Genus	Vol. 24(3-4): 261-273	Wrocław, 28 XII 2013

Have most species already been, or will they never be discovered? (are optimists or pessimists realists?)

Roman B. Hołyński
PL-05822 Milanówek, ul. Graniczna 35, skr. poczt. 65, e-mail: holynski@interia.pl

Abstract. Recently Costello *& al.* (2012; 2013a,b,c) and some other authors suggested that – contrary to the opinion of the majority of systematists – nowadays taxonomy is flourishing rather than being in crisis, and the decreasing numbers of species named by an average taxonomist shows that most of those actually living on the Earth have already been described; their further conclusion is that the alarming perspective of extinction of great part of living organisms before scientists will acquire knowledge of their very existence is much overstated. Herein I try to show that these claims are both theoretically flawed [based on glaringly inadequate (for this kind of questions) definitions of a "taxonomist" and "unit effort": neglectful underestimation of factors diverting the taxonomists' attention from descriptive work and making that work much more time-consuming and less effective] and contradicted by observable trends.

Key words: biodiversity, descriptions, extinctions, predictions, taxonomy

... I know of a few "very modern museums" which have become so over-staffed with theoretical systematists or molecular biologists that even basic identifications of major groups of plants and animals cannot be done! Ng 2000

...one of the most threatened species in world: the natural historian and general entomologist. Leather 2008

...es sind nicht nur viele seltene Käfer vom Aussterben bedroht, sondern auch die Taxonomen, die diese Käfer bestimmen können. Sprecher-Uebersax *& al.* 2013

...there are more taxonomists describing species than ever before. Costello *& al.* 2013

It is the almost general feeling among "organismal" biologists that taxonomy is nowadays in a deep crisis, the number of active taxonomists is alarmingly low and further decreasing, and conditions needed for their effective work (jobs, financial support, and possibilities to collect specimens and publish the results) become less and less satisfactory. On the other hand, negligent "conscience-salving" opinions or suggestions for "crisis management" have also been formulated: some authors question the very need to make the yet undiscovered organisms known; some consider traditional taxonomical studies as altogether outdated and superfluous because they expect DNA sequences to resolve everything from species identification to phylogenetic history; others see the remedy in rapid internet publications replacing printed journals and books; there are also believers in the omnipotence of technological gadgets (computerization, online databases, remote digital imaging, *&c*.) – I have already discussed these claims on several occasions (Hołyński 2001a, 2003, 2005, 2008a,b,c, 2010) and will not expatiate upon them here. However, the authors of some papers which have recently come to my attention try to persuade the scientific (and, consequently, not only scientific…) community that "*instead of a decline in taxonomy, the field has never been stronger*", and "*there have never been so many people describing new species, which can be considered a minimal number of taxonomists*", who have "*greater ability to explore and sample habitats*" (quotations from Costello *& al.* 2013c), *&c*. So, which is the true? Does the available information support the pessimistic or optimistic evaluations? The question is especially important in view of the conclusions drawn by both parts: while "pessimists" estimate that only a small fraction of the really existing species have been discovered, and the majority of those yet unknown will become extinct before we will become aware of their existence, according to the "optimists" "*this golden age of taxonomy ... accompanied by a decline in the number of species described per taxonomist suggested that a significant portion, probably over half, of all species on Earth, have already been described*" (Costello *& al.* 2013c), and the danger of extinction is anyway not so great because "*the lag time for this extinction debt may be centuries or millennia*" (Costello *& al.* 2013b)!

In my opinion, which I try to substantiate below, the "optimistic" conclusions [exhaustively summarized in some recent publications by Costello *& al.* (2012, 2013a,b,c), so that in further discussion I will quote mostly from them] have been based on ***generally false*** interpretation of ***partly true*** assumptions. The "corner stone" of their argumentation has been formulated by Costello *& al.* (2013c) as the first part of the title: "*More taxonomists describing significantly fewer species per unit effort*" – I am unable to verify the actual numbers, but if their definition of "taxonomists" ["*people describing one or more new species*"] is ***literally*** accepted, that main premise is almost certainly adequate. However, there are problems just with this definition, especially as applied to the evaluation of numerical trends: what does the phrase "*more taxonomists*" really mean, is an "average" taxonomist at the beginning of 21st century equivalent of that working 150, 100, or only 50 years earlier? Many lines of evidence show that the equivalence is ***not even approached***: contrary to the earlier times, nowadays – with extremely rare exceptions – true "full time" taxonomists (scientists devoting all or

almost all their time and effort to discover, describe, and classify living organisms) simply ***do not exist***!

