

Scientific death-knell of databases? Errors induced by database manipulations and its consequences

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Abstract

References to *Terebratulina caputserpentis* attributing its authorship to Zbyszewski, 1957, not to Linnæus, 1767 have been found in three recent publications, in the collections of the Muséum National d'Histoire naturelle de Paris and in several on-line databases. The use in these databases seems to have arisen from WoRMS (World Register of Marine Species), specifically from WBD (World Brachiopoda Database) of which the three authors of this paper are the editors (authors). The page concerning *T. caputserpentis* (Linnæus, 1767) has been modified by WoRMS staff without the knowledge of these editors (authors).

The decrease of the specialists in systematics and their replacement by IT specialists question the scientific reliability of the online databases as well as the specimen labelling in museums. The absence of scientific rigour becomes their Achilles' heel. Several other cases of errors are quoted and developed. In spite of applications to the staff of databases in biodiversity, the situation continued degrading so much so that today these bases are reached by the Peter principle and can no longer be used for scientific requirements, except if verifying all the desired data.

Key-words

Databases; Brachiopod; *Terebratulina*; *retusa*; *caputserpentis*; Web-based taxonomy.

Résumé

Glas scientifique pour les bases de données ? Erreurs induites par des manipulations de bases de données et leurs conséquences.- La découverte de l'attribution de *Terebratulina caputserpentis* (Linnæus, 1767) à un autre auteur (Zbyszewski, 1957) nous a conduit à rechercher l'origine de cette citation. Cette espèce est synonyme de *T. retusa* (Linnæus, 1758), espèce type du genre. Des références à *T. caputserpentis* (Zbyszewski, 1957) ont été trouvées dans trois publications récentes, dans les collections du Muséum National d'Histoire naturelle de Paris et dans plusieurs bases de données en ligne, dont l'origine semble provenir de WoRMS (World Register of Marine Species), donc de la base de données WBD (World Brachiopoda Database) dont les trois auteurs de cette note sont les éditeurs (auteurs). C'est à leur insu que la fiche du synonyme *Terebratulina caputserpentis* (Linnæus, 1767) a été modifiée par les informaticiens de WoRMS.

La diminution du nombre de spécialistes en systématique et leur remplacement par des techniciens informaticiens obligent à revoir la fiabilité des bases de données mises en ligne ou même l'identification des spécimens dans les muséums. L'absence de rigueur scientifique devient leur talon d'Achille. Plusieurs autres cas d'erreurs sont cités et développés.

Malgré des interventions auprès des responsables techniques des bases de données en biodiversité, la situation a continué à se dégrader au point qu'aujourd'hui ces bases sont atteintes par le principe de Peter et ne peuvent plus être considérées comme utilisables par la communauté scientifique, sauf à vérifier l'exactitude de toutes les données souhaitées.

Mots-clefs

Banques de données ; Brachiopode ; *Terebratulina* ; *retusa* ; *caputserpentis* ; WEB-taxinomie.

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1. Introduction

The decrease of specialists in systematics and their replacement by IT specialists question the scientific reliability of the online databases as well as the specimen labelling in museums. The absence of scientific rigour becomes their Achilles'

heel. In spite of applications to the staff of databases in biodiversity, the situation continued degrading so much so that today these bases are an example of the Peter Principle (Peter & Hull, 1969) and can no longer be used for scientific requirements, except if verifying all the desired data. An

example of the above is the recent use of the terebratulid species *Terebratulina caputserpentis* in several on-line databases.

References to *Terebratulina caputserpentis* attributing its authorship to Zbyszewski, 1957, and not to Linnæus, 1758 who first published the name *caputserpentis* as *Anomia caputserpentis* in accordance with the criteria of availability (ICZN, 1999, Articles 10 to 20, see also Article 50) have been found by the present authors in three recent publications. This inerrant attribution is also in the collections of the Muséum National d'Histoire naturelle de Paris and what could be more problematical, in several on-line databases. The misuse in these databases seems to have arisen from WoRMS (World Register of Marine Species), to be precise from WBD (World Brachiopoda Database) of which the three authors of this paper are the editors (authors). The page concerning *T. caputserpentis* (Linnæus, 1767) has been modified by WoRMS staff without the knowledge of these editors (authors).

