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A review of *Biogeography and biodiversity of western Atlantic mollusks* by Edward J. Petuch.

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Biogeography and biodiversity of western Atlantic mollusks by Edward J. Petuch
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Introduction

This work introduces a new biogeographic system for western Atlantic mollusks based on quantitative analysis of endemism in selected families of gastropods. The blurb on the back cover states: "[This is] the first book to use quantitative methodologies to define marine molluscan biogeographical patterns" and "the author's algorithms demonstrate that the bulk of molluscan biodiversity is concentrated in forty separate centers of speciation, ranging from Cape Hatteras, North Carolina, south to Argentina." The author reviews prior biogeographic treatments and divides the tropical western Atlantic fauna into three provinces, Carolinian, Caribbean and Brazilian.

In his Introduction the author expresses his great enthusiasm for biogeography as it is "one of the most intellectually satisfying branches of marine biology." In the book, biogeography, as inclusive of all the disciplines listed for it on page xvi, is treated briefly in the introduction to each province. Biodiversity is determined by the average endemism in only ten families and subfamilies of marine mollusks. Despite statements to the contrary, some of these supraspecific groups are notoriously over-named and in a state of taxonomic flux.

The percentage of endemism has long been a method of determining the limits of biogeographical provinces and subprovinces. Here the author has set his own percentages, as do many biogeography authors. The "quantitative methodologies" must refer to the "algorithms" used to determine the percentage of endemism in the groups selected. This will be discussed later in this review.

One chapter is devoted to each of fifteen subprovinces, some of them newly named or refined. There are two appendices. Appendix 1 lists the taxa used in the provincial and subprovincial analyses and Appendix 2 contains descriptions of eleven new genera and subgenera and thirty-one new species and subspecies.

As this review will show, although some intriguing ideas are presented in this work it is riddled with errors that cast doubt on its reliability as does the fact that it is based entirely on large gastropods, which constitute only a small percentage of the total western Atlantic molluscan fauna.

The numerous illustrations, all labeled as Figures, include maps, scenic views, and mollusks. Of 435 nominal species of mollusks illustrated, 213 of them were named by Petuch. The figures are unfortunately not of high quality, with most being half-page or less in size. A ventral view of the newly described *Cinctura* in Figure 3.6 would have been more beneficial for users than having both dorsal and ventral views of a previously named *Aurinia* in Figure 5.1, a species that does not even enter into the biodiversity equations.

Some figures will be familiar to those who have read other Petuch works. However, although smaller, the color images of Figures 8.2 and 10.11 are much better than the full page images published in 1988. Outline maps are provided for each province showing the limits of the provinces and subprovinces. In the map of the Caribbean Molluscan Province (Figure 2.4) there is an un-

numbered and unlabeled large void between northern South America and Hispaniola. The seven subprovinces are numbered on the map, but unfortunately the numbers for subprovinces 1, 2 and 3 do not match the code numbers assigned to them (page 177). On the other province maps (Figures 2.1, 10.1) the map numbers match the code numbers. All the maps would be more useful with at least some of the countries outlined, even if only on the coastline, especially Figure 2.6 of South America.

The book is difficult to use as there is no index for the included taxa. The only index is to the pages prior to the two appendices, and even this does not include taxon names in the discussions or the figure captions. In the text prior to the appendices, numerous species are listed as endemic species in families not included in Appendix 1. These are presented without author or date and are not in the index. As an example of the problems encountered without an index, in the caption to Figure 3.6 "*Stramonita bucheki* Petuch, new species" and "*Mercenaria hartae* Petuch, new species" appear with no other information. In the caption to Figure 5.6 slightly more information is given for "*Engina dicksoni* Petuch, new species … (see Appendix 2)." One can then go to Appendix 2 and start looking for it page-by-page.

Provinces and Subprovinces

In a lengthy and interesting "history of molluscan biogeographic research in the western Atlantic" appears a statement that is part of the basis for the provincial concept presented on the following pages. It is stated on page 2 that "Valentine (1973: 337) was the first to offer a quantitative definition of a faunal province. His scheme involved the use of a *50% Rule* [emphasis as published], where at least one-half of the species living within the province must be endemic." Petuch has cited Valentine for this "rule" before (Petuch & Drolshagen 2010: 16) and it was noted to be incorrect by Allmon (2011: 3). What Valentine wrote, on the page cited by Petuch, was: "A much quoted "rule" that has been used to identify provincial regions is that at least one-half of the species living therein must be endemic (that is, native). However, there is no special reason to employ any particular arbitrary level of endemism, and it is in fact theoretically possible that a province could possess no endemic species at all and yet have distinctive communities."

The point here is that the definition of a province depends upon the person making the divisions and this misquote is not necessary to further the provincial scheme presented. It is noted that Valentine referenced "the species living within the province", not simply representatives of selected family groups.

There is a discussion on page 3 of "biogeographical classifications that have been proposed over the past 150 years." In listing the three provinces recognized in this book, the final one is "the Brazilian Province that I proposed in 1988." What Petuch meant by that statement is not known, as in 1988 there was no indication it was novel. Perhaps he meant "a mollusk-based Brazilian Province" as the term Brazilian Province has been around for many years (e.g., Ives 1891, emending earlier usage).

Petuch has a section on "Western Atlantic paleoprovinces and paraprovincialism" beginning on page 10. No comments are here made about this section, but those interested should read comments on Petuch's treatment of paleoprovinces by Landau, Vermeij, & da Silva (2007: 445–450) and on paraprovincialism by Lyons (1991: 200–201).

Provinces are a useful tool in biodiversity studies. It is also instructive if they may then be subdivided into subprovinces. To arrive at what is presented as a precise method of division, Petuch has selected ten families and subfamilies of gastropods for his analyses. His basis for the choice of families/subfamiles is stated to be: "… because of their relatively well-established and stable systematics." This statement is difficult to accept considering that Olivinae, Conidae and the rather new family Conilithidae are notoriously overnamed. If Conidae is well established, why are eight new Conidae genera, four new Conidae species, as well as one new Conilithidae genus and six new Conilithidae species, necessary in this book? Additionally, ten undescribed species in these two families, mostly endemic to a subprovince, are listed and coded.

