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ORIGINAL ARTICLE

Further report of *Bariaka alopiae* Cressey, 1966 (Copepoda, Siphonostomatoida) from the Indian Ocean with new host and geographic record

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Abstract A copepod parasite, *Bariaka alopiae* Wilson, 1932 (Eudactylinidae) infested on thresher sharks caught from the Indian Exclusive Economic Zone off Andaman and Nicobar archipelago, eastern Indian Ocean is further reported. Adult females of *B. alopiae* were collected from the gill filaments of two host species, *Alopias pelagicus* Nakamura and *A. superciliosus* Lowe. The species *B. alopiae* can be easily distinguished from other species within the genus by the following characteristic features: cylindrical body devoid of spines, eighteen segmented antennules and four segmented abdomen. In the Indian Ocean, this parasite was known only from its original description 51 years ago, based on materials from western Indian Ocean off Madagascar. Further the present study reports, *A. pelagicus* as a new host for this parasite.

Keywords Ectoparasites · *Bariaka alopiae* · *Alopias pelagicus* · *Alopias superciliosus* · Andaman and Nicobar waters

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Introduction

The copepod parasite family Eudactylinidae Wilson, 1932 comprises 12 genera with 46 valid species and is characterised by elongated cylindrical body demarcated into cephalothorax and an unsegmented trunk except in the genera *Eudactylina* Van Beneden, 1853, *Nemesis* Risso, 1826 and *Kroyeria* Van Beneden, 1853 (Pillai 1985; Walter and Boxshall 2018). Seven of these genera are monotypic and most of them are host specific (Walter and Boxshall 2018), infesting the gills of elasmobranchs and rarely on teleost like *Lichia amia* Linnaeus.

The genus *Bariaka* Cressey, 1966 was created to accommodate *Bariaka alopiae* Cressey, 1966, a parasitic eudactylinid copepod collected from the gills of the bigeye thresher, *Alopias superciliosus* caught off Nosy Iranja, Madagascar in the Western Indian Ocean during International Indian Ocean Expedition (collected by Cressey) and Pacific Ocean (by S. Kato). After this report, Pillai (1985), while cataloguing copepod parasites of Indian waters, redescribed *B. alopiae* using samples collected by Cressey. Reports on further instances of collection of this species from the Indian Ocean could not be encountered in the literature.

In the month of October 2017, during the exploratory longline operations conducted onboard MFV *Blue Marlin*, the research vessel of the Fishery Survey of India (FSI) Port Blair, in the Indian Exclusive Zone (EEZ) off Andaman and Nicobar archipelago; we collected 15 adult females of this parasite from the gills of *A. pelagicus* and *A. superciliosus*. The current findings establish *A. pelagicus* as a new host for this parasite. Further, this forms the first report of this species from the Indian EEZ and a rediscovery of the species from the Indian Ocean after its first report 51 years ago.

Materials and methods

Parasite specimens were collected from the gill filaments of *A. pelagicus* and *A. superciliosus* caught opportunistically by the multifilament tuna longlining vessel MFV *Blue Marlin* during her October 2017 exploratory survey voyage from station number nine (10°19.2′N and 093°07.0′E; station depth—1310 m *A. pelagicus*) and station number 10 (10°16.5′N; 092°21.1′E, station depth—1209 m *A. superciliosus*) in the eastern Andaman waters (Fig. 1). The parasite specimens were removed from the hosts using fine forceps and preserved in 70% ethanol onboard. After the completion of the voyage, preserved samples were brought to the shore laboratory and cleared with lactic acid. The specimens were examined under a stereo microscope and measured using an ocular micrometer. The appendages were dissected using fine needles for detailed studies using a compound microscope. The parasite was identified according to Cressey (1966) and Pillai (1985). Microphotographs of all the samples were taken using a digital camera attached to the stereo microscope. Morphological characters of the specimens collected were compared with description of holotype female deposited in the United States National Museum (USNM 113035) by Cressey (1966) and the specimen descriptions by Pillai (1985). Voucher specimens are deposited at the Museum of the Port Blair Base of Fishery Survey of India (Ref. No. MUS.FSI.PB/EBP/05/2018).

Results and discussion

TAXONOMY

Order: Siphonostomatoida Thorell, 1859

Family: Eudactylinidae Wilson C.B. 1932

Genus: *Bariaka* (Cressey, 1966)

***Bariaka alopiae* (Cressey, 1966)**

Bariaka alopiae Cressey, 1966:324; Pillai, 1985:637

Types: The holotype female (USNM 113035), allotype male (USNM 113036), and four paratype females (USNM 113037) are held at the United States National Museum.