An example may serve to illustrate one aspect of the difference: on the 102 pages of his revision of Asiatic *Trachys F.* a renowned specialist of **Buprestidae** (**Coleoptera**), Jan Obenberger (1929), treated 197 species, 106 of them described as new; my (Hołyński 2009) review of *Chrysochroa Dej.*, containing only 133 subspecies in 72 species, with but 2 sp. and 5 ssp. new, is a book of 400 pages – why could the Czech author have used (on the average) one page per two (1 new and 1 old) species, while I needed three pages per one taxon? My more detailed descriptions give only relatively insignificant part of the answer: much more important is the inclusion of extensive "background" (reassessment of the classification of the entire subtribe), phylogenetic reconstructions, 124 maps, and not strictly taxonomic (biogeographical, evolutionary, *&c.*) theoretical considerations. Obenberger's (1929) work, like the ovewhelming majority of taxonomic papers written before the last quarter of the 20th century, provides virtually nothing beyond keys and diagnoses.

During 65 years [1910-1964] of his scientific activity Obenberger has authored [not co-authored!] 458 publications (Jelínek 1977) – practically all of them taxonomic, the majority containing exclusively or almost exclusively short descriptions of new taxa [many of his papers – consisting of few (sometimes only 1 or 2) lines long diagnosis of a single new species, subspecies or variety – now look simply ridiculous…]. And Obenberger was no exception: his contemporaries, especially those most prolific in describing new taxa, typically (some of them almost exclusively: see *e.g. "mélanges exotico-entomologiques*" of Pic or "*diagnoses préliminaires*" of Bourgoin with 7 or 10 descriptions per page) published their contributions in similar form! Now it would be difficult to find a journal whose editor would accept such paper – of course we can (and do) consider the change as a welcome improvement, but for the here discussed questions positive or negative evaluation is irrelevant: the only important aspect is that earlier workers, concentrating on serial production of short diagnoses, could have published much more of them "per unit effort" than their modern colleagues devoting greater part of this effort to more elaborated descriptions accompanied by (or even only accompanying…) high-level classifications or biogeographic, phylogenetic, evolutionary *&c*. considerations! The case of Wanat (2001), aware of the existence of 10 times more species than had been described before the publication of his book (see tab. 1) is not exceptional: even my own "database" contains several tens (many of them – like those at least 19 new *Trachys F.* species collected by me 25 years ago in New Guinea from where only 13 had been known before – since decades!) of undescribed taxa which I have had no time to formally name, and almost any taxonomist could produce as long or longer list: even for some vertebrate specialists much more descriptive work remains to be done than the optimists' calculations suggest [*e.g.* Meegaskumbura *& al.* (2002) report *"… the discovery of an endemic radiation of >100 species … from Sri Lanka, … from which only 18 rhacophorine species were known previously … An extensive survey, primarily in the island's remaining 750 km² of rain forest, revealed upwards of 140 anuran species, …"*; Vieites *& al*. (2009) write of "*vast underestimation*" of the amphibian biodiversity of Madagascar; *&c.*].

Costello *& al.* (2013c) noticed that "*more exacting publication standards, the increasing number of publications and specimens that need to be studied by authors of taxonomic papers, or other factors, may partly offset the modern efficiencies in taxonomy*", but the formulation shows that they had grossly underestimated, in fact neglected the importance of this effect. Firstly, the "*modern efficiencies*" may indeed sometimes improve the ***quality*** of taxonomic work, but – at least in the context of the currently prevailing editorial, funding and other bureaucratic policies – almost invariably ***decrease*** the ***pace*** of work (and, consequently, "*the number of species described per taxonomist*")! But even in the rare situations where *e.g.* digital photographing could save the time otherwise spent on drawings, this effect is not "*partly offset*" but by far overwhelmed by the widened scope and elevated standards of modern taxonomic research!

But even this is not the full story: the really advantageous (considered advisable by the author and truly improving the scientific value of his work) "*exacting standards*" make but a small part of various purely formal (serving nothing beyond compliance to current fashion and/or fads of the publisher), several pages long "instructions for authors" and other editorial procedures ("*a typical paper that receives appropriate peer review and flows through the system* [of "*an efficiently operated scientific journal*"] *... can spend 9 months to a year on various desks before actual publication*" – Erwin *&* Johnson 2000); monstrously inflated formal requirements for grant applications; scores of reports, justifications, clearings, research plans before, during and after anything has been done: it is this hundred-headed bureaucratic hydra that "devours" a greater part of present-day scientists' time ["*a U.S. government study found that university faculty members spend about 40 percent of their research time navigating the bureaucratic labyrinth, and the situation is no better in Europe. An experimental physicist at Columbia University says he once calculated that some grants he was seeking had a net negative value: they would not even pay for the time that applicants and peer reviewers spent on them*" – Anonym (Sci. Am. editors) 2011]. At that, most of those professional biologists interested in the study of biodiversity are in fact employed as ecologists or molecular biologists [if at all: "*'The Museum tradition is dying. ...' (Robert E Ricklefs, 1980). ... 'The museum tradition is not dying – it is being killed ... by university departments that have eliminated evolutionary or morphological biology from their curricula, and by museum administrators who fill curatorships with ecologists, ethologists and chemists while their collections languish' (Storrs L. Olson, 1981)*" – McAlpine 1986], and that the current "rat race" in hunt for "quotation indexes", "impact factors" and similar (scientifically irrelevant but decisive on chances to get a job, grant, or degree) appearances forces the author to publish his/her papers in "renowned" journals which – besides being not always really appropriate but "in return" extraordinarily restrictive in terms of time-consuming formalities – usually do not accept truly taxonomic papers unless they are embellished with often superfluous but "impressive" sophisticated statistical "verifications", based on more or (usually…) less reliable molecular "barcodes", or altogether "masqueraded" as essentially ecological or phylogenetic works. Taking all the above into consideration it becomes evident that a currently working biologist counted by "optimists" as a taxonomist (having described one or more species) is, on the aver-

