

Species of *Ecphora*, Including the Subgenus *Stenomphalus*, in the Pungo River Formation

Druid Wilson

ABSTRACT

Published references to the genus *Ecphora* and the subgenus *Stenomphalus* and their species are summarized, including American and European stratigraphic and geographic occurrences. *Ecphora* "quadricostata" of the Maryland St. Marys Miocene is here named *Ecphora* (*Ecphora*) *gardnerae* and two other new species, *Ecphora* (*Ecphora*) *pamlico* and *Ecphora* (*Stenomphalus*) *aurora* are described from the Middle Miocene Pungo River Formation. *E. (S.) aurora* is noted in both America and Europe.

Introduction

Specimens of the species of the gastropod genus *Ecphora* have long engaged the interest of naturalists and collectors alike. In areas where they are available *ecphoras* are second only to shark teeth as fossils of interest to the public. Perhaps no American fossil has been so widely illustrated, particularly copies of *Ecphora* "quadricostata" figured by Martin in the *Maryland Geological Survey Miocene* volume in 1904. It has been claimed that *Ecphora quadricostata* was the first American fossil to be illustrated (Shattuck, 1904:xxxiv; Vokes, 1957:30; Raup, 1961:606). As pointed out by Harris (1937:443) and also noted by Ward and Blackwelder (1975:3), three extinct Tertiary species, *Chesapecten jeffersonius*, *Mercenaria "tridacnoides"*, and the *Ecphora* are all illustrated in Lister's *Historiae Conchyliorum*. The various parts of Lister's two editions of his work were published between 1685 and 1697 and the Huddesford edition in 1770. According to the findings of Engelmann (1846:461) and Wilkins (1957:203–204), no claim to priority can be made for Lister's figure of *Ecphora*; the plate on which it appears was not published until 1770 in the Huddesford edition. One hesitates, but the figure representing *Chesapecten jeffersonius*, published in the first edition of Lister in

liber III in 1687 (pl. 167), apparently is first; a close second is *Mercenaria "tridacnoides"* in the appendix to liber III (Lister, 1688, pl. 499).

Discovery in North America of specimens of new species of *Ecphora* (*Ecphora*), and of *Ecphora* (*Stenomphalus*) (until now known only in the Miocene of Europe), are of great interest, and their probable relationships with European species are also possibly of great significance.

Three species of *Ecphora* occur in the Pungo River Formation: *Ecphora* (*Ecphora*) *tricostata* Martin, and the two new species, *Ecphora* (*Ecphora*) *pamlico* and *Ecphora* (*Stenomphalus*) *aurora*. Only *Ecphora tricostata* has been collected in place, as reported by Gibson (1967:639, fig. 4). Nevertheless, the matrix associated with the specimens indicates that each species occurs in a separate bed. According to Gibson, *E. tricostata* occurs in unit 7 at the top of the Pungo River Formation. Gibson (pers. com.) considers that the matrix of limestone with considerable phosphate grains associated with a float specimen of *E. tricostata* may indicate that it came from as low as unit 5. He believes that the small pebble-sized phosphate in the matrix associated with specimens of *Ecphora pamlico* is characteristic of beds lower than unit 5, but not as low in the section as the thoroughly phosphatized matrix of the specimens of *Ecphora* (*Stenomphalus*) *aurora*. *E. (S.) aurora* may also occur in the Burdigalian and Helvetian Miocene in France. I believe that Cossmann and Peyrot (1924:534–536, pl. 14: fig. 47, pl. 15: fig. 19) have misidentified this species as *Ecphora moulinsii* (Brochon, 1849:117–128, figs. 1, 2), a strikingly different species named from type Burdigalian at Léognan, France. It is interesting that *Ecphora* (*Ecphora*) *jauberti* (Grateloup, 1840, pl. 1: figs. 3, 4), a very rare European species related to *E. (E.) pamlico*, occurs in the Tortonian Miocene of Saubrigues, France, according to Cossmann and Peyrot (1924:534). If this is so, then *E. (E.) jauberti* occurs later than *E. (S.) aurora* in France, just as the closely related *E. (E.) pamlico* apparently does at Lee Creek. No particular significance can be placed on these possible temporal-stratigraphic relationships until *pamlico* and *aurora* are collected in place in America and the rare *jauberti* is recollected in France. Cossmann and Peyrot (1924:534–535) reported

Druid Wilson, Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

that the type specimen of *E. jauberti* (Grateloup) is lost and no other specimens have been collected.

ACKNOWLEDGMENTS.—My appreciation is tendered to Jack H. McLellan and Royal Mapes without whose collecting this paper would never have been written, to Robert H. McKinney and Haruo Mochizuki of the U.S. Geological Survey for the excellent photographs and prints, and to Barbara Bedette for ever ready and timely aid. I am especially grateful to Dr. Elizabeth Kuster-Wendenburg of the Naturkundemuseum, Kassel, Germany, for her early response to my request for information about the type-species of the subgenus *Stenomphalus*. I thank Dr. Karl Kleemann of Naturhistorisches Museum Wien, Austria, for a xerox of a part of a very rare publication.

Genus *Ecphora* Conrad, 1843

Ecphora Conrad, 1843:310.