Using several search engines to try to identify the original citation of *Terebratulina caputserpentis* with "Zbyszewski, 1957" as author, the result led surprisingly to two databases WoRMS (our own!) and GBIF. Other databases, i.e., Catalogue of Life, Taxonomicon, which for years linked to WoRMS for brachiopods, have reiterated the error.

Checking our World Brachiopoda Database (WBD) on WoRMS, we discovered a page on "*Terebratulina caputserpentis* (Zbyszewski, 1957)" (*sic*) as a synonym of *T. retusa*. The editors would never have published such a page (see in the section below quotation on their papers on these species). How did this happen? Only the staff of WoRMS has access to our database and could modify the page probably by changing the author's name. This is not the first case of changes in the database by the staff without agreement of the editors. Several other examples occurred recently, like the tropical brachiopod *Lingula anatina* recorded in the UK waters, which is incorrectly recorded in MSBIAS (Marine Species of the British Isles and Adjacent Seas), a database hosted by VLIZ (Vlaams Instituut voor de Zee, Belgium) as is similar to our WoRMS database. These facts call into question the scientific content of WoRMS pages, unwittingly but obviously the credibility of the editors and the reliability of WoRMS and more broadly of all databases with scientific contents.

Regarding the GBIF (Global Biodiversity Information Facility), the analysis of the results is more complex. The so-called "*Terebratulina caputserpentis* (Zbyszewski, 1957)" appears to be the only synonym, and the priority attribution of *T. caputserpentis* (Linnæus, 1767) is not listed. Of the 18 "occurrences" provided in this database for the "species" "*Terebratulina caputserpentis* (Zbyszewski, 1957)" we consider worth adding the following comments. About its location: South Africa (n° 477223472): from Agulhas Bank, Challenger Expedition, we believe that this "occurrence" is based on Davidson (1880, p. 12; 1886, p. 36 and

Pl. VII, figs. 1-5), who described and illustrated specimens of *Terebratulina (Agulhasia) davidsoni* King, 1871 (now *Agulhasia davidsoni* King, 1871; see Logan, 2007, p. 3099 and papers cited therein), not *Terebratulina caputserpentis* as quoted in GBIF. Moreover, *Terebratulina caputserpentis* var. *septentrionalis* recorded (described and illustrated) off the Cape of Good Hope by Davidson (1880, p. 13, 33; 1886, p. 38, 70 and Pl. V fig. 54) [now *Terebratulina abyssicola* (Adams & Reeve, 1850); see also Logan, 2007, p. 3098 and papers cited therein] is listed in GBIF under *T. caputserpentis* Zbyszewski and not *T. abyssicola*. Regarding the locations "Norway, United Kingdom" it should be noted that all known "*Terebratulina*" records in these areas are related to *T. retusa* not to "*Terebratulina caputserpentis* (Zbyszewski, 1957)" (see Brunton & Curry, 1979, p. 38; Cohen *et al.*, 1991, 1993; Álvarez & Emig, 2005, p. 139; Logan, 2007, p. 3098; Álvarez, 2016; and papers cited therein). Regarding the occurrences "Canada" and "Italy" it should be noted that only *T. septentrionalis* (Couthouy, 1838) has been recorded in Canada and that only *T. retusa* occurs in the Mediterranean, as both living and fossil forms (e.g., Brunton & Curry, 1979, p. 38; Álvarez & Emig, 2005, p. 139; Logan, 2007, p. 3098; Emig, 2016; and papers cited therein).

