



Ranitomeya fantastica: Some species are simply so amazing in appearance that their specific name should so indicate!

BRAD WILSON

Discovering and Naming New Species of Amphibians

Joseph R. Mendelson III

Department of Herpetology, Zoo Atlanta

Scientists currently recognize **6,478 species of amphibians** (www.amphibiaweb.org; 28 March 2009) in the world. Of these, about 560 are salamanders, about 170 are caecilians, and the remaining thousands represent the vast diversity of frogs. However, nearly every new trip into the yet underexplored regions of the planet results in the discovery of more previously unknown species. In fact, according to the IUCN Amphibian Conservation Action Plan published in 2007, known amphibian species have increased by about 40%, and perhaps 50% of all extant amphibians remain undiscovered and undescribed — a serious underestimation of biodiversity on earth! Indeed, as we are battling to prevent the extinction of many amphibians, we are continuing to discover new species every year. This means, of course, that as the amphibian extinction crisis continues, we doubtlessly are losing species that we never knew existed.

The processes of cataloging, describing, and naming species and groups of species are known as the science of taxonomy. The closely related field of systematics seeks to understand the evolutionary relationships among all species. Amphibian taxonomists, working with data from anatomy, behavior, DNA, and all sorts of other information, work to discover, describe, and name new species. Such efforts are basic to cataloging life on earth and also for addressing the increasingly imperative conservation needs of amphibians. Indeed, taxonomic studies are a basic component of conservation efforts — conserving a species that is not known to exist and that does not even have a name is difficult at best. Taxonomists will admit that realizing that you are the first scientist



MICHAEL D. KEEN

Anotheca spinosa: The specific name refers to the unusual bony ornamentation that crowns the head of this species.



RON HOLT

Centrolene ilex: The specific name is Latin for the Holly plant. In this case, the name was chosen in honor of well-published herpetologist Priscilla Hollister “Holly” Starrett.

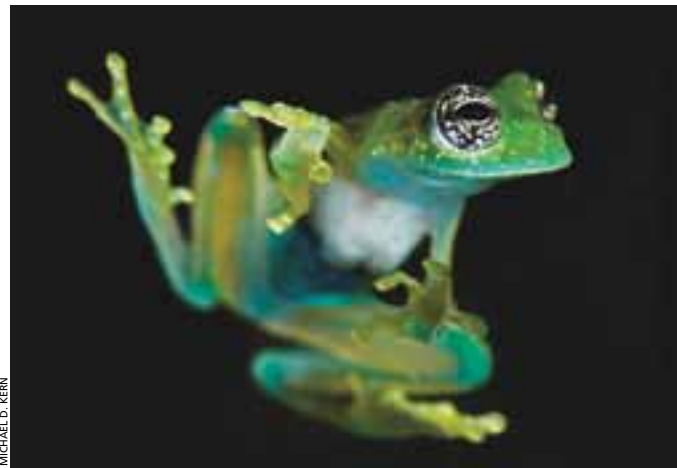
— perhaps the first human — to see a particular species is quite a thrill, and coining the permanent scientific name for an animal is a great honor. Occasionally, a headline will announce the discovery of a particularly unusual new species of amphibian (e.g., the truly bizarre Purple Frog, *Nasikabatrachus sahyadrensis*, that turned up in the Western Ghats of India a few years ago), but new species typically are announced to the world in the pages of scientific journals, where only academic herpetologists and the most ardent hobbyists are likely to become aware of the discovery.

As exciting as are discoveries of the new species, the path to discovery can take different routes. Sometimes, the first sighting in



JOSEPH R. MENDELSON III

Charadrahyla nephila. The specific name is derived from the Greek *nephos*, meaning cloud, and *philia*, meaning fondness, alluding to the cloud forest habitat to which this species is restricted.



MICHAEL D. KERN

Cochranella albomaculata. The specific name is composed of the Latin *albus*, meaning white, and *macula*, meaning spotted, in clear reference to the spotted pattern of the species.

the field is all that is necessary; such was the case when William Duellman and I found the first specimen of *Hylomantis hulli* in Loreto, Peru, one night in the mid-1990s. In other situations, field workers may think that they have a new species at hand, but it can only be verified by considerable efforts back in the laboratory to compare (using anatomical and/or molecular tools) the newly collected material with other specimens. Sometimes, in such situations, a considerable delay separates the original discovery from the verification — as was the case when Martín Bustamante and I discovered *Pristimantis gagliardoi* in Cañar, Ecuador, in 2004, or, during my first trip to Mesoamerica, when I found *Incilius* (= *Bufo*) *campbelli* in Alta Verapaz, Guatemala, in 1989. Other times, new species become apparent only after exhaustive studies of geographic variation among museum specimens of what was previously considered to be a widespread species that had been collected over decades or centuries. This is how we “discovered” several new species of Mesoamerican toads that had previously been referred to as *Incilius coccifer*, including *I. signifer* from central Panama. Finally, sometimes anatomy can be difficult or downright misleading. I struggled for years, examining many hundreds of specimens of the familiar

