MUSEUMS, CONSERVATORIES, COLLECTIONS:
STRATEGIES AND INFRASTRUCTURES
FOR DOCUMENTING BIODIVERSITY

Discovering, documenting and defining species:
the quest for shared programmes, protocols and principles

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The sheer scale of the taxonomic enterprise is an obstacle to conservation and science which is compounded by the deterioration of traditional taxonomy as an institutional discipline. However, major international conservation NGOs have partly obviated this obstacle by conducting their own analyses to guide investments in terrestrial biodiversity. If these analyses are correct and the investments pay off, the pressure to complete the taxonomic enterprise becomes somewhat less intense. Nevertheless, taxonomy can hugely benefit conservation in the next 25-50 years by forming an alliance with national and international conservation institutions to work on the identification of “Key Biodiversity Areas”, in particular small centres of endemism in plants, invertebrates and fish. Protocols for the responsible collection of rare material, and principles for species definition, need also to be developed and are already in a reasonably advanced state in the ornithological sector of the conservation community.

At the close of the second millennium the number of species known by formal scientific description stood at around 1.5-2 million. The number of species still awaiting such description was less certainly judged to be 4-6 million (Novotny et al. 2002), although the possibility remains that the number may be higher by an order of magnitude. Recently Soulé (1990) calculated that the number of systematists working on tropical species was roughly 1,500, and that each describes on average five species per year. If therefore we allow that the earth holds 4-6 million undescribed species, at the current rate of accretion we will need another 500-800 years to complete the inventory; or, if there are 40–60 million species, another 5,000-8,000 years.

Clearly this circumstance is wholly unsatisfactory, and needs to be remedied. However, it is not just that the speed of the systematic enterprise is so disconcertingly slow; it is also that, in many areas, for many groups and over many years, it has seemingly been getting much slower. For example, the rate of acquisition of bird skins at the United Kingdom’s Natural History Museum (formerly British Museum: Natural History) was approximately 40 for every working day throughout the one-hundred-year period 1850-1950, but by 1990 this had fallen to around 50 per year (Collar & Rudyanto 2003). In this particular case, such deceleration can in part be attributed to the dismantling of British colonial rule in many parts of the world, but there is no evidence that new national museums have continued with biodiversity sampling at rates which in any way compensate. Indeed, all over Europe and in much of the United States, major collections of bird and other specimens suffer from the same syndrome as the U.K.’s Natural History Museum, with fewer and fewer staff available to work on extending the specimen holdings or on analysing the existing material, in spite of the critical role that such material plays in providing baseline and detailed morphological evidence. (It is important to stress that continuing collecting of material serves a vital role in systematics, even in relatively well-studied groups; in the case of birds, photographs, tape-recordings, living tissue samples, ecological measurements and behavioural assessments can supplement but never fully supplant specimens as evidence.) Compounding the problem is that most such collections are experiencing inadequate levels of investment in curation, and are deteriorating badly as a result.
Unfortunately, as we all know, the same can also be said about the planet: it is not just the systematic enterprise whose circumstance is unsatisfactory and in need of remedy. Recognising how serious the situation has become for them, some taxonomists have been pressing for a new revitalisation of the great systematic enterprise, a dramatic acceleration and expansion of its work and scope, employing a “planetary-scale tool” and “cyber-infrastructure” in which bar-coding, molecular sampling and the internet will be used to create the ultimate virtual museum (Wheeler et al. 2004a). There is of course considerable value and attraction in this idea, even if it may appear somewhat far-fetched (but bar-coding is already a reality with considerable potential). However, it comes as something of a surprise to realise that this new pressure derives from the perceived need not only to understand biodiversity for the sake of being better able to save it, but also “to document those components of biodiversity that will ultimately not survive” (Wheeler et al. 2004b).

On reflection, of course, it is possible to sympathise with this aspiration: no scientist wishes to see organisms become extinct (with the possible exception of those that cause certain human diseases), but, if it is to happen, there should certainly be an attempt to discover and catalogue as much as possible of what will be lost. Even so, there is a terrible defeatism inherent in this position, and it is not something that a conservationist can easily share, particularly in the knowledge that the sum of knowledge required to create the new “encyclopaedia of life” over the next 25 years is in the region of US$3 billion (Wilson 2004). In the greater picture, US$3 billion is very little, especially over such a time-frame, and especially in comparison with the sums that get spent on “defence” and the exploration of space. Nevertheless, conservationists could do a great deal with US$3 billion, and the prospect of such sums, such energy, such expertise, being diverted for the revivification of systematics, in the name of biodiversity that (in part) will not survive the current extinction crisis, raises some pertinent questions. Is the accelerated drive to discover and catalogue another six million species any longer relevant in this crisis? Is it in any case feasible? What can taxonomy really contribute to conservation at this stage in the planet’s deterioration?