Diagnosis

The identification of *B. alopiae* is still based on Cressey (1966) and Pillai (1985). The body is vermiform and almost cylindrical (Fig. 2A), without dorsal plates and distinctive segmentation (Fig. 3A). Total length ranged from 8.9 to 9.8 mm and the greatest width recorded is 0.9 mm. Head is fused with first thoracic segment to form cephalothorax (Fig. 2B). The cephalothorax is longer than broad and its length is about 15.3% of the total body length. The free thoracic segments are indistinctly demarcated and

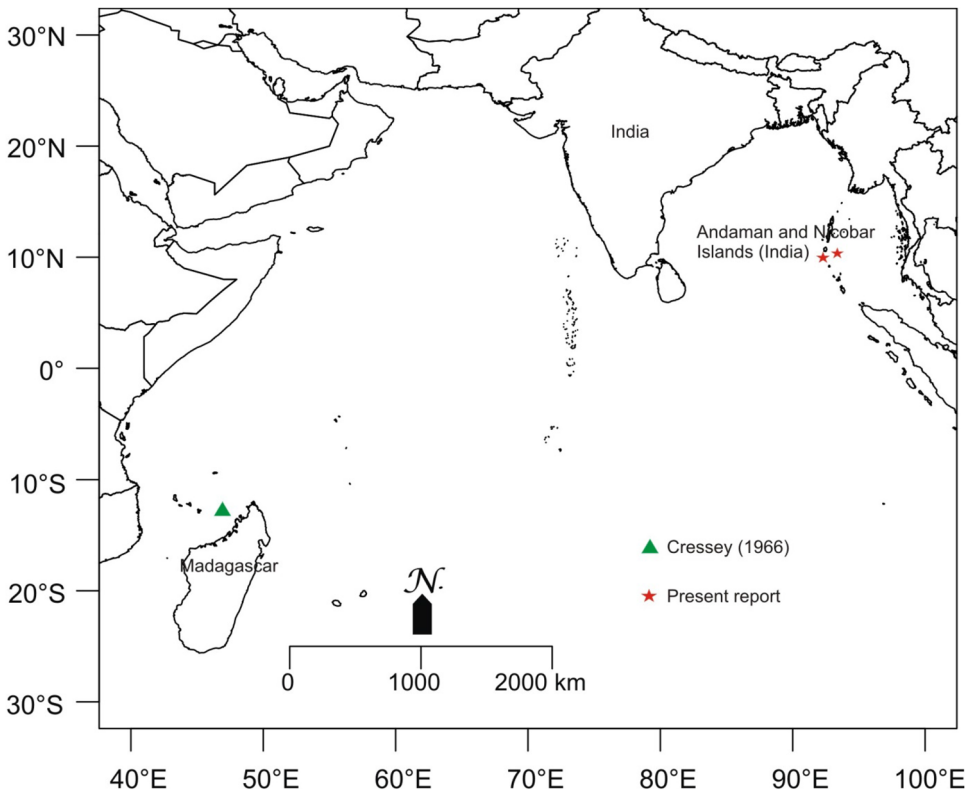

Fig. 1 Map showing reported distribution locations of *B. alopiae* in the Indian Ocean