Gulf Coast Toad (*I. valliceps*), convinced that populations in the USA and northern Mexico represented a different species than those in southern Mexico and Central America — but I simply could not pinpoint where (presumably in central Mexico) they separated. An objective read from DNA profiles, collected over my years of driving up and down the Caribbean Coast of Mexico, finally helped find the contact zone (with no evidence of hybridization, which was somewhat surprising) near the small village of Palma Sola in Veracruz, Mexico. Interestingly enough, my graduate student at the time, Daniel Mulcahy (lead author on that particular paper) had identified that exact spot on a topographic map as being the contact zone between the two species — and he had never been to Mexico! I always thought the contact zone would be found much farther to the North, which underscores the importance of bringing an objective mind to any ongoing project. This particular study led not to the naming of a new species, but rather to the resurrection of an old name that had been officially “retired” into synonymy. Thus, the long-forgotten name *I. nebulifer* (originally coined by Girard in 1854) came to be applied to the more northerly populations of this strikingly crested toad. I can tell you that some people were not happy to have the scientific name of such a common backyard toad in Texas and Louisiana suddenly changed — and my experience suggests that US herpetologists are more resistant to taxonomic changes than are most of our international colleagues, although I can’t tell you why.

New species names are most often published in peer-reviewed scientific journals. In general, authors are expected to conduct



RON HOLT

Cochranella granulosa. The specific name refers to the distinctive granular texture of the skin that is clearly evident in this photograph.



MICHAEL D. KERN

Craugastor megacephalus. *Mega* is Greek for large, and *cephalo* refers to head, the name was evidently chosen to describe both the morphology of this species and, perhaps, to serve as a patronym for a great many herpetologists.

some kind of analysis involving an examination of specimens that are available to the scientific community, such as those housed in natural history museums. An author usually is expected to designate a holotype, a single specimen that “bears the name of the new species.” Additional material, sometimes referred to as paratypes, might also be described, and relevant information, such as individual variation and sexual dimorphism, might be learned from these. The commonly used term “type locality” refers to the site from which the holotype was collected. After the original description is published, the name may be used in subsequent literature, field guides, zoo signage, etc. . . . If a name is used prematurely (i.e., before the formal publication), it may be forced into early — and permanent — retirement by the ICZN (International Code of Zoological Nomenclature). Certainly some taxonomists have experienced this blunder by mentioning the new, unpublished name to the news media or another published outlet. In this case, a new name must be chosen, which could be very disappointing for all involved.

What’s in a Name?

In theory, taxonomy is a simple process based on the simple rule “A single name for each species.” Of course, nature can be tricky and consistent application of such a simple rule is sometimes quite difficult. The rules governing names (ICZN) are notoriously confusing, ambiguous, and conflicting — and they often are misinterpreted and incorrectly implemented, even by experienced taxonomists!

Genus & species: Most practicing taxonomists use a system of binomial (two names) nomenclature to identify each unique species (the “species” name) and the category of genus to help identify its evolutionary relationships with other species. These names are usually derived from Latin or Greek, but words from other languages may be used. Using the scientific name for the Green Treefrog as an example, the first word in the binomial is the genus and is always capitalized (*Hyla cinerea*). The second word in the binomial is the specific epithet and it is not capitalized (*Hyla cinerea*). A species name will always be used for a given species, unless further research indicates that species is not, in fact, different from other previously described species. In this case, the invalid name is synonymized and effectively retired from use. The name of the genus may change when, for example, new information indicates a different classification better reflects the evolutionary histories of a given species. An example here would be the recent work by our colleagues at The American Museum of Natural History (<http://research.amnh.org/herpetology>) that has changed the generic allocations of many species of amphibians (<http://digitallibrary.amnh.org/dspace/handle/2246/5781>). Such name changes sometimes annoy biologists and hobbyists, as the names of their focal creatures keeps changing! However, this is a necessary evil that reflects progress in our understanding of evolutionary history. Sometimes, when a species is transferred to another genus, the gender of the specific name must be changed to match that of the new genus, thus we can see



Dendropsophus marmoratus. *Marmor* means marble in Greek, and was applied to this species in reference to the marbled cryptic coloration on the dorsal surfaces of this frog.

subtle changes such as the case of the Cane Toad, which changed from masculine (*Bufo marinus*) to feminine (*Rhinella marina*) to reflect the gender of its current generic allocation. Such a change reflects the rules of Latin grammar and does not have any biological significance.

