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Biodiversity and biosystematic research in a brave new 21st century information-technology world

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Abstract
A variety of challenges to biodiversity and biosystematics research are discussed. Despite escalating estimates of the biodiversity of the planet, resources being devoted to advance this knowledge have been in decline. Despite the proliferation of information technologies, the focus of knowledge has frequently shifted to making existing information readily available rather than generating new knowledge. The principles of authorial responsibility and of explicit documentation of knowledge are under siege. The shortfall of investment in training, research, and collections management (the "taxonomic deficit") has led to a "taxonomic impediment" to ecological research, at a time when rates of extinction appear to be rising dramatically. The contents of the present volume represent stepping-stones of biodiversity research – a discipline vital to the future of life on the planet.

Keywords
Coleoptera, biodiversity, biosystematics, extinction, taxonomic deficit

Introduction

The Earth is a remarkable place, harbouring a multitude of different life forms – an astonishing number of which are insects. Many lay people are surprised to discover that the the scientificestablishment does not know how many species of organisms exist. In fact, scientists can't even agree on an estimate. Raven (1992) wrote that, "We cannot even estimate the number of species of organisms on Earth to an order of magnitude, an appalling situation in terms of knowledge and our ability affect the human prospect positively. There are clearly few areas of science about which so little is known, and none of such direct relevance to human beings."

Although to date, upwards of 1.7 million species of organisms have been described, estimates of the number of species on Earth ranges from ten million to upwards of one hundred million (Ehrlich and Wilson 1991). In the Coleoptera, Erwin (1982) estimated that there were approximately 8,150,000 species of beetles in the tropics alone; and estimates of the total number of insect species range from 1.87 to 80 million (Evans and Bellamy 1996).

We also know remarkably little about many of these species; what they eat, where they live, and how they conduct their lives. Even in Canada, a relatively well-studied and not overly biologically diverse country, there are great gaps in our knowledge. Danks (1978) estimated that of approximately 66,498 species of insects likely to be found in Canada, 32,826 (49%) are unrecorded or undescribed. Clearly, the state of knowledge is even at an even lower level in the many less studied and more biologically diverse tropical countries. This lack of knowledge about our world, coupled with the recent unparalleled surge of technological advances in information technologies, carries with it the seeds of concern for as Alexander Pope wrote in 1709 "A little learning is a dangerous thing".

Information is more readily accessible that it has ever been. The Internet is in large measure responsible for this. One can go online and access literature, photographs, databases, reports, etc., all within a matter of minutes – if not seconds. But such information has its limits, determined in large measure by the time and resources that are available to digitize already existing information. But is a reliance on the Internet a wise decision when it comes to information retrieval? Frequently, we hear younger people complain that if they can't find information online, then it must not exist. University educators complain that reports written by students cite only those resources available on-line, and that many contemporary students don't know what a library is or how to use it. Capacity for storage of information is virtually limitless, and the speed at which can be accessed is almost immediate. Consequently, the focus of knowledge has often shifted to making information more readily available, rather than generating new information. While digitizing the Biologia Centrali-Americana (EBCA 2006) was a remarkable achievement, it must not be forgotten that this work only scrapes the surface of biological diversity in Central America, and that many more generations of work will be required before, for example, we have a complete knowledge of beetles that feed on palms in Costa Rica. However, such gaps in our knowledge are frequently forgotten. And therein lies the concern.

It must also not be forgotten, that not everything available in the electronic domain is discernibly true (or false). Many sources of information online are not refereed and quality control may be minimal or non-existent. Citations are frequently not provided to make clear the sources of information, there is a proliferation of anonymity, and documents can be (and frequently are) revised rapidly and frequently. The enormously popular and successful Wikipedia (Wikipedia 2009), which now has implementations in 266 languages (the largest of which, in English, has over 2,938,000 entries), is essentially anonymous. There are over 75,000 active contributors who "do not need specialized qualifications to contribute … as long as they do so within the Wikipedia's editing policies." Increasingly "cited" in many contexts, the Wikipedia is diametrically opposed to the scientific tradition of knowledge, which stresses authorial responsibility and a clear and identifiable pathway of its origins and evolution.

Nevertheless, there is a tacit assumption among many lay people, that the vast amount of information presently available means that the task of discovering and understanding our world is nearing completion. In fact, as the popular aphorism has it, the more we know, the more we realize we don't know. Unfortunately, such popular misperceptions appear to have percolated into the strata of decision making, funding, and future policy direction for science and technology. Too often, there is an emphasis on modes and methods of presentation, and not on discovery – something increasingly apparent in granting agency guidelines for the preparation of proposals.

In the United States, the space agency NASA has an annual budget of $17.6 billion to, "understand and protect our home planet; to explore the universe and search for life; to inspire the next generation of explorers." What the collective budget might be for studies in the natural sciences in the United States is uncertain, however for National Science Foundation it is approximately $6 billion annually. This is roughly one-third that of NASA, yet we don't even know *if* life exists elsewhere.

Furthermore, coincident with the dearth of financial resources devoted to biodiversity and biosystematic studies in much of the world, there is also an ever-diminishing pool of human resources to undertake such research. In past decades there has been a dramatic "de-emphasis" of training in disciplines such as systematics and taxonomy in the context of university education, in favour of disciplines such as molecular biology and genetics. Many university biology graduates are unable to recognize almost any living organism to the level of species, and have seldom, if ever, used a dichotomous key. Furthermore, some graduate students might not even be able to properly classify the organisms they study. The ballooning estimates of the global number of invertebrate species has lead to a realization that the effort required to describe and classify them, is vastly in excess of the taxonomic resources (human and financial) that are currently available (Lawton et al. 1996). This shortfall of investment in training, research, and collections management has been termed the "taxonomic deficit" which inevitably leads to a "taxonomic impediment" to applied and theoretical ecological research.

The need is particularly acute given that anthropogenic activities are currently bringing about the extinction of species at a very rapid rate. For instance, May et al. (1995) calculated that expected species life-spans of birds and mammals in the contemporary period are 2–3 orders of magnitude shorter than average species life-span in the 1–10 million years BP timeframe as deduced from the fossil record, a situation that Ehrlich (1995) called a "species extinction crisis."

Efforts like the present volume are contributions to casting our attention to a world where we know life does exist, and an important reminder of the importance of allocating resources in exploring the biodiversity of the planet Earth. This special issue of Zookeys on the Biodiversity, Biosystematics and Ecology of Canadian Coleoptera, builds upon the body of papers contained in the first issue of the same title. The present contributions cover taxonomic groups in families such as the Cerambycidae, Gyrinidae, Haliplidae, and Staphylinidae; they include biosystematic papers that describe new species and review particular taxa; they survey the biodiversity in regions of Canada, or at particular sites; investigate functional ecological groups such as saproxylic beetles and their contribution to the dynamics of forest ecosystems; and provide illustrations of the how faunal inventories can contribute to a zoogeographic understanding of phenomena such as latitudinal gradients in species diversity, and the geographic basis for proportionate faunal composition. These individual contributions are the stepping-stones of biodiversity research – a discipline not only of value for its own sake, but as is increasingly clear, vital to the future of life on the planet and hence of the human enterprise itself.

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