TYPE-SPECIES.—*Fusus 4-costatus* Say (1824:127, pl. 7: fig. 5); by monotypy. Say's protograph is of the species found in the Yorktown Formation of Virginia. Sohl (1964:173) characterized the genus *Ecphora* as

small to moderately large subfusiform shells and a moderately low spire. Whorls strongly shouldered, with strong spiral carinations over periphery; basal constriction strong. Whorls may be loosely attached. Aperture ovate, produced to a narrow, generally elongate and curving siphonal canal terminating in a moderately strong notch; outer lip crenulate; inner lip moderately thick, free or partly attached over parietal surface. Umbilicus broad, open, deep, and margined by a serrate strong carina.

Shells of *Ecphora* consist of two layers; a thick outer translucent brown layer and a thinner light-colored inner layer, which is sometimes leached away. Zalman Altschuler (pers. com.) of the U.S. Geological Survey has determined by x-ray identification that the outer layer of specimens of *E. quadricostata* and *E. gardnerae* is almost entirely calcite and the inner layer entirely aragonite. Aragonite, being less stable, is often leached away, as in the numerous specimens of *Ecphora quadricostata* from the Yorktown Formation at Lee Creek.

Ecphora tricostata Martin (1904:209, pl. 52: figs. 5, 6) occurs in the Miocene Calvert Formation (rarely in the Choptank) in Maryland and in the Pungo River Formation in North Carolina.

Some species not originally referred to the genus *Ecphora* are here included in it and some initially called *Ecphora* are here excluded from it.

Rapana tampaensis Dall (1890 [1890–1903]:153; 1915:78, pl. 13: fig. 8), first referred to *Ecphora* by Cossman (1903:65), is from the Tampa Formation of Florida. The species also occurs in the "Silverdale" beds (USGS 23108) of North Carolina. These beds are approximately of the same age. Current research in micro- and macro-paleontology of the Silverdale fauna indicates that it may be late Oligocene in age rather than early Miocene. The

fragmentary specimen from these beds identified by Richards (1943:524, pl. 85: fig. 16) as *E. quadricostata*, is apparently the same as an undescribed species from Silverdale in the U.S. National Museum collection (USGS 21943).

The specimen (USNM 112520) from Church Hill, Maryland (Calvert Formation) figured by Dall (1892 [1890–1903] pl. 20: fig. 14) as *Rapana tampaensis* Dall, var.? and referred to as *Ecphora tampaensis* by Martin (1904:211, pl. 52: fig. 9) followed by Grabau and Shimer (1909:787, fig. 1152a) was later named *Rapana ecclesiastica* by Dall (1915:78). Martin had noted that "*Fasciolaria (Lyrosoma) sulcosa*" of Whitfield (1894, pl. 17: figs. 9, 10; not Conrad (1830:220, pl. 9: fig. 8) was related; subsequently Richards and Harbison (1942:211) synonymized Whitfield's species with *ecclesiastica*. I am indebted to the late W.P. Woodring for pointing out (pers. com.) that *ecclesiastica* should be referred to the genus *Tritonopsis* Conrad (1865:20) found in the late Eocene of Panama (Woodring, 1973:477, pl. 70: figs. 26, 27) and the Oligocene of Mississippi.

Sohl (1964:173) has outlined the problem of considering *Ecphora proquadricostata* Wade, a Cretaceous species, as the earliest known *Ecphora*. Zalman Altschuler (pers. com.) has determined that the entire shell of *E. proquadricostata* is aragonitic. This fact strengthens my opinion that there is no direct genetic connection with the known later species, though as pointed out by Sohl, the Cretaceous species is morphologically like *Ecphora*. I believe that the earliest undoubted ecphoras are in the Oligocene both in Europe and in North America. *Ecphora koeneni* G6rges (1952:6, pl. 2: fig. 11a, b) judging from the figure, is an *Ecphora*, sensu stricto. It is from the Oligocene of North Germany. The poorly preserved impression identified by Dall (1894:301) as "*Ecphora quadricostata*" from the "land phosphate" rock of South Carolina, is undoubtedly of the genus *Ecphora*. An examination of the associated specimens and Dall's list of species indicates that they come from the Oligocene Cooper Marl.

Ecphora (Ecphora) gardnerae, new species

FIGURE 1A,B

Ecphora quadricostata.—Martin 1904:207, pl. 52: fig. 1.

It is now known that most if not all of the fossils described by Say in 1824 came from Virginia rather than Maryland, contrary to Say's title "An Account of Some of the Fossil Shells of Maryland." According to Gardner (1948:201), "Mansfield believed from internal evidence that they came not from Maryland but from Virginia" and Dall (1892 [1890–1903]:351) had earlier doubted the provenience of a Say species. Ward and Blackwelder (1975:9, 16) have shown that the common pecten of the Maryland Miocene is not *Pecten madisonius* Say as formerly universally used, but that the name in fact belongs to a Yorktown species of

