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CONCHOLOGISTS OF AMERICA, INC.

In 1972, a group of shell collectors saw the need for a national organization devoted to the interests of shell collectors; to the beauty of shells, to their scientific aspects, and to the collecting and preservation of mollusks. This was the start of COA. Our membership includes novices, advanced collectors, scientists, and shell dealers from around the world. In 1995, COA adopted a conservation resolution: Whereas there are an estimated 100,000 species of living mollusks, many of great economic, ecological, and cultural importance to humans and whereas habitat destruction and commercial fisheries have had serious effects on mollusk populations worldwide, and whereas modern conchology continues the tradition of amateur naturalists exploring and documenting the natural world, be it resolved that the Conchologists of America endorses responsible scientific collecting as a means of monitoring the status of mollusk species and populations and promoting informed decision making in regulatory processes intended to safeguard mollusks and their habitats.

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Front cover: *Chicoreus nobilis* Shikama, 1977, photographed *in situ* by Guido Poppe, off Mactan Island, Cebu, Philippines, 2008. This is one of the many muricids with three varices, in this case they are frondose. See the article by Dr. Emily Vokes on pages 4-10. Both the front cover image and this example of a cleaned specimen are courtesy of www.conchology.be, © 2017 Philippe & Guido Poppe - www.poppe-images.com

Back cover: A notional chambered nautilus constructed of paper by Mike Sanchez of the Natural History Museum of New Mexico. The story on how he constructs these is on page 37-38.

Editor's comments:

This was a fun issue to put together, with some great articles and lots of quality shell images. Our first article is by **Dr. Emily Vokes**, who writes on convergence in muricid shell morphology - or how come so many of them have three varices: whether winged (her concentration here), frondose, spiny, or rounded? She specifically looks at four subfamilies with 18 genera –all with three winged varices. In support of her article I received a number of quality shell images from Guido and Philippe Poppe of **Conchology.be** (including the live shot on the cover) and Marcus and José Coltro of **femorale.com**. Both of these dealers have quality web sites with shell images of thousands of specimens, and both have for years supported *American Conchologist.* I truly thank all of you.

Our second article is by the well-know author of *Bahamian Seashells* (1 & 2), **Colin Redfern**. Colin regales us with his six-week adventures in the shallows off the Caribbean island of Martinique, and in the lab, all in support of Dr. Philippe Bouchet (senior professor of malacology at the Muséum national d'Histoire naturelle (MNHN), Paris) and his ongoing worldwide biodiversity survey. Colin gives the reader a true taste of just what is involved in this project and the inner mechanisms that keep it running. We can all thank Colin for volunteering to spend six weeks in a tropical paradise.

Our third article is by **Yannik Roell**, a COA grant recipient, reporting on his research of shell morphology and environment in the Galapagos Islands. The landsnails he is researching are tiny, but his work is important in continuing our understanding of how different mollusks adapt to differing environments.

I finish off the articles in this issue with a review of the Nautilidae, the various species called chambered nautilus. I follow this up with a short piece on the paper shell art of **Mike Sanchez**. His 'paper nautilus' really has to been seen and handled to fully appreciate the artistry involved.

We also have some 'In Memoriam' announcements, a very important book review, and the report on the North Carolina Shell Show.

In closing, **I NEED MATERIAL!** Professionals and amateurs, get busy typing. If it is of interest to you, please share it with our readers. Thanks,

Tom Eichhorst

Convergence, a taxonomist's nightmare

Emily H. Vokes

Taxonomy – Orderly classification of plants and animals according to their presumed natural relationships (Merriam-Webster).

From the time of Aristotle people have tried to introduce some sense of order into the animal world. With the beginning of printing in the Fifteenth Century we see several works, often with beautifully hand-colored plates featuring illustrations of seashells and usually arranged in some sort of fancied natural order, but taxonomy really begins with Linnaeus (1758), who first attempted to arrange all animals into a simple scheme, based upon what he saw as related morphology. As discussed in a previous paper (Vokes, 2017, p. 3) what he considered a species is really today a genus, but he got people thinking about "systems" of nature (it is named *Systema Naturae*, after all) and he was soon followed by other workers, each trying to come up with a better "system." The best of these was Jean-Baptiste Lamarck, who refined Linnaeus's all-inclusive look at the entire Animal Kingdom, with a seven volume treatise (1815-1822) on just invertebrates ("Animaux sans Vertèbres"). Of course this included non-mollusks like insects, corals, and crustaceans, but vol. 7 comprises the best attempt to gather species of gastropods into smaller groups, all related and identifiable by shell morphology.

As Linnaeus's species are really genera, Lamarck's genera are really families, although it took us a while to recognize this. It is true that the members of each of his genera do share a morphological similarity, but the question becomes — how similar is similar? The species that comprise Lamarck's genus "*Murex*" are all similar in having three or more varices, and a more or less extended siphonal canal. With only 68 species this was good enough, but today with over 1400 species what were once deemed minor differences become more critical. Through the years we learned, in addition to the shell, to examine radulae, opercula, and body parts; and more recently we have discovered DNA and various microscopic techniques. Each new discovery indicates that what we once deemed a homogeneous group called "*Murex*" may be divided into some 176 genus-groups, divided into about 10 subfamilies (Vokes, 2012).

How do we begin to separate this multitude of species into what we hope are actually closely related groups? The answer is, with great difficulty. The subfamily Muricinae now comprises most of the species that were once considered "*Murex*." One of the primary criteria is still the presence of varices, which may number three or more. If there are only three, are they spiny (*Murex* s.s., *Vokesimurex*, *Siratus*), frondose (*Chicoreus*, *Triplex*), rounded (*Haustellum*, *Phyllonotus*, *Dermomurex*), or winged (*Pterynotus*, *Timbellus, Pterochelus*)? Examples are shown on plate 1. And what about the other subfamilies? It turns out that most of these are characterized by either having more than three varices, or even almost no varices at all.

Houart recently (2014) separated the spinose forms and earlier (1992) separated the frondose species into *Chicoreus* s.s, with a labral tooth, and *Triplex*, without a labral tooth. Those with rounded varices span the entire family Muricidae and are divided among numerous genera in several subfamilies, well beyond the scope of this study. The list of those groups that have three winged varices is astounding. There are about 140 species divided among the following genus-groups (in alphabetical order with no relationships recognized [differs slightly from Merle *et al.* and WoRMS]; * indicates type):

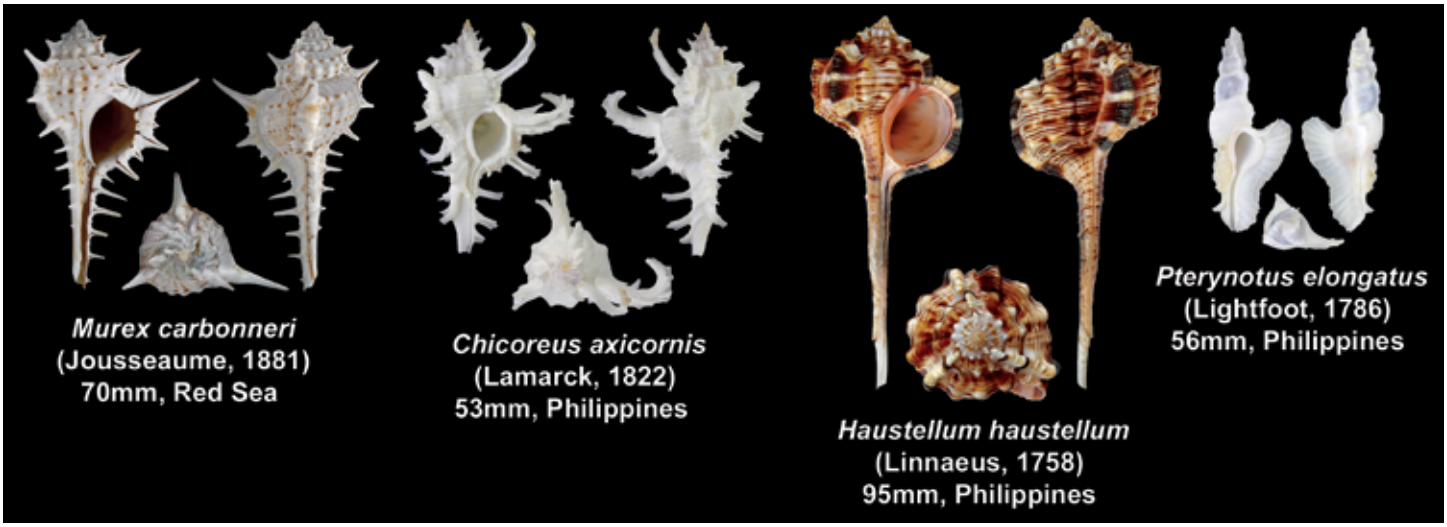

Plate 1. Representative muricids with three varices of differing characteristics: *Murex* – spiny, *Chicoreus* – frondose, *Haustellum* – rounded, and *Pterynotus* – winged. Images modified from H. Zell photographs, Wikipedia.com.

MURICINAE

Chicomurex Arakawa, 1964
- *C. elliscrossi* (Fair, 1974)
- *C. globus* Houart, Moe & Chen, 2015
- *C. gloriosus* (Shikama, 1977)
- *C. laciniatus* (G. B. Sowerby II, 1841)
- *C. lani* Houart, Moe & Chen, 2014
- *C. protoglobosus* Houart, 1992
- *C. pseudosuperbus* Houart, Moe & Chen, 2015
- *C. ritae* Houart, 2013
- *C. rosadoi* Houart, 1999
- *C. superbus* (G. B. Sowerby III, 1889)* **(Pl. 3-1)**
  [+ *C. problematicus* (Lan, 1981)]
- *C. tagaroae* Houart, 2013
- *C. turschi* (Houart, 1981)
- *C. venustulus* (Rehder & Wilson, 1975)

Chicopinnatus Houart, 1992
- *C. arbaguil* (Houart, 2015)
- *C. dharmai* (Houart, 2015)
- *C. guillei* (Houart, 1985)
- *C. laqueatus* (Sowerby, 1841)
- *C. loebbeckei* (Kobelt, 1879)
- *C. mocki* (Beals, 1997)
- *C. orchidiflorus* (Shikama, 1973)* **(Pl. 3-2)**

Naquetia Jousseaume, 1880
- *N. barclayi* (Reeve, 1858)
  [+ *N. annandalei* (Preston, 1910)]
- *N. cumingii* (A. Adams, 1853) [*trigonulus* of authors]
- *N. fosteri* (D'Attilio & Hertz, 1987)
- *N. jickelii* (Tapparone Canefri, 1875)
- *N. manwaii* Houart & Héros, 2013
- *N. rhondae* Houart & Lorenz, 2015
- *N. triqueter* (Born, 1778)* **(Pl. 3-3)**
- *N. vokesae* (Houart, 1986)

Ponderia Houart, 1986
- *P. abies* Houart, 1986
- *P. caledonica* Houart, 1988 **(Pl. 3-4)**
- *P. canalifera* (G. B. Sowerby II, 1841)
- *P. elephantina* Houart, 1990
- *P. magna* Houart, 1988
- *P. zealandica* (Hutton, 1873)*

Prototyphis Ponder, 1972
- *P. angasi* (Crosse, 1863)* **(Pl. 3-5)**
- *P. eos* (Hutton, 1873)
- *P. gracilis* Houart & Héros, 2008
- *P. paupereques* (Powell, 1974)

Pterochelus Jousseaume, 1880
- *P. acanthopterus* (Lamarck, 1816)* **(Pl. 3-6)**
- *P. akation* (Vokes, 1993)
- *P. ariomus* (Clench & Pérez Farfante, 1945)
- *P. duffusi* Iredale, 1936 [+ *P. phillipsi* (Vokes, 1966)]
- *P. triformis* (Reeve, 1845)
- *P. undosus* (Vokes, 1993)
- *P. westralis* (Ponder & B. R. Wilson, 1973)

Pterymarchia Houart, 1995
- *P. aparrii* (D'Attilio & Bertsch, 1980)
- *P. barclayana* (H. Adams, 1873)
- *P. bibbeyi* (Radwin & D'Attilio, 1976)
- *P. bipinnata* (Reeve, 1845)
- *P. bouteti* (Houart, 1990)
- *P. elatica* Houart, 2000
- *P. martinetana* (Roding, 1798)
- *P. triptera* (Born, 1778)* **(Pl. 3-7)**

Pterynotus Swainson, 1833
- *P. albobrunneus* Bertsch & D'Attilio, 1980
- *P. bednalli* (Brazier, 1878)
- *P. brianbaileyi* Mühlhäusser, 1984
- *P. elongatus* (Lightfoot, 1786)
- *P. laurae* Houart, 1997
- *P. miyokoae* Kosuge, 1979
- *P. patagiatus* (Hedley, 1912)
- *P. pellucidus* (Reeve, 1845)
- *P. pinnatus* (Swainson, 1822)* **(Pl. 3-8)**

Purpurellus Jousseaume, 1880
- *P. gambiensis* (Reeve, 1845)* **(Pl. 3-9)**
- *P. macleani* (Emerson & D'Attilio, 1969)
- *P. pinniger* (Broderip, 1833)

Siratus Jousseaume, 1880 (only 4 of 32 species)
- *S. alabaster* (Reeve, 1845)
- *S. beauii* (P. Fischer & Bernardi, 1857) **(Pl. 3-10)**
- *S. consuela* (A. H. Verrill, 1950)
- *S. tenuivaricosus* (Dautzenberg, 1927)

