JOHNSONIA

Published by
The Department of Mollusks
Museum of Comparative Zoölogy, Harvard University
Cambridge, Massachusetts

FEBRUARY 12, 1965 | *PANDORIDAE* | VOL. 4, NO. 44

THE FAMILY PANDORIDAE IN THE WESTERN ATLANTIC[1]

BY

Kenneth J. Boss[2] and Arthur S. Merrill[3]

The family Pandoridae, as represented by its single nominate genus, is cosmopolitan in distribution with a concentration of species in the cooler waters of the northern hemisphere. A number of species are boreal while a single one is circumpolar. The coasts of eastern Asia, western North America and eastern North America constitute the areas in which *Pandora* is most highly differentiated. Tropical and subtropical waters do not appear to suit most members of the genus and the group is therefore poorly represented in the faunas of Africa, South America and the Indo-Pacific.

Within species of the northern hemisphere, allopatric patterns of geographic speciation are evident, and from the known embryological evidence, localized populations seem to be maintained by the short-lived pelagic stage. One phenomenon resulting from geographic isolation and subsequent evolutionary divergence is the existence of species pairs. In this case the new and distinct species, having been derived from the same ancestral stem, possess many morphological traits in common. Barriers to the genetic introgression of such populations may be either intrinsic or extrinsic, and in the present state of malacological knowledge, the extrinsic mechanisms are better known and more easily deduced. The classic example includes the numerous paired species found separated by the Isthmus of Panama.

In *Pandora*, the fauna of the Western Atlantic is largely represented by analogous elements in the Eastern Pacific. Such a distinctive barrier as an isthmus need not always be evident. The Japanese species *wardiana* Adams is analogous to the Pacific North American *grandis* Dall. Both species are very similar morphologically but *wardiana* is distinguished by its unusually great size. Intraoceanic speciation in the littoral fauna may also be detected by similar allopatric patterns. In the Western Atlantic, *gouldiana* and *trilineata* exemplify this phenomenon and are analogous species. Gardner (1943) has noted that this specific distinction may be traced to the Miocene.

---

[1] Published with the aid of a Milton Grant.

[2] Ichthyological Laboratory
Bureau of Commercial Fisheries
United States Fish and Wildlife Service
Department of Interior
Washington, D.C.

[3] Biological Laboratory
Bureau of Commercial Fisheries
United States Fish and Wildlife Service
Department of Interior
Oxford, Maryland

Contrary to Dall (1903) and Grant and Gale (1931), the fossil history of *Pandora* begins in the Tertiary not in the Cretaceous (Zittel, 1900). Stoliczka (1871) has confirmed this by asserting that no recognizable *Pandora* occur in Mesozoic deposits. In Europe, the genus has been found as early as the Eocene of the Paris Basin (Deshayes, 1860; Cossmann, 1886), and the fossil species *primaeva* Deshayes of these sediments is not unlike modern *glacialis*. The genus does not appear until the Miocene in North America; there do not seem to be any available Eocene records. The modern elements of the Western Atlantic fauna may be traced directly to the Miocene where numerous species had already developed.

Anatomical Notes

In *Pandora*, the thin transparent mantle is thickened ventrally and its lobes are united along its entire length except for the pedal and siphonal gapes. Along the edge of the mantle, the outer, middle and inner lobes may be most easily discerned at the pedal gape which extends from the anterior adductor muscle ventrally to a point just behind the base of the foot (pl. 115, 15). At this point the inner longitudinal muscular lobes of the mantle edge fuse: the fusion is complete to the incurrent siphon and not only a cuticular junction (Allen, 1954). In *Pandora gouldiana*, the incurrent siphon (pl. 115, 10) possesses two rows of papillae, the inner row generally with about 15–18, the outer row with about 18–20. The excurrent siphon (pl. 115, 9) has only a single row of papillae, numbering about 20 in *gouldiana* (Perkins, 1869; Morse, 1919). The siphons are

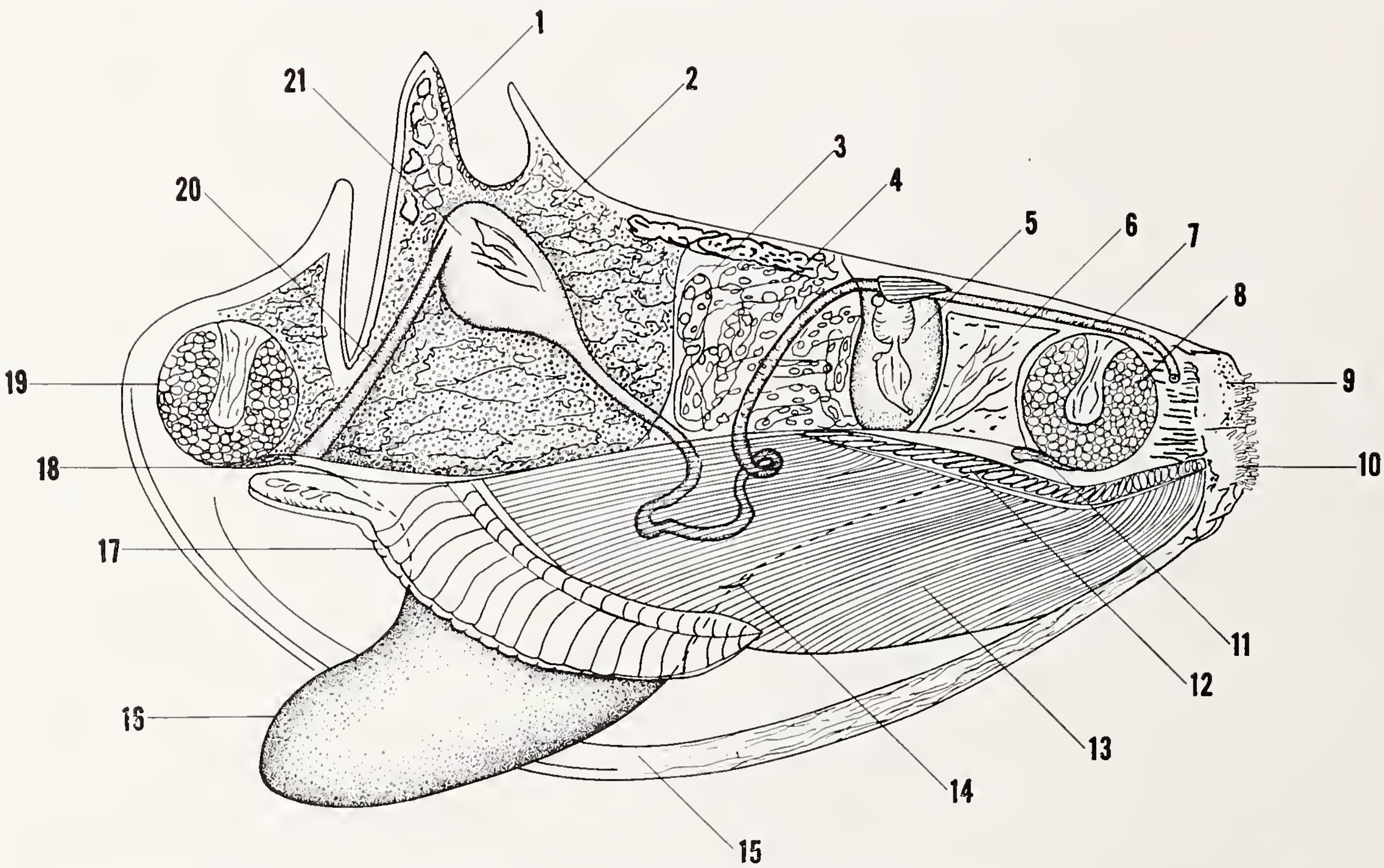

Plate 115. Diagram of the gross anatomy of *Pandora gouldiana* Dall, left valve and mantle removed.
1. Specialized cells to secrete resilium and lithodesma. 2. Digestive diverticula. 3. Ovary. 4. Pericardial (Keber's) gland. 5. Heart. 6. Kidney. 7. Rectum. 8. Posterior adductor muscle with quick and catch muscle fibers. 9. Excurrent siphon with papillae. 10. Incurrent siphon with papillae. 11. Posterior pedal retractor. 12. Outer demibranch. 13. Inner demibranch. 14. Byssal gland and groove. 15. End of mantle union and beginning of pedal gape. 16. Foot. 17. Labial palps. 18. Anterior pedal retractor. 19. Anterior adductor muscle with quick and catch muscle fibers. 20. Esophagus. 21. Stomach.

short, united at their bases but separated by an internal intersiphonal septum. In *gouldiana*, the siphons are light brown in color, mottled with black dots. The muscular lobes of the mantle are thickened in this area to form the siphonal retractor muscles; nevertheless, the siphons are not capable of great extension and the animal in its burrowing habit is more or less limited to the epifaunal regions of the substrate.

The thickened muscle lobes of the mantle attach irregularly to the shell to form a discontinuous pallial line (pls. 117 and 118, 5). The anterior and posterior adductor muscles (pl. 115, 8 and 19) are subequal in size and are differentiated into "catch" and "quick" fibers. The anterior pedal retractor (pl. 115, 18) has its origin along the ventral surface of the anterior adductor muscle and inserts antero-dorsally in the foot. It is more extensive and better developed than the posterior pedal retractor (pl. 115, 11) which is small, thin and somewhat tendon-like. The latter muscle inserts into the foot postero-dorsally and has its origin at the base of the posterior adductor muscle. Both pedal retractors are unusual in that their origins are along the ventral border of the adductor muscles.

The mantle is completely united dorsally and there is a specialized area of cells beneath the umbo which function in the secretion of the resilium and the lithodesma (pl. 115, 1; and pls. 117–118, 8 and 9).

The laterally compressed foot (pl. 115, 16) is large, well developed and capable of considerable extension through the antero-ventral pedal gape. A byssal gland and groove (pl. 115, 14) are present but no byssus is developed in the adult stage although early post-larval *Pandora* may utilize byssal strands for attachment to the substrate (Allen, 1961).

As is characteristic of members of the Anatinacea, the gills of *Pandora* are separated into dorsally upturned outer and ventral inner demibranchs (Deshayes, 1848; Menegaux, 1890). The outer demibranch (pl. 115, 12) is small and very much reduced, consisting of only a single direct lamella (Pelseneer, 1911). The inner demibranch (pl. 115, 13), consisting of both internal and external lamellae, extends posteriorly nearly to the opening of the incurrent siphon where they are pendantly free and not attached to the siphonal septum as in *Anatina* (Burne, 1920). Just ventral and posterior to the foot at the nominal origin of the posterior pedal retractor muscle, the inner demibranch of the right and left sides unite. The remainder of the anterior portion of the demibranch is attached along its proximal margin to the body. The lamellae of *Pandora inaequivalvis* Linnaeus are plicate and heterorhabdic with a specific number of filaments per plica (Ridewood, 1903). Atkins (1937) has described the ciliary currents, and Allen (1954) has figured the sorting mechanisms of the gill ciliation. The paired and bilobed labial palps (pl. 115, 17) are plicate and contiguous with the inner demibranch.

The mouth is situated at the anterior margin of the labial palps. In *Pandora gouldiana*, a relatively long esophagus (pl. 115, 20) leads to the stomach (pl. 115, 21) which possesses a developed gastric shield and crystalline style. Allen (1954) and Purchon (1958) have described in detail the structure and function of the stomach of *Pandora inaequivalvis*. A large diffuse digestive diverticulum surrounds the stomach and connects with it by numerous ducts. The style-sac is combined with the midgut which extends postero-ventrally from the stomach, convolutes in the testicular tissue of the foot and arises abruptly to pass through the tubulous ovary and then through the pericardial wall to form the rectum. Continuing posteriorly out of the pericardium the rectum passes over the dorsum of the posterior adductor muscle and terminates with the anus in the excurrent siphonal cavity.

The structure of the nervous system of *Pandora* has been discussed by Duvernoy (1854). It is sufficient to mention that the cerebropleural ganglia are near the ventral surface of the anterior adductor muscle and are connected by a commissure. Long cerebro-visceral connectives extend posteriorly to the visceral ganglia at the base of the posterior adductor muscle, and separate cerebro-pedal connectives join the cerebropleural ganglia to the pedal ganglia. According to Pelseneer (1911), there are paired otoliths associated with the pedal ganglia.

The cardiac system of *Pandora* (see pl. 116) includes a large pericardium within which the paired auricles and ventricles are located and through which the rectum passes. The auricles attach to the pericardial wall near the kidneys and lead dorsally to the paired ventricles which lie below the alimentary canal. The ventricles then unite to form a common bulbus arteriosus which envelopes a portion of the rectum and which gives rise to the anterior and posterior aortae. Both the ventricle and auricle possess spheroidal structures the function of which is unknown. Dorso-lateral to the pericardium are the paired Keber's organs or pericardial glands.

As noted by Lacaze-Duthiers (1854), *Pandora* is monoecious with both male and female gonads occurring in a single individual. It appears that this hermaphroditic condition is typical of the Anatinacea. Arvy and Gaillard (1956) have noted that in *Pandora inaequivalvis* a parasitic cercarean, *Cercaria melanocystea*, destroys the gonad tissue, and replaces it with dark colored sporocysts. The nephridial system of *Pandora glacialis* has been considered by Odhner (1912), and pl. 117 illustrates the general structure of the reproductive and nephridial systems in *Pandora*. The ovary is more or less dorsal, tubular and superficial, occupying the central portion of the visceral mass. The testis is diffuse and consists of irregular glandular tissue buried deeply about the convolutions of the in-

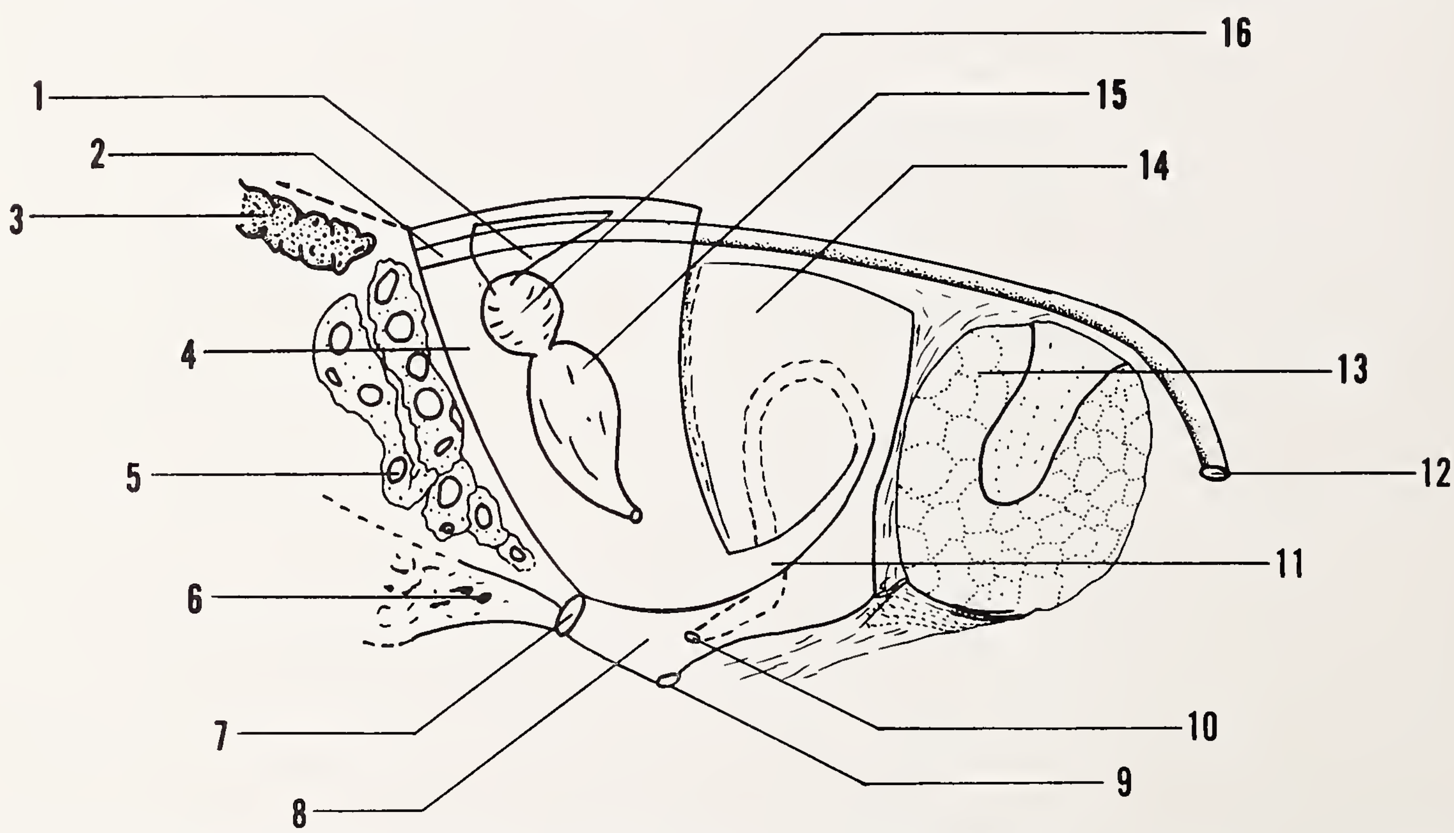

Plate 116. Diagram of the urogenital system of *Pandora*. 1. Bulbus arteriosus. 2. Rectum. 3. Pericardial gland (Keber's organ). 4. Pericardium. 5. Ovary. 6. Testis. 7. Common genital pore. 8. Urogenital canal. 9. Urogenital pore or orifice. 10. Nephroproct. 11. Reno-pericardial canal (Wimpertrichter). 12. Anus. 13. Posterior adductor muscle. 14. Kidney. 15. Auricle. 16. Ventricle.

testine in the dorsal mass of the foot. The testis and ovary open via a common genital pore into the urogenital canal. The kidney is located between the pericardium and the posterior adductor muscle. A ciliated reno-pericardial funnel or Wimpertrichter connects the cavity of the pericardium with the kidney. Thence the kidney leads via a renal orifice or nephroproct into the urogenital canal. Excretory wastes and reproductive products are thereby expelled into the suprabranchial chamber via a common urogenital orifice or pore.

