The Coleopterists Bulletin, 54(3):269–278. 2000.

NAMING SPECIES, A NEW PARADIGM FOR CRISIS MANAGEMENT IN TAXONOMY: RAPID JOURNAL VALIDATION OF SCIENTIFIC NAMES ENHANCED WITH MORE COMPLETE DESCRIPTIONS ON THE INTERNET

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Abstract

The process of taxonomic description and validation of names under the International Code of Zoological Nomenclature (Fourth Edition) is central to providing the anchor by which present and future seekers of knowledge attach and subsequently retrieve information about species and their phylogenetic associations. Since Linnaeus (1758), 4,400 ± 363 species of insects have been described per year. If 25 to 30% of all species are beetles, and some 400,000 are estimated to be described to date, even taking the lower end of reasonable estimates at 8 to 10 million species of insects total, we still have more than 2 million beetle species yet to describe. At the current pace of some 3,154 beetle species described per year (1978 to present: BIOSIS, Zoological Record), we could "finish" the job in the year 3056 using the present system. While traditional descriptions published in widely circulated journals has been the mainstay of taxonomy and served the science well, we are entering a phase that might be called crisis management in taxonomy. This results from recent higher demands on taxonomists due to a general recognition that biodiversity is disappearing at an alarming rate, the so-called Sixth Extinction Crisis, and a reduced number of practicing descriptive taxonomists. Therefore, a new description paradigm that provides for rapid validation of new taxonomic names is paramount to plans for national biodiversity surveys. This new paradigm is elaborated and examples are given for both traditional and projected methods of species descriptions and rapid publication with additional extensive use of the Internet and server system to store and transmit more complete details and images.

> "One other characteristic of modern taxonomy seems to me to be that emphasis has shifted from descriptions to actual specimens, or from words to animals. Descriptions cannot be made full enough and accurate enough to satisfy later workers. Each generation of taxonomists must see the actual specimens used by earlier generations, and I think the tendency now is, or should be, to make descriptions short, but of course explicit and carefully calculated, and to make specimens widely available."
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> P. J. Darlington, Jr., 1971

An enormous unknown tropical fauna has yet to be recorded in the scientific literature, as well as a relatively vast store of temperate species. The process of taxonomic description and validation of names under the International Zoological Code of Nomenclature (Fourth Edition) is central to providing the anchor by which present and future seekers of knowledge attach and subsequent-

ly retrieve information about species and their phylogenetic clades (Thompson, 1997). Standing on the shoulders of Daniel Janzen's giant imagination (the All Taxa Biodiversity Inventory (ATBI) initiative in Costa Rica), the Coleopterists participating in the National Biodiversity Inventory of Costa Rica (the INBio project) are moving toward a new paradigm in naming species and inclusive taxa rapidly, hence providing the anchor. The purpose of this paper is to present the method by which we will rapidly document the new species and other higher level beetle taxa for the National Biodiversity Inventory of Costa Rica. However, only part of the paradigm is in reality new, that is, combining name validation in print and putting additional details at a web site. The "rapid publication" aspect was proposed as the "Pilot Registry of Zoology" by W. L. Brown (1961) and independently, as "Data Documents for Systematic Entomology (DDSE)" by R. H. Arnett (1970). Had there been a biodiversity crisis and desktop computers in their day, a mere 30 some years ago, the grand idea of these pioneers already would have found a niche!

