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Luiz Alexandre Simões de Castro

**Hydryphantoidea Piersig, 1896 (Acari: Parasitengonina:
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Rhynchohydracaridae:**

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For Miriam and Marina

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What, no myths?

“[...] the fascinating world of the very small never came to the notice of primitive peoples. If you think about this for a minute, it is not really surprising. They had no way of even knowing it was there, and so of course they didn't invent any myths to explain it! It wasn't until the microscope was invented in the sixteenth century that people discovered that ponds and lakes, soil and dust, even our body, teem with tiny living creatures, too small to see, yet too complicated and, in their own way, beautiful – or perhaps frightening, depending on how you think about them.”

Richard Dawkins (2011, p. 95-96)

RESUMO

Ácaros aquáticos, também conhecidos como Hydrachnidia, Hydrachnidiae, Hydrachnellae ou Hydracarina, podem ser encontrados em todos os ambientes de água doce e pertencem à coorte Parasitengonina, caracterizada por um tipo de desenvolvimento único dentro dos Acariformes, em que as larvas ocupam um nicho diferente dos outros estágios: após emergir dos ovos, são hexápodes e procuram um hospedeiro adequado, tornando-se ectoparasitas. O tempo de vida desta fase, assim como o tipo de hospedeiro e os locais de fixação são diversos. Após ingurgitadas, as larvas entram em um estágio quiescente chamado protoninfa, e então passam por uma muda e desenvolvem um quarto par de pernas, atingindo as condições de deutoninfa ativa, tritoninfa inativa e adulto ativo. Por essa razão, adultos e ninfas podem ser encontrados no mesmo ambiente, como predadores. Os Hydrachnidiae são compostos por 7 superfamílias e o monofiletismo deste grupo foi recentemente recuperado por meio de análises moleculares, com exceção de Hydryphantoidea, considerada parafilética. Na América do Sul, esta superfamília é representada por 4 famílias: Hydryphantidae, Hydrodromidae, Rhynchohydracaridae e Thermacaridae. Dentre os Hydryphantoidea, Rhynchohydracaridae apresenta origem sul-americana, com as subfamílias Clathrosperchontinae e Rhynchohydracarinae vivendo em águas correntes límpidas. Nesse contexto, o objetivo deste trabalho foi estudar os Hydryphantoidea da América do Sul com ênfase em Rhynchohydracaridae. Novas espécies dos gêneros *Clathrosperchonella* (fêmea, macho e larva) e *Rhynchohydracarus* (fêmea e macho) do Brasil foram descritas. DNA barcodes foram obtidos pela primeira vez para esta família, com sequências do gene COI para *Clathrosperchon minor*, *C. punctatus*, *Clathrosperchonella olovi* sp. nov. e *Rhynchohydracarus armiger* sp. nov. Uma proposta de homologia para estruturas do idiossoma *dorsalia*, *ventralia*, *lateralia* e *glandularia* em Rhynchohydracaridae é apresentada, padronizando futuros estudos morfológicos e novas descrições. Novas ocorrências de Hydryphantoidea são relatadas para o Brasil e Equador. Um catálogo de espécies de Hydryphantoidea descritas até o momento para a América do Sul é apresentado, com mapas de distribuição e uma chave ilustrada para famílias, subfamílias, gêneros e subgêneros.

Palavras-chave: Ácaros aquáticos. Riachos. Morfologia. Taxonomia integrativa. COI.

ABSTRACT

The water mites, also known as Hydrachnidia, Hydrachnidae, Hydrachnellae or Hydracarina, can be found in all freshwater environments and belong to the cohort Parasitengonina, characterized by a unique type of development within Acariformes, in which the larvae occupy a different niche from the other stages: after emerging from the eggs, hexapod larvae search for a suitable host and become ectoparasites. The life span of this stage, as well as the type of host and the places of attachment, are diverse. After engorged, larvae enter into a quiescent stage called protonymph, and then undergo a molt and develop a fourth pair of legs, reaching the conditions of active deutonymph, inactive tritonymph and active adult. For this reason, adults and nymphs can be found in the same environment, as predators. Hydrachnidae is composed of 7 superfamilies and the monophyly of this group has been recently recovered by means of molecular analysis, except for Hydryphantoidea, considered paraphyletic. In South America, this superfamily is represented by four families: Hydryphantidae, Hydrodromidae, Rhynchohydracaridae and Thermacaridae. Among hydryphantoids, Rhynchohydracaridae presents a South American origin, with the subfamilies Clathrosperchontinae and Rhynchohydracarinae living in pristine running waters. In this context, the aims of this work were study the Hydryphantoidea of South America with an emphasis in Rhynchohydracaridae. New species of the genera *Clathrosperchonella* (female, male and larva) and *Rhynchohydracarus* (female and male) from Brazil are described. DNA barcodes were obtained for the first time for this family, with sequences of the gene COI for *Clathrosperchon minor*, *C. punctatus*, *Clathrosperchonella olovi* sp. nov. and *Rhynchohydracarus armiger* sp. nov. A proposal for the homologies of dorsalia, ventralia, lateralialia and glandularia in Rhynchohydracaridae is presented and should help to facilitate and standardize future morphological studies and descriptions of new species in this family. New reports are presented for Brazil and Ecuador. A catalog of all described species of Hydryphantoidea until the moment for South America is presented, with maps of distribution and an illustrated key for the families, subfamilies, genera and subgenera.

Keywords: Water mites. Streams. Morphology. Integrative taxonomy. COI.

