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What Does Tropical Society Want from the Taxonomist?

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Preamble

This chapter will mean different things to different people. Not all generalizations about the interface between systematics and the user apply equally to all taxa, to all institutions, to all regions of the world, to all subsets of taxonomists. My examples are meant to clarify a point and not to be an attack on the chosen example. It is a safe bet that I know next to nothing about the taxonomic status of your particular taxon or your own personal efforts to alleviate some of the problems mentioned here. If some of the attitudes or ideas expressed here are objectionable, instead of despairing, accept the challenge of coming up with a better solution to the general problem of what to do to ensure that we don't lose most of tropical biodiversity in the next five decades.

Introduction

The wording of the chapter heading is the message. I do not ask 'What does the taxonomist have to offer tropical society?' Tropical society's taxonomic needs recently have been, can be and should be a major rejuvenating force in systematics.

Tropical society wants, first and foremost, for the taxonomist to give it a cleaned up naming system, a cleaned up and workable set of Latin binominals and manipulation mechanisms for filing, comparing, searching, recording and working with the species-level units that constitute the backbone of the bountiful

biodiversity resource of tropical nations. Such a gift from the systematics community will give tropical societies the framework on which to hang and organize its biodiversity management, research, production, needs and aesthetics. Such a gift will position systematists quite centrally in the social explosion that is sweeping across the developing tropical nations.

In the majority of tropical countries the opportunity still exists to cause 5–20% of the national territory to become a conserved wildland that is highly valued, and therefore retained into perpetuity, for the diverse products of its wildland biodiversity. This means the retention and legitimization of 90% or more of the world's extant biodiversity. This means that we stop thinking about a country as divided into 'conserved wildlands' and 'production areas' and start thinking about a country as divided into two kinds of production zones, each with different products.

Placing conserved wildlands into sustainable and non-destructive production consists of three roughly consecutive steps. First, some wildlands need to be saved.This is most commonly manifested in a national park system. But one needs to know very little of taxonomic specifics to take this step. Second, you have to know what is in the conserved wildlands. This knowledge is not so as to protect them directly from poachers, fire, or ecotourists. This is so that society can know what is there, this is so that biologists and administrators can plan how to use their genes, chemistry, viewing populations and other products without destroying them. This is to produce an annotated catalogue for the warehouse and keep it well stocked. Third, you have to put wildland's products to work. This demands a biologically literate society and economy, a society and economy that can rely on the products form the conserved wildland.

Contemporary systematics is the language for the basic managerial, intellectual and scientific framework for non-destructive production from conserved wildlands. Without systematics, tropical conserved wildlands are little more than verdant countryside containing big trees, showy birds and woolly mammals, a biodiversity that humanity has handled with common names and lay concepts since time began. This may be all right in botanical gardens and zoos but it constitutes less than 1% of tropical biodiversity.

But – and this is a large but – systematics is like every other human guild. For more than two centuries, systemics has evolved its knowledge, technology and goals in response to a somewhat different set of social circumstances from those of a contemporary tropical developing society that recognizes the managed biodiverse wildland as one of its productive sectors. Here I examine a tropical national biodiversity inventory as something that a tropical society needs from the systematics community, the sorts of adjustments this need asks of systematists, and what this opportunity offers to systematics.

A National Biodiversity Inventory

Why go to the expense and effort to conduct a tropical national biodiversity inventory? Of what use is a list of species? Does it matter how many species are on the list or even whether they occur in that country?

It doesn't matter how many species are on the list; every tropical country with remaining wildlands of substance has hundreds of thousands of species. They will either become extinct or they won't. The importance of knowing whether they occur in the country is directly proportional to how much is known about them, rather than due to their presence in the list. The list of species is a by-product of an inventory – not the goal of the inventory. The list is the index in the shopping catalogue. The list is one of many ways to signal the existence and whereabouts of knowledge of what is in the greenhouse, the warehouse, the corporation's inventory.

So, when a tropical country asks for a inventory, it is not asking for a list of its species *per se*. It is asking for the building of a knowledge and reference system. For this system, a species list will appear as a by-product and index.