Raven (1988), Janzen (1997) and Erwin (1997) among others have decried the molluscan pace of new species descriptions while the natural world disappears in front of our very eyes. Whitmore (1997), based on FAO assessments, reported that 15 million hectares of primary pantropical forests have been lost annually since 1960. With these landscape conversions, Laurance and Bierregaard (1997), summarizing others, believed the extinction rate is hundreds or thousands of times higher than natural levels. Lovejoy (1980) estimated that 600,000 species have already become extinct since humans appeared on the world scene. Yet, since Linnaeus (1758), only 4,400 ± 363 species of insects have been described per year (Erwin 1997). Guesses at the number of species extant on the planet range from 20,000 (John Ray, as cited by Westwood, 1833) to 100 million (Stork 1988; May 1990; Gaston 1991; Wilson 1988; Raven 1988). Testable hypotheses of the richness of insect species range from 3.5 to 30 million (Erwin 1982; Hodkinson and Casson 1991; Ødegaard 1999). If 25 to 30% of all species are beetles (Hammond 1992), and we know we have described some 400,000 to date, even taking the moderate estimates (say 8 to 10 million species), we still have more than 2 million beetle species yet to describe. At the current pace of 7,100 total insect species described per year since 1979, we will come to an end of the descriptive process just for beetles in the year 3056! How many of these species will still be extant by then? How many habitats will be left to maintain them? How much natural history knowledge will we have lost without ever having recorded it? While traditional descriptions published in widely circulated journals has been the mainstay of taxonomy and served the science well, we are entering a new phase that might be called "crisis management in taxonomy" (G. E. Ball pers. comm.). With more than 15 million hectares of natural environment disappearing or undergoing conversion to a less biodiverse landscape, and with species that have, in general, ranges far smaller than jaguars, monkeys, and peccaries, we can expect that not many habitats will exist for the vast multitude of arthropod species. And, we will have recorded nothing about the majority of them for future generations.

W. L. Brown, Jr. (1961) and Ross H. Arnett, Jr. (1970) addressed the need for rapid species descriptions; they were ahead of their time because no extinction crisis was perceived and no one paid much attention to their proposals. Taxonomic writing continued at a pace dictated by due caution that seemed to place a premium on thoroughness and care, in preference to speed. However, Darlington (1971) explained his use of the short description for his treatment

of the carabid beetles of New Guinea and this was echoed and emphasized by Erwin (1972) in his review of Darlington's tome. Essentially, Darlington expressed the view (and the practice) that taxonomists prefer to see authentically identified specimens rather than read a description. He further noted that a unique specimen needs a fuller description than a species known from many specimens, in case the unique one might get lost or destroyed. His principle was to collect many and distribute them widely. Despite these early ideas and Darlington's model, taxonomy did not change much.

In the past 50 years though, the environment changed through progressive deterioration, we humans have become overpopulated, and resources are becoming scarce and are poorly distributed across humanity; we have entered the "Sixth Extinction Crisis" (Eldridge 1998).

Curiously, W. L. Brown, Jr. (1961) also commented on how difficult and costly it was to obtain descriptions of new species of ants that were published in "Moravia, Japan, and Uruguay" even though the citations appeared in the Zoological Record. His ideas and efforts resulted, later in the decade, in an initial International Taxonomic Register with species descriptions on cards that were sold for $1.25 per set. The cards look remarkably like species web pages on various servers today (*e.g.*, The Tree of Life, URL—phylogeny.arizona.edu/tree/phylogeny.html; INBio URL—http://www.inbio.ac.cr; and the Smithsonian, URL—http://entomology.si.edu/databases.html) even with color images, except they were on paper stock. Had he and Arnett known that in the 1940's, the US Military had already put the "vacuum-tube" computer to good use, perhaps the taxonomy of many groups would be far more advanced today than they presently are. Yet, even today, the systematics community is not generally aware of the incredible research going on behind the scenes at research and development companies with regard to "smart" computers. How will these affect taxonomic procedures? The new International Code of Zoological Nomenclature (Fourth Edition) allows for names to be validated from publication on permanent digital media such as compact discs (CD's) and distributed to libraries, but a transition to this mode will also require Zoological Record and other abstracting services to obtain access to these CD's (Thompson pers. comm.). For the short-term, the naming paradigm described here seems the prudent course of action for the Costa Rica survey.