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LIST OF ABBREVIATIONS AND INITIALS

BNHM	British Natural History Museum, London, England
DCB	Departamento de Ciências Biológicas, São José do Rio Preto, Brazil
FMNH	Field Museum of Natural History, Chicago, USA
GNHM	Göteborgs Naturhistoriska Museum, Gothenburg, Sweden
IFML	Instituto Fundación Miguel Lillo, Tucumán, Argentina
MBR	Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Buenos Aires, Argentina
MNH	Museum of Natural History, Podgorica, Montenegro
MNHN	Muséum National d'Histoire Naturelle, Paris, France
MNHU	Museum für Naturkunde der Humboldt Universität, Berlin, Germany
NRM	Naturhistoriska Riksmuseet, Stockholm, Sweden
RMNH	Naturalis Biodiversity Center, Leiden, The Netherlands
SMF	Senckenberg Museum, Frankfurt, Germany
SMNH	Swedish Museum of Natural History, Stockholm, Sweden

LIST OF SIMBOLS

M	moles
µl	microliter
mg	miligram
ml	millilitre
s	seconds
RPM	revolutions per minute
mQ	milli Quality
PCR	Polymerase Chain Reaction
dNTPs	deoxynucleotide triphosphates
Taq	thermostable DNA polymerase I
COI	cytochrom oxydase subunit 1
mtCOI	mitochondrial cytochrom oxydase subunit 1

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1 GENERAL INTRODUCTION

1.1 Characterization and biology of water mites (Hydrachnidiae)

There are approximately 7500 species of water mites *sensu stricto* (Acariformes: Hydrachnidiae), also known as Hydrachnidia, Hydrachnellae or Hydracarina, distributed among 56 families, 485 genera and 214 subgenera (WALTER *et al.* 2009; ZHANG *et al.* 2011; DABERT *et al.* 2016; SMIT, 2020b). Water mites can be found in all freshwater environments, both lentic and lotic, from phytotelmata (plants that accumulate water), e.g. bromeliads (ROSSO DE FERRADÁS & FERNÁNDEZ, 2001; PEŠIĆ *et al.* 2015a, 2015b), water-filled treeholes and leaf axils (SMITH & HARVEY, 1989; WALTER & PROCTOR, 2013), lakes, temporary ponds, rivers (PROCTOR, 2015), the hyporheic interstitial zone of streams (GOLDSCHMIDT & RAMÍREZ-SÁNCHEZ, 2020), springs and seepage areas (COOK, 1974), near-freezing glacial meltwater (WALTER & PROCTOR, 2013) and even in hot springs (COOK, 1980, 1988; MARTIN & SCHWOERBEL, 2002). Just one family (Pontarachnidae) has secondarily invaded brackish waters and the coastal region of the oceans (PROCTOR *et al.* 2015; CHATTERJEE *et al.* 2019).

Water mites belong to the cohort Parasitengonina (WALTER *et al.* 2009). This cohort is characterized by a unique type of development within Acariformes, in which the larvae occupy a different niche from the other stages: after emerging from the eggs, hexapod larvae search for a suitable host and become ectoparasites (SMITH *et al.* 2010; SMITH & COOK, 2016). The duration of this stage, the type of host and the places of attachment on the host, are diverse (LANCIANI, 1971; PRASAD & COOK, 1972; SMITH, 1984; SMITH & OLIVER, 1986). In most taxa, larvae parasitize insects of many orders, such as Odonata, Plecoptera, Hemiptera, Diptera and Trichoptera (PROCTOR *et al.* 2015). In some more derived groups, larvae live as commensals in sponges or as parasites of mussels, snails or amphibians (GOLDSCHMIDT *et al.* 2002, 2020, 2021a, 2021b; GOLDSCHMIDT & KOEHLER, 2007; GOLDSCHMIDT & FU, 2011; MARTIN & SCHWOERBEL, 2002; SMITH & COOK, 2016). After becoming fully engorged, larvae enter into a quiescent stage called protonymph, and then they undergo a molt and develop the fourth pair of legs, reaching the conditions of active predatory deutonymph, inactive tritonymph and finally, active predatory adult.

Depending on the species, adults and nymphs feed on eggs and larvae of insects, cladocerans, ostracods and copepods. Less frequently, some species prey on other mites and also rotifers, nematodes, oligochaetes and isopods (WALTER & PROCTOR, 2013; PROCTOR *et al.* 2015).

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5 GENERAL CONCLUSION

The early derivative Hydryphantoidea occurs in all continents, except Antarctica, and comprises 7 families. Four of them are found in South America, with a great richness of genera and species. The Hydryphantidae represents the major group, composed of 10 genera. The knowledge of this lineage of interesting soft-bodied water mites is far from being totally understood. Some regions are poorly sampled or completely unknown in terms of the composition of fauna. The diversity of different biomes and the extensive hydrography enable each watercourse to harbor a myriad of new taxa. Furthermore, the association between water mites and their insect hosts remains largely unknown. Several hydryphantids, for instance, and all rhynchohydracarids inhabit pristine running waters and their prey and hosts during the larval stage still have been waiting to be discovered. Moreover, these have been rapidly destroyed and most species will get extinct before we will be able to describe or even collect them. Therefore, probably a large part of the diversity of water mites will never be described.

Prospective works might focus on sampling greater varieties of freshwater environments, including stagnant and running waters. However, it is necessary not only to discover new species of Hydryphantoidea and describe them, but also to recollect the already described species for improving the barcode library. Presenting a catalog, with a key for all species for this paraphyletic lineage was one of the first steps for further investigations. Furthermore, establishing a regular pattern for idiosomal structures in Rhynchohydracaridae will be very important for future taxonomic issues.