Timbellus de Gregorio, 1885
- *T. atlantideus* (Bouchet & Warén, 1985)
- *T. bilobatus* Houart, 2012
- *T. concavopterus* (Kosuge, 1980)
- *T. corbariae* Houart, 2015
- *T. crauroptera* (Houart, 1991)
- *T. emilyae* (Espinosa, Ortea & Fernández-Garcés, 2007)
- *T. fernandezi* (Houart, 2000)
- *T. flemingi* (Beu, 1967)
- *T. fulgens* (Houart, 1988)
- *T. goniodes* Houart & Héros, 2015
- *T. guesti* (Harasewych & Jensen, 1979)
- *T. havanensis* (Vokes, 1970)
- *T. leucas* (Locard, 1897)
- *T. levii* (Houart, 1988)
- *T. lightbourni* (Harasewych & Jensen, 1979)
- *T. marshalli* (Houart, 1989)
- *T. pannuceus* Houart & Héros, 2015
- *T. phaneus* (Dall, 1889)
- *T. phyllopterus* (Lamarck, 1822)
- *T. radwini* (Harasewych & Jensen, 1979)
- *T. richeri* (Houart, 1987)
- *T. rubidus* (Houart, 2001)
- *T. stenostoma* (Houart, 1991)
- *T. sublimis* Houart, 2012
- *T. vespertilio* (Kuroda *in* Kira, 1959) **(Pl. 3-11)**
- *T. xenos* (Harasewych, 1982)

Trialatella Berry, 1964
- *T. abyssicola* (Crosse, 1865)
- *T. antecessor* (Vokes, 1975) [+*T. cuna* (Petuch, 1990)]
- *T. boucheti* (Garrigues & Merle, 2014)
- *T. cunninghamae* (Berry, 1964)*
- *T. fajouensis* (Garrigues & Merle, 2014)
- *T. leali* (Houart, 1991)
- *T. neglecta* (Habe & Kosuge, 1971) **(Pl. 3-12)**
- *T. oxum* (Petuch, 1979)
- *T. pruvosti* (Garrigues & Merle, 2014)
- *T. seposita* (Houart, 1993)
- *T. tararensis* (Garrigues & Merle, 2014)
- *T. triclotae* (Houart, 2001)
- *T. trondleorum* (Houart, 1990)

OCENEBRINAE

Ceratostoma Herrmannsen, 1846
- *C. burnetti* (Adams & Reeve, 1849)
- *C. foliatum* (Gmelin, 1791) **(Pl. 4-13)**
  - [+ *alata* Chemnitz (not avail.) & *C. monodon* (Eschscholtz, 1829)]
- *C. fournieri* (Crosse, 1861)
- *C. monoceros* (G. B. Sowerby II, 1841)
- *C. nuttalli* (Conrad, 1837)*
  - [+ *C. aciculiger* (Valenciennes, 1846), *C. albescens* (Dall, 1919) & *C. albofasciata* (Dall, 1919)]
- *C. rorifluum* (Adams & Reeve, 1849)

Pteropurpura Jousseaume, 1880
- *P. benderskyi* Emerson & D'Attilio, 1979
- *P. bequaerti* (Clench & Pérez Farfante, 1945)
- *P. centrifuga* (Hinds, 1844)
- *P. dearmata* (Odhner, 1922)
- *P. deroyana* Berry, 1968
- *P. erinaceoidea* (Valenciennes, 1832)
- *P. esycha* (Dall, 1925)
- *P. fairiana* (Houart, 1979)
- *P. festiva* (Hinds, 1844) [+ *P. diminutus* (Dall, 1915) & *P. gaza* (M. Smith, 1940)]
- *P. macroptera* (Deshayes, 1839)* [+*P. carpenteri* (Dall, 1899), *P. petri* (Dall, 1900), *P. alba* (Berry, 1908) & *P. tremperi* (Dall, 1910)]
- *P. modesta* (Fulton, 1936)
- *P. plorator* (A. Adams & Reeve, 1845) [+ *C. expansus* (G.B. Sowerby II, 1860) & *C. brachypteron* (A. Adams, 1863)]
- *P. sanctaehelenae* (E. A. Smith, 1890) ?
- *P. trialata* (G. B. Sowerby II, 1834)
- *P. vokesae* Emerson, 1964 **(Pl. 4-14)**

MURICOPSINAE

Pygmaepterys E. H. Vokes, 1978 (only two species)
- *P. dondani* (Kosuge, 1984) **(Pl. 4-15)**
- *P. menoui* (Houart, 1990)

Subpterynotus Olsson & Harbison, 1953 (one fossil species)
- *S. textilis* (Gabb, 1873) **(Pl. 4-16)**

TRIPTEROTYPHINAE

Pterotyphis Jousseaume, 1880
- *P. fimbriatus* (A. Adams, 1854)
- *P. pinnatus* (Broderip, 1833)* **(Pl. 4-17)**
- *P. ryalli* Houart, 1996

Tripterotyphis Pilsbry & Lowe, 1932
- *T. arcana* (DuShane, 1969)
- *T. cancellatus* (G. B. Sowerby II, 1841)
- *T. colemani* (Ponder, 1972)
- *T. fayae* (Keen & Campbell, 1964)
- *T. lowei* (Pilsbry, 1931)*
- *T. norfolkensis* (Fleming, 1962)
- *T. robustus* (Verco, 1895)
- *T. triangularis* (A. Adams, 1856) **(Pl. 4-18)**

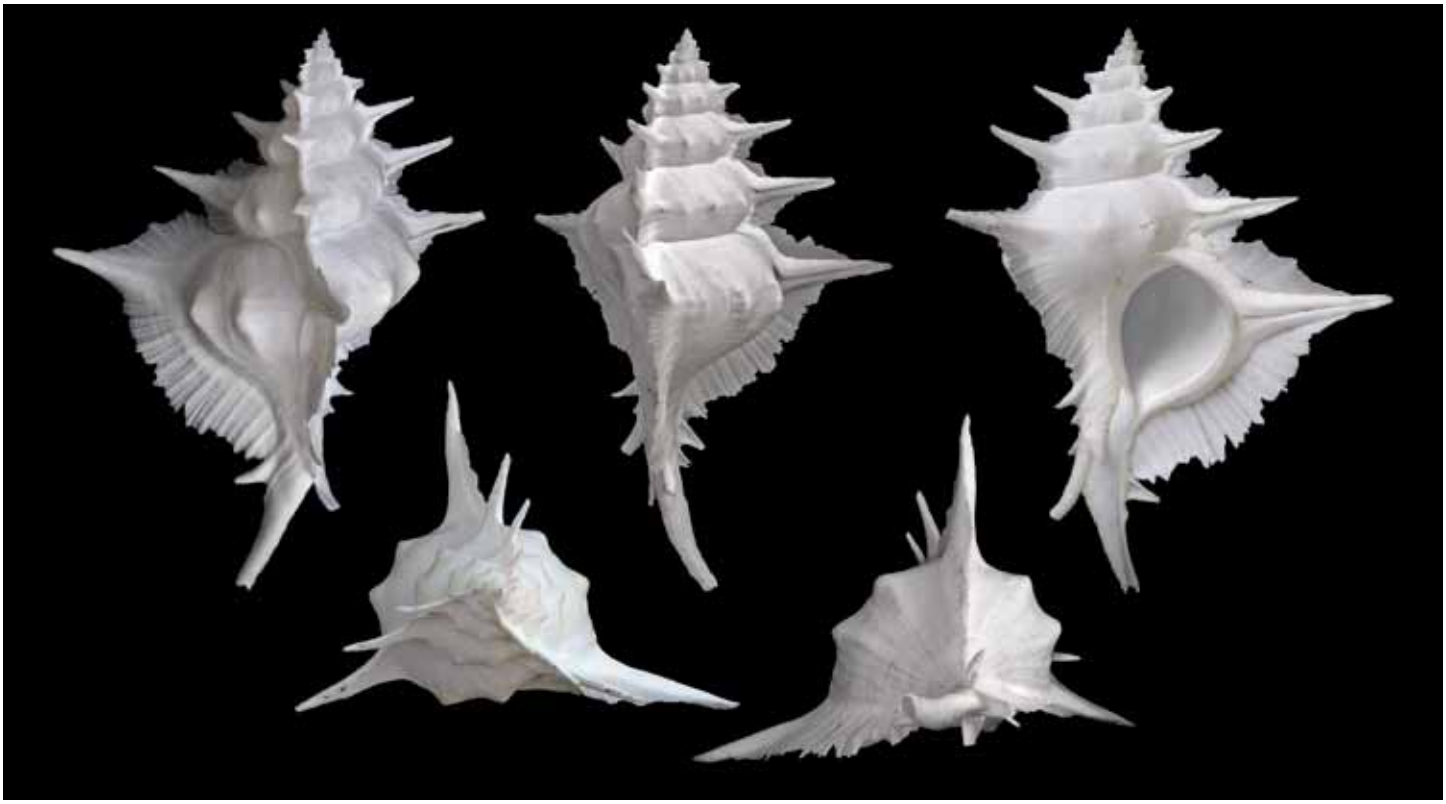

Plate 2. *Siratus alabaster* (Reeve, 1845) 150mm, Philippines, adapted from H. Zell, Wikipedia.com.

Here we have an overwhelming collection of convergence, which is how we describe distantly related creatures that have developed similar body forms to cope with some environmental challenge. One of the most frequently cited examples of convergence is the development of wings in bats (Mammalia) and birds (Aves), two groups of vertebrates that have modified the forelimbs into wings. Obviously the bats and birds developed wings in order to fly, but what has driven the Muricidae? What is it in their DNA that seems to call out for three winged varices? There must be some evolutionary benefit for the pattern to be so pervasive. But what is it? It is not likely to be defense from predators, as in the spiny species. I seriously doubt that it is sexual attraction, which figures so prominently in the ornamentation of birds ("See how strong and healthy I am"). It has been suggested that it gives stability to the shell. If a three-winged species is dislodged from a rocky perch, the shell spirals downward and lands with the aperture down, but few species regularly perch on rocky ledges. Perhaps it simply has the effect of making the shell bigger and less easy to swallow. Honestly, we do not know!

After Lamarck's separation of the Linnaean genera into more meaningful groups, other authors began the process of dividing them into ever smaller units, based upon morphology. Among the earliest was Swainson, who in 1833 proposed the genus *Pterynotus* for ALL the three-winged forms. Shortly thereafter, in 1837, Conrad proposed *Cerostoma* for the three-winged group easily separated by the presence of a labral tooth. As this name is preoccupied, it was subsequently emended to *Ceratostoma* by Hermannsen (1846). That seemed to be the limit until 1880, when Jousseaume (much ahead of his time!) proposed 47 new genera for the Family Muricidae, including *Siratus*, *Pterotyphis*, *Pteropurpura*, *Marchia*, *Naquetia*, *Pterochelus*, and *Purpurellus*. Today all of these are recognized as valid taxa, except for *Marchia*, which is considered a synonym of *Pterynotus*.

It is certain that the three-winged morphotype has a long geological history reaching back to the beginnings of the Cenozoic (66 MYA). There are species as old as *Pterynotus matthewsensis* (Aldrich, 1886) from the Paleocene (66-56 MYA), and numerous examples from the Eocene (56-33.9 MYA) from both the United States and France. In 1979, Harasewych and Jensen did a review of the genus *Pterynotus* and concluded that there were at least four distinct lineages, which they believed gave some insight into the evolution of the group, although they did not advocate dividing them into separate subgenera. They did note that the name *Timbellus* (type: *Murex latifolus* Bellardi, 1872) had been proposed for those thin delicate shells such as *Pterynotus phaneus* (Dall). This is the position I also took when I reviewed the Western Atlantic fossil and Recent species in 1992. In 2011, however, Merle *et al.*, in a monumental study of the fossil and Recent species of Muricinae from the entire world, divided up 89 Recent species of three-winged Muricinae (only) into the multitude of genus-groups cited above. In particular, they divided what was *Pterynotus* into two genera: *Pterynotus* s.s (type: *Murex pinnatus* Swainson) and *Timbellus* (type: *M. latifolius* Bellardi). *Timbellus* got the lion's share of the species (*Pterynotus* s.s – 8; *Timbellus* – 22). The subgenus *Timbellus* was proposed back in 1885 by an obscure Italian paleontologist Antonio de Gregorio, for two Pliocene fossil species, *Murex latifolius* and *M. latilabris,* both of Bellardi. Not accepted until the Merle *et al.* opus, this is by far the largest group of three-winged murices currently recognized, with not only 26 living species (some described since 2011), but another 59 fossil species, the majority (38) from Europe.

Merle *et al*.'s thinking is based upon a large study of the molecular phylogenetic framework of the Muricidae done by Barco *et al*. (2010) in which they examined, within almost 80 species of Muricidae, only two species of "*Pterynotus"* – *P. elongatus* (Lightfoot) and *P. fulgens* Houart. Among their conclusions (2010, p. 1037), only some of which confirmed previous taxonomic divisions, was that the genus *Pterynotus* is composed of at least two unrelated lineages. One includes *P. elongatus*, with a sculptural pattern similar to the type species *P. pinnatus*, and the second group includes *P. fulgens*. It is hard to determine exactly the defining morphological characteristic of *Timbellus*, but it seems primarily to be a smoother shell, and the two lines must represent the ultimate in convergence.

Within the various genus-groups cited in the Muricinae, all of the species in each group are more or less winged. The single exception to this is *Siratus,* in which the vast majority of species are spinose. There are, however, a handful of winged forms, including two of the most elaborately winged species of any group – *Siratus alabaster* (Reeve) (Pl. 2) and *S. beauii* (Fischer and Bernardi) (Pl. 3).

Other than in the Muricinae, three-winged forms are seen rarely, with two genera in the Ocenebrinae – *Ceratostoma*, with six Recent species, and *Pteropurpura*, with 15 Recent species. The tiny three-winged typhine subfamily Tripterotyphinae, with a total of 11 species in only two genera, is distinguished from all the other typhines, which have four varices. The Tripterotyphinae also have a more ornate surface ornamentation* and, in this case, it is probably the tubes that represent convergence.

