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Benign effect of the fish parasitic isopod *Ceratothoa* cf. *imbricata* on *Selenotoca multifasciata* (Scatophagidae) from Australia

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ABSTRACT: The tongue-biter cymothoid isopod *Ceratothoa* cf. *imbricata* is nearly ubiquitous in buccal cavities of the banded scat *Selenotoca multifasciata* (Scatophagidae) from Waterloo Bay, south-east Queensland. To test whether infestation affects fish growth or condition significantly, we explored parasitism and condition in 122 *S. multifasciata* specimens. The internal area of the buccal cavity and that occupied by ovigerous female isopods were measured, allowing the relative proportion of free internal area of the buccal cavity (PFIAO) to be calculated. Of 122 fish, 119 (97.5%) were infected; 35.3% had large female isopods, the remaining infections comprised much smaller mancae, juveniles and adult males. Mean intensity of infection was significantly correlated with fish total length (TL). In some fish, the female isopod occupied up to 80% of the buccal cavity area. There was little evidence of attachment damage in the buccal cavity; only 9 of 43 hosts analysed had restricted damage to the tissues at the points of attachment of the female isopod. Condition factor, food intensity index and stomach weight did not differ between fish with and without female *C.* cf. *imbricata*. The relative proportion of free internal area of the buccal cavity with respect to the fish total length (PFIAO/TL^2 ratio) of fish infected with females correlated with food intensity and condition factor. Although the correlation was significant, the actual effect was not large because more than 70% of these 2 indices was not explained by the PFIAO/TL^2 ratio ($r^2 < 0.3$ in both cases). Despite the dramatic appearance of infestations and the high prevalence of *C.* cf. *imbricata* in the population, the near-absence of pathological alterations and the limited effect of the isopod on the condition indices and food intensity suggest that this isopod is relatively benign for *S. multifasciata*.

KEY WORDS: *Ceratothoa* cf. *imbricata* · Oral ectoparasite · *Selenotoca multifasciata* · Asymptomatic infection

INTRODUCTION

Parasites can play an important role in the biology of fishes and can affect their behaviour, health and distribution (Rohde 1993). Cymothoid isopods are large ectoparasites that infest a diverse array of tropical and temperate fishes worldwide (Brusca 1981). They are protandrous hermaphrodites with multiple life stages. The first stage (mancae or early juvenile I stage) consists of a short phase as free-living organisms with good swimming ability, after which they need to find a fish to take their first meal (within 1 to several days) or they die (Tsai & Dai 1999, Mladineo 2003, Fogelman & Grutter 2008). Upon finding a suitable host, they initiate feeding, generally on blood and macerated tissues (mucus, epithelium and subcutaneous tissues) (Colorni et al. 1997, Bunkley-Williams & Williams 1998, Horton & Okamura 2003, Östlund-Nilsson et al. 2005). They attach to skin, fins, branchial or buccal cavities, or burrow into the

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musculature of fishes. Most are highly site specific (Bunkley-Williams & Williams 1998). Females are always much larger than the males on an individual host.

There are reports of various pathologies caused by cymothoids including tissue damage, growth defects, decrease in mean host weight and size, depressed fecundity and increased mortalities (Adlard & Lester 1994, 1995, Horton & Okamura 2001, 2003, Rajkumar et al. 2005, Ravi & Rajkumar 2007, Fogelman & Grutter 2008). In contrast, some studies have failed to find such serious effects of infection as those listed above (e.g. Ruiz & Madrid 1992, Landau et al. 1995, Bakenhaster et al. 2006). Species of the genus *Ceratothoa* affect both wild and cultured fish populations. These parasites may significantly depress growth or other parameters in both wild and cage-reared fishes (Šarušic 1999, Papapanagiotou & Trilles 2001, Mladineo 2002, Horton & Okamura 2003).