age, equivalent to ***but a fraction*** of a "typical" taxonomist of 19th or first half of 20th century, who was not discriminated as "outdated philatelist" and, not being compelled to sacrifice a greater part of the time on the altar of *Santa Bureaucratia* or even bother with (scientifically justified or not – no matter in this context) "*more exacting publication standards*", could have paid practically all his/her effort to the effective study of plants, beetles or lizards! When the respective "calibration" is made, any illusion of "*decline in the number of species described per taxonomist*" disappears: indeed, the ***real*** "unit taxonomist" describes now by far more species than ever before!

By the way, Costello *& al.* repeatedly (2012, 2013a,b,c) claim that the "*et al. effect*" (the current custom to sign the description of a species by more than one "author") "*did not affect the overall trends*" (the alleged "*decrease in number of species described per author*") – this assertion, however sophisticated statistics have been used to support it, simply cannot be true, being evident logical and arithmetical impossibility: if a description has been "authored" by, say, three persons, the "*number of species described per author*" is, of course, ⅓ instead of 1; if collectors, ecologists, statisticians, molecular biologists are counted as "taxonomisits", their number is artificially inflated what, again, leads to underestimation of "descriptions per taxonomist"!

According to Costello *& al.* (2013c) "*… active taxonomists and publications describing new species … are now distributed more globally than before the 1950s and continue to increase in number in Asia*" – perhaps in some groups such tendency is indeed discernible, but it is anyway much too slight to have any significant effect compensating the strong generally negative trends described above! Among *ca.* 200 authors of the more than 400 publications quoted in my review of the subtribe **Chrysochroina Cast.** (Hołyński 2009) there was ***not a single one*** native to any tropical African, south Asian or Oceanian country where almost all the chrysochroines live; generally in the **Buprestidae Leach** – a group containing *ca.* 3000 known Indo-Pacific species – I am aware of but two (both later synonymized) specific names introduced (in 1935…) by an author from that area (in this case from Siam). And buprestids are no exception: no more than two or three of the 2769 species-group taxa included in the Table 1 (see below) have been described by local south Asian, African or tropical American authors!

So much about the "*increasing number of active taxonomists*", but the "unit effort" – even after having been recalculated as "per unit taxonomist" – needs further "calibration"! Costello *& al.* (2013c) claim that "*the modern efficiencies in access to remote locations, sampling, specimen preparation, use of traditional and molecular characters, photography and publication suggest increasing efficiency in taxonomic discovery*" – I find this assertion very… say: unfitting… Methods of specimen preparation – at least in most groups I am more or less acquainted with – have not significantly changed since the 19th century, and where they did (*e.g.* to enable the examination of recently introduced characters), they [almost?] invariably became more complicated and time-consuming, *i.e.* ***less*** efficient in terms of the number of described species; the same can be said of the "*use of traditional and molecular characters*" and publication (preparation of the manuscript as well as procedures after submission). As to the "*access to remote locations*" – well, roads and means of transport are probably more

