Journal of the Marine Biological Association of the United Kingdom

cambridge.org/mbi

Marine Record

Cite this article: Mesaglio T, Dowse M, McMartin G (2022). First record of the barnacle *Conchoderma virgatum* on an ephippid fish. *Journal of the Marine Biological Association of the United Kingdom* **102**, 174–177. https://doi.org/10.1017/S0025315422000340

Received: 8 November 2021
Revised: 24 May 2022
Accepted: 2 June 2022
First published online: 6 July 2022

Key words:
Conchoderma; epibiont; Lepadidae; Perciformes

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First record of the barnacle *Conchoderma virgatum* on an ephippid fish

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Abstract

The goose barnacle *Conchoderma virgatum* is a highly opportunistic epibiont, with observations of attachment to a wide range of marine organisms. Attachment to perciform fishes, however, is rarely observed. Observations of *Conchoderma*-osteichthyan associations in general are also rare in the southern hemisphere, especially in Australian waters. We present the first record of *C. virgatum* as an epibiont on an ephippid fish (*Platax teira*). This is also only the second known record of *C. virgatum* attached to a perciform fish in the Tasman Sea. We also summarize all previous known observations of *C. virgatum* in association with perciform fishes.

Introduction

Goose barnacles (Lepadidae) are a cosmopolitan pelagic biofouling group, attaching themselves to almost any floating or moving substrate (Thiel & Gutow, 2005). Although most common on debris such as pumice, wood or plastic, they can also attach to living organisms. *Conchoderma virgatum* is especially opportunistic and has been observed attached to a diverse range of other marine species, including sea snakes (Yamato *et al.*, 1996; Alvarez & Celis, 2004), sharks (Beckett, 1968), fishes (Balakrishnan, 1969; Hastings, 1972; Nagasawa *et al.*, 2020) and even penguins (Nascimento *et al.*, 2010).

Most observations of *C. virgatum* as epibionts, however, are on whales (Uchida & Araki, 2000; Ólafsdóttir & Shinn, 2013) or sea turtles (Hernández-Vázquez & Valadez-González, 1998; Angulo-Lozano *et al.*, 2007), with the relatively slow speed of these hosts possibly facilitating easier attachment. Settlement on whales is often indirect, with *C. virgatum* attaching to other epibionts such as whale barnacles (*Coronula* spp.) rather than the smoother surface of the whales themselves (Félix *et al.*, 2006). Settlement on turtles is also biased towards hard or heterogeneous sites, such as carapace ridges and epidermal abrasions (Eckert & Eckert, 1987). In cases of settlement on fishes, the same preference for hard substrates occurs (Crozier, 1916), with *C. virgatum* recorded as attaching to the spines or rough skin of hard-bodied tetraodontiforms such as porcupinefishes or filefishes (Crozier, 1916; Balakrishnan, 1969), or to other hard body structures such as the bills of swordfishes (Beckett, 1968).

Results and discussion

Here we present the first known record of *Conchoderma virgatum* attached to an ephippid fish, the longfin batfish (*Platax teira*), and only the second known record of *C. virgatum* attached to a perciform fish in the Tasman Sea. During a recreational dive on 9 June 2013 at the ex-HMAS Adelaide, an artificial dive reef ~1.8 km off the New South Wales Central Coast, Australia (33.46°S, 151.45°E), an adult *P. teira* with an epibiont attached to its right pelvic fin was observed and photographed at ~22 m water depth (Figure 1). The photographs were uploaded to the online biodiversity citizen science platform iNaturalist (www.inaturalist.org) on 3 July 2020, and the epibiont identified as *C. virgatum*. This observation is also the first known record of *P. teira* as a host for any lepadid barnacle species.

Given their typical lack of external hard body parts such as spines, perciform fishes are relatively rarely observed as hosts for *C. virgatum* (Table 1), and indeed many of these cases involve indirect attachment via settlement on ectoparasitic *Pennella* copepods (e.g. Lazarus & Sreenivasan, 1977; Hernández-Trujillo *et al.*, 2014; Massi *et al.*, 2014). Mucus secretions by perciform fishes may play a strong role in preventing direct attachment by barnacle larvae (Shomura *et al.*, 1968; Dulčić *et al.*, 2015). The relatively smooth bodies of perciform fishes likely also contribute to reduced attachment success; lepadid barnacles such as *Conchoderma* and *Lepas* typically show strong preferences for rough or irregular surfaces when attaching to floating debris (Foster & Willan, 1979; Mesaglio *et al.*, 2021). In this record, direct settlement on *P. teira* was likely facilitated by the relatively slow swimming speed of this fish species, and by attachment to the right pelvic fin, allowing the barnacle to avoid the main mucus layer on the fish's body.