In the Olividae, only Olivinae is treated, with 35 named and two unnamed species and subspecies listed, of which Petuch is author or senior co-author of 15. Tursch & Greifeneder (2001) synonymized all of Petuch's western Atlantic species, but they recognized only three western Atlantic species. Two subsequent works have reviewed *Oliva* and recognized more western Atlantic species: Sterba (2004) and Hunon, Hoarau & Robin (2009). Summarizing across Sterba and Hunon *et al.*, *Malacolog* (Rosenberg 2009) shows sixteen western Atlantic *Oliva* as valid, including four Petuch species recognized by Hunon *et al.*: *Oliva barbadensis* Petuch & Sargent, 1986; *Oliva sargenti* Petuch, 1987; *Oliva goajira* Petuch & Sargent, 1986; and *Oliva bayeri* Petuch, 2001. The latter species is not even on the list of index taxa on page 188 but is listed on page 209 from Columbia [*sic*; = Colombia]. The currently accepted level of diversity is less than half of what Petuch advocates, and only one quarter of his taxa of *Oliva* are accepted as valid at the species level.

In addition to the considerable discrepancy among authors about the validity of some named *Oliva*, in a footnote on page 188 Petuch announces that "recent research by Pierre Recourt, The Netherlands, has shown that there are at least ten more unnamed species of Caribbean *Americola* [*sic*; = *Oliva* (*Americoliva*)]." The taxonomy of Olivinae in the western Atlantic is demonstrably not "well-established and stable" and the subfamily should not be used as a basis for a study of this sort.

In the Fasciolariidae, only species of the nominate subfamily are utilized, and in Volutidae only Lyriinae are included. Why?

Only gastropods are selected to determine provincial divisions in this book, bivalves and other molluscan classes being totally ignored. No indication is given that other taxon groups had been tried and found to be useless in determining divisions, nor is there any mention of demarcations that might have been tried and abandoned.

Determination of Provinces and Subprovinces

The method of defining provinces by a percentage of endemism is standard practice. In this new book the limited number of families and subfamilies utilized seems insufficient, especially as some of them are considered to be over-named. However, taxonomic concerns will not directly enter into this discussion.

Petuch's method of determining endemism for each provincial area is detailed on page 6, where he mentions that he has introduced a new "*25% Rule*" [emphasis as published] for subprovinces. This percentage is the "*subprovincial combined index*" [emphasis as published].

Appendix 1 of the book is a list of ten families or subfamilies, referred to by Petuch as "provincial index taxa," with a list of the species in each that occur in the western Atlantic. The species are coded for the various subprovinces in which they are found. These "code numbers" do not appear anywhere in the text and are identified only on page 177. Mention of the appropriate code for each of the subprovinces within the relevant text would have been helpful.

What is called "the taxon index"(T), is generated by the total number (n) of endemic species in one of the 10 included families, divided by the total number (N) of species in that family within the (sub)province. This simple procedure is represented by the equation:

$$T = \frac{n}{N}(100),\ T > 50$$

The "T > 50" is not part of the equation but indicates a result greater than 50 which is not necessary for each family. The T is capitalized only in the formulae for provinces and is lower case (t) in those for subprovinces where "t = > 25", which again is not necessary and is, in fact, often not the case. This distinction is confused from the start as on page 31 the "taxon index" formula for provinces is used for a subprovince.

$$P = \sum_{n=1}^{10} \frac{Tn}{10},\ P > 50$$

$$S = \sum_{n=1}^{10} \frac{tn}{10},\ S > 25$$

The above impressive-appearing formula is used to generate a quantity P (Province) or S (Subprovince) representing the percentage of endemism. This nonstandard "mathematical" notation, referenced as an algorithm, for "the average"

used by Petuch is unnecessarily made more confusing by his symbolism. In standard mathematical notation *tn* denotes the product of two variables. What is intended within the "formula" is that *t* is a variable, and *n* is an index, notational denoted as a subscript. Confusingly, in the expression *tn* the *n* is not the same as the *n* used for the number of endemic species but is a "dummy index" which disappears in the final result.

t_1 = percentage of endemism of Modulidae

t_2 = percentage of endemism of Turbinellidae

. . . . .

t_{10} = percentage of endemism of Plesiotritoninae

In Petuch's "formula" the denominator is confusingly placed inside the unnecessary sigma [Σ] addition symbol. It does not depend on the summation index *n* and can be placed in front of the summation sign. This symbolism could be completely eliminated by the use of:

$$S = 1/10\ [t_1 + t_2 + t_3 + \cdots + t_{10}]$$

Under even cursory scrutiny of the computational results and the data used it is obvious that discrepancies exist. These have been recomputed for subprovinces as shown below. The percentage figures shown for the provinces do not reflect the exact result obtained from the data given for their determination, but the large number of taxa impedes reconstructing them. It will be noted that for only five of the 15 subprovinces does the published *t* number equal the result given by the published data appearing immediately above the statement of "quantity" (= S) for each subprovince. Some of the differences increase S while others decrease S. Most differences are negligible, but some are dramatic.

Table 1 lists [B] the S numbers as stated by Petuch for each subprovince; [C] the S numbers determined from the *N* and *n* figures published by Petuch for each subprovince; [D] S numbers derived from the taxa list in Appendix 1.

Not only are the *t* figures often misapplied to the formula, resulting in an incorrect S quantity, the *N* and *n* quantities do not always match the listings in the Appendix 1 index list. An audit of one listing shows the result of such errors. The Texan Subprovince index taxa are entered (p. 66)

Table 1

A = code number for subprovince

B = S as stated in the text

C = S as derived from the numbers given in the text

D = S as derived from the numbers of species (*N*) and endemic species (*n*) as listed in Appendix 1.

