Colombian Amphibians: Cryptic diversity and cryptic taxonomy
By Mauricio Rivera-Correa

Colombia, the northernmost country in South America, is well known as one of most biodiverse regions in the world. It is unique due to its equatorial location, its vast expanses of coast, its complex Andean orogeny, its interconnected river network, and its position connecting Central and South America. These and others factors have favored processes of diversification and specialization of its fauna and flora, which have resulted in its exceptional biodiversity. Thus it has historically been an ideal setting for research in the field of taxonomy, the discipline that discovers, defines, describes and names species.

It is thanks to the work of taxonomists that Colombia currently has 749 formally recognized amphibian species, and considered second only to Brazil in amphibian species richness, with just 140 less species (see Amphibiaweb, 2011). Historically these figures have been the result of efforts by a relatively small number of taxonomists, and in more recent decades, of the impressive work of J. D. Lynch, who has described over 200 species for Colombia.

Despite such great individual efforts, in recent years there has been a gradual decreasing trend in the number of new amphibian species described for Colombia. The numbers are not encouraging, less so when compared to new discoveries and formal descriptions in other Neotropical countries. For example, since 2005 approximately 140 and 115 new species have been described for Brazil and Peru respectively, while only 27 species were described for Colombia in the same period (Amphibiaweb, 2011; Frost, 2011; Fig.1) and only two of them described in the current decade. This small figure for Colombia is the direct result of the recent death of some prominent taxonomists or of a shift of interests to other taxonomic groups. This indicates that currently, Colombia does not have a consolidated community of amphibian taxonomists undertaking the task of describing many of these new species, as required.

Despite limitations in the Colombian context, in other countries taxonomy has emerged as a solid scientific discipline of unforeseen advances, particularly in addressing complex problems of species with cryptic morphology. Today we have easy access to tools that traditional taxonomists could only have dreamed of. For example, online databases with information about the species, their taxonomic history, their distributions and some systematic reviews (e.g. amphibian species of the world, AMNH), networks of natural history museums where most type specimens have been deposited (i.e. HerpNet), available gene sequence and gene bank collections (i.e. NCBI, popularly known as GenBank), a constant stream of amphibian photographs by professional and amateur contributors, even scans of the type specimens (e.g. Calphotos to University of California Berkeley, or Encyclopedia of Life - EOL), and the wide distribution of taxonomic literature through colleagues or journal databases (e.g. BioOne, JSTOR, SciELO), among others.

Several factors might be discouraging the advance of amphibian taxonomy in Colombia. They are not exclusive, nor do they necessarily operate together, but they are latent in the national academic and scientific arenas: 1) a shortage of faculty trained in amphibian taxonomy to guide and encourage an acquaintance with this trade; 2) a biased perception of taxonomy as an ancient discipline involving hundreds of specimens stored in dusty dark spaces; 3) a depiction of taxonomy a classic, tedious and painstaking task; 4) an increasingly limited availability of funding from academic institutions to support expeditions; 5) a lack of support for the consolidation of biological reference collections; 6) an ongoing illegal armed conflict that has worsened over the last two decades, restricting access to explored and unexplored areas, and preventing the enrichment of collections and the collection of potential new species; and 7) the regulation of biological research (i.e. biological inventories, mobilization and exchange of specimens with international institutions, and access to genetic resources) governed by legislation which is often restrictive, bureaucratic, costly and exhausting to deal with.

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On the other hand, taxonomists in general and amphibian taxonomists in particular, are more than ever facing the challenge of defining and describing cryptic diversity in the context of incalculable species extinction. Thus, address taxonomic problems, especially those with cryptic morphology from different but complementary disciplines makes the taxonomy even more fascinating and attractive. It is increasingly common to find amphibian descriptions that combine information from different lines of evidence, integrating qualitative and quantitative analyses of the morphology (i.e. stand out diagnostic characters and multivariate analysis of morphometric distances) bioacoustic analysis (from digital recordings, which are more economical and efficient in the field), molecular analyses that help infer phylogenetic relationships and the degree of molecular divergence between candidate species, CT scans that analyze skeletal system without altering of specimens, and geographic information systems and ecological niche requirements indicating spatial and resource use segregation. The combination of all this information is evidence that, in many cases, could not be unveiled using the traditional morphological.
For this reason, descriptions of new amphibian species from highly biodiverse countries continue to accrue, especially in the last decade, with the joint efforts of different partners, while single-author contributions steadily decline (Joppa et al. 2011). It is signal that taxonomy is nourished by the collaboration between different multiple domains and colleagues from several institutions. For example, *Atelopus patazensis* and *A. eusebiodiazi* were described by four Peruvian researchers working for three different NGOs and universities in Peru and the U.S., or the description of *Hypsiboas gladiator* involved researchers from four different countries. This collaboration contributes to more effective, efficient, and rigorous descriptions, backed up by different lines of scientific evidence.

In recent years, a small group of colleagues who share a common interest in Colombian herpetofauna, have ventured both into little-explored localities and in the shelves of biological collections. With the help of researchers from different institutions and organizations for financial support, and by integrating multiple lines of evidence, we are finding many species with potential to be described, formerly overlooked due to either misidentification or cryptic morphology (examples of species currently being described, Fig 2.). Should other colleagues join us in this task, cryptic diversity will probably emerge from anonymity, and we will be leading a transformation from individual to collective work, with all its synergies. As is true for other taxa, amphibian description is a dedicated task, and one that seldom has the support of other sectors of society. However, as more scientific contributions are brought to spotlight of public knowledge, the more likely such sectors, especially the government, will be to change their vision. Perhaps then they will understand that a better knowledge of our own diversity provides the tools to make state policies that adequately address the conservation of our species.

In Colombia, where progress hinges on the use of biodiversity as the greatest resource, the moment seems appropriate for the emergence of new generations that continue to illustrate and be witness to this biological diversity. Efforts to make sampling more efficient and increase the rate at which new taxa are described, are needed today more than ever. Failing to do so, is risking that extinction will precede knowledge. Thus, I make an urgent call a new generation that will contribute establish and consolidate a strong community of taxonomists in Colombia. In their habitats and in the biological collections, new candidate species remain to be described by the scientific community and presented to society. That, indeed, would be a great legacy and long-lasting.

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**Literature Cited**


**Fig 2.** Undescribed species endemic to the Andes Mountains of Colombia being described with the participation of several colleagues and with different lines of evidence. *Hyloscirtus* sp (aff. *piceigularis* top left); *Rulyrana* sp (aff. *orejuela* top right); *Pristimantis* sp (aff. *acutirostris* bottom left); *Atelopus* sp (aff. *eonaconensis* bottom right). Photos Marco Rada and MRC.