

Cardiocephaloides spp. (Digenea) from the eyes and brain of endemic South African klipfish

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INTRODUCTION

The small genus *Cardiocephaloides* Sudarikov, 1959 (Family Strigeidae) contains seven species that have been described globally. However, only one of these species have been found in South Africa: *Cardiocephaloides physalis* (Lutz, 1927). Adults of this species have been found to cause mortalities in the chicks of the African penguin *Spheniscus demersus* (Linnaeus, 1758), whereas metacercariae have been found in the eyes of the South American plichard *Sardinops sagax* (Jenyns, 1842), in South Africa.

The super klipfish *Clinus superciliosus* (Linnaeus, 1758) and the bluntnose klipfish *Clinus cottoides* (Valenciennes, 1836) are endemic to the coast of southern Africa and have been the focus of various studies. However, their digenean diversity has not been fully explored yet. Thus the **aim** of this study was to assess the diversity of digeneans from these two host species collected along the South African coast.



Clinus superciliosus

MATERIALS & METHODS

Sampling

Eighty three *C. superciliosus* were collected from Saldanha Bay, Cape Town harbour, Hermanus, Tsitsikamma National Park, Jeffreys Bay and Chintsa; and six *C. cottoides* were collected in Jeffreys Bay.

Morphological study

Digenean specimens were stained with Mayer's haematoxylin or acetocarmine and permanently mounted in Dammar gum on slides. Slides were used for morphological measurements and drawings.

Molecular study

Genetic markers used: 28S rDNA, ITS2 rDNA and *cox1* mtDNA. Novel sequences were compared to available sequences in GenBank and included in phylogenetic analyses using Bayesian inference (BI) and maximum likelihood (ML) methods.