	A	B	C	D
Georgian	C1	30.2	28.3	34.5
Floridian	C2	39	32	22.9
Suwannean	C3	31.9	31.9	28.1
Texan	C4	28.4	28.4	14.4
Yucatanean	C5	34.8	34.8	25.6
Bermudan	CR1	46.2	36.6	35.8
Bahamian	CR2	53.9	41.4	46.5
Antillean	CR3	32.4	27	32.6
Nicaraguan	CR4	31.6	31.5	39.1
Venezuelan	CR5	34.1	32.5	27.3
Grenadian	CR6	48.3	35.4	35.8
Surinamian	CR7	25	14.1	13.5
Cearaian	B1	46.2	46.2	22.4
Bahian	B2	61	48.5	29.9
Paulinian	B3	50	50	27.5

with the resulting *t*, *N* and *n* numbers, and it is stated that the "index quantity is S = 28.4" and that "this high level of endemism (S>25) demonstrates that the Texan Subprovince is a differentiable biogeographical entity." Although the figure 28.4 is correct using the numbers listed at the top of page 66, the *N* and *n* numbers listed do not agree with the list of index taxa coded as C4 (= Texan Subprovince). Differences noted:

Modulus – *t* = 100, *N* = 1, *n* = 1 – In the index taxa there are no *Modulus* coded C4. *Modulus modulus* (Linnaeus, 1758), which occurs in Texas, is coded only for subprovinces of the Caribbean Province but is not endemic to any. As there is no endemic *Modulus*, *n* = 0 and *t* = 0, not 100.

Conidae – Ten species are coded as C4 with two shown as endemic, resulting in $t = 20$ instead of 11.

Fasciolariinae – Five taxa are coded for C4 with one as endemic. While there is a question about that species being endemic, it has not been changed here, and taxa are treated as listed. The correct result, based on five species, is $t = 20$

Cancellariinae – Seven taxa are coded C4, not 2 as listed on page 66. As only one is stated to be endemic, t = 14.

Based on these numbers, S = 14.4 which is far below Petuch's minimum of 25. Even this low "index quantity" is greater than that shown by Rosenberg *et al.* (2009: 580) who found that the northwest Gulf of Mexico has only 19 endemics out of a total of 765 known gastropod species (= 2.5% endemism). A subprovince, as defined by Petuch, is not justified by the data presented.

Similar failings have been found in other subprovince summations. In the Floridian Subprovince (C2) the S number derived from the published numbers on pages 47–48 is 22.9, again below the "standard" 25. This S number would only be 12.9 if an unnamed *Enaeta* were not included. It is one of 21 unnamed taxa that are coded as endemics.

The use of only selected groups to determine endemism, while it may be an entirely new approach, seems lacking in logic. It is quite easy to see that the addition of one or more groups to the 10 selected for this study, especially if they include many non-endemic species, could dramatically change the results. As noted above, the addition of one unnamed species as an endemic can change the S number by 10.

Basing provinciality on a percentage of endemism of species is understood, but as presented here it is only endemism in included families that is considered. An included family with 25 species, none of which are endemic, has the same value ($t = 0$) in the "algorithm" as a family with only one species, it being non-endemic. A family with only one species, but which is endemic, has the highest ($t = 100$) value.

Regardless of the groups selected, if the "index taxa" are not correctly coded, or if they are miscounted when arriving at the percentage of endemism, the process is meaningless. As there are 10 subprovinces, with 15 family and subfamily groups in each for which *N* and *n* numbers must be determined, there are therefore 300 numbers that must be derived from the index taxa list. Comparison of the printed numbers from each subprovince with the coded index taxa reveals that of these 300 numbers, 127 do not match. This means, of course, that 42% of the numerical data are incorrect. Some of the differences have minimal, if any, effect. A few changes made to the taxa list that could affect some of these numbers is given in the discussion of Appendix 1 below.

Appendix 1: Provincial Index Taxa

This section lists the taxa "used for the provincial and subprovincial analyses shown throughout this book." The taxa listed lack both author and date, thus making it difficult for those who might note an unfamiliar name and wish to locate its origin. An arrangement similar to that used for showing the range of taxa by Landau *et al.* (2007: 457), including author and date for each taxon, would have been preferable.

It must be noted that in the lists of Provincial index taxa there are numerous nomina originally named by Petuch that have been placed in synonymy by other systematists but that are treated as valid for the purpose of establishing the faunal areas. Such synonymies are totally ignored by Petuch, with two exceptions. The first is on page 53 in the figure caption where *Gradiconus anabathrum tranthami* (Petuch, 1995) is followed by "(*G. antoni* Cargile and *tortuganus* Petuch and Sargent are synonyms)." This is repeated in abbreviated form on page 180. The unusual reason for this synonymy is discussed in Petit (2011: 2). The second appears on page 93 in the figure caption where *Oliva zombia* Petuch & Sargent, 1986 is stated to be a synonym of *Oliva* (*Americoliva*) *broderipi* Ducros de St. Germaine, 1857. Both of these synonymies were initiated by Petuch.

Listed and counted as index taxa are 21 taxa that are identified only by a genus name followed by "new species" and the code number. This, of course, makes verification of the list impossible. Most of these unnamed species are coded for only one subprovince.

It is axiomatic that errors in this list affect the analyses which form the core of the book. Only a few index taxa, for which references are literally at hand or with which I am familiar, have been checked. The absence of authors and dates on the names hinders extensive checking of ranges, etc. Arrangement here as in the Appendix:

Modulus modulus (Linnaeus, 1758) is listed in the Appendix but this common species is not coded as CR2. It has been included here as a constituent of the subprovince. Also see following note about *M. honkerorum*.