So, what is an inventory? At its minimum it is a taxonomically clean specimen and information data base that indicates at least one place in the country where a species can be found. As the country's biodiversity is studied and used by all walks of society, the inventory will come to be ever more rich in information on species' geographic ranges, habitat ranges and natural history (including references to whatever literature exists). The inventory will become taxonomically cleaner as a continent's biodiversity is studied and used by all walks of society. Other countries' inventories, new monographs, new biological information, cladistics, etc., will be the mechanics of this clean up.

What is the alternative to an inventory? As each species comes to be of interest or concern to someone in society, at that moment do whatever taxonomic and ecological homework seems to be necessary so that a lack of taxonomic or ecologic understanding does not impede action. We must be frank. Much of the interaction between extra-tropical society and biodiversity has been based on this principle. Much of the contemporary dwindling of interest in taxonomy in extra-tropical countries has its roots in this principle. But it is one thing when the biodiversity to manage is a single crop pest and two biological control agents, and quite another when the biodiversity is 300 000 species of insects being sampled for their defensive chemistry. And if the fate of a tropical country is to be one monomorphic agroscape, as is for example China, Haiti, Holland and El Salvador today, then a non-inventory methodology may be adequate (especially if it allows us to put more effort into the tropical countries that see something more interesting for their populace than rice fields, cotton fields and anthrodeserts).

National or Regional?

The actual unit of action for a tropical inventory may be anything from one country to a complex of countries that blanket some relatively natural geopolitical or biopolitical unit. Efforts such as those described here have the greatest chance of success if initiated under loving care and feeding by one country, but once established are quite likely to grow to encompass neighbouring countries and thus become regional by action rather than by political decree.

What Should Be the First Products of a National Inventory?

Identification guides for the species within a major taxon

When the systematists involved feel that they have better than 90% of the country's species in hand for a taxon, the taxon is ready for an identification guide. These should be compilations in formats appropriate to the in-country user community and to the ways that the guides would be used (field guide, laboratory guide, hard copy, CD-ROM, HyperCard stacks, etc.). The language should be that of the in-country user community, and it is highly desired that the guide be published simultaneously in English.

An identification guide should begin with a description and discussion of the natural history of the taxon, followed by a review of its overall degree of taxonomic cleanliness. Colour photographs of the species should be included wherever taxonomically useful, and drawings or black and white photographs otherwise. Each species should be represented by a block of information containing the following.

1. The most current Latin binominal, and common names if there are any; lacking common names, the Latin binominal becomes the common name as well.
2. Synonyms.
3. A brief taxonomic diagnosis depending heavily on reference to illustrations and stressing how to distinguish the species from other similar species in the guide.
4. A brief description of its overall geographic and habitat range as known to date.
5. A detailed description of its in-country geographic and habitat range as known to date, with localities tied to a thorough map and gazetteer of localities.
6. A detailed discussion of what is known of its biology overall.
7. A detailed discussion of what is known of its biology within the country.
8. Source (literature, field notes, etc.) for each factual block of information.

Traditional keys should receive minimal use, being replaced by pictorial keys and illustrations in almost all cases. Descriptions of new species should be published

in the traditional places for these, rather than in the identification guides.

Production – publication and other duplication processes – should be facilitated, if not completed, through desk-top publishing at the national biodiversity management institution. In-country publication is essential to ensure lowest prices and availability of the guides. Prices should be at cost. However, some of the information gathering may reasonably be viewed as part of the cost. On the other hand, it is also highly appropriate to subsidize the process as a way of maximizing the flow of the guides into the general populace.

Reference collections

The national reference collections, and their computerized associated specimen data, are the baseline working reference for the identification guides. These collections will also be used by later generations of taxonomists and biologists to verify identifications based on the identification guides, or sometimes to do the direct identifications. The reference collections are simultaneously the voucher specimens for the inventory locality data and for the identifications themselves. And even the identifications in the reference collection will shift somewhat as further studies reveal sibling species and polymorphic species that have been excessively lumped or split.