In cooperation with INBio and the Coleopterists Bulletin, we have adopted the system described herein to accelerate the molluscan pace of traditional taxonomy and get the job done in Costa Rica. INBio (whose mission depends on knowing the Costa Rican fauna) will pay page full charges for new descriptions of Costa Rican taxa (one page per new taxon). The Coleopterists Bulletin (whose support is crucial to this endeavor) will be supplemented with extra pages quarterly (depending upon receipt of appropriate and peer-reviewed manuscripts). A special Editorial Board will handle peer review of these manuscripts and the Editor of the Coleopterists Bulletin will have the last word regarding actual publication.

Hence it will be possible to get new names validated in as little as three months!

The INBio Initiative

The beetle fauna of Costa Rica, indeed of all Central America, is substantially unknown and much of what is known is still unrecorded, for example, only 52% of the carabid genera and 47% of the elaterid genera known to be

Table 1. Current status of the Carabidae of Costa Rica.

Source	Tribes	Genera	Species
Literature	36	70	253
Additional numbers from USNM, UASM, and INBio collections	0	58	?
Additional predicted (known to occur elsewhere in Central America)	0	31	?
Predicted	36	133	1,100+

represented in Costa Rica (from museum collections) have actually been recorded in the scientific literature. Based on records from neighboring countries some 31 more genera of carabids and 6 genera of elaterids are predicted to be represented (Tables 1, 2). The last "comprehensive" coverage, **Biologia Centrali-Americana,** was published in the late 1800's and covered approximately 16% and 7%, respectively, of the presently described fauna (using Carabidae and Elateridae as the yardsticks). Most species at that time were known from one or a few localities, and even less specifically recorded from the newly declared Conservation Areas of Amistad Caribe, Amistad Pacifico, Huetar Norte, Arenal, Cordillera Volcanica Central, Guanacaste, Isla del Coco, Osa, Pacifico Central, Tempisque, Tortuguero which are the main target areas of the INBio survey. During the 20th Century, many additional species were recorded and described in widely scattered taxonomic literature with very few monographic treatments. This literature registers an additional 19% of expected carabid species and a few scattered descriptions of elaterids. Most of these descriptions have not been brought together in revisions and monographs, thus are unusable except by the specialist. In only a few cases, modern checklists of species have been made since Blackwelder (1944) and only for a few beetle families (*e.g.,* Erwin, *http://entomology.si.edu,* and Johnson, *http://www.abs.sdstate.edu*—Databases: Checklist of the Western Hemisphere Carabidae and Costa Rican Elateridae, respectively). For example, more than 1,100 carabid species are predicted to occur in Costa Rica, but only 253 actually have been recorded in the literature, thus far. For the Elateridae, only 61 species have been recorded with another 400 expected. We believe these examples reflect the general pattern for the rest of the beetle families as well.

Due to the wide range of habitat types in the conservation areas under study at INBio as part of the National Biodiversity Inventory, we expect our beetle inventory to contain 80% of the actual Costa Rican fauna, or perhaps as many as 18,000 species. A project covering all these species is clearly outside the

Table 2. Current status of the Elateridae in Costa Rica.

Source	Tribes	Genera	Species
Literature	17	33	61
Additional numbers from examined collections	0	9	218 described 30+ undescribed
Additional predicted (known to occur elsewhere in Central America)	0	?	?
Predicted	17	42?	400+

realm of possibility given present financial and personnel constraints. However, a concentrated and detailed study of a few large families in a selected suite of habitats in these conservation areas will substantially advance the knowledge of beetle biodiversity in Costa Rica, and will represent a very important step in the right direction.

A comprehensive plan of activities has been undertaken in the form of short-term and intermediate-term goals which aim to partially rectify an astonishing lack of information about the most biodiverse groups of organisms on the planet (particularly for Costa Rica and its conservation areas) and make this information accessible to an audience. The plan will eventually lead to a complete inventory of Costa Rican beetles and knowledge of their natural history—the long-term goal of INBio, indeed, of all Coleopterists. Further, an organized system for the national and international dissemination of knowledge about these beetles is unified within the inventory and dependent upon Internet delivery to users. The overall plan will provide a management framework for all collecting, specimen processing, and information dissemination.