Eggs in the ovary are already encapsulated and Pelseneer (1911) detected zygotes in early developmental stages within the gills and pallial cavity of *Pandora elongata* Carpenter. Burne (1920) reported eggs in the suprabranchial chamber of *Anatina*. Internal incubation appears to occur with some frequency within the Anatinacea.

The developmental biology of *Pandora inaequivalvis* has been discussed by Allen (1961). In that species, the eggs are quite large (105–125 μ in diameter) with considerable food reserves and similar lecithotrophic conditions also are found within *P. glacialis* Thorson (1936); Ockelmann (1958) and *P. gouldiana* (Perkins, 1869). Development appears to be rapid with metamorphosis occurring in less than four days. The larvae are generally released from the encapsulated eggs within 22 hours after fertilization and the veliger is short-lived, spending less than 24 hours in the plankton; dispersal, therefore, is somewhat minimized. In the settling stage of the dissoconch, attachment to the substrate is implemented by means of a byssus, and complete metamorphosis including the development of the labial palps, gills and foot is then completed. Allen's observations (1961) were experimentally derived, but they do not preclude the possible incubation of young as indicated by Pelseneer (1911). The time of spawning appears to vary from species to species. In *gouldiana*, it takes place in late spring or early summer, while in *glacialis* it occurs in late August (Ockelmann, 1958). We have seen eggs of *gouldiana* extended in mucus strands from the outer perimeter of the mantle. Presumably these mucus strands cling to the substrate until the eggs develop to a free-swimming stage. The eggs, obtained from specimens in Woods Hole, Massachusetts, measured between 130–140 μ.

Shell Morphology

The shell structure of *Pandora* has been discussed by Carpenter (1848). He described the shell of *Pandora inaequivalvis* as consisting of an internal nacreous and laminate layer and an external crystalline, prismatic layer. Between these layers is a so-called membranous partition. An organic periostracum covers the external portions of the shell and when this is worn away the underlying prismatic layer may be abraded revealing the internal aragonitic nacre. The abrasion of the prismatic layer appears to be common in such species as *Pandora gouldiana* and causes the external aspect of the shell to become a dull powdery white.

The ligament in *Pandora* consists of a number of portions. Posterior to the umbo and connecting the opposing valves, there is a thin ligamental sheath formed by a thickened periostracal covering. Along the anterior dorsal margin, another somewhat stronger sheath of ligamental tissue joins the valves; the attachment of this ligamental tissue is particularly evident in the left valve of *Pandorella* where a slight concavity is present along the anterior dorsal margin near the anterior cardinal tooth (pl. 119, 3). Internally a strong resilium is developed which consists of compressed layers of ligamental material.

In some subgenera, notably *Pandorella* and *Clidiophora*, a calcified supportive lithodesma subtending the resilium is developed.

The configuration of the dentition is somewhat complex in *Pandora*. It appears that quite recently some measure of morphological stability has been reached in the evolution of these structures. Dall (1903) recounted the numerous irregularities and the lack of stability in the fossil representatives of *Pandora* in the Miocene of North America. Even

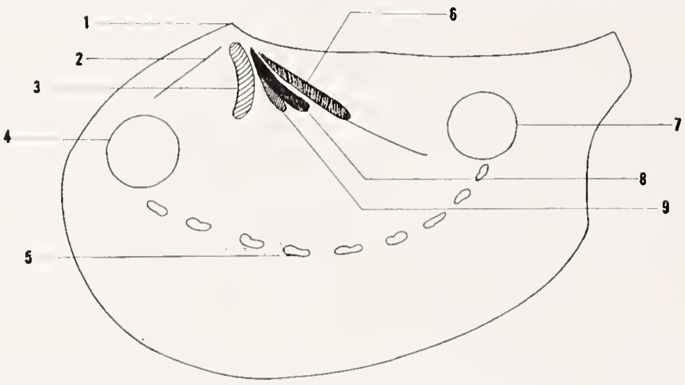

Plate 117. Diagram of the right valve of *Pandora gouldiana* Dall. 1. Umbo. 2. Anterior cardinal tooth. 3. Central pedunculate cardinal tooth. 4. Anterior adductor muscle scar. 5. Pallial muscle scar. 6. Posterior cardinal tooth. 7. Posterior adductor muscle scar. 8. Resilium. 9. Lithodesma.

in the recent species, particularly in such species as *Pandora gouldiana* Dall, variation of dental configuration is considerable. One of the simplest dental patterns is encountered in *Pandora inaequivalvis* Linnaeus, which has a well developed central pedunculate cardinal tooth in the right valve and poorly developed posterior and central teeth in the left.

For the purposes of uniformity and clarity, the following descriptive system will be utilized in discussion of the morphology of each species. The structural configuration upon which the discussion is based is taken from *Pandora gouldiana*, where a full complement of representative dental structures is present (pls. 117 and 118).

The dorsal internal hinge of the left valve possesses a number of unconformities—thickenings, protuberances and concavities. The anteriormost of these is called the anterior cardinal tooth. It may take the form of an elongate conspicuous internal ridge which is dorso-ventrally aligned (e.g., *gouldiana*, pls. 117 and 118, 2) or it may coalesce with the anterior dorsal margin to form a thickened structure along the hinge line and be aligned in an anterior-posterior direction (e.g., *glacialis*, pl. 119, 2). This tooth or its representative in a fusion with the hinge line is always evident to some degree. Its particular type of formation is a clue to subgeneric affinities in that *Clidiophora* possesses a

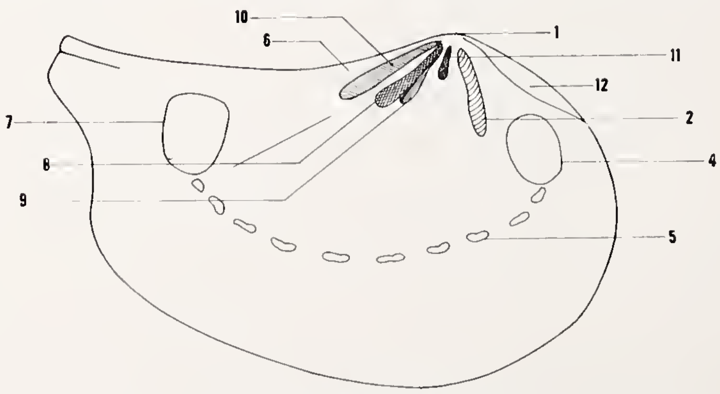

Plate 118. Diagram of the left valve of *Pandora gouldiana* Dall. 1. Umbo. 2. Anterior cardinal tooth. 4. Anterior adductor muscle scar. 5. Pallial muscle scar. 6. Posterior cardinal tooth. 7. Posterior adductor muscle scar. 8. Resilium. 9. Lithodesma. 10. Posterior fossa for the intrusion of the posterior cardinal tooth of the opposite valve. 11. Median cardinal tooth. 12. Anterior dorsal margin and ligamental concavity.

distinct anterior cardinal tooth parallel to the dorso-ventral axis of the shell, and *Pandorella* possesses a less distinct tooth, usually somewhat adpressed to the anterior dorsal margin and arranged in an anterior-posterior plane. The anterior terminus of this tooth presents a relationship to the anterior adductor muscle scar. In *Clidiophora*, the scar may or may not rest wholly beneath the terminus while in *Pandorella* the anterior adductor muscle scar is generally beneath the terminus or ventral border of the tooth.

Along the dorsal margin beneath the umbos is a deep cavity immediately behind the proximal terminus of the anterior cardinal tooth. The cavity or fossa receives the central, pedunculate cardinal tooth (pl. 117, 3) of the right valve when the valves are interlocked. A thin, raised central tooth (pl. 118, 11) separates the cavity for the pedunculate tooth from the resilial complex. The resilium (pl. 117, 8) rests upon an excavated surface, the posterior portions of which are slightly thickened and elevated to form the boundary of the posterior fossa or cavity (pl. 118, 10) which is the interlocking fixture for the posterior tooth of the right valve. Along the posterior dorsal margin of the valve, this fossa has a thickened ridge nominally referred to as the posterior cardinal tooth (pl. 118, 6), but in reality this is not a strong or well developed structure in *gouldiana*. Subtending the resilium is the calcareous lithodesma. In *Pandora claviculata*, the type of *Clidiophora*, there is a particularly well developed and elongate posterior lateral tooth which extends parallel to the posterior dorsal margin of the valve. In the subgenus *Foveadens*, as represented by *Pandora panamensis* Dall from the Eastern Pacific, there is a connective shelf which unites the long posterior lateral cardinal tooth with the posterior dorsal margin to form a hollow structure. While in other groups, notably the South Pacific *Coelodon*,

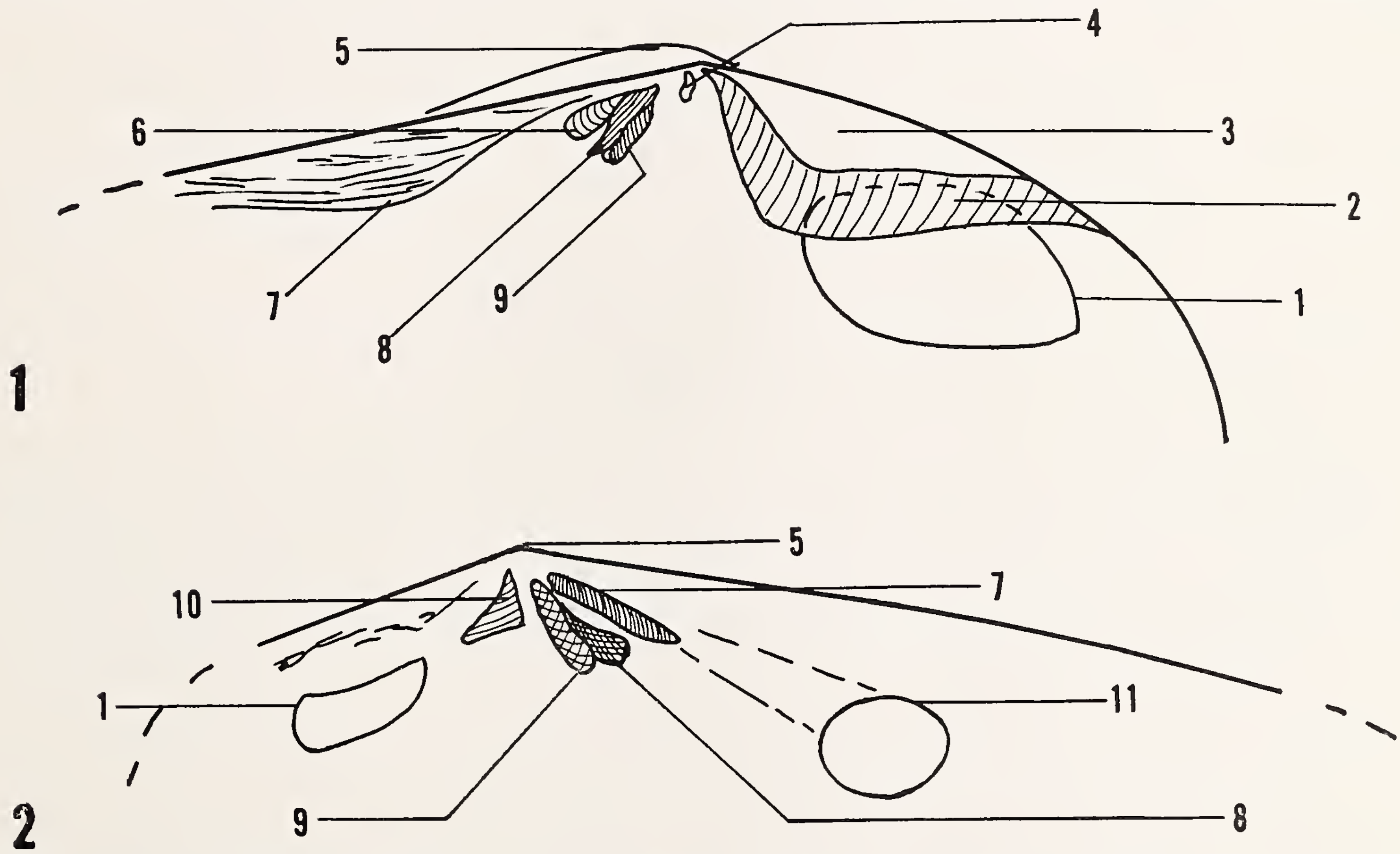

Plate 119. Diagrammatic enlargement of the hinge of *Pandora glacialis* Leach. Fig. 1. Internal view of the left valve. Fig. 2. Internal view of the right valve. 1. Anterior adductor muscle scar. 2. Anterior cardinal tooth. 3. Anterior dorsal margin and ligamental area. 4. Median cardinal tooth. 5. Umbo. 6. Posterior fossa for the intrusion of the posterior cardinal tooth of the right valve. 7. Posterior cardinal tooth. 8. Resilium. 9. Lithodesma. 10. Central pedunculate cardinal tooth. 11. Posterior adductor muscle scar.

as represented by *Pandora ceylanica* Sowerby, this tent-like connective structure occurs between the anterior and medial cardinal teeth.

The dentition of the right valve is characterized by an anterior cardinal tooth (pl. 117, 2) which radiates from the umbo to the dorsal margin of the anterior adductor muscle scar and which is defined by a radial fossa or sulcus which parallels it. In *Pandorella* and *Pandora* s.s. this cardinal tooth is so obscure that it usually is described as being absent, whereas in *Clidiophora* it is more highly developed and distinct and in *Coelodon* the tooth is strong and elevated. Medially there is a strong and central pedunculate cardinal tooth (pl. 117, 3) which is semilunate, subtrigonal, or diamond-shaped in cross section. This tooth appears to be developed in all species. Posterior to the pedunculate cardinal tooth is the resilium (pl. 117, 8) which rests on the excavated anterior under surface of the posterior cardinal tooth (pl. 117, 6). The calcareous lithodesma is attached to the ventral surface of the resilium. The posterior cardinal tooth is variously developed, ranging from a short stubby excrescence as seen in *P. inflata*, new name (=*brevis* Verrill & Bush) to the elongate thickened and strong structure in *P. gouldiana*. In *P. inaequivalvis*, the posterior tooth is obsolete and regarded as completely absent. It is not unusual for a thickened internal riblet to extend from the distal terminus of the posterior cardinal tooth toward the posterior adductor muscle scar.

The dentition is not as well developed in all species as it is in *gouldiana*. For example, in *inaequivalvis*, the left anterior cardinal tooth is somewhat hollowed beneath and buttressed with a ventral flange. The posterior fossa is not developed and no definite posterior tooth may be identified. In the right valve, the anterior cardinal tooth is obsolete, being represented by a feeble ridge, and no vestige of a posterior tooth is evident; only the central pedunculate cardinal tooth is strong and conspicuous. A lithodesma is lacking in *inaequivalvis* and in combination with the reduced dentition, these characters define the nominate subgenus.

ABBREVIATIONS

ANSP	Academy of Natural Sciences of Philadelphia
BCF	Bureau of Commercial Fisheries, Woods Hole, Massachusetts
BMNH	British Museum (Natural History), London
MCZ	Museum of Comparative Zoology
USNM	United States National Museum

The aforementioned abbreviations are used predominantly in the section under each species entitled "specimens examined." We have made a special note of those stations where living specimens were collected by the insertion of "(live)" following the station data. Where no comment is made, the specimens collected were dead.

SYSTEMATIC TREATMENT

Superfamily Anatinacea

Family Pandoridae *Gray* 1847

Description. Shell of small to moderate size, not exceeding 60 mm. in length, crescent-shaped, more or less compressed, inequilateral with the anterior portion short and the posterior long and often rostrate, inequivalve with the left valve usually the more convex and larger and the right valve flattened or somewhat concave. Umbo generally elevated, pointed and often corroded. Hinge complex, with subexternal ligamental portions and an internal resilium, which is sometimes supported by a calcareous lithodesma. Hinge dentition variable but generally the right valve possesses a large pedunculate, central cardinal tooth while the left valve possesses anterior and/or posterior cardinal teeth. Shell generally whitish; external prismatic layer rather easily corroded; internal layer nacreous.

Pandora *Bruguière* 1797

Pandora Bruguière 1797, Encyclopédie Méthodique, Vers Testacés **2**: pl. 250, figs. 1a–c; Lamarck 1799, Mem. Soc. Hist. Nat. Paris, an. vii, p. 88 (type species by subsequent monotypy, Lamarck 1799, *Tellina inaequivalvis* (Linnaeus) 1758), *non* Mühlfeld 1811 (Mollusca), *nec* Eschscholtz 1829 (Ctenophora), *nec* Haliday 1833 (Diptera), *nec* Chevrolat 1834 (Coleoptera), *nec* Westwood 1848 (Lepidoptera), *nec* Koch 1850 (Arachnida), *nec* Sars 1895 (Crustacea).

Calopodium Röding 1798, Museum Boltenianum, 1st Ed., p. 166; 1819, *Ibid.*, 2nd Ed., p. 116 (type species by monotypy, *Calopodium albidum* Röding [= *Tellina inaequivalvis* (Linnaeus) 1758]).

Trutina Brown 1827, Illustrations of the Conchology of Great Britain and Ireland, 1st Ed., pl. 13, fig. 5; 1844; *Ibid.*, 2nd Ed., p. 104, pl. 47, figs. 5, 12 and 13 (type species by monotypy, *Trutina solenoidea* Brown [= *Solen pinna* Montagu 1803 (= *Tellina inaequivalvis* (Linnaeus) 1758)]).

Pandorina Scacchi 1836, Catalogus conchyliorum regni neapolitani, p. 6, *non* Scacchi 1833 (Mollusca), *nec* Bory de St. Vincent 1827 (Protozoa).