Modulus honkerorum is listed in Appendix 1 with the notation "B2 (see Appendix 2)." In Appendix 2, *M. honkerorum* is described as a new species with type locality "off Tarpum Bay, Exuma Sound, Eleuthera Island, Great Bahama Bank, Bahamas." The correct code number should be CR2 and not B2. It is so treated here.

Atlanticonus ritae is listed in Appendix 1 with code CR with no number. As it is stated to be endemic to Rosalind Bank, it has been assigned the code CR4.

Lindaconus baylei is listed in Appendix 1 with "(= *spurius arubaensis*) CR5." This same synonymy was cited by Petuch (2003: 295), in the genus *Spuriconus*, with range as "northern Colombia to Isla Margarita, Venezuela and Aruba." If that range is correct, it should also be included in CR6. No change has been made in this compilation.

Tenorioconus mappa is listed in Appendix 1 without a code but its range is given as "(Venezuela, Trinidad and Tobago, Barbados)," and it is herein treated as occurring in Subprovinces CR5 and CR6.

Artemidiconus yemanjae is in a list of taxa endemic to the Cearaian Subprovince (= B1) on page 148. In the list of index taxa it is coded only as B2 (p. 182). That assignment is not changed in this compilation.

Dalliconus "new species ('*macgintyi* [sic; = *mcgintyi*]' from Brazil) B2, B3, B4" is listed in Appendix 1 (page 183). There is no subprovince with the code letter B4 on page 177, where the code numbers are assigned, and B4 has not been found elsewhere.

Jaspidiconus oleiniki is listed in Appendix 1 with the notation "B2 (see Appendix 2)." In Appendix 2 it is described as a new species with type locality "Nixon's Harbour, South Bimini Island, Bimini Chain, Great Bahama Bank, Bahamas." The correct code letter should be CR2 and not B2. It is so treated here.

Cinctura branhamae is coded as endemic in C5 but its Recent range includes C4 (*fide* Snyder *et al.* 2012: 36).

Cinctura lilium is coded as endemic in C4 but its Recent range includes C5 (*fide* Snyder *et al.* 2012: 36).

Cinctura totuganum [sic; = *C. tortugana* (Hollister, 1957)], coded as endemic for C3, also occurs in C2 (*fide* Snyder *et al.* 2012: 36).

Fasciolaria agatha is coded as B2 but its type locality is off Ceará (= B1). It has not been included here in either as it is not in Fasciolariinae but is now placed in Fusininae (*fide* Mallard 2010: 11-12, a determination stated electronically earlier by Rosenberg on *Malacolog*).

Fasciolaria bullisi is coded as endemic in C5 but its Recent range is off western Florida and Yucatan Platform, Mexico (*fide* Snyder *et al.* 2012: 34). The type locality for this species is about 80 miles west of Tampa Bay.

Fasciolaria tephrina is coded as C4 & C5 but its range is in CR4 (*fide* Snyder *et al.* 2012: 34).

Fasciolaria tulipa hollisteri is coded as endemic in C5 but its Recent range is western Venezuela, Caribbean Colombia, and Aruba (*fide* Snyder *et al.* 2012: 34).

Pleuroploca granulilabris has been excluded as it is not in Fasciolariinae but is now placed in Peristerniinae (*fide* Snyder *et al.* 2012: 58, a determination stated electronically several years earlier by Rosenberg on *Malacolog*).

Oliva bifasciata bollingi is in the Appendix list without a code letter. As it is rarely used as a valid name, no code letter has been introduced in this compilation.

Oliva reclusa is coded CR without a number. On page 210 it appears is in a discussion with

Aruba being the only location mentioned. It is here treated as CR6.

Axelella smithi is listed on page 39 as being "endemic to the Carolinas." The Appendix List correctly indicates that it occurs in multiple subprovinces.

Majox chariessum [sic; = *chariessus*] is listed on page 39 as "endemic to the Carolinas." *Pleurotoma chariessa* Watson, 1881 was described from west of the Azores, and also off the Canary Islands. Other "endemics" in this list have not been researched.

Other taxon items

Aphera is listed on page 8 as a member of a relict fauna in the "unusual composition of the northern Colombian-Venezuelan offshore fauna" although it does not occur there. In Petuch's 1981 paper on this relict fauna there is an *Aphera*, identified at the time as *A. islacolonis* (Maury, 1917) but later named *A. lindae* Petuch, 1987. The correct type locality, off Barbados, was not published until 1988 and is so localized in this current work on pages 137 and 189. The incorrect locality originally given is also mentioned on page 137. It has previously been discussed in detail by Petit (2012a: 6). The mention of its being found in association with "other rarely seen Caribbean gastropods" seemingly indicates that more than one specimen has been found, but the genus is still known extant only from the single specimen of *A. lindae* Petuch, 1987.

As for the relevance of this "relict fauna," it is noted that Petuch (1981) listed 45 nominal taxa as the relicts supporting his paper. Of those 45 taxa, 14 were later named as new Recent species by Petuch and six by others. There are twelve species that had been previously named from the Recent fauna but misidentified and one never had a name but was included as "sp." Of the remaining twelve "relicts", six are in Turridae which is badly in need of work in the Caribbean (and elsewhere), and at least one is considered to be a fossil and not living. It is difficult to determine, but it seems that Petuch is now treating as "relict fauna" any fauna that contains species of genera that are also found in the fossil record as he refers to "living members" of "species complexes."

Axelella agassizii (Dall, 1889) is on pages 39 and 189. It is not a member of this genus but is the type of the genus *Agatrix* Petit, 1967. The two genera are not closely related.

Triplofusus papillosus (Sowerby, 1825) is Figure 2.3A. On page 16 it is listed with the note "often listed as *T. giganteus*" with no author or date for the latter name. In the Appendix it is listed simply as "(= *giganteus*)." Snyder (2003) incorrectly used this synonymy, but the Sowerby name must be a *nomen dubium* as it cannot be identified to the species level. The species has been identified as *Triplofusus giganteus* (Kiener, 1840) in recent works by Snyder, Vermeij & Lyons (2012: 43) and others.