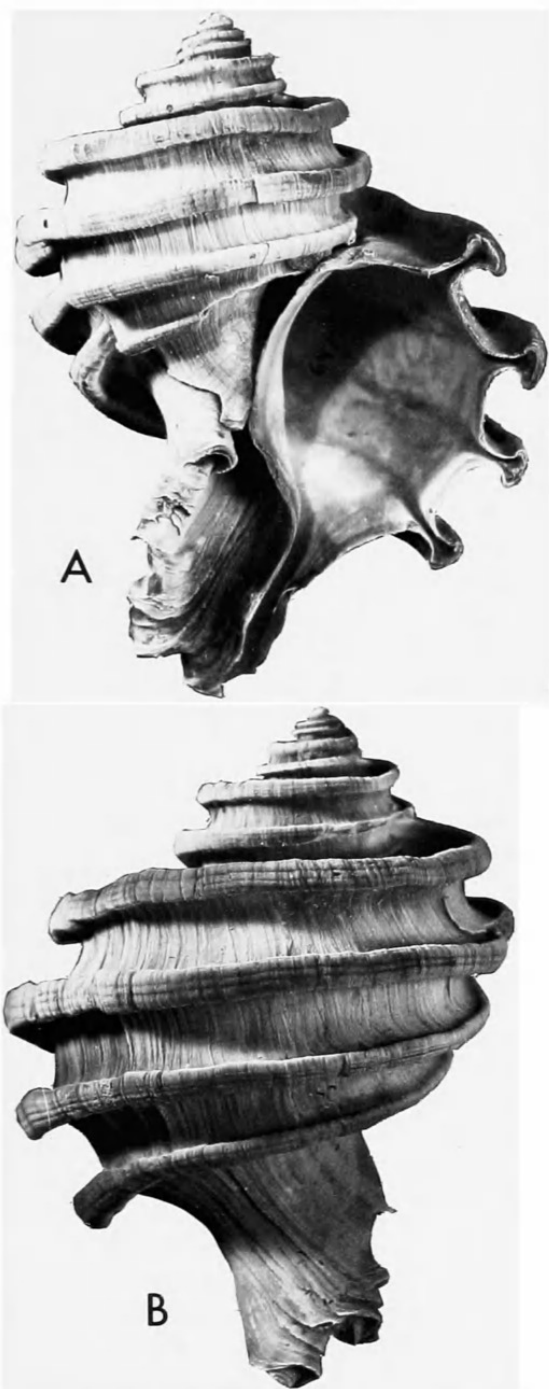


FIGURE 1.—*Ecphora (Ecphora) gardnerae*, new species, holotype, USNM 647519, height about 120 mm; A, apertural view; B, dorsal view.

Virginia. This confusion of locality undoubtedly initiated the chain of coincidence that resulted in the common *Ecphora* of the St. Marys Miocene of Maryland masquerading under the name "*Ecphora quadricostata*," which properly belongs to the Yorktown species of Virginia. This St. Marys Miocene species is here named *Ecphora (Ecphora) gardnerae*, new species. In *Ecphora gardnerae* the four prominent spiral ribs become stronger with maturity, in contrast to the ribs in *E. quadricostata*, which become weaker with age. The holotype of *Ecphora gardnerae* (USNM 647519) is the specimen figured by Martin.

Probably because the name *Ecphora quadricostata* had been preempted for the Maryland St. Marys species, the name *Ecphora umbilicata* (Wagner) has had some usage as the name for the Yorktown species. "*Fusus umbilicata* Wagner" Dall (1898 [1897]:9, pl. 2: fig. 2) is a synonym of *Ecphora quadricostata* Say, as very early recognized by Cossmann (1898:110), as well as a homonym of *Fusus umbilicata* Smith (1839:98, pl. 1: fig. 2). It has also been used by Martin (1904:209, pl. 52: fig. 4) for a Choptank Miocene species of Maryland, which apparently needs a name. Mansfield (1930:71) recognized that the Choptank species was not the same as *F. umbilicata* Wagner (i.e., *E. quadricostata*). Dall (1898:8) related the circumstances concerning "Wagner's plates" and reference to them in Bronn's Index (1848:517, 1849:455). Brochon's repeated reference (1849:119, 124, 127) to "*Fusus quadricostatus* Wagner" (with no mention of Say) establishes their circulation, but their subsequent treatment by Martin (1904:209) and by Mansfield (1930:70) as validly published is not justified. In any case, a date earlier than 1839 would have to be proved because of the prior use of the name by Smith. These bits of information indicate probable correspondence between Brochon and Wagner and perhaps realization by Wagner that his figure represented Say's species *quadricostatus*. Brochon (1849:128) does establish that "le *Fusus* de Wagner provient des couches pliocenes de Virginie," a fact apparently not known to Dall. Another nominal species, *Ecphora parvicostata* Pilsbry (1911:438, fig. 1), with only "Maryland" for locality, is apparently nothing more than an extreme variation of *E. quadricostata* and must have come from Virginia.

A large well-preserved specimen (USNM 106919) of *Ecphora* in the National Museum of Natural History supposedly from Florida was identified by Dall as *Ecphora quadricostata*. Because it was repeatedly mentioned by Dall and undoubtedly had an early influence on his thinking concerning the age of the beds from which it was supposed to have come, it seems desirable to document and dispose of the specimen. It had come to the National Museum from R.E.C. Stearns, who was on an expedition to Florida in 1869. Dall (1885:82) first reported the specimen as found at Tampa "on the long rocky point"; later he (1887:166) identified the locality as Ballast Point, and later still (1890:8, 125) as "Long Key . . . containing no solid rock of any sort." At this time Dall seems to have had some reservations probably due to the discrepancies. Although he still considered the specimen as possibly from the silex bed, he recognized that the specimen was not silicified. Dall and Harris (1892:125) referred it to a "later horizon" and Dall's final notice (1903 [1890–1903]:1596) in his "List of Species of the Floridian Miocene" repeated this pronouncement. A critical examination of the specimen and comparison with specimens from the St. Marys River leads to the conclusion that it is a specimen of *Ecphora gardnerae* from the St. Marys Miocene of Maryland. Stearns (1869:466–467) did not

mention the find in his account of his stay on Long Key or any other locality. His wide interests and knowledge of mollusks is so well demonstrated that it seems unlikely that a find so unusual would have gone unrecorded. There seems to be no satisfactory accounting for this confusion. Eppert's reference (1966:49, 58) to "*Ecphora quadricostata umbilicata*" is a lapsus and undoubtedly concerns Stearns' specimen.