The specimens are also a massive data base for questions of intra- and interspecific geographic variation in morphology, genetics, body chemistry, etc. Species and localities should be represented by long series, specimens that can be freely sacrificed in later years and centuries for chemistry, DNA and other uses unimagined today. While these specimens would not normally be in large enough numbers that they themselves could be of direct commercial value, research based on small samples of them could well be. The reference collections should not be confused with collections of vouchers for particular studies, vouchers that must be maintained to verify the names used in those studies.

The source of the national reference collections should be the collecting and sampling activities in the national inventory process. This process is carried out by parataxonomists and national curators, in collaboration with the international taxonomic community. The care of the reference collections, and their curatorial methodologies, should be state-of-the-art for the preservation of biological specimens into perpetuity.

Each species with a Latin binominal attached to it

Early in the inventory process it is commonplace to use codes for what appears to be species. However, by the time that an identification guide is published or otherwise made available there should be a formal Latin binominal attached to what is believed to be a species. Generic, tribal and subfamilial assignments may shift with time and greater analysis and knowledge, and synonymies will result in name changes, but experience has been that the user community can accommodate

to these formalized shifts far better than they can work with an ocean of species known by names such as 'the green shiny one with a red dot that sometimes eats trompillo' or '*Desmia* species 67'.

This part of taxonomic housecleaning will demand a lot of research papers with titles something like '47 new species of chrysomeline chrysomelids from Costa Rica'. These papers should be constructed, and their primary and secondary types distributed, with the thought in mind that their contained information will be used primarily to produce the national identification guides, aid in the later production of other identification guides for other tropical countries, and contribute to eventual monographs and cladistic analyses. For example, short descriptions and wide distribution of many paratypes may be much better than lengthy descriptions and micro-morphological studies done at the time. These descriptive papers should be in English, and thus maximally international in user-friendliness, rather than in the (perhaps other) language of the identification guides and their back-up data bases.

National administrative and technical staff

It is necessary to have a body of nationals who are philosophically and technically capable of biodiversity information management in an institutionalized administrative home that generates biodiversity products, uses these products, and generates more advanced inventory processes and products.

The national administrative and technical staff who conduct the national inventory – ranging from the parataxonomists to the curators to the directorate – constitute a nuclear human resource in the development and management of the nation's biodiversity resources. These persons have their roots in many different national and international traditions, but now form a novel institution that is neither museum, private collection nor government bureaucracy. It is a private, non-profit, public-interest node in the information flow from the nation's wildland living biodiversity to the final appreciators and consumers in-country and internationally.

As the national inventory nears completion, as well as long before this date to a lesser degree, this self-perpetuating cluster of human resources will find itself specializing in the gathering of biodiversity information – natural history, ecology, behaviour, etc. – directly from the nation's wildlands. Simultaneously, it will find itself immersed in the aggressive dissemination of this information, and associated samples, into the society-wide user community. This community can always use more awareness of what biodiversity products are potentially available.

The incorporation of the developed world's systematics community in the tropical development process

The international taxonomic community plays an extremely important role in

technical and philosophical guidance in the in-country formation of a national inventory. This is true technology transfer. But to do this, the international taxonomic community must abandon or diminish some of its own cherished taxonomic traditions and lifestyles, and put its abilities to work facilitating the process described here – a process that has much in common with the last two centuries of taxonomic work, but also differs significantly. Not all persons and institutions in the developed world will care to participate, but those that do will be an experienced body of 'new taxonomists' who will both have many decades of productive and appreciated opportunity ahead of them, and even, perhaps, be able to initiate some sort of similar process in their extra-tropical countries.

How Long Should it Take?

In a tropical country or small region where only 10–40% of the land is still wildlands, society has 10–15 years to demonstrate that its wildland biodiversity is a material and intellectual resource worthy of incorporation into the socio-economic fabric of the country. If the inventory is not complete and also well incorporated by then, the wildlands will probably be ploughed under by expanding population pressures and the disappearance of the economic inviability of tropical habitats, as biotechnology designs plants that can produce crops on what are viewed as the 'worst' soils and microlivestock that can eat virtually anything. In reply to the frequent comment that it is impossible to inventory several million species in a decade, my comment is that we either add in the resources and the mind-set to do it, or we kiss tropical biodiversity goodbye.