comfortable than a hundred years ago, but these "*modern efficiencies*" are negligible in comparison with exponentially growing number of "*all kinds of obstacles and discouraging regulations (special very expensive 'research visas', 'necessary' permits to perform studies, restrictions in collecting and/or taking or sending the material abroad, &c., &c., &c.*" – Hołyński 2008a)! Earlier the greater part of the specimens in major museums have been acquired as private collections sold or donated by the owner, or procured by "occasional", paid or voluntary, collectors (soldiers, doctors, merchants, missionaries, tourists) on the request of interested scientists – now such request would expose the serviceable person to serious troubles: scientific collecting has become a dangerous activity even to professional biologists [not long ago some Polish colleagues were imprisoned in Brazil, a group of Czechs or Slovaks in India, while in the Philippines also a "*group of entomologists ... trying to develop a molecular profile of different populations [of] some dangerous groups of mosquitoes, especially those responsible for dengue fever ... was taken to jail in handcuffs ... Their ambassador had to travel down from Jakarta to secure their release. They left behind 22 vials of dead mosquitoes in alcohol – which presumably now are in the ''black museum'' of the environment department as a major triumph. ... At the same time Manila was plastered with posters on how to kill as many mosquitoes as possible in dozens of ingenious ways*" – Larsen 2005]. I wonder how such attitude towards scientific collecting may "*suggest increasing efficiency in taxonomic discovery*"? And we have not mentioned the system of funding, now obtainable in practice only through grants, allocated in theory to particular projects but in fact to specifically listed and separately evaluated expenses, what compels scientists to decide between Scylla of formulating applications according to the known or expected preferences of funding agencies [neither taxonomy in general, nor – especially! – collecting expeditions in particular, are (to put it very mildly…) among the favorites!] rather than to the real needs, and Charybdis of further reducing the anyway meagre (usually no more than some 5-15% of submitted proposals are successful) chances to receive any support…

All the above makes it evident that "*this golden age of taxonomy*" is a simple illusion, and the "*increasing number of active taxonomists and publications describing new species*" – even if real, what I am not able to verify – is based mainly on inadequate definition of a "taxonomist" and misinterpretation of increasing monopolization of descriptive papers by "*the largest taxonomic journal*" (*Zootaxa*) as a reflection of ***generally*** positive trend. Thus, the (also unverifiable for me but probably real) "*significant decline in the number of species described new to science overall per author*" is the obvious (in fact unavoidable) effect of the combination of higher (much more time-demanding) scientific standards, increasing interest in phylogeny, biogeography and higher classification (diverting taxonomists' attention from purely descriptive work), adverse propaganda ("*XIX. century philately*") and discriminative attitude (of funding agencies, publishers, *&c.*) towards taxonomy, grotesquely inflated bureaucracy, and obstructions against collecting. None of these circumstances may justify the suggestion "*that a significant portion, probably over half, of all species on Earth, have already been described*" (although, naturally, earlier workers have already "selectively" discovered the majority ***of the largest, most attractive, commonest, easiest to find***, ***&c.***

– see *e.g*. fig. 4 in Hołyński 2001b – and it is rather easy to understand that finding, recognizing and describing the host of small, dull, more "cryptic" organisms proceeds at slower pace).

In my earlier paper (Hołyński 2001b) I estimated that "*at least*" *ca.* 65-70% of the living jewel beetles (**Coleoptera: Buprestidae**) remain undescribed, and at least 50% have not even become available for description (not collected). The evidence accumulated since that time strongly suggests that also this was an underestimation: while some large, colourful (used as jewellery!) "collectors' treasures" (*Sternocera Esch.*, *Chrysochroa Dej.*) may indeed be almost completely known, the overwhelming majority consists of inconspicuous, interesting only to specialists, small beetles like *Agrilus Curt.* (*ca*. 4000 species known!) or *Trachys F.* (*ca*. 800) – and any detailed taxonomic study of such little creatures results in significant (usually spectacular) increase in number of known species! Several examples have been quoted in the above-mentioned paper, and some more added herein, but to verify whether buprestids are not exceptional in this respect (what seemed anyway unlikely: it is a relatively popular group, probably better – not less – studied than the average) I have checked also the "description history" of several non-buprestid taxa extracted from recent revisional works (see tab. 1). The selection has been carried out according to three criteria: **1)** I have the respective publications in my "home library"; **2)** together they should offer for analysis possibly variable (in taxonomical, geographical, ecological sense) set of taxa; **3) Vertebrata**, **Rhopalocera**, **Lucanidae** and other exceptionally popular groups have been omitted: they represent the small but relatively very well studied "tip of the iceberg", and their inclusion would obviously distort the picture.

The results are, I think, persuasive. Although the last two decades are represented very incompletely, altogether (for all analyzed taxa) by far the greatest number (428) of species was described between 1991 and 2000, followed (279) by the next (2001-2010), hardly more than "rudimental" (for 13 out of 18 analyzed groups the source publications appeared before the end – six of them even before the beginning... – of that period) decade! And so despite the fact that the most speciose (1045 spp.) group, nearly cosmopolitan (but predominantly Holarctic!) *Anthaxia Esch.*, was just one of the two for which the peak occurred in the early 20th century. Moreover, in 11 out of 18 analyzed groups, including ***all*** totally or predominantly tropical, more than half (or at least – in New Guinean *Agrilus Curt.* – almost half) of known species have been described ***after 1970*** with (usually strongly marked) culmination in the last or last-but-one of the included decades; in some cases that last included decade resulted in as many (Brazilian **Gastrotricha**) or more (Indian **Salticidae**, Australo-Pacific **Apioninae**) descriptions than all the earlier times together (as to the last mentioned group, not only 39 of the 65 named species have been described in the cited 2001 publication, but additional 213 undescribed – it was a revision on generic/subgeneric level, so detailed species-level taxonomy was out of its scope and was restricted to the type-species of [sub-]genera – were already known to its author)! All this does not look like convincing evidence to support the allegation that the "*period of greatest discovery was in the first decade of the 20th century*" (Costello *& al.* 2012): only one (**Trombidiidae**) of the here analyzed group shows the highest peak (36 descriptions) at that time, but

even in this case the second-best (not much lower: 31) result marks the last included – 1991-2000 – decade…