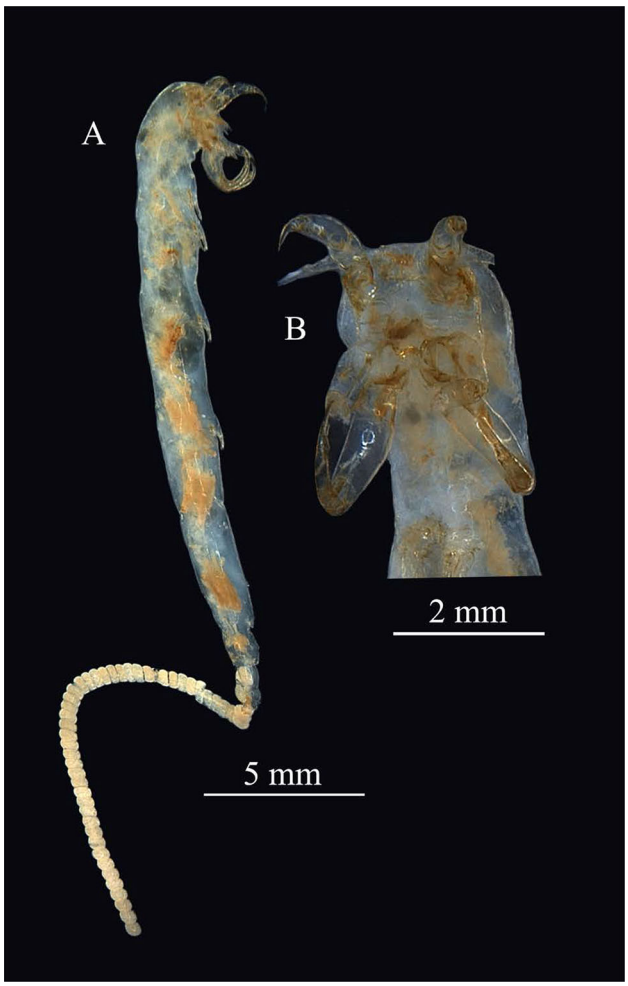

Fig. 2 A–B, Micrographs of *Bariaka alopiae* adult female. A, lateral view and B, ventral view of the head

forms 72.4% of the body length. The first three free thoracic segments are of about equal width, whereas segment bearing 5th leg is narrower than preceding segments. Genital segment, which forms about 5.1% of the body length, is fused with last thoracic segment and is nearly bilobed ventrally. The abdomen is slender, four segmented and forms about 6.1% of the body length. Caudal rami are very small, with three spines and three setae on the posterior region. Egg-sacs are uniseriate, straight and about half the total length.

Antennules (Fig. 3B) are slim with 18 segments, and bears slender setae. Antennae are (Fig. 3C) four segmented, regularly narrowing, with a second segment having two setae on the inner borders. Third segment has a patch of small median tubercles and the fourth segment is modified to a claw having a broad base carrying a setae on the inner margin medially. The mandibles are located within the mouth tube and are of a typical caligoid styliform type. First maxilla is (Fig. 3D) biramose; exopod is with 3 setae; of them central one is prominent and its endopod bears two long setae at the tip. Second maxilla (Fig. 3E) is 3 segmented; distal end of the second segment is covered with prominent hairs and the terminal segment is modified into stout claw. Maxilliped (Fig. 3F) is three segmented. Broader basal segment bears a strong spine on the inner side and the size of the first segment gradually narrowed to join curved second segment, which also bears a curved inner process medially. Terminal claw is formed with two stout setae of different sizes. First four thoracic legs are biramous, fifth leg rudimentary with three minute setae arranged equidistantly and the sixth leg is modified into knob like structures posterio-laterally.

Basipod of leg 1 (Fig. 3J) and first segment of endopod bears the patch of spinules; distal corners of endopod segments are modified into spiniform processes and the terminal segments bears curved setae. Second leg (Fig. 3G) is similar to leg 1 and lacks the curved terminal setae, but is with additional spinules on second endopod segment and first exopod segment. Third (Fig. 3H) and fourth (Fig. 3I) legs are similar to leg 2 respectively, but are with fewer setae on the terminal segments. Each lobe of fifth thoracic leg bears three setae and plumose setae near the base (Fig. 3K). Sixth legs are modified into knobs, which slightly protrudes into genital segment from where long, uniseriate egg strings are emerged (Fig. 3L).

The abdomen is four segmented and the first segment is sub rectangular (0.18 length × 0.35 mm width) and its width is about 60% of the genital segment. The second segment is the smallest (0.06 × 0.26 mm) among all abdominal segments. The lateral margins of third segment are rounded, and its length is about half of the width (0.14 × 0.27 mm). The fourth segment is a little wider than long (0.21 length × 0.29 mm width) and narrows down towards extremities. Caudal rami are very small with three spines and three setae and are attached to the fourth abdominal segment posterio-laterally.

Occurrence

We studied 15 adult females (Fig. 2) collected from *A. pelagicus* (nine parasite specimens from a single shark) and *A. superciliosus* (six parasite specimens from a single shark). They were attached on the gill filaments of the hosts by penetrating the secondary lamellae using their clawed antennae and maxillipeds. *B. alopiae* was recorded with a prevalence of 20% on *A. pelagicus* and 50% on *A. superciliosus*. All the parasites were adult females and 11 of them were ovigerous, carrying an 80-100 eggs per ovigerous females.