Rapid publication of new species descriptions (and that of higher level inclusive taxa) is **paramount** to the plan.

Historical Perspectives

The Coleopterists Bulletin is a prime example of an efficiently operated scientific journal that publishes taxonomic papers. Yet, a typical paper that receives appropriate peer review and flows through the system can spend 9 months to a year on various desks before actual publication. Only papers that are expedited for special reasons, and at significantly higher costs, are published sooner.

Not unexpectedly, a short review of recently published descriptions in the Coleopterists Bulletin revealed a significant variation in the length of these descriptions. Each of the descriptions reviewed for our purpose meets the goals of adequately providing an anatomical and morphological impression of the taxon treated. Our selections of examples were chosen only to illustrate our discussion. However, consideration of description length is critical to developing a rapid publication plan, particularly when viewed from the perspective of time necessary for preparing descriptions and the cost of the publication process.

No general standards or recommendations exist for determining length or content of taxonomic descriptions. The length of any given description is a decision for the taxonomist who takes into consideration the traits requiring treatment, the relative importance of individual traits, terminology and grammar used in the description, available resources for publication, and traditional treatments within the group of taxa concerned. The great variation of description length and content is a consequence of the 'due care' tradition. Linnaeus (1758) began with, *e.g.*, a six lines of text diagnosis of *Musca domestica,* that included differentiation, previous literature, distribution, habitat, and comments on larvae and pupae. This was his comprehensive yet succinct entry for species n. 54 (Thompson and Pont 1993). What has happened since Linnaeus?

Selected recently published descriptions in the Coleopterists Bulletin were classified into three broad categories, simply—lengthy, moderate, and short. This was done to provide an estimation of necessary resources for publishing INBio manuscripts. Descriptions that fit the "lengthy" category ranged from approximately three-quarters of a page to more than a page in length. These

descriptions ranged in length from nearly 700 words to over 1,200 words per description. Examples of such descriptions would include Flowers (1997) who exceeded this high number for a genus description, but provided species descriptions of about 400–450 words. These descriptions were published with a smaller font size that reduced the overall page length of each description. Moron (1999) published on the lower end of this range, approximately 650–700 words per description, but these were printed in a larger font size and consequently each description occupied a proportionately greater number of pages.

An example of a "moderate" length description was published by Sforzi and Bartolozii (1993), where each description was just short of 500 words. This description length occupies approximately 2/3 of a Coleopterists Bulletin page, using a standard font. Similarly, Nelson and MacRae (1994) used approximately 450–480 words per description. This length of description approximates one-half of a page, depending on font size, but leaves little room remaining for additional information or illustrations on the same page.

Descriptions classified as "short" fell into the few words category (Erwin 2000) to the 400-word range. Examples of the latter were Clark (1993) and Lee and Jäch (1996), both of whom used about 200 words per description, and Miller (1995) who used about 250 words per description. These authors included multiple descriptions, with additional information and illustrations, in relatively short manuscripts. We believe that such examples support our contention that inventory taxonomy need not be lengthy or complicated, particularly with recognition of alternative and feasible forms of data presentation being available, *i.e.,* web pages.

We have obtained agreement with the Executive Council of the Coleopterists Society that INBio program descriptions will be printed in a smaller font to permit variation between descriptions, yet maximize available space. Illustrations are encouraged, but should be restricted to salient structures essential for recognizing the new taxon. With present technology and the web page/server system being developed by INBio, enhanced descriptions with extensive use of illustrations will be available to complete the philosophy of "due caution."