Melongena (*Rexmela*) *corona winnerae* Petuch, 2004 [sic; = 2003] listed on page 40 as a constituent of the "Palm Beach Provinciatone" but is not in a family that is included in the lists of index taxa. It is mentioned here to note that in both 2011 and 2012 this taxon was treated by Petuch & Sargent as a form, not as a subspecies.

Plicoliva zelindae oceanica [Coltro] is listed on page 159 as an endemic. Although appearing on the lists of many shell dealers, this species has never been described and the name is a *nomen nudum*.

Voluta polypleura (Crosse, 1876) is discussed on pages 99–100. It is stated that the type has been lost. It is further stated that "The true *Voluta polypleura* (Figure 7.2B), with its neotype specimen in the Division of Mollusks at the National Museum of Natural History at the Smithsonian Institution (*Voluta polypleura*, Neotype Number USNM 894291), is now known to be an inhabitant of shallow-water coral reefs around the Caratasca Cays (new type locality) and Vivorillos [sic; = Vibrorillas] Cays of Honduras." There is in the USNM a newly deposited specimen with this name, number and locality, but there is no indication that it is a neotype, and it is not in the type collection. The designation of a neotype must be made in accordance with the Code (I.C.Z.N. Article 75). It does not appear that all of the numerous requirements for neotype designation have been met, especially Article 75.3.4.

In the discussion surrounding *Voluta polypleura*, it is stated "a unique species radiation, endemic to the Nicaraguan Subprovince, contains the following species." That is followed by a list of ten nomina, one of which is listed simply as "*Voluta new species*." Of the remaining nine, seven were named by Petuch, as were the Honduran species *V. garciai* and *V. harasewychi* which are omitted with no stated reason. All of the species named by Petuch, with the exception of *V. morrisoni*, have been placed in synonymy or considered to be forms by various authors.

It is alleged that with the definitive identification of *V. polypleura*, *V. demarcoi* can be removed from synonymy and that "specimens of other western Caribbean species, such as *hilli, kotorai, ernesti* and *retimirabila* [*sic*], have been misidentified by many volute workers," and "these Nicaraguan Subprovince endemic volutes should now be considered to be separate full species." It is not explained how correction of one synonymy can make other synonyms "full species." At the end of the discussion it is mentioned that "recent collecting has uncovered at least three more geographically isolated unnamed species." One new species on page 99 becomes three new species on page 100. That is rapid speciation!

Locations are given for the species in the list of *Voluta* on pages 98 and 99. *Voluta morrisoni* is listed as "endemic to Rosalind and Serranilla Banks," but the unstated type locality is off Roatan Island. That is quite a distance for a species in a group whose species are supposedly very restricted in range. Also, the type locality for *V. retemirabilis* is Caratasca Cays, Honduras, and although it was shown by García (1993: 12) to occur off Misteriosa Bank, no statement of a change in type locality was made. Such a declaration should now be made, as it is stated to be endemic to Misteriosa Bank, a locality unfortunately not on the map provided (Figure 7.1). Possibly this is because Misteriosa Bank may not be within the limits of the Nicaraguan Province as defined on the map, which lacks latitude and longitude lines.

Coltroconus delucai (Coltro, 2004) is listed as a species in the new genus *Coltroconus*, followed by "(Figure 10.7B, C; *C. bodarti* Coltro, 2004, is a synonym)." The final sentence in that paragraph is: *Coltroenus* [*sic*] *bodarti* (Coltro, 2004) is now known to be a synonym of *C. iansa*. Does this mean that *C. delucai* = *C. bodarti* = *C. iansa*?

Although the placing of his nomina into synonymy by others is not noted by Petuch, an exception is made if such synonymy has been reversed. On page 63 the family Pectinidae is rather gratuitously listed with the single species *Lindapecten lindae*, both the genus and species having been named by Petuch in 1995. Petuch listed it as "*Lindapecten lindae* (Note: Mikkelsen and Bieler [2007] incorrectly placed the closely related *Lindapecten muscosus* in the genus *Aequipecten* and ignored the genus *Lindapecten*. This is now known to be in error, as demonstrated by Waller [2011], who fully accepts the genus *Lindapecten* as the valid name for this group of endemic western Atlantic spiny scallops. The type species of *Lindapecten* is *L. lindae*.)"

The latter statement is incorrect as the type species of *Lindapecten* is *Pecten muscosus* Wood, 1828 as designated by Petuch himself. The most striking element of Petuch's statement is the omission of Waller's statement that "*Lindapecten lindae*, for which Petuch gave no size, is merely a juvenile of *L. muscosus* with very elongate projecting spines on its major plicae." Petuch accepts Waller's use of *Lindapecten* but selectively ignores Waller's rejection of his *lindae*.

Mikkelsen and Bieler's failure to use *Lindapecten* had already been pointed out by Petuch on page 27, but is obviously important enough to him to bear repeating. Not stated is that the usage by Mikkelsen & Bieler was prior to Waller's paper. Until Waller's paper appeared, *Lindapecten* was subordinated to *Aequipecten* by numerous authors [e.g., Dijkstra & Kilburn (2001: 307)], but only Mikkelsen and Bieler are named by Petuch.

Another reference to an "error" by Mikkelsen & Bieler appears on page 17 in a discussion of subspecies of *Argopecten irradians*, including *A. i. taylorae* Petuch, 1987. Petuch states: "Mikkelsen and Bieler, 2007, incorrectly refer to the Florida Bay populations of *Argopecten irradians taylorae* as *Argopecten concentricus*. The use of the name *taylorae* for the Florida Bay scallop is overwhelmingly supported by genetic and statistical data

[Marelli *et al.*, 1997], which Mikkelsen and Bieler apparently ignored."