The generic name *Pandora* possesses a complex nomenclatorial history and it is hoped that the present treatment may settle some of the discrepancies of the past as well as rule out the possible usage of any junior synonyms. The name originated with Hwass and its introduction dates from Chemnitz (1795) who remarked:

> Der Herr Justissrath Hwass hat aus solchen Tellinen, die oben einen flachen Deckel und unten eine tiefe Unterschale haben, wie *Tellina inaequivalvis*, *crystallina* und andere, ein neu Geschlecht errichtet und es *Pandora* genannt.

Some controversy concerning the appropriate generic name was interjected into the the literature by Prashad (1932) and Winckworth (1934). In 1944, the International Commission of Zoological Nomenclature published Opinion 184 which had the effect of sanctioning the generic names of Chemnitz which occurred in the nonbinomial volumes of the Conchylien-Cabinet. Various authors thereby quoted "*Pandora* Hwass [in] Chemnitz" or merely "*Pandora* Chemnitz" (Hertlein and Strong, 1946; Keen, 1958; Palmer, 1958; Olsson, 1961). Opinion 184 was reversed with the decision to place the first eleven volumes of the first edition of the Neues Systematisches Conchylien-Cabinet of Martini-Chemnitz on the official index of rejected literature. This action rendered *Pandora* Chemnitz unavailable.

Prashad (1932) recognized that the name *Calopodium* Röding 1798 was introduced before Lamarck's usage of *Pandora*. Numerous workers were aware that Bruguière had included *Pandora* without a trivial name in a plate caption in the Encyclopédie Méthodique. For plate 250 of volume 2 of the plates, Sherborn and Woodward (1906) have established the correct date as 1797. Stewart (1930) employed Bruguière's name and, notwithstanding the evidence marshalled by Dodge (1947), the generic name *Pandora* Bruguière 1797 is valid and available according to the International Code of Zoological Nomenclature (1961) (15th Congress), Art. 11 (c) (i) and Art. 16 (a) (vii).[1]

[1] Winckworth (1934) would no doubt have given the same interpretation but was held to Opinion 1 (1907) which eliminates names based on plate captions.

The questions concerning type species and type designations for the genus have been variously interpreted (Palmer, 1958). There are actually numerous subsequent and different type designations for the genus (Schmidt, 1818; Children, 1823; Gray, 1847; Stoliczka, 1871; Kobelt, 1878; Dall, 1903). Lamarck (1799) was the first to use *Pandora* with a specific epithet and an interpretation of the Code shows that *Tellina inaequivalvis* Linnaeus becomes the type species by subsequent monotypy [Art. 68 (a) (ii) (2)].

Röding (1798) introduced *Calopodium* with the single species *albidum*, under which *Tellina inaequivalvis* Linnaeus was given as the only reference. Therefore, *Calopodium albidum* is a junior synonym of *Tellina inaequivalvis* and the generic name *Calopodium* is absolutely synonymous with *Pandora*.

Subgenus **Clidiophora** *Carpenter*

Clidiophora Carpenter 1864, Proc. Zool. Soc. London, p. 576 (type species, by original designation, *Clidiophora claviculata* Carpenter 1855 [=*Pandora arcuata* Sowerby 1830]).

Clidiphora 'Carpenter' Johnson 1934, Proc. Boston Soc. Nat. Hist. **40** (1): 31, error for *Clidiophora* Carpenter.

According to Dall (1903), *Clidiophora* is characterized by three teeth in the left valve, the posterior of which is much elongated and by three teeth in the right valve, the anterior of which is weak. A lithodesma, subtending the internal resilium, is present.

Clidiophora is represented by three species in the Western Atlantic. The type of the subgenus is found in the Eastern Pacific and possesses an unusually elongate posterior cardinal tooth in the left valve. None of the Western Atlantic species possesses such a highly developed right posterior cardinal tooth. The diagnostic traits which separate this subgenus from *Pandorella* include the nature of the left and right anterior cardinal teeth. In the right valve, the anterior cardinal tooth is weak and obsolete, but nevertheless a definitive structure may be discerned extending from the umbonal area to the dorsal margin of the anterior adductor muscle scar. The right posterior cardinal tooth is somewhat diagnostic since it is more elongate and stronger than the homologous structure in *Pandorella*. Most important, and perhaps the most easily detected, diagnostic trait is the left anterior cardinal tooth which extends more or less perpendicularly to the antero-posterior axis of the shell (that is, it is more or less parallel to the dorso-ventral axis). In *Pandorella* this structure is not aligned in a dorso-ventral direction. In *Pandora s.s.* the tooth is coalesced with the anterior dorsal margin and a lithodesma is absent (see pls. 118 and 119, 1).

Pandora (Clidiophora) gouldiana *Dall*

Plate 120, figs. 3–4; Plate 121, fig. 4; Plate 122, figs. 5–6

Pandora trilineata 'Say' Conrad 1831, Amer. Marine Conch., p. 49, pl. 11, figs. 1–2; Russell 1839, Jour. Essex County Nat. Hist. Soc. **1**(2): 54; Gould 1841, Invert. Mass., 1st Ed., p. 44; DeKay 1843, Nat. Hist. N.Y. **5**: 239, pl. 33, figs. 310 a–b; Mighels 1843, Boston Jour. Nat. Hist. **4**: 314; Stimpson 1851, Shells New England, p. 23; Binney 1870 [in] Gould, Invert. Mass., 2nd Ed., p. 62, fig. 379; Perkins 1869, Proc. Boston Soc. Nat. Hist. **13**: 143; Tryon 1874, Amer. Marine Conch., p. 136, pl. 18, figs. 305–7; Apgar 1891, Jour. New Jersey Nat. Hist. Soc. **2**(2): 108; Morse 1919, Proc. Boston Soc. Nat. Hist. **35**(5): 160–1, fig. 17, *non* Say 1822.

Pandora (*Clidiophora*) *gouldiana* Dall 1886, Bull. Mus. Comp. Zool. **12**: 312; 1889, Bull. 37, United States Nat. Mus., p. 68, pl. 59, fig. 14; 1902, Proc. United States Nat. Mus. **24**: 511, pl. 32, fig. 7 (type locality, Woods Hole, Mass.; holotype, USNM 95490).[1]

Pandora (*Clidiphora*) *gouldiana* Dall, Johnson 1934. Proc. Boston Soc. Nat. Hist. **40**(1): 31, error for *Clidiophora* Carpenter.

Plate 120. Figs. 1 and 2. *Clidiophora inornata* Verrill and Bush 1898 [=*Pandora* (*Clidiophora*) *inornata*]. USNM 49760, *Speedwell*, Station 327, off Cape Cod, south end of Stellwagen Bank, in 17 fathoms. Fig. 1. External view of the left valve of a syntype (4.7x). Fig. 2. External view of the right valve of a syntype (4.7x). Figs. 3 and 4. *Pandora* (*Clidiophora*) *gouldiana* Dall 1886. USNM 95490, Woods Hole, Massachusetts. Fig. 3. External view of the left valve of the holotype (2.6x). Fig. 4. External view of the right valve of the holotype (about 2.4x).

Description. Shell extending to 35 mm. in length (about $1\frac{1}{2}$ inches) and to 27 mm. in height (about 1 inch), somewhat compressed, thin or subsolid to solid in large adults, inequilateral, inequivalve with the left valve of a weak convexity and with the right valve more or less flattened but often centrally a little convex and weakly swollen. Umbos in the anterior third of the shell, elevated, pointed and conspicuous. Anterior margin somewhat broadly rounded and distinctly separated from the ventral margin at the terminus of the anterior radial sulcus; ventral margin convex, rising behind and slightly indented beneath the rostrum; anterior dorsal margin straight to convex, smoothly confluent with the anterior margin in adults but generally well differentiated in youthful stages; posterior dorsal margin long, concave and rising posteriorly to form a rostrum; posterior margin very short and more or less oblique to the dorso-ventral axis of the shell. In the left valve, there is at least one strong posterior radial ridge extending from the umbo to the base of the posterior margin and usually another more dorsal ridge is found with a

[1] Dall noted that what numerous New England authors had been calling *trilineata* Say was truly a species hitherto undescribed and that true *trilineata* Say was a form with a more southerly range. Dall very briefly described *gouldiana* in a footnote in the *Blake* report and then later figured it.

sulcus between the ridges; these ridges generally define the rostrum. An anterior radial sulcus extends in a nearly straight line, dorso-ventral fashion from the umbo to the place where the ventral margin and the anterior margin are confluent; this sulcus sharply delimits the two margins. In the right valve a weak posterior radial sulcus extends from the umbo to the base of the posterior margin just ventral to the posterior dorsal margin. Concentric sculpture evident on the left valve as irregular, coarse undulations. Radial lines may be evident on the right valve. Hinge generally stout, strong and well developed; resilium with a lithodesma. In the left valve, the anterior cardinal tooth dorsoventrally straight to arcuate, separate from the anterior dorsal margin; central tooth short, small and obsolete; resilium long, resting in a depression which is thickened along its sides; posterior cardinal tooth consists of a mere thickening of the hinge line. In the right valve, the posterior cardinal tooth is strong, acutely subtrigonal, and the resilium rests in a fossa along its anterior surface; central pedunculate tooth elongate to sublunate; anterior tooth more or less obsolete and weak, grooved behind and extending from the umbonal region directly to the dorsal boundary of the anterior adductor muscle scar. Muscle scars rounded and well impressed. Pallial sinus consisting of small individual scars extending between the anterior and posterior adductor muscle scars. Color white, powdery to shining externally, nacreous internally.

length	height	width	
28.5 mm.	19.5 mm.	4.0 mm.	Holotype of *gouldiana* Dall
34.3	21.4	5.8	Duxbury, Mass.
32.6	22.0	7.0	Harpswell Island, Maine
32.3	26.1	6.6	off Wellfleet, Massachusetts Bay
29.0	18.4	5.2	Winthrop, Mass.
27.4	16.9	4.5	Woods Hole, Mass.
22.7	13.3	2.6	" " "
18.9	12.4	2.4	off Block Island, Mass.
15.3	8.5	2.0	" " " "
9.4	4.7	1.1	Long Island, New York

Remarks. *Pandora gouldiana* appears to be one of the most common *Pandora* of the Western Atlantic and it is often encountered as a conspicuous element in the littoral fauna of New England. It has been recorded in numerous faunal lists and some literature concerning its natural history is available. Early New England authors confused this northern species with the slender and elongate allopatric southern species *Pandora trilineata* Say. The latter is distinctly the closest ally of *gouldiana* and as Jacot (1921) and Richards (1936) have indicated, there is some doubt about the specific identity of each. The primary distinguishing trait which separates *gouldiana* from *trilineata* is in the proportion of the shell. The length-height ratio in *trilineata* is greater than it is in *gouldiana;* that is, *trilineata* is more elongate and narrow whereas *gouldiana* tends to be more quadriform or subrectangular. The posterior rostrum in *trilineata* is therefore more conspicuous and distinct while in *gouldiana* the rostrum is short, tending toward bluntness. The height of the valve just anterior to the beginning of the rostrum is greater in *gouldiana* and, in point of fact, the ventral margin tends to be convex and expanded in this region. On the contrary, *trilineata,* is narrowed posteriorly, the ventral margin rising more abruptly and the shell height contracted. It may be said that *gouldiana* is coarsely sculptured with undulations in the left valve and that the shell appears to be thicker and heavier than its southern counterpart which has been called the "elegant, slender" species. *Pandora gouldiana* and *trilineata* appear to be allopatric but in contradiction to Dall (1903), *trilineata* does range north of Cape Hatteras and has been represented in numerous samples taken in Chesapeake Bay.

Another close relative of *gouldiana* is the sympatric species *inornata*, which lacks the definitive posterior radial ridges. A full account of the differences separating *gouldiana* and *inornata* is given under 'Remarks' in *inornata*.

The range of variation exhibited by *gouldiana* is particularly important in regard to dental configuration. The anterior laminate cardinal tooth of the left valve is normally perpendicular or in alignment with the dorso-ventral axis of the shell and further it is generally widely separated from the anterior dorsal margin; however, in some individuals such a configuration does not always obtain and this cardinal tooth may become arcuate and extend quite close to the anterior dorsal margin, although always being distinctly separated from it. The terminus of the tooth may or may not be contiguous with the dorsal aspect of the anterior adductor muscle scar. Such conditions point out more than the relative instability of dental morphology in a single species; they show that the rudiments of subgeneric classification rest upon weak fundamentals and that the subgeneric taxonomy of the whole family becomes open to circumspection.

The questionable value of subgeneric traits is further made apparent when the radial lines on the external surface of the right valve are considered. These structures in *gouldiana* link it, as a member of *Clidiophora*, with *Pandorella* (=*Kennerlia*). The dental structure of *Clidiophora*, as exhibited by *gouldiana*, is slightly more complex in being thickened and more heavily expressed, but fundamentally quite similar to that of *Pandorella*.

According to Perkins (1869), *gouldiana* is abundant in muddy substrates at shallow depths in Long Island Sound. Apgar (1891) recorded the species along the coast of New Jersey where it was found in sand and mud; and Sumner, Osburn and Cole (1913) charted its occurrence and listed it as one of the commonest mollusks in Buzzards Bay and Vineyard Sound. In the Woods Hole vicinity, specimens were found living in from 3 to 19 fathoms, predominantly in mud, sand or muddy-sand substrates, although it was mentioned that specimens were sometimes found on gravelly substrates. We have taken *gouldiana* in considerable numbers on the pebbly bottom off Block Island, and at numerous stations along the middle Atlantic in a variety of bottom substrates. A tabulation of specimens obtained in the living state shows that the species may be found in depths down to 100 fathoms. Gould (1841) mentioned that it is often encountered nestling among and upon oysters.

Perkins (1869) and Morse (1919) have discussed briefly some aspects of the anatomy of *gouldiana*. The former mentions that the individuals are filled with ova in April and May; and Sullivan (1948), who unfortunately could not observe the larva, showed that the prodissoconch is very long in proportion to its height. Observations on the eggs of *gouldiana* have been given earlier (see page 185). The species is hermaphroditic and spawning occurs in late spring or early summer. The trochophore and veliger periods are probably short (Allen, 1961). For a discussion of the gross morphology of this species, see the anatomical notes (pl. 115).

The fossil history of *gouldiana* is extensive. An immediate precursor which is found in the Miocene is *Pandora crassidens* Conrad with its contemporaneous related forms *Pandora crassidens majorina* Gardner and *Pandora prodromos* Gardner and Aldrich. Gardner (1943) has given a thorough discussion of the morphological interrelationships among these fossils, all of which may be construed as belonging to the lineage of the modern species *gouldiana*. From the Pliocene of Florida, Olsson and Harbison (1953) have identified *crassidens*, and from the Pleistocene, Blake (1953) and Richards (1962) have listed localities in Massachusetts, New Jersey, and Maryland for *gouldiana*.

Range. This species has been found in Canadian waters as far north as Gaspé, Quebec and is commonly encountered southward along the Atlantic coast to Cape Hatteras, North Carolina in depths to 100 fathoms.

Specimens examined. QUEBEC: Gaspé (USNM). NEW BRUNSWICK: Escuminac Point; Sand Island (both USNM). PRINCE EDWARD ISLAND: Malpeque Bay (live) (MCZ); Cape Egmont (live) (USNM). CAPE BRETON ISLAND: Eastern Harbour, Cheticamp, in 2–4 fathoms (USNM). NOVA SCOTIA: Macoun, in 5–13 fathoms (USNM); Banquereau Bank, in 80 fathoms (live) (MCZ); Digby (USNM). MAINE: St. Croix River (MCZ); Frenchman's Bay (live) (MCZ); Blue Hill Bay; Penobscot Bay; Bakers Island, in 20 fathoms (live) (all USNM); North Haven (live) (MCZ); west side of Harpswell Island (USNM); Eastern Point, west side of Chebeague Island (live); High Pine Ledge (live) (both MCZ); *Bache*, Station 42B, 6 miles SE of Boon Island (43°05′ N; 70°28′ W), in 68 fathoms (live) (USNM). MASSACHUSETTS: Tillies Bank, in 78 fathoms (live); Marblehead (live); Swampscott (all MCZ); Winthrop; Chelsea (both USNM); Stellwagen Bank (live); Garnet Ledge, Duxbury (live) (both MCZ); Eastham (live) (MCZ); Cape Cod Bay, 8 miles off Wellfleet, in 15 fathoms (live); Truro (both USNM); Provincetown (live); Dennisport (live); Poponesset Beach, Mashpee (live) (all MCZ); Woods Hole (live); *Fish Hawk*, Station 1211, north end of Woods Hole, in 6–8½ fathoms; off North Falmouth, in 6 fathoms (live) (all USNM); *Asterias*, Station E, Buzzards Bay (live) (BCF); New Bedford; *Blake*, Station 308, 200 miles E of Cape Cod (41°24′ N; 65°35′ W), in 1242 fathoms (both USNM); *Albatross* III, cruise 101, Station 89, central Georges Bank (41°29′ N; 67°28′ W), in 23 fathoms (BCF); East Georges Bank (41°20′ N; 66°50′ W), in 37 fathoms (in fish stomach) (MCZ); *Fish Hawk*, Station 1240, SSE of Gayhead Light, in 18½ fathoms (USNM); off Gay Head, in 75–100 fathoms (live) (MCZ); *Albatross* III, cruise 70, Station 4, 60 miles E of Nantucket (41°06′ N; 68°38′ W), in 26 fathoms; *Albatross* III, cruise 70, 17 miles SE of Nantucket (41° 01′ N; 69°42′ W), in 20 fathoms (both BCF). RHODE ISLAND: Tiverton; Sakonett River, 6 miles S of Tiverton, in 2–3 fathoms (live) (both MCZ); *Fish Hawk*, Stations 786 and 787, off Newport, in 19 fathoms (live) (USNM); Watch Hill; off Block Island (live) (both MCZ); *Delaware*, cruise 62-7, Station 62, 12 miles SE of Block Island (41° 01′ N; 71°19′ W), in 29 fathoms (live, with eggs, June 19, 1962); *Delaware*, cruise 62-7, Station 64, 14 miles S of Block Island (41°00′ N; 71°30′ W), in 30 fathoms (both BCF). CONNECTICUT: Long Island Sound, off Stonington (live); off Fishers Island, 6 miles S of New London (live) (both MCZ); *Bluelight*, Station 423, Fishers Island Sound, in 17 fathoms; *Fish Hawk*, Station 1624, 3 miles S of Bridgeport, in 5 fathoms (live) both USNM). NEW YORK: Peconic Bay, Long Island (USNM); *Delaware*, Station 2–1, alt. tow 53, 7 miles SE of Montauk Point, Long Island (40°58′ N; 71°44′ W), in 26 fathoms (live); Northport, Long Island (both MCZ); Hempstead Harbor, Long Island (USNM); Coney Island; *Delaware*, Station 3–2, alt. tow 38, 19 miles SE of Moriches Inlet (39°49′ N; 72°57′ W), in 36 fathoms (live) (both MCZ). NEW JERSEY:

