



Species delimitation of the genus *Latrodectus* (Araneae: Theridiidae) by DNA Barcode and morphological evidence.

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Abstract

The genus *Latrodectus* Walkenaer 1805, commonly called black widows, is worldwide distributed with 31 known species. This genus has great importance because the toxicity of its venom to humans, being considered medically important species due to the periodic prevalence of bites.

Species of this genus are taxonomically difficult to determine. First, due to the taxonomic history of *Latrodectus*, with multiple synonyms and revalidation of species, and second because several species have no discrete boundaries of morphological characters that distinguish them.

In this research, we hypothesized phylogenetic relationships of the genus *Latrodectus* from two molecular markers (COI and alpha-latrotoxin). Also, we contrast the molecular relationships with morphological variation, so that in this way can be established discrete characters that allow to obtain the identity of *Latrodectus* species. Phylogenetic analyzes were performed under a Bayesian approach, implemented in BayesPhylogenies Software. Using the gene tree the limits among species based on the bPTP model are established.

The results show a high genetic divergence among the specimens allocated under different nominal entities allowing to develop efficient procedures for species determination. Phylogeny in conjunction with the delimitation species approach (by BPTP) are congruent with few but enough morphological characters that allow to separate the different species. Also, clades show species distributional patterns in agreement with ancestor-descendant relatedness, except for the species in Africa and Asia that are fragmented into two clades. Morphological analysis are consistent with the phylogenetic and it is possible to find species delimitations with discrete characters. Also, new synonymous and possible new species are given.

Background

Considering the current evidence that shows the historical and taxonomic complexity of the genus *Latrodectus* given by description of morphological characters which overlap within species of the genus (Levi 1959), species validated by isolation reproductive (Abalos 1980), uncertainty of the natural supra generic groups *mactans*, *geometricus*, *curacaviensis* and *tredecimguttatus* (Levi 1959, McCrone & Levi 1964, Abalos 1980, Lotz 1994 vs. Garb 2004), synonyms or arbitrary claims (Levi 1959, Roth & Craig 1970, Schmidt et al., 1994), species without description of robust morphological characters as described by Schmidt & Klaas (1991), type individuals being lost (e.g. *L. curacaviensis*) and possible new species (Aguilera 2005), an integral study is necessary where morphological and molecular characters are analyzed.

Results

In this research, we hypothesized phylogenetic relationships of the genus *Latrodectus* with iBOL markers-COI and also the gen alpha-latrotoxin. We also contrast the molecular relationships with morphological variations, which allow us to establish discrete characters to obtain the identity of *Latrodectus* species. From the phylogenetic analyzes we obtained the gene tree and in conjunction with the bPTP model allow us to confirm that iBOL markers are useful to determine the limits among species.

The results show a high genetic divergence among the specimens allocated under different nominal entities, greater than 2%, and species with 0% genetic divergence, variable divergence and possible new species are shown in Table 1.

In addition, the gene tree shows that the actually known suprageneric groups correspond to artificial groups and it is possible to recover only two groups, *mactans* group and *geometricus* group (Fig. 1), both with a high support which are validated by robust morphological characters (spermathecae disposition). Moreover, phylogeny in conjunction with the delimitation species approached by the bPTP model are congruent with few but enough morphological characters that allow to separate the different species. These combination of discrete characters, such as number of loops of spermathecae ducts, general coloration and abdominal setae in some females species, palp morphology (radix and conductor) in male can be used for the different species.

The phylogenetic and morphologic analysis allowed us to identify synonymous species, possible new species from easter Island, Nomen dubia and inquerenda species (Table 2) and especially to clarify the phylogenetic relationships among the *Latrodectus* species (Fig 1).

There are three clades of species grouped by distributional ranges: South America, North America and Australia-New Zealand clades.

Table 1: Genetic divergence for *Latrodectus* species with taxonomic implications

Divergence				
0 %	0 %	0 %	2,3 %	variable
<i>L. thoracicus</i>	<i>L. coralinus</i>	<i>L. hasselti</i>	<i>L. geometricus</i>	<i>L. hesperus</i>
<i>L. mirabilis</i>	<i>L. diaguita</i>	<i>L. katipo</i> 78	<i>L. sp.</i> 38 - 51 n. sp. Easter island	
<i>L. variegatus</i>	<i>L. sp</i> 146 - 157 Colombia			
<i>L. sp</i> 156 Chile				

Conclusion

- The *mactans* group and the *geometricus* group are natural groups. They are evidenced with morphological characters, such as the disposition of the spermathecae.
- Three species groups can be separated by geographical distributions: Australia - New Zealand, North America, South America.
- From the phylogenetic analyzes, the delimitation of species, and with morphological characters it can be inferred that of the known and currently described 31 *Latrodectus* species, only 24 species are recognized and one possible new species which need to be described.
- Discrete character sets can be proposed that allow the differentiation of males and females of most *Latrodectus* species, among which the most relevant are: Coefficient TT, Abdominal setae and internal genitalia of the female and most important morphology of the male palp

Abalos. 1980. Las arañas del género *Latrodectus* en la Argentina.