Well, there are a few taxa showing, indeed, apparent decline in the number of described species in the last decades – does it mean that little remains to described? No, it only reflects the fact that the number of taxonomists at each time is by far not sufficient to "cover" all groups, so each of the latter experiences cycles of being more or less intensively studied. A copepod genus *Thermocyclops Kief.* may serve as a very instructive example compared with its closest relative, *Mesocyclops Sars*: up to the early 1980-s the pace of their descriptions ran roughly parallel (with the number of new *Thermocyclops Kief.* generally *ca*. twice higher), culmination in both cases between 1920 and 1960 – the peak of activity of two most prolific 20th century copepod taxonomists: Kiefer and Lindberg – and deep depression thereafter. However, an influential paper by Van de Velde (1984) and series of later publications mainly by Hołyńska resulted in more than tripling (46 added to the previous 21) of the number of *Mesocyclops Sars* known by 2003, whereas for *Thermocyclops Kief.* the depression continued. Such oscillations between "*periods of greatest discovery*" and those of relative stasis are observable in almost any group, and almost always the high stands are easily explainable by the activity of one or two especially productive authors [**Copepoda** (here *Thermocyclops Kief.* and *Mesocyclops Sars*): Kiefer and Lindberg in mid-XX c., **Buprestidae** (*Anthaxia Esch.*): Théry and Obenberger somewhat earlier), or even a single publication (New Guinean *Agrilus Curt.*: Deyrolle 1864]!

Except for some exceptionally attractive and/or economically important groups, and few others predominantly European or North American, recent review of almost any taxon reveals the same situation. How, then, Costello *& al.* (2012, 2013a,b,c) and other "optimists" could have arrived at the astonishing conclusion that "*probably over half, of all species on Earth, have already been described*"? Generally, as stated already in the introduction, the main reason was misinterpretation of the probably true basic assumptions: that the number of "taxonomists" (defined as authors who have described – or, more exactly, signed the description of – one or more species) and the amount of effort (measured as number of publications containing one or more of such descriptions) increased in the recent decades, and the rates of species description "*per unit effort*" decreased. As shown above, both definitions are glaringly misleading, and together result in enormous (not by 5 or 10%, but 5- or 10-***fold***!) overestimation of the ***real*** "effort", ***i.e. under***estimation of "rates ***per unit effort***"! Even conservatively assuming that the above-quoted "*U.S. government study*", showing that "*university faculty members spend about 40 percent of their research time navigating the bureaucratic labyrinth*", was approximately exact and valid also for other countries [I am rather convinced that generally – and especially in taxonomy – the situation is worse…] only 60% of the contemporaneous scientist's "research" time is left to scientific work. Let's further (still more conservatively!) assume that on the average half of that time (much less or near zero for some "amateurs", but usually much more than half for "professionals") is devoted to non-descriptive work (higher classification, phylogeny, biogeographical or ecological considerations, molecular analyses), and half of the remainder 30% on complying to the current requirements as regards quality of descriptions, documenta-

tion, nomenclatural rules *&c*., as well as on studying (and adjusting the paper to) the editorial demands ("instructions for authors") as to the immensely important questions of where to put a comma and whether the pagination must be indicated by "pp." or ":", and we have but 15% of the "research time" available to describe new species; after substraction of the hours spent on struggling with various programs for online-only submission, discussions with peer reviewers, *&c*., *&c*., *&c*., less that 10% is left!

Of course it is a very rough estimation, but anyway the real average "unit taxonomist" of the last decades is clearly equivalent to but a small fraction of that characterizing his/her colleague working 50 or 100 years ago, and any further calculation based on uncorrected numbers must have led to drastically unrealistic conclusions! And they did, as suggested not only by the "theoretical" considerations, papers like Hołyński (2001b), or the data gathered in the table 1, but even by *e.g*. Costello *& al.*'s (2012) own fig. 4, where the cumulative curves representing the numbers of ***actually described*** species show no indication of approaching "plateau" (in fact, they turn consistently upwards!), and "downturning" is seen only in the extrapolated "*based on the number of species described until 1900, 1950, 1980, and from* [?] *2009*" sections (with the Authors' own comment that those "*using earlier years of description significantly* [by *ca*. 100%! – RBH] *underestimated the number of species later discovered*", what by itself is the evidence of irreliability of either basic assumptions, or "models", or both…).