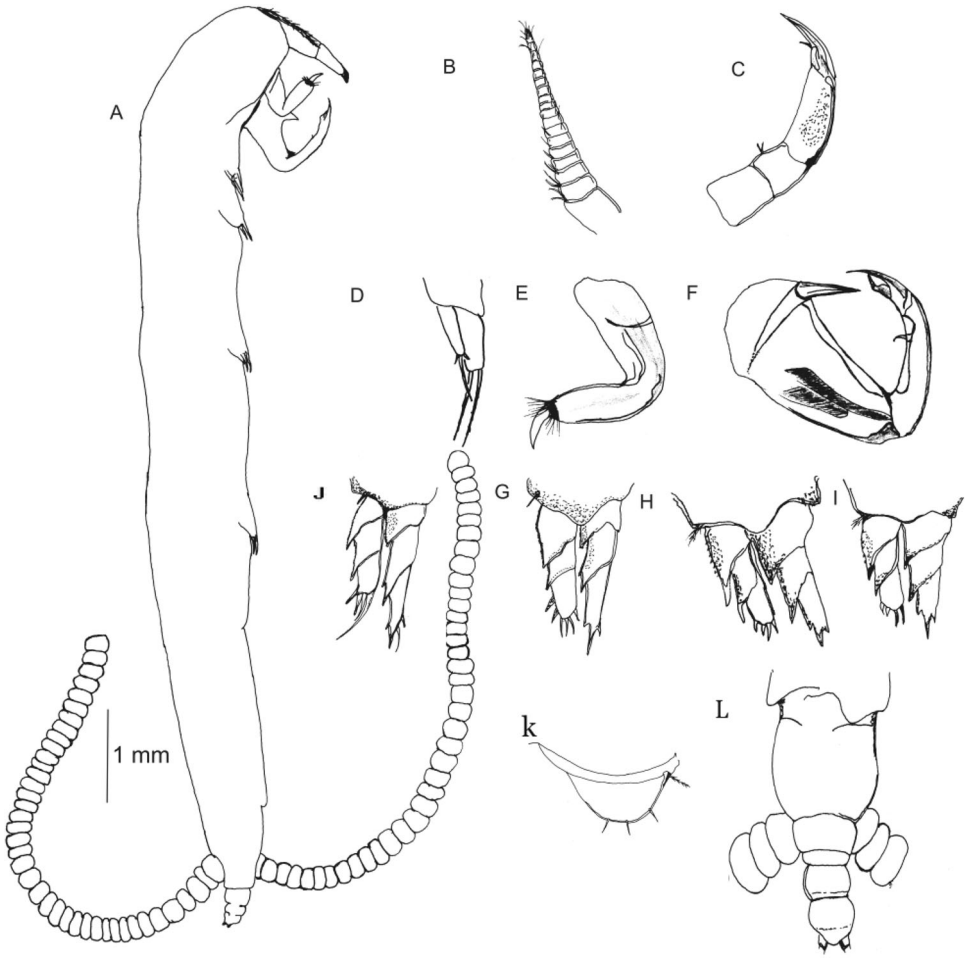

Fig. 3 A–K, *Bariaka alopiae* adult female. A, Line drawing of whole copepod B, Antennule C, Antenna D, First maxilla E, Second Maxilla F, Maxilliped G-J, First to fourth thoracic legs, K, Fifth leg L, Genital segments and caudal rami. The appendages are not in scale

Discussion

Most of the meristic and morphometric characters of our specimens are in sync with the original description of *B. alopiae* by Cressey (1966) and the samples examined by Pillai (1985). Minute variations are noted in the number of setae on the terminal segment of the antennae, our specimens have one in contrast to two setae as observed by Pillai (1985). Similarly 15–16 segments in the antennules, whereas present specimens have 18 segmented antennules similar to the holotype description (Cressey 1966). The thoracic segments of our specimens are indistinctly demarcated and sclerotisation was not prominent as mentioned by Pillai (1985). The endopod of the first thoracic leg bears a single prominent spine and spinules on the distal end as described by Cressey (1966), but lack setae in contrast to the original description. The illustration of the second thoracic leg by Pillai (1985) has an additional pointed process on the first segment of endopod other than the prominent spine, which was absent in our specimens as well as in the original description. Leg 5 bears three naked setae and plumose setae near the base in each lobe; in contrast to specimens studied by Pillai (1985) with four plumose setae.

Rokicki and Borowicz (1987) and Benz (1993) had studied with *B. alopiae* collected from the Atlantic Ocean. However, after the original description of *B. alopiae* 51 years ago from the western Indian Ocean, present study reports its occurrence from Indian EEZ with a new location report, Andaman. Further a new host, *A. pelagicus* for the copepod parasite.

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Author's contribution MN: Data collection, assist in the drafting of manuscript. SPV: Data collection, lead in the writing of manuscript, SSS: Data collection, AAMH: Work design and provided critical feedback, LR: Work design and supervised the project.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest (financial, academic, commercial, political or personal). No funding has been received for the conduct of this study and preparation of this manuscript.

Informed consent This article does not contain any identifying information about any individual.

Ethical approval The specimens not under the listed category of experimental animals which need ethics approval.

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