry
1977 *Sootryenella ewekoroensis* Adegoke
1992 *Botula pirriei* Stilwell & Zinsmeister