Delaware, Station 3–2, alt. tow 33, 40 miles E of Barnegat Inlet (39°39′ N; 73°12′ W), in 22 fathoms (live); *Delaware*, Station 3, tow 3, 65 miles E of Atlantic City (39°08′N; 73°08′ W), in 40 fathoms (all MCZ); Cape May (USNM); *Delaware*, Station 4–3, alt. tow 27, 75 miles E of Cape May (38°52′ N; 73°23′ W), in 36 fathoms (live) (MCZ). Delaware: Lower Middle Shoal, Delaware Bay, in 3 fathoms (live); off Lewes, in 3½ fathoms (live) (both USNM); *Delaware*, Station 4–3, alt. tow 24, 69 miles E of Indian River Inlet, (38°32′ N; 73°31′ W), in 46 fathoms (live) (MCZ). Maryland: *Delaware*, Station 4–5, alt. tow 1, 47 miles E of Ocean City (38°04′ N; 74°06′ W), in 41 fathoms (live) (MCZ). Virginia: *Delaware*, Station 5–4, alt. tow 20, 48 miles E of Assateague Cove (37°50′ N; 74°23′ W), in 35 fathoms (live); *Delaware*, Station 5, tow 3, 49 miles E of Metomkin Inlet (37°39′ N; 74°23′ W), in 40 fathoms (live); *Delaware*, Station 6–5, alt. tow 17, 56 miles E of Cape Charles (37°05′ N; 74°48′ W), in 34 fathoms (live); *Delaware*, Station 6, tow 3, 60 miles E of Cape Henry (36°51′ N; 74°45′ W), in 40 fathoms (live); *Delaware*, Station 6–7, alt. tow 5, 53 miles E of False Cape (36°44′ N; 74°48′ W), in 35 fathoms (all MCZ). North Carolina: *Delaware*, Station 8–7, alt. tow 11, 23 miles E of Bodie Island (35°59′ N; 75°04′ W), in 18 fathoms (live); *Delaware*, Station 7–8, alt. tow 8, 31 miles E of Bodie Island (35°54′ N; 74°55′ W), in 36 fathoms (live) (both MCZ).

Pandora (Clidiophora) trilineata *Say*

Plate 121, figs. 1–3

Pandora trilineata Say 1822, Jour. Acad. Nat. Sci. Philadelphia, 1st Ser., **2**: 261; 1830, American Conchology, pl. 2 (Great Egg Harbor, New Jersey; types not seen, not in ANSP).

Pandora nasuta Sowerby 1830, Species Conchyliorum, *Pandora*, pl. 1, figs. 18, 19 (locality unknown; types not seen).

Clidiophora trilineata Say. Carpenter 1864, Proc. Zool. Soc. London, p. 597.

Clidiophora nasuta Sowerby. Carpenter 1864, Proc. Zool. Soc. London, p. 597.

Pandora (*Clidiophora*) *trilineata* Say. Dall 1886, Bull. Mus. Comp. Zool. **12**: 311.

Pandora (*Clidiophora*) *floridana* Dall 1886, Bull. Mus. Comp. Zool. **12**: 312 [*nomen nudum*].

Pandora (*Clidiphora*) *trilineata* Say. Johnson 1934, Proc. Boston Soc. Nat. Hist. **40**(1): 31, error for *Clidiophora* Carpenter.

Description. Shell extending to 30 mm. in length (about 1¼ inches) and to 14 mm. in height (about ⅝ inch), somewhat compressed, subsolid, inequilateral, inequivalve with the left valve overlapping the right ventrally, but both valves are weakly convex. Umbos in the anterior fourth or fifth of the valve, elevated, pointed and conspicuous. Anterior margin broadly convex, markedly distinguished from the ventral margin at the anterior radial sulcus; ventral margin smoothly rounded, convex, rising behind, slightly indented and contracted beneath the rostrum. Anterior dorsal margin short, straight to concave, generally not smoothly confluent with the anterior margin in young individuals; posterior dorsal margin elongate, concave and arcuate; posterior margin very short, forming the pointed terminus of the rostrum. In the left valve, two strong radial ridges with an intermediate sulcus extending from the umbo posteriorly; these ridges define the rostrum behind; an anterior radial sulcus extends in a dorso-ventral arcuation and delimits ventrally the confluence of the anterior and ventral margins. In the right valve, two radial and concomitant sulci extend posteriorly from the umbo; anterior radial sulcus arcuate and more or less obscure. Concentric sculpture consisting of irregular and weak lirations; the valves generally appear to be smooth. Hinge with an internal resilium and lithodesma. In the left valve, the dentition consists of an anterior lateral tooth which is strong and extends parallel to the dorso-ventral axis, of a weak rib-like central tooth and of an obsolete posterior tooth. In the right valve, the dentition consists of an obsolete straight anterior ridge-like tooth, a central thickened pedunculate tooth and a long thin posterior tooth on the under surface of which rests the resilium. Adductor muscle scars rather large, rounded and well impressed. Pallial sinus consists of irregular individual scars extending between the anterior adductor and posterior adductor muscle scars. Shell white, sometimes vitreous and transparent; nacreous internally.

Plate 121. Figs. 1, 2 and 3. *Pandora (Clidiophora) trilineata* Say 1822. USNM 61028, Tampa, Florida, in 6 fathoms. Fig. 1. Internal view of the right valve (about 3.8x). Fig. 2. Internal view of the left valve (about 3.8x). Fig. 3. External view of the left valve (about 4.5x). Fig. 4. *Pandora (Clidiophora) gouldiana* Dall 1886. Internal view of the left valve of a paratype, USNM 95490, Woods Hole, Massachusetts (about 2.4x). (Specimen sprayed with ammonium chloride vapor.)

length	height	width	
19/20 in.	9/20 in.	??	Holotype of *trilineata* Say (original measurements)
29.3 mm.	13.8 mm.	—	Pensacola, Florida
23.6	10.6	1.9 mm.	*Eolis*, Station 21, off Beaufort, North Carolina
19.9	8.9	1.9	Tampa, Florida
17.9	7.8	1.7	" "
14.8	5.8	1.4	Matagorda Bay, Texas
14.1	6.6	1.6	*Fish Hawk*, Station 8338, off Butler's Bluff, Chesapeake Bay
11.0	5.1	1.3	Carancahua Bay, Texas

Remarks. The original citation of localities by Say included the specific locality, Great Egg Harbor, New Jersey, as well as the general locality "the coast of Georgia and East Florida." The specimen figured is the elongate, slender species which is found in the south but not in the north. The differences between northern and southern species were detected by Gould, who suggested that Say's figure was incorrect in its representation of the species in Massachusetts. Dall recognized that a subrectangular, more roughly sculptured species inhabited northern waters while a sharply rostrate, narrowly arcuate species was found in the south.

Today the close propinquity of *trilineata* and *gouldiana* is recognized. A full account of the differences which serve to distinguish these species has been given under Remarks on *gouldiana* (see p. 192).

The separation of these two closely related species in their allopatric distributions may be dated from the Miocene. Gardner (1943) has discussed the *Clidiophora* of the Miocene and Pliocene formations and has shown that *Pandora toumeyi* Gardner and Aldrich appears to be an early representative in the lineage of *trilineata*. Dall (1903) gives a number of Miocene, Pliocene and Pleistocene localities for *trilineata* and its precursors. Maury (1920) has listed this species in the Pleistocene near New Orleans, and Richards (1962) has given a number of Pleistocene localities along the Atlantic coastal plain. The consolidation of the dentition into more definitive structures and into more stable configurations appears to be a trend in the evolution of this species since the Miocene.

Pandora trilineata is found in shallow waters from 1 to 24 fathoms, most often in mud substrates, but the species also occurs in sandy bottoms and even in shell-gravel substrates. Parker (1956, 1959) and Ladd (1951) have shown that the species appears to be most abundant in conditions of high salinities in the passes and protected bays along the Texas coast.

Range. *Pandora trilineata* is found north of Cape Hatteras as far as Chesapeake Bay. It occurs south through Florida and in the Gulf of Mexico to Port Aransas in western Texas.

Specimens examined. Virginia: *Fish Hawk*, Station 8595, Chesapeake Bay, in 12 fathoms; *Fish Hawk*, Station 8338, off Butler's Bluff, Chesapeake Bay, in $3\frac{3}{4}$ fathoms; *Fish Hawk*, Station 8500, off Cape Henry, Chesapeake Bay, in 9 fathoms (all USNM); *Delaware*, Station 6, tow 2, 50 miles E of Cape Henry (36°53′ N; 74°59′ W), in 20 fathoms (MCZ). North Carolina: *Delaware*, Station 8–7, alt. tow 10, 35 miles NE of Cape Hatteras (35°32′ N; 74°57′ W), in 24 fathoms (live); *Delaware*, Station 8, tow 1, 18 miles NE of Cape Hatteras (35°24′ N; 75°12′ W), in 14 fathoms (live) (both MCZ); *Albatross* I, Station 2597, 20 miles E of Swash Inlet, between Cape Hatteras and Cape Lookout (34°57′ N; 75°43′ W), in 15 fathoms; shoals west of Pivers Island (near Beaufort); *Eolis*, Station 21, off Beaufort, in 6–9 fathoms; *Albatross* I, Station 2619, 25 miles SE of Cape Fear (33°38′ N; 77°36′ W), in 15 fathoms (all USNM). South Carolina: Charleston (MCZ); Beaufort (USNM). Florida: Manatee River; $3\frac{3}{4}$ miles SSW off Longboat Pass, Manatee County, in 6 fathoms (both USNM); Tampa Bay (live) (MCZ); Tampa, in 6 fathoms (USNM); Pensacola (MCZ; USNM). Texas: Galveston (MCZ); Matagorda Bay; Carancahua Bay; Pass Cabello, Matagorda Island (all USNM); Port Aransas (MCZ).

Pandora (Clidiophora) inornata *Verrill and Bush*

Plate 120, figs. 1–2

Clidiophora inornata Verrill and Bush 1898, Proc. U.S. Nat. Mus. **20:** 819, pl. 95, figs. 5 and 6 (*Speedwell*, Station 327, off Cape Cod, south end of Stellwagen Bank, in 17 fathoms; syntypes, USNM 49760).

Pandora (*Clidiophora*) *inornata* Verrill and Bush. Johnson 1915, Occ. Pap. Boston Soc. Nat. Hist. **13:** 38.

Pandora (Clidiphora) inornata Verrill and Bush. Johnson 1934, Proc. Boston Soc. Nat. Hist. **40**(1): 31 [error for *Clidiophora* Carpenter].

Description. Shell extending to 19 mm. in length (about $\frac{3}{4}$ inch) and to 12 mm. in height (about $\frac{1}{2}$ inch), elongate, rostrate posteriorly and rounded anteriorly, inequilateral, inequivalve with the left valve convex and the right valve more or less flattened. Umbos in the anterior third of the shell blunt, rounded and inflated in the left valve. Anterior margin broadly rounded and smoothly confluent with the ventral margin; ventral margin gently convex, rising and straight to indented behind; anterior dorsal margin convex and smoothly confluent with the anterior margin; posterior dorsal margin long and slightly concave; posterior margin short and more or less straight and forming an oblique truncation. In the left valve, two weak, divaricating, external, radial ridges posteriorly, the ventral ridge the stronger, and with a weak sulcus separating it from the dorsal ridge. Anterior radial sulcus in the left valve weak, not disrupting the ventral contour of the shell but delimiting the confluence of the anterior margin and the ventral margin. Concentric sculpture weak; coarse growth rings strongly evident, particularly on the left valve. Hinge with a lithodesma, an internal resilium and external ligament. Dentition of the left valve with a strong, thickened anterior cardinal tooth with an excavation above; central cardinal tooth small but developed; posterior lateral tooth consists of a subproximal thickening of the hingeline. Dentition of right valve with a strong, elongate posterior cardinal tooth and a central thickened sublunate, pedunculate cardinal tooth; anterior cardinal tooth consists of an obscure thickening, extending from the umbo to the anterior adductor muscle scar. Adductor muscle scars well impressed, moderately large, subrhomboid to elongate-ovate in shape. Pallial sinus consisting of irregular, individual scars extending between the anterior and posterior adductor muscle scars. Shell white, internally nacreous, externally dirty-white to a light brown and somewhat glabrous.

length	height	width	
16.7 mm.	10.1 mm.	3.4 mm.	Syntype of *inornata* Verrill and Bush
18.8	11.6	3.6	*Speedwell*, Station 251, off Race Point Light
18.5	12.0	4.0	" " " " " " "
15.1	10.1	3.8	" " " " " " "
12.0	6.9	2.2	*Bache*, Station 33B, Stellwagen Bank
11.3	6.7	2.0	*Speedwell*, Station 327, S end of Stellwagen Bank
10.2	5.2	1.7	*Speedwell*, Station 251, off Race Point Light

Remarks. Pandora inornata is a comparatively rare species of limited geographical distribution. It is easily confused with its close ally, *P. gouldiana* Dall, and, for this reason, has often remained undetected in collections. Both *inornata* and *gouldiana* belong to the subgenus *Clidiophora*, but *inornata* is much more stable in its traits and its range of variation is not as great as that of *gouldiana. Pandora inornata* is thicker, more heavily shelled in its youthful stages, stronger, more solid, of a smaller maximum size, of lower proportionate height, and of a less intense nacreous interior. Such traits are difficult to quantify but a closer examination of specimens usually suffices to distinguish each species.

The left anterior cardinal tooth in *inornata* is arcuate and thickened proximally; this tooth terminates distally at or near the uppermost portion of the anterior adductor muscle scar where it forms a weak ridge extending out to the border of the valve; the anterior adductor muscle scar therefore appears to be deeply impressed. In *gouldiana*, the anterior cardinal tooth generally descends along the dorso-ventral axis from the umbonal region; however, in the range of variation some specimens of *gouldiana* have an arcuate anterior cardinal tooth but its terminus is more distinct than the homologous structure in *inornata* and there does not appear to be ridge-like extensions of the tooth to the border of the valve. The anterior adductor muscle scar in such specimens of *gouldiana* does not appear to be so strongly impressed.

The anterior dorsal margin of *inornata* tends to be convex, rounded and more or less smoothly confluent with the anterior margin. In contrast, the anterior dorsal margin of *gouldiana* is usually straight or slightly concave and there is a slight flaring rather than a smooth confluence where this margin meets the anterior margin. A definitive ventral ridge and supernumerary ridges are lacking in *inornata* while along the posterior dorsal margin in *gouldiana* there is a double ridge—a strong ventral one which runs completely to the posterior ventral angulation and defines the posterior rostration, and a weaker somewhat obsolete dorsal one. Between these ridges in *gouldiana* there is a depression or weak sulcus.

Range. This species is localized and restricted in distribution from below Nova Scotia to the southern part of Cape Cod and has been taken alive in depths to 35 fathoms.

Specimens examined. Nova Scotia: 14 miles S of Cape Sable, in 45 fathoms (MCZ). Massachusetts: Jeffries Ledge, in 35 fathoms (live); off Duxbury, in 18 fathoms (live); Stellwagen Bank, in 23 and 35 fathoms (live) (all MCZ); *Bache*, Station 33B, Stellwagen Bank (42°20′ N; 70°18′ W), in 22 fathoms (live); *Speedwell*, Station 327, S end of Stellwagen Bank (42°11′ N; 70°12′ W), in 17 fathoms (live) (both USNM); *Gosnold*, Station 1209, S end of Stellwagen Bank (42°10′ N; 70°14′ W), in 20 fathoms (live) (BCF); *Speedwell*, Station 251, $6\frac{3}{4}$ miles off Race Point Light (42°10′ N; 70°10′ W), in 24 fathoms (live) (USNM). *Jenni B*, Stations (035° true north from Provincetown monument) 37, in 14 fathoms (live); 17, in 24 fathoms (live); 19, in 30 fathoms; *Jacqueline*, Stations (064° true north from Cape Cod Light) 33, in 37 fathoms; 6, in 21 fathoms (all BCF); *Fish Hawk*, Station 964, 5 miles SE of Chatham, in 10 fathoms; *Speedwell*, Station 367, $5\frac{1}{2}$ miles ESE of Chatham (41°38′ N; 69°49′ W), in 12 fathoms (live); *Fish Hawk*, Station 978, 6 miles ESE of Chatham, in 17 fathoms (live); *Fish Hawk*, Station 981, 16 miles ESE of Chatham Light, in 43 fathoms (all USNM).

Subgenus **Pandorella** *Conrad*

Pandorella Conrad 1863, Proc. Acad. Nat. Sci. Philadelphia, for 1862, p. 572 (type species, by monotypy, *Pandora arenosa* Conrad 1834), *non* Laseron 1951.

