



# Novel report of three parasites of wahoo, *Acanthocybium solandri* (Cuvier, 1832) from Andaman and Nicobar Islands

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Original Article

## Abstract

Information on the parasites infesting wahoo, *Acanthocybium solandri* (Cuvier, 1832) from the Andaman and Nicobar Islands are reported for the first time. Two copepod parasites, *Lernaenicus seeri* Kirtisinghe, 1934 (Pennellidae Burmeister, 1835) and *Brachiella thynni* Cuvier, 1830 (Lernaepodidae Milne Edwards, 1840) and a digenean endoparasite *Hirudinella ventricosa* (Pallas, 1774) Baird, 1853 (Hirudinellidae Dollfus, 1932) were recovered from the wahoo sampled from Junglighat fish landing center in Port Blair. Prevalence, mean intensity and load of infestation and co-occurrence of parasites are described and discussed.

**Keywords:** Copepod parasite, new record, pennellids, endoparasites, trematodes

## Introduction

The wahoo, *Acanthocybium solandri* (Cuvier, 1832), a large pelagic predatory fish in the family Scombridae, is a widely distributed species occurring in all tropical and subtropical

waters of the world (Froese and Pauly, 2019). Wahoo is one of the fastest growing fishes (Zischke *et al.*, 2013) and have been recorded to a maximum weight of 96.4 kg (Theisen *et al.*, 2008) while the maximum total length reported is 250 cm (Sommer *et al.*, 1996). However, most of the specimens caught in the fishery had the total length range of 85-105 cm (Collette and Nauen, 1983). It is one of the most sought after sport fish species, usually caught with high speed trolls. Most of the wahoo catch are recorded as bycatch in the longline and purse-seine fisheries (Zischke, 2012) targeting tunas and swordfish, although they are occasionally targeted by recreational, subsistence, and artisanal fisheries in some parts of the world oceans (Zischke *et al.*, 2013). In the Andaman and Nicobar archipelago, wahoo is one of the most highly prized table fish and is sold as "seer fish" along with streaked Spanish mackerel *Scomberomorus lineolatus* (Cuvier, 1829) and narrow-barred Spanish mackerel, *S. commerson* (Lacepède, 1800).

Parasitic infestation on wahoo is fairly well documented in literature (Vijayakumar and Chandrasekar, 1992; Williams and Bunkley - Williams, 1996; Romeo *et al.*, 2005, Ho and Lin, 2012; Raja *et al.*, 2014; Venmathi Maran *et al.*, 2014). However, parasites of this species occurring in the Andaman and Nicobar waters are not studied so far. In this perspective, we surveyed

the parasites infesting on wahoo from Andaman and Nicobar Islands and recorded two parasitic copepods, *Lernaeenicus seeri* Kirtisinghe, 1934 (family Pennellidae Burmeister, 1835) and *Brachiella thynni* Cuvier, 1830 (family Lernaeopodidae Milne Edwards, 1840) and a digenean parasite *Hirudinella ventricosa* (Pallas, 1774) Baird, 1853.

Family Pennellidae are generally large sized, meso- or ecto-parasitic copepods penetrating deeply the tissues of their hosts (Kabata, 1988). This family includes 24 genera of which seven, *Lernaeenicus* Lesueur, 1824, *Cardiodectes* Wilson, 1917, *Peniculus* Nordmann, 1832, *Peniculisa* Wilson, 1917, *Lernaeolophus* Heller, 1865, *Pennella* Oken, 1815 and *Peroderma* Heller, 1865 are recorded from India (Pillai, 1985; Walter and Boxshall, 2019 b, c). The members of the genus *Lernaeenicus* Lesueur, 1824 are characterized by slender body, a characteristic head with two to three branched or unbranched horn like processes, which enable them to embed in the host tissues (Pillai, 1985) and the buccal area not forming a proboscis (Castro Romero, 2014). There are 30 valid species (Walter and Boxshall, 2019) in this genus and of them ten are reported in Indian seas (Raja *et al.*, 2016). *L. seeri* has been reported in the mainland India from both west (Varghese *et al.*, 2010) and east coasts (Vijayakumar and Chandrasekhar, 1992; Raja *et al.*, 2014, 2016) of the Indian Exclusive Economic Zone (EEZ) and the present report forms the first record of this parasite from the Indian EEZ off Andaman and Nicobar Islands.