Ecphora (Ecphora) pamlico, new species

PLATE 1: FIGURES 1, 2

Shells moderately large with angle-sided whorls; three prominent spiral thin flange-like costae at the whorl angles. Secondary sculpture of many spiral bands between costae; bands becoming obsolete or nearly so on the flattened shoulder; posterior interspace between the costae wider than anterior interspace. Aperture ovate; anteriorly produced into a very narrow, broadly curved canal. Umbilicus large, rounded and bordered by a regularly and weakly stepped (or serrated) carina.

Most specimens are both distorted and defective; neither spires nor canals are complete in any specimen. The holotype is the only undistorted large specimen (Plate 1: figure 2).

MEASUREMENTS.—Holotype, height about 65 mm, width about 65 mm; aperture of holotype not exposed; figured paratype, height about 58 mm, width about 44 mm.

Ecphora (E.) pamlico is represented by 25 specimens; all are caught up in a phosphatized matrix with dark phosphate pebbles throughout. A small slab collected by Royal Mapes contains nine specimens. No specimen has been collected in place, but the associated matrix is considered by Gibson (pers. com.) to indicate beds lower than unit 5 of the Pungo River Formation.

REMARKS.—*Ecphora (E.) pamlico* is related to a large undescribed species of *Ecphora* in the National Museum of Natural History from zone 10 of the Calvert Formation of Maryland, collected by the late Sydney F. and Doris Blake. It is also related to *E. (E.) jauberti* (Grateloup) (Plate 1: figures 3, 4) found in the Tortonian of Saubrigues, France.

TYPES.—Holotype USNM 647668; figured paratype USNM 647671, unfigured paratypes USNM 647669-647670, 647672-647679.

OCCURRENCE.—Known only from the Pungo River Formation at Lee Creek, North Carolina.

Subgenus *Stenomphalus* Sandberger, 1861

Subgenus *Stenomphalus* Sandberger, 1861:222.

The type-species by subsequent designation (Dall, 1890: 124) is *Fusus cancellatus* Thomä (= *Ecphora (Stenomphalus) caerulea ornata* Bucher). The nomenclatorial imperatives

and the interspecific relationship are derived from the work of Zilch (1983:93–101, pl. 10), who has recently published the results of his studies of the species group to which the type-species belongs. *Fusus cancellatus* Thomä (1845:162, pl. 4: fig. 8) is four times preoccupied; first by Sowerby (1826:45). Braun's later, undescribed substitute name (1851:1131), listed thus "*Fusus brevis* A. Braun (*F. cancellatus* Thomae a.o.a. O.S. 162)," valid only by the included reference to Thomä's species, is preoccupied by *Fusus brevis* Brown (1827, pl. 48: fig. 34). The earliest described species name in the group is *Buccinum caeruleum* Römer-Büchner (1827:18, pl. 1: figs. 1–3) published in a work so rare that it was not recorded in the famed Index Animalium of Sherborn. A copy of Römer-Büchner's work could not be located in the United States, and I have seen only a xerox of the pertinent part. A species named by Bucher (1913:93, 96, pl. 1: figs. 8–10) *Stenomphalus cancellatus ornatus* is from the type-locality of *F. cancellatus*. Since Wenz's (1932) resurrection of Römer-Büchner's species name and revision of the nomenclature, *S. caeruleus ornatus* Bucher has been maintained as the valid name for the type-species of *Stenomphalus* Sandberger. Presumably the species is quite variable; Thomä's type figures (1845, pl. 4: figs. 8a, 8b) show obvious differences from the somewhat larger specimens figured by Sandberger (1860, pl. 17: figs. 7, 7a, 7b). Sandberger's figures have been considered as representing the typical form by Boettger (1883:218). Both Thomä and Sandberger reported the species as abundant at Hochheim, the type-locality. Thirteen specimens in the U.S. National Museum collections from three localities (Hochheim, Florsheim, and "Flonheim u. Alzey," including seven from the type-locality (Hochheim), are more nearly like Thomä's figures in size and outline, but some of them exhibit the broader spiral bands of Sandberger's figures. According to Zilch (1983) the type-locality is in the early Miocene "Cerithien-Schichten" of the Mainz Basin, Germany.

The shells of the species of the subgenus *Stenomphalus* are characterized by a reduction in the strength of the spiral sculpture and a much less prominent umbilicus. The species are generally smaller than species of the typical subgenus.

Ecphora (Stenomphalus) aurora, new species

PLATE 2: FIGURES 1–5

?*Rapana (Ecphora) Moulinsii* (Brochon).—Cossmann and Peyrot, 1924:534, pl. 14: fig. 47; pl. 15: fig. 19?

Shell moderately large for the subgenus, pyriform with rounded whorls bearing three primary low but prominent spiral bands, which in turn bear secondary bifid spiral bands; the anterior primary band hardly set off from the anterior secondary bifid spiral bands of the anterior of the body whorl; shoulder flattened and sunken below edge of posterior primary band. Broadly ovate aperture anteriorly pro-

duced into a slightly curved siphonal canal. Umbilicus anteriorly produced and bordered by a rudely stepped carina.