Kennerlia Carpenter 1864 (Aug.), Brit. Assn. Adv. Sci. Report for 1863, pp. 602 and 638; 1864 (Nov.). Proc. Zool. Soc. London, p. 602 (type species, by subsequent designation, Stoliczka 1871, p. 61, *Pandora Kennerlia bicarinata* Carpenter 1864 [=*Pandora* (*Kennerlia*) *bilirata* Conrad 1855]).

Kenerlia Carpenter. Paetal 1875, Fam. Gatt. Moll., p. 103 [error for *Kennerlia* Carpenter].

Kennerleya Carpenter. Fischer 1887, Manuel de Conchy., p. 1158 [emend. for *Kennerlia* Carpenter].

Kennerleyia Carpenter. Dall 1903, Trans. Wagner Free Inst. Sci., Philadelphia **3**(6): 1517 [emend. for *Kennerlia* Carpenter].

Kennerlyia Carpenter. Dall 1915, Proc. U.S. Nat. Mus. **49**: 448 [error for *Kennerlia* Carpenter].

Panderella Conrad. Palmer 1958, Memoir 76, Geol. Soc. Amer., p. 76 [error for *Pandorella* Conrad].

Vokes (1956) has documented the usage of *Pandorella* and has shown that it is a senior synonym of *Kennerlia*. Palmer (1958), Keen (1958), and Olsson (1961) have adopted the subgeneric name *Pandorella* to replace the previously widely employed *Kennerlia*. According to Dall (1903), the characters which typify the subgenus *Pandorella* (=*Kennerlia*) include the presence of radial lines on the external surface of the right valve and an internal lithodesma or calcified supporting structure attached to the base of the resilium. Further, the dental configuration is typified by an obsolete right anterior cardinal tooth and a left anterior cardinal tooth which is adpressed to or coextensive with the anterior dorsal margin of the valve.

This subgenus, although widely distributed in the northern hemisphere, is particularly well developed in the Western Atlantic and Eastern Pacific areas. Its origin is apparently dated from the Miocene of North America.

Pandora (Pandorella) arenosa *Conrad*

Plate 122, figs. 1–2; Plate 125, fig. 3

Pandora arenosa Conrad 1834, Jour. Acad. Nat. Sci. Philadelphia, 1st Ser. **7**(1): 130–131; 1838, Fossils of medial Tertiary, p. 2, pl. 1, fig. 3 (Yorktown [Miocene], Virginia; syntypes, ANSP 30584).

Myadora arenosa Conrad 1848, Proc. Acad. Nat. Sci. Philadelphia (for 1846) **3**: 21.

Pandorella (*Pandora*) *arenosa* Conrad 1863, Proc. Acad. Nat. Sci. Philadelphia (for 1862), 2nd Ser. **6**: 572.

Pandora oblonga 'Sowerby' Dall 1881, Bull. Mus. Comp. Zool. **9**: 109, *non* Sowerby 1830.

Pandora sp. Bush 1885, Report U.S. Comm. Fish and Fisheries for 1883, p. 86.

Pandora carolinensis Bush 1885, Trans. Conn. Acad. **6**(2): 474 (USFC *Albatross* I, Station 2113, off Cape Hatteras, North Carolina, in 15 fathoms; holotype, USNM 35701).

Pandora carolininensis Bush. Dall 1885, Bull. U.S. Geol. Sur., no. 24, p. 213 (error for *carolinensis* Bush).

Pandora (*Clidiophora*) *carolinensis* Bush. Dall 1886, Bull. Mus. Comp. Zool. **12**(6): 311, pl. 8, figs. 8–8a.

Pandora (*Kennerleyia*) *arenosa* Conrad. Dall 1903, Trans. Wagner Free Inst. Sci. Philadelphia **3**(6): 1518.

Pandora (*Kennerleya*) *arenosa* Conrad. Maury 1920, Bull. Amer. Paleo. **8**(34): 40.

Pandora (*Kennerlia*) *arenosa* Conrad. Johnson 1934, Proc. Boston Soc. Nat. Hist. **40**(1): 31; Gardner 1943, Geol. Sur. Prof. Paper 199-A, p. 45, pl. 10, figs. 16, 19, 20.

Pandora (*Pandorella*) *arenosa* Conrad. Olsson 1961, Panamic-Pacific Pelecypoda, Ithaca, N.Y., p. 454.

Description. Shell extending to 20 mm. in length (about 4/5 inch) and to 12 mm. in height (about 1/2 inch), subelliptical, solid, inequilateral and inequivalve with the left valve markedly convex and the right valve weakly concave. Umbos far anterior, in the anterior fifth of the total shell length, weakly pointed and prosogyrous. Anterior margin narrowly rounded, uniting in an indentation with the ventral margin at the anterior radial sulcus. Ventral margin broadly convex, rising arcuately and with an indentation behind. Anterior dorsal margin weakly convex in the left valve, weakly concave in the right. Posterior dorsal margin long, gently inclined, descending along its length and somewhat concave far posteriorly. Posterior margin short, oblique and irregular, forming a blunt rostrate truncation. Left valve with an external posterior curvilinear ridge extending from the umbo to the base of the posterior margin and delineating the posterior slope as well as the posterior rostration. An interior radial sulcus extends from the umbo ventrally, dividing the anterior margin and the ventral margin. Along this sulcus the concentric sculpture is depressed. Right valve with an external radial ridge dorsally, and directly ventral to it, a strong radial sulcus. Concentric sculpture consisting of closely spaced, fine lirations, stronger in the left valve and flexed along the anterior radial sulcus. Radial lines occur in the right valve. Hinge with a lithodesma, an internal resilium, and an external ligament, particularly evident along the anterior dorsal margin of the left valve. Dentition of the right valve consists of a thickened, moderately elongate posterior cardinal tooth, a central rectangular pedunculate cardinal tooth, and an obscure anterior thickening representing the anterior cardinal tooth. Dentition of the left valve consists of a thickened, horizontal tooth above which is a concave excavation,

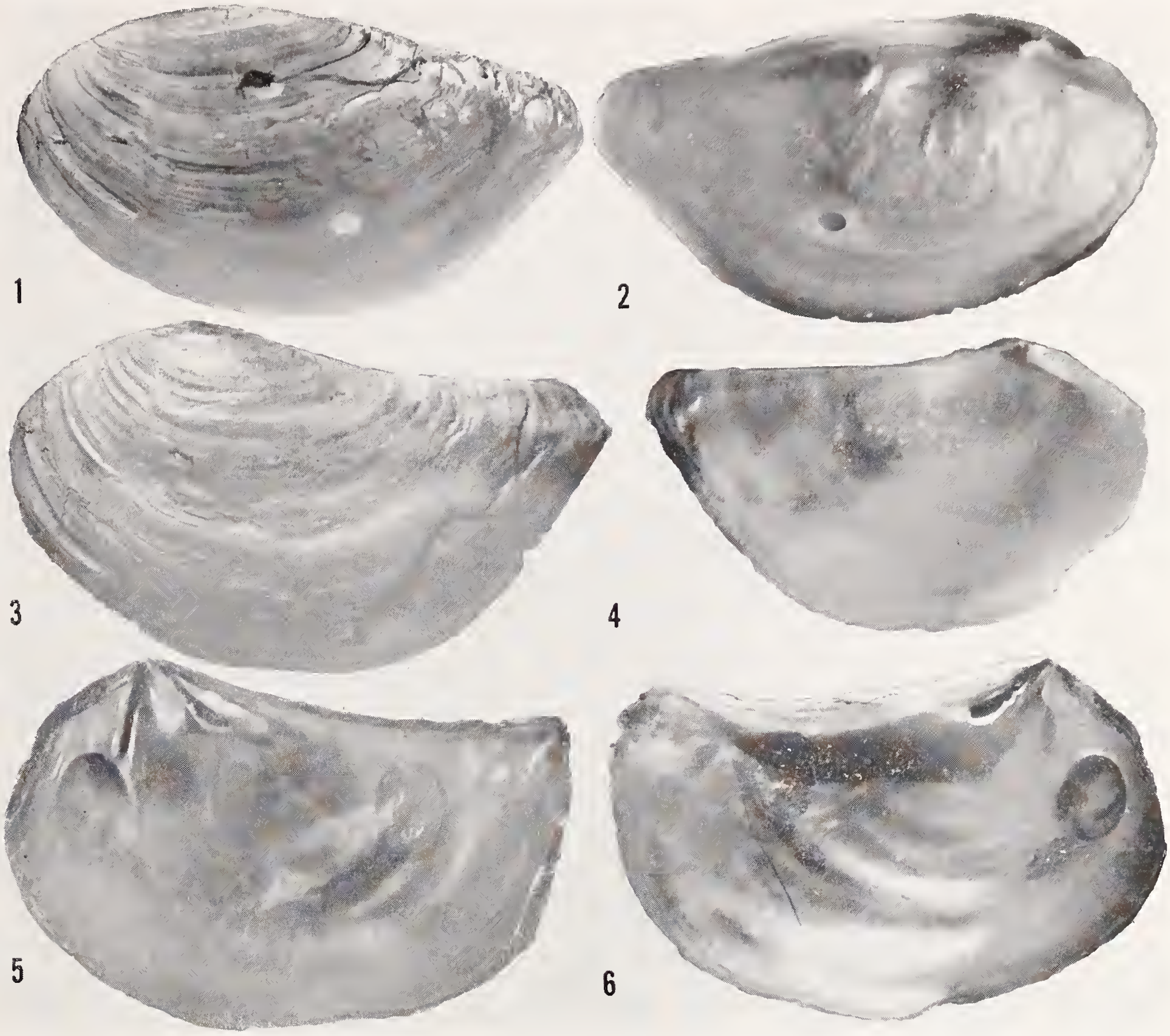

Plate 122. Figs. 1 and 2. *Pandora carolinensis* Bush 1855 [=*Pandora* (*Pandorella*) *arenosa* Conrad 1834]. USNM 35701, *Albatross* I, Station 2113, off Cape Hatteras, North Carolina, in 15 fathoms. Fig. 1. External view of the left valve of the holotype (about 5.8x). Fig. 2. Internal view of the left valve of the holotype (about 5.8x). Figs. 3 and 4. *Pandora* (*Kennerlyia*) *glacialis* var. *eutaenia* Dall 1915 [=*Pandora* (*Pandorella*) *glacialis* Leach 1819]. USNM 171062, Sitka Harbor, Alaska, in 15 fathoms. Fig. 3. External view of the left valve of a syntype (about 2.8x). Fig. 4. Internal view of the left valve of a syntype (about 3x). Figs. 5 and 6. *Pandora* (*Clidiophora*) *gouldiana* Dall 1886. USNM 95490, Woods Hole, Massachusetts. Fig. 5. Internal view of the right valve of a paratype (about 3x). Fig. 6. External view of the left valve of a paratype (about 2.6x).

a central thin cardinal tooth in the resilial complex and the posterior cardinal tooth which consists of a thickening of the posterior dorsal margin. Adductor muscle scars impressed, small and subcircular; the anterior adductor muscle scar in the left valve partly obscured under the concavity of the anterior lamina. Pallial line consisting of individual and numerous, well impressed scars, forming a series of punctations extending between the anterior adductor and posterior adductor muscle scars. Shell white, highly shining and nacreous internally, dull, somewhat chalky and slightly eroded externally.

length	height	width	
13.5 mm.	7.5 mm.	2.6 mm.	Holotype of *carolinensis* Bush
19.4	11.3	4.0	*Albatross* I, Station 20011, off Vero Beach, Florida
19.0	11.1	—	" " " " " " "
18.0	11.6	—	" " " " " " "
16.7	9.1	2.9	*Albatross* I, Station 2277, off Cape Hatteras, N.C.
15.0	8.5	3.1	" " " " " " "
8.3	4.1	—	*Albatross* I, Station 2112, off Cape Hatteras, N.C.
7.1	3.3	—	*Albatross* I, Station 2114, off Cape Hatteras, N.C.

Remarks. *Pandora arenosa* is small and heavily shelled. It is primarily characterized by its highly nacreous interior and its strong convexity of the left valve. In the Western Atlantic it may be confused with *Pandora bushiana* Dall. From the latter, which is its nearest relative in this area, *arenosa* may be distinguished by its strongly curvilinear posterior radial ridge, its more rostrate form and its thicker and heavier shell. *Pandora bushiana* tends to be more narrowly elongate and more compressed than *arenosa* and it is not as nacreous. Immature or small individuals of *arenosa* do not possess the ventral inflation of the adults and they are of more narrow proportions, being somewhat lanceolate in outline. Such young specimens might easily be confused with *bushiana*, but they may be distinguished specifically by their strong rotundity and their developed left anterior cardinal tooth. *Pandora inflata* (=*brevis* Verrill and Bush) which also may be confused with *arenosa* is thin and in some cases translucent; its posterior margin is blunt and not rostrate; its radial posterior ridge is not curvilinear, is generally more widely removed from the posterior dorsal margin and is also not completely carinate to the posterior margin.

Pandora arenosa has some structural features in common with *Pandora filosa* Carpenter of the Pacific Northwest, but *filosa* is not as strongly enrolled (convex in the left valve), nor does it possess as distinct a posterior ridge.

The original description of *Pandora carolinensis* Bush is incorrect in its orientation of the anterior and posterior parts of the animal and the shell, that is, directions are reversed. The first figure for *carolinensis* Bush is that of Dall (1886, pl. 8, figs. 8a–b) and it compares with the type figure of *arenosa* Conrad. Dall first synonymized *carolinensis* with *arenosa* and there appears to be no question concerning this treatment.

The fossil history of *arenosa* begins in the Miocene. Indeed, the recent species is based on Conrad's description of a shell from the Miocene of Yorktown, Virginia. A number of other named fossil forms represent very close relatives of *arenosa*. In Miocene formations, these include *Pandora dodona* Dall from the Oak Grove Sands of Florida, *Pandora lata* Dall from St. Mary's, Maryland, and *Pandora dalli* Gardner from the St. Mary's formation, Virginia. *Pandora naviculoides* Gardner is another close ally from the Pliocene Waccamaw formation, North Carolina. *Pandora arenosa* has also been recorded from the Pliocene of the Caloosahatchee marl, Shell Creek, Florida (Maury, 1920) and from the Pleistocene of North Carolina (Richards, 1962).

This species was very well represented in the *Albatross* dredgings off Cape Hatteras, but rarely was the species encountered alive. Off Florida where known living specimens have been collected, the species appears to prefer a coarse substrate in shallow water.

Range. *Pandora arenosa* is found from off Currituck Beach, North Carolina south to the Gulf of Mexico as far west as Texas and as far south as Yucatan, Mexico, in depths to 20 fathoms (live) and 640 fathoms (dead). Perry and Schwengel (1955) have reported it off Sanibel Island in the Gulf of Mexico from 4–6 fathoms. Singley (1893) and Pulley (1952) have recorded it from Texas.

Specimens examined. North Carolina: *Delaware*, Station 7–6, alt. tow 12, 44 miles E of Currituck Beach (36°19′ N; 74°55′ W), in 29 fathoms (MCZ); *Albatross* I, Station 2307, 30 miles ESE of Oregon Inlet (35°42′ N; 74°54′ W), in 43 fathoms (USNM); *Albatross* I, Station 2112, 12 miles ENE of Cape Hatteras (35°20′ N: 75°18′ W), in 15 fathoms; *Albatross* I, Station 2277, 9½ miles ENE of Cape Hatteras (35°20′ N; 75°19′ W), in 16 fathoms; *Albatross* I, Station 2113, 8 miles ENE of Cape Hatteras (35°20′ N; 75°19′ W), in 15 fathoms; *Albatross* I, Station 2114, 11 miles E of Cape Hatteras (35°20′ N; 75°20′ W), in 14 fathoms; *Albatross* I, Station 2615, 28 miles SE of Cape Fear (33°45′ N; 77°25′ W), in 18 fathoms (live) (all USNM). South Carolina: *Miss Kim*, Station 9, 37½ miles, 130° off Sandy Point, Raccoon Key (32°28′ N; 78°47′ W), in 20 fathoms (live) (MCZ). Florida: *Albatross* I, Station 20011, off Vero Beach, in 46 fathoms (USNM); off Sanibel Island, in 6 fathoms; off Charlotte Harbor, in 13 fathoms (both MCZ); Sarasota Bay (live); 3¾ miles SSW of Longboat Pass, Manatee County, in 6 fathoms (live) (both USNM); 120 miles W of Clearwater, in 34–36 fathoms (MCZ). Mexico: *Albatross* I, Station 2361, off Cabo Catoche, Yucatan (22°08′ N; 86°51′ W) (USNM); *Blake*, Yucatan Strait, in 640 fathoms (MCZ).

Pandora (Pandorella) bushiana *Dall*

Plate 123, figs. 1–3

Pandora (*Kennerlia*) *bushiana* Dall 1886, Bull. Mus. Comp. Zool. **12**(6): 312 (Tampa, Florida, in 6 fathoms; holotype, USNM 61029).

Pandora (*Kennerleyia*) *bushiana* Dall 1902, Proc. United States Nat. Mus. **24**: 511, pl. 31, fig. 3.

Pandora (*Kennerleya*) *bushiana* Dall. Maury 1920, Bull. American Paleo. **8**(34): 40.