Scats (family Scatophagidae) are common fishes in tropical and temperate Indo-Pacific waters in harbours, natural embayments, brackish estuaries and lower reaches of freshwater streams, often in small aggregations (Parenti 2004). The banded scat *Selenotoca multifasciata* (Richardson, 1846) is a euryhaline scatophagid that is common throughout the Indo-West Pacific, from Sulawesi (Indonesia) to western and eastern Australia and New Caledonia (Kottelat 2001). This benthopelagic species has a wide salinity tolerance and is found in freshwater, brackish water and marine habitats, but only juveniles with a total length (TL) of up to about 9 cm stay in freshwater for a prolonged period (Lee et al. 1993). This species has minor commercial importance, being occasionally sold fresh in local markets. Juveniles are collected for the aquarium fish trade. The species feeds preferentially on filamentous algae and secondarily on aquatic macrophytes and may be useful for controlling fouling in aquaria, grow-out ponds and aquaculture cages (Lee et al. 1993).

Knowledge of the biology of the species of the family Scatophagidae in Australian waters is incomplete, with data existing for only some species. The food and feeding habits of *Scatophagus argus* (Linnaeus, 1766) from Indian waters (Datta et al. 1984, Gandhi 2002), Thailand (Wongchinawit & Paphavasit 2009), the Philippines (Barry & Fast 1992) and Taiwan (Lin et al. 2007) have been described in detail. Preliminary data regarding reproduction and growth have been provided by Barry & Fast (1992) in the Philippines and by Shao et al. (2004) in Taiwanese waters. Likewise, some parasites of *Scatophagus argus* have been described in Indonesia (Yuniar et al. 2007, Palm & Rückert 2009) and Australia (Pulis & Overstreet 2013). In contrast, information about the biology and parasitic fauna of *Selenotoca multifasciata* is limited and fragmentary. There is partial information about its trophic habits (Lee et al. 1993), and some trichodinid ciliates and faustulid and haploporid trematodes have been described (Cribb et al. 1999, Dove & O'Donoghue 2005, Pulis & Overstreet 2013).

We found that in Moreton Bay *Selenotoca multifasciata* is parasitized by *C.* cf. *imbricata* (Fabricius, 1775). Individuals of *Ceratothoa* species settle preferentially in the buccal cavity of benthopelagic fishes and are often known as tongue-biters. Female *C.* cf. *imbricata* occupy a substantial proportion of the buccal cavity of their hosts. The large size of this parasite relative to the volume of the buccal cavity of fish raises the question of whether it affects its host. The present work thus reports on this cymothoid isopod, attempts to shed light on the host–parasite relationship, explores variation in prevalence in the host population, and tests for significant effects on growth and condition of the fish host.

MATERIALS AND METHODS

Specimens of *Selenotoca multifasciata* were captured from Waterloo Bay (Moreton Bay off Queensland, east coast of Australia) with a tunnel net. A total of 122 specimens were collected during November 2008 and placed immediately on ice in the field. They were processed in the laboratory immediately after return from the field. TL was measured to the nearest mm prior to dissection and 4 size classes were assigned (Size 1 [S1]: TL < 22.9 cm; Size 2 [S2]: 23 < TL < 26.9 cm; Size 3 [S3]: 27 < TL < 30.9 cm; Size 4 [S4]: TL > 31 cm). Liver, gonads, stomach contents (StW) and eviscerated body (EW) were weighed to the nearest 0.01 g. Gonads were immediately fixed in 10% buffered formalin for histopathological assessment. They were processed into paraffin, sectioned at 5 µm and stained with haematoxylin and eosin. Stages of oocyte growth were determined from histological preparations of the gonads of 120 females and the sexual stage of each fish was determined. To differentiate between mature and immature individuals, stages of maturity (maturity code) were classified after Carrassón & Bau (2003): I, immature (only oocytes in chromatin nucleolar stage); II, immature (presence of oocytes in perinucleolar stage); III, immature (presence of oocytes in cortical alveoli stage); IV, maturing (presence of oocytes in vitellogenic stage); and V, ripe (presence of mature oocytes). Thus, individuals with gonads in stages I to III are immature, and the presence of gonads with oocytes in vitellogenic and ripe stages (stages IV and V) indicate mature specimens.