The family Lernaeopodidae is one of the diverse groups of parasitic copepods with 48 valid genera which parasitize both elasmobranchs and teleosts (Walter and Boxshall, 2019 a, b). They have a unique mode of attachment as a result of modified maxillary arms with a bulla at the tip enabling them to attach to the hosts (Kabata, 2003). The genus *Brachiella* Cuvier, 1830 of this family consist of twelve valid species, of which five have been reported earlier from Indian mainland (Pillai, 1985). Present study records the first *Brachiella* species from the Andaman and Nicobar waters.

The digenean trematod genus *Hirudinella* de Blainville, 1828 includes three valid species parasitizing many large pelagic fishes. The cosmopolitan fleshy worm *H. ventricosa* (Hirudinellidae) parasitize on different scombrids, dolphin fishes and billfishes, but shows high affinity towards wahoo (Williams and Bunkley- Williams, 1996). Adults of this parasite attach to the host's stomach lining and feed on their blood (Williams and Bunkley- Williams, 1996). Raja *et al.* (2014) reported this parasite infecting wahoo of east coast of mainland India and the present report forms the first record of this parasite from the Indian EEZ off Andaman and Nicobar Islands.

## Material and methods

Parasites from the Wahoo *A. solandri* (Cuvier, 1832) (Fig. 1A) were collected during the routine field survey at Junglighat fish landing center (Latitude 11°39'22N; 92°43'82E), Port Blair, Andaman & Nicobar Islands. A total number of 484 host fishes were examined for external parasites on the mouth, body surface, gills and fins during the study period August 2017 to September 2018. However, only 43 fishes could be dissected for studying the endoparasites. Total length of the hosts ranged between 70 to 105 cm; weighing 03 to 7.5 Kg. Parasites collected from the landing centre were carefully removed and stored in 70% alcohol for further analysis in the laboratory. Microphotographs were made using a digital camera attached to the stereo microscope (LEICA 125 C). The parasites were identified according to Kirtisinghe (1934); Kabata (1979); Pillai (1985) (for copepod parasites) and Gibson (1976) (digenean parasite). Prevalence and mean intensity were calculated based on Margolis *et al.* (1982). Voucher specimens were deposited at the National Zoological collections of Zoological Survey of India, Andaman and Nicobar Regional Centre (ZSI/ANRC); ZSI/ANRC 22358 *L. seeri*, ZSI/ANRC 22359 *B. thynni*, ZSI/ANRC 22360 *H. ventricosa*.

## Results and discussion

After detailed analysis of wahoo landed at Junglighat fish landing centre during the period August 2017 to September 2018, two parasitic copepods from body surface and one digenean endoparasite from gut were recovered.

### Taxonomy

Order: Siphonostomatida Burmeister, 1835  
Family: Pennellidae Burmeister, 1835  
Genus: *Lernaeenicus* Lesueur, 1824  
*Lernaeenicus seeri* Kirtisinghe, 1934

### Diagnosis

Total of 119 specimens of *L. seeri* Kirtisinghe, 1934 (Fig.1C) were collected from the body surface of *A. solandri*. All the parasites were found deeply embedded in the host body by making a small hole in the epidermis, and penetrated in to the musculature leaving their trunk, abdomen and egg sacs hung outside. Total lengths of the parasite specimen were in the range 9.3 to 11.5 cm. Cephalothorax bears two pairs of characteristic horn like structures (Fig. 1F). Dorso-lateral horns (5.9-9.3 mm in length) longer than the ventro-laterals (3.8 -4.6 mm in length). A long (1.5 to 1.8 mm) and slender neck connects the trunk (1.7 to 2.2cm), wider than the neck. Abdomen very long (6.3 to 7.7 cm) and about same diameter