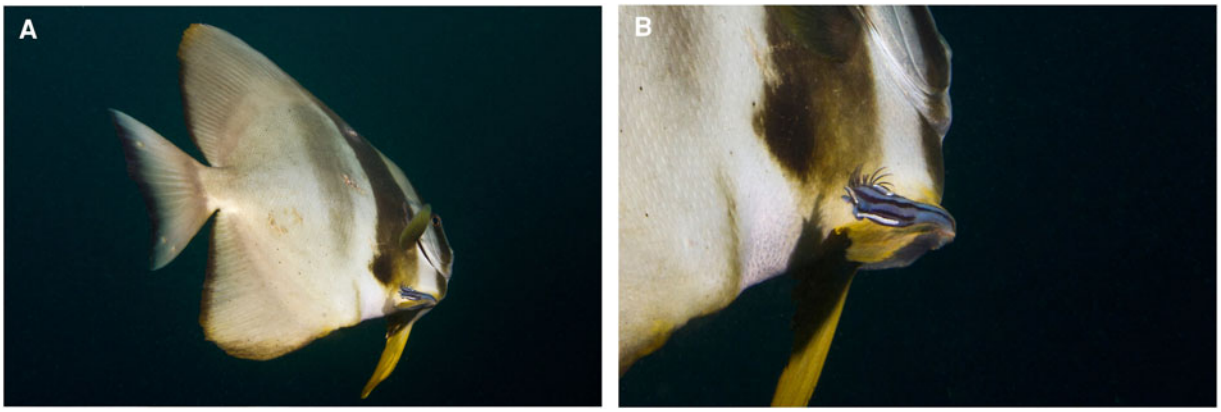

Fig. 1. (A) Lepadid barnacle *Conchoderma virgatum* attached to the right pelvic fin of a longfin batfish (*Platax teira*); (B) Close-up of *C. virgatum*. Observation made on 9 June 2013 at the ex-HMAS Adelaide, an artificial dive reef ~1.8 km off the New South Wales Central Coast, Australia at ~22 m water depth (33.46°S, 151.45°E).

Table 1. Known records of *Conchoderma virgatum* on perciform fishes

Family	Host species	Attachment	Source	Date	Location
Arripidae	*Arripis georgianus*	Direct; dorsal fin and midline between eyes	Williams & Bunkley-Williams (2019)	27 July 2019	Busselton, Western Australia
Echeneidae	*Echeneis naucrates*	Direct; soft dorsal fin, and unspecified attachment point	Stubbings (1965)	30 December 1954, and October 1955	Gorée, Senegal, and Bargny, Senegal (given as 'Barguy')
	Remora remora	Direct; dentary	Shomura *et al.* (1968)	23 January 1963	~650 km SE of the Island of Hawai'i
Ephippidae	*Platax teira*	Direct; right pelvic fin	Present record	9 June 2013	Central Coast, New South Wales
Istiophoridae	*Istiompax indica*	Indirect (via *Pennella* copepod)	Australian Museum	no collection date; deposited 1939	Sydney, New South Wales
	Istiompax indica	Indirect (via stingray spine embedded in the marlin's mouth)	Anislado-Tolentino *et al.* (2021)	2–3 May 2015	Huatulco, Oaxaca, Mexico
	Istiophorus albicans	Indirect (via *Pennella* copepods)	Fowler (1953)	March 1953	Pinas Bay, Panama
	Istiophorus platypterus	Direct; lesion above first anal spine	Shomura *et al.* (1968)	6 July 1963	~300 km WNW of the British Indian Ocean Territory
	Istiophorus platypterus	Indirect (via copepod *Pennella instructa*)	Varghese *et al.* (2009)	15–18 September 2006	North-western Indian EEZ
	Istiophorus platypterus	Indirect (via copepod *Pennella instructa*)	Pradeep *et al.* (2016)	February 2016	Andaman and Nicobar Islands
	Kajikia audax	Indirect (via *Pennella* copepods)	Hiro (1936)	22 September 1934, and 3 November 1934	Banda Sea, SE of Seram Island, and north of Morotai Island
	Kajikia audax	Indirect (via *Pennella* copepods)	Hiro (1937)	Not given	Waters around Seto Marine Biological Laboratory, Japan
	Kajikia audax	Indirect (via copepod *Pennella filosa*) Direct; close to the vent	Williams (1963)	Not given	East African coast, between 2°50'S and 8° 40'S, and to mostly within ~50 km of the coast
	Kajikia audax	Indirect (via copepod *Pennella filosa*)	Hernández-Trujillo *et al.* (2014)	4 December 2012	~48 km west of Baja California Sur, Mexico
	Xiphias gladius	Indirect (via *Pennella* copepods)	Hiro (1937)	Not given	Waters around Seto Marine Biological Laboratory, Japan
	Xiphias gladius	Direct; bill Indirect (via copepod *Pennella* copepods)	Beckett (1968)	23 September 1964 to 5 August 1968	Waters between Cape Hatteras and the Grand Banks, North-west Atlantic Ocean