Description. Shell extending to 16 mm. in length (about ⅝ inch) and to 8 mm. (about ⅜ inch) in height, thin to fragile, narrowly elongate, inequilateral, inequivalve with the left valve convex and the right valve somewhat concave. Umbos placed in the anterior fifth of the valve, small and pointed. Anterior margin narrowly rounded, weakly convex, and with an indentation becoming confluent with the ventral margin at the anterior radial sulcus; ventral margin broadly rounded, convex, rising posteriorly and sometimes indented posteriorly; anterior dorsal margin somewhat concave, sigmoid, and descending; posterior dorsal margin very long, weakly convex, gently descending and sometimes weakly ascending posteriorly; posterior margin short, irregular and forming a blunt subrostrate truncation. In the left valve, a single weakly carinate, subcurvilinear ridge extends from the umbo to the base of the posterior margin behind; the anterior radial sulcus nearly perpendicular and defining the confluence of the anterior margin with the ventral margin. In the right valve, two ridges dorsally and two weak radial, subsigmoid sulci extending from the umbo to the posterior margin. Concentric sculpture weak, finely incised and closely set. Hinge with an internal resilium, a lithodesma and an external ligament. Dentition of left valve with a flattened, partly protruding anterior cardinal tooth with a concave surface; the external ligamental area, excavated above this tooth, is very narrow; central cardinal weak, fine, and bordering the resilial pit; posterior cardinal tooth long, thin, laminate and coextensive with the thickened hinge line. Dentition of right valve with a long thin posterior cardinal tooth, a narrow pedunculate central cardinal tooth; no true anterior cardinal tooth, but localized thickenings along the anterior dorsal margin and near the anterior adductor muscle scar do occur. Adductor muscle scars well impressed and rounded. Pallial sinus consists of individual scars extending between the anterior muscle scar and the posterior adductor muscle scar. Shell white, covered with a brownish white periostracum with superficial radiations evident externally on the left valve, nacreous but not highly shining internally.

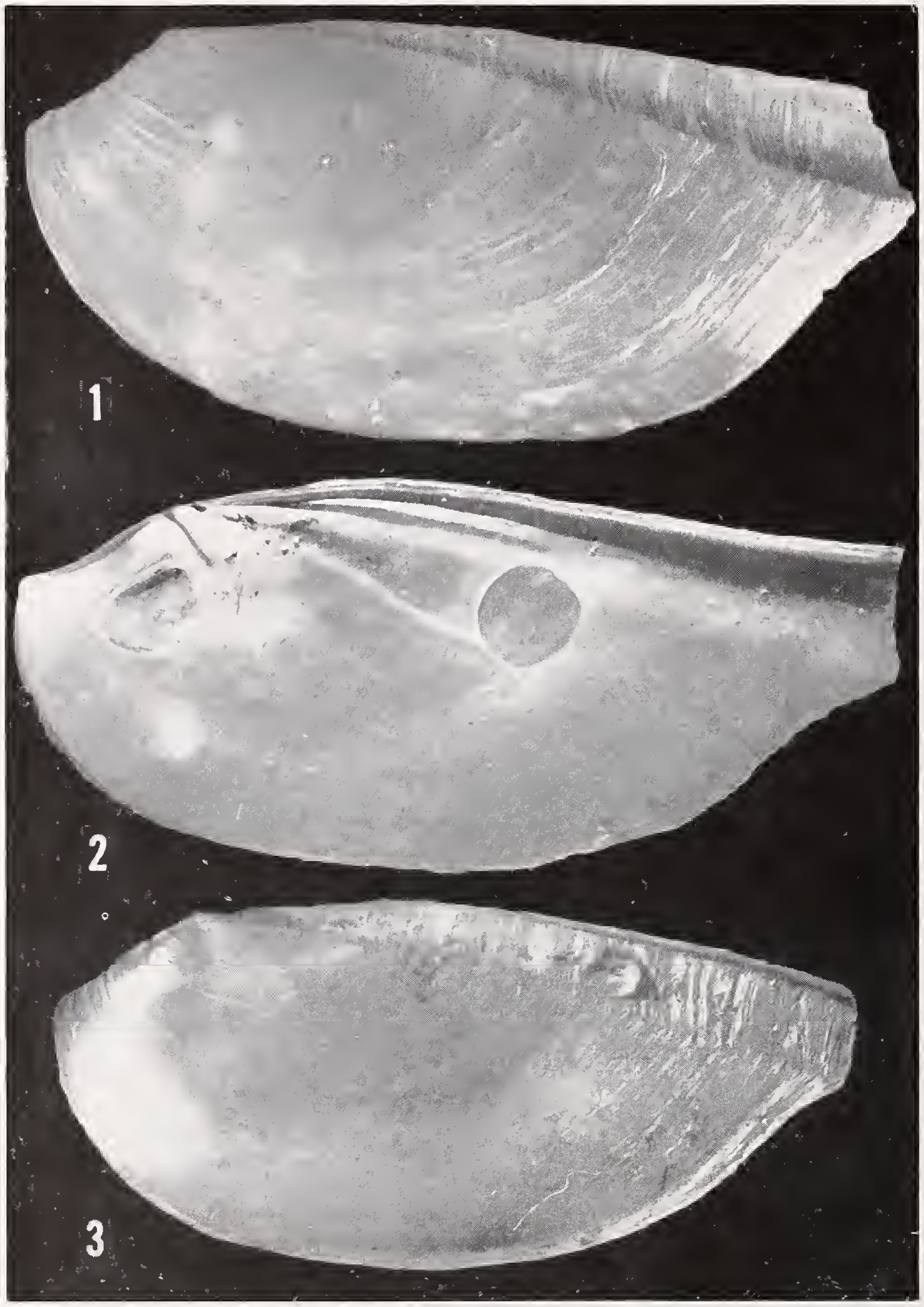

Plate 123. Figs. 1 and 2. *Pandora* (*Pandorella*) *bushiana* Dall 1886. USNM 599331, off Destin, Florida, in 20 fathoms. Fig. 1. External view of the left valve (about 7.3x). Fig. 2. Internal view of the right valve (about 7.4x). Fig. 3. *Pandora* (*Kennerlia*) *bushiana* Dall 1886 [=*Pandora* (*Pandorella*) *bushiana* Dall]. External view of the left valve of a syntype. USNM 61029, Tampa, Florida, in 6 fathoms (about 8.6x).

length	height	width	
11.5 mm.	5.5 mm.	1.0 mm.	Holotype of *bushiana* Dall
15.2	7.7	1.8	off Destin, Florida, in 20 fathoms
11.9	5.2	1.0	*Barrera*, Station 208, off Bahía Honda, Cuba, in 1–12 fathoms
8.9	4.1	0.8	" " " " " " " " " "

Remarks. This species is rather poorly known. It appears to be a more tropical species with some distribution in the Antilles. According to Warmke and Abbott (1961), it is commonly encountered in dredgings. Established depth records for the species indicate a shallow water habitat not exceeding 25 fathoms, and Perry and Schwengel (1955) have listed its occurrence off Sanibel Island in 4–6 fathoms. Parker (1956) found it dead at eight stations in the deep shelf zone along the Texas coast.

The presence of a lithodesma and the union of the left anterior cardinal tooth with the anterior hinge line places this species within the confines of *Pandorella.* Its closest relative appears to be *Pandora arenosa* which is a more strongly and heavily shelled species. *Pandora bushiana* is less convex in the left valve and when living, is covered with a light brownish periostracum. In addition, its left anterior cardinal tooth tends to be somewhat weakened and concave. Another species with which *bushiana* may be confused is *Pandora inflata* which is swollen ventrally and broadly truncated posteriorly. According to Dall's original comments, *bushiana* possesses a convex posterior dorsal margin and its rostrum points ventrally. Both these traits may be observed in the species but they are neither constant nor diagnostic.

Range. Pandora bushiana occurs from off Cape Fear, North Carolina south through the Florida Keys to the northern part of Florida, the Bahama Islands, Cuba and south to Yucatan. It has been found living in depths to 25 fathoms.

Specimens examined. North Carolina: *Albatross* I, Station 2615, 27 miles ESE of Cape Fear (33°45′ N; 77°25′ W), in 18 fathoms (live) (USNM). South Carolina: *Miss Kim,* Station 9, about 37½ miles, 130° off Sandy Point, Raccoon Key (32°34′ N; 78°51′ W), in 10 fathoms (live); *Miss Kim,* Station 11, about 43¼ miles, 130° off Sandy Point, Raccoon Key (32°31′ N; 78°51′ W), in 25 fathoms (live) (both MCZ). Florida: *Eolis,* Station 83, off Government Cut, Miami, in 3 fathoms (live) (USNM); 5 miles E of Carysfort Light, in 96–107 fathoms (MCZ); *Eolis,* Station 33, off Tortugas, in 16 fathoms (live) (USNM); off Sanibel Island, in 6 fathoms (live) (MCZ); off Tampa, in 6 fathoms (live) (USNM); off Destin, in 18–20 fathoms (MCZ; USNM); off Fort Walton, in 16–19 fathoms (MCZ). Bahamas: Moraine Cay (MCZ); *Eolis,* Station 50, N. Bimini Island, in 20 fathoms (USNM). Cuba: *Barrera,* Station 208, off Bahía Honda, in 1–12 fathoms (live) (USNM). Mexico: *Albatross,* Station 2361, off Cabo Catoche, Yucatan (22°08′ N; 86°15′ W), in 25 fathoms (USNM).

Pandora (Pandorella) inflata, new name

Plate 124, figs. 1–4; Plate 125, figs. 1–2

Kennerlia glacialis 'Leach' Verrill 1881, Proc. United States Nat. Mus. **3**: 397, *non* Leach 1819.

Pandora (*Kennerlia*) *glacialis* 'Leach' Dall 1889, Bull. United States Nat. Mus., no. 37, p. 69, *pars, non* Leach 1819.

Kennerlia brevis Verrill and Bush 1898, Proc. United States Nat. Mus. **20**: 821, pl. 88, figs. 7a–b (*Albatross* I, Station 2248, 67 fathoms, S of Nantucket, Massachusetts; holotype, USNM 40232), *non* Sowerby 1829.

Pandora (Kennerlia) brevis Verrill and Bush. Johnson 1934, Proc. Boston Soc. Nat. Hist. **40**(1): 31, *non* Sowerby 1829.

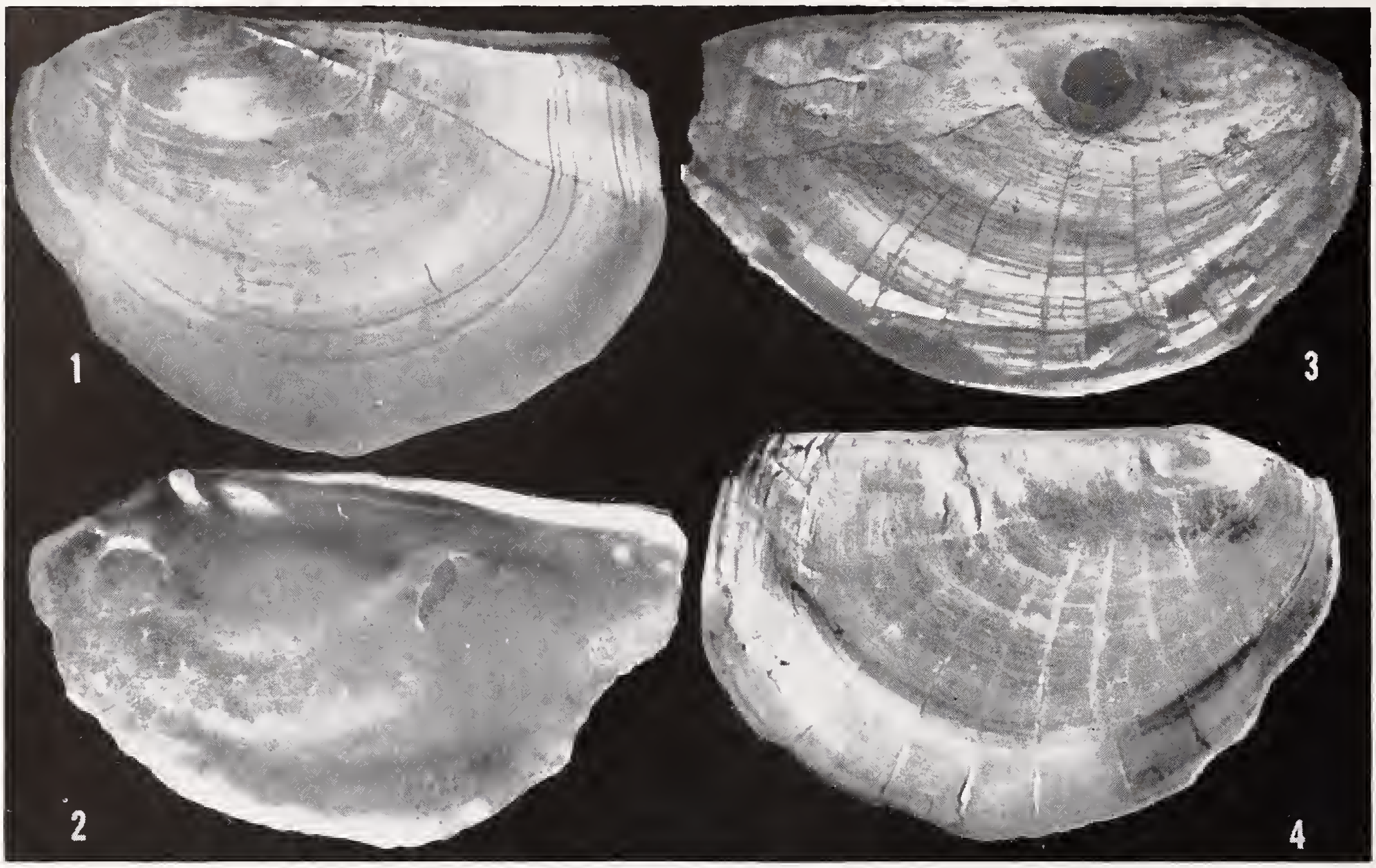

Plate 124. Figs. 1 and 2. *Pandora (Pandorella) inflata*, new name. Fig. 1. External view of the left valve. USNM 444729, *Eolis*, Station 309, off Fowey Light, Florida, in 60 fathoms (about 8.3x). Fig. 2. Internal view of the right valve. USNM 323233, *Albatross* I, Station 2369, off Cape San Blas, Florida, Gulf of Mexico, in 26 fathoms (about 6.8x). Fig. 3. *Kennerlia brevis* Verrill and Bush 1898, *non* Sowerby 1829 [=*Pandora (Pandorella) inflata*, new name]. External view of the right valve of the holotype. USNM 40232, *Albatross* I, Station 2248, S of Nantucket, Massachusetts, in 67 fathoms (about 8.3x). Fig. 4. *Pandora (Pandorella) inflata*, new name. External view of the right valve. USNM 444729, *Eolis*, Station 309, off Fowey Light, Florida, in 60 fathoms (about 7.9x).

Description. Shell extending to 18 mm. in length (about $\frac{3}{4}$ inch) and to 9 mm. in height (about $\frac{3}{8}$ inch), subsolid to fragile, somewhat translucent, inequilateral, inequivalve, with the left valve markedly convex and tumid and the right valve concave. Umbos situated in the anterior quarter of the valve, small and somewhat pointed. Anterior margin narrow, short, weakly convex and markedly distinct from the ventral margin; ventral margin broadly convex, rising but not indented behind; anterior dorsal margin gently descending and weakly convex; posterior dorsal margin more or less straight, long, and slightly descending; posterior margin confluent with the ventral margin, nearly straight and forming a broad blunt truncation. Left valve with a strong anterior radial sulcus which strongly delimits the confluence of the anterior margin and the ventral margin. Left valve with two radial posterior ridges, the ventral one the stronger and more carinate. The posterior ridges rarely extend all the way to the posterior margin. In the right valve there are two radial ridges along the posterior dorsal margin and ventral to these are two distinct radial sulci extending posteriorly from the umbo. Concentric sculpture consisting of closely spaced, weakly incised sulci; radial sculptural lines evident in the right valve. Hinge with an internal resilium, a lithodesma and an external ligament. Dentition of the left valve consists of a strongly curved anterior cardinal tooth with an excavated ligamental concavity above it, a resilial complex consisting of a medial ridge and an excavated resilial pit; posterior cardinal tooth a mere thickening along the posterior dorsal margin. Dentition of the right valve consists of an angular, thin posterior cardinal tooth with an internal ray beneath extending to the posterior adductor muscle scar, a straight central pedunculate tooth, no true anterior tooth, but a thickening of the anterior dorsal margin at the hinge line and a thickening dorsal to the anterior adductor muscle scar. Adductor muscle scars well impressed, small and rounded. In the left valve, the anterior adductor muscle scar is beneath the cavity of the anterior cardinal tooth. Pallial sinus consists of weak, individual, punctations extending between the anterior and posterior adductor muscle scars. Shell dirty white externally, nacreous internally and shining externally, particularly along the curvature of the left valve.

length	height	width	
9.0 mm.	4.8 mm.	1.2 mm.	Holotype of *brevis* Verrill and Bush
9.3	5.1	—	Paratype (right valve) of *brevis* Verrill and Bush
12.6	8.6	—	*Albatross* I, Station 2268, off Cape Hatteras
12.1	8.8	2.3	*Fish Hawk*, Station 920, off Manasquan Inlet, New Jersey
11.3	7.3	—	*Albatross* I, Station 2265, off Cape Henry, Virginia
9.8	6.2	1.5	*Eolis*, Station 151, off Government Cut, Miami, Florida
6.1	3.3	0.8	*Eolis*, Station 366, E of Ragged Key, Florida

Remarks. The name *brevis*, introduced by Verrill and Bush for this species, is preoccupied by the *brevis* of Sowerby. We have chosen the descriptive name *inflata* to apply to this species. *Pandora inflata* appears to be most closely allied to *Pandora glacialis* Leach which is of a more northern distribution. The latter lacks the more or less distinct radial and somewhat carinate ridges of the left valve. The anterior lateral laminar tooth of the left valve in *inflata* has an excavated area above it whereas in *glacialis* this tooth appears to be flush with the anterior dorsal margin of the hinge line and the excavated area, if at all present, is very much reduced. The swollen convexity of the left valve of *inflata* also is distinct from the more oblate convexity of *glacialis*. The right valve of *glacialis* may be somewhat convex whereas in *inflata* it is somewhat concave.

Pandora inflata may be confused with *P. arenosa* but it may be differentiated by its lack of posterior rostration, distinct division of the anterior margin and the ventral margin caused by the anterior radial sulcus and its radial carinate ridges in the left valve. These ridges in *arenosa* tend to be curvilinear whereas in *inflata* they are straight. The anterior sulcus is dorso-ventral in *arenosa* while it is somewhat oblique in *inflata*.