In all of the other subfamilies we see no three-winged forms, with one very notable exception. In the Muricopsinae, in the otherwise four- to six-varixed genus *Pygmaepterys*, there are just two species that have somehow rediscovered the three-winged form, *P. dondani* (Kosuge) and *P. menoui* (Houart). And in the fossil record there is one relatively common species, S*ubpterynotus textilis* (Gabb).

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*The strange *Cinclidotyphis myrae* DuShane, 1969, because of the ornate surface ornamentation and the inter-varical tubes, resembles species of *Pterotyphis* and has been placed by some in Tripterotyphinae, but the greatly reduced varices plus the open siphonal canal more closely resembles the genus *Galfridus*, and suggests placement in Ergalataxinae. The locality (West Mexico – *Cinclidotyphis vs*. Australia/New Zealand – *Galfridus*) does support placement in Tripterotyphinae. Convergence like this drives taxonomists crazy!

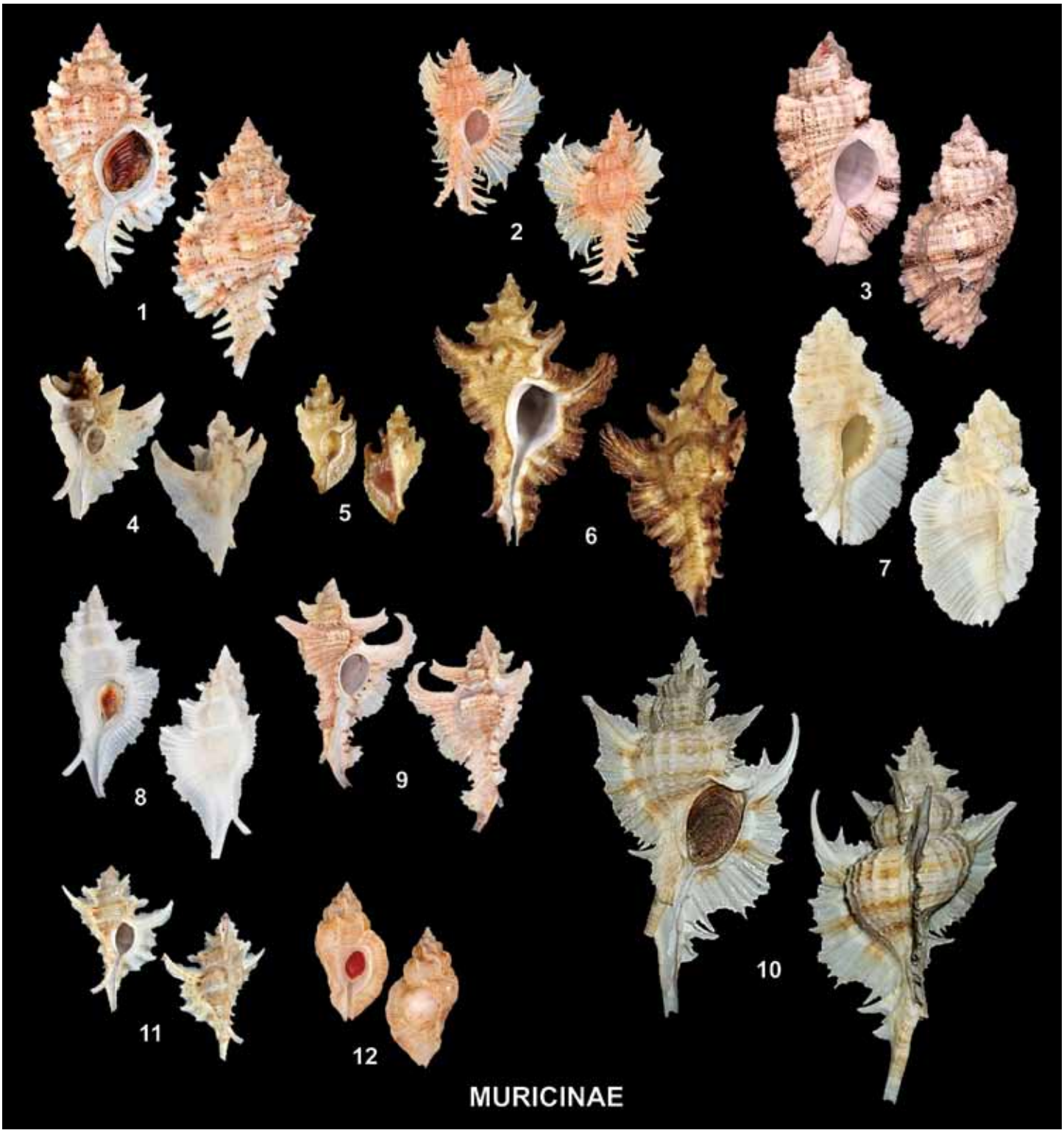

Plate 3. 1. *Chicomurex superbus* (G. B. Sowerby III, 1889) 65mm, Taiwan (www.femorale.com). 2. *Chicopinnatus orchidiflorus* (Shikama, 1973) 38mm, Philippines (www.femorale.com). 3. *Naquetia triqueter* (Born, 1778) 60mm, Indo-Pacific (www.femorale.com). 4. *Ponderia caledonica* Houart, 1988, 30mm, New Caledonia (www.femorale.com). 5. *Prototyphis angasi* (Crosse, 1863) 16mm, S. Australia (www.conchology.be). 6. *Pterochelus acanthopterus* (Lamarck, 1816) 64mm, NW Australia (www.conchology.be). 7. *Pterymarchia triptera* (Born, 1778) 55mm, Philippines (www.femorale.com). 8. *Pterynotus pinnatus* (Swainson, 1822) 28mm, Philippines (www.conchology.be). 9. *Purpurellus gambiensis* (Reeve, 1845) 43mm, Senegal (www.femorale.com). 10. *Siratus beauii* (P. Fischer & Bernardi, 1857) 75mm, Gulf of Mexico (www.jaxshells.org). 11. *Timbellus vespertilio* (Kuroda *in* Kira, 1959) 24mm, Japan (www.femorale.com). 12. *Trialatella neglecta* (Habe & Kosuge, 1971) 22mm, Philippines (www.femorale.com).

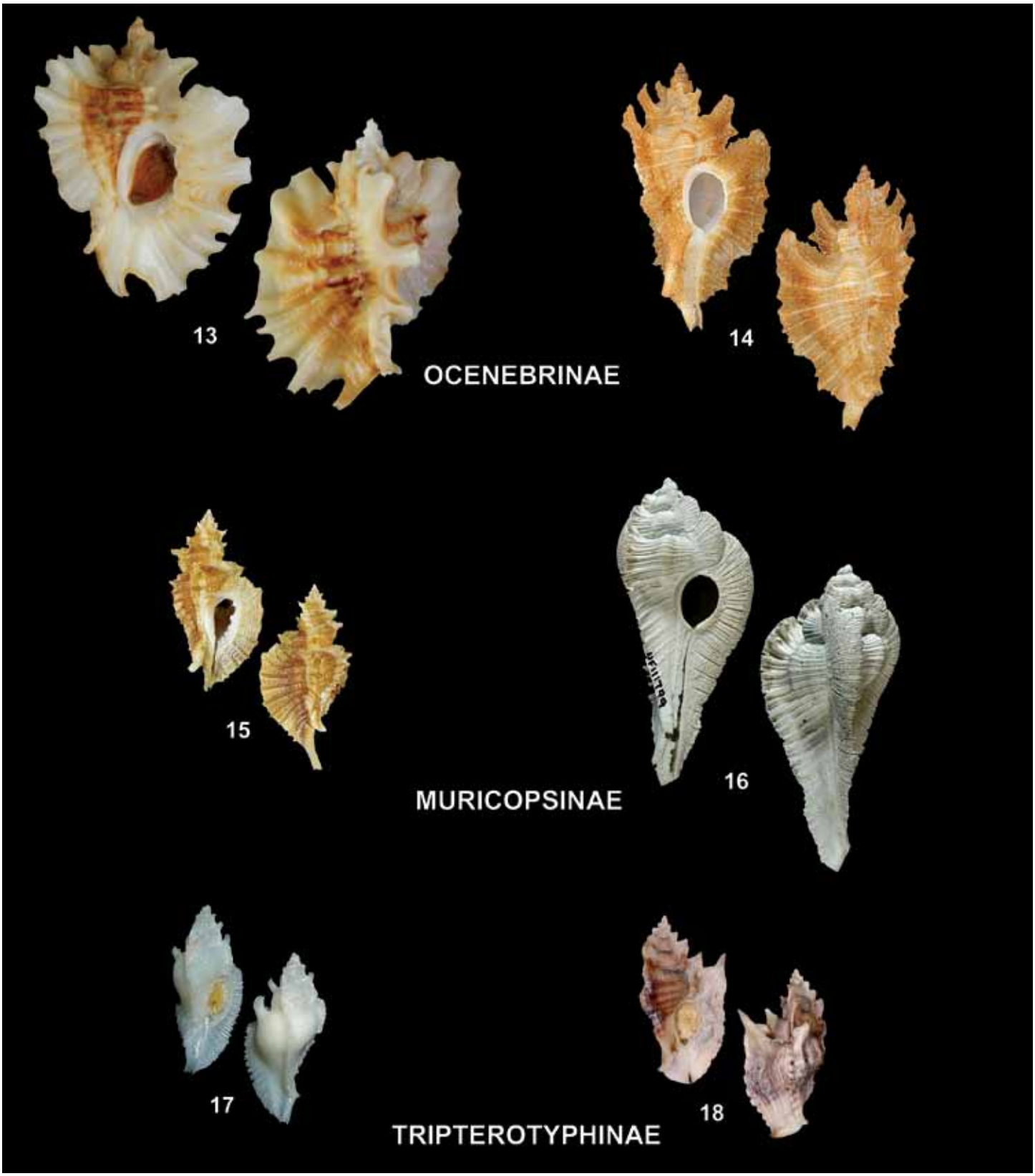

Plate 4. 13. *Ceratostoma foliatum* (Gmelin, 1791) 68mm, W. USA (www.femorale.com). 14. *Pteropurpura vokesae* Emerson, 1964, 54mm, W. USA (www.femorale.com). 15. *Pygmaepterys dondani* (Kosuge, 1984) 23mm, Philippines (www.conchology.be). 16. *Subpterynotus textilis* (Gabb, 1873) 56mm, fossil, Pinecrest beds, upper Pliocene, SE USA (courtesy of Florida Museum of Natural History). 17. *Pterotyphis pinnatus* (Broderip, 1833) 22mm, Bahamas and Caribbean (www.conchology.be). 18. *Tripterotyphis triangularis* (A. Adams, 1856) 30mm, Bahamas and Caribbean (www.femorale.com).

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Neptunea Award

Submissions are due prior to 1 June 2018

Guidelines can be found under the *Neptunea* Award section of the COA web page (wwwconchologistsofamerica.org) and in the *American Conchologist* September 2017 issue. Also additional information on a list of past winners may be found in the same issue of American Conchologist, page 37.

Return to the Caribbean: the Madibenthos Expedition to Martinique

Colin Redfern

In February of 2016 I had the good fortune to receive an email from Dr. Philippe Bouchet, senior professor of malacology at the Muséum national d'Histoire naturelle (MNHN) in Paris, inviting me to be a member of a team that would carry out a six-week biodiversity survey of the waters surrounding the Caribbean island of Martinique. Rapidly accepting the invitation before Dr. Bouchet had an opportunity to change his mind, I felt it best to mention that my scuba diving days were now behind me. I was relieved to receive a reply explaining that my contribution would consist of collecting in the intertidal and shallow subtidal zones, together with *ex situ* photography of living animals. The Madibenthos Expedition would be starting in September, and was named with reference to Madinina, an early name for Martinique (fig. 1).

Fig. 1. The author snorkeling for mollusks off Martinique (once called Madinina).

I had several months in which to make necessary upgrades to my macrophoto gear, the goal being to assemble a system that would be acceptable as carry-on luggage for the flight from Miami to Martinique. The backbone of this system was an Olympus macrophoto stand with extension bar that I had been using since 1980. My aging Canon EOS 20D was replaced by a 6D and I also upgraded to the latest Canon ring lite, the MR-14EX II. This equipment was attached to the stand via an Adorama focusing rail. My Canon MP-E 65mm macro photo lens was still in prime condition and I added a Canon 100mm macro lens that, for reasons explained later, was never put to use. I managed to squeeze all of this equipment into a 12x13 inch Mountainsmith camera case, together with spare battery and charger, remote shutter release, and angle viewer (fig. 2). This in turn fitted into a carry-on case with enough extra space to accommodate an Olympus TG-4, a small but very versatile waterproof camera.

Fig. 2. My camera and associated gear, all tightly packed to fit in a carry-on case.

The Madibenthos team consisted of 63 members from 10 different countries, and in addition to malacologists, included experts in such fields as the study of sponges, crustaceans, coral, reef fishes, and algae. The original plan was for the team to spend three weeks based in the capital of Fort-de-France on the Caribbean side of the island and three weeks on the Caravelle Peninsula on the Atlantic side. For various reasons, however, it became preferable to be based in Fort-de-France for the entire six weeks, where we were hosted by the French Navy in Fort Saint-Louis. I was greeted there by Philippe Bouchet, and soon had the opportunity to meet for the first time some people with whom I had

previously only corresponded. I first exchanged letters with Anders Warén in 1989, when he kindly reviewed and commented on my photos of eulimids from Abaco, Bahamas, so it was a pleasure to finally be able to thank him in person after so many years. I also had my first meeting with Jesús Ortea and Manuel Caballer, with whom I had collaborated on a study of the Bahamian Rissoellidae in 2014. Over the course of the next few days I would meet several other malacologists whose names were familiar to me from papers that they had authored or correspondence that we had shared. I hope that they will all forgive me for not using their titles in this report. There was a time many years ago when I could converse quite comfortably in French, and I was disappointed to find that I had almost completely lost that ability, however, everybody was kind enough to speak to me in English whenever possible.