Actual description content will vary from taxon to taxon, depending upon characters of value for each family. Most useful descriptions will exceed traditional expectations of satisfactory completeness within 350–400 words. Our recommendation is for total individual descriptions between 150–250 words and not to exceed 300 words. Yet, the most important diagnostic traits that will permit recognition and discrimination of the new taxon from its nearest relatives must be included. Descriptions must be kept to salient characters, such as autapomorphies and recognition traits. An attempt to completely describe all anatomical and morphological traits can be achieved on the web page. The general format for naming in the Coleopterists Bulletin, in fact, approaches a minimalist diagnosis for each taxon. But, this is not wrong! In reality, there has never been a codified requirement for lengthy descriptions, only tendencies and preferences by traditional taxonomists to be complete and accurate. We do not deride anyone for such efforts, but suggest that old habits and traditions must change to meet the coming crisis in getting faunas recorded before they are gone.

The New Description Paradigm

Participating Coleopterists in the INBio National Biodiversity Inventory are going to use the following format for the supplemental pages to the Coleop-

terists Bulletin (e.g., *see supplemental pages in this issue). A species, or more inclusive taxon, description will be limited to one page and will contain the following, in the following format (see example in the supplemental pages of this issue of the Bulletin):*

Title

(Short, containing the number and rank of new taxa, name of appropriate higher-level taxon, *e.g.,* Genus and Family (plus Coleoptera in parentheses))

Author/address

Abstract

(Short, giving only new taxon name(s), appropriate supra generic assignments, and georeference of type locality for each new species-level taxon, and the type species for each new genus-level taxon).

[Introduction]

Provide text that will serve to introduce the paper, for example, reason for descriptions vis-à-vis the INBio inventory, summary of what is described, and/or taxonomic history by citing the most recent monograph or revision, etc., if any. Give reference to the INBio web site where detailed descriptions, natural history, distribution maps, illustrations and photos will be found for the taxa described as: http://www.inbio.ac.cr/ubis/.

Accounts of Taxa

(Description—about ½ page, to be balanced with the illustrations)

Taxon name (include author(s)), **new "taxon"**
(See new code requirements here)

Type Series. Holotype declaration and its information; include paratypes here, or below, or refer to long lists of secondary types on the INBio web site. If the latter, give here the number of male and females to be found on the web site. Georeference is required in lat/long or the Lambert system in use at INBio (the Lambert "LN" or "LS" on INBio specimen labels); use the format <LN 000000,000000>. In addition, some specimens have "#0000" following the LN or LS number. This is a "LOT" number and should also be reported following the LN or LS number, *e.g.,* (INBio: LN 000000,000000 #0000). The BIMS program at INBio can translate lat/long to Lambert, Polar, etc. Also provide the INBio Bar Code number in the form <CRI 000–000000>.

Derivation of Name. Short explanation of the name (see new code recommendations) including how the word is used (*e.g.,* adjectives, noun in apposition) and in the case of a new generic name, its gender.

Diagnosis. Short and concise with one or two autapomorphies within genus; reference Fig. #.

Description. Basic, depending upon group and traditionally viewed attributes; reference Fig. #. Provide measurements traditional for group.

Specimens Examined. If listed here, georeference required (see format required above) and note paratypes either here or above, *i.e.,* sex and number of specimens. Long lists of specimens can be put on the web site to save space here. Provide a summary here of Costa Rican Conservation Areas, since that is a requirement of the Unidades Basica de Información (UBI) at the web site. Also list other countries from which specimens were seen.

Notes. Use this category if needed, but keep ancillary notes to a minimum. Web pages can be used for extended discussion of natural history attributes. [**Illustrations.** required and taking about 1/3 to 1/2 page; keep "Figure Captions" concise, see a recent Coleopterists Bulletin for formatting of captions. Provide a "scale line" with figures.]

Illustrations can be very space consumptive. However, illustrations of salient traits should be presented, such as genitalia. Keep them small to fit into no more than 1/3 to 2/5 of a page. This basic format is suggested for single taxon descriptions. Descriptions for multiple taxa should take advantage of increased brevity potential of text, possibly allowing for more illustrations on a case-by-case basis. In general, consider a single page for each taxon, or average for multiple taxa.

