

SYSTEMATICS OF *ELPIDIUM* MÜLLER, 1880 (PODOCOPIDA: LIMNOCYATHERIDAE) AND IMPLICATIONS TO BRAZILIAN ATLANTIC FOREST BIOGEOGRAPHY

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Introduction

Elpidium Müller, 1880 is a freshwater genus restricted to phytotelmatic environments, particularly tank-bromeliads, with estimated distributional range throughout the Neotropical region, specially in humid forest areas (Danielopol et al. 2014).

Considering its dependence on vectors, especially amphibians, to disperse (Lopez et al. 2005), this wide geographic distribution would be marked by a high level of diversity and endemism (Little & Hebert 1996), with species clusters occurring in some, but not all sub-regions of the Neotropical region.

Here, we aim to (1) increase the diversity known for *Elpidium*, specially in Brazilian Atlantic Forest regions; (2) discuss the monophyly of *Elpidium* and its internal and external relations and (3) explore the possibility of using *Elpidium* to understand the historical biogeography of the Brazilian Atlantic Forest.

Methods

The material used to describe the new species was collected in tank-bromeliads sampled from seven Brazilian states in three different regions: southeast (Espírito Santo, São Paulo), northern (Amazonas) and northeast (Ceará, Paraíba, Pernambuco, Bahia).

To the phylogenetic analysis, 80 morphological characters (four continuous and 76 discrete, of which 29 are from carapace and 47 from appendages) were used. *Cytheridella* sp., *Gomphocythere huwi* and *Metacypris srisononae* were defined as the outgroup while *Intrepidocythere ibipora*, eight *Elpidium* species previously described and the new 13 *Elpidium* species here proposed were treated as the internal group. Matrix was made using Mesquite 3.2 and analysis was made with software TNT (Tree analysis using New Technology) (Goloboff, Farris & Nixon 2008) with heuristic search and implied weight (k value = 3). Final art was made with Figtree 1.4.2.

Results and Discussion

Thirteen new species were described (Fig. 1, 2): eight were the first records of the genus for the states they were collected and seven occur in the Northeast Brazilian Atlantic Forest, the most fragmented and threatened Brazilian Atlantic Forest sub-region.

From the phylogenetic analysis, a single most parsimonious tree was found. *Intrepidocythere ibipora* appears as the sister group of *Elpidium* (Fig. 3) and *Elpidium* as a monophyletic group (Fig. 4), sustained by a number of synapomorphies. Concerning internal relations, Jamaican species seems to form a well-established group (Fig. 5). Other internal clades are not so stable and need to be better understood.

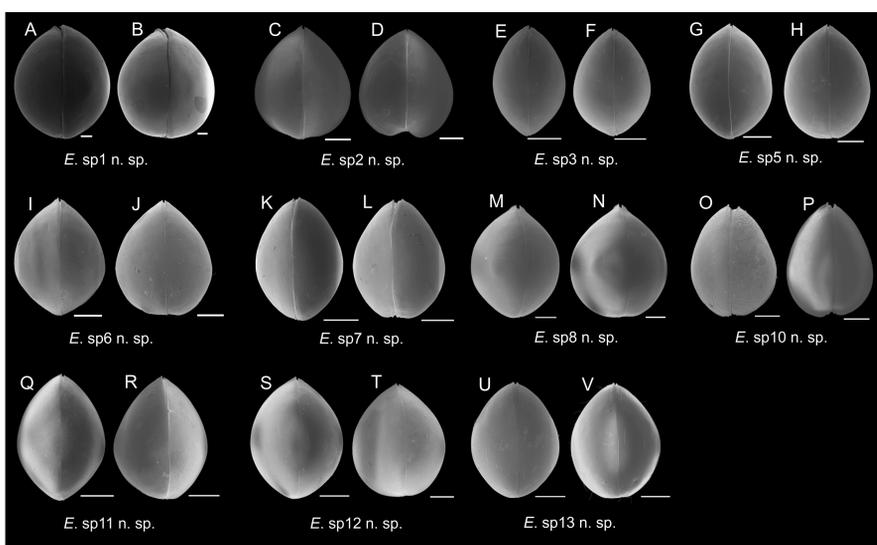


Fig. 1. New *Elpidium* species, dorsal view. A, C, E, G, I, K, M, O, Q, S, U, male; B, D, F, H, J, L, N, P, R, T, V, female. Scale bars: A, B – 100µm; C–V – 200µm.