All fish were examined for the presence of *Ceratothoa* cf. *imbricata* in the buccal cavity. The host head was dissected on the left side of the sagittal plane, the internal area of the buccal cavity (IAO) and the area occupied by the isopod (OAI) was measured (in cm^2) using an Integrated Image Analysis System (ProgRes CapturePro 2.7) (Fig. 1). Free internal area of the buccal cavity (FIAO) was calculated as FIAO = IAO − OAI, then the relative proportion of free internal area of the buccal cavity was calculated as PFIAO = (FIAO/IAO) × 100% for fish infected with female isopods as well as those infected with other life stages. To analyse possible effects on the food intensity index and condition factor, the ratio PFIAO/TL^2 was also calculated. All parasites were collected, counted and preserved in 70% ethanol. Isopod lengths were measured to the nearest 0.1 mm and weights (IW) to the nearest 0.0001 g.

In order to compare the physical and feeding conditions of fish infected with female isopods (those that occupy more than 45% of the buccal cavity), condition indices of 43 fish individuals bearing a female *C.* cf. *imbricata* on the tongue and the remaining fish without females were calculated. The condition indices calculated to evaluate fish condition were gonadosomatic index (GSI: gonad weight × 100/EW), hepatosomatic index (HSI: liver weight × 100/EW), condition factor (CF: EW × 100/(standard $length^3$)) and food intensity index (K: StW × 100/EW).

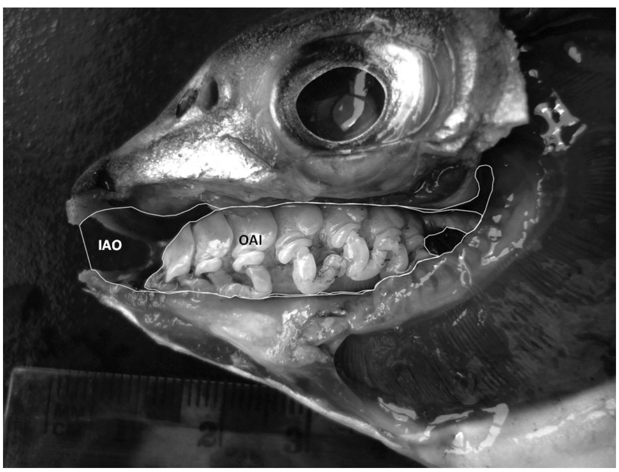

Fig. 1. Head of *Selenotoca multifasciata* dissected on the left side of the sagittal plane. IAO: internal area of the buccal cavity; OAI: the area occupied by the isopod *Ceratothoa* cf. *imbricata*

The prevalence of isopods (*P*) and mean intensity of infection (*I*) were calculated according to Bush et al. (1997).

Variation of indices was investigated for data pooled by the 4 size classes of *S. multifasciata* and by the stage of host maturity (maturity/immaturity) using analysis of variance (ANOVA) and *t*-tests, after verifying a normal distribution. When the original data (GSI, *I*, IW, PFIAO, StW) did not fit the assumptions of ANOVA (normality and homogeneity of variances), they were normalized by logarithmic transformation. The mean values of the transformed data were then compared by ANOVA, followed by a Student-Newman-Keuls (SNK) multiple-comparison test. A *t*-test was used for a comparison of mean values of TL, EW, GSI, HSI, CF, K and StW for hosts with and without female *C.* cf. *imbricata*. Female isopod prevalence across size classes of fish was analysed by means of Fisher's exact test.

RESULTS

The great majority of individuals of *Selenotoca multifasciata* (120) were females (mean TL = 27.28 cm). Only 2 small males (TL of 21.3 and 22 cm) were captured. Table 1 shows relationships between the most important biological parameters of the host population. Of these, liver weight showed stronger correlation with TL and EW than gonad weight with the same parameters. GSI and HSI did not correlate positively with fish size (Fig. 2), whereas they increased significantly with the maturity of *S. multifasciata* (Table 2). Notwithstanding this pattern, CF and K decreased significantly with increase in fish size (Fig. 2), and exhibited higher values in the mature specimens (Table 2).

