

**Catalina Ramírez-Portilla**

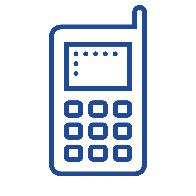
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**Research Editors**

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Dear Editors,

On behalf of all co-authors, I am excited to submit our research manuscript entitled **“Solving thecoral species conundrum”** to be considered for publication as a report in the journal *Science*. In this study, we addressed the long-standing problem of coral species delimitation using three different lines of evidence -morphology, breeding compatibility, and molecular biology- applied to a case of study that encompasses challenges affecting coral taxonomy as whole. Congruent results emerging from the independent approaches we used, demonstrated the feasibility of developing an accurate coral taxonomy by applying criteria more sensitive to detect divergence both at morphological and molecular level. In addition, our results challenge the generally accepted idea that coral morpho-species cannot be distinguished using molecular approaches, and that the most likely explanation for the extended genealogical incongruence between molecular markers is rampant hybridization among coral species.

Delimiting species is not only a central issue in evolutionary and systematic biology, and a prerequisite to physiological, ecological and population genetic studies, but also essential to develop effective conservation strategies for threatened ecosystems. In words of Carl Linnaeus, *“The first step of science is to know one thing from another”* (*[[1]](#footnote-1)*). However, more than 260 years after the dawn of zoological nomenclature and taxonomy [set by the 10th edition of Linnaeus’ *Systema Naturae* (*[[2]](#footnote-2)*)] delineation of species boundaries remains a challenge, particularly in species rich genera.

In corals, extensive evidence arising from molecular and reproductive approaches, has cast doubt on traditional taxonomy based on morphological characters of the coral skeleton. The highly diverse coral genus *Acropora* is emblematic of these quandaries, epitomizing not only an ecologically important group that has been greatly affected by global warming, but also one of the most taxonomically challenging (e.g. in the most recent revision of the genus only one-fourth of the nominal species were considered valid). Similarly, standard molecular approaches have failed to capture profound differences in the ecology and biology of the *Acropora* corals, with closely related species usually found interspersed in gene trees⁠. Indeed, the widespread incongruence displayed between morphology and standard molecular approaches, the discordant results attained with different molecular markers, the considerable overlap in reproductive timing among morpho-species, and the seemingly permeable barriers to interbreeding have been often evoked as evidence for ongoing hybridization between *Acropora* species. However, only the case of the Caribbean species ([[3]](#footnote-3)) stands as a robust example of hybridization in this coral genus so far.

In the last decades, high-throughput molecular techniques have overcome methodological limitations such as the lack of species-level resolution and the paucity of markers. Still, the problem of poor coral taxonomy and the issues stemming from it have not been addressed in the journal *Science* since 1992, when Knowlton *et al.* ([[4]](#footnote-4))established both the value of implementing independent lines of evidence to substantiate species boundaries, and the effect that inaccurate species delimitation can have in applied and basic research.

In this context, we believe that the findings presented in our paper will appeal to the readers of *Science* primarily for two reasons. First, our results illustrate that it is possible to breach the gap between traditional morphology-based taxonomy, standard and leading-edge molecular approaches to the problem of species delimitation in corals. On one hand, by including informative characters and quantitative approaches in addition to traditional morphology-based taxonomy; and in the other by combining genome-based approaches to screen for conserved and informative loci at species-level; with broadly accessible tools, such as traditional sequencing of markers defined and amplified from these loci.

Secondly, this study provides results that contradict the notion that due to hybridization among coral species, morpho-species of *Acropora* cannot be distinguished using molecular approaches. Contrastingly, the congruence of the results obtained from the lines of evidence we used for coral species delimitation in this study, supported the clear distinction of boundaries among closely related species of *Acropora*. In particular, breeding trials supplied biologically relevant information that not only delineated as different the sympatric species used as a study case, but also revealed how unlikely is hybridization to occur among them. In the light of these arguments, we hope you will consider sending out our manuscript for review.

Each of the authors has approved the contents of this paper and has agreed to the *Science* journal submission policies. We also confirm that this manuscript has not been published and is not under consideration for publication elsewhere. Should you select our manuscript for review, we would like to suggest the following potential reviewers due to their expertise and background:

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* **Dr. Bert Hoeksema**, Honorary Professor, University of Groningen, Naturalis Biodiversity Center, Netherlands. E-mail: bert.hoeksema@naturalis.nl

The main datasets generated for this study are provided as supplementary files (Data S1 – S3) or have been deposited in Dryad (DOI XXX), GenBank (table S3) and SRA repositories (table S4). Additional files and scripts can be found at a private GitHub repository that can be accessed per direct e-mail request to catalina.ramirez.portilla@gmail.com and that will be publicly available once the manuscript is published: https://github.com/catalinarp/SpeciesDelimitationTabularAcropora.

Please do not hesitate to contact us if you need any additional information on our side.

Sincerely,

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1. ()C. Linnaeus, *“Letter to the Marquis of Grimaldi”* in *A selection of the correspondence of Linnaeus, and other naturalists from the original manuscripts*, J. E. Smith, Ed. (Longman, London, 1821), pp. 459 – 463. [↑](#footnote-ref-1)
2. ()C. Linnaeus, *Systema naturæ per regna tria naturæ, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis* (L. Salvii, Stockholm, 1758), vol. 1, pp. 564. [↑](#footnote-ref-2)
3. () S. V Vollmer, S. R. Palumbi, Hybridization and the evolution of reef coral diversity. *Science*. 296, 2023–2025 (2002). [↑](#footnote-ref-3)
4. () N. Knowlton, E. Weil, L. A. Weight, H. M. Guzman, Sibling Species in *Montastraea annularis*, coral bleaching, and the coral climate record. *Science*. 255, 330–333 (1992). [↑](#footnote-ref-4)