For those countries with less than about 10% of the land still remaining in (conservable or restorable) wildlands, it might well be best not to embark on the inventory process as outlined here, but rather to view the country's few bits of remaining wildlands as national treasures to be restored and saved at almost any cost, a cost most likely to be paid by international connoisseurs of tropical biodiversity. Here, salvage collecting for living and dead gene banks may also be highly appropriate.

In those few cases where a tropical country still has more than 50% of its national terrain in wildlands, one can enter into the inventory process on a scale of several decades, or one can wait a decade and hope that (i) we can do a quicker and better job with those countries later through experiences gained today; (ii) the world might even evolve into a global level of understanding whereby such areas are conserved largely through the same forces that would today conserve 50 km^2 of English original forest, if there were any.

What is not an Inventory?

Ecological studies

Ecological, behavioural, etc., studies of the species being inventoried are, sadly, largely out of place in the inventory process. A kind of scientific triage is in order in these tight times. If ecological studies are to be funded and conducted, it should be where an explicit need in the biodiversity conservation process is being met and where the funds are clearly originating in that need (e.g. institutions funding ecological research, payback from commercialization of ecological information, etc.).

When mixed into an inventory, ecological sampling schemes almost invariably slow down the inventory process, and use funds that could have been used to speed or broaden the inventory. Once the identification guides are in hand, then the biodiversity package is available for all to work with – cladists,monographers, ecologists, ecotourists, school groups, biodiversity prospectors, etc. Ecotaxonomic sampling is a particularly difficult tradition to abandon in favour of inventory. Somehow it has become regal 'to know what fraction of the fauna is present in a sample'. However, it is extremely difficult to identify where in the tropics such a sampling scheme is in fact needed for commercialization, straightforward conservation, education, etc.

To be blunt, a country does not want to know what fraction of the moth fauna comes to a black light. It wants to be able to identify the moths at the light so that it can begin to make a multitude of intellectual and commercial uses of them. This viewpoint is particularly difficult for ecologists, since they quite understandably want to apply their professional abilities to the general conservation problem at hand. Quite frankly, however, for the next several decades in the tropics, their energy could be better spent working on the multitude of ways that ecological understanding contributes to the flow of biodiversity information into the general populace and on specific ecological studies that enhance the non-destructive use of conserved wildlands by in-country society.

Cladistics

Establishing the phylogenetic relationships within the species-rich package of tropical biodiversity serves a very real organizational function. If these relationships are accurately established, the taxonomic framework is itself a highly functional tool in allowing the biologist to infer unknown traits of a species. And the more we get to know about certain species, the more effective is this tool. However, cladistic relationships are far easier to establish accurately in data-rich rather than in data-poor groups. This entire package of activity is definitely of second priority to the collection process and the identification guides. As with taxonomic monographs, cladistic analyses are far higher in quality when they contain the species-level input from several different national inventories.

Monographs

The systematist can work for decades, accumulating information throughout the range of some major taxon, and eventually publish a definitive monograph. This research style is, however, antithetical to a national inventory as envisioned here. It is far better to put several years of effort into establishing a detailed taxonomic and biological understanding of the focal taxon in several species-rich countries spread throughout the range of the focal taxon. These nodes of understanding will generate far more information overall about the focal taxon than the single taxonomic specialist could have gathered in several decades of work. With these processing centres in place, the taxonomist is in an excellent position to generate a final monograph. We might even begin to see multi-authored monographs, the product of real collegial activity between the international taxonomist and the specialist curators in the countries being inventoried.

PhD degree programmes

Put most simply, the developing tropical countries simply do not have the luxury of funds, time and human resources to bundle up their best people and send them off to spend decades in systematics PhD programmes in the extra-tropical countries. It must also be recognized that the PhD was a degree invented to meet a societal need and a university self-replacement need that does not fit particularly well in the developing tropics of today. We can all look forward to the day when a PhD in biodiversity information management or its analogue is a core portion of tropical developed society, but if we orient training today in that direction, there won't be any biodiversity information to manage in two decades.