There are two problems with Petuch's statement. First, Mikkelsen and Bieler did not use the name *concentricus* in their book. They stated, under *Argopecten irradians*, that three subspecies have been recognized but do not mention any of them. Second, there are two "Marelli *et al.* 1997 papers" (see References Cited herein). The final sentence of the abstract in Marelli *et al.* (1997a: 31) is "Neither morphometrics nor genetic evidence supports the proposed status of *A. i. taylorae* as distinct from Florida populations of *A. i. concentricus*." The next paper (Marelli *et al.* 1997b) focused on the subspecific status of *concentricus*, without a definitive result, but showing that it is possibly "not appropriate as a name for bay scallop stocks of Florida and the eastern Gulf of Mexico, and if those stocks merit subspecific recognition, then *A. i. taylorae* Petuch, 1987, is the first available name." With *concentricus* not being available for Florida populations, *A. i. taylorae* will be the valid name if subspecific status is justified. The subspecies *A. i. taylorae* is not restricted to the Florida Keys, as it was in its original description, but encompasses what was commonly cited as *A. i. concentricus* in the eastern Gulf of Mexico.

Appendix 2 – New genera and new species

Appendix 2 is titled "Additions to western Atlantic molluscan biodiversity." In this Appendix Petuch introduces eleven new genera and subgenera in addition to 31 new species and subspecies. In the short introduction to the Appendix Petuch states: "while compiling the taxonomic data for the provincial and subprovincial analyses … I found that several important new genera and species were still undescribed." Further, "As many of these belong to … the 10 key provincial index taxa … I felt that it was important for these indicator mollusks to be formally described." Despite this appropriate concern, 21 species and subspecies in the lists of index taxa in Appendix 1 are undescribed and listed as "n.sp." Below are comments on a few of these new taxa.

Planaxis (*Supplanaxis*) *nancyae* is described from "under rocks in 2 m depth off southern Gonave Island, Haiti" and it is stated that "it lives in a completely different environment from *P.* (*Supplanaxis*) *nucleus*, being found in subtidal depths of 2-5 m, where it lives on algae-covered rocks or under coral rubble." An article (Rich, 2012) gives the name of the species and includes the same color pictures as in Figure 6.13A, B. The article states that: "According to Petuch, the specimen, which a diver found a couple of years ago off Gonave Island, Haiti, is the second species of *Planaxis* known to be from the tropical western Atlantic Ocean." It further states that: "Everett Long said the diver, who works for a company that collects and sells shells for the hermit crab 'pet' industry, grabbed a bunch of small shells one day and sent him some of the smaller ones, by way of a mutual friend."

In conversation, Emilio García advised that he had seen the type and other specimens, which had been sent to him by a friend in early 2011 for identification and determination of a possible locality, as the specimens were without data. That friend, Frank Frumar, confirmed (pers. comm. 30 May 2013) that he had sent the specimens, obtained from a bucket of shells intended for hermit crabs, to García and that they were accompanied by no locality data. The dealer from whom they were obtained only knew that they had been "shipped in from Haiti." Frumar advises that he gave two of the specimens, to Everett Long and still has the other three in his possession. As they all came from the same five-gallon bucket of shells, those three specimens should qualify as topotypes!

Modulus hennequini is described from off Roatan Island, Honduras and is compared only to *M. kaicherae* Petuch, 1987 from the Carolinian Province. Petuch (2003 [his 2004]: 265) described a "relict fauna" from Honduras containing *M. bermontianus* Petuch, 1994. The only other *Modulus* in the Taxa List for the Nicaraguan Subprovince are *M. modulus* (Linnaeus, 1758) and *M. carchedonicus* (Lamarck, 1822). Either *M. hennequini* has now been determined to be different from *M. bermontianus*, or *M. bermontianus* needs to be added to the index taxa as a separate species. If the living and fossil species are really different species but alike enough to have been considered to be the same, *M. hennequini* should have been compared to *M. bermontianus*.

Pusula bessei new species, Figure 7.11B, C. This species, for which only one specimen is mentioned, is said to have "only been collected on Roatan Island [Honduras], to where it may be endemic." It is compared to *Pusula pediculus* (Linnaeus, 1758), from which it differs in almost all characters. It is also compared to "the red-based *P. pacei* (Petuch, 1987) from the Bahamas." Both of these species are only half the size of *P. bessei*. In 1995 and 1996 Emilio García obtained five specimens of this species, from three different banks off the northeastern coast of Honduras and sent them to Gary Rosenberg at the Academy of Natural Sciences of Philadelphia, who intended to describe it as a new species. This excerpt from an email dated 25 November 1998 from Rosenberg to García, made available by Rosenberg, explains why the species was not described then:

> "I mentioned [to Petuch] that I was working on the new species from Honduras, and he said that he has specimens of it that he is treating in his new book. But surprisingly, he does not consider it to be a new species. He thinks that it is *Niveria permagna bermontiana* Petuch, 1994. I had considered this possibility, but rejected because his description of the fossula did not seem to fit (he did not illustrate the ventral side of the species). Anyway, he showed me a series of fossil specimens that convinced me that the fossula is variable in strength, and I have ended up agreeing that the shell is probably *Niveria permagna bermontiana*."

A specimen was retained at the Academy and catalogued, and the species added to *Malacolog*. *Niveria bermontiana* was listed by Petuch (2003 [his 2004]: 265) as part of a "relict Bermont fauna" of Honduras." It is inconceivable that a comparison would not be made between *bermontiana* and *bessei* if the two are distinct species. Too close for comparison? See discussion above for *Modulus hennequini*.