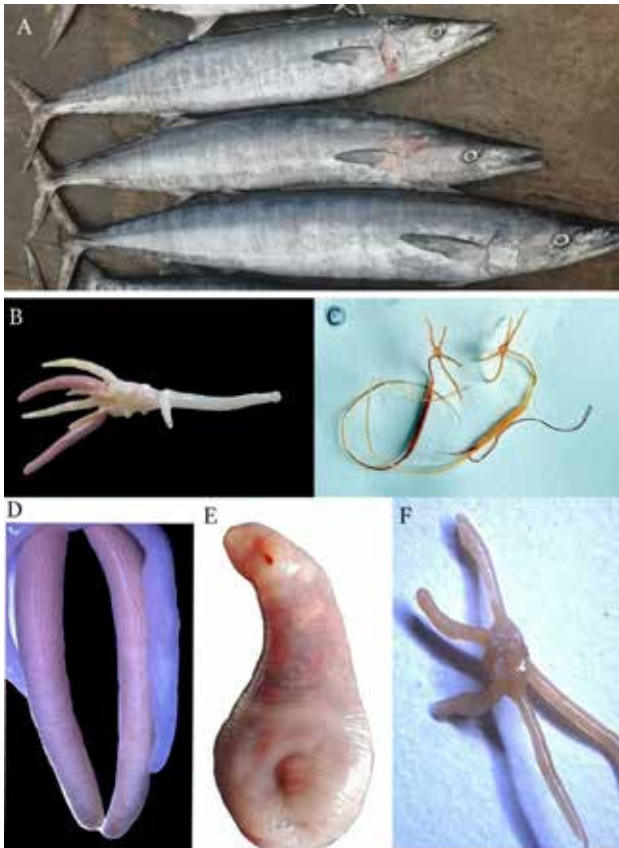


Fig. 1. A) Host *Acanthocybium solandri* (Cuvier, 1832); B) *Brachiella thynni* Cuvier, 1830; C) *Lernaenicus seeri* Kirtisinghe, 1934; D) *B. thynni* egg sacs; E) *Hirudinella ventricosa* (Pallas, 1774) Baird, 1835; F) *L. seeri* head process.

as neck; bears two slender and long egg sacs (7.0 to 8.1 cm), which is light bluish in fresh condition. Prevalence of *L. seeri* was 0.11%. The mean intensity of infestation for the population (abundance) was 0.24 and the mean intensity per infected fish was 2.08, whereas the range of parasite load per infected fish was between 02 to 08 numbers. Mean intensity and parasitic load vary within a host species; a single host wahoo was infested by 33 parasitic pennellids (Raja *et al.*, 2014). The number and position of the horn-like extensions on the head are the main species differentiating characteristic of the genera *Lernaenicus* (Pillai, 1985; Raja *et al.*, 2016). *L. anchoviellae* Sebastian and George, 1964 have cephalon with two short stumpy horns (Pillai, 1985), *L. seeri* and *L. alatus* Rangnekar, 1961 have four horns whereas *L. stromatei* Gnanamuthu, 1953, *L. hemirhamphi* Kirtisinghe, 1932, *L. polynemi* (Bassett-Smith, 1898) possess three horns on the dorsal of the head (Raja *et al.*, 2016).

Of the 32 valid species of the genus *Lernaenicus* (Walter and Boxshall, 2019 c) ten have been reported from India (Pillai, 1985; Raja *et al.*, 2016). Kirtisinghe (1934) described the *L. seeri* from the wahoo caught in Sri Lankan waters. Our record extends

the distribution range of the species to Andaman and Nicobar waters. Most of the parasites in the present study were recovered from the belly region and some of them even found attached to the caudal fin. Raja *et al.* (2016) stated that *L. seeri* shows a preference for the ventral side of the host for attachment. *L. seeri* in early stages attaches to the host by its antennae and maxilliped and make primary lesion on the epidermis using mouth parts through which it penetrate, to host tissue and holds firmly with the help of horns (Raja *et al.*, 2014). The presence of wound in the epidermis may lead to secondary bacterial infection and such wounds reduce the marketability of the fish. On most of such occasions, fish vendors pluck the parasites leaving its head and portion of the trunk inside the host body. High prevalence and mean intensity was recorded in January followed by October and September during the study period. Similar kind of high prevalence and mean intensity during post monsoon was recorded by Raja *et al.* (2014) for the samples collected from southeast coast of India.

### Taxonomy

Order: Siphonostomatida Burmeister, 1835  
 Family: Lernaepodidae Milne Edwards, 1840  
 Genus: *Brachiella* Cuvier, 1830  
*Brachiella thynni* Cuvier, 1830