To sum up: the (almost certainly true) decline in the number of species described on the average by a contemporary "taxonomist" is neither a proof nor even suggestion that "*most species having already been described*" [although, of course, ***every*** description since Linnaeus (1758) leaves less (and, on the average, less easy to find and/or recognize) taxa available for later students, what unavoidably negatively influences the pace of further discoveries – but this has nothing to do with the actual proportion of the number of already known species to those yet unknown!]. The trend is more than sufficiently explained by the increased involvement of the "modern" taxonomists in non-descriptive work, multiplication of administrative regulations against collecting and exchange, scarcity of truly taxonomic jobs, discriminative system of (anyway inadequate) funding, anti-taxonomic propaganda ("XIX-century stamp collecting"), rampant formalities in publication process, and especially grotesquely inflated bureaucracy leaving but a tiny fraction of the "***research*** time" to actual research [a professor in the Warsaw Institute of Zoology, asked what he was just working on, answered: "I will ***work*** after 4pm, now I am a ***clerk***, not scientist"; unfortunately arranging any problem of everyday life is also plagued by ubiquitous bureaucracy, robbing also a great part of the "home time" ("after 4pm") when he, like most taxonomists, could have been "scientists not clerks"…]! These negative factors cannot be even partly compensated by technological gadgets and methodological (*e.g*. statistical) tools, which may (albeit not always do…) improve the quality of descriptive work but almost invariably ***adversely*** influence its "quantitative" efficiency.

Conclusion: I do not see any symptom of approaching exhaustion of species remaining to discover and describe: I do not know whether 25, 10, or 5% have hitherto been named, but as well theoretical considerations as observed trends in almost all "sampled" groups evidence that much work remains still to be done before we arrive at 50%...

REFERENCES

Anonym, [Editors]. 2011. Dr. No Money: The broken science funding system. Scientists spend too much time raising cash instead of doing experiments. Sci. Am. [25 IV 2011]

Bílý, S., 1997. World catalogue of the genus *Anthaxia* Eschscholtz, 1829 (Coleoptera: Buprestidae). Folia Heyr., **Suppl. 2**: 1-190.

Costello, M.J., S. Wilson, B. Houlding. 2012. Predicting total global species richness using rates of species description and estimates of taxonomic effort. Syst. Biol., **61**, 5: 871-883.

Costello M.J., R.M. May, N.E. Stork. 2013a. Can we name Earth's species before they go extinct? Science, **339**, 6118: 413-416.

—, 2013b. Response to comments on "Can we name Earth's species before they go extinct?" Science, **341**: 237d

Costello M.J., S. Wilson, B. Houlding. 2013c. More taxonomists describing significantly fewer species per unit effort may indicate that most species have been discovered. Syst. Biol., **62**, 4: 616-624.

Curletti, G., 2001. The genus *Agrilus* in Australia (Coleoptera, Buprestidae). Jew. B. **9**: 1-45.

—, 2002. The genus *Agrilus* in Australia – Supplement 1 (Coleoptera, Buprestidae). Jew. B., **11**: 1-4.

—, 2003. The genus *Agrilus* Curtis, 1825 in Solomon Islands. (Coleoptera, Buprestidae). Bol. Mus. Reg. Sci. Nat. Torino, **29,** 1: 135-159.

—, 2006. The genus *Agrilus* Curtis, 1825 in New Guinea and nearest islands. Ann. Mus. Civ. St. Nat. G. Doria, **98**: 157-257.

Deyrolle, H., 1864. Description des Buprestides de la Malaisie recueillis par M. Wallace. Ann. Soc. Ent. Belg., **8**: 1-272; 305-312.

Erwin, T.L., P.J. Johnson. 2000. Naming species, a new paradigm for crisis management in taxonomy: rapid journal validation of scientific names enhanced with more complete descriptions in the Internet. Col. Bull., **54**, 3: 269-278.

Hołyńska, M., J.W. Reid, H. Ueda. 2003. Genus *Mesocyclops* Sars, 1914. Guides to the Identification of the Microinvertebrates of the Continental Waters of the World. **20**: 12-213.

Hołyński R.B. 2001a. Crisis management in taxonomy: medicine or poison? Col. Bull., **55**, 2: 243-247.

—, 2001b. The number of species of the Indo-Pacific Buprestidae Leach (Coleoptera). Jew. B., **10**: 35-48.

—, 2003. Obligatory „peer-reviewing": can cosmetics really help? Antenna, **27**, 4: 251-256.

—, 2005. Philosophy of science from a taxonomist's perspective. Genus, **16**, 4: 469-502.

—, 2008a. Taxonomy crisis, biodiversity disaster – and sabotaging regulations. Munis Ent. Zool, **3**, 1: 1-6.