All large well-preserved specimens of *E. (S.) aurora* are somewhat distorted; the strong step-like feature of the outer lip just below the shoulder on the figure of the holotype (Plate 2: figure 1) is a result of distortion. The umbilical region of the paratype (Plate 2: figure 5) is the least distorted of any specimen.

MEASUREMENTS.—Holotype, height 80 mm, width 55 mm; illustrated paratype, height 44.5 mm, width 30.5 mm.

SPECIMENS EXAMINED.—*Ecphora (S.) aurora* is represented by 95 specimens including many fairly well-preserved specimens and some steinkerns. They all have a completely phosphatized matrix that Gibson (pers. com.) regards as occurring lower in the Pungo River Formation than the matrix associated with *E. (E.) pamlico*, new species.

TYPES.—Holotype, USNM 647654 (Plate 2: figures 1–3); illustrated paratype, USNM 647656 (Plate 2: figures 4, 5); other paratypes, USNM 647655, 647657–647667.

OCCURRENCE.—Pungo River Formation, Lee Creek, North Carolina, and Saucats (Peloua), France.

REMARKS.—*Ecphora (S.) aurora* is not related to any American species, but it seems to be the same as the species figured by Cossmann and Peyrot (1924) from France as *Rapana (Ecphora) moulinsii* (Brochon); particularly their figured specimen from the Burdigalian at Saucats (Peloua) (Plate 2: figure 7). Brochon's species (1849:117–128, figs. 1, 2) was described from the type Burdigalian at Léognan (Coquillat) and the original figures copied here (Plate 1: figures 5, 6) are strikingly different from the figures of Cossmann and Peyrot. Cossmann and Peyrot (1924:536) suggested that the specimen from the Helvetian at Salles

figured by them may be reworked; if this is true, both species are confined to the Burdigalian.

Stratigraphic Order of the American Species of *Ecphora*

- E. quadricostata* (Say): Yorktown Formation and equivalents. Virginia to Florida; traditional late Miocene of the Coastal Plain; currently regarded as Pliocene by many micropaleontologists.
- E. gardnerae*, new species: St. Marys Miocene of Maryland and Eastover Formation, late Miocene, of Virginia. (See Ward and Blackwelder, 1980:19, 28; pl. 1: fig. 2).
- E. "umbilicata"* of Martin: Choptank Miocene of Maryland.
- E. tricostata* Martin: Choptank and Calvert Miocene of Maryland and upper part of Pungo River Formation (unit 7) in North Carolina. My report (see Espenshade and Spencer, 1963, table 10) of *Ecphora* cf. *E. tricostata* in a drill hole sample from central north Florida, said to be of middle(?) Miocene age, is based on fragmentary material. However, both the "cf." of the species and the query of the age should be removed.
- E. pamlico*, new species: Pungo River Formation of North Carolina, but apparently below the occurrence of *E. tricostata*.
- E. aurora*, new species: Lower part of the Pungo River Formation of North Carolina.
- E. tampaensis* (Dall): Tampa Limestone of Florida, "Silverdale beds" of North Carolina (USGS 23108); early Miocene or late Oligocene.
- E. "quadricostata"* of Dall: Cooper Formation Oligocene of South Carolina.

Literature Cited

- Boettger, O.
1883. Palaeontologische Mittheilungen: Die Arten der Gattungen Stenomphalus Sbg. und Cypraea L. im Mainzer Becken. *Offenbacher Vereins für Naturkunde Bericht*, 22/23:217–224, plate 1.
- Braun, A.
1851. Die fossile Fauna des Mainzer Beckens: Wirbellose Thiere. In F.A. Walchner, *Handbuch der Geognosie . . .*, second edition, pages 1112–1141.
- Brochon, E.H.
1849. Note sur une pyrule nouvelle de Léognan (P. de Des Moulins.—*P. moulinsii*, Nob.).—Quelques mots sur le genre.—Descriptions et figure de l'espèce. *Actes de la Société Linnéenne de Bordeaux*, 16:117–128, 2 figures.
- Bronn, H.G.
1848. *Index Palaeontologicus, oder Uebersicht der bis jetzt bekannten fossilen Organismen . . .* Volume 1/2, 1382 pages.
1849. *Index Palaeontologicus, oder Uebersicht der bis jetzt bekannten fossilen Organismen . . .* Volume 3, 1106 pages. Stuttgart.
- Brown, Thomas
1827. [Illustrations of the Conchology of Great Britain and Ireland.] pages i–v, 52 plates [with extensive explanations]. London.
- Bucher, W.
1913. Beitrag zur geologischen und paläontologischen Kenntnis des jüngeren Tertiärs der Rheinpfalz. *Geognostische Jahresheft* 26: 1–103, plates 1–2.
- Conrad, T.A.
1830. On the Geology and Organic Remains of a part of the Peninsula of Maryland; with appendix. *Journal of the Academy of Natural Sciences of Philadelphia*, 6:205–230, plates 9, 10.
1843. Descriptions of a New Genus, and of Twenty-nine New Miocene, and One Eocene Fossil Shells of the United States. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1:305–311.
1865. Catalogue of the Eocene and Oligocene Testacea of the United States. *American Journal of Conchology*, 1(1):1–35.
- Cossmann, A.E.M.
1898. [Review of] Notes on the Paleontological Publications of Professor William Wagner, by W. H. Dall. *Revue Critique de Paléozoologie*, 2e Ann.—1898, 3:110–111.
1903. *Essais de Paléoconchologie Comparée*. Volume 5, 215 pages, 9 plates. Paris: private publication.
1925. *Essais de Paléoconchologie Comparée*. Volume 13, 345 pages, 11 plates. Paris: private publication.