Of the 122 specimens of *S. multifasciata* analysed, 119 (P = 97.54%) were infected with 625 individuals of different life stages of a single species of *Ceratothoa* (MI = 5.25). According to Dr. N. Bruce of the Queensland Museum (pers. comm.) who was sent

Table 1. Relationships between total length (TL), eviscerated weight (EW), liver weight (LW) and gonad weight (GW) in scat *Selenotoca multifasciata*

Sex	Variables	n	r	p	Equation regression
♂ ♀	TL vs. EW	122	0.98	0.0001	$EW = 0.044\ TL^{2.67}$
♂ ♀	TL vs. LW	120	0.76	0.0001	$LW = 0.002\ TL^{2.528}$
♂ ♀	EW vs. LW	120	0.82	0.0001	LW = 0.027 EW − 0.653
♀	TL vs. GW	120	0.40	0.0001	GW = 1.146 TL − 20.742
♀	EW vs. GW	120	0.47	0.0001	GW = 0.041 EW − 2.725

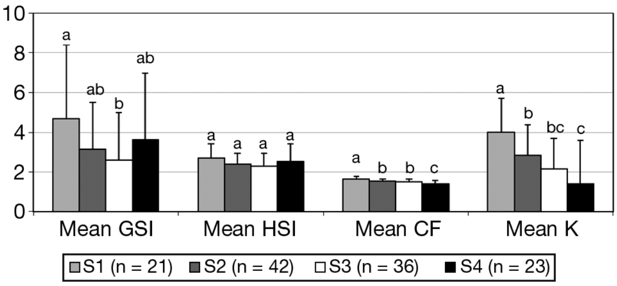

Fig. 2. Mean (+SD) gonadosomatic index (GSI), hepatosomatic index (HSI), condition factor (CF) and food intensity index (K) comparison (ANOVA) between 4 size groups (S1 to S4) of *Selenotoca multifasciata* (same letters indicate lack of significant differences)

representative specimens, this form can be best identified as *C.* cf. *imbricata*. The species appears close to *C. banksii* (Leach, 1818), which has long been regarded as a junior synomym of *C. imbricata*. Dr. Bruce and colleagues are currently working on a study to bring *C. banksii* out of synonymy with *C. imbricata*. Until such a study is published, the present form is best known as *C.* cf. *imbricata*.

Of the 119 infected individuals, 43 (P = 35.25%) had 1 female isopod greater than 20 mm in total length that occupied more than 45% of the buccal cavity; the remaining infections were much smaller mancae, juveniles or adult male isopods. The maximum number of isopods found in the buccal or orobranchial cavity of a host was 20 (mainly mancae and some juvenile isopods), but 85.2% of parasitized fish had 10 or fewer isopods. The isopod numbers found most frequently were 2 (16.4%) and 3 (21.3%). In such cases, the female, which ranged between 20 and 35 mm in length, was attached to the tongue and the male or males (with a maximum length of 15.8 mm and considerably smaller, 10 to 21 mm shorter, than the corresponding female) were attached behind the female on the gill arches. Mancae or juvenile isopods between 3 and 6 mm in size were often observed on the walls of the mouth and gill chamber of the hosts. There were significant differences between S1 and S4, and between S2 and S4 (ANOVA, and a posterior SNK multiple-comparison test; Table 3). Female isopod prevalence ranged between 26 and 53% (Table 3), and significant differences between the prevalences of S2 and of S4 were observed (χ^2 = 4.388, p = 0.036). The fish infected with female isopods were significantly heavier than the remaining fish (Table 4).