Building on the achievements of taxonomy ever since Linnaeus, several major international conservation NGOs have used information relating to species to produce important global analyses of the distribution of biodiversity. The crucial assumption behind these analyses is that the patterns of endemism generated by the species used are reflected in the biota more generally, including the many more species that are yet to be discovered. In other words, the distributions of the majority of the remaining 4-6 million species lie within areas already identified as priorities for conservation. BirdLife International has mapped concentrations of avian endemism as “Endemic Bird Areas” (EBAs) (Bibby et al. 1992, Stattersfield et al. 1998). IUCN-The World Conservation Union and World Wide Fund for Nature have jointly charted the distribution of plant richness and endemism around the world in “Centres of Plant Diversity” (CPDs) (Davis et al. 1994, 1995, 1997). World Wildlife Fund US has broken the main biomes of the world into “Ecoregions” (Olson & Dinerstein 1998, Burgess et al. 2004). Conservation International has identified threatened areas of high biodiversity as “Hotspots” (Mittermeier et al. 1999, 2004, Myers et al. 2000). Each of these exercises has its own merit and applicability, and all of them serve to inform decisions, taken both within the NGOs themselves and externally, over the priority with which particular areas of the world should be treated. EBAs, CPDs, Ecoregions and Hotspots now dominate the species conservation agenda in many parts of the planet, and there is now a crucially important move to amalgamate these agendas under the banner of “Key Biodiversity Areas” (Eken et al. 2004; see below). Through one or other of these analyses, the great majority of the critical areas for terrestrial biodiversity appear to have been identified.

If this is the case, and if the conservation community is successful in preserving representative parts of the areas that have been identified, then the need for greatly accelerated taxonomic work within them is rather less pressing. Moreover, if the conservation community is correct in its analyses, then the need for greatly accelerated taxonomic work outside these areas is also rather less pressing. (To explain this second point: areas with lower concentrations of biodiversity tend to be those with widespread, weedier species which by definition are far less at risk than those concentrated in richer areas.) My questions about the immediate relevance of the systematic enterprise are therefore real. This is emphatically not to call in doubt the relevance of the enterprise as a generality. It ought to be beyond any consideration that all biological study and all conservation depend on taxonomy, and ultimately cannot function without it. This is a permanent truth. Governments around the world need to recognise that natural history museums must have proper long-term financial investment, staffing levels that fully reflect the biodiversity of the country or region served, and a philosophical commitment as robust as that accorded to higher education in the most enlightened of states.

Nevertheless, present conditions are not particularly edifying. It is not just that museums have suffered such a withering lack of recent investment, and that scientific collecting and curation have become so marginalised by molecular studies and managerial ignorance. There is something more insidious to acknowledge: systematics and taxonomy form what is in many areas the most anomalous branch of biology, because it is the least refereed. This arises in part from the circumstance in which many smaller (and some large) museums (1) permit curators to become established for life in positions which undergo virtually no review, and (2) have founded journals in which to publish the results of in-house research which (again)
undergo virtually no review; and it also arises from the fact that (3) global expert status can so quickly be acquired by working on a previously unstudied group of taxa, thereby rendering peer-review almost impossible. Once a curator has tenure in a museum with an endowed journal, he or she may be free to pursue particular courses of research without reference to, and without refereeing by, the wider community of biologists. Consequently, for many groups of animals and perhaps plants, according to an entomologist colleague quoted in Collar (1999), “much taxonomy is intensely parochial, buried in exceedingly obscure publications, based on very small numbers of specimens and almost totally divorced from the contents of major museum collections and associated literature”.

There is, then, a real problem that the systematic enterprise has no clear agreed direction or coherence. Currently it is limping along as an extended series of uncoordinated random activities while at the same time day-dreaming of a massive reinvention of itself as the informatic engine-house of biodiversity studies. So the questions arise: what practical half-way house between these two extremes (one unacceptable, one unachievable) can serve the planet best in the next 25-50 years? And again—what can taxonomy most usefully do now to further the cause of biodiversity conservation?

I believe that the solution is for museums to work with national and international conservation NGOs—whose relevance in this matter is as yet entirely unrecognised by the Global Taxonomy Initiative of the CBD (Convention on Biological Diversity)—to develop an agenda to focus taxonomic studies on areas and groups of species which have largely been missed in the analyses mentioned above. In fact this has already happened to good effect in the recent Global Amphibian Assessment (www.globalamphibians.org), although only because the agenda was clearly set by conservation need. The future agenda for conservation-systematics partnerships should, in my view, be driven by the need to plot more precisely the global distribution of biodiversity and, in particular, to identify and profile the many small centres of endemism in plants, invertebrates and fish which remain as yet undetected (or only suspected) within and between EBAs, CPDs or Hotspots. The early identification of new areas and confirmation of the importance of known ones (which can in part be pursued through the use of mammalian and avian subspecies) will greatly contribute to the new Key Biodiversity Areas (KBA) initiative, which aims to build on similar existing initiatives and criteria for birds and plants by refining and applying a globally coherent and consistent set of criteria for the objective identification of manageable sites for conservation (Eken et al. 2004). There is also a pressing need for systematics to support conservation in clarifying the taxonomic and hence conservation status of particular taxa and groups of taxa, so that they can be confidently red-listed by IUCN; this, too, will feed the KBA process.