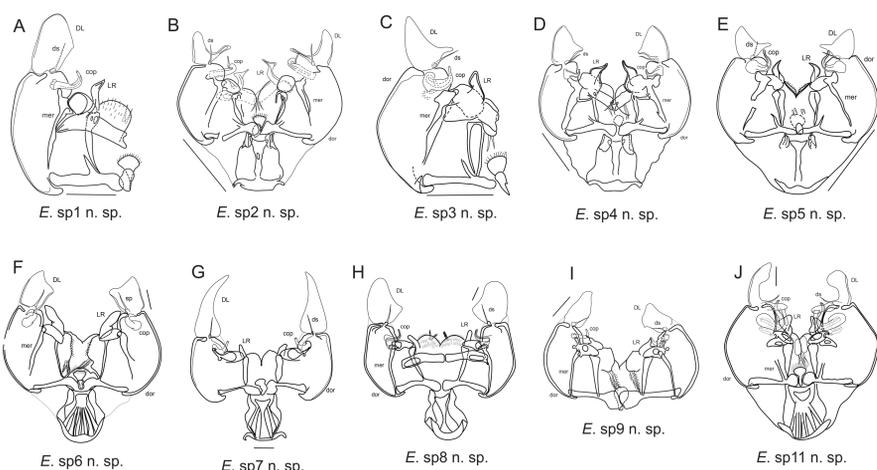


Fig. 2. New *Elpidium* species, A–J, males, hemipenis. Scale bars: A–J – 0.05mm.

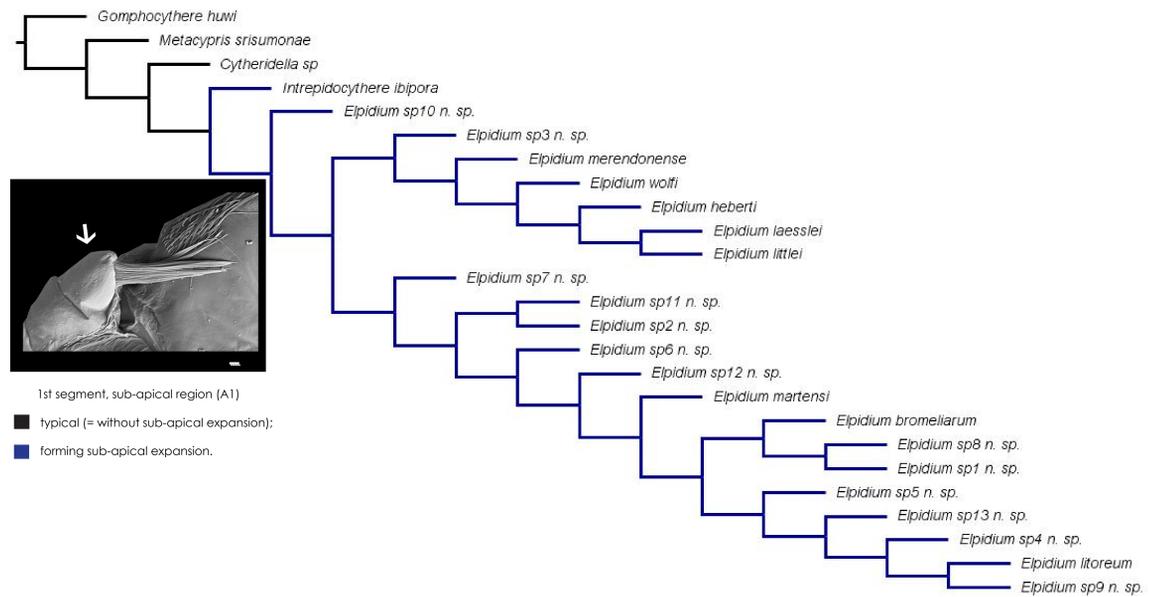


Fig. 3. Morphological phylogeny for *Elpidium*. The presence of a sub-apical expansion on antennula is one of the synapomorphies for the *Elpidium* + *I. ibipora* clade.