Of the fish infected with females, 79.1% had 4 or fewer isopods. The most frequent infection was of 1 female with 1 (34.9%) or 2 (25.6%) males. The size of the female isopods was linearly proportional to that of the host (r = 0.601, p = 0.0001) and weight of female isopods increased significantly with host size (ANOVA, $F_{(3,39)}$ = 8.487, p = 0.0001; Table 3). Although females were always found attached to the host's tongue, the tongues of *S. multifasciata* presented no apparent signs of atrophy. There was little

Table 2. Mean (±SD) total length (TL, in cm), gonadosomatic index (GSI), hepatosomatic index (HSI), condition factor (CF) and food intensity index (K) comparison (*t*-test) between immature and mature individuals of *Selenotoca multifasciata* (same superscript letters indicate lack of significant differences)

Sexual stage	n	TL	GSI	HSI	CF	K
Immature	70	27.8^a ± 3.6	1.55^a ± 0.54	2.15^a ± 0.54 (n = 68)	1.49^a ± 0.15	2.20^a ± 1.75
Mature	50	26.6^a ± 4.6	5.82^b ± 3.10	2.85^b ± 0.61	1.53^a ± 0.13	3.07^b ± 2.01

Table 3. Mean (±SD) intensity of infection (I), female isopod *Ceratothoa* cf. *imbricata* prevalence (P, in %), female isopod weight (IW, in g), free internal area of the buccal cavity (FIAO, in cm^2), proportion of free internal area of the buccal cavity (PFIAO, a: for all fish individuals; b: for fish infected with female isopods) comparison (ANOVA) between 4 size groups of *Selenotoca multifasciata* (see 'Materials and methods' for size group limits). Same superscript letters indicate lack of significant differences (values in parentheses indicate sample numbers for each variable)

Size group	I	P	IW	FIAO	PFIAO(a)	PFIAO(b)
S1	4.19^a ± 2.96 (21)	38.10^{ab} (21)	0.71^a ± 0.26 (8)	2.41^a ± 1.39 (21)	72.0^a ± 34.2 (21)	34.7^a ± 13.3 (9)
S2	4.74^a ± 3.82 (42)	26.19^a (42)	0.99^{ab} ± 0.49 (11)	3.38^b ± 1.37 (42)	82.0^a ± 29.5 (42)	41.9^a ± 20.9 (13)
S3	5.21^{ab} ± 4.41 (34)	33.33^{ab} (36)	1.40^b ± 0.33 (12)	3.51^b ± 1.77 (36)	74.4^a ± 33.1 (36)	38.5^a ± 19.5 (15)
S4	7.18^b ± 4.92 (22)	52.27^b (23)	1.51^b ± 0.46 (12)	3.77^b ± 1.73 (23)	68.1^a ± 31.4 (23)	43.6^a ± 17.6 (13)
Total	5.25 ± 4.14 (119)	35.25 (122)				

Table 4. Mean (±SD) fish total length (TL, in cm), eviscerated weight (EW, in g) and condition (GSI, HSI, CF, K, stomach weight: StW) comparison (*t*-test) between *Selenotoca multifasciata* with and without female *Ceratothoa* cf. *imbricata* (same superscript letters indicate lack of significant differences). See Table 2 for definition of abbreviations

Fish	n	TL	EW	GSI	HSI	CF	K	StW
Without female isopod	79	$26.71^a \pm 3.69$	$295.1^a \pm 105.0$	$3.08^a \pm 2.67$	$2.43^a \pm 0.64$	$1.50^a \pm 0.15$	$2.74^a \pm 1.85$	$7.33^a \pm 5.89$
With female isopod	43	$28.07^a \pm 4.68$	$355.8^b \pm 163.7$	$3.80^a \pm 3.27$	$2.47^a \pm 0.73$	$1.52^a \pm 0.13$	$2.23^a \pm 1.98$	$6.06^a \pm 5.74$

evidence of damage in the buccal cavity; only 9 of the 43 fish carrying females analysed had restricted damage to the tissue at the points of attachment of the female isopod in the buccal cavity.