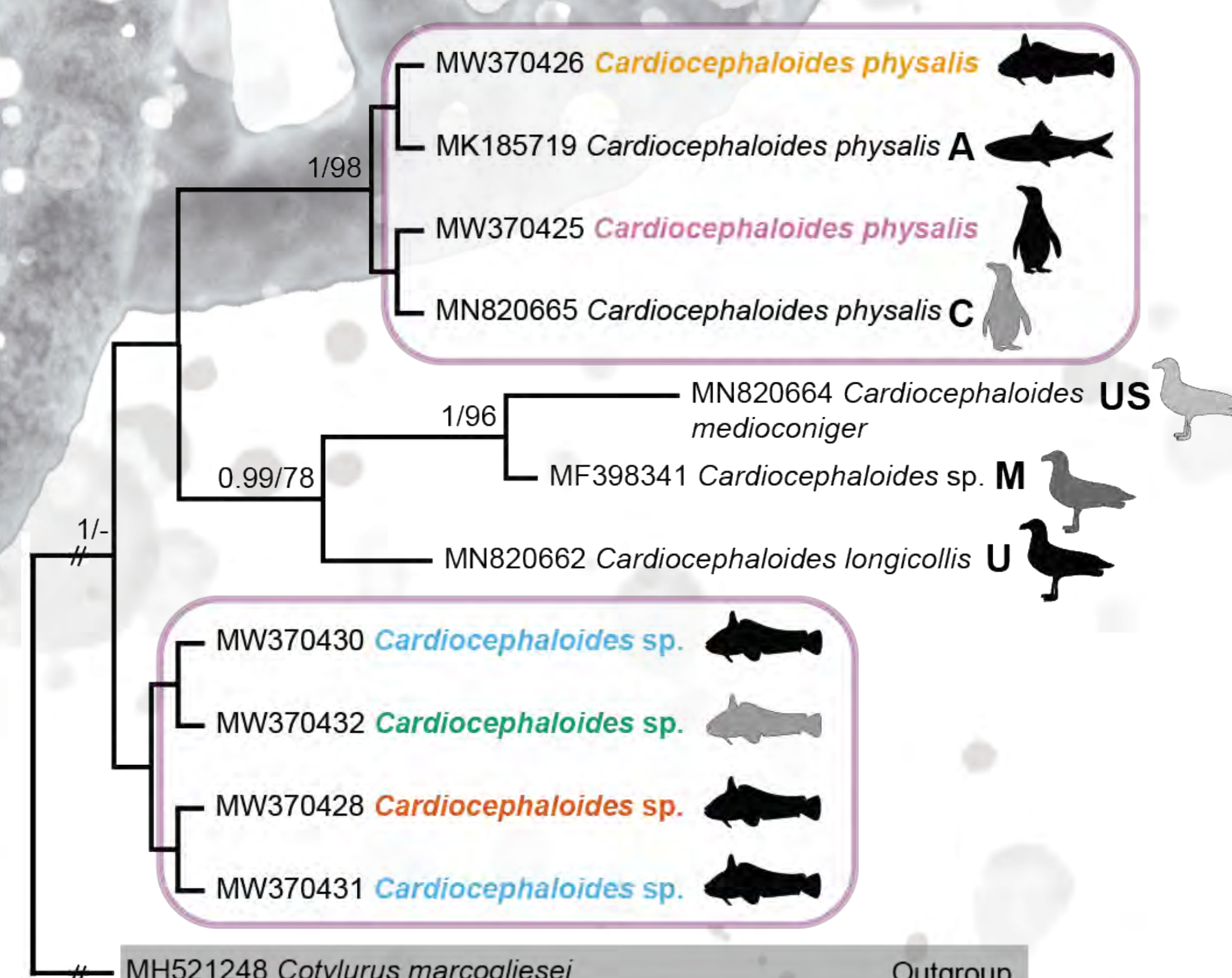
RESULTS & DISCUSSION

Cardiocephaloides physalis

Of the 89 fishes collected, 21 were infected with metacercariae of the genus *Cardiocephaloides*. Most metacercariae were present in the eye vitreous humour of fishes, but some were found in the brain of fish from Saldanha Bay and Chintsa. Fishes from Saldanha Bay also had the highest intensity of infection with these parasites. Interestingly, no digeneans were found in the fishes collected in Cape Town harbour.

Morphological and molecular analyses revealed that the metacercariae found during this study belong to two species: *C. physalis* and an unidentified species of *Cardiocephaloides*. We therefore provide the first detailed morphological description associated with DNA sequences of *Cardiocephaloides* spp. from South Africa. We also confirmed that the diversity of *Cardiocephaloides* in South Africa is higher than previously recorded. Based on molecular sequence data for a more variable gene (*cox1*), the broad geographic distribution of *C. physalis* has been confirmed, as this species is reported from both Africa and South America. Also, *Cardiocephaloides* sp. was found to be conspecific to an unidentified sporocyst found from whelks in New Zealand, based on ITS1 analyses.

Cardiocephaloides sp.



Localities

Chintsa
Hermanus
Jeffreys Bay
Saldanha Bay
East coast
Tsitsikamma National Park

Hosts

Clinus superciliosus
Clinus cottoides
Sardinops sagax
Larus argentatus
Larus occidentalis
Thalasseus maximus
Spheniscus demersus
Spheniscus magellanicus

Bayesian inference tree based on 28S rDNA. Nodal support values are given as BI/ML. Support values lower than 0.90 (BI) and 70 (ML) are not shown. Newly generated sequences are highlighted in bold. Abbreviations: A, Atlantic Ocean, South Africa; C, Chile; M, Mexico; U, Ukraine; US, United States of America.

CONCLUSION

- This is the first report of clinid fishes as intermediate hosts of *Cardiocephaloides* spp.
- *Clinus superciliosus* and *C. cottoides* are good potential candidates for studies regarding host-parasite interactions, especially parasite manipulation of host behaviour.
- We highlight the importance of molecular analyses in the accurate identification of digeneans, especially larval stages that are more difficult to identify morphologically.