2. Present status of the species *Anomia caputserpentis* and *Anomia retusa*

The species name *retusa* was first used as a valid binomial by Linnæus in his description of *Anomia retusa* in the tenth edition of the *Systema Naturae* (1758, p. 701, number 191) with the following description: "*A. texta ovovata striata retusa: convalle longitudinali, nate perforata*" and the comment: "*Habitat in pelago Norvegico supra Alcyonia. D. Pennant.*" Although in this occasion, no illustration, or reference to a previous illustration was provided, from the description given it is clear that to Linnæus "*retusa*" was a **strongly ribbed living** species.

In the same edition, Linnæus erected the species *Anomia caputserpentis* (1758, p. 703, number 200). Under "*Caputserpentis. 200.*" Linnæus gave a brief description: "*A. texta ovovata laevi gibba: valvula altera apice longiore*" and the observation: "*Habitat fossilis. Natium altera postice gibba, perforata.*" Linnæus gave no illustration, but referred to "*Columnn. purp. 22. f. 2.*" Colonna's work (Colonna, 1616; Fabio Colonna = Fabius Columna = Fabij Columnnae) was commented and the illustration reproduced by Lee *et al.* (2001, pp. 84-85, 92-93, and Fig. 1 respectively; see also Muir-Wood, 1955, Fig. 2). On p. 85, Lee *et al.* (2001) pointed out that "**the two upper brachiopods in the Colonna figure are both smooth terebratulid brachiopods with large open foramens and strongly delineated growth bands.**" Across the two drawings on the upper right and upper left of Colonna's page 22 is the caption "*concha anomia vertice rostrato*". Lee *et al.* (2001, p. 26) stated that Colonna himself regarded both specimens,

those in the upper right and upper left “similar to one another”. To these authors (Lee *et al.*, 2001, p. 86) the smooth, unfolded specimen on the upper right on page 22 [the specimen that Linnæus (1758, p. 703) described as *Anomia caputserpentis*] “certainly came from Pliocene strata near Andria” while the specimen illustrated on the upper left on page 22 [the specimen that Linnæus (1758, p. 703) described as *Anomia terebratula*] although from an unknown locality, the sediment contained in its interior (see also Colonna, 1616, p. 24) allowed Lee *et al.* (2001, p. 86) to suppose that this specimen “was collected from the same Pliocene calcarenites at Andria”, an inland town west of Bari. Although there is no scale on the illustration, the brachiopod on the upper right (*Anomia caputserpentis*) is at natural size (-*icon magnitudinem aequat*- on page 23 in *Purpura*). A very important issue for the case we are discussing in this paper, we want to stress what Lee *et al.* (2001, p. 86) concluded when referring to the strongly folded and the unfolded specimens illustrated on Colonna (1616) that “From the many specimens of *Terebratula* collected by the authors [Lee *et al.*] from Colonna’s Andria locality and from elsewhere in Italy, it is apparent that the brachiopods in any fossil assemblage/population vary considerably in the degree of folding and may be rectimarginate to biplicate or suciplicate. **Thus, both specimens labelled by Colonna as *Concha anomia vertice rostrate* are species of *Terebratula* (sensu lato), and given the wide variation in populations of Neogene *Terebratula*, might be conspecific.**” In fact, a few years before, Hanley (1855, p. 123; see also Thomson, 1927, p. 186) already stated that: “the name *Anomia caputserpentis* Linnæus, 1758 (p. 703) was applied to a fossil smooth *Terebratuloid*, most likely from the Italian Tertiary” (see discussion on its locality in Brunton & Cocks *in* Brunton *et al.*, 1967, pp. 174-175; Bergström & Hageltorn, 1968, pp. 111-128; Lee *et al.*, 2001, p. 86). According to a strict application of the rules of nomenclature, Thomson (1927, p. 186) stated that “*Terebratulina* with type *Anomia caputserpentis* Linné would have to be used for a smooth *Terebratuloid*, and presumably would become a synonym of *Terebratula*”; although he also warned that: “this method of interpretation is not accepted by many authors, and not good purpose would be served by applying it to the present case”.