—, 2008b. Taxonomy in changing world – The ends and the means (comments to Agnarsson & Kuntner, 2007). Munis Ent. Zool., **3**, 2: 541-547.

—, 2008c. God save us from friends, or: How to ensure taxonomy against passing away by dint of a successful operation? Pol. Tax. Mon., **15**: 3-54.

—, 2009. Taxonomic structure of the subtribe Chrysochroina Cast. with review of the genus *Chrysochroa* Dej. (Coleoptera: Buprestidae). Warszawa: Gondwana: 1-421.

—, 2010. Taxonomy and the mediocrity of DNA barcoding – some remarks on Packer et al. 2009: DNA barcoding and the mediocrity of morphology. Arthr. Syst. Phyl., **68**, 1: 143-150.

Jelínek, J., 1977. Bibliography of scientific papers of prof. Dr. Jan Obenberger. Acta Ent. Mus. Nat. Pr., **39**: 5-27.

Karanovic, T., W. Lee. 2012. Arthropoda: Crustacea: Harpacticoida: Parastenocarididae. Parastenocaridid copepods. *Inv. Fna. World,* **21, 2**: 1-231.

Kim, I.-H., 2010. Arthropoda: Crustacea: Copepoda: Cyclopoida, Siphonostomatoida. Symbiotic copepods. *Inv. Fna. Korea,* **21, 5**: 1-222.

Kisielewski, J., 1991. Inland-water *Gastrotricha* from Brazil. Ann. Zool., **43**, Suppl. 2: 1-168.

Larsen, T.B., 2005. Hazards of butterfly collecting. 'Fossil on a pin' – Keele University, UK, 1993. Ent. Rec., **117**: 109-111.

Leather, S.R., 2008. Conservation entomology in crisis? [review: Stewart & al. 2007]. TREE, **23,** 4: 184-185.

Lee, W., E. Park, S.J. Song. 2012. Arthropoda: Crustacea: Copepoda: Harpacticoida. Marine Harpacticoida. *Inv. Fna. Korea,* **21, 11**: 1-276.

Linnaeus, C., 1758. Systema naturae per regna tria naturae secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Ed. 10. Holmiae: Laurentii Salvii 1: 1-823.

Lis, J.A., 1999. Burrower bugs of the Old World – a catalogue (*Hemiptera*: *Heteroptera*: *Cydnidae*). Genus, **10**, 2: 165-249.

Mąkol, J., 2000. Catalogue of the world Trombidiidae (Acari: Actinotrichida: Trombidioidea). Ann. Zool., **50**, 4: 599-625.

McAlpine, D.F., 1986. Curators and natural history collections: have we become islands in science? Proc. 1985 Workshop Care Mainten. NH Coll.: 7-14.

Meegaskumbura M., F. Bossuyt, R. Pethiyagoda, K. Manamendra-Arachchi, M. Bahir, M.C. Milinkovitch, C.J. Schneider. 2002. Sri Lanka: an amphibian hot spot. Science, **298**: 379.

Mirabdullayev, I.M., J.W. Reid, H. Ueda. 2003. Genus *Thermocyclops* Kiefer, 1927. Guides to the Identification of the Microinvertebrates of the Continental Waters of the World, **20**: 214-314.

Ng, P.K.L. 2000. Biodiversity challenges for Southeast Asia in the new millenium and the role of the Raffles Museum. Nat. Sci. Mus. Monogr., **18**: 3-23.

Obenberger, J., 1929. Revision des espèces exotiques du genre *Trachys* Fabr. du continent asiatique. Acta Ent. Mus. Nat. Prag., **7**, 58: 5-106.

Pomorski, R.J., 1998. *Onychiuridae* of Poland (*Collembola: Onychiuridae*). Wrocław: Pol. Tax. Soc.: 1-201.

Prószyński, J., 1992. *Salticidae* (*Araneae*) of India in the collection of the Hungarian National Natural History Museum in Budapest. Ann. Zool., **44**, 9: 165-277.

Riedel, A., 1995. Kritische Bemerkungen und Ergänzungen zur Kenntnis der Subfamilie *Zonitidae* sensu lato (*Gastropoda*, *Stylommatophora*) der Türkei. Übersicht der Arten. Fragm. Faun., **38**, 1: 1-86.

Schminke, H.K., 2011. Arthropoda: Crustacea: Malacostraca: Bathynellacea. Parabathynellidae. *Inv. Fna. World,* **21, 1**: 1-244.

Sprecher-Uebersax, E., M. Geiser, M. Hicklin. 2013. Die Käfersammlung Frey – eine Kostbarkeit für die Wissenschaft. Mitt. Natforsch. Ges. Beider Basel, **14**: 3-19.

Van de Velde, I., 1984. Revision of the African species of the genus *Mesocyclops* Sars, 1914 (Copepoda: Cyclopidae). *Hydrob.,* **109**: 3-66.

