f33 Biodiversity within a species

< cichlid (pronounced *sick-lid*), distinctive populations: ESUs >

> It is really laughable to see what different ideas are prominent in various naturalist's minds, when they speak of species; in some, resemblance is everything and descent of little weight — in some, resemblance seems to go for nothing, and Creation the reigning idea — in some, descent is the key, — in some, sterility an unfailing test, with others it is not worth a farthing. It all comes, I believe, from trying to define the undefinable
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> —Darwin in a letter to Joseph Hooker, 24 December 1856.[1]

A study of cichlids in Lake Victoria finds so many "species" evolved since the lake filled after a dry spell 12,400 years ago,[2] that researchers came to value lazy days when new ones were not found. In the 1980s, Nile perch were introduced as a harvestable fish. Their depredations of the cichlid are that half of 500 species formerly identified are now extinct. Recently, overfishing activities have increased the turbidity of the lake.[3] This has placed a further toll on the cichlids' famed diversity as it is "interfering with the ability of these strongly visual fish to find their preferred bright mates. The result may be interbreeding of closely related species and loss of the more spectacularly colored forms" writes reviewer Christine Mlot in the magazine *Science News* of the article that reported this finding in *Science*, 19 September 1997. Is this reporting correct? For example, once ranked as separate Asian-deer subspecies (races), Indian muntjacs and Chinese muntjacs can't produce fertile hybrids and are now assigned to two species.

In a letter to *Science News*, Charles Masi writes: "I have a problem with the phrase 'interbreeding of closely related species.' When I was in school, the word 'species' referred to a population of animals physically capable of mating to produce fertile offspring. Ergo, if they're interbreeding, they can't be separate species." [4]

Not so, scolds Mlot: "Biologists have debated what a species is ever since Darwin's [*sic*] time. Most would probably add to the schoolhouse rule the notion of 'reproductive isolation.' That is, a collective of sexually reproducing organisms generally recognized to be a species is somehow isolated from mating with other collectives [euphemism for races], even if they are 'physically capable.' They may be isolated by a mountain range, for example, or by different behaviors or preferred habitats that prevent them from interacting. The key is that they are isolated under natural, undisturbed conditions. In the case of the cichlids, the closely related fish are isolated into breeding collectives by their different colors and feeding habits. The cloudiness of the water breaks down that isolation. For more about species, see Edward O. Wilson's *The Diversity of Life* (*Norton*, 1992, p. 38)" or look in the appendix of *Speciation* by J. A. Coyne and H. A. Orr (2004)."[5]

Masi's definition of species, often ignorantly attributed to, and surely to the once distress of the late Ernst Mayr, was clearly stated in *Histoire Naturelle* (1749-85). In this, taking his cue from Ray but disabusing his definition from consideration of how many "species" God had created "in the Beginning," Buffon provided for a purely empirical parsing:

> We should regard two animals as belonging to the same species if, by means of copulation, they can perpetuate themselves and preserve the likeness of the species; and we should regard them as belonging to different species if they are incapable of producing progeny by the same means. Thus the fox will be known to be a different species from the dog, if it proves to be the fact that from the mating of a male and a female of these two kinds of animals no offspring is born; and even if there should result a hybrid offspring, a sort of mule, this would suffice to prove that fox and dog are not of the same species—inasmuch as this mule would be sterile.[6]

Ernst Mayr in his 1942 (*Systematics and the Origin of the Species*)[7] and 1963 (*Animal Species and Evolution*)[8] accounts of species, shifted emphasis for the origin of these to "reproductive isolation," which, beginning in 1914, Erwin Stresemann had espoused as the defining property of species.[9]

Masi, unlikely to be mollified by these disclosures from on high, could yet take heart in the concept of "biodiversity," a fresh entry in the dictionary in 1986 (***Footnote f33.1***) that refers to the diversity of *distinctive populations within* a species (and replaces any need for the tarnished word "races") and allows for, Gasp! the radish hybrid (*Raphanus*) upstart that has driven its parents of two previous species (*R. raphanistrum* and *R. sativus*) to extinction.[10] Natural selection operates on phenotype to forward a genotype. This process is not evenhanded even when boundaries are thoroughly blurred for, as in a rainbow demonstrably with an infinite gradation of color, red is distinct from blue. Essential for species' preservation for ecological, economic, or aesthetic reasons, is the conservation of biodiversity. "Species extinction has a huge ethical significance," says Walter V. Reid, for by the time a species is endangered it is already ecologically or economically insignificant (in short, it is ecologically extinct).[11] But losing populations gets to the economic importance.[12] "A case in point," suggests Mlot "is the overfishing of local populations of fish, such as cod in the North Sea."[13]

Population extinctions are a concern and in number far exceed species extinctions. Of species extinctions, even if 95 percent of species are lost, Sean Nee and Robert M. May claim most of the major branches of the tree of life will persist. That is the long view (geologic time), but in human terms (lived time) Jennifer B. Hughes, Gretchen C. Daily, and Paul R Ehrlich in 1997 calculated that each species has on average 220 populations, totaling 1.1 billion to 6.6 billion populations globally and in tropical forests, they estimate 1,800 populations are lost every hour![14]

Estimates in 1998 are that only about 10 per cent of the species on Earth are known to science. And time and again, false has been the assumption that there is nothing there. In his review of *The Scientific Voyage of HMS Challenger* by Richard Corfield, 2003, Laurence A. Marschall notes: "When Challenger set sail, the prevailing wisdom was that ocean life could not exist below about 300 fathoms (1,800 feet). Yet virtually every time the dredge was hauled up from the deep, ... many weird creatures came to light."[15] A first deepsea dredge sample from 2,000 fathoms off Lisbon, Portugal, Richard Corfield notes in *The Silent Landscape*, 2004, brought up a sea lily which class (Crinoidea) of echinoderms were formerly known only as fossils. This fed into to an alternative possibility, much contemplated by Darwin, that the (supposed) unchanging (so supposed primordial), tranquil, deep seafloor would prove to be a haven for ancient life forms upon which natural selection, working to perfect life forms, had long since run its course.