Significant ambiguities arose soon after, when Linnæus in the twelfth edition of the *Systema* (1767) changed his previous description of *Anomia caputserpentis* to “*A testa obovata striata tomentosa: valvula altera nate longiore perforata. Fn. suec. 2154. Column. purp. 22.f.2. Gualt. test.t. 96.f. D. Hiatat in abyssu M. Norvegici. Testa obovata, tomentoso, antice compressa, longitudinaliter striata, alba. Valvula superior postice prominens logiorque apice perforato ligamento affixo coralliiis Zoophytisve; haec antice paulo longior & declinata. Inferior valvula rotundata, antice retusa, postice brevior. Margo utriusque crenulatus. Cardo dente utriusque testae utrinque ad latus*

prominens”, while that of *A. retusa* remained. Thus, as Brunton & Cocks (1967, p. 294) stated, “in the 1767 edition these two species, *A. caputserpentis* and *A. retusa*, appear to be indistinguishable and this change in concept of *A. caputserpentis* has resulted in ambiguity.”

A further complication emerged when d’Orbigny (1847, p. 249) erected the genus *Terebratulina* with *Anomia caputserpentis* Linnæus as type species. D’Orbigny clearly thought of this as the species as redefined in 1767, the species subsequently considered as synonymous with *Anomia retusa* (see discussion in Brunton & Cocks, 1967, p. 295).

Later, Davidson (1886) pointed out that “no species of Brachiopoda has been more thoroughly or more carefully studied than the *Anomia caputserpentis* of Linnæus [1767, p. 1153].” He considered *Anomia retusa* of Linnæus (1767, p. 1151) as synonymous of *Terebratulina caputserpentis* which has been recorded in many Tertiary outcrops in Europe. This synonymy has been confirmed by Hanley (1855, p. 123) at least for the Recent ribbed specimens, in his book on the shells of Linnæus. Dall (1920; see also Thomson, 1927, p. 186) has pointed out that “*Terebratulina caputserpentis* should be known by the specific name *retusa* described under *Anomia retusa* by Linnæus (1758, p. 701) which has page precedence over *Anomia caputserpentis* Linné 1758, p. 1758.” Most subsequent authors (e.g., Hanley, 1855, p. 123; Davidson, 1886, p. 17; Dall, 1920, p. 296; but not for example Ehlert, 1887 [1], Fischer & Ehlert, 1891, p. 29) have recognised that *A. caputserpentis* Linnæus, 1767, is synonymous with *A. retusa* Linnæus, 1758. More recently, Brunton & Cocks (1967; see also Brunton & Cocks *in* Brunton *et al.*, 1967, and Lee *et al.*, 2001) discussed in detail the ambiguities that arose when Linnæus (1767) changed this description of *A. caputserpentis* from a smooth, fossil brachiopod to a capillate [2] living species (now *Terebratulina retusa*), although he retained the reference to the Colonna figure. To solve this ambiguities Brunton & Cocks (1967) sent an application to the International Commission on Zoological Nomenclature (Ruling of the Commission, 1968) stating that “it is generally agreed that *Anomia caputserpentis* Linnæus, 1758, is not of the genus *Terebratulina*

¹ p. 1247 *Terebratulina caputserpentis* (de 0 à 2160 mètres). Spitzberg, détroit de Davis, N.-E. des mers d’Europe, côtes d’Ecosse, océan Atlantique, golfe de Gascogne, côte de la Jamaïque, Corée, Australie, côte d’Afrique.

p. 1250: *Terebratulina caputserpentis*, var. *septentrionalis*. O. de Kerguelen.

p. 1314-1315 *Terebratulina*, d’Orbigny, 1847 (Type : *T. caputserpentis*, Linné. Pl. XV, Fig. 3).

The specimens recorded from the locations cited above belongs to various species and genera.