Vieites, D.R., K.C. Wollenberg, F. Andreone, F. Glaw, M. Vences. 2009. Vast underestimation of Madagascar's biodiversity evidenced by an integrative amphibian inventory. Proc. Nat. Ac. Sci., **106**, 20: 8267-8272.

Wanat, M., 2001. Genera of Australo-Pacific *Rhadinocybinae* and *Myrmacicelinae*, with biogeography of the *Apionidae* (*Coleoptera*: *Curculionoidea*) and phylogeny of the *Brentidae* (*s. lato*). Olsztyn: Mantis: 1-432.

Wiesner, J., 2013. The chennelli group of the Genus *Therates* Latreille (Coleoptera: Cicindelidae). 114. Contribution towards the knowledge of Cicindelidae. Ins. Mundi, 315: 1-86.

Table 1

Taxon	Area	Habitat	1758-1760	1761-1770	1771-1780	1781-1790	1791-1800	1801-1810	1811-1820	1821-1830	1831-1840	1841-1850	1851-1860	1861-1870	1871-1880	1881-1890	1891-1900
Gastropoda: Zonitidae	Turkey	terrestrial	1	1	2			2			8	2	7	2	7	13	2
Gastrotricha	Brazil	freshwater										1		2		6	
Araneae: Salticidae	India	terrestrial										3			2	3	4
Acarina: Trombidiidae	World	terrestrial	1	1	1			2			2					3	4
Crustacea: Harpacticoida	Korea	marine									1	4		3		1	
Crustacea: Parastenocarididae	World	groundwater															
Crustacea: Thermocyclops	World	freshwater											1	1		1	2
Crustacea: Mesocyclops	World	freshwater											1				2
Crustacea: Siphonostomatoida	Korea	symbiotic														1	
Crustacea: Parabathynellidae	World	groundwater															
Insecta: Onychiurinae	Poland	terrestrial	1											1	2		2
Insecta: Cydnidae	Old World	terrestrial	2	2	3	2	2	4	1		18	18	31	29	17	64	17
Insecta: Therates	S-Asia	terrestrial													1		3
Insecta: Anthaxia	World	terrestrial	2	1	2	7	2	5		6	26	20	22	19	12	31	76
Insecta: Agrilus	Australia	terrestrial					1				2	3		1	3		5
Insecta: Agrilus	Solomons	terrestrial									1		5				1
Insecta: Agrilus	N. Guinea	terrestrial				1				1		1	1	21	4		5
Insecta: Apioninae	Australo-Pacific	terrestrial												1		5	
Sum			7	5	8	10	5	13	1	7	58	52	68	80	48	128	123

Table 1 + cont.

Taxon	Area	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2013	Sum	indes-cr.	Source
Gastropoda: Zonitidae	Turkey	3	6	1	1	2	1	8	6	15	10			100		Riedel 1995
Gastrotricha	Brazil	3	4	5	2			1		5	29			58		Kisielewski 1991
Araneae: Salticidae	India	2		1						1	30			46		Prószyński1992
Acarina: Trombidiidae	World	36	14	30	20	15	28	25	11	12	31			236		Mąkol 2000
Crustacea: Harpacti-coida	Korea	2		1	2	3		2	6	2	13	10	1	51		Lee & al.. 2012
Crustacea: Parasteno-carididae	World		1		6		3	8	4	6	6	6	4	44		Karanovic & Lee 2012
Crustacea: Thermo-cyclops	World	1	1	9	13	2	10	3	1	4		2		51		Mirabdullayev & al. 2003
Crustacea: Meso-cyclops	World	2	1	6	4	2	3			29	16	1		67		Hołyńska & al. 2003
Crustacea: Siphono-stomatoida	Korea				2		2	5	7	3	14	2		36		Kim 2010
Crustacea: Parabathy-nellidae	World			2	1	2	17	32	27	11	11	67	4	174		Schminke 2011
Insecta: Onychiurinae	Poland	1	3	1	6	3	15	3	2	5	1			46		Pomorski 1998
Insecta: Cydnidae	Old World	25	57	4	9	3	21	18	28	16	159			550		Lis 1999
Insecta: Therates	S-Asia	5								4	28	8	5	54		Wiesner 2013
Insecta: Anthaxia	World	46	75	128	108	45	41	50	71	76	78	81	15	1045		Bílý 1997 + >
Insecta: Agrilus	Australia		1	9	1		6					16		48		Curletti 2001-2002
Insecta: Agrilus	Solomons				1							9		17		Curletti 2003
Insecta: Agrilus	N. Guinea	1		4				3	1			38		81		Curletti 2006
Insecta: Apioninae	Australo-Pacific	3	4	9						2	2	39		65	>213	Wanat 2001
Sum		130	167	210	176	77	147	158	164	191	428	279	29	2769		