Fig. 3. One of two large inflatable military-style tents that proved not quite capable of handling the heat and were wisely dismantled prior to tropical storm Matthew. The team coped with these issues and continued work.

One of my first impressions was the extent to which the logistical problems had been addressed. A shipping container from France had already delivered items ranging in size from inflatable dive boats to tweezers. This included, for example, scuba tanks and air compressors, dissecting microscopes and light sources for everybody that needed them, and trestle tables with chairs of appropriate height. Inevitably there were some unexpected problems. Work areas had to be reassigned when the interior of two large inflatable military-style tents (fig. 3) proved to be hotter than anticipated, and the tents had to be temporarily deflated when tropical storm Matthew passed over the island on September 28, disrupting scheduled activities for a couple of days. Lesser problems occurred almost daily, but a solution was always found.

Meals were taken in the naval canteen and it was here that Philippe introduced us all to each other and announced that breakfast would be available the following morning from 5:45 to 6:30 in preparation for a 7 o'clock departure from the docks. The three-person "intertidal team" consisted of (fig. 4, left to right) Laurent Charles (curator at the Museum of Bordeaux), myself, and Serge Gofas (professor at the University of Malaga).

It wasn't long before I found out that my knees were no longer reliable when maneuvering from one large slippery rock to another. I was much safer in the water and consequently spent many hours collecting while snorkeling. Together with local boat captains we visited every possible habitat, accessing shorelines from sandy beaches (fig. 5) or rocky promontories (fig. 6). We sampled mangrove-lined bays (fig. 7) and many areas of mixed habitats (fig. 8), using whatever collecting technique was appropriate. Serge Gofas is shown using a chisel (fig. 9) to collect live "worm shells" from the rocks and pulling a small hand dredge (fig. 10) to collect olivellids. In the final weeks of the expedition we quite often accessed collecting sites by road in the company of Régis Delannoye, a French member of the team who had lived on Martinique for the past twenty years and was very familiar with potential collecting sites.

Fig. 4 – Our three-person "intertidal team" (left to right) Laurent Charles (curator at the Museum of Bordeaux), myself, and Serge Gofas (professor at the University of Malaga). Our boat captain Maurice is in the background.


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Figs. 5-8 show a typical variety of collecting sites for the "intertidal team." Fig. 5 – sandy beach habitat, fig. 6 – rocky promonitory habitat, fig. 7 – mangrove-lined bay habitat, fig. 8 – mixed habitat.


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Fig. 9 – Serge Gofas uses a chisel to collect "worm shells," and in fig. 10 he is shown hand dredging for olivellids.
Fig 11 – (a) Dominique Lamy after (b) retrieving a loaded dredge from 70 meters depth with (c) small capstan winch.


11a 11b 11c

The dredge boat left the dock each morning, sometimes very early to take advantage of calmer seas. I had the opportunity to be on board one morning to watch Dominique Lamy bring in a loaded dredge from 70m with the aid of a gas powered capstan winch, after which he was able to take a well-earned rest (fig. 11a-c). Meanwhile teams of divers were collecting material by various means, including brushing, vacuuming, and hand-picking. In 2012 Martin Snyder was a member of the Karubenthos Expedition to Guadeloupe and subsequently wrote a very informative article in *American Conchologist*. He described the team's collecting methods in detail and the same methods were used on Martinique. I would be unable to improve on those descriptions and recommend that readers access that article, which is available online (see below). Videos of these methods can also be seen on the Madibenthos website at http://madibenthos.mnhn.fr/fr/carnet-bord.

Great care was taken to ensure that all material was assigned a reference number to record the collecting event from which it was obtained, together with a prefix to denote the method of collection. The material was then taken to the "cold room" where it was laid out in trays, each with the reference number attached (fig. 12). Here for example (fig. 13) is a tray of sponges awaiting examination by Nicole de Voogd, an expert from the Naturalis Biodiversity Center in Leiden, Netherlands. Nicole can be seen on the left in fig. 12.

An important process takes place on the dock, where rocks and other assorted items brought in by diving and dredging are washed with sea water, with the results filtered through a series of sieves with holes of diminishing diameter. The final two "fractions" consist of fine and very fine material, most of which is destined for the photo lab for sorting under a microscope. Anders Warén is seen here in the cold room (fig. 15) with some material from a penultimate fraction, while a container of very fine material awaits examination in the photo lab (fig. 14). The photo lab was housed in the Fort's two-room "Lafayette" building, with Martinique's infamous Mont Pelée cloud-topped in the distance (fig. 16). For those unfamiliar with this volcano's history, the stunning events of 1902 are vividly described at https://www.earthmagazine.org/article/benchmarks-may-8-1902-deadly-eruption-mount-pelee.

The lab consisted of two rooms, the smaller of which was mainly used (fig. 17) by José "Pepe" Espinosa, Jesús Ortea, and Manuel Caballer. Manuel had assembled a small aquarium, and most living opisthobranchs, marginellids, cystiscids and rissoellids were photographed or drawn with camera lucida in this room. In the final weeks the room was also used by Marcel Koken for the study of bioluminescence in marine invertebrates. The larger room (fig. 18) was used for sorting and photography, with one corner reserved for algae study. During our time at Fort Saint-Louis more than 900 students from local schools visited the lab and had the opportunity to observe small living mollusks through the microscopes (Fig. 19). Philippe Maestrati (on the right, fig. 20) made all the decisions as to which specimens needed to be photographed and which should be selected for barcoding. He had a remarkable ability to remember the species that had already been photographed, so that no unnecessary duplications took place. The specimens selected for barcoding were then taken to the "tissue clipping lab," where Giulia Fassio and Barbara Buge (fig. 21) prepared them for the molecular sequencing that would eventually take place at the Museum in Paris. Preparation included the challenging work of removing soft parts from the shell so that tissues or whole specimens could then be fixed and preserved in ethanol.

On our first day in the photo lab we agreed that it would save valuable time if I avoided changing lenses on my camera, so it was decided that I would work only with my MP-E 65mm macro photo lens, photographing living specimens that were about 5mm or less in length. Larger specimens were photographed by Laurent Charles or Philippe Maestrati. All photos were logged, and after six weeks I had photographed more than 550 specimens, taking several photos of each specimen in order to ensure that all aspects of the living animal were represented. Anyone familiar with this process will be aware of the frustrating tendency of mollusks to retract into their shell at the very moment that you have them in sharp focus. A few of the resulting photos are shown in fig. 22, not reproduced to scale. It would be premature to attempt identification of all these species, but the photos will give some indication of the great variety of small mollusks collected by members of the expedition. During many years of collecting in the Bahamas I managed with great difficulty to collect a few empty shells belonging to genera such as *Sansonia* and *Euchelus*, so it was a memorable experience to observe live specimens crawling around in a dish below my camera lens. I was unfamiliar with many of the photographed species and had certainly never expected to have the opportunity to photograph living solenogasters, one of which is included in fig. 22.

It was not all work and no play. The whole team would sometimes take a day off, with most of us meeting for lunch or dinner at a restaurant elsewhere on the island. On one occasion Régis Delannoye guided a group of us to a couple of locations in the rainforests of northern Martinique (fig. 25) and five of us are shown here in a variety of rainforest attire – (fig. 27, left to right: Régis Delannoye, Jesús Ortea, myself, Pepe Espinosa, and Manuel Caballer). Shortly afterwards I had my first encounter with a tarantula (fig. 24). I'm not usually comfortable around spiders, but I must admit that this one was very handsome in its natural habitat. Doubtless I would have felt differently if observing it on the ceiling above my bed. Sometimes the word would be passed around our work rooms at the naval base that cocktails and hors d'oeuvres would be available in the dock area

Fig. 12 – collected material awaits sorting in the cold room.

Fig. 13 – a tray of sponges awaiting examination by Nicole de Voogd, an expert from the Naturalis Biodiversity Center in Leiden, Netherlands.

The final two "fractions" consist of fine and very fine material, most of which is destined for the photo lab for sorting under a microscope. Fig. 14 – a container of very fine material ready for examination in the photo lab while fig. 15 – Anders Warén is seen in the cold room with material from a penultimate fraction.

Fig. 16 – our photo lab at the entrance to Fort Saint-Louis, with the infamous volcano, Mont Pelée in the background.

Fig. 17 – denizens of the smaller photo room, (L to R): José "Pepe" Espinosa, Jesús Ortea, and Manuel Caballer.

Fig. 18 – the larger of the two rooms was used for sorting and photography, with one corner reserved for algae study.

Fig. 19 – the larger room was also where more than 900 students from local schools were able to observe the normally unseen world of microscopic-sized living mollusks.

Fig. 20 – Philippe Maestrati (on the right) made all decisions as to which specimens needed to be photographed and which should be selected for barcoding.

Fig. 21 – specimens selected for barcoding were taken to the "tissue clipping lab," where Giulia Fassio and Barbara Buge prepared them for the molecular sequencing that would eventually take place at the Museum in Paris.

Fig. 23 – Philippe Bouchet thanks our hosts for their hospitality at an event that featured a choice of delicious crêpes and a welcome respite from lab work.

Fig. 24 – my first encounter with a tarantula in the wild. This is a protected species in Martinique.

Fig. 22 – Some of the more than 550 living specimens photographed (not reproduced to scale, but with a maximum size of about 5 mm). Many specimens will require further study for correct identification. Note the solenogaster ("s" shaped, one down from the top row, in the middle).

Fig. 25 – Régis Delannoye guided a group of us to a couple of locations in the rainforests of northern Martinique. Fig. 26 (below) - at one location Laurent Charles pointed out that this was prime habitat for some species of land snails.

Fig. 27 – five intrepid rainforest explorers, left to right: Régis Delannoye, Jesús Ortea, myself, Pepe Espinosa, and Manuel Caballer.

at 5 o'clock, and Philippe Bouchet (fig. 23) thanked our hosts for their hospitality at an event that featured a choice of delicious crêpes. We were invited to tour a French frigate that was docked at the base for a few days and there were also other opportunities for relaxation and exploration.

Early estimates suggest that more than a thousand mollusk species previously unrecorded from Martinique were collected, including a surprising number that were not recorded from Guadeloupe in the 2012 expedition. In due course many of these will prove to be new to science and several have already been described. By the end of the expedition the team had conducted 506 collecting events and it was calculated that the 63 members had spent a combined 19,700 working hours in the labs and in the field. Preserved material had required the use of 211 gallons of ethanol, generously contributed by the Plantations Saint James on Martinique. Funding also came from the European Regional Development Fund (ERDF), the Collectivité Territoriale de Martinique (CTM), and Banque Régionale d'Escompte et de Dépôt (BRED). Coordinated by MNHN, the expedition was spearheaded by the French Agency for Marine Protected Areas (AAMP), the Martinique Directorate of the French Ministry for the Environment (DEAL), and the Martinique Bureau of Water (ODE). An important result of the survey was the observation that the health of Martinique's marine environment has been severely compromised by pesticide and fertilizer run-off, overfishing, and the inevitable stresses of an ever-increasing island population. Unfortunately it will be very difficult or perhaps impossible to reverse this trend.

It is difficult to imagine that anybody else with Philippe Bouchet's malacological credentials could be better suited to the task of organizing and leading an expedition of this size and complexity. Somehow he manages to overcome the inevitable unforeseen challenges without ever losing his multilingual sense of humor and it was a great pleasure to be a member of his team.

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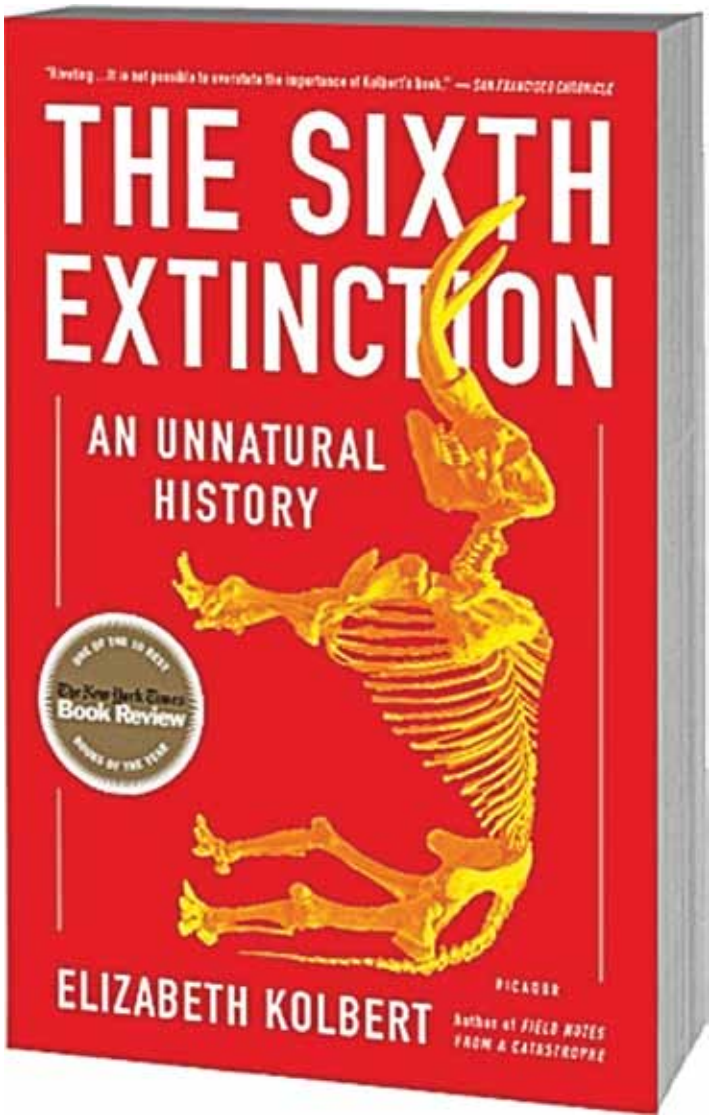
The Sixth Extinction: An Unnatural History

by Elizabeth Kolbert

ISBN (hard cover) 1250062187, (paperback) 978-1250062185, (ebook) 978-08050-9979-9; published in 2014 by Harry Holt & Co., N.Y., New York & Picador, Reprint edition (January 6, 2015), hard cover 5.5 x 8 inches, 336 pages. Cost approximately $17.09 hardcover, $10.87 paperback, &9.99 eTextbook, and $28.40 Audio CD.