² Capillate = shell surface with very fine radial ridges on outer surface. From capilla = very fine radial ridge on outer surface of the shell (see Williams & Brunton, 1997).

d'Orbigny; *A. caputserpentis* Linnæus, 1767 = *A. retusa* Linnæus, 1758; and that d'Orbigny's original concept of the genus *Terebratulina* is based upon the living species *A. caputserpentis* Linnæus, 1767 [non 1758] which is the junior synonym of *A. retusa* Linnæus." Brunton & Cocks (1967, p. 295) proposed also "that the type-species of *Terebratulina* d'Orbigny, 1847, be changed from *Anomia caputserpentis* Linnæus, 1758, to *Anomia retusa* Linnæus, 1758." In fact, nowadays no brachiopod specialist would discuss this authorship and synonymy: *Anomia retusa* Linnæus, 1758 = *A. caputserpentis* Linnæus, 1767 as type species of *Terebratulina* d'Orbigny, 1847 (see, for example, Álvarez, 2016; Álvarez & Emig, 2005; Bitner & Dulai, 2008; Bitner *et al.*, 2008; Brunton & Cocks, 1967 and in Brunton *et al.*, 1967 [3]; Emig, 2010, 2012, 2014, 2016; Emig *et al.*, 2015; Lee *et al.*, 2001, 2006; Paknevitich *et al.*, 2013; Taddei Ruggiero & Bitner, 2008). Finally, it should be noted that *T. retusa* is well known in Europe since the Miocene, in particular in the Mediterranean realm and largely distributed today in the Mediterranean Sea and that many Holocene and Tertiary species formerly placed under *Anomia* and/or *Terebratulina* have been transferred to *Terebratula*, *Dyscolia*, *Chlidonophora*, *Eucalathis*, *Murravia* or *Cancellothyris* (see Thomson, 1927, p. 187; Lee *et al.*, 2001, p. 89; Treatise on Invertebrate Paleontology, 1997-2007).

3. Discussion

Although the authorship of both *Terebratulina* species, *retusa* and *caputserpentis* are well clarified (see text above), specimens identified as *Terebratulina caputserpentis* appeared at least in three recent papers with Zbyszewski (1957) [not Linnæus (1758)] as author. For example, Estevens *et al.* (1999) quoted this species in the Miocene of the peninsula of Setúbal with reference to Zbyszewski (1957). Later, González Álvarez (2013) identified *Terebratulina caputserpentis* again with Zbyszewski, 1957 as author, in the Miocene of the Eastern Canary Islands, from a dorsal valve, partially broken. González Álvarez (2013) stated that this species is considered to be synonymous with *T. retusa* (Linnæus, 1758) and in addition cited the list of synonyms published by Emig (2012, not 2002 as stated by the author): "*caputserpentis*" is mentioned several times, i.e., *Anomia caputserpentis* Linnæus, 1767 (its original name), and *Terebratulina caputserpentis* d'Orbigny, 1847. Surprisingly, the publication of Zbyszewski (1957) is not cited. Of course only the valid species name *T. retusa*, with Linnæus, 1758 had to be used when referring to the well ribbed terebratuloid described by Linnæus (1758, p. 701; 1767, p. 1151 and 1153). More recently, in 2014, in a congress poster, González *et al.* figured *Terebratulina caputserpentis*, again with Zbyszewski

(1957) as author, recorded from the Mio-Pliocene of the Canary Islands.

Besides these citations, in the collection of the Muséum National d'Histoire naturelle de Paris, specimens are identified as "*Terebratulina caputserpentis* (Zbyszewski, 1957)" (*sic*) and others as "*T. caputserpentis* (Linnæus, 1758)" – not 1767! – and online it is stated "Le nom d'espèce *Terebratulina caputserpentis* pourrait présenter un cas d'homonymie." According to Pierre Lozouet, curator of invertebrates conservation at the Museum (pers. comm., 2015), the specimens arrived in the Museum in 1969, belonging to the collection Staadt, a great collector of molluscs: it was labelled "V. Demange May 1931", and on another label the origin of the record "Siacca Italie" on the back in another script "*Terebratulina caputserpentis* Zbyszewski". Some years ago, during the computerization of the collections, the name "Zbyszewski (1957)" was erroneously introduced as species author. These specimens are now referred to WoRMS n° [AphiaID: 181482].