How to Conduct a Tropical National Inventory

The national inventory process described here has two primary roots. The first, and very familiar to all international taxonomists, is the knowledge base in the minds, collections, literature and catalogues of the established international community of taxonomists. With a few exceptions in medicine and agriculture, this root has its primary origin in the search for taxonomic understanding *per se*. This search is on a nearly infinite time line and driven largely by the very great curiosity about biodiversity held by almost every international taxonomist. Not only does the international taxonomic community contribute to the national inventory process as mentor and with techno-philosophical guidance, but it can also contribute its very great information base and the gigantic taxonomic framework that it already has in place. It is this framework on which the Latin binominals and supra-generic names of a nation are hung.

Second, and more disruptive to the *status quo*, is a massive nation-wide collecting and specimen preparation effort carried out by national parataxonomists

and curators. They are trained for these purposes and hired from the appropriate sectors of society. It is they who bring in the actual specimens and get them into a format that leads to identification guides, reference collections, samples, etc. Again, the international taxonomist plays the role of mentor to apprentices, contributor to planning and sampling strategies, collaborator in the science and overall stimulant. His role needs to be primarily in-country and in the national language. When in his home institution, he is primarily a mentor to the apprentice in the specific processes of the inventory as well as doing taxonomy in collaboration with the national curators.

How Do Administrations in the Extra-tropical Systematics Community Become Involved and What Is the Cost?

The global mission

Administrations concern themselves with their institutional mission. This mission is traditionally defined by the society served by the institution. The first, the most difficult, and the most powerful step for an extra-tropical taxonomic institution or programme is to move from a provincial to a global outlook. The irony is that the large biodiversity institutions – national museums, large private museums, large universities, the USDA, CSIRO, IIE, etc. – have for more than a century been conducting a haphazard and opportunistic inventory of the tropics. But it has been focused and guided by the personal curiosity of staff or by the immediate economic concerns of the tax base, directions that change with the coming and going of individuals and the fickle fates of pest problems.

What is needed – desperately needed – is that these large administrations accept as a portion of their institutional missions a global responsibility for participation in the development of in-country biodiversity understanding in the tropics. This acceptance may be manifest either in facilitating their individual staff members to participate in the various focused national inventory efforts that are springing up across the tropics, and/or in guiding a portion of their institutional efforts in the direction of one or several of these national inventories. They can even help by being very public about their involvement.

On the one hand this acceptance will mean a material cost to the institution. Only the institution can evaluate to what degree it is compensated by the consequences – an increased global climate favouring the funding of biodiversity research, staff increase in morale through accepting a direct socially acceptable challenge, enormous multiplier effects in the form of nationals conducting their part of this extremely collaborative effort, long-term salvation of most of tropical biodiversity into perpetuity, etc. On the other hand, the bulk of the cost of tropical biodiversity inventory will be born initially by international development organizations and processes (as global capital investment), and by the tropical governments themselves. The annual operations costs will gradually be met by

the actual intellectual and economic gains from properly managed biodiversity information from conserved tropical wildlands. That is to say, no one expects that the world's established taxonomic institutions will bear the direct cost of tropical national biodiversity inventories.

And how much time can the extra-tropical institutions expect to have to participate in this kind of global process? Until the human war against tropical wildland biodiversity is over. This will be one to five decades, depending on the country. But I also suspect that by the end of this process the major biodiversity information management institutions will constitute a global network that will be the most intense in the tropics, and that today's strong balance towards extra-tropical institutions will no longer exist.

Convenios and agreements

When tropical taxonomy moves beyond being a collection of the activities of individual taxonomists, it is time for formal agreements of collaboration to begin to appear between the extra-tropical taxonomic institutions and the various national or small region inventory programmes. The most salient feature of such agreements is that they be written in such a manner that they facilitate the extra-tropical institution in its interactions with its funding base and in planning its long-range initiatives, and that they give the tropical country – justifiably nervous about its powerful northern neighbours – a proof and feeling that this is a truly collaborative effort.