It seems this is the year for belated book reviews. Last issue it was the 2014 publication of Roland Houart's superb *Living Muricidae of the World* and we now have another book from 2014 that I believe is important enough to bring to your attention. *The Sixth Extinction* by Elizabeth Kolbert is no obscure shell reference book - although the author does discuss molluscan extinctions. This is a New York Times best seller (one of New York Times 10 best books of the year) and a Pulitzer Prize winner. The San Francisco Chronicle stated, "It is not possible to overstate the importance of Kolbert's book." So, others have pretty much established its importance, to which I must now add, it is eminently readable - a page turner. The author weaves science with story-telling in such a manner that the awe-inspiring and sobering facts of what is happening in the world around us reads like the best thriller.

Much of what is covered in this volume is probably known to the majority of our readers, at least in a peripheral sense. Most shell collectors are interested in nature in general and are thus at least vaguely or perhaps keenly aware of geologic extinction events, the modern plight of millions of dying bats in the US, the disastrous effects of big game poaching in Africa, the *chytrid* fungus killing off entire species of frogs in the New World, etc. If you read *The Sixth Extinction*, you will not only add flesh to this skeletal framework of knowledge of these events, but you will learn so much more. These topics are but four of the 13 chapters in this book.

The first chapter of the book begins with, "Beginnings, it's said, are apt to be shadowy. So it is with this story, which starts with the emergence of a new species maybe two hundred thousand years ago. The species does not yet have a name–nothing does–but it has the capacity to name things." The author then goes on to outline and explain the Sixth Extinction, a mankind-caused event happening around us. This is not dry stuff. She posits (and scientists agree) about five earlier catastrophic extinction events and carefully makes the case for an additional such event, the sixth, taking place right now. The book is an exciting, fascinating, enjoyable (though sometimes downright scary) read, and certainly something worthy of attention by each and every one of us. The very concept of extinction, that a species could literally disappear from the earth, has only "recently" gained a foothold in our thinking. Linnaeus was literally describing shells and setting up our modern taxonomic system decades before the concept of extinction was conceived much less accepted! Really. Read the second chapter.

The chapter on ocean acidification and reef destruction is one of the scary chapters. And unlike a dry recounting of research efforts, Elizabeth Kolbert was there. She traveled the world to personalize the facts presented in this book. Accompanied by relevant scientists, she investigated the varied and often disturbing facets of this story – crawling through bat caves, diving in poisonous waters, trekking through rainforests, or digging through dusty museum relics. Elizabeth Kolbert brings to life what is perhaps the most serious event of our lives.

I bought the ebook for my Kindle, but after reading it I purchased the hard cover for my library. This is critically important stuff, presented with readable clarity and vivid conceptions.

Tom Eichhorst

COA Grant Summary

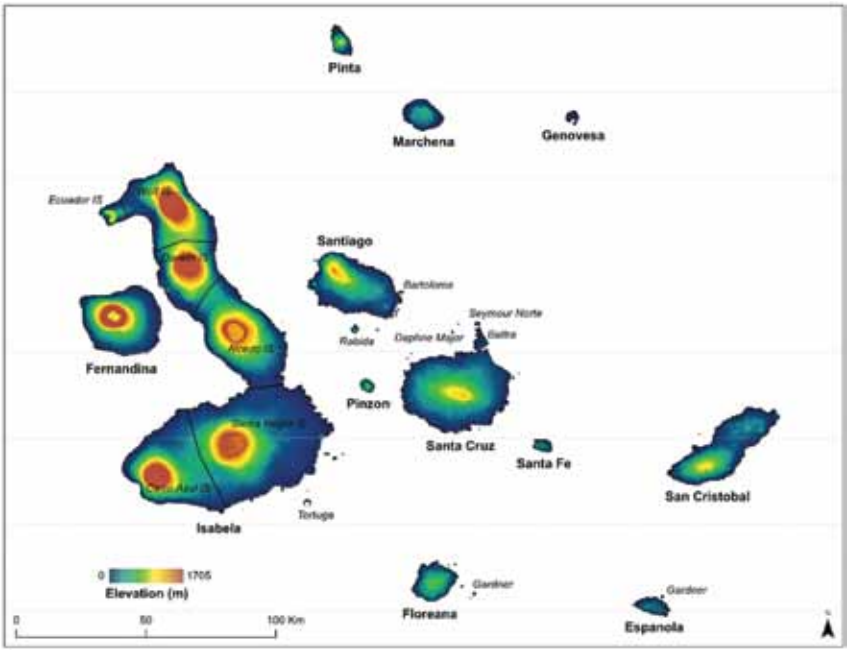
Yannik Roell

In May 2016, I was awarded $2,200 by COA to conduct my master's research in the Galapagos. I helped offset the costs of a two-month field season with this money from the grant. The grant was used to pay for flights from Idaho to Galapagos, transportation while on the islands, and housing.

During this time, I collected morphological and physiological measurements on a genus of terrestrial land snails, *Naesiotus*. There were 276 snails collected which brought my total with my 2015 field season to a total of 471 snails. The new field season allowed me to extend my work to 2 more islands and 6 more species for a total of 14 species across a wide range of elevational gradients. Portable temperature recording devices (iButtons) were placed on one of the new islands to start collecting fine-tuned temperature data throughout the year.

The author in the Galapagos study area.

My overall research is to understand the effect of environmental variation on species richness and trait diversity across the Galapagos Archipelago. The goal of my dissertation is to understand how variation in habitat can promote changes across islands and in species. The first objective of this project is to link how island ontogeny* shapes the number of species found on islands. The second objective is to quantify the association between habitat features and variation in morphology and physiology of species. The grant has helped fund my second objective.



For my first objective, I use the species richness of terrestrial vertebrates, invertebrates, and plants of the Galapagos. The species richness for each island will help determine the effect of different topography measures on a range of taxonomic groups. Each taxonomic group will be tested to see if they follow the hump-shaped trend that the general dynamic model (GDM) of oceanic island biogeography predicts. The GDM will be extended by determining if there is one topographic index that can be used across a range of taxa or if each taxonomic group has a different index that is most important to measure topographic complexity.

For my second objective, I use a well-studied adaptive radiation in the Galapagos, the land snail *Naesiotus*. *Naesiotus* inhabits most islands in the Galapagos, from lower elevations that are hot and arid to higher elevations that are cool and humid. Along this environmental gradient these species exhibit diverse shell sizes and shapes. Shell morphology is likely important for many different aspects of snail survival. Shells provide protection against predation, prevent water loss, and dissipate heat to avoid desiccation. Previous studies have shown that Galapagos snails with more elongated shell shapes tend to be found in more arid zones and snails with rounder shell

* The study of the origination and development organisms from the time of fertilization of the egg to the organism's mature form, or in this case, of an island from formation to maturity.

shapes tend to be found in more humid zones. This phenotypic-environment association suggests that snails with different shell shapes have adapted to different habitats; however, morphological adaptation is likely to be associated with a difference in metabolic costs related to building and maintaining a shell.

Thus although work in this system using phylogenetically controlled analyses has identified a strong link between shell morphology and ecology, a thorough study of physiological variation within and among species is needed to identify the proximate mechanisms and ultimate causes responsible for ecological diversification.

I appreciate the opportunity that was given to me by being able to use the grant money to have an extended field season and further my research. The money was used effectively to make the quality of my research even better.

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One of the elongated species, *Naesiotus reibischi* Dall, 1895, 9-10mm, crawling on one of many thorned bushes of the Galapagos.

Raw snails sold for consumption in Otavalo, Ecuador.

***Naesiotus albermarlensis* Dall, 1917, 10-11mm.**

***Naesiotus wolfi* Reibisch, 1892, 10-12mm, with a moderately elongated shell.**

***Naesiotus albermarlensis*, up close and personal (note the leaf hopper).**

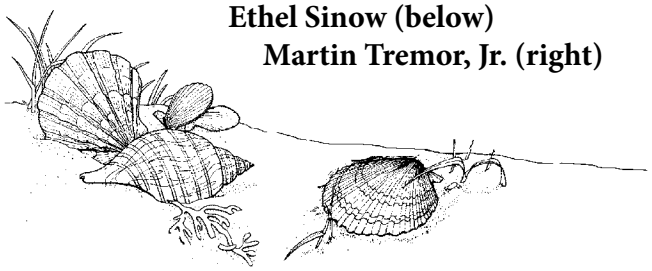
Dr. John Pojeta, Jr. passed away on 6 July 2017. John was a graduate of the University of Cincinnati, where he met and formed a life-long partnership with his wife Mary Lou. After graduation, he was appointed to the U.S. Geological Survey and served as geologist, paleontologist, and eventually Branch Chief through a rich and distinguished career. Since retirement in 1994, he remained active as Scientist Emeritus with the U.S.G.S. and as Research Associate of the Department of Paleobiology at the Smithsonian's Museum of Natural History.

Throughout his career, John focused on Ordovician and Cambrian mollusks. He will be remembered for his diligence and teamwork on research of fossils from Kentucky, Australia, and Antarctica (to name three of many areas in which he worked). He and Mary Lou were both enthusiastic supporters of numerous professional organizations, but especially of the Paleontological Research Institution and the Paleontological Society. Their joint contributions are recognized by the Pojeta Award (paleosoc.org/grants-and-awards/pojeta-award), commemorating their dedicated service to the Paleontological Society for several decades. The award, in part, recognizes exceptional service in the field of paleontology, above and beyond expected or existing roles or responsibilities.

During the 1990s, John worked with the Association of Applied Paleontological Sciences (AAPS) in the creation of their scholarship program. He was instrumental in getting the word out to graduate students in invertebrate paleontology about the scholarships offered by this paleontological organization. For much of the 1990s John worked with Neal Larson and others to get names of candidates for the James R. Welch Scholarship. Because of his diligence and cooperation many students were able to benefit from the support of AAPS to help fund their collecting so that they could complete their research in order to complete their degrees. John authored a number of professional papers. Perhaps his best known work is his work with Lucy Edwards on the 1997 *Fossils, Rocks, and Time* (right). Online: https://pubs.usgs.gov/gip/fossils/contents.html & as a pdf at: https://pubs.usgs.gov/gip/7000011/report.pdf

In Memoriam:

John Pojeta, Jr. (left)
Ethel Sinow (below)
Martin Tremor, Jr. (right)



Ethel Sinow, long-time Sanibel-Captiva Shell Club member and supporter, passed away on 26 March 2017 at the age of 93. She and her husband Sidney moved to Sanibel in the early 1990s. Ethel began studying piano at age 7 and at the age of 12 she gave her first public piano concert at Orchestra Hall in Chicago. She graduated from Hyde Park High School at 16 and continued her piano studies at the Chicago Music College and Roosevelt University. Ethel gave piano concerts for the next 60 years in venues throughout the United States.

Ethel became a docent at the Bailey-Matthews Shell Museum (below) when it opened in 1995. In 2015 she was honored for her twenty years of continuous service at the museum. She was an ardent sheller and could be found most every day walking the Middle Gulf beaches. She began entering scientific exhibits in the annual club shell show in 2000 and continued through 2016, winning a number of ribbons and awards over the years. Ethel loved to help people understand shells and shelling, and would spend all three days of the shell show enthusiastically answering show attendees' questions. Her dependable help and knowledgeable presence in the scientific room will be greatly missed.

Martin E Tremor, Jr passed away on Saturday evening, October 14, 2017, in Beach, North Dakota. He was 83. Martin had recently worked on an all-inclusive and very impressive shell show exhibit of the cockles, Cardiidae. I don't think I ever heard how he came to choose cockles to learn about, as he accumulated the shells for his multi-award-winning exhibits, but he did a fabulous job in a fairly short time. We became friends in his quest for information about these shells, as well as specimens, and I shared shells with him from my collection. He was single-handedly responsible for renewing my excitement over my own long-time collection of Cardiidae, the only shells I collect, and I will always be grateful to him for that, and for his warm friendship. Conrad Forler, his life partner of 40 years, always helped Martin with his beautiful shell show exhibits, and will care for the beautiful Australian shepherd dogs they shared, Gemini and Charley.

Sue Hobbs

Aside from award winning shell show exhibits (the top photo shows Martin with his COA Award from a recent shell show), Martin was an avid and quite successful field collector. He published a number of articles on his different shelling trips. Some of these may be viewed online on the Jacksonville Shell Club web page. Three such articles are:

All the Wonders of Maui – www.jaxshells.org/hawaii.htm

Make Mine Eleuthra – www.jaxshells.org/eleuth.htm

A shelling Trip to Key West – www.jaxshells.org/kwest.htm

From *Tidelines*, the St. Petersburg Shell Club newsletter (September 2016) came this image of a 2,400-year-old sculpture in marble of a Mediterranean pelican's foot, *Aporrhais serresianus* (Michaud, 1828). The image was originally posted by Andrea Glez on Archaeology & Prehistoric Wonders, and then on Facebook (12 June 2016) by Molluscan Pictures. The sculpture is dated at 425 BC, from Greece.