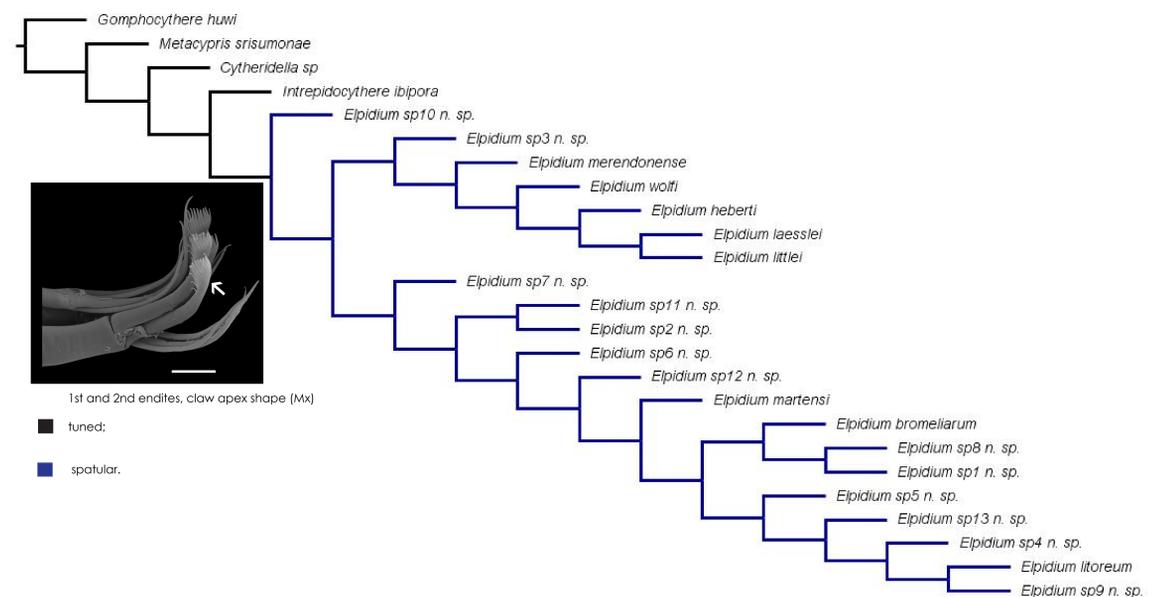


Fig. 4. Morphological phylogeny for *Elpidium*. The claw shape on the 1st and 2nd endites of the maxilla is one of the synapomorphies for the *Elpidium* clade.

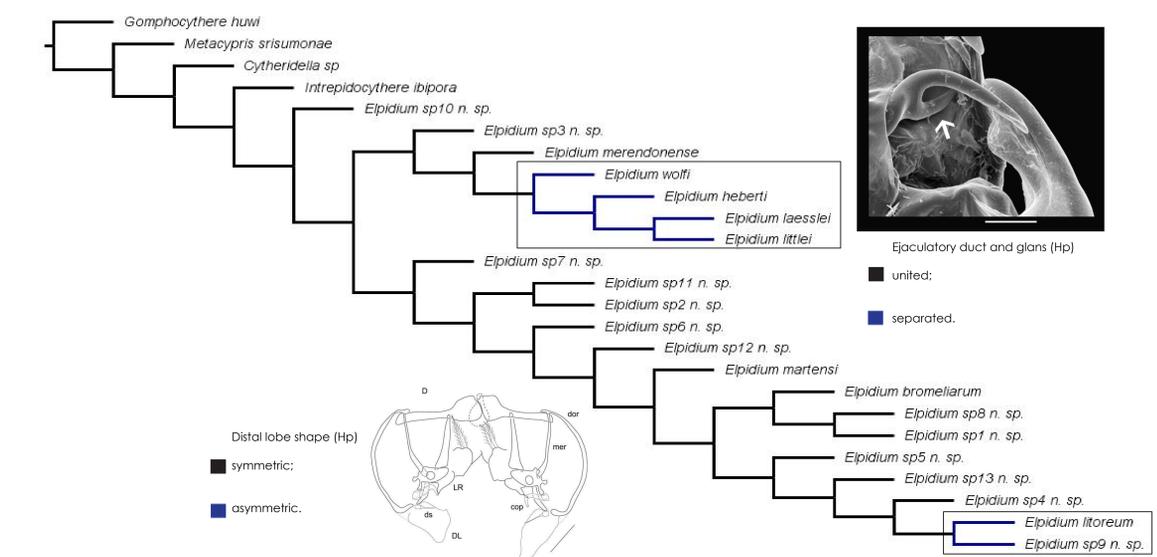


Fig. 5. Morphological phylogeny for *Elpidium*. The ejaculatory duct and glans separated in hemipenis is a synapomorphy for the Jamaican clade. The asymmetric shape of distal lobe in hemipenis is a synapomorphy of the clade *E. litoreum* + *Elpidium* sp9 n. sp.

The geographic distribution of all known *Elpidium* species is mapped and the next stage of this ongoing project is accessing the evolutionary history of the genus related to the Atlantic Forest and to evaluate the congruence between the *Elpidium* phylogeny and the Brazilian Atlantic Forest areas cladogram as defined by DaSilva et al. (2016).

References

- Danielopol, D. L., Pinto, R. L., Gross, M., Pereira, J. S., Riedl, N. On the evolutionary biology of *Elpidium* ostracods (Limnocytheridae, Timiriasevinae): a proposal for pluridisciplinary studies. *Geo-Eco Marina*, 20: 87–129, 2014.
- DaSilva, M. B., Pinto-da-Rocha, R. 2016. Historical relationships of areas of endemism of the Brazilian Atlantic rain forest: a cladistic biogeographic analysis of harvestman taxa (Arachnida: Opiliones). *Current Zoology Advance Access*, 1–11.
- Goloboff, P. A., Farris, J. S., Nixon, K. C. TNT, a free program for phylogenetic analysis, 24(5): 774–786, 2008.
- Little, T. J. & Hebert, P. D. N. 1996. Endemism and ecological islands: the ostracods from Jamaican bromeliads. *Freshwater Biology*, 36 (2), 327–338.
- Lopez, L. C. S., Filizola, B., Deiss, I., Rios, R. I. Phoretic behaviour of bromeliad annelids (*Dero*) and ostracods (*Elpidium*) using frogs and lizards as dispersal vectors. *Hydrobiologia*, 549(1):15–22, 2005.