Murexiella deynzerorum new species is described from the Bahamas. It is not compared to any described species but is said to "most closely resemble a still unnamed species from Biscayne Bay, Florida, and the Florida Keys, which has been referred to by most authors as *Murexiella macgintyi* (M. Smith, 1938)." It is also stated that *M. macgintyi* is an early Pleistocene fossil. There is no figure of this unnamed species to which comparisons are made. As this unnamed species is said to be from Biscayne Bay and the Florida Keys, the omission of any mention of it from two recent books on shells of southern Florida and the Keys (Petuch & Sargent, 2011, 2012) is notable. In those books four species of *Murexiella* from southernmost Florida are illustrated. Comparison with the most appropriate of those would have been instructive.

Cinctura hunteria keatonorum new subspecies. In the discussion of *Cinctura* species on page 203 is listed "*Cinctura hunteria keatonorum* Petuch & Sargent, 2012." This subspecies may have been intended to be included in a work by Petuch & Sargent in 2012. Whatever the cause, it is an attention-getting *lapsus,* as is the spelling in the next line of this discussion, where Hollister is rendered as Hoolister.

Polygona bessei new species is a synonym of *Lamellilatirus sunderlandorum* Lyons & Snyder, 2013 which was published on 10 March 2013. The species was compared with *Fusus ceramidus* Dall, 1889, the type species of *Lamellilatirus* Lyons & Snyder, 2008, in both descriptions.

Roquesia lindae new species, described in subfamily Ergalataxinae. It is compared only to *Minibraria monroei* (McGinty, 1962) and to eastern Pacific species of *Phyllocoma*. This is a juvenile *Colubraria* that cannot be identified to species from data presented. The known species can be distinguished by their protoconchs, but the protoconch of this species is not mentioned by Petuch and is not clear in the figure.

Stramonita buchecki new species. The author is to be commended for figuring for comparison two other species of *Stramonita*. This type of attention to comparative details would have been helpful for the other new taxa.

Arubaconus new genus. The type species of this new genus is *Conus hieroglyphus* Duclos, 1833. The only species included in the genus, it is stated to "somewhat resemble" *Conus isomitratus* Dall, 1896 from the Miocene Chipola Formation. After a discussion of the differences between the living and fossil species it is stated that: "The Florida fossil may represent the oldest known member of *Arubaconus*, demonstrating that the genus evolved

in the Chipolan Subprovince of the Baitoan province. If so, then *A. hieroglyphus* can be considered a Miocene relict taxon." In this instance Petuch's fixation on "relict taxa" has gone too far as *A. hieroglyphus* cannot be a "Miocene relict taxon" unless conspecific specimens are found in the Miocene. A different congeneric species in the fossil fauna does not make the living species a relict.

Tuckericonus new genus. In the discussion of other species in the genus (page 219), an unnamed species is said to have "a multinucleate protoconch." The probable intent here is that it has a multispiral protoconch, but that is not certain. What is certain is that "multinucleate" is a perfectly good biological term, but it has no application in malacology.

Provinciatones

Some subprovinces have further divisions referred to as "Provinciatones." A review of these indicates that they are composed primarily (in at least one case, Palm Beach, entirely) of taxa named by Petuch.

Type localities

Incorrect type localities may, and should be, corrected. However, such correction is normally made in a taxonomic setting, not in a list of endemic taxa or in a figure caption. Also, some explanation of the reason for change should be given, as the three species listed below were all published with detailed locality data.

Gradiconus aureopunctatus (Petuch, 1987). The caption for Figure 7.5E includes this statement: "(originally incorrectly stated as coming from the Paraguana Peninsula of Venezuela but now known to be from the muddy coastlines of Nicaragua and Honduras, the type locality is here emended to 'off Puerto Cortez, Honduras, on mud bottom, 3 m depth')."

Kellyconus rachelae (Petuch, 1988). A list on page 140 includes this correction: "the holotype actually comes from 100 m depth off Boca Araguao, Orinoco River Delta, Venezuela."

Sandericonus perprotractus (Petuch, 1987). A list on page 140 includes this correction: "the holotype actually comes from 100 m depth off Boca Araguao, Orinoco River Delta, Venezuela."

Other minor items

A discussion of the Nicaraguan Subprovince includes the statement "with many previously unknown Panamic-Caribbean analogue species pairs." On this subject, Keen (1971: 2) referred to them as "cognate species (the term 'analogous' of earlier authors now is frowned on as not in harmony with usage elsewhere in biology)." Cognate species were discussed in detail by Vermeij (1978: 212) who gave a list of Panamic-Caribbean cognates. Of the species mentioned by Petuch as analog [= cognate] none are listed by Vermeij, all but one having been described by Petuch after 1978.

The holotypes of some species named by Petuch in earlier works are figured in this book. The measurements given do not always match the original. Some differences in holotype measurements, especially of nomina named in 1987, were changed in later works but without comment or mention of original data. Those taxa are not included here, nor are most differences in measurement of 1 mm or less.

Figure 3.2E – *Argopecten gibbus carolinensis* Grau, 1952. Author's name should be in parentheses.

Figure 3.2F – *Polygona williamlyonsi* Petuch & Sargent, 2011. Authors' names should be in parentheses.

Figure 4.4B – *Bulla striata frankovichi* Petuch & Sargent is dated 2011 instead of 2012.

Figure 4.4C – *Nassarius websteri* Petuch & Sargent is dated 2011 instead of 2012.

Figure 4.8A – *Prunum frumari* Petuch & Sargent is dated 2011 instead of 2012.

Figure 4.9C – *Oliva* (*Americoliva*) *sayana sarasotaensis* [*sic*] Petuch & Sargent, 1986. The name *sarasotaensis* is an incorrect subsequent spelling of *sarasotensis*. This spelling also appears on pages 188 and 210.

Figure 4.12B – The holotype of *Myurellina lindae* Petuch, 1987 is stated to measure 64 mm. When originally described it was stated to be 63 mm. As it was originally described as a *Terebra*, author's name should be in parentheses.