The percentage of empty stomachs was not significantly different between individuals with and without female isopods (25.6 vs. 15.2%; $\chi^2 = 1.965$, $p > 0.05$). The presence of female isopods was not significantly associated with fish condition (GSI, HSI, CF, K, StW), either across the entire sample or for any size class (Table 4). In 4 fish, the female isopod occupied from 80 to 86% of the buccal cavity area. The FIAO of fish infected with some isopod life stages showed a trend of increase with the size of host, with significant differences between the smallest and largest fish (Table 3). In contrast, there was no difference in the relative FIAO (PFIAO) between the 4 size classes of host, either for all fish infected with any isopod or for fish infected with female isopods. The measure of FIAO exhibited moderate but significant correlation with StW for fish parasitized by female isopods ($n = 43$, $r = 0.312$, $p = 0.042$). The relative FIAO with respect to the total length of fish (PFIAO/TL^2) showed moderate correlation with the food intensity index ($n = 43$; $r = 0.316$, $p = 0.039$) and a correlation with the condition factor ($n = 43$, $r = 0.543$, $p = 0.000$).

DISCUSSION

The size of the sexes of *Selenotoca multifasciata* found here was quite different, males being much smaller than females, as has also been observed in *Scatophagus argus*, the other scatophagid known in the study area (Shao et al. 2004).

The high prevalence of *Ceratothoa* cf. *imbricata* found in *S. multifasciata* (98%) is atypical of cymothoid isopod populations in wild fish populations. In tropical (e.g. Weinstein & Heck 1977, Hayward et al. 1998) and Mediterranean waters (e.g. Charfi-Cheikhrouha et al. 2000, Matašin & Vučinić 2008, Mladineo et al. 2009), cymothoids frequently occur at prevalences below 25%. In contrast, prevalences in fish farms have been reported to exceed 50% and approach 100% (Sievers et al. 1996, Horton & Okamura 2001, Mladineo 2002).

Mean intensity of infection increased with the size of host. In contrast, most cymothoids preferentially infect relatively small fish and prevalence often falls rapidly from small to larger fish (Berkeley & Houde 1978, Marks et al. 1996, Bakenhaster et al. 2006). This is the case for mancae and juveniles of *C. oestroides* (Risso, 1916) (Varvarigos 2003) and *Artystone trysibia* Schioedte, 1866, for which such a preference has been suggested by successful infestations of relatively small fish (Alberto et al. 2009). In experimental infections of *Diplodus annularis* (Linnaeus, 1758), the percentage of successful infections was lower in larger than in smaller fish (Mladineo & Valic 2002). The prevalence of isopods is presumably usually high for small host sizes because they are more vulnerable to infestation than older fish (Bakenhaster et al. 2006). Our results indicate that this pattern is not general; in this case, *C.* cf. *imbricata* is capable of infesting large *S. multifasciata*, showing that older fish are also vulnerable to infection.

The linear correlation between the size of the isopods and the size of their host suggests either that the parasites grow with their hosts (Weinstein & Heck 1977, Maxwell 1982, Leonardos & Trilles 2003), or that, having found their hosts, they grow rapidly to a maximum size beyond which the restricted environment of the fish buccal cavity prevents further growth, as has already been seen for some other Cymothoidae (Colorni et al. 1997). The significant correlation between the size of *C.* cf. *imbricata* and *S. multifasciata* is also consistent with strong host fidelity after infestation by the manca or juvenile stage, which has been found in other species of external branchial, buccal and burrowing cymothoids (Weinstein & Heck 1977, Maxwell 1982, Adlard & Lester 1995, Landau et al. 1995, Colorni et al. 1997, Bakenhaster et al. 2006). This relationship between the sizes of parasite and the host also suggests a long host association and that multiple broods are probably produced (Williams & Williams 1982).