### Diagnosis

A total number of 346 female specimens (Fig. 1B) of *B. thynni* were collected from 215 hosts during the study period. Total lengths of the parasites were in the range 31.4 mm to 34.6 mm. Colour of specimens in fresh condition off-white for the body, with pinkish, elongated egg sacs. Cephalothorax elongated (18.02 mm), cylindrical in shape and longer than trunk (7.54 mm). Maxilla (4.20 mm) also cylindrical, tapering towards the anterior bulla. Maxilliped short and stout with a curved spine, trunk longer (7.54mm) than wide; widest at the posterior end (5.77 mm). Two pairs of unequal processes, almost cylindrical in shape present on the base of the trunk; dorsal pair longer (14.84 mm) than the ventral pair (12.09 mm). Abdomen and caudal rami absent. Two elongated egg sacs, filled with hexagonal eggs of 0.2 mm size present on all the specimens caught. These egg sacs (Fig. 1D) slightly elongated than the dorsal processes (17.26 mm in length and 1.69 mm in width respectively). *B. thynni* can be distinguished from its close congener *B. trichiuri* Gnanamuthu, 1951 by the presence of indistinctly segmented trunk, elongated cephalothorax and indistinct carapace. Prevalence of *B. thynni* was 44.42%. The mean intensity of infestation for the population (abundance) was 0.71 and the mean intensity per infected fish was 1.6, whereas the range of parasite load per infected fish was 01 to 03 numbers.

*B. thynni* was first reported from *Thunnus alalunga* Bonnaterre in 1830 and they infest mostly on ocean migrating scombrids (Nagasawa, 2015) such as streaked seer fish (*Scomberomorus lineolatus* Cuvier), king mackerel (*S. cavalla* Cuvier), greater amberjack (*Seriola dumerili* Risso), albacore (*Thunnus alalunga* Bonnaterre), Atlantic bluefin tuna (*T. thynnus* Temminck and Schlegel), yellowfin tuna (*T. albacores* Bonnaterre) and Pacific bluefin tuna (*T. orientalis* Temminck and Schlegel). However, they show high affinity towards wahoo (Williams and Bunkley-Williams, 1996; Cressey and Cressey, 1980; Nagasawa, 2015; Walter and Boxshall, 2019). All the specimens in the present study were recovered from the pectoral fin base of wahoo. These parasites are well adapted to hide in the pit behind the pectoral fin base and rarely found on other parts of the body and gills (Williams and Bunkley-Williams, 1996). Of the twelve valid species of *Brachiella* Cuvier, 1830 five were reported from India (Pillai, 1985). It is a first record to Andaman and Nicobar Islands.

## Taxonomy

Order: Trematoda

Family: Hirudinellidae Dollfus, 1932

Genus: *Hirudinella* de Blainville, 1828

*Hirudinella ventricosa* (Pallas, 1774) Baird, 1853.

## Diagnosis

We collected 85 specimens of *H. ventricosa* from 43 wahoo caught from Andaman and Nicobar waters. Total lengths of parasites were in the range of 2.2 to 4.6 cm in fresh condition (Fig. 1E). Colour of the specimen varied between slight pinkish to brown. *H. ventricosa* can be easily distinguished from other digenean by the characteristic fleshy body surface with transverse folds and wrinkles. Body elongated and widest at the posterior end whereas in *H. ahi* (Yamaguti, 1970) hind body elongated and the body at the level of the ventral sucker nearly as wide as at the level of the posterior hind body (Yamaguti, 1970; Calhoun *et al.*, 2013). *H. ventricosa* possess two suckers close to each other at the anterior end. Nigrelli and Stunkard (1947) studied morphometrics of *H. ventricosa* caught from *A. solandri* who reported body length ranging from 31 to 58 mm, oral sucker to ventral sucker width ratio of 1:1.9-2.2. These results are in agreement with the observations made in the present study. The oral sucker is larger and opens in to pharynx, it continued as oesophagus. It possesses a median genital pore which opens ventrally near the oral sucker. The excretory pore is at posterior end. Prevalence of *H. ventricosa* was 90.69%. The mean intensity of infestation for the population (abundance) was 1.97 while the mean intensity per infected fish was 2.17, whereas the range of parasite load per infected fish was between 02 to 03 numbers. The prevalence could go up to 100% as noted

in the population of *A. solandri* caught off the Gulf of Mexico (Calhoun *et al.*, 2013).

The adult of *Hirudinella* typically attaches itself to the stomach lining (Manooch and Hogarth, 1983) and feeds on blood (Williams and Bunkley-Williams, 1996). Wahoo is the preferred host of *H. ventricosa*, but, it has also been reported from different species of tunas, billfishes, pilot fish, barracuda, king mackerel and dolphins (Williams and Bunkley-Williams, 1996; Gibson, 1976; Raja *et al.*, 2014). Chakrabarti *et al.* (2012) reported 36 parasitic trematodes including *H. ventricosa* from the stomach and intestine of commercially important fishes in India.

