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(Digenea: Sanguinicolidae) from five families of tropical Indo-Pacific fishes**

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***Cardicola* Short, 1953 and *Braya* n. gen. (Digenea: Sanguinicolidae) from five families of tropical Indo-Pacific fishes**

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Abstract

A survey of Pacific coral reef fishes for sanguinicolids revealed that two species of Lutjanidae (*Lutjanus argentimaculatus*, *L. bohar*), six species of Siganidae (*Siganus corallinus*, *S. fuscescens*, *S. lineatus*, *S. margaritiferus*, *S. punctatus*, *S. vulpinus*), seven species of Chaetodontidae (*Chaetodon aureofasciatus*, *C. citrinellus*, *C. flavirostris*, *C. lineolatus*, *C. reticulatus*, *C. ulietensis*, *C. unimaculatus*), three species of Scombridae (*Euthynnus affinis*, *Scomberomorus commerson*, *S. munroi*) and three species of Scaridae (*Chlorurus microrhinos*, *Scarus frenatus*, *S. ghobban*) were infected with morphologically similar sanguinicolids. These flukes have a flat elliptical body, a vestigial oral sucker, a single testis, separate genital pores and a post-ovarian uterus. However, these species clearly belong in two genera based on the position of the testis and genital pores. Sanguinicolids from Lutjanidae, Siganidae, Chaetodontidae and Scombridae belong in *Cardicola* Short, 1953; the testis originates anteriorly to, or at the anterior end of, the intercaecal field and does not extend posteriorly to it, the male genital pore opens laterally to the sinistral lateral nerve chord and the female pore opens near the level of the oötype (may be anterior, lateral or posterior to it) antero-dextral to the male pore. Those from Scaridae are placed in a new genus, *Braya*; the testis originates near the posterior end of the intercaecal field and extends posteriorly to it, the male pore opens medially at the posterior end of the body and the female pore opens posterior to the oötype, antero-sinistral to the male pore. The second internal transcribed spacer (ITS2) of ribosomal DNA from these sanguinicolids and a known species, *Cardicola forsteri* Cribb, Daintith & Munday, 2000, were sequenced, aligned and analysed to test the distinctness of the putative new species. Results from morphological comparisons and molecular analyses suggest the presence of 18 putative species; 11 are described on the basis of combined morphological and molecular data and seven are not because they are characterised solely by molecular sequences or to few morphological specimens (n=one). There was usually a correlation between levels of morphological and genetic distinction in that pairs of species with the greatest genetic separation were also the least morphologically similar. The exception in this regard was the combination of *Cardicola tantabiddii* n. sp. from *S. fuscescens* from Ningaloo Reef (Western Australia) and *Cardicola* sp. 2 from the same host from Heron Island (Great Barrier Reef). These two parasite/host/location combinations had identical ITS2 sequences but appeared to differ morphologically (however, this could simply be due to a lack of morphological material for *Cardicola* sp. 2). Only one putative species (*Cardicola* sp. 1) was found in more than one location; most host species harboured distinct species in each geographical location surveyed (for example, *S. corallinus* from Heron and Lizard Islands) and some (for example, *S. punctatus*, *S. fuscescens* and *Chlorurus microrhinos*) harboured two species at a single location. Distance analysis of ITS2 showed that nine species from siganids, three from scombrids and five from scarids formed monophyletic clades to the exclusion of sanguinicolids from the other host families. *Cardicola milleri* n. sp. and *C. chaetodontis* Yamaguti, 1970 from lutjanids and chaetodontids, respectively, were the only representatives from those families that were sequenced. Within the clade formed by sanguinicolids from Siganidae there was a further

division of species; species from the morphologically similar *S. fuscescens* and *S. margaritifera* formed a monophyletic group to the exclusion of sanguinicolid species from all other siganid species.

Key words: *Cardicola* Short, 1953; *Braya* n. gen.; Sanguinicolidae; Digenea; Perciformes; Chaetodontidae; Lutjanidae; Scaridae; Scombridae; Siganidae; Indo-Pacific Region

Introduction

The Sanguinicolidae von Graff, 1907, digeneans of the blood circulatory system and body cavity of marine and freshwater teleosts, elasmobranchs and holocephalans, currently comprises 24 genera from 51 families and 15 orders of fishes. Of the 16 genera known to infect teleosts of the order Perciformes, *Cardicola* Short, 1953, which contains 12 described marine species, is reported from the heart and the blood vessels of the kidney, liver, gill and coelom of fishes from the Chaetodontidae (Butterflyfishes), Cheilodactylidae (Morwongs), Kyphosidae (Drummers or Sea Chubs), Latidae (Barramundi or Lates Perches), Mugilidae (Mulletts), Odacidae (Cales and Weed-Whiting), Sciaenidae (Drums or Croakers), Scombridae (Tunas, Bonitos and Mackerels) and Sparidae (Sea Breams or Porgies) (see Smith (2002) and Bullard and Overstreet (2004)). This genus is distinguished by the possession of transverse rows of small ventro-lateral spines, an H-shaped intestine with anterior caeca shorter than, or about the same length, as the posterior pair, a largely inter-caecal single testis, separate sinistral sub-marginal genital pores, a medial ovary in the posterior third of the body, a post-ovarian uterus, a metraterm and a vitellarium that is follicular. *Cardicola* may or may not possess a cirrus-sac but does lack an oral sucker, an auxiliary external seminal vesicle, a seminal receptacle and a Laurer's canal (Short 1953; Smith 2002).

During a survey of fishes from Moreton Bay and the Great Barrier Reef off Queensland, Ningaloo Reef off Western Australia, and sites off Palau, Moorea and New Caledonia we found 18 undescribed sanguinicolids, belonging to *Cardicola* and a new genus, *Braya*, in the sinus venosus, heart and gills of lutjanid, siganid, scarid and scombrid fishes. The new species are described here together with new host records and a redescription of *Cardicola chaetodontis* Yamaguti, 1970.

Material and methods

Collection locations

Fishes were collected off Heron Island (23°26'S 151°54'E) and the Swain Reefs complex (21°54'S 152°22'E and 21°36'S 152°22'E) on the southern Great Barrier Reef (GBR), Lizard Island (14°40'S 145°27'E) on the northern GBR, Bribie Island (26°57'S 153°07'E) and North Stradbroke Island (27°36'S 153°27'E) in Moreton Bay (southeast