Other studies on cymothoids in free-living populations (Landau et al. 1995, Matašin & Vučinić 2008) suggest no serious injury is involved. We found no regression of the tongue comparable to that described in some other fishes (Romestand & Trilles 1977, Brusca & Gilligan 1983) infected with buccal cavity isopods. The restricted tissue damage at the points of attachment of the female isopod in the buccal cavity of *S. multifasciata*, observed only in 9 exemplars, suggests that the attachment of the isopod may not be as debilitating as might be expected. Similar results have been found for other cymothoids (Maxwell 1982, Landau et al. 1995, Colorni et al. 1997).

C. cf. *imbricata* females may reduce the amount of food ingested by *S. multifasciata*, especially when their marsupium is swollen with eggs or larvae. The PFIAO of hosts infected with *C.* cf. *imbricata* females showed moderate correlation with both the food intensity index K and condition factor CF (more than 71% of these 2 indices were not explained by the PFIAO/TL^2 ratio, $r^2 < 0.3$ in both cases), indicating that isopod size may have a small effect on the amount of food ingested. However, infection did not have a significant effect on the mass of stomach contents at capture and the infected fish displayed no other detectable signs of feeding stress (K, StW) or effects on condition indices (CF, HSI, GSI), and no apparent effect on growth relative to uninfected fish. Similar results are frequent in field studies (Weinstein & Heck 1977, Landau et al. 1995, Marks et al. 1996, Colorni et al. 1997, Bakenhaster et al. 2006). Williams & Bunkley-Williams (2000) suggest that condition factors may not be sensitive enough to detect negative effects on some hosts except in cases of very intense infestation. The lack of effect detected here for StW and K of infected *S. multifasciata* supports the conclusions suggested by the condition indices.

The pathological effects of cymothoid isopods on their hosts appear to cluster at 2 extremes. Some associations are quite severe and can even cause host death (Adlard & Lester 1994, Fogelman et al. 2009), whereas others are comparatively benign (Brusca 1981, Colorni et al. 1997, Bakenhaster et al. 2006). It appears that *C.* cf. *imbricata* affects the general wellbeing of *S. multifasciata* only slightly. The high prevalence of the isopod, the lack of gross pathological alterations and the lack of or apparently marginal effect of the isopod on condition indices or food volume found in their hosts support this claim. Cymothoids appear to be significantly pathogenic in situations in which the host fish is placed in physically stressful environments or where the parasite is large relative to the size of the host (Adlard & Lester 1994, Papapanagiotou & Trilles 2001). The effects of infection by cymothoids may be particularly dramatic in aquaculture systems (Papapanagiotou et al. 1999, Papapanagiotou & Trilles 2001). In cage culture systems, the presence of a permanent population of wild fish species around the cages means that exchange of cymothoids between wild infected and cultured fishes is inevitable (Šarušic 1999). In aquaculture systems, among other factors, stocking fish at high densities may lead to stress that could both increase susceptibility to cymothoid infections and lead to an inhibition of host growth. These disorders can affect fish condition, reproduction and survivorship (Sievers et al. 1996, Šarušic 1999, Horton & Okamura 2001, Papapanagiotou & Trilles 2001). Pathogenesis may also be marked in systems where the parasite is huge relative to the size of the host (Adlard & Lester 1994, Fogelman et al. 2009).

Some wild fish species that act as carriers for isopods important in aquaculture may have an impact over a wide geographical range. Some migratory fishes, such as *Trachurus* spp., which are known to swim across the Pacific, may infect farmed fishes when they approach aquaculture cages in search of easy food (Sievers et al. 1996), and thus inflict significant losses on cultured species. *C. banksii* (a junior synonym of *C. imbricata*) has been recorded in striped trumpeter *Latris lineata* (Forster, 1801) cultured in sea cages (Andrews et al. 2013). Although *Trachurus murphyi* Nichols, 1920 was probably the source of the infection in striped trumpeter, as schools of these fish pass by the fish farms during summer (Andrews et al. 2013), *S. multfasciata* is also a candidate carrier of the cymothoid infection to this or other fish species in sea cage systems.

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