(*Continued*)

https://doi.org/10.1017/S0025315422000340 Published online by Cambridge University Press

Table 1. (*Continued.*)

Family	Host species	Attachment	Source	Date	Location
	Xiphias gladius	Direct; bill, and lower jaw Indirect (via copepod *Pennella* copepods)	Garibaldi & Relini (2003)	Summer-autumn of 1996–2001	San Remo, western Ligurian Sea
	Xiphias gladius	Indirect (via copepod *Pennella instructa*)	Merella *et al.* (2005)	January 2003	Port of Alghero, Sardinia
	Xiphias gladius	Indirect (via *Pennella* copepods)	Loud (2012)	2012	Fish Market, Paotere, Makassar, Sulawesi
	Xiphias gladius	Indirect (via copepod *Pennella instructa*)	Massi *et al.* (2014)	October 2013	SW of Pantelleria Island, Strait of Sicily
	Xiphias gladius	Indirect (via copepod *Pennella instructa*)	Ramdani *et al.* (2021)	February–May 2019	Gulf of Bejaia, Algeria
Lobotidae	*Lobotes surinamensis*	Direct; occipital region of head	Dulčić *et al.* (2015)	12 May 2013	Raša Bay, Istria, Croatia
Polyprionidae	*Polyprion oxygeneios*	Direct; jaw	Foster (1978)	Not given	SSE of Aldermen Islands, New Zealand
Rachycentridae	*Rachycentron canadum*	Indirect (via copepod *Lernaeolophus sultanus*)	Dawson (1969)	13 August 1968	Horn Island, Mississippi
Zanclidae	*Zanclus cornutus*	Indirect (via copepod *Pennella diodontis*)	Lazarus & Sreenivasan (1977)	24 September 1971	Not given

Interestingly, there are observations of *C. virgatum* as a pioneer species on smooth surfaces (Mesaglio *et al.*, 2021), however, settlement is almost always followed by rapid predation due to their soft bodies and immobility once attached (Iljin *et al.*, 2013; Mesaglio *et al.*, 2021). Attachment to perciform fishes may therefore be more common than realized, with the rarity of observations possibly driven by predation by e.g. cleaner wrasses (Losey *et al.*, 1994).

Conclusions

As the first record of *C. virgatum* as an epibiont on an ephippid fish (and by extension, the first on the species *P. teira*), and only the second record of *C. virgatum* attached to a perciform fish in the Tasman Sea, this observation extends our knowledge of the distribution of *C. virgatum* as an epibiont, and of the known hosts for *C. virgatum*.

Acknowledgements. We thank Shane Ahyong and Hayden Schilling for their comments which improved the manuscript. We also thank Helen Stoddart and Amanda Hay for the Australian Museum records they provided to us, Connie Fleischer and Fulvio Garibaldi for providing us with difficult to access papers, and Paul Mesaglio for translating a paper from Italian. Two anonymous reviewers provided thoughtful comments that improved this manuscript.

Author contributions. M.D. and G.M. made the original observation, and provided edits and comments on all drafts. T.M. conceived the idea for this paper and wrote the first draft. All authors read and approved the final manuscript.

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