Present study records the first occurrence of Lernaepodid *B. thynni* Cuvier, 1830, pennellids *L. seeri* Kirtisinghe, 1934 and *H. ventricosa* (Pallas, 1774) Baird, 1853 in the Andaman and Nicobar waters. In certain case host was infested with both the parasites along with endoparasite *H. ventricosa* (Pallas, 1774) Baird, 1853. A detailed study on the parasites associated with wahoo is needed for the better understanding of co-occurrence of these parasites and their impact on the host.

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## References

- Calhoun, D. M., S. S. Curran, E. E. Pulis, J. M. Provaznik and J. S. Franks. 2013. *Hirudinella ventricosa* (Pallas, 1774) Baird, 1853 represent species complex based on ribosomal DNA. *Syst. Parasitol.*, 86:197-208.
- Castro Romero, R. 2014. Two new genera of pennellids (Copepoda: Siphonostomatoida): *Propeniculus* and *Pseudopeniculus*, each with a new combination, *Propeniculus trichiuri* (Gnanamuthu, 1951) and *Pseudopeniculus asinus* (Kabata and Wilkes, 1977). *Crustaceana*, 87: 551-569.
- Chakrabarti, S., A. Ghosh and K. Venkataraman. 2012. Trematode parasites of economically important fishes of West Bengal, India. *Trends Parasitol. Res.*, 1: 2319-3158.
- Collette, B. B. and C. E. Nauen. 1983. FAO Species Catalogue. Vol. 2. Scombrids of the world. An annotated and illustrated catalogue of tunas, mackerels, bonitos and related species known to date. Rome: FAO, *FAO Fish. Synopsis*, 125(2):137 pp.
- Cressey, R. F. and H. B. Cressey. 1980. Parasitic copepods of mackerel- and tuna like fishes (Scombridae) of the world. *Smithson. Contr. Zool.*, 311: 1-186.
- Froese, R. and D. Pauly. 2019. FishBase. World Wide Web electronic publication. Available from : <http://www.fishbase.org/> accessed on 10.01.2019.
- Gibson, D. I. 1976. Monogenea and Digenea from fishes. *Discovery Reports*, 36: 179-266.
- Ho, J. S. and C. L. Lin. 2012. *Gloiopotes hygomianus* Steenstrup and Lutken (Copepoda: Eurypboridae) parasitic on wahoo (*Acanthocybium solandri*) of Taiwan. *J. Fish Soc. Taiwan*, 39:47-55.
- Kabata, Z. 1979. Parasitic Copepoda of British fishes. Ray Society, London, England, 468pp.
- Kabata, Z. 1988. Copepoda and Brachiura. In: L. Margolis and Z. Kabata (Eds.), Guide to the parasites of fishes of Canada. Part II - Crustacea. Canadian Special Publication of Fisheries and Aquatic Sciences, p. 3-127.
- Kabata, Z. 2003. Copepods parasitic on fishes. The Linnean Society of London and Estuarine and Coastal Science Association. 274 pp.