The identification and inventorying of species, called *alpha taxonomy*, is labor intensive and, with little funding, remains the preserve of enthusiastic amateurs. Misnaming is rife and more than 6 million names are scattered in more than 1,000, mostly entomology, journals for what might be 1.5 million species.[16] Nevertheless, biodiversity research is grounded in alpha taxonomy. Taking cognisance of this the British government's Darwin Initiative encourages the production of user-friendly identification keys.[17] Most individuals who are currently doing alpha taxonomy are only interested in the species of their own country. Taxa identified as requiring the greatest amount of research, however, are precisely those, according to Henry Disney,[18] and for them a global perspective *is* essential.

Of 45,000 vertebrate species (mammals, birds, and reptiles) institutions could save possibly 925 kinds. And what of subspecies? 16 of 37 high-priority animals, monitored by a conservation coalition called *Species Survival Plan*, have subspecies. As "not all subspecies are equal," Oliver Ryder in 1986 urged "conservation of evolutionarily significant units (ESUs) within species."[19] The ease of sequencing DNA and improvements in family-tree analysis allowed Craig Moritz in 1994 to propose the following practical procedure to accomplish this:[20]

- Show the proposed ESUs are full, separate, branches of a family tree based on similarities (a situation referred to as reciprocal monophyly) in animals' mitochondrial DNA (mtDNA).
- Make sure that the mtDNA represents deep, strong branches. For this, the nuclear DNA should show "significant divergence" between the ESUs.

For groups that just miss ESU status under these rules, Moritz proposes a lesser category: management unit, or MU. For these, he requires only that certain versions of genes be more common in one MU than another.

Family trees are being redrawn to adjust for what Sid Perkins in 2001 has referred to as the "disconnect between physical appearance and genetic relationships."[21] Genetic markers in the DNA of animals link visually diverse animals as elephants, elephant shrews, and aardvarks, and, also, have shown the flamingo that has been with its distinct form since at least its oldest known fossil, which dates 50 million years old, is closely linked to grebes, which are diving birds that by their looks (medium sized, stocky body, long neck, small head) were thought to be related to loons.

Darwin asked why rain forests have so many species: "What explains the riot?" The question of the latitudinal diversity gradient (biodiversity gradually increases going from temperate to tropical latitudes) (***Footnote f33.2***) is old, big, and still puzzles as Elizabeth Royte recounts in *The Tapir's Morning Bath*, 2001.[22] Biodiversity studies describe diversity of: genes (as such); species (for their relative richness in different genes); and, ecosystems (for the relative richness in the different processes to which the genes ultimately contribute).

> Because we do not know yet precisely which genes or characters will be of value in the future, first they must all be treated as having equal value, and second, the greatest value for conservation will come from ensuring the persistence of as many different genes or characters as possible, as a form of insurance.
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> For example, a dandelion and a giant redwood can be seen to represent a richer collection of characters in total, and so greater diversity value, than another pair of more similar species, a dandelion and a daisy. This shows how the phenotypic characters (or the genes that code for them) could provide a 'currency' of value for biodiversity. Pursuing this idea, we will then need to maximise richness in the character currency within the conservationists' 'bank' of managed or protected areas.
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> —Natural History Museum, Cromwell Road, London. [23]

In the computer age, species names could become just codes. Yet, Pier Luigi Nimis wonders: "How many amateurs, having found a rare *L. splendens* on an old oak, will exclaim joyfully to their companions: 'Wow! Look at this! I've found X157YR22297!' I also wonder what they should say when, more cautiously, they think they've found just 'a *Lichenia*'. Surely not 'I've found something starting with X157...'."[24] ❑

Footnote f33.1 Norman Myers in 1988 designated biodiversity "hotspots" to be where there is a disproportionate number of endemic species (species that are found nowhere else) and a high rate of habitat loss. Publishing in *Nature*, 24 February 2000, Myers and other ecologists identified 25 "hotspots" that together are only 1.4 percent of Earth's surface and yet contain 44 percent of all higher plant species and 35 percent of all land vertebrate species.[25] To monitor the ways different ecologies are changing with the goal of lessening by management the rate of biodiversity loss,[26] Robert J. (Bob) Scholes and Ms. R. (Oonsie) Biggs in 2005 have published a workable[27] biodiversity intactness index (BII).[28]

Footnote f33.2 Although equivalent to traveling 150 miles toward the equator is every 1000 feet down a mountain, diversity between peaks *decreases* as their tops are like islands separated by an "ocean" of lowland.[29]

Comment

As no one definition of species can be devised, one could use retronyms to inform such as: buffon species (when viability of offspring is a criterion) or mayr species (when sexual isolation is a criterion), or COI species*.

*DNA sequence differences in mitochondrial genes, if they are of large size and evolve slowly, can be used to distinguish species. Two suitable mitochondrial genes are cytochrome oxidase subunit I (COI) and cytochrome b (cyt-b).