[Repeat all new taxa under the heading "**Accounts of Taxa**", each with a one page limit, or distribute text and illustrations over the same number of pages, as there are new taxa, if combining all illustrations onto one or more plates.]

Acknowledgments

[If necessary here, include a concise statement, otherwise put these on the web page.]

Literature cited

(If any given, use standard Coleopterists Bulletin format)

Summary

We expect that the combination of validation of names through minimal publication space combined with elaborated descriptive web site enhancement, color images of taxa, illustrations of distinctive attributes, and up-dateable INBio 'on-the-fly' GIS maps to be a better way to record the fauna than the often delayed traditional (fixed and expensive) approach on paper. We believe we have no choice, as the statistics prove. It has taken 242 years to publish 1.7 million names of organisms. At this pace, it will require 1,224 years to describe and publish a conservatively estimated remaining 8.6 million species of insects! What if there are really 30 million species? The current pace is clearly not acceptable!

With our recommendations, manuscript preparation time is greatly reduced, publication is expedited, and publication costs, in the Costa Rican project, are guaranteed from the contractor. In combination with the use of web site opportunities for expanded taxon treatment and illustrations and images, we believe that taxonomic description writing and name validation should no longer be an inhibition to biodiversity inventories.

Summaries of all species web pages for a genus or for an area can be combined with identification keys to make a monograph or faunal treatment. These in turn can be made available on the web or on digital media, or both.

Both for scientific knowledge and wise use of natural resources for humankind, we need organized and retrievable information on what species are out there in nature's factories, where they are, what are their limits, and what they are doing . . . **not later,** but **now** (Janzen pers. comm.).

Acknowledgments

We especially thank F. Christian Thompson, who has given much thought to the topics we discuss here, as well as served our community well on the

International Commission of Zoological Nomenclature. We also thank the following entomologists for critically reviewing our concepts and/or early drafts of this paper: R. Anderson, G. E. Ball, J. Brown, Y. Camacho Garcia, D. H. Kavanaugh, F. T. Hovore, W. Moore, M. Pogue, A. Solis, A. Solis.

Literature Cited

Arnett, R. H. 1970. Entomological information storage and retrieval. The Bio-Rand Foundation, Inc., Baltimore, MD.

Blackwelder, R. E. 1944–1957. Checklist of the coleopterous insects of Mexico, Central America, the West Indies, and South America. Bulletin of the United States National Museum, No. 185, Parts 1–6.

Brown, W. L. 1961. An international taxonomic register: preliminary proposals. Systematic Zoology 10: 80–85.

Clark, W. E. 1993. The weevil genus *Neomastix* Dietz (Coleoptera: Curculionidae, Anthonomini). Coleopterists Bulletin 47:1–19.

Darlington, P. J. Jr. 1971. The carabid beetles of New Guinea. Part IV. General consideration; analysis and history of fauna; Taxonomic supplement. Bulletin of the Museum of Comparative Zoology 142:129–337.

Eldrige, N. 1998. Life in the balance: humanity and the biodiversity crisis, Princeton University Press.

Erwin, T. L. 1972. Review: the carabid beetles of New Guinea, by P.J. Darlington, Jr. Systematic Zoology 21:343–347.

Erwin, T. L. 1982. Tropical forests: their richness in Coleoptera and other arthropod species. Coleopterists Bulletin 36: 74–75.

Erwin, T. L. 1997. Biodiversity at its utmost: tropical forest beetles [pp. 27–40]. *In:* Biodiversity II. Understanding and protecting our biological resources (M. L. Reaka-Kudla, D. E. Wilson, and E. O. Wilson, editors). Joseph Henry Press, Washington, D. C.

Erwin, T. L. 2000. Arboreal beetles of Neotropical Forests: taxonomic supplement for the *platyscelis* group with new species and distribution records (Coleoptera: Carabidae, Lebiini, Agrina). Coleopterists Bulletin. 54:90–119.

Flowers, R. W. 1997. Revision of the genus *Cayetunya* Bechyné (Coleoptera: Chrysomelidae, Eumolpinae), with descriptions of three new species. Coleopterists Bulletin 51(4):384–399.