From all written above, we realize some zoologists and/or palaeontologists, professionals or amateurs, do not consult the Code adopted by the International Commission on Zoological Nomenclature (ICZN, 1999), and so do not follow the mandatory provisions and recommendations when writing their manuscripts submitted to journals or contributions to different symposia, and later incorporate in databases without the supervision of specialists in systematics. This is especially important when these studies are carried out by people unfamiliar with the taxonomy and the detailed morphology of many of the taxa involved (see discussion in Álvarez *et al.*, 2010, p. 28). For the species we are using here as example of the scientific errors induced by database manipulations and its consequences, Article 50 of ICZN (1999) entitled "Authors of names and nomenclatural acts" is very clear when stating that "The author of a name or nomenclatural act is the person who first publishes it [Arts. 8, 11] in a way that satisfies de criteria of availability [Arts. 10 to 20]...". Following these mandatory provisions it is clear that Linnæus is the author to which the species *Anomia retusa* and *A. caputserpentis* must be attributed [Linnæus 1758, p. 701, and p. 703 respectively]. The three Linnæus species, *Anomia retusa* Linnæus 1758 (p. 701), *A. pubescens* Linnæus, 1767 (p. 1153), and *A. caputserpentis*, as described by Linnæus (1767, p. 1153) (non Linnæus, 1758, p. 703), are considered synonyms (see ICZN, 1999, pp. 117-118, and Brunton & Cocks in Brunton *et al.*, 1967, pp. 174-175).

4. Conclusions

A taxonomist judgement or references to previous work for a given taxon are obviously needed to confirm the taxon identification. The bibliographic knowledge about the quoted material is needed to manage a database. Thus, *Terebratulina caputserpentis* should never have been cited with "(Zbyszewski, 1957)" as author (only in synonymy lists), because Linnæus (1767, p. 1153)

³ "Genus *Terebratulina* d'Orbigny, 1847 - TYPE SPECIES. – *Anomia retusa* Linnæus, 1758, by subsequent designation of Brunton & Cocks in Brunton *et al.* (1967: 176)"

was the first person who published the name *caputserpentis* satisfying the criteria of availability and priority. In addition *Terebratulina caputserpentis* (Linnæus, 1767) is, since Dall (1920), a work of reference in present brachiopod taxonomy), commonly if not always listed in the synonymy list of *Terebratulina retusa* (Linnæus, 1758) (e.g., Brunton & Cocks in Brunton *et al.*, 1967, p. 175). Any researcher working on this phylum knows that it is useful to peruse the Treatise on Invertebrate Paleontology (1st edition 1965, 2nd edition 1997-2007), which was an omission in the works of Estevens *et al.* (1999), González Álvarez (2013), and González *et al.* (2014).

More and more databases, but also museums, no longer have systematists available to confirm the identification of their cited or curated taxa. The drastic reduction of taxonomists, so-called morphologists, is currently due to their non-replacement after retirement. It is a political will, at least in the European Union, partly supported by scientific disciplines, such as geneticists and molecularists. This situation is not new and has even been widely anticipated. At the first International Congress on brachiopods in Brest in 1985, the organizing committee proposed the revision of brachiopod systematic (Emig & Rachebœuf, 1986), expecting that in 20 years, such a task could not bring together all the necessary specialists to revise the brachiopods. The 2nd edition of Part H of the Treatise on Invertebrate Paleontology (1997-2007) was the result. Today the rationale of this visionary project is evident.