Recent common practice requires that authors include an etymology section in their paper that explains what the new name means, how they constructed it, and why they chose that name. Frequently, these can be the most interesting aspects of an entire paper (well, maybe beyond the illustrations of the new species). In previous generations, etymologies were rarely included, leaving modern scientists to guess why a particular name was chosen. In some cases, the name choice may seem obvious and appropriate — one can assume to understand why Shaw chose the name *maculatum* (meaning spotted) for the common Spotted Salamander (*Ambystoma maculatum*). However, one can only wonder why Linnaeus chose to name the familiar Cane Toad *Rhinella marina*, apparently referring to the ocean — the last time I checked, Cane Toads don't live in saltwater.

Although ICZN rules allow any word (from any language) to be used as a species name, in most cases, species names are formed from Greek words, Latin words, or "Latinized" words. Several dictionaries provide word roots and combinations (e.g., Borror's *Dictionary of Word Roots and Combining Forms*; Mayfield Publishing Company) that are quite useful when forming a new name or simply "translating" the names of one's favorite creatures. Some commonly used themes and constructions include:

Geography: Geographic names often are used as a basis for forming a new name, and frequently are constructed using the suffix *-ensis*, which denotes place, locality, or country. An example would be the treefrog *Plectrohyla guatemalensis*. This name implies "the *Plectrohyla* from Guatemala." An example from the U.S. would be the Narrowmouth Toad, *Gastrophyrne carolinensis*. Another approach to using geographic place names simply Latinizes the place name itself in an adjectival form. For example, the name of the toad *Anaxyrus* (= *Bufo*) *mexicanus* translates into "the Mexican *Anaxyrus*." Other examples include the Woodland Salamander, *Plethodon neomexicanus* (in which case the name "New Mexico" was Latinized, which is not strictly required by ICZN), or the familiar toad, *Anaxyrus americanus*. A slightly different approach uses the place name more directly, for example, the caecilian *Dermophis oaxacae*, which translates into "the Oaxaca *Dermophis*" (rather than the *Dermophis* from Oaxaca or the Oaxacan *Dermophis*). Another example of this approach would be the U.S. Torrent Salamander, *Rhyacotriton cascadae*. A similar method does not even Latinize the place name; for example the Costa Rican toad *Crepidophryne chompipe* is from a mountain called Chompipe.

Patronyms: Honoring a person or persons is another common practice. Although clearly frowned upon professionally, the ICZN does not explicitly prohibit an author from naming a new species in honor of him- or herself. Certainly some megalomaniacal taxonomists have attempted such at some points, and perhaps have even succeeded! To bestow the honor of a specific patronym for a new species upon someone can be accomplished in several ways. The most usual approach is to simply Latinize their last name. I did this in honor of Jonathan A. Campbell with the description of *Incilius campbelli*. Another Mexican frog, *Plectrohyla hazelae*, was named by E.H. Taylor, one of the most prolific herpetologists of the 20th Century, in honor of Hazel Roberts, who assisted with fieldwork (note that the female ending of the specific epithet reflects gender). If one wishes to honor more than one person in the same family, then a plural ending could be used, as was done in the case of *Hyla wrightorum*, which was named to honor Anna Allen and



Ecnomiophyla rabborum. The name honors equally the conservationists George and Mary Rabb. Note the suffix *-orum*. If the frog were named solely for George Rabb, the name would be *E. rabbi* (e.g., the Mexican salamander *Dendrotriton rabbi*), and if it had been named for Mary Rabb, the name would have been cast as the feminine *E. rabbae*.



Eurycea splelaea. This species was named after its cave- and aquifer-dwelling habits, as *spleum* is Latin for cave. In this case, the name was modified to the feminine to match the feminine gender of the generic name.

Albert Hazen Wright. A creative use of this construction may be found when the taxonomist forms the patronym such that it honors a group or culture, rather than a specific person or persons; *Eleutherodactylus avicporum*, refers to "bird catchers," thus honoring a group of ornithologists who helped discover the species in Peru. Some names reference the language or beliefs of the people living in the region where the animal occurs. For example, The Rain Frog, *Craugastor chac*, named in reference to *Chac*, the mighty God of Rain in traditional Mayan culture. Taxonomists have fun bestow-



Herpele squalostoma. The specific name is a compound word that translates to "shark mouth," *squalus* is Latin for shark, and *stoma* means mouth. Caecilians have a powerful bite, and this species is no exception.

ing such a great honor on their heroes and friends, so patronyms are quite common on taxonomic checklists for all taxa.