In the Eastern Pacific, *Pandora bilirata* Carpenter and *P. convexa* Dall seem most similar to *inflata*. From *bilirata*, which is probably more closely allied, *inflata* may be distinguished by its more pellucid, subtransparent shell and its greater inflation. *Pandora convexa* is a larger species with a rostrate posterior end, which is lacking in *inflata*.

There does not seem to be a record for *Pandora inflata* in Tertiary deposits in North America.

Range. Pandora inflata occurs from the latitude of Sandy Hook, New Jersey, south along the east coast and both sides of Florida. It has been found living in depths between 26 and 90 fathoms and appears to be most populous in the Straits of Florida.

Specimens examined. New Jersey: *Delaware*, Station 2–1, alt. tow 50, 126 miles E of Sandy Hook (40°16′ N; 71°22′ W), in 46 fathoms (live) (MCZ); *Albatross* I, Station 2242, 160 miles E of Manasquan Inlet (40°15′ N; 70°27′ W), in 58 fathoms; *Fish Hawk*, Station 920, 150 miles E of Manasquan Inlet (40°13′ N; 70°41′ W), in 63 fathoms; *Albatross* I, Station 2248, 190 miles E of Manasquan Inlet (40°07′ N; 69°57′ W), in 67 fathoms (all USNM); *Delaware*, Station 3–2, alt. tow 31, 73 miles E of Atlantic City (39°20′ N; 72°52′ W), in 40 fathoms (live); *Delaware*, Station 3, tow 5, 101 miles

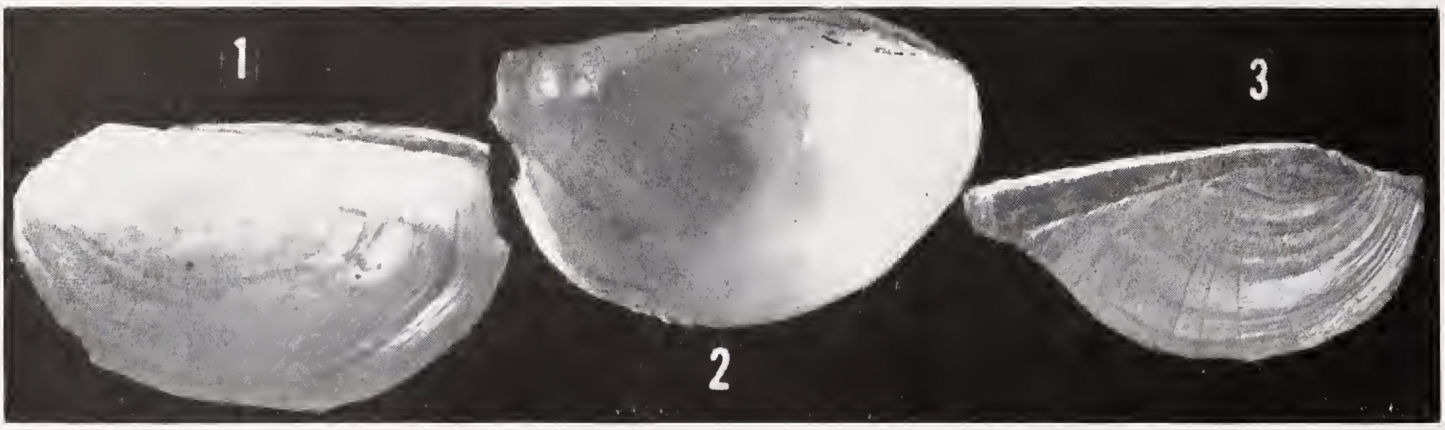

Plate 125. Fig. 1. *Kennerlia brevis* Verrill and Bush 1898, *non* Sowerby 1829 [= *Pandora* (*Pandorella*) *inflata*, new name]. External view of the left valve of the holotype, USNM 40232, *Albatross* I, Station 2248, S of Nantucket, Massachusetts, in 67 fathoms (about 5.7x). Fig. 2. *Pandora* (*Pandorella*) *inflata*, new name. Internal view of the left valve. USNM 323233, *Albatross* I, Station 2369, off Cape San Blas, Florida, Gulf of Mexico, in 26 fathoms (about 4.6x). Fig. 3. *Pandora carolinensis* Bush 1885 [= *Pandora* (*Pandorella*) *arenosa* Conrad 1834]. External view of the right valve of the holotype. USNM 35701, *Albatross* I, Station 2113, off Cape Hatteras, North Carolina, in 15 fathoms (about 3.6x).

E of Cape May (39°00′ N; 72°48′ W), in 80 fathoms (live) (both MCZ). Virginia: *Albatross* I, Station 2265, 65 miles E of Cape Henry (37°07′ N; 74°35′ W), in 70 fathoms (USNM). North Carolina: *Albatross* I, Station 2268, 20 miles ESE of Cape Hatteras (35°10′ N; 75°06′ W), in 68 fathoms; *Albatross* I, Station 2612, 30 miles SSE of Cape Lookout (34°11′ N; 76°10′ W), in 52 fathoms (all USNM). Florida: Lake Worth (McGinty) (live); off Palm Beach in 130 fathoms; off S. Palm Beach in 75 fathoms (McGinty) (all MCZ); *Eolis*, Stations off Miami, in 24–60 fathoms; *Eolis*, Stations off Government Cut, Miami, in 25–90 fathoms; *Eolis*, Stations off Fowey Light, in 28–125 fathoms; *Eolis*, Station 189, off Cape Florida, in 67 fathoms (live); *Albatross* I, Station 2646–8, off Cape Florida (25°47′ N; 80°05′ W), in 84–85 fathoms; *Eolis*, Stations off Ragged Key, in 65–90 fathoms; *Eolis*, Station 350, off Triumph Reef, in 70–90 fathoms (live); *Eolis*, Stations off Ajax Reef, in 40–100 fathoms; *Eolis*, Station 376, off Caesars Creek, in 90 fathoms (live); *Eolis*, Station 58, off Turtle Harbor, in 50 fathoms (all USNM); NNE off Carysfort Light, in 100 fathoms (live) (MCZ); *Eolis*, Station 45, Lower Matecumbe Key (shore drift); *Eolis*, Station 145, off Long Reef, in 40 fathoms (both USNM); 6 miles SE of Sombrero Light, in 66 fathoms (live); $\frac{1}{2}$ mile SSE of Looe Key, in 29 fathoms (both MCZ); *Eolis*, Stations off Sambo Key, in 50–75 fathoms; *Albatross* I, Station 2315, off Key West (24°26′ N; 81°48′ W), in 37 fathoms; *Eolis*, Stations off Key West, in 55–63 fathoms; *Eolis*, Stations off Sand Key, in 58–62 fathoms; *Eolis*, Station off Dry Tortugas, in 16 fathoms; *Albatross* I, Station 2369, off Cape San Blas (29°16′ N; 85°32′ W), in 26 fathoms (live) (all USNM).

Pandora (Pandorella) glacialis *Leach*

Plate 122, figs. 3–4; Plate 126, figs. 1–4

Pandora glacialis Leach 1819 (June), Journal de Physique **88:** 465; 1819 (July), [in] Ross. Voyage of Discovery . . . Baffin's Bay, 2nd Ed., Appx. 4, p. 174: 1819 (Sept.), Annals of Philosophy **14:** 203–204 (Baffin's Bay . . . Spitzbergen, here restricted to Baffin's Bay; syntypes, BMNH, Reg. No. 196273).

Pandora (Kennerlia) glacialis Leach. Carpenter 1864, Proc. Zool. Soc. London, p. 603.

Kennerlia glacialis Leach. Bush 1883, Proc. United States Nat. Mus. **6:** 245, figs. 1–1a.

Pandora (Kennerlyia) glacialis Leach. Dall 1915, Proc. United States Nat. Mus. **49:** 448.

Pandora (Kennerlyia) glacialis var. *eutaenia* Dall 1915, Proc. United States Nat. Mus. **49:** 449 (Sitka Harbor, Alaska, in 15 fathoms; syntypes, USNM 171062).

Pandora (Kennerlyia) glacialis Leach. Oldroyd 1924, Marine Shells West Coast North America **1:** 89, pl. 15, fig. 11 and pl. 42, figs. 3–4.

Pandora (Kennerleya) glacialis Leach. Lamy 1924, Jour. de Conchy. **78:** 112.

Pandora (Kennerleya) glacialis var. *eutaenia* Dall. Lamy 1924, Jour. de Conchy. **78:** 113.

Pandora (Kennerlia) glacialis glacialis Leach. LaRocque 1959, Catalogue Rec. Moll. Canada, Nat. Mus. Ottawa, Bull. **129:** 44.

Pandora (Kennerlia) glacialis eutaenia Dall. LaRocque 1959, Catalogue Rec. Moll. Canada, Nat. Mus. Canada, Ottawa, Bull. **129:** 44.

Description. Shell extending to 22 mm. in length (about $\frac{7}{8}$ inch) and to 19 mm. in height (about $\frac{3}{4}$ inch), elongate, thin and rather fragile, inequilateral, markedly inequivalve with the left valve convex and centrally inflated and the right valve centrally flattened and sharply concave ventrally; the right valve overlaps the left valve dorsally along the posterior dorsal margin. Umbos anterior, about one-third the total length from the anterior margin, blunt and generally eroded. Anterior margin narrowly rounded, uniting in an indentation with the ventral margin at the anterior radial sulcus; ventral margin broadly rounded, convex and uniting smoothly with the undifferentiated posterior margin, forming a rounded posterior end. Anterior dorsal margin short, nearly straight to slightly convex; posterior dorsal margin long and straight to weakly concave. Left valve with a weak anterior radial sulcus, sharply delimiting the confluence of the anterior margin with the ventral posterior ridge or sulcus lacking so that the umbonal inflation is smooth. Right valve with a weak single posterior radial ridge along the posterior dorsal margin where the overlap with the left valve occurs. Concentric sculpture closely spaced, generally worn away; radial lines evident on the right valve. Hinge with a lithodesma and internal resilium. Dentition of the right valve consists of a long posterior laminate cardinal tooth, a central subtrigonal pedunculate cardinal tooth and an obsolete (or completely absent) anterior cardinal tooth; an extensive external ligament along the anterior dorsal margin present. Dentition of the left valve with a thickened anterior cardinal tooth coextensive with the anterior dorsal margin; weak central cardinal tooth; posterior cardinal tooth formed by a thickening along the posterior dorsal margin. Adductor muscle scars impressed, particularly the anterior scar in the right valve; pallial line consists of irregularly arranged individual scars. Shell white, shining internally, chalky and eroded externally; erosion often reveals the nacreous layer of the left valve externally; periostracum thickened and dull dirty white.

length	height	width	
21.2 mm.	13.5 mm.	3.8 mm.	Between Cape Mugford and Hebron, Labrador, in 60 fathoms
20.6	11.0	3.8	Bight, Shannon Island, N.E. Greenland
12.8	7.9	2.6	King Francis Joseph Fjord, N.E. Greenland
12.1	7.4	2.3	Collingham's Cove, Hamilton Inlet, Labrador, in 7 fathoms
9.4	5.3	1.5	Grande Creve, Gaspé, Quebec, in 20–40 fathoms

Remarks. In the Western Atlantic, *Pandora glacialis* stands more or less widely separated from other *Pandora.* It is distinguished by its left anterior cardinal tooth which is coalesced with the anterior dorsal margin of the shell. There does not appear to be an excavated cavity dorsal to this tooth. Verrill (1881) identified some specimens as *glacialis* which later proved to be a new species, *Pandora brevis* Verrill and Bush (*non* Sowerby) (=*P. inflata*), which may be confused with *glacialis.* The presence of a carinate ridge and the swollen ventral portion of the left valve of *inflata* immediately separates it from *glacialis.*

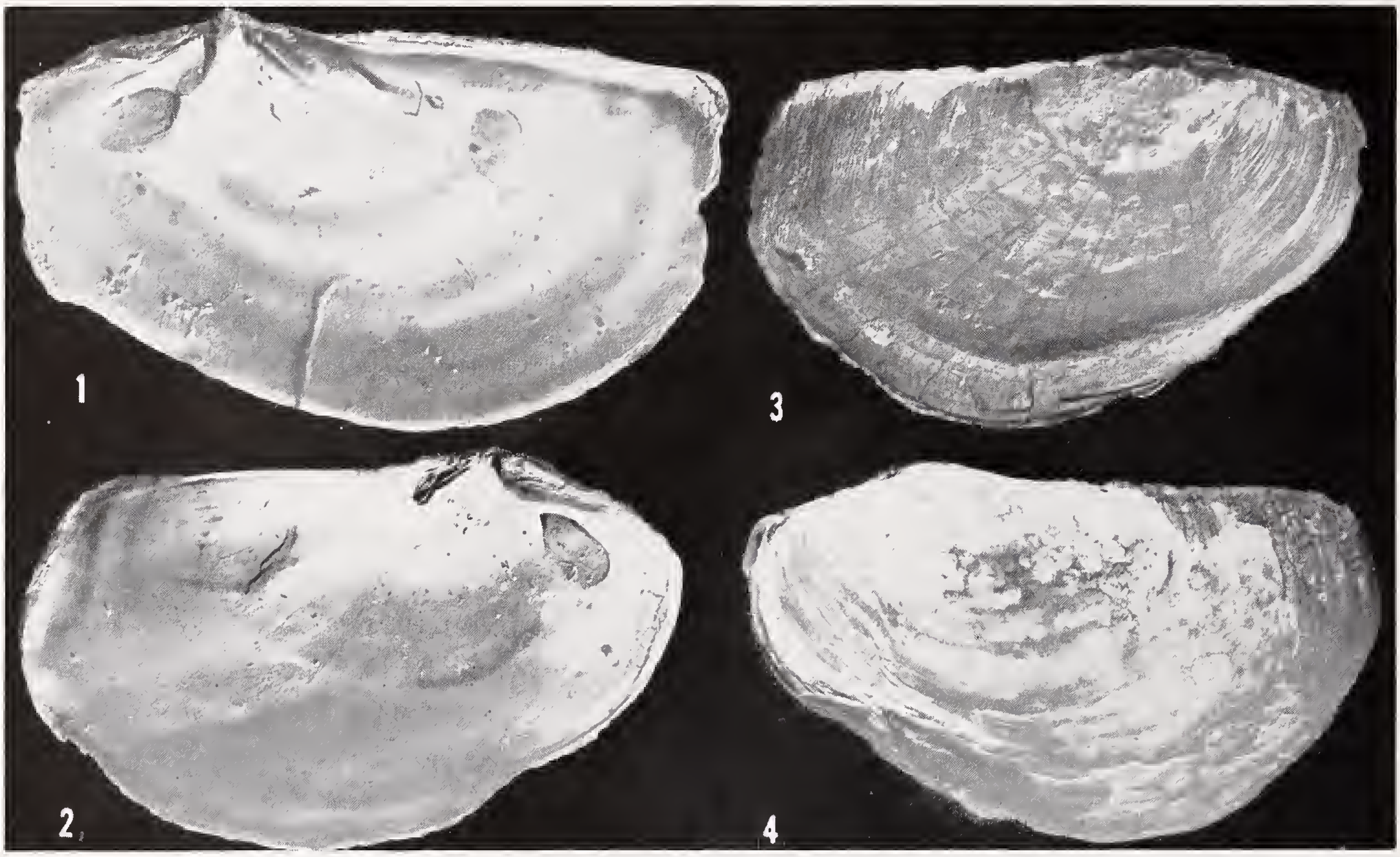

Plate 126. Figs. 1–4. *Pandora* (*Pandorella*) *glacialis* Leach 1819. Figs. 1 and 2. USNM 444667, between Cape Mugford and Hebron, Labrador. Specimens sprayed with ammonium chloride vapor. Fig. 1. Internal view of the right valve (about 3.9x). Fig. 2. Internal view of the left valve (about 3.3x). Figs. 3 and 4. USNM 50680, *Albatross* I, Station 2499, N of Sable Island, in 130 fathoms. Fig. 3. External view of the right valve (about 2.9x). Fig. 4. External view of the left valve (about 3x).

Ockelmann (1958) has reported that *glacialis* is a member of the *Gomphia fluctuosa* community in East Greenland, occurring at depths between 3 and 10 fathoms on sandy bottoms near the open sea. The species is hermaphroditic (Thorson, 1936), and Ockelmann has indicated that spawning takes place later than mid-August in East Greenland and that the larval development is lecithotrophic with a pelagic stage which is either very short or entirely lacking. It appears that *glacialis* is a filter feeder and Odhner (1915) has recorded the presence of mud and plankton in the alimentary canal.

An amphipod, *Metopa groenlandica* Hansen, has been reported attached to the ctenidia of specimens of *glacialis* collected in East Greenland (Stephensen and Thorson, 1936).

From samples of living populations, the depth range of this species is between 3 and 130 fathoms. As Clarke (1962) has pointed out, Gorbunov's record (1946) of 1040 fathoms represents a dead specimen which occurred advectitiously at this great depth. Soft bottom types, including mud, sand, and muddy sand are preferred by *glacialis.*

Some ecological factors must contribute to the peculiarly large specimens of this species along the Alaskan coast from Prince Williams Sound to Sitka, for samples from this area are larger and somewhat more rostrate posteriorly. For these populations, Dall (1915) established the varietal name *entaenia* which is included in the synonymy.

This species has been found fossil in the Pliocene of California in the Pico formation near Ventura (Waterfall, 1929). *Pandora arctica* Dall of the Leda Clays of Saco, Maine and of St. John, New Brunswick appears to be an immediate precursor of *glacialis*. Richards (1962) has listed the Pleistocene deposits in which *glacialis* has been found. Feyling-Hanssen (1955) has recorded *glacialis* in the late Pleistocene of West Spitzbergen.