- Kirtisinghe, P. 1934. *Gloiopotes watsoni* n.sp. and *Lernaenicus seeri* n. sp., parasitic copepods of fish from Ceylon. *Parasitology*, 26:167-175.
- Manooch, C. S. and W. T. Hogarth. 1983. Stomach contents and giant trematodes from wahoo, *Acanthocybium solandri*, collected along the south Atlantic and Gulf coasts of the United States. *Bull. Mar. Sci.*, 33: 227-238.
- Margolis, L., G. W. Esch, J. C. Holmes, A. M. Kuris and G. A. Schad. 1982. The use of ecological terms in parasitology (report of an ad hoc committee of the American Society of Parasitologists). *J. Parasitology*, 68: 131-133.
- Nagasawa, K. 2015. Infection of *Brachiella thynni* (Copepoda, Lernaepodidae) on Pacific bluefin tuna, *Thunnus orientalis* (Actinopterygii, Scombridae) cultured in Japan. *Crustaceana*, 88 (7-8): 945-948.
- Nigrelli, R. and H. Stunkard. 1947. Studies on the genus *Hirudinella*, giant trematodes of scombriform fishes. *Zoologica*, 31: 185-196.
- Pillai, N. K. 1985. Parasitic copepods of marine fishes. In: The Fauna of India. Calcutta. Zoological Survey of India, 900 pp.
- Raja, K., B. A. Venmathi Maran, A. Gopalakrishnan, A. Saravanakumar, R. Vijayakumar and K. Sinduja. 2014. Infestation of *Lernaenicus seeri* (Copepoda: Pennellidae) and *Hirudinella ventricosa* (Digenea: Hirudinellidae) on wahoo *Acanthocybium solandri* collected from Parangipettai, southeast coast of India. *Tropical Biomedicine*, 31: 477-486.
- Raja, K., A. Saravanakumar, A. Gopalakrishnan, R. Vijayakumar, U. W. Hwang, and B. A. Venmathi Maran. 2016. The genus *Lernaenicus* Lesueur (Copepoda, Siphonostomatoida, Pennellidae) in India: a checklist with notes on its taxonomy and ecology. *Zootaxa*, 4174 (1): 192- 211.
- Romeo, T., E. Azzurro and E. Mostards. 2005. Record of *Acanthocybium solandri* in the central Mediterranean Sea, with notes on parasites. *J. Mar. Biol. Assoc. UK*, 85: 1295-1296
- Sommer, C., W. Schneider and J. M. Poutiers. 1996. FAO species identification field guide for fishery purposes. The living marine resources of Somalia. FAO, Rome, 376 pp.
- Theisen, T. C., B. W. Bowen, W. Lanier and J. D. Baldwin. 2008. High connectivity on a global scale in the pelagic wahoo, *Acanthocybium solandri* (tuna family Scombridae). *Molecular Ecology*, 17: 4233-4247. <https://doi.org/10.1111/j.1365-294X.2008.03913.x>
- Varghese, S. P., K. Vijayakumar, M. Vinodkumar and V. D. Mhatre. 2010. On the first report of two parasites from the large pelagic predatory fishes of Indian EEZ. In: Book of abstracts, National symposium on parasite taxonomy, biodiversity and fish health - environmental health. Helminthological Society of India, 12-13 March, 2010.
- Venmathi Maran, B. A., Y. S. Oh, H. J. Choi and J. G. Myoung. 2014. Seasonal occurrence and habitat of two pennellids (Copepoda, Siphonostomatoida) infecting marine farmed black scorpion and Korean rockfish in Korea. *Tropical Biomedicine*, 31(2): 362-369.
- Vijayakumar, K. and S. Chandrasekhar. 1992. On the occurrence of 'wahoo' *Acanthocybium solandri* in the hooks and line catches off Lawsons Bay, Visakhapatnam. *Mar. Fish. Infor. Serv., Tech. Ext. Ser.*, 15-16: 115.
- Walter, T. C. and G. Boxshall. 2019a. World of Copepods database. Lernaepodidae Milne Edwards, 1840. Accessed through: World Register of Marine Species at: <http://www.marinespecies.org/aphia.php?p=taxdetails&id=135525> on 2019-02-02.
- Walter, T. C. and G. Boxshall. 2019b. World of Copepods database. Pennellidae Burmeister, 1835. Accessed through: World Register of Marine Species at: <http://www.marinespecies.org/aphia.php?p=taxdetails&id=135532> on 2019-02-02.
- Walter, T. C. and G. Boxshall. 2019c. World of Copepods database. *Lernaenicus* Lesueur, 1824. Accessed through: World Register of Marine Species at: <http://www.marinespecies.org/aphia.php?p=taxdetails&id=135644> on 2019-01-09.
- Walter, T. C. and G. Boxshall. 2019d. World of Copepods database. *Brachiella thynni* Cuvier, 1830. Accessed through: World Register of Marine Species at: <http://www.marinespecies.org/aphia.php?p=taxdetails&id=135839> on 2019-01-09.
- Williams E. H and L. Bunkley-Williams. 1996. Parasites of offshore, big game sport fishes of Puerto Rico and the western North Atlantic, Puerto Rico Department of Natural and Environmental Resources. San Juan, Puerto Rico, and Department of Biology, university of Puerto Rico, Mayaguez, Puerto Rico, 384 pp.
- Yamaguti, S. 1970. Digenetic Trematodes of Hawaiian Fishes. Tokyo, Keigaku Publishing Co., 436 pp.
- Zischke, M. T. 2012. A review of the biology, stock structure, fisheries and status of wahoo (*Acanthocybium solandri*), with reference to the Pacific Ocean. *Fish. Res.*, 119-120: 13-22.
- Zischke, M. T., S. P. Griffiths and I. R. Tibbetts. 2013. Rapid growth of wahoo (*Acanthocybium solandri*) in the Coral Sea based on length-at-age estimates using annual and daily increments on sagittal otoliths. - *ICES J. Mari. Sci.*, 70: 1128-1139.