WoRMS remains the only global database to bring together a large panel of scientists who have skills to ensure the taxonomic relevance and excellence in systematics. Yet this specificity, recognized worldwide, is only weakly supported by WoRMS management staff. Because requests from scientific editors to set stricter scientific rules have not been taken into account, the case *Terebratulina caputserpentis* could happen. None of the WBD editors have read Zbyszewski (1957). They know that every brachiopod specialist must be aware of *Terebratulina caputserpentis* (Linnæus, 1767) = *T. retusa* (Linnæus, 1758) as type species of *Terebratulina* d'Orbigny, 1847; this genus is the one having the largest number of extant species (25) and also of Tertiary genera (Thomson, 1927; Emig *et al.*, 2013). The change could only have been made by the WoRMS staff, who ensure technical maintenance of the database WBD, unbeknownst to the editors; that action constitutes a professional misconduct. It seems clear that the effects have not been assessed, i.e., the propagation of this false information through various web sites and databases, and even Wikipedia, thus questioning of the scientific credibility of the publishers. The editors immediately corrected the page in WBD. It is now up to those responsible of WoRMS to make arrangements to avoid such future possibilities. They should also inform all who have been misled by this manipulation.

This case reveals the fragility of scientific databases, some of which contain hundreds or even thousands of species. It is impossible to regularly check all the taxonomic entries, which is a flaw that can lead to errors by technical staff out of scientific control. Previous similar cases have already been reported, however no action has been taken to prevent future such mistakes. These changes jeopardize the scientific credibility of all databases and for that represent an Achilles heel. The copy-paste from one database to others should not excuse the obligation for other editors to check the validity of the transferred data.

To illustrate this remark, another recent case in WBD can be cited: the inarticulated brachiopod *Lingula anatina*, a tropical to warm temperate species, unknown in European waters, has suddenly and incorrectly been reported in British waters by MSBIAS (Marine Species of the British Isles and Adjacent Seas). By crediting the *Lingula anatina* WBD page by the MSBD web site, this citation implies the scientific expertise of WBD-WoRMS. Another example in GBIF (Global Biodiversity Information Facility) is the report of *Terebratulina caputserpentis* (Zbyszewski, 1957) in Canadian Atlantic waters based on a handwritten list under *Terebratulina caputserpentis*. Actually, the valid species in this region is *T. septentrionalis* (Couthouy, 1838). Similarly, in several genetic and molecular databases, synonyms appear as valid species, and consequently even in scientific publications.

Such errors are usually based on reference to publications, reports, and other documents, or simply photographs, still without scientific expertise concerning the species, i.e., verification of the identity and the validity of the name. It is also forgotten that the identification of specimens is carried out on a set of taxonomic characters which usually require dissection, as for brachiopods, or more elaborate techniques such as use of electron microscopy or histology as for Phoronida (see Emig, 1979). Following the fashionable tendency on biodiversity, the mapping of taxa is based on these databases. But here also errors in identification or in nomenclature lead to incorrect species distributions, which cannot be used for scientific interpretation, in particular when dealing with biodiversity. Furthermore, one can also add that about 10-30% of fossil and current species of brachiopods described by specialists are in fact synonymous.

In summary, because the databases are no longer completely reliable, therefore they cannot serve as references for the scientific community unless the taxonomy is vetted by specialists. The Peter Principle (Peter & Hull, 1969) applies to the management of the databases related to biodiversity.

Note: The authors are responsible for all the words/text highlighted in bold all through the manuscript.

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⁴ Álvarez F. and Emig C.C. were members of the Editorial Committee and authors of the part H Revised, Brachiopoda, of the Treatise on Invertebrate Paleontology (1997-2007).

Additional data

Links to online databases:

- WoRMS (Word Register of Marine Species): <http://www.marinespecies.org/>
- WBD (World Brachiopoda Database): <http://www.marinespecies.org/brachiopoda/index.php>
- MSBIAS (Marine Species of the British Isles and Adjacent Seas):
<http://www.marinespecies.org/msbias/>
- Catalogue of Life: <http://www.catalogueoflife.org/>
- Taxonomicon: <http://taxonomicon.taxonomy.nl/>

Links to WEB sites:

- BrachNet: <http://paleopolis.rediris.es/BrachNet/> - webmaster: Emig C.C.
- Phoronida: <http://paleopolis.rediris.es/Phoronida/> - webmaster: Emig C.C.