Characteristics of the animal or its habitat: Another commonly used approach to forming names for new species is to base them on a distinctive feature possessed by the new taxon. Salient morphological characteristics of the animal may be singled out, such as in the case of the Mexican Toad, *Incilius spiculatus*, which has particularly spiny tubercles on the skin, or the Web-toed Salamander, *Hydromantes*



Hypsiboas rufitelus. The bright red webbing between the digits on this species is reflected in its name, which is derived from the Latin *rufus*, meaning red, and *tela*, meaning weave (usually used in reference to cloth).



Incilius signifer: The name is derived from the Latin *signifer*, meaning marked, and was chosen in reference to the distinctly marked ventral pattern of this toad — a ventral pattern that is unique among the closely related members of the Central American *Incilius coccifer* Group.



Ambystoma maculatum: The name is from the Latin *macula*, meaning spot, in reference to the spots that comprise the dorsal pattern of this salamander.

platycephalus, where *platy* means flat and *cephalus* refers to the head, providing a particularly appropriate description of this flat-headed species. The characteristic may be behavioral as well, such as in the Central American Leaf Frog, *Agalychnis saltator*, known for its leaping proclivities, in which *saltator* means jumper, or our familiar Slimy Salamander, for which *Plethodon glutinosus* is a clear reference to its famously glutinous skin secretions. Sometimes authors will look to the habitat of the species and derive a name from that, such as the cloudforest-dwelling Mexican Treefrog, *Charadrahyla nephila*, where *nephila* is derived from the Greek *nephos*, meaning cloud, and *philia*, meaning fondness; when combined, these two words allude to the cloudforest habitat to which this species is restricted. A simpler example may be found with the US salamander, *Eurycea aquatica*, clearly named for its aquatic habits.

Unlike scientific names, common names are not regulated by any code and often vary from one place to another (see Powell 2002. Understanding animal classification. *Iguana Times* 9:18–26.). Obviously, an English common name would differ from the



Plethodon caddoensis: This salamander is endemic to the Caddo Mountains of southeastern Oklahoma and adjacent Arkansas. The name translates to “the *Plethodon* from Caddo” and is a clear reference to the mountains of the same name.



Pristimantis gagliardo: A recently named species honoring amphibian biologist and conservationist Ron Gagliardo of The Amphibian Ark.

Spanish name for the same species. In addition, various names might be used for the same animal in various parts of its range by indigenous peoples or local residents. Scientists generally avoid the inevitable confusion by using scientific names that are unique to each species, but some efforts have been made to provide “standard” common names for amphibians and reptiles, such as those that have been used for years by ornithologists for birds. For example, the official name list of the American Society of Ichthyologists and Herpetologists (ASIH), Herpetologists’ League (HL), and the Society for the Study of Amphibians and Reptiles (SSAR) provides English common names for species in the United States and Canada (B.I. Crother, ed., 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America, North of Mexico, with Comments Regarding Confidence in our Understanding*. 6th edition. SSAR) and the Center for North American Herpetology has published *Standard Common and Current Scientific Names for North American Amphibians, Turtles, Reptiles, and Crocodilians* by J.T. Collins and T.W. Taggart (2009). The SSAR also published *Nombres Estandar en Espanol en Ingles y Nombres Cientificos de*



Ranitomeya summersi: A recently named species honoring amphibian biologist Kyle Summers, who has published extensively on Poison Dart Frogs.

los Anfibios y Reptiles de Mexico / Standard Spanish, English, and Scientific Names of the Amphibians and Reptiles of Mexico by E.A. Liner and G. Casas-Andreu (2008, 2nd ed.). Standardized common names are certainly useful, but ultimately no authority can dictate what local people should call the animals in their own backyards — what may be a *Desmognathus* or Seal Salamander to one person may well be a “Spring Lizard” to the caretaker of an Appalachian seep. This is not a problem, as long as scientific names are governed by stable rules acknowledged by scientists and enforced by the ICZN.

Acknowledgments

The following persons were generous with comments and/or permission to use their imagery: David Kizirian, Ron Gagliardo, Jenny Pramuk, Ed Kabay, Darrel Frost, Suzanne Collins, Ron Holt, Brad Wilson, Michael Kern, Martin Bustamante, and Jay Savage. The author’s fieldwork in Central America has been funded by the National Geographic Society, Theodore Roosevelt Fund of the American Museum of Natural History, and the National Science Foundation (grants 0613802 and 9705277 to Jonathan A. Campbell).



Rhyacotriton cascadae: This is a geography-based name that translates as “the Cascades *Rhyacotriton*” and was applied in reference to the Cascades Range northwestern North America.