Figure 4.12C – The holotype of *Dauciconus aureonimbosus* (Petuch, 1987) is stated to measure 25.5 mm. When originally described it was stated to be 27 mm.

Figure 4.12D – The holotype of *Lindafulgur lyonsi* (Petuch, 1987) is stated to measure 128 mm. When originally described it was stated to be 132 mm.

Figure 6.5E – The holotype of *Purpuriconus donnae* (Petuch, 1998) is stated to measure 28 mm; when originally described it was stated to be 26 mm.

Figure 6.6A – The holotype of *Muricopsis zylmanae* Petuch, 1993 is stated to measure 38 mm; when originally described it was stated to be 34 mm.

Figure 6.6E – The holotype of *Polystira bayeri* Petuch, 2001 is stated to measure 26 mm; when originally described it was stated to be 21 mm.

Figure 6.14E – The holotype of *Muricopsis warreni* Petuch, 1993 is stated to measure 24 mm; when originally described it was stated to be 17 mm.

Figure 7.2F – *Voluta retemirabilia* [*sic*] Petuch, 1981 was originally described as *Falsilyria retemirabilis* and should be cited as *V. retemirabilis* (Petuch, 1981). The misspelling *retemirabilia* also appears in the list on pages 99 and in the text on page 100.

Figure 8.11F – The holotype of *Gradiconus gibsonsmithorum* (Petuch, 1986) is stated to measure 18 mm; when originally described it was stated to be 20 mm.

Figure 8.12G – The holotype of *Pseudocyphoma gibsonsmithorum* Petuch, 1987 is stated to measure 17 mm; when originally described it was stated to be 15 mm.

Figure 9.6F,G – The holotype of *Dalliconus colletteae* [*sic*] Petuch, new species, is stated to measure 21 mm; where it is described on page 220 the measurement is 20 mm. Also, on page 220 the species is described as *D. coletteae*, the correct spelling as it is named for someone named Colette.

Figure 9.7A – *Strombina* (*Cotonopsis*) *lindae* (Petuch, 1988). This species was originally described as a *Strombina*, and the author's name should not be in parentheses.

Page 178 – SP codes for 2 species of *Vasum* are in italics.

Page 181 – *Purpuriconus alainalaryi* [*sic*] is an error for *P. alainallaryi* (Bozzetti and Monnier, 2009).

Page 182 – *Dalliconus macgintyi* [*sic*] is an error for *Dalliconus mcgintyi* (Pilsbry, 1955).

Page 183 – *Dalliconus rainseae* [*sic*] is an error for *D. rainesae* (McGinty, 1953).

Page 187 – *Cinctura totuganum* [*sic*], without author or date, is *C. tortugana* (Hollister, 1957). On page 203 this species is listed in a discussion with both author and date cited but with author's name rendered as Hoolister.

Page 188 – *Oliva fugurator* [*sic*] is an error for *O. fulgurator* (Röding, 1798).

Page 188 – Footnote mentions *Americola* [*sic*], obviously an error for the new subgenus *Americoliva*.

Page 189 – Cossmann is misspelled as Cossman.

Page 227 – the name of the *Journal de Conchyliologie* is misspelled.

Publication date

In common with most books there is no printed date of publication giving day and month. The copyright date on the colophon page is 2013, and the book was published on April 2, 2013. This date appears on the publisher's web site and was verified by a representative of the publisher (pers. comm., John Sulzycki, senior editor, 22 April 2013). This is mentioned here as there is a term on this colophon page that was not included in a recent paper on the dating of books (Petit 2012b). The term is "version date" and appears as "Version Date: 20130226" which is, obviously, February 26, 2013. The publisher has explained that this date is listed for internal production purposes. It is the date on which the copyright page was created for the work.

Petuch's Bibliography

There are only 84 references listed, of which 45 (54%) were authored or co-authored by Petuch. Some published in the same year are out of se-

quence. The following Petuch citations contain errors as noted.

1972 – Title and pagination are incorrect

1974b – Journal and issue should be *Veliger* 17(1), not 17(3)

1981a – Pagination incorrect. Should be 307–347

1993a – Journal issue should be 25(266), not 24(266)

1993b – Journal issue should be 25(267), not 24(267)

2004 – It has been shown to have been published in 2003

Summary

It is with genuine regret that I review another Petuch book containing errors of fact that could have been prevented had a little more time gone into its preparation. If numbers of species are to be used in determining the limits of provinces and subprovinces, then those numbers should be entered according to the lists of index taxa provided and, after being entered, they should be added up correctly. The errors of entry and addition are, taken singly, minor and impact few determinations. However, the number of such errors is enough to raise questions about the quality of other portions of the book. The unnecessary and non-standard "equation" used to determine the percentage of endemism would not be so glaring if the printed numbers utilized matched the numbers derived from Appendix 1 and if they had been correctly added.

Overshadowing the mathematical errors, and errors in extracting the taxa for the compilations, is the author's failure to consider the work of others. A rather large number of the index taxa that were introduced by Petuch have been placed in the synonymy of other species by various workers. These are totally ignored by Petuch. This action shows a considerable disregard for the work of others.

The only subjective items in this review are the statement about the new genus *Roquesia*, which is included as it is too obvious to overlook, and the synonymy of *Polygona bessei*. No taxonomic judgments are made about any of the other new taxa.

A final word about the "algorithm formula." I am reminded of a dinner party at which Maine lobsters, not a common meal here in the Deep South, were the main course. After dinner the hostess went in the kitchen where the cook was packing up leftovers to take home and saw the empty lobster shells were on the table. She asked why, as they were absolutely of no use. The cook replied that she knew they were no good, but she was taking them because "they sure will make my garbage look classy."

Acknowledgements

Appreciation is expressed to John Sulzycki, Senior Editor, CRC Press/Taylor & Francis Group, Boca Raton, Florida, for his discussions regarding book production and for permitting use of the two formulae reproduced herein.

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