gist, being held captive by taxonomists' specimens that decide whether I've seen or banded what species is "fallacious and needless." A taxonomist needs to provide field biologists with measurable parameters that will distinguish one species from another and in some cases one subspecies from another. If these distinctions cannot be made in the field on living individuals, but instead require collecting specimens, then we must give up any hope of monitoring our wildlife populations because changes in populations will only be determined upon the death of all individuals of the indistinguishable species. There's truly something wrong with this picture.

In response to Winker's causes for taxonomy's current affliction, he deserves a "Welcome Back, Hegel" lapel button for emphasizing the importance of species, the theory, above individuals, the reality. Regarding natality and mortality among populations, the population biologist needs to inform the taxonomist when and where to collect not vice versa. I wholeheartedly agree that the comparative method (induction) has been ignored, in favor of the experimental method (deduction); and that "'...observation in biology has probably produced more insights than all experiments combined' (Mayr 1982:32)."

Nevertheless the needed phenotypic measures for taxonomy and systematics—size, patterns, and color—are attainable in the field on live captures as are genotypic indicators. And if Winker's misplaced morality means I respect individuals of other species in the same manner as *Homo sapiens*, then I am misplaced and happy to be there. Death is definitely part of the game, but our goals in taxonomy can be achieved with living specimens. In what manner dead individuals can tell you all you need to know about living individuals and their populations remains a mystery.

Taxonomy needs to be in every core curriculum of our grade schools

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The Role of Taxonomy and Systematics

A recent essay by Winker (1996) throws down the gauntlet regarding the place and importance of taxonomy and systematics in today's biological realm. Taking up the challenge that "diversity of life is known to us only through the efforts of taxonomists and systematists..." I agree that in the past this was the case, but in the present it is not. Taxonomy and systematics are tools to be used by biologists in expanding our knowledge of life. As a population biolo-

and high schools. Our children need to know how to identify the plants and animals that make up our world. Taxonomy's database is in the field, assisting population and community biologists with species identification. As my oldest daughter often instructs me—*adjust*—I offer Dr. Winker the same advice.

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Grant's position regarding the collection of specimens and the role of taxonomy and systematics in biology needlessly polarizes the issue. First, taxonomy and systematics are not synonymous. Systematics is the study of organismal diversity and interrelationships; taxonomy is the description, naming, and classification of organisms. Both rely heavily on scientific research specimens. Also, it must be remembered that research specimens are samples of a renewable resource, and in birds it has been shown repeatedly that scientific collecting has an insignificant negative effect on populations and species. In contrast, this collecting provides profoundly important benefits to science.

Grant appears to have difficulty accepting the fundamental role of taxonomy and systematics in biology. He views the taxonomist's role as one of servitude to field biologists, stating that the taxonomist needs to provide field biologists with characters that enable accurate separation of species. Taxonomy does provide this service to biology as a whole and has done so for over a century. *The basis for this taxonomic work is the museum specimen.* One cannot accept and use a taxonomy and the characteristics it is based upon without acknowledging (Grant's "held captive by") this specimen basis. Nor should one demand and use a service and not make a return contribution (e.g., by supporting taxonomists or depositing specimens).

Grant also states that if species limits cannot be determined in the field on living individuals, but instead require collection, then we forego any hope of wildlife monitoring. This is wrong because it ignores sampling theory and basic statistics: collecting all of anything is ridiculous. One can readily work with a population in different ways simultaneously, including both monitoring and collecting. If one is conducting a field study (e.g., mark-recapture), the quality of the research will be dramatically enhanced if a subsample of the individuals are preserved as museum specimens. This is not some onerous additional work serving an invisible scientist in some museum; it is simply good science. Preserved specimens deposited in recognized systematics collections represent two things: documentation of a study and a tangible database for the field of organismal biology. Both are needed, even in seemingly well understood species.

Consider the multitude of studies conducted on the leopard frog (*Rana "pipiens"*) a common "species" now recognized to be a complex of nearly two dozen species (Hillis 1988). Another example can be found in studies of the common North American deer mice (*Peromyscus leucopus* and *P. maniculatus*), where species identifications have been based on characteristics giving a success rate that is hardly better than chance (Rich et al. 1996). Any study of these common frogs or mice that did not preserve voucher specimens failed in two important ways: it did not adequately document the study organism and it did not provide the raw material necessary to distinguish evolutionarily important lineages and their distributions. Biologists are committing these failures every day!

These examples represent common organisms from a region that is comparatively well known; imagine the failure rate in the tropics and in lesser-known organisms. Our understanding of avian diversity and distribution also lacks a considerable amount of clarity, no matter how adamant the suggestions to the contrary (Phillips 1975; Remsen 1995 and references therein). Given avian mobility (e.g., greater than 50% of North American species are Nearctic-Neotropic migrants; Rappole 1995), the task of the ornithologist is in some ways more problematic.

Hillis (1988) showed that the number of recognized species in the *Rana "pipiens"* complex varied profoundly during more than 150 years and that it is currently steeply rising. This phenomenon is common in many vertebrate taxa, including the entire class Aves. Thus, the taxonomy and characters that organismal biologists use today to identify study organisms may be virtually useless in the future. The preservation of some specimens assures that a biologist's research won't become similarly useless as a consequence. The voucher specimen says "this is what I worked with" and provides future systematists and taxonomists with the raw material needed to resolve species and subspecies limits, distributions, geographic variation, development, etc. By-products of this work include the discovery and documentation of characteristics useful for all biologists in the determination of species, subspecies, sex, age, etc.

It is not even remotely true that systematics and taxonomy can be done wholly with living organisms. Even nontraditional samples of living individuals should be avoided when possible because these compromise scientific quality and are of limited utility (Remsen 1995; Winker et al. 1996). It is also not true that the database of taxonomy is in the field. Rather, this database is the world's systematics collections. The greater

world is the source of these data, and it is this source we wish to understand and conserve. Preserving tiny representative samples of the world's multitudinous organisms in systematics collections has given us an immense amount of understanding and can continue to do so. Field study of living organisms also increases our understanding. Grant fails to grasp that one does not preclude the other; each enhances the other, as most museum ornithologists know, because most are also field biologists. For example, as a population biologist I have banded more birds than I will ever collect. As an ornithologist, however, I recognize that preserving some specimens improves my own field research and has immense value to ornithology as a whole through the subsequent efforts of specimen-based avian researchers.

The point of my essay was that much work remains to be done to understand extant diversity, and that the influx of specimens is grossly inadequate to serve this need. Our understanding of diversity is only resolvable to the degree that specimen material is available to systematists and taxonomists (including nontraditional specimens such as tissues, recordings of vocalizations, etc.). The adjustment we must all strive to make is to work together to increase our understanding of the natural world and achieve solutions for its preservation and management.

Grant's response represents a complaint from one area of biology about the activities in another and an argument about whose domain is superior. Neither is superior; both are necessary, and organismal biology as a whole will be improved through cooperation and collaboration. Taxonomy, a fundamentally important area of biology, is suffering at a time when we need health and vigor. At issue is the quality of biological science and the body of knowledge that we can bring to bear on the problems of conserving biodiversity. Ceasing or diminishing specimen collection sacrifices scientific quality and is not a reasonable option. In addition, the value of specimens as a legacy for the future would be difficult to overstate. In an era of rapid environmental change we are not making a serious attempt to preserve representative samples of today's phenotypic and genetic diversity and its present distribution. Castigation of today's researchers by future biologists for neglecting this important obligation and unique opportunity seems assured.

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