There are two subfamilies in the family Aporrhaidae: Aporrhainae Gray, 1850, with a single genus, *Aporrhais* Costa, 1778, and four extant species (*A. pesgallinae* Barnard, 1963; *A. pespelicani* (Linnaeus, 1758); *A. senegalensis* Gray, 1838; and *A. serresianus* (Michaud, 1828). The second subfamily is Arrhoginae Popenoe, 1983, with a single monospecific genus, *Arrhoges* Gabb, 1868, and the single species, *A. occidentalis* (Beck, 1836). There are dozens of fossil genera within the family and a plethora of synonyms. Below is an actual *Aporrhais serresianus*, in this case the typical dextral shell, rather than the sinistral shell as sculpted.

The common but little-known chambered nautilus

Thomas E. Eichhorst

10,000 Nautiluses

Approximately 500 million years ago (MYA), during the Late Cambrian period, ocean-going shelled predatory cephalopods developed - the nautilids or nautiluses. The term nautilus is from the Latinized Greek *ναυτίλος* or sailor. The fossil record is rather extensive and shows this group to be major predators during the Ordovician period (488.3-443.8 MYA) to the start of the Silurian period (443.7-419.3 MYA) with some species growing to over eight feet in length. Some authorities believe the explosion of nautilus species was responsible for the extinction of the trilobite - its natural prey (Ward, 1988). The extinct nautilus genus *Lituites* flourished during this period and fossil shells have been recovered from North America, South America, Europe, and China. These shells formed in a planospiral shape during juvenile growth and then extended in a straight section of growth equal to or exceeding the length of the spiral portion. The shells were divided into separate chambers similar to that seen in modern nautilids.

***Nautilus pompilius* Linnaeus, 1758, the chambered nautilus, photographed at night off Manus Island, in 2008 by Charles Rawlings. Millions have been collected and sold over the past couple hundred years, yet there is still much we do not understand about this fascinating creature and its close relatives.**

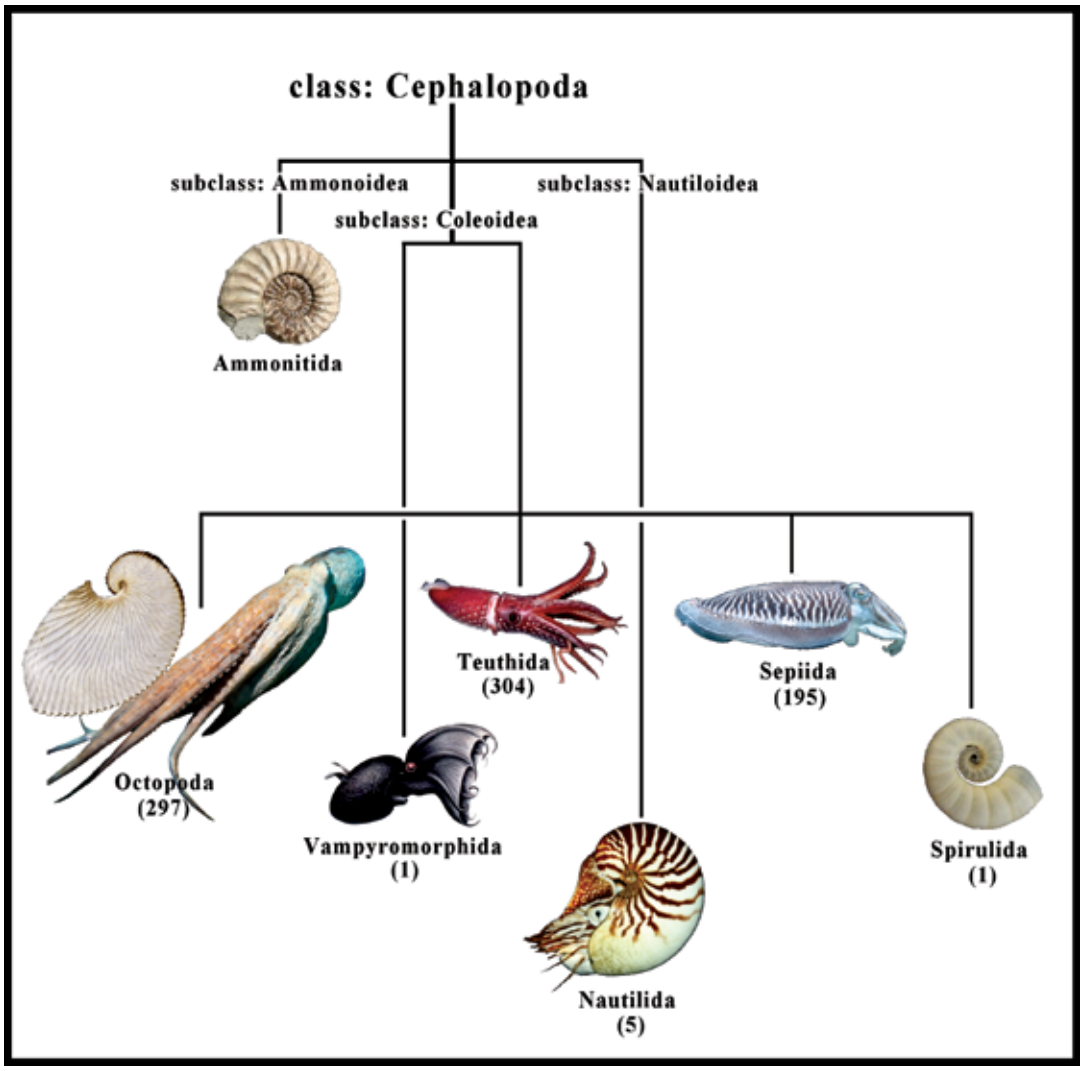
During the Devonian (419.2-358.9 MYA) ammonites first appeared, probably originating from bactritoid nautilids. Devonian nautilid genera numbered about 22 and are true nautilids in structure. The order Bactritida is considered ancestral to both the ammonites and the modern cephalopods. Despite appearances, ammonites, which died out during the Cretaceous-Paleogene extinction event (66 MYA, killing off 3/4 of all plant and animal species on earth), are no more closely related to extant nautilids than they are to extant cephalopods (octopus, squid, cuttlefish). All are in the class Cephalopoda, but the octopuses (order Octopoda), squid (order Teuthida), vampire squid (order Vampyromorphida), spirula (order Spirulida), cuttlefish (order Sepiida), and argonauts (order Octopoda) are all in the subclass Coleoidea, while the nautiluses (order Nautilida) are in the subclass Nautiloidea, and the ammonites are in the subclass Ammonoidea (with numerous orders and suborders).

Lituites lituus* Monfort, 1808, fossil ancestor of the nautilids. This fossil is from Hunan, China, but the genus was found worldwide. *Lituites is **an extinct nautiloid genus from the Middle Ordovician and was planospirally coiled on the juvenile portion of the shell but then extended the shell in a long, generally straight adult section. Image from Wikipedia.com.**

Nautilids declined somewhat during the late Devonian, but then flourished again during the Carboniferous

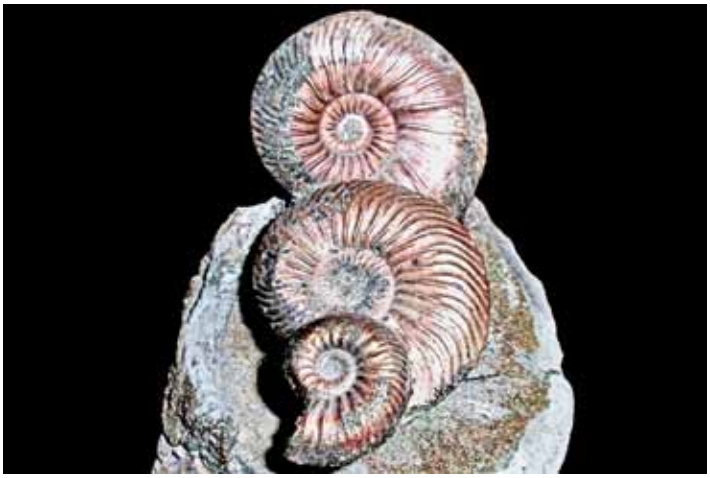
(358.9-298.9 MYA), with 16 families and some 75 genera. They decreased again during the Permian (298.9-252.2 MYA), and survived the Permian-Triassic extinction event (252 MYA), only to almost completely die out during the Triassic-Jurassic extinction event (201.3 MYA).

Only a single genus (*Cenoceras*), similar in appearance to modern nautilids, survived the Triassic-Jurassic extinction event. They flourished again through the Mesozoic (252-66 MYA), and survived (as previously noted) the Cretaceous-Paleogene extinction event (66 MYA). Several genera flourished throughout the Paleocene (66-56 MYA) and the Eocene (56-33.9 MYA), but out of maybe 10,000 nautilus species that thrived at different times in the world's oceans, only a single family (Nautilidae) survives today, with two genera: *Nautilus* Linnaeus, 1758 and *Allonautilus* Ward & Sanders, 1997 - (*allo* meaning different).



Notional tree demonstrating the relationships of various members (at the order level) of the class Cephalopoda. Note that extinct ammonites and extant nautiluses are in separate subclasses from all of the other cephalpods. All of the Recent cephalopods, EXCEPT the order Nautilida, belong to the subclass Coleoidea.

A fossil nautilus in the family Cymatoceratidae, probably the most common nautiloid family of the Cretaceous. The shell is noticibly similar to modern nautiloids, complete with a smooth surface and relatively flat septa.



Fossil ammonites, on the other hand, have heavily axially ridged shells. These particular specimens (identity unknown) have the outer shell replaced by iron pyrite.

An immature *N. pompilius* in a public aquarium. Once a rare sight, but relatively common today. Image from Wikipedia.com.

***Nautilus belauensis* viewed from the front, although the animal is traveling away from the viewer. Like other cephalopods, the hyponome or funnel of the nautilus provides a means for "jet" propulsion.**

Close up of the nautiloid simple pinhole eye (no lens). Image modified from Hans Hillewaert, Wikipedia.com.

The Life of the Nautilus

The chambered nautilus has a simple "pinhole" type eye (no lens) and about 90 tentacles that, unlike the octopoids, lack suckers. These tentacles are long and soft and can retract into a harder sheath. They use a ridged surface to stick to their prey and are known to have a strong grip (Kier, 1987). They have a pair of rhinophores (small appendages) located near each eye that are thought to function as scent detectors (Kier, 1987). Nautilids reproduce sexually (dimorphic) but there is little readily apparent sexual dimorphism in the shell (a slight shell size difference at maturity with males averaging about 13mm larger shell diameter was measured by Dunstan et al., 2011), although there are differences in the soft body parts (Ward, 1988; Griffin, 1900). Gravid female nautilus lay 10-20 eggs yearly (polycylic spawning) in shallow water, which take 12 months to hatch; contrary to most cephalopods that lay eggs once and die (terminal spawning) (Rocha et al., 2001). The young hatch with a complete shell with seven chambers, at a size of about 25mm (Grulke, 2016). The nautilus lifespan is estimated to be in excess of 20 years, but they do not reach sexual maturity until approximately 15 years. Their reproductive period is thus limited to 5+ years and although juvenile specimens were once objects of mystery, they were finally trapped at the same depths as feeding adults (Dunstan et al., 2011). The first hatchling ever observed was a captive at the Waikiki Aquarium, Hawaii, in 1985 (Grulke, 2016)

Nautilids are carnivorous and feed on both live prey and carrion. Because of this scavenging habit, they have been called an animal that will "eat anything that smells." (Ward, 1988) They typically spend daylight hours at depths from 300 to 1,000 feet and then ascend at night to feed in shallower water. This, along with their scavenging of dead and odiferous food items, has made them vulnerable to trapping (Ward, 1988).

The volume and density of liquid in the chambers of the nautilid shell are controlled by the animal and used to control its depth. A small tube called the siphuncle runs through the center of each septum and is used by the animal to control the amount of liquid and air in each chamber (Grulke, 2016). Typically, only the last chamber (most recently constructed) is full of liquid, the earlier chambers are emptied and full of air for buoyancy. A new chamber is not begun until the last chamber is half emptied of fluid (Ward, 1988). Chambers are added at a rate of one every 4-5 weeks (12-13 each year) when the animal is immature. This time interval increases as the nautilus ages until adult size when it adds a chamber only every 4-5 months. This growth rate is dependent upon water temperature, food availability, and shell condition. A damaged shell aperture takes precedence and no new septum is produced until the aperture damage is completely repaired (Ward, 1988). The outer edge of the aperture grows at between 0.13mm-0.25mm per day, again

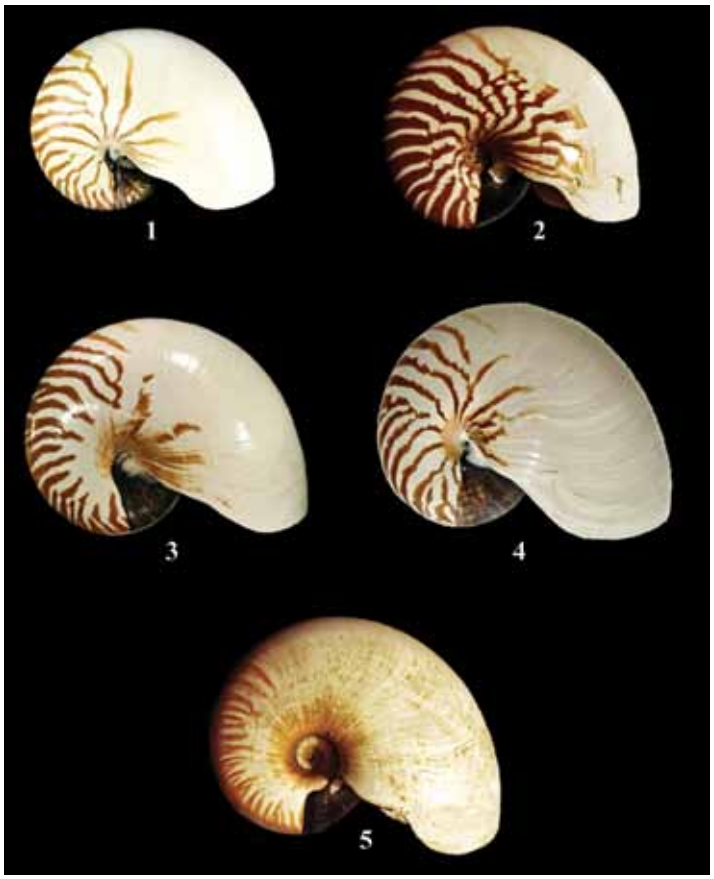
slowing at maturity. As the septum or chamber wall of the most recently constructed chamber is thickened with growth, the animal begins slowly removing the liquid. It is estimated that depths beyond 2000 feet would cause the shell to implode due to the water pressure (Ward, 1988).