Range. *Pandora glacialis* is predominantly high arctic and circumpolar in its distribution; however, it extends to lower latitudes on both coasts of North America. It is normally found as far south as the Gulf of St. Lawrence on the Atlantic coast and Vancouver Island and the Straits of Juan de Fuca, British Columbia, on the Pacific coast. The species inhabits the Arctic coasts of Canada, Alaska, the Soviet Union and Scandinavia. It has been found in numerous localities in East Greenland (Ockelmann, 1958), but is not known from West Greenland or Iceland. Odhner (1915) gives an extended list of records with references to citations in European literature. The species has been taken alive in depths to 130 fathoms.

Specimens examined. Arctic Ocean: Matochkin Shar (=strait), Novaya Zemblya, in 5–6 fathoms; U.S.S. *Corwin*, north of Bering Strait; off Icy Cape, Alaska, in 17 fathoms; off Cape Sabine, Alaska, in 13 fathoms; off Point Belcher, Alaska, in 9 fathoms (all USNM). Bering Sea: U.S.S. *Corwin*, in Bering Straits, in 30 fathoms; north end of Nunivak Island, Alaska, in 9 fathoms; *Albatross* I, Station 3554, off Pribiloff Island (56°34′ N; 170°19′ W), in 62 fathoms (all USNM). North Pacific Ocean: Port Etches, Hinchinbrook Island, in 15 fathoms; Port Mulgrave, Yakutat Bay, in 30 fathoms; Lituya Bay, in 8 fathoms; Sitka Harbor, in 12–15 fathoms; Victoria, Vancouver Island, in 65 fathoms (all USNM). Greenland: Bight, Shannon Island (live); Cape Stosch, Godthaabs Gulf, in 7 fathoms; King Franz Joseph Fjord (live) (all USNM). Labrador: Halfway between Cape Mugford and Hebron, in 60 fathoms (live); Collingham's Cove, Hamilton Inlet, in 7 fathoms (live) (both USNM). Quebec: Grand Greve, Gaspé, in 20–40 fathoms (live) (USNM). Newfoundland: *Albatross* I, Station 2458, off SE Newfoundland (46°48′ N; 52°34′ W), in 89 fathoms (USNM). Nova Scotia: *Albatross* I, Station 2499, N of Sable Island (44°46′ N; 59°55′ W), in 130 fathoms (live) (USNM); East of Cape Sable, in 55 fathoms (MCZ). Massachusetts: Liberty Street, Danvers (live) (MCZ).

* * * *

Notes

The existence of species of *Pandora* along the Atlantic Coast of South America is difficult to document. At least two specific names have been used in the South American literature.

Pandora braziliensis 'Gould ms' Sowerby 1874 [in] Reeve, Conchologica Iconica **19**: *Pandora*, pl. 2, fig. 15.

Pandora cistula Gould 1850. Proc. Boston Soc. Nat. Hist. **3:** 217; 1852. United States Explor. Exped., Moll., p. 396, pl. 33, figs. 500–500b.

No specimens of any pandorid from South America were available to the authors at the time of this study and therefore neither of the above have been treated systematically in the text.

* * * *

BIBLIOGRAPHY

Allen, J.A. 1954. On the structure and adaptations of *Pandora inaequivalvis* and *P. pinna*. Quart. Jour. Micro. Sci. **94**(4): 473–482.

Allen, J.A. 1961. Development of *Pandora inaequivalvis* Linné. Jour. Embryol. Exp. Morphol. **9:** 252–268.

Allen, M.P. and J.A. 1955. On the habits of *Pandora inaequivalvis* Linné. Proc. Malac. Soc. London **31:** 175–185.

Apgar, A.C. 1891. Mollusks of the Atlantic coast of the United States south to Cape Hatteras. Jour. New Jersey Nat. Hist. Soc. **2:** 75–162.

Arvy, L. and J.M. Gaillard. 1956. Castration parasitaire de *Pandora albida* (Röding), *P. inaequivalvis* L., mollusque pelecypode eulamellibranche par *Cercaria melanocystea* n. sp. cercaire à grande queue resiculeuse. C.R. Acad. Sci., Paris **243:** 1074–1077, 3 figs.

Atkins, D. 1937. On the ciliary mechanism and interrelationships of lamellibranchs. Pt. 2. Quart. Jour. Micro. Sci. **79:** 379–421.

Blake, S.F. 1953. The Pleistocene fauna of Wailes Bluff and Langley Bluff, Maryland. Smithsonian Misc. Coll. **121**(12): 32 pp.

Burne, R.H. 1920. Mollusca. Pt. IV. Anatomy of Pelecypoda. British Antarctic Expedition (Terra Nova), Zool. II, no. 10, pp. 233–256, pls. 1–4.

Carpenter, W. 1848. Report on microscopic structure of shells. Report Brit. Assoc. Ad. Sci. [for 1847], pp. 93–134, pls. 1–20.

Chemnitz, J.H. 1795. [in] Martini-Chemnitz. Neues systematisches Conchylien-Cabinet **11:** 211.

Children, J.G. 1823. Lamarck's Genera of Shells. Quart. Jour. Sci., Lit., and Arts **14:** 301.

Clarke, A.H. Jr. 1962. Annotated list and bibliography of the abyssal marine mollusks of the world. Nat. Mus. Canada, Bull. 181, 114 pp.

Cossmann, A.E.M. 1886. Catalogue des coquilles fossiles d'Éocène des environs de Paris. Pelecypodes. Ann. Soc. Roy. Malac. Belgique **21**(4th Ser., vol. 1): 17–186, pls. 1–8.

Dall, W.H. 1886. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877–78) and in the Caribbean Sea (1879–80), by the U.S. Coast Survey steamer "Blake", Lieut. Commander C.D. Sigsbee, U.S.N. and Commander J.R. Bartlett, U.S.N. commanding.

XXIX. Report on the Mollusca. Part 1. Brachiopoda and Pelecypoda. Bull. Mus. Comp. Zool. **12**(6): 171–318, 19 pls.

Dall, W.H. 1889. A preliminary catalogue of the shell-bearing marine mollusks and brachiopods of the southeastern coast of the United States with illustrations of many of the species. U.S. Nat. Mus., Bull. 37, 221 pp., 74 pls.

Dall, W.H. 1903. Tertiary fauna of Florida. Transactions of the Wagner Free Institute of Science of Philadelphia **3**(6): 1515–1522.

Dall, W.H. 1915. A review of some bivalve shells of the group Anatinacea from the west coast of America. Proc. U.S. Nat. Mus. **49**: 441–456.

Deshayes, G.P. 1848. Histoire naturelle des Mollusques. Mollusques Acephales. Exploration scientifique de l'Algerie, pp. 240–260, Paris.

Deshayes, G.P. 1860. Description . . . animaux sans vertébres. Mollusques Acephales Dimyaires. Paris **1**: 912 pp., 89 pls.

Dodge, H. 1947. The Molluscan genera of Bruguière. Jour. Paleo. **21**(5): 484–492.

Duvernoy, M. 1853. Mémoires sur le systéme nerveux des Mollusques Acephales. Mém. Acad. Sci., Paris **24**: 3–312.

Feyling-Hanssen, R.W. 1955. Stratigraphy of the marine Late-Pleistocene of Billefjordan, Vestspitsbergen. Skrifter norsk Polarinst. **107**: 1–186, 27 pls., 57 figs.

Gardner, J. 1943. Mollusca from the Miocene and Lower Pliocene of Virginia and North Carolina. Pt. 1. Pelecypoda U.S. Geol. Sur., Prof. Paper 199-A, 178 pp., 23 pls.

Gorbunov, C.P. 1946. Bottom life of the Novosiberian shoalwaters and the central part of the Arctic Ocean. Dreifuiushchaia ekspeditsiia Glavseomorputi na ledokol' nom parokhodi 'G. Sedov', 1937–1940. g.g. Trudy **3**: 30–138. [Not seen by the authors.]

Gould, A.A. 1841. A report on the Invertebrata of Massachusetts. Cambridge, 373 pp.

Grant, U.S. IV, and H.S. Gale. 1931. Catalogue of the marine Pliocene and Pleistocene Mollusca of California. Memoirs San Diego Soc. Nat. Hist. **1**: 1,036 pp., 32 pls.

Gray, J.E. 1847. A list of the genera of recent Mollusca, their synonyms and types. Proc. Zool. Soc. London **15**: 129–219.

Hertlein, L.G. and A.M. Strong. 1946. Eastern Pacific Expeditions of the New York Zoological Society. 35. Mollusks from the west coast of Mexico and Central America. Pt. IV. Zoologica **31**(3): 93–120, 1 pl.

Jacot, A.P. 1921. Some marine molluscan shells of Beaufort and vicinity. Jour. Elisha Mitchell Sci. Soc. **36**: 129–145, pls. 11–13.

Keen, A.M. 1958. Sea shells of tropical west America. Stanford Univ. Press, 624 pp., 1709 figs., 10 color pls.

Kobelt, W. 1878. Illustriertes conchylienbuch. Nürnberg, 391 pp.

Lacaze-Duthiers, F.J.H. 1854. Recherches sur les organes genitaux des Acephales Lamellibranches. Ann. Sci. Nat., 4th Ser., Zool. **3**: 155–248, pls. 5–9.

Ladd, H.S. 1951. Brackish-water and marine assemblages of the Texas coast, with special reference to Mollusks. Publ. Inst. Marine Sci. **2**(1): 125–164.

Lamarck, J.B.P.A.M. 1799. Prodrome d'une nouvelle classification des coquilles. Mem. Soc. Hist. Nat. Paris, pp. 63–90.

Maury, C.J. 1920. Recent molluscs of the Gulf of Mexico and Pleistocene and Pliocene species from the Gulf States. Pelecypoda. Pt. 1. Bull. Amer. Paleo. **8**(34): 3–115, 1 pl.

Menegaux, A. 1890. Recherches sur la circulation des Lamellibranches marins. Besancon, 296 pp.

Morse, E.S. 1919. Observations on living lamellibranchs of New England. Proc. Boston Soc. Nat. Hist. **35**(5): 139–196.

Ockelmann, W.K. 1958. The Zoology of East Greenland. Marine Lamellibranchiata. Medd. om Grönland **122**(4): 256 pp., 3 pls.

Odhner, N. 1912. Morphologische und phylogenetische Untersuchungen über die Nephridien der Lamellibranchien. Zeits. f. wissen. Zool. **100**(2): 348–350.

Odhner, N. 1915. Die Mollusken des Eisfjordes. Zool. Ergebn. Schwed. Exped. nach Spitzbergen 1908. K. svenska Vetensk. Akad. Handl. **54**(1): 1–274, 13 pls.

Olsson, A.A. 1961. Mollusks of the Tropical Eastern Pacific. Panamic—Pacific Pelecypoda. Paleontological Research Inst., Ithaca, N.Y., 574 pp., 86 pls.

Olsson, A.A. and A. Harbison. 1953. Pliocene Mollusca of southern Florida. Acad. Nat. Sci. Phila., Monograph 8, Pt. 1, 361 pp.

Palmer, K.V.W. 1958. Type specimens of marine mollusca described by P. P. Carpenter from the West Coast (San Diego to British Columbia). Geol. Soc. Amer. Memoir 76, 376 pp., 35 pls.

Parker, R.H. 1956. Macro-invertebrate assemblages as indicators of sedimentary environments in East Mississippi Delta Region. Bull. Amer. Assoc. Pet. Geol. **40**(2): 295–376, 8 pls.

Parker, R.H. 1959. Macro-invertebrate assemblages of central Texas coastal bays and Laguna Madre. Bull. Amer. Assoc. Pet. Geol. **43**(9): 2106–2166.

Parker, R.H. 1960. Ecology and distributional patterns of macro-invertebrates, northern Gulf of Mexico. Recent Sediments, Northwest Gulf of Mexico, 1951–1958. Amer. Assoc. Pet. Geol., Tusla, pp. 302–381.

Pelseneer, P. 1911. Les Lamellibranches de l'Expedition du Siboga. Partie Anatomique. Siboga-Expeditie, Monographie 103 a, 125 pp., 26 pls.

Perkins, G.H. 1869. The molluscan fauna of New Haven. Proc. Boston Soc. Nat. Hist. **13**: 109–163.

Perry, L.M. and J.S. Schwengel. 1955. Marine shells of the western coast of Florida. Paleontological Research Inst., Ithaca, N.Y., 318 pp., 55 pls.

Prashad, B. 1932. Pelecypoda of the Siboga Expedition. Siboga-Expeditie, Monographie 53 c, 353 pp., 9 pls.

Purchon, R.D. 1958. The stomach in the Eulamellibranchia: Stomach Type IV. Proc. Zool. Soc. London **131**: 487–525.

Pulley, T.E. 1952. An illustrated check list of the marine mollusks of Texas. Texas Jour. Sci. **2**: 167–199, 13 pls.

Richards, H.G. 1936. Marine shells of James Bay. Amer. Midl. Nat. **17**(2): 528–545.

Richards, H.G. 1962. Studies of the marine Pleistocene. Pts. 1 & 2. Trans. Amer. Phil. Soc. **52**(3): 1–141.

Ridewood, W.G. 1903. On the structure of the gills of the Lamellibranchia. Phil. Trans. Roy. Soc. London, Ser. B, **195**: 147–284.

Röding, P.F. 1798. Museum Boltenianum. Hamburg, 199 pp.

Schmidt, F.C. 1818. Versuch der Conchylien-Sammlungen. Gotha, 252 pp.

Sherborn, C.D. and B.B. Woodward. 1906. On the dates of publication of the natural history portions of the Encyclopédie Méthodique. Ann. Mag. Nat. Hist., Ser. 7, **17**: 577–582.

Singley, J.A. 1893. Contributions to the natural history of Texas. Pt. 1, Texas Mollusca. Preliminary list of the land, fresh water and marine mollusca of Texas. 4th Ann. Report Geol. Survey Texas, Pts. 1 & 2, pp. 299–343.

Stephensen, K. and G. Thorson. 1936. On the amphipod *Metopa groenlandica* H. J. Hansen found in the mantle cavity of the lamellibranchiate *Pandora glacialis* Leach in East Greenland. Medd. om Grönland **118**(4): 7 pp.

Stewart, R.B. 1930. Gabb's California Cretaceous and Tertiary type lamellibranchs. Acad. Nat. Sci. Phila., Spec. Publ. No. 3, 314 pp., 17 pls.

Stoliczka, F. 1871. Memoirs Geol. Survey India. Palaeontologia Indica. Cretaceous Fauna of southern India **3**: 1–537.

Sullivan, C.M. 1948. Bivalve larvae of Malpeque Bay, Prince Edward Island. Fish. Res. Board Canada. Bull. 77, 36 pp., 22 pls.

Sumner, F.B., R.C. Osburn, and L.J. Cole. 1913. A biological survey of the waters of Woods Hole and vicinity. Part II. Section III. A catalogue of the marine fauna. Bull. U.S. Bur. Fish., 31, Pt. 2, pp. 545–794.

Thorson, G. 1936. The larval development, growth and metabolism of Arctic marine bottom invertebrates. Medd. om Grönland **100**(6): 155 pp.

Verrill, A.E. 1881. Notice of the remarkable marine fauna occupying the outer banks off the southern coast of New England, No. 2. Amer. Jour. Sci., 3 ser. **22**: 292–303.

Vokes, H.E. 1956. Notes on, and rectifications of, pelecypod nomenclature. Jour. Paleo. **30**(3): 762–765.

Warmke, G.L. and R.T. Abbott. 1961. Caribbean Sea-shells. Narberth, Pennsylvania, 346 pp., 44 pls.

Waterfall, L.N. 1929. Univ. California Pub., Bull. Dept. Geol. Sci. **18**(3): 71–92, pls. 5–6.

Winckworth, R. 1934. Names of British Mollusca III. Jour. Conch. **20**(2): 51–53.

Zittel, K.A. von. (trans. by C. R. Eastman). 1900. Text-book of Palaeontology. New York **1**: 390 pp.

Book Reviews

Gould, A.A. 1841, Report on the Invertebrata of Massachusetts, Cambridge, Mass., pp. xiii + 373, pls. 15. This was the first publication in North America to cover extensively the fauna of a geographic area the size of the State of Massachusetts. All types of mollusks are covered: the land, freshwater and marine forms. A few other Phyla are covered, such as the Crustacea, Annelida and Echinodermata, but not the Insecta. 318 out of 373 pages are devoted to the Mollusca.

The full impact of this volume upon the culture of that period probably will never be fully known. It was a great stimulation to W. H. Dall as a young malacologist as it was to many other scientists. Gould gave a copy to William Stimpson, then only a young man, and this single gift was responsible for his career in the field of malacology.

Gould made all of the 213 beautifully executed figures which were then engraved on copper plates. His descriptions are full and exceedingly clear and understandable.

Gould, A.A., edited by W.G. Binney 1870, Report on the Invertebrata of Massachusetts, Boston, Mass., pp. v + 524, pls. 12 and 405 text figures. The 1841 edition was soon out of print, and in 1865 the Legislature of Massachusetts directed a new and revised edition of this work to be published by Dr. Gould. In 1866, Dr. Gould, with the revision only partially completed, died. In 1867, the Legislature authorized the Governor and Council to appoint some person to complete the work, and W. G. Binney was chosen to do this task. The original copper plates could not be located, so the task fell to E. S. Morse to make a complete set of drawings on wood which composed the text figures. All of the plates but one are in color and these mainly showing nudibranchs and cephalopods. All of the figures on the plates as well as the text figures are numbered, continuing the numbers given in the first edition. The last figure in the first edition was no. 213, the first figure on the first plate in the second edition is no. 214 and ends on the last plate with fig. 349. The text figures start with no. 350 and end with no. 755.

Old as this work is, it still is our standard reference for New England, the names being modernized by C. W. Johnson's "Mollusca of New England" (1915) and his "List of Marine Mollusca of the Atlantic Coast from Labrador to Texas" (1934).

The first edition was concerned mainly with Massachusetts; the second edition was much broader in scope and dealt with nearly all of New England.

—W. J. Clench