- Cossmann, A.E.M. and A. Peyrot
1924. *Conchologie Néogénique de l'Aquitaine*. 4(2):323–621, plates 8–18.
- Dall, W.H.
1885. Miocene Deposits in Florida. *Science*, 6:82.
1887. Notes on the Geology of Florida. *American Journal of Science*, (3)34(201):161–170.
1890–1903. Contributions to the Tertiary Fauna of Florida with Especial Reference to the Miocene Silex-beds of Tampa and the Pliocene Beds of the Caloosahatchie River. *Transactions of the Wagner Free Institute of Science of Philadelphia*, 3, part 1 (1890):1–200, plates 1–12; part 2 (1892):201–474, plates 13–22; part 3 (1895):475–570; part 4 (1898):571–948, plates 23–35; part 5 (1900):949–1218, plates 36–47; part 6 (1903):1219–1654, plates 48–57.
1894. Notes on the Miocene and Pliocene of Gay Head, Martha's Vineyard, Mass., and on the "Land Phosphate" of the Ashley River District, South Carolina. *American Journal of Science*, (3)48(286):296–301.
1898. Notes on the Paleontological Publications of Professor William Wagner. *Transactions of the Wagner Free Institute of Science of Philadelphia*, 5 [15 Oct. 1897]:7–11, 3 plates.
1915. A Monograph of the Molluscan Fauna of the *Orthaulax pugnax* zone of the Oligocene of Tampa, Florida. *United States National Museum Bulletin*, 90:1–173, plates 1–26.
- Dall, W.H., and G.D. Harris
1892. Correlation Papers, Neocene. *United States Geological Survey Bulletin*, 84:1–349, figures 1–43, plates 1–3.
- Engelmann, Wilhelm
1846. *Bibliotheca Historico-Naturalis: Verzeichniss der Bücher über Naturgeschichte welche . . . in den Jahren 1700–1846 . . .* Volume 1, 786 pages. Leipzig.
- Eppert, H.C., Jr.
1966. Stratigraphy of the Upper Miocene Deposits in Sarasota County, Florida. *Tulane Studies in Geology*, 4(2):49–61, figures 1, 2.
- Espenshade, G.H., and C.W. Spencer
1963. Geology of Phosphate Deposits of Northern Peninsular Florida. *United States Geological Survey Bulletin*, 1118:1–115, plates 1–12, tables 1–25.
- Gardner, J.A.
1948. Mollusca from the Miocene and Lower Pliocene of Virginia and North Carolina, Part 2: Scaphopoda and Gastropoda. *United States Geological Survey Professional Paper*, 199-B:179–310, plates 24–38.
- Gibson, T.G.
1967. Stratigraphy and Paleoenvironment of the Phosphatic Miocene Strata of North Carolina. *Geological Society of America Bulletin*, 78(5):631–650, 4 figures, 2 plates.
- Görges, J.
1952. Neue Invertebrata aus dem Norddeutschen Oberoligozän. *Paläontologische Zeitschrift*, 26(1/2):1–9, plates 1–2.
- Grabau, A.W.A., and H.W. Shimer
1909. *North American Index Fossils: Invertebrates*. Volume 1, viii + 853 pages. illustrated. New York.
- Grateloup, J.P.S. de
1840. *Conchyliologie fossile des terrains tertiaires du bassin de L'Adour* Atlas, xx + 12 plates, 48 plates. Bordeaux.
- Harris, G.D.
1937. First Century of Progress in Cenozoic Marine Invertebrate Paleontology. *Geological Society of America Bulletin*, 48(4):443–462.
- Huddesford, William, editor
1770. *M. Lister, Historiae sive Synopsis methodicae Conchyliorum . . .* Altered edition in 6 parts: iv + 6 (notes) + 7 (plate explanations) + [ii] + 12 + 77 (index) pages, 1059 plates. Oxonii.
- Lister, M.
1685–1697. *M. Lister, Historiae sive Synopsis methodicae Conchyliorum . . .* First edition (1685–1692), 1057 plates; second edition (1692–1697), 1059 plates. Londini.
- Mansfield, W.C.
1930. Miocene Gastropods and Scaphopods of the Choctawhatchee Formation of Florida. *Florida Geological Survey Bulletin*, 3:1–190, plates 1–21.
- Martin, G.C.
1904. Systematic Paleontology: Gastropoda. *Maryland Geological Survey, Miocene*, pages 131–270, plates 39(part)–63.
- Pilsbry, H.A.
1911. A New *Ecphora* of the Chesapeake Miocene. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 63:438–439, figure 1.
- Raup, D.M.
1961. The Geometry of Coiling in Gastropods: *Proceedings of the National Academy of Sciences*, 47(4):602–609, 4 figures.
- Richards, H.G.
1943. Additions to the Trent Marl of North Carolina. *Journal of Paleontology*, 17(5):518–526, plates 84–86.
- Richards, H.G., and A. Harbison
1942. Miocene Invertebrate Fauna of New Jersey. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 94:167–250, figures 1–9, plates 7–22.
- Römer-Büchner, B.J.
1827. *Verzeichniss der Steine und Thiere, welche in dem Gebiete der freien Stadt Frankfurt und deren nächsten Umgebung gefunden werden*. Frankfurt am Main. [Not seen.]
- Sandberger, C.L.F. von
1858–1863. *Die Conchylien des Mainzer Tertiärbeckens*. 1–72, plates 1–10, 1858; 73–112, plates 11–15, 1859; 113–152, plates 16–20, 1860; 153–232, plates 21–30, 1861; 233–272, plates 31–35, 1862; 273–358 + 8 unnumbered index pages, 1863. Wiesbaden. [Bibliographic details from p. 150 of F. Schönendorf, 1907. Verzeichnis der im Naturhistorischen Museum zu Wiesbaden Aufbewahrten Originale. Abteilung für Geologie und Paläontologie. 1. Originale zu Frid. Sandberger, Die Konchylien des Mainzer Tertiärbeckens. *Jahrbuch Nassauischen Vereins Naturkunde*, 60:148–169.]
- Say, T.
1824. An Account of Some of the Fossil Shells of Maryland. *Journal of the Academy of Natural Sciences of Philadelphia*, 4:124–155, 410, plates 7–13. [Reprinted 1896 in G.D. Harris, A Reprint of the Paleontological Writings of Thomas Say, *Bulletins of American Paleontology*, 1(5):300–346.]
- Shattuck, G.B.
1904. Geological and Paleontological Relations, with a Review of Earlier Investigations. *Maryland Geological Survey, Miocene*, pages xxxiii–cxxxvii.
- Smith, J.
1839. On the Last Changes in the Relative Levels of the Land and Sea in the British Islands. *Wernerian Natural History Society Memoir*, 8:49–113, plates 1–2.
- Sohl, N.F.
1964. Neogastropoda, Opisthobranchia and Basommatophora from the Ripley, Owl Creek, and Prairie Bluff Formations. *United States Geological Survey Professional Paper*, 331-B:1–344, plates 1–52.
- Sowerby, J.
1812–1846. *The Mineral Conchology of Great Britain . . .* 7 volumes. London. [For bibliographic details and dates see p. 323 of R.B. Newton, 1891. *Systematic List of the Frederick E. Edwards Collection of British Oligocene and Eocene Mollusca in the British Museum*