Assigning taxonomists to such an effort

The interaction between the international taxonomist and the developing biodiversity inventory and its staff is sufficiently delicate that it is very important that all participants feel very content with their involvement. The adjustments are all very difficult in the best of times (learning new languages at middle-age, spending long times away from home without bringing back the specimens (booty) formerly associated with 'a trip to the tropics', co-authoring papers, sharing specimens, reduced rates of monographic publications, sharing one's lifetime memory bank of taxonomic information, living by others' schedules, formalizing one's work into something computerizable, etc.), and not something that can be easily assigned.

It has been the experience to date that making time and minimal resources available for those who want to participate is adequate to attract a sufficient number of international taxonomists to the tropical national biodiversity inventory process. An extra incentive is the case where an institution can assist with the costs of occasional working visits to the international taxonomist's home institution by nationals in apprenticeship or other forms of collaboration.

What Does the Taxonomist Have to Offer Tropical Society?

Tropical countries want taxonomists to join the teacher workforce that is putting biodiversity literacy into tropical intellectual and economic life. The taxonomist's alphabet, grammar and syntax offer us a far greater biological literacy than that ever held by our ancestors, who in their time had a quite elegant understanding of the wildlands in which they evolved. The contemporary taxonomist is not conscious of his fortune. When he walks through wildland nature, he can read it. Every insect is the title of a book. Every tree is a word in a paragraph. Every bird is a paragraph in a chapter. Humans can once again learn to read tropical wildland nature. Then it will no longer be a green oozy mass to be pummelled into the mud. Then it will be a cascade of books.

Hymenoptera?

And what does all this have to do with Hymenoptera? They are no exception.

Postscript

Even as I write this, my message is becoming obsolete. I believe that I am observing an extraordinarily rapid shift in attitudinal emphasis among taxonomists towards making their activity user-friendly. This shift is in fact quite amazing and impressive. The nature of taxonomic work is in itself highly conservative: it appears to select for practitioners with a proclivity for being slow to change – it doesn't.

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Suggested Additional Reading

Aldhous, P. (1991) 'Hunting license' for drugs. *Nature* 353, 290.

Eisner, T. (1990) Prospecting for nature's chemical riches. *Issues in Science and Technology* Winter 1989–1990, 31–34.

Erwin, T.L. (1991) How many species are there? Revisited. *Conservation Biology* 5, 330–333.

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

Hovore, F.T. (1991) INBio: by biologists, for biologists. *American Entomologist* 37, 157–158.

Janzen, D.H. (1987) Oh, I forgot about zoos. *Oikos* 48, 241–242.

Janzen, D.H. (1989) La biodiversidad y la sostenibilidad de Costa Rica. In: *Memoria ler Congreso. Estrategia de conservacion para el desarrollo sostenible de Costa Rica. Ministerio de Recursos Naturales, Energia y Minas.* San Jose, Costa Rica, pp. 329–337.

Janzen, D.H. (1990) Sustainable society through applied ecology: the reinvention of the village, Foreword pp. xi–xiv. In: Goodland, R. (ed.), *Race to Save the Tropics.* Island Press, Washington DC, 218pp.

Janzen, D.H. (1991) How to save tropical biodiversity. *American Entomologist* 37, 159–171.

Miller, S.E. (1991) Entomological collections in the United States and Canada. *American Entomologist* Summer, 77–84.

Reid, W.V. and Miller, K.R. (1989) *Keeping Options Alive: the Scientific Basis for Conserving Biodiversity.* World Resources Institute, Washington, DC, 128pp.

Sandlund, O.T. (1991) Costa Rica's INBio: towards sustainable use of natural biodiversity. Norwegian Institute for Nature Research (NINA). *Notat* 007, 1–25.

Tangley, L. (1990) Cataloging Costa Rica's diversity. *Bioscience* 40, 633–636.

Wilson, E.O. (ed.) (1988) *Biodiversity.* National Academy Press, Washington DC, 521pp.

Wilson, E.O. (1990) *Success and Dominance in Ecosystems: the Case for Social Insects.* Ecology Institute, D-2124, Oldendorf/Luhe.