Gaston, K. J. 1991. The magnitude of global insect species richness. Conservation Biology 5:283–296.

Hammond, P. 1992. Species inventory [pp. 17-39]. *In:* Global biodiversity: status of the earth's living resources (B. Groombridge, editors). Chapman & Hall, London.

Hodkinson, I. D., and D. Casson. 1991. A lesser prediction for bugs: Hemiptera (Insecta) diversity in tropical rain forests. Biological Journal of the Linnaean Society 43:101–109

Janzen, D. J. 1997. Wildlife biodiversity management in the tropics [pp. 411-431]. *In:* Biodiversity II. Understanding and protecting our biological resources (M. L. Reaka-Kudla, D. E. Wilson, and E. O. Wilson, editors). Joseph Henry Press, Washington, D.C.

von Linné, C. 1758. Systema naturae per regna tria naturae secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis, ed. 10, vol 1, 823 pp. Holmiae.

Laurance, W. F. and R. O. Bierregaard Jr., 1997. Preface. A crisis in the making. *In:* Tropical forest remnants: ecology, management, and conservation of fragmented forests (W. F. Laurance, and R. O. Bierregaard Jr., editors).University of Chicago Press.

Lee, C., and M. A. Jäch. 1996. Review of the genera *Eubria* Latreille and *Microeubria* Lee and Yang (Coleoptera: Psephenidae, Eubriinae). Coleopterists Bulletin 50(1): 39–51.

Lovejoy, T. E. 1980. A projection of species extinctions [pp. 328-331]. *In:* The Global

2000 Report to the President (G. O. Barney, editor). U.S. Council on Environmental Quality, Washington, D.C.

May, R. M. 1990. How many species? Philosophical Transaction of the Royal Society of London (B) 330:293–304.

Miller, W. V. 1995. Two new species of *Heterocerus* Fabricius from Mexico (Coleoptera: Heteroceridae). Coleopterists Bulletin 49:249–252.

Moron, M. 1999. Four new species of *Phyllophaga* Harris (Coleoptera: Melolonthidae, Melolonthinae) from southeastern Mexico. Coleopterists Bulletin 53:377–387.

Nelson, G. H., and T. C. MacRae. 1994. *Oaxacanthaxia nigroaenea* Nelson and MacRae, a new species from Mexico (Coleoptera: Buprestidae). Coleopterists Bulletin 48(2):149–152.

Ødegaard, F. 1999. Host specificity as a parameter in estimates of arthropod species richness. Dr. of Science Thesis, Norwegian University of Science and Technology, Tronheim.

Raven, P. H. 1988. Our diminishing tropical forest, [119-122]. *In:* Biodiversity (E. O. Wilson, editor). National Academy of Sciences Press, Washington, D.C.

Sforzi, A., and L. Bartolozii. 1993. A new species of *Stratiorrhina* Pascoe from Malaysia and Borneo and description of the female of *Eterodiurus singularis* Senna (Coleoptera: Brentidae). Coleopterists Bulletin 47:293–300.

Stork, N. 1988. Insect diversity: fact, fiction, and speculation. Biological Journal of the Linnaean Society 35:321–337.

Thompson, F. C., and A. C. Pont. 1993. Systematic database of *Musca* names (Diptera). Koenigsten, Koeltz Scientific Books. 221 pp.

Whitmore, T. C. 1997. Tropical forest disturbance, disappearance, and species loss [pp.3-12]. *In:* Tropical forest remnants: ecology, management, and conservation of fragmented forests (W. F. Laurance and R. O. Bierregaard Jr., editors). University of Chicago Press.

Wilson, E. O. 1988. The current state of biological diversity [pp. 3-18]. *In:* Biodiversity (E. O. Wilson, editor). National Academy of Sciences Press, Washington, D.C.

(Received and accepted 27 April 2000; full page charges borne by the author.)