- (*Natural History*) . . . xxviii + 365 pages, 1 table. London: British Museum (Natural History).]
- Stearns, R.E.C.
1869. Rambles in Florida. *American Naturalist*, 3(6):281–288; (7):349–356; (8):397–405; (9):455–470.
- Thomä, C.
1845. Fossile Conchylien aus den Tertiärschichten bei Hochheim und Wiesbaden Gesammelt, und in Naturhistorischen Museum zu Wiesbaden Aufgestellt. *Jahrbuch Nassauischen Verein für Naturkunde*, 2:125–166, 4 plates.
- Vokes, H.E.
1957. Miocene Fossils of Maryland. *Maryland Geological Survey Bulletin*, 20:1–85, plates 1–31.
- Ward, L.W., and B.W. Blackwelder
1975. *Chesapecten*, a New Genus of Pectinidae (Mollusca: Bivalvia) from the Miocene and Pliocene of Eastern North America. *United States Geological Survey Professional Paper*, 861:1–24, figures 1–2, plates 1–7.
1980. Stratigraphic Revision of Upper Miocene and Lower Pliocene Beds of the Chesapeake Group, Middle Atlantic Coastal Plain. *United States Geological Survey Bulletin*, 1482-D: 61 pages, 25 figures, 5 plates.
- Wenz, W.
1932. Wirbellose Metazoa des Neozoikums. In W. Salomon-Calvi, *Oberrheinischer Fossilkatalog*, 7:1–95.
- Whitfield, R.P.
1894. Mollusca and Crustacea of the Miocene Formations of New Jersey. *United States Geological Survey Monograph*, 24:1–193, plates 1–24.
- Wilkins, G.L.
1957. Notes on the *Historia Conchyliorum* of Martin Lister (1638–1712). *Journal of the Society for the Bibliography of Natural History*, 3(4):196–205.
- Woodring, W.P.
1973. Geology and Paleontology of Canal Zone and Adjoining Parts of Panama: Description of Tertiary Mollusks (Additions to Gastropods, Scaphopods, Pelecypods: Nuculidae to Malleidae). *United States Geological Survey Professional Paper*, 306-E:453–540, plates 67–82.
- Zilch, Adolf
1983. Die Typen und Typoide des Natur-Museums Senckenberg, 69: Mollusca: Muricidae: Rapaninae: *Stenomphalus*. *Archiv für Molluskenkunde*, 113(1/6):93–101, plate 10.