All of this being said, there are actually a number of long-standing mysteries remaining about nautilids. One of the more intriguing begins with early descriptions of nautilid anatomy. In 1832, Sir Richard Owen[1] published a description of the anatomy of *Nautilus pompilius*. He provided several detailed plates with descriptive labels for the different parts of the animal's anatomy - except one unique organ that he was unable to identify (Owen, 1832). This was followed in 1841 by a publication on nautilus anatomy by Achille Valenciennes[2]. Again, the mystery organ remained so. Then came Jan van der Hoeven[3] in 1850 who found and described this same mystery organ. Part of the dilemma during this time was the scarcity of specimens. Only rarely did a returning ship offer up a usable *Nautilus* specimen, and it seldom came along with the soft animal parts. Eventually it was noticed that the mystery organ differed in male and female specimens and it was assumed to be reproductive in nature. This was not intuitive as the organ is located under the buccal mass (mouth parts) of the animal. It was thought the organ might be glandular in nature (another shot in the dark). The organ is divided into two primary structures in female specimens and called the organ of Valenciennes and the organ of Owen. In males, it is undivided and called the organ of van der Hoeven. Most recently, John M. Arnold in *Reproduction and Embryology of Nautilus* (2010) found spermatophores [sperm packets] lodged within the female Valenciennes organ.

Nautilus Species Today

Nautilids today are represented by three or up to nine species (and a few subspecies) – depending upon which author does the counting. According to the World Register of Marine Species (WoRMS, www.marinespecies.org) there are perhaps 80 named species in 3 genera: *Allonautilus*, *Eutrephoceras* & *Nautilus* (only 2 extant, *Eutrephoceras* is a fossil genus), with all but 5 being fossil species or *nomina dubia* (scientific name cannot be identified with a particular species).[4]

The common name 'chambered nautilus' usually refers to ***Nautilus pompilius*** Linnaeus, 1758, although it is often indiscriminately used for the other species of nautilus as well. Other common names for this species include: emperor nautilus, pearly nautilus, nautile flammé (French), and nautilo común (Spanish) (WoRMS, 2017). *Nautilus pompilius* is the most commonly encountered nautilus and ranges throughout the South Pacific, from Japan to the Great Barrier Reef, and from Indonesia to Fiji. It is the largest of the modern nautilids and can attain a shell size of 254mm (10 inches) (Quiquandon et al., 2015). The earliest fossil record of a modern nautilus species is from early Pleistocene deposits off Luzon, in the Philippines (Ryoji et al., 2008).



Extant nautilids

1. ***Nautilus belauensis*** **Saunders, 1981**
2. ***Nautilus macromphalus*** **G.B. Sowerby II, 1849**
3. ***Nautilus pompilius*** **Linnaeus, 1758 (type)[5]**
4. ***Nautilus stenomphalus*** **G.B. Sowerby II, 1849**
5. ***Allonautilus scrobiculatus*** **(Lightfoot, 1786) (type)**

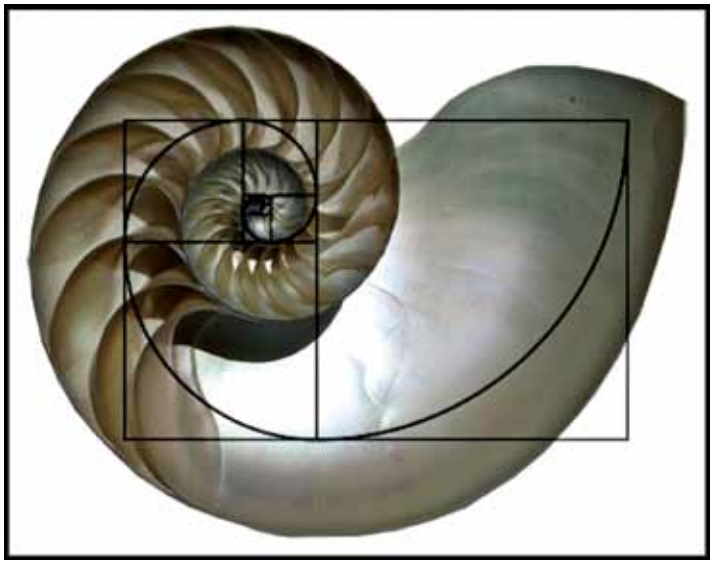
[1] Sir Richard Owen (1804-1892) was a well-known and prolific British naturalist perhaps best known for coining the word *Dinosauria* ('terrible lizards,' from the Greek deinos, 'terrible', and sauros, 'lizard').
[2] Achille Valenciennes (1794–1865) was a respected French naturalist who published on various subjects, including: parasitology, herpetology, the taxonomy of mollusks and fish, and a range of systematic classifications, linking fossil and Recent species.
[3] Jan van der Hoeven (1801-1868) was a Dutch zoologist, naturalist, magazine publisher, and author. He considered himself a generalist with degrees in physics and medicine. He was one of the last to teach his classes in Latin.
[4] Both *Allonautilus perforatus* (Conrad, 1847) and *Nautilus repertus* Iredale, 1944, considered valid species by many shell dealers and collectors, are listed by WoRMS as *nomina dubia*.
[5] *Nautilus pompilius suluensis* Habe & Okutani, 1988, a typically smaller version of *N. pompilius* found in the Sulu Sea, Philippines, is not presently recognized as a valid subspecies by WoRMS.

Allonautilus scrobiculatus was not sighted in the wild from 1986 to 2015. When Peter Ward of the University of Washington (with appointments in both the Department of Earth and Space Sciences and the Department of Biology) and his colleague Bruce Saunders from Bryn Mawr College sighted *Allonautilus scrobiculatus* off the coast of Ndrova Island in Papua New Guinea in 2015, only two other people in the world had ever recorded a live sighting of this rare species (Urton, 2015). This species grows in excess of 200mm and is found (rarely) in the waters off Papua New Guinea and the Solomon Islands.

Nautilus belauensis is known as the Palau nautilus because it is found in the waters off the Republic of Palau. It is similar in appearance to *Nautilus pompilius*, and shares with this species a closed umbilicus covered by a callus. Shell size exceeds 210mm and is second only to *Nautilus pompilius*. The *Nautilus belauensis* shell has a series of ridges, which, along with a differing radula, were enough to warrant separate species status.

Nautilus macromphalus, sometimes called the bellybutton nautilus, is native to the waters off New Caledonia and northeastern Australia. The shell has been measured at 180mm and it has an indented umbilicus without the covering callus found in *Nautilus pompilius* and *Nautilus belauensis*. It is otherwise similar in appearance to both of these species.

Nautilus stenomphalus is sometimes called the white-patch nautilus based on white markings around the umbilicus. It is found along the Great Barrier Reef. Like *Nautilus macromphalus*, this species has an indented umbilicus without a covering callus. The shell can attain 200mm in size, although it is usually smaller. In general the shell is lighter colored than the other species, but real differences are mostly in the soft body parts.



The "golden spiral" superimposed over a nautilus shell half. While the shape of the nautilus shell spiral is similar to the "golden spiral," they are not even a close match.

The Nautilus & Humankind

The shell growth pattern visible when the shell is sliced in half bilaterally has often been touted as an example of the "golden spiral." This is a logarithmic spiral (or equiangular spiral or growth spiral) based on the "golden ratio" of $r = ae^{b\theta}$. This mathematically precise expanding spiral (or the closely related Fibonacci spiral) has been 'found' any number of times in nature, but perhaps the most touted example is the nautilus shell. While the shell does display a logarithmic spiral, unlike the mathematical models, the ratio of the expanding nautilid shell changes as it grows. Measured nautilus ratios ranged from 1.24 to 1.43, while the "golden Ratio" is a fixed 1.6180339887 (Peterson, 2005; Fabio, 1999).

Perhaps the first description and illustration of nautilus was by Pierre Belon in 1553 in *De aquatilibus.*

According to Owen (1832) the nautilus was perhaps first described by Aristotle (384-322 BC), but questions remain as it is doubtful he saw a living specimen and the possibility exists he was describing a paper nautilus - *Argonauta*. Like the extinct ammonites, the *Argonauta* are more closely related to living octopus and squid than to the nautilids. According to Saunders & Landman (1989), the first description **and** illustration of nautilus was by Pierre Belon in 1553 in *De aquatilibus* and the first depiction of the nautilus animal was by Rumpf (better known by his later appellation Rumphius) in 1705.

Nautilus specimens eventually found their way to Europe in sufficient numbers where the shell became a popular item in many a curiosity cabinet. Some were inscribed in the manner of scrimshaw, others polished down (after an acid bath removed most of the outer shell) to the nacre layer. Both the polished shells and natural shells were then often mounted on stems to make drinking vessels. The shells were frequently further ornamented with gold or silver filigree.

Various polished and decorated nautilus shell cups. From left to right: a Dutch cup circa 1592, a German cup circa 1700s, an unknown origin circa 1700, and a Polish cup circa 1750.

The nautilus shell featured in many paintings from the 15th century. This is a portion of "Stillleben mit hohem goldenen Pokal" (Still life with a high golden cup) by Pieter Claesz (1597-1660). Image from Wikipedia.com.

"The Chambered Nautilus" by Andrew Wyeth (1917-2009) where the bed canopy mirrors the shape of the nautilus shell aperture. Image from Wikipedia.com.

The shell is also featured in other areas of art. Oliver Wendell Holmes, Sr. (1809-1894) wrote a poem titled "The Chambered Nautilus" in 1858 (his son was Oliver Wendell Holmes, Jr., who served many years as a US Supreme Court Justice). The first two lines read,

"This is the ship of pearl, which, poets feign,
Sails the unshadowed main,"

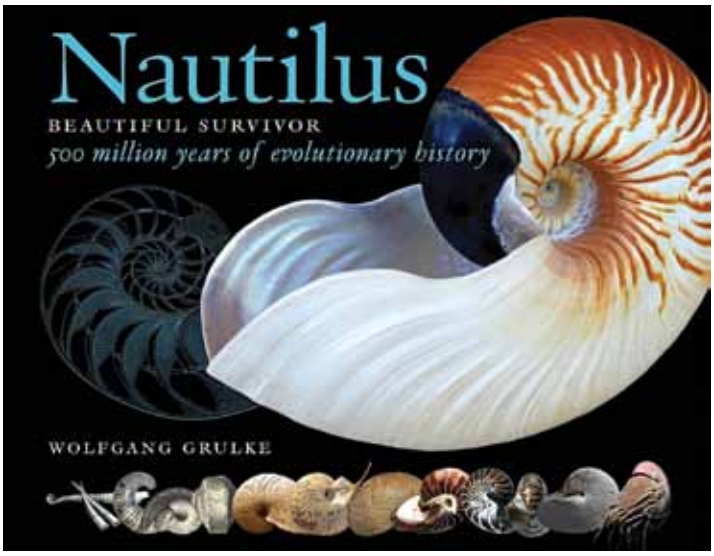
The American painter Andrew Wyeth (1917-2009) (perhaps most famous for his painting "Christina's World," also painted "The Chambered Nautilus," in which the bed canopy mirrors the shape of the nautilus shell aperture. Most of us grew up with the Jules Verne novel *Twenty Thousand Leagues Under the Sea*, or at least the Walt Disney movie interpretation with Captain Nemo's submarine *Nautilus*. There is also a Russian rock band named "Chambered Nautilus," and a search for "nautilus" on www.art.com will turn up dozens upon dozens of modern nautilus art prints.

The chambered nautilus remains a very popular shell and was commonly sold by specimen shell dealers as well as in tourist shops. It has been estimated that during the last few decades some 100,000 were harvested annually as a food item or for use of the shell nacre layer for inlay (mostly this later purpose). As stated by Dunstan et al. (2011), "The life history traits of late maturity (12–15 years), long gestation (10–12 months), and long life span (20+ years) combined with their low fecundity (10–20 eggs per year) makes nautilids particularly vulnerable to over-exploitation." They further state, "Recent studies on the Philippines fishery has shown declines in catch per unit effort of around 80% in 10–20 years, with relatively low effort by 3–4 local fishermen in each locality." The U.S. Fish and Wildlife Service Law Enforcement Management Information System (LEMIS) compiles data from U.S. wildlife declaration forms required for import or export of any wildlife, it indicates that between 2005 to 2010, over 789,000 chambered nautilus products were imported to the U.S. (Angelis, 2015). The numbers exported to China (where the shell nacre layer is a popular inlay item) and other far east countries was undoubtedly as high or higher. These different studies indicate heavy fishing of a population not yet understood and certainly not measured as to its sustainability. This prompted the U.S. to propose listing all nautilus species (both genera) in Appendix II of CITES (Convention on International Trade in Endangered Species of Fauna and Flora). The initial proposals for such a listing began in 2010 and were finally voted on and enacted in December 2016. Indonesia and India had previously listed *Nautilus pompilius* as a restricted species, but the new CITES restrictions apply to all nautilid species. Under Appendix II of CITES (not presently endangered but needs monitoring to ensure continued viability), any export of a nautilus species must be accompanied by a permit from the signatory country of origin.

