

Evaluation of the PhD thesis “Taxonomy, phylogeny and phylogeography of selected groups of aquatic beetles (Coleoptera: Hydrophilidae, Hydraenidae) of the Caribbean region” by Albert Deler-Hernández

This thesis is organized in several chapters. The Introduction summarizes the knowledge on the Caribbean aquatic beetle families. The next section is a short chapter on the geological history and biogeography of the Caribbean, mentioning the different hypotheses explaining the faunal composition of this region. This second chapter also has a section on the amber fossils of the Dominican Republic and on how molecular phylogenies aid in reconstructing geological events.

After these two chapters the candidate presents a series of publications and manuscripts. The first part includes two manuscripts (one in press); the second part is a list of published papers (seven). All the contributions are related to the subject of the thesis.

The Introduction is a nice summary on the knowledge of the aquatic beetle families found in the Caribbean region. Eleven families are covered, four of Adephaga and seven of Polyphaga. Two tables listing the genera and number of species known for the Caribbean region are included, and the endemism of the species is summarized (for example how many species are endemic to one island, how many are widespread or are of a continental origin). The second chapter, even though brief, is useful since it mentions the three different hypotheses developed to explain the present distribution of the Caribbean fauna, and how the available information suggests that this distribution may be explained by a combination of these hypotheses, not just one.

The published papers are all of the highest quality. They are clearly written and beautifully illustrated with both line drawings and photographs.

The published papers are all contributions to the knowledge of the Caribbean water beetle fauna. The first paper is a description of a new species of *Phaenonotum*; the next two papers are generic revisions of two genera: *Berosus* (for Cuba), and *Oosternum* (for the West Indies). The fourth paper is also on the genus *Phaenonotum*, with redescriptions of species and lectotype designations. The fifth paper describes larvae of three *Berosus* species, including detailed descriptions of their chaetotaxy. The last two papers are on Hydraenidae, one describes two new species of *Hydraena*, and the other describes the larvae of six species.

The paper in press is again on the genus *Phaenonotum*, it is a detailed study of the genus for the Caribbean region, based on a molecular study which has interesting biogeographical results. It explains the evolutionary history of the genus in the Caribbean, and also adds four new species to this genus. Finally, the manuscript is a revision of the genus *Crenitulus*; it is based mostly on molecular data and some morphological characters, and describes nine new species.

The published papers (including the paper in press) are in well-known journals (*Zootaxa*, *Zookeys*, *Acta Entomologica Musei Nationalis Pragae*, *Deutsche Entomologische Zeitschrift*, *Aquatic Insects* and *Zoological Journal of the Linnean Society*).

Below I list several comments and questions which I expect the candidate will have in mind for the defense of his Dissertation.

- 1- My first comment is with regards to the format of the thesis. Perhaps this format is common in your University, but I am used to theses that are organized as a unit, and not a combination of independent pieces of research related to a more general topic (as the title of the dissertation states). Usually (based on my experience) a

thesis has one or more objectives or hypotheses; to fulfill this or these hypotheses the candidate (after performing a thorough bibliographical search) develops the necessary techniques, obtains results and finally analyzes the results generating a discussion and sometimes also conclusions. I asked about the thesis format, and was informed of the two possibilities regarding thesis approaches (at the Charles University): one big work, or several smaller projects (papers). Based on my experience, both things (at least in the field of Systematics) can be done at the same time: prepare a large revision or project, and in the meantime publish shorter papers. I want to ask the candidate to explore which are the strengths and weaknesses of both approaches to a dissertation (one piece of work vs. several short papers).

- 2- Regarding the deposition of the Type Material. The Holotypes (and probably in most cases Paratypes too) of species described by you were deposited in foreign institutions. For example, species of *Phaenonotum* (collected between 2013 and 2016) are deposited in NMPC (National Museum, Prague Czech Republic); something similar occurs with *Crenitulus* species. Personally, I have had problems trying to see or locate type material from my own country, and sometimes I have had to describe a new species without being able to see holotypes of related species (money to visit foreign institutions in developing countries is not readily available, and sending type material is something that many institutions never do because of the risk of mailing holotypes). How you feel about this situation? Shouldn't Holotypes be deposited in Institutions of their country of origin?
- 3- Considering that I am a traditional systematist (working with morphology, but searching a different set of characters since I work mostly with immature stages), and that I do not use molecular techniques. Therefore I am not familiar with the techniques and ways of obtaining and analyzing molecular data. In order to enlighten me I have a few questions that may seem trivial to those familiar with these techniques:
 - a. In the *Crenitulus* paper you performed two analyses: 5 genes combined and single genes. The results are different since 5-gene trees are better resolved and have good support, while single-gene trees are only partly congruent with the 5-gene analysis.
 - i. Apparently the more genes you add the better resolution you obtain, then, why not keep adding more genes?
 - ii. Could the genetic distances become reduced by adding more genes could and what appears as a "complex" (in the 5-gene tree) end up being a cloud of closely related OTU's that have to be considered just one species? An answer to this should come from the literature or personal experience (I am not asking you to add genes to your study).
 - b. While analyzing the *C. yunque* complex you mention that 9-11 species were recognized based on which gene/genes you used. Moreover, in one case (the *Crenitulus iviei-naranjoi-lajoncherei* complex) you define the species based on molecular data, but in another case (the *Crenitulus jiri-yunque-cristal* complex) you define the species based on morphology. Could this be considered as a lack of consistency in the way species are recognized?

- c. The definition of species using molecular data is based on distances, which is the rationale to decide which distance is enough to define a species and/or higher taxa?
 - d. Are you aware of any paper going beyond a molecular study (systematic study of course) that confirms that closely "molecular" defined species are really so (that is they are not compatible or yield sterile hybrids) by performing hybridization/cross studies? For example, studies as those performed by Frank Young with *Tropisternus* in the '60s.
- 4- In the *Crenitulus* paper you only performed molecular phylogenies, you did not add morphological characters to the matrix. But genital morphology was used to define some species where molecular data did not work. I also see some differences in size, coloration and shape of palpi. Do you think it would be possible to make a morphological matrix and combine it with the molecular data and explore this "total evidence" approach?
- 5- In the *Phaenonotum* paper, the one in press dealing with biogeographical aspects, you mention that morphology alone is not useful for species-level identification. You also performed a molecular analysis which resulted in several trees. In this paper you did have morphological characters since you also present a key for the identification of the species. Why here you did not add the morphological characters to the analysis? Are you going to try other sources of characters for species delimitation (i.e. larval morphology, behavior)?
- 6- In the Introduction you gave a brief introduction to what are considered the beetle families with aquatic representatives. I was surprised to see that Scirtidae (a widespread and numerous family) are not known for the Caribbean region (at least they were not included in the introduction). Is this true?

I consider that Albert Deler-Hernández has done a fine job. His publications are of an excellent quality. I really enjoyed his morphological work since he has proved to be able to work well with both larvae and adults. His biogeographical and molecular work is also very interesting. The candidate has done a good job and I think the requirements for the Ph.D. are fulfilled and I recommend it for the final defense. I will provide the final evaluation after the defense.

Esquel, September 05, 2017

Miguel Archangelsky, Ph.D.