Aguilera. 2005. El género *Latrodectus* Walckenaer, 1805 (Araneae: Theridiidae) en Chile y antecedentes de su veneno.

Garb et al. 2004. The black widow spider genus *Latrodectus* (Araneae: Theridiidae): phylogeny, biogeography and invasion history.

Levi. 1959. The spider genus *Latrodectus* (Araneae, Theridiidae).

Lotz. 1994. Revision of the genus *Latrodectus* (Araneae: Theridiidae) in Africa.

McCrone & Levi. 1964. North American Widow spiders of the *Latrodectus curacaviensis* group. (Araneae: Theridiidae).

Roth & Craig. 1970. Arachnida of the Galapagos Islands.

Schmidt et al. 1994. Zur Kenntnis der Spinnenfauna der Kapverdischen Inseln (Arachnida: Araneida).

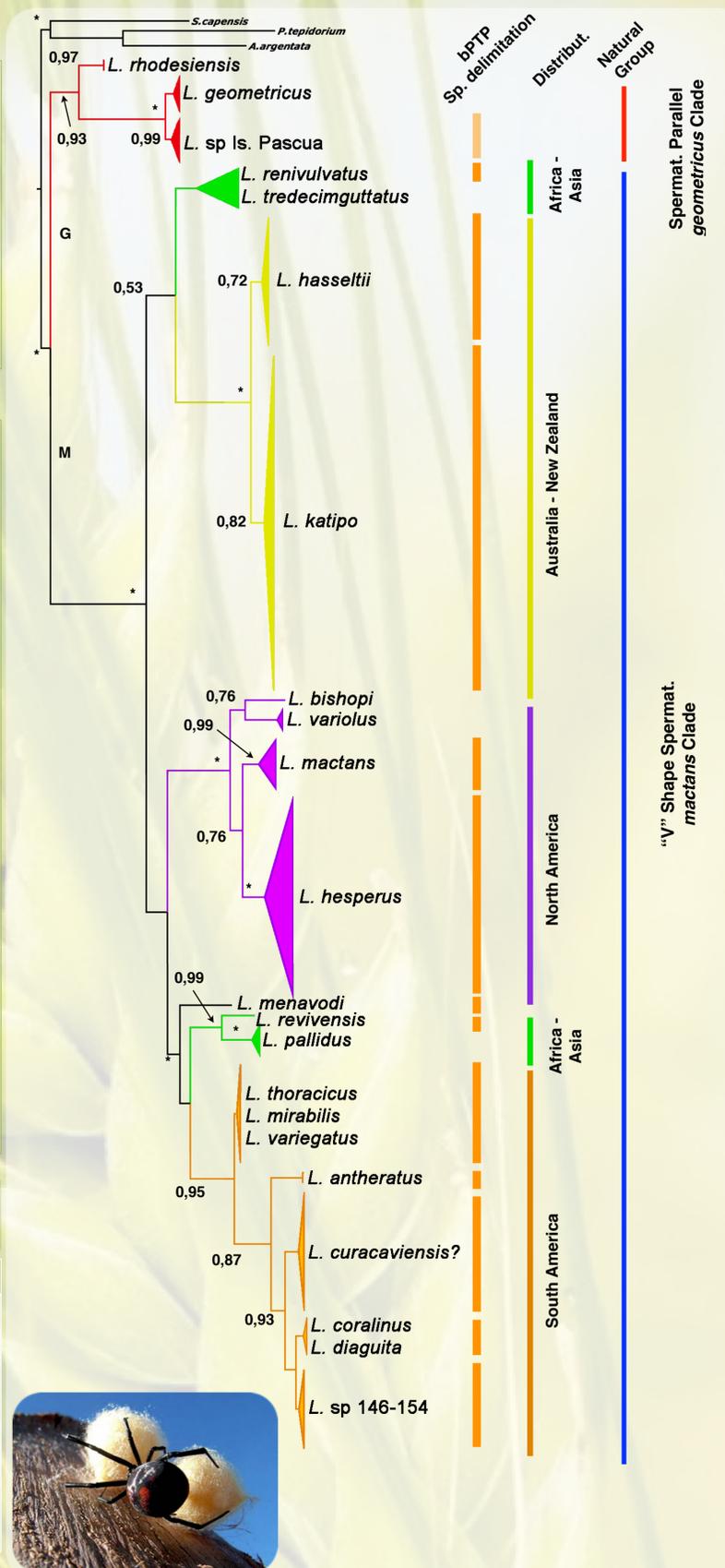


FIGURE 1: *Latrodectus* phylogeny based on BMCMC analysis obtained from the sequences of the COI gene, where BMCMC represents the consensus tree of N = 6055 trees of the convergence of the Markov chain. Subsequent probabilities over 0.5 are shown in each node.

Table 2: Taxonomic results

Valid specie	Sinonimous
<i>L. thoracicus</i>	<i>L. diaguita</i> , <i>L. quartus</i> and <i>L. mirabilis</i>
<i>L. geometricus</i>	<i>L. obscurior</i>
Missidentification	
<i>L. variegatus</i>	
Nomen dubium	
<i>L. variegatus</i> , <i>L. erythromelas</i>	
Nomen Inquerenda	
<i>L. curacaviensis</i>	

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