A rare image of a living *Allonautilus scrobiculatus* photographed by Peter Ward off the coast of Papua New Guinea. The thick fleshy periostracum is clearly visible. Only a handful of people have seen this species alive. Image used with permission.

Known to feed on both live prey and carrion, nautilus are fairly easy to bait. Here *Nautilus pompilius* is feeding on a dead red snapper used as bait at 703 meters, the deepest recorded nautilus depth. Image from Dunstan, Andrew J., et al. (2011), accessed on Wikipedia.com.

***Nautilus macromphalus* at 15 meters, night dive, New Caledonia, photo by Pierre Sylvie, Wikipedia.com.**



A modern treatment of nautilus is *Nautilus: Beautiful Survivor* by Wolfgang Grulke (2016). Melds just enough science with stunning images to be thoroughly captivating. Well worth the money.

Saving the Nautilus

In all of this activity, if blame is laid, and it usually is, it is laid upon the shell trade. Trapping the animals to eat as a causal factor was not a consideration, nor was the use of the shell nacre for inlay work considered. Nautilids have forever captured the public's attention with the shape and coloring of the shell. Add to that the attempts to link the shell to numerical equations and even mystical events, and while not as cute as the sea otter or majestic as the blue whale, it does capture its share of publicity. Even the scientific press has statements calling the nautilus, "The world's most mathematically perfect marine species..." and "...the natural embodiment of the Fibonacci spiral..." (Platt, 2016). This same author goes on to talk about the importation of 1.7 million nautilus shells to the U.S. in the last 16 years, sold for between $15 and $200, in a trade that, "... has all but depleted many populations of these ancient animals." (Platt, 2016). Certainly the nautilus has been overfished, and hopefully this new CITES listing will provide some control without turning the shell into a museum piece only. Interestingly though, the nautilus fishing industry in the Philippines collapsed over 10 years ago (before any action to officially control nautilus fishing. Trapping nautilus is "...a difficult, time-consuming and expensive process..." (Grulke, 2016). The prices paid for the shells has remained low while expenses of up to $10,000 for a single expedition have put most fishermen out of business (Grulke, 2016). The new CITES restrictions (see Wolf & Lee, 2017: 17) and the fact that fishing pressures have already been severely curtailed, mean these wonders of nature have a chance - if you discount the fact that nautilids are extremely temperature sensitive and warming ocean temperatures may present more of a challenge than this cephalopod with a 500 million year history can survive.

Select Nautilus References:

Angelis, Patrica de. 2015. U.S. Trade Overview (2005-2010). in *Chambered Nautilus Experts Workshop Report Summary*, 4-5 June 2014, National Marine Fisheries Service (NMFS) & U.S. Fish and Wildlife Service (FWS), Silver Spring, MD. Online: https://www.fws.gov/international/cites/cop17/ussubmissions/inf_2014_nautilus_workshop_report.pdf.

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Thomas E. Eichhorst

North Carolina Shell Show – 14-15 October 2017

Despite having to change dates at the last minute due to Hurricane Irma, the annual North Carolina Shell Show was a resounding success. This year there was a new trophy presented, The Bosch Award, in memory of the late Dr. Donald T. and Eloise Bosch, longtime members of the NC club. Don was a pioneer in field collecting and shell research in Oman during his decades as a medical missionary and surgeon in that country. He is author and coauthor of a number of books on the shells of Oman and the Arabian Peninsula. He and his wife, Eloise and their three children David, Paul and Bonnie were active collector's in Oman and discovered many species of shells unknown to science. A number of them were named for members of the Bosch family, including the spectacular, *Punctacteon eloiseae*. Next year the winner of the Masters Trophy will also automatically be awarded the Bosch Trophy, an arrangement unique to the NC Shell Show.

John Timmerman won the COA Award for his display, "Mollusk Geometry." Using six large display cases (over 16 feet), John explained molluscan geometry, including logarithmic spirals, bilateral symmetry, asymmetry, fractal growth patterns, and fractal geometry.

The Master's Trophy (left) and the new Bosch Award (right) are shown here, both won by Jeannette Tysor & Ed Shuller for "Malacologists Important in Describing NC Marine Mollusks." These two awards will continue to be presented together at NC shell shows.

Scientific Trophy Winners:

Best Photography - scientific: Vicky Wall, "*Americoliva sayana*"

Best NC Collection: Brady Semmel, "Greetings From the Beaches of NC"

Alta VanLandingham Award for Best Self-Collected Exhibit: Jim & Linda Brunner, "Three Bay Sampler"

The Janet Durand Award: Irmgard Cate, "Shell Whale"

Best Fossil Exhibit: Ron Hill, "Calcite Replacing *Mercenaria permagna*"

Best Small Scientific Exhibit: Vicky Wall, "The Snail the Dinosaurs Saw"

Best Self-Collected Shell: Vicky Wall, "*Busycon carica*"

Best Shell In Show: Ron Hill, "*Austroharpa wilsoni*"

Dean & Dottie Weber Environmental Awareness Trophy: Brady Semmel, "Greetings from the Beaches of North Carolina"

The Bosch Award: Jeannette Tysor & Ed Shuller, "Malacologists Important in Describing NC Marine Mollusks"

DuPont Trophy: Doug Wolfe, "Mollusks and Shells From My Very Own Backyard"

Conchologists of America Award: John Timmerman, "Mollusk Geometry"

Arts & Crafts Trophy Winners:

Best Arts and Crafts Using Actual Shells: Rose Bunch, "untitled seahorse pulling carriage"

Best Arts and Crafts Depicting Shells: Peter Brimlow, "untitled embroidery"

Best Sailor's Valentine: Mary Brackman, "I'm Getting Married in the Morning"

Best Photography - Artistic: Ron Hill, "Banded Coral Shrimp on Yellow Sponge"

The venue for the shell show is the Cape Fear Museum, New Hanover Co., Wilmington, North Carolina.

Special Award Winners:

People's Choice Award: Doug Wolfe, "Mollusks and Shells From My very Own Backyard"

Judge's Special Award Ribbons: Mary Brackman: "First Attempt" - a Sailor's Valentine

Karlynn Morgan: "*Calliostoma* - Top This"

Phyllis Gray: "*Liguus*"

Trophies Not Awarded: Novice & Junior

Blue Ribbon Winners:

North Carolina Collection: Brady Semmel, "Greetings from the Beaches of North Carolina"

Regional Self-Collected: Jim & Linda Brunner, "Three Bay Sampler"

Regional Collection Any Source World-wide Self-Collected: Vicky Wall, "Adventures in the Western Atlantic"

Land Snails: Phyllis Gray, "*Liguus*"

Fossil Mollusks: Ron Hill, "Calcite Replacing *Mercenaria permagna*

Single Shell Self-Collected: Vicky Wall, *Busycon carica*

Single Shell Self-Collected: Amy Dick, *Scaphella junonia*

Single Shell Any Source: Ron Hill, *Austroharpa wilsoni*

Single Shell Any Source: Everett Long, *Panopea bitruncata*

Educational Collection: John Timmerman, "Mollusk Geometry"

Mollusk Natural History: Doug Wolfe, "Mollusks & Shells From My Own Back Yard"

Best Small Exhibit (10' or less): Vicky Wall, "The Snail the Dinosaurs Saw"

Beach Collected Shells: Brady Semmel, "Greetings from the Beaches of North Carolina"

Best of the Best (Masters): Jeannette Tysor & Ed Shuller, "Malacologists Important in Describing NC Marine Mollusks"

Shell Photography (scientific): Vicky Wall, *Americoliva sayana*

Shell Photography (artistic): Ron Hill, "Banded Coral Shrimp on Yellow Vase Sponge"

Mike's nautilus

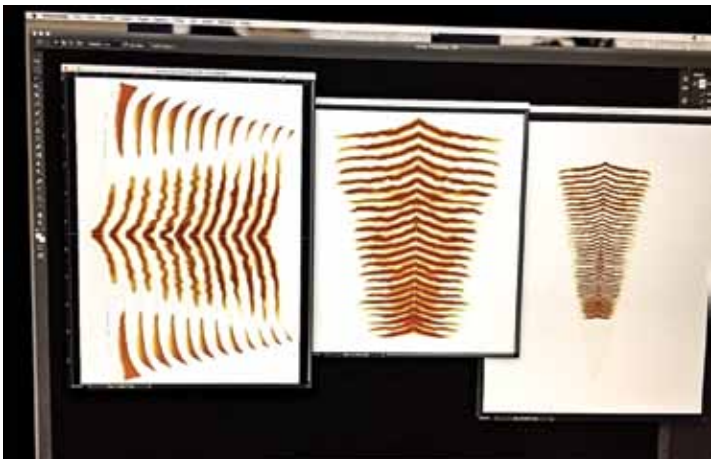
Tom Eichhorst

A friend of mine, in fact a "shell buddy," (the best kind of friend) is the Naturalist Center/School Programs Educator for the New Mexico Museum of Natural History in Albuquerque, New Mexico. His name is Michael Sanchez, and aside from running The Naturalist Center for the museum, a place where visitors of all ages can learn about the natural world of New Mexico, he is an artist - but first, The Naturalist Center. This is a spacious area the museum set aside for one-on-one contact with the natural world. Mike ensures the rooms are stocked with turtles, snakes, fish, spiders, frogs, minerals, nests, insects, fully articulated skeletons, leaves, lichens, etc., and even sea shells - all available (where and when appropriate) for observing and, most importantly, handling. Mike and his hard working team of volunteers know their stuff and this area of the museum is always packed. With modern kids seemingly further and further removed from the natural world, this place is truly special. So what about the artist part?

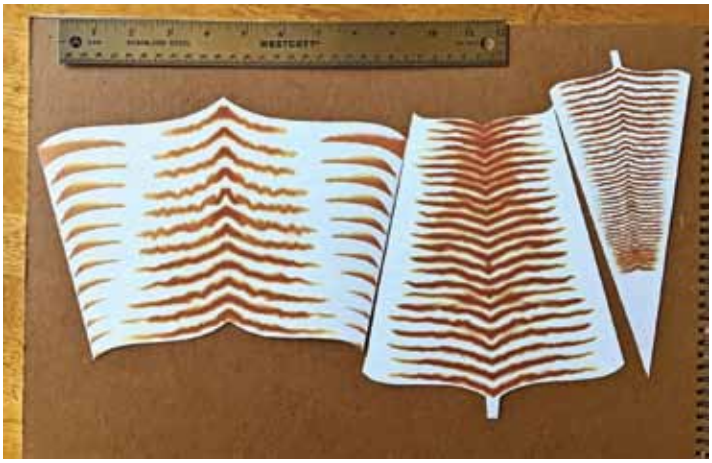
Mike has demonstrated his artistic talents in any number of ways, but of interest here is when those talents intersect the world of shells. He has provided shell art for *American Conchologist* (*Lambis chiragra* (Linnaeus, 1758) that was a back cover and now hangs in my house), but most of his artistic endeavors end up supplementing the material in The Naturalist Center. Some of the art, however, is for his personal use and enjoyment. He has constructed rare volute shells out of resin that are impossible to tell from the real specimen without picking his copy up in hand and closely examining the aperture. When I was preparing the article on the chambered nautilus, I remembered another bit of art he had done, this time with paper. Working with a computer to generate and print the images, scissors, glue, and a lot of imagination, Mike constructed notional nautiluses. Remember, he works with fossils a lot, so these are conceptual fossil nautiluses. The end result weighs what a single sheet of paper weighs, yet is strong enough that he had no problem letting my four-year-old granddaughter examine the finished product.

On the next page are a few images demonstrating the process of constructing a paper nautilus, not to be confused with that other paper nautilus, the *Argonauta*. This is certainly not a tutorial, but I thought the process was interesting enough to pass on to the readers of *American Conchologist*. The back cover shows the finished product.

Tom Eichhorst

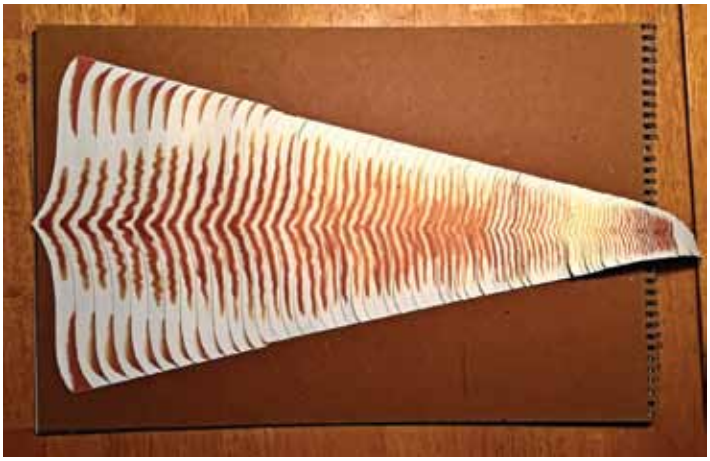


1. First the images are created (lots of trial and error) on Paint Shop and then printed on three sheets of paper.



2. Next the images are cut out in a predetermined shape - to facilitate rolling into a nautiloid coil. The central tab is used to glue the pieces together.

3. Here the three pieces are glued together in a triangular shape and cut in between the brown stripes with an Exacto-knife.



4. The glued and sliced final product is laid out for rolling and gluing (it will have to be turned over to roll it up).

5. The shell is formed by rolling the shape from the narrow portion towards the wider portion. Individual slats are sparingly glued together as they are rolled.

6. The finished shell. Now it just needs the animal inserted. Personally, I was happy with the shell, but Mike went ahead and added the animal - see back cover.