How is such an alliance between taxonomy and conservation to be brokered? A major obstacle is that while conservation can easily provide a small cadre of well-informed experts to work on helping to identify areas for exploration, taxonomy cannot. There is no obvious pre-existing body which can speak on behalf of the museum community. However, a group of representatives of that community could be selected on the basis of their eminence and vision, so that their authority might hold sway with a good proportion of taxonomic institutions predisposed to contribute their energies to a coherent strategy. Under the unfurling umbrella of the KBA programme, the first (consultative) phase of the museum project might last 2-3 years and be spent on identifying actual or potential centres of endemism (conservation bodies of various types pooling their knowledge with the museum community), both inside and outside existing priority areas; the second would take 15-20 years and target for field study and museum analysis all the areas identified in phase one, validating them (or not) as further KBAs; and the third, overlapping the second and undertaken by the conservation bodies in the partnership, would look at the methods to conserve the validated sites. Somewhere in the world—presumably Sweden—preparations must currently be under way for a conference to celebrate in 2008 the 250th anniversary of the publication of the first edition of Systema Naturae (not to mention the 150th anniversary of Darwin & Wallace’s lecture), and to promote the cause of systematics still further. Such a conference would be an ideal venue to showcase and formally launch a programme linking conservation and taxonomy.

It is essential to stress that not all the material used in the diagnosis of new centres of endemism would need to be collected. One of the crucial things to recognise about natural history museums today is that they are vast repositories of unworked specimens. If there were proper investment in the curation and databasing of this material, and if these databases could talk to one another, the identification of many new local centres of endemism would be merely a few clicks of a mouse away, without the need for costly expeditions which may often risk merely duplicating earlier work. It is impossible to over-emphasise this point: quite apart from failing to have sampled many areas of the planet, biologists are completely failing to make proper use of the sampling that our pioneering predecessors have already undertaken.

Naturally, however, such a programme must reassert the need to continue to collect biological material. The problem of rights associated with that material is novel and complex, and requires sensible resolution through the offices of the CBD. However, the danger that collecting might itself compound extinction risks
needs also to be addressed. An exchange between Renssen (1995) and Collar (2000) appears to have capped off an extended period of debate on the topic within ornithology, the former having proposed a set of criteria to govern number of specimens of a species to be taken at a site based on weight thresholds (weight being a rough proxy for abundance), the latter modifying these criteria to take account of various important factors including IUCN threat category and criteria. Collar (2000) also set forth a ten-point protocol which, among other things, called for (a) an international committee to act as an arbiter over the collection of threatened species, (b) a worldwide inventory of museum specimens of species threatened with extinction so as to minimise needless additional collection, (c) restraint in the collection of new species until their conservation status can be judged to be secure, (d) various types of restraint or prohibition with respect to globally, nationally and locally threatened species and those in protected areas, and (e) the establishment of a worldwide federation of collecting museums which accepts such a protocol, and polices its membership accordingly. This kind of protocol could be established across the board for plants and animals.

In recent years ornithology has witnessed another extended but more significant debate, concerning species concepts. This clearly also matters to conservation, since the use of the phylogenetic species concept is, for example, generally predicted to double the number of bird species recognised (Agapow et al. 2004), as has recently happened with primates (Groves 2001). Stability in lists of major taxonomic groupings is obviously unachievable in the immediate or medium term, but relative stability is vital to conservation, since major perturbations make it impossible to maintain intelligible and consistent red lists on which (at least in part) to base priorities, or indeed national and international laws with which to enforce protective measures (Collar 1997, Isaac et al. 2004). On present evidence the trend seems to be towards maintaining use of the biological species concept, but applying it with considerably narrower species limits than were acknowledged in the mid-twentieth century; this is certainly the position of my own organisation, BirdLife International. However, once again there is a major challenge for conservationists and systematists to work together to establish a set of practical rules to standardise the species units included on taxonomic lists (Mace 2004); and again the CBD, through its Global Taxonomy Initiative, perhaps furnishes the most appropriate forum for this.

Dialogue leading to joint programming between conservation NGOs and systematists is not generally practised, and is not generally considered worth practising. I believe this to be a terrible misjudgement. At the very least, it drives both disciplines on separate but competing trajectories in quest of funding and programmes, both making claims, independent of the other, about their centrality to the biodiversity cause. In reality, each needs the other. Conservationists, building on the work of taxonomy over two and a half centuries, have set the needs also to be addressed. An exchange between Renssen (1995) and Collar (2000) appears to have capped off an extended period of debate on the topic within ornithology, the former having proposed a set of criteria to govern number of specimens of a species to be taken at a site based on weight thresholds (weight being a rough proxy for abundance), the latter modifying these criteria to take account of various important factors including IUCN threat category and criteria. Collar (2000) also set forth a ten-point protocol which, among other things, called for (a) an international committee to act as an arbiter over the collection of threatened species, (b) a worldwide inventory of museum specimens of species threatened with extinction so as to minimise needless additional collection, (c) restraint in the collection of new species until their conservation status can be judged to be secure, (d) various types of restraint or prohibition with respect to globally, nationally and locally threatened species and those in protected areas, and (e) the establishment of a worldwide federation of collecting museums which accepts such a protocol, and polices its membership accordingly. This kind of protocol could be established across the board for plants and animals.

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