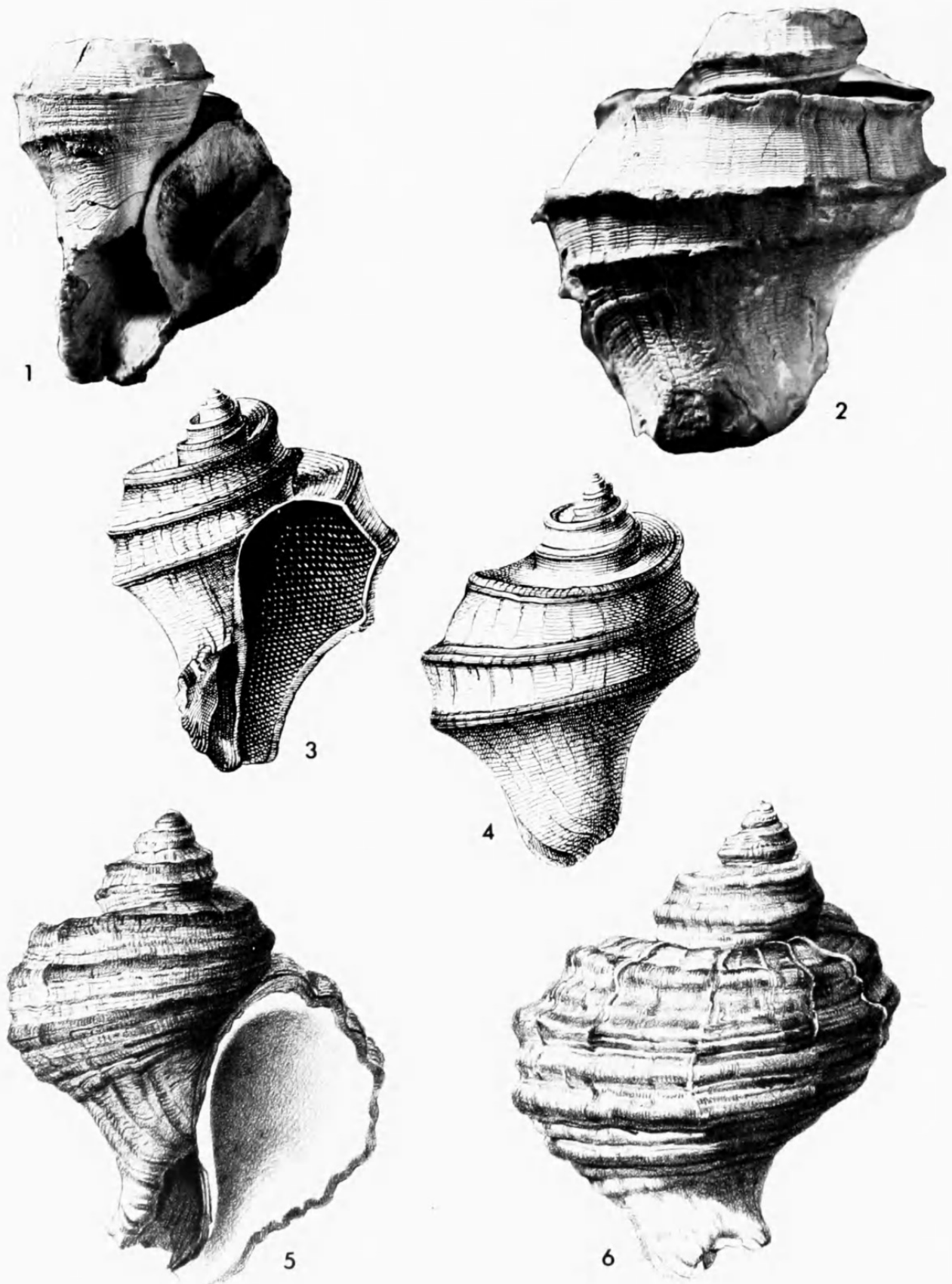


PLATE 1

- 1, 2. *Eophora (Eophora) pamlico*, new species: 1, paratype, USNM 647671, apertural view, height about 58 mm; 2, holotype, USNM 647668, dorsal view, height about 65 mm.
- 3, 4. *Eophora (Eophora) jauberti* (Grateloup), Saubrigues, France, Tortonian Miocene (after Grateloup, 1840): 3, apertural view; 4, dorsal view.
- 5, 6. *Eophora (Stenomphalus) moulinsii* (Brochon), Léognan, France, type Burdigalian Miocene (after Brochon, 1849): 5, apertural view; 6, dorsal view.



PLATE 2

- 1-5. *Ecfhora (Stenomphalus) aurora*, new species: 1-3, holotype, USNM 647654, height 80 mm; 4, 5, paratype, USNM 647656, height 44.5 mm: 1, apertural view; 2, dorsal view; 3, apical view; 4, apertural view; 5, dorsal view.
- 6, 7. ?*Rapana (Ecfhora) moulinsii* sensu Cossmann and Pevrot: 6, Salles, France, Helvetian Miocene; 7, Saucats (Peloua), France, Burdigalian, Miocene (after Cossmann and Pevrot, 1924): 6, apertural view; 7, dorsal view.



Wilson, Druid. 1987. "Species of *Ecphora*, Including the Subgenus *Stenomphalus*, in the Pungo River Formation." *Geology and paleontology of the Lee Creek Mine, North Carolina* 61, 21–29.

View This Item Online: <https://www.biodiversitylibrary.org/item/266428>

Permalink: <https://www.biodiversitylibrary.org/partpdf/352105>

Holding Institution

Smithsonian Libraries

Sponsored by

Smithsonian Institution

Copyright & Reuse

Copyright Status: In copyright. Digitized with the permission of the rights holder.

Rights Holder: Smithsonian Institution

License: <http://creativecommons.org/licenses/by-nc-sa/4.0/>

Rights: <http://biodiversitylibrary.org/permissions>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.