Short communication

Harmful parasitic crustaceans infecting wild arripids: A potential threat to southern Australian finfish aquaculture

Sarah R. Catalano a, Kate S. Hutson a,b,*

a Marine Parasitology Laboratory, DX 650 418, School of Earth and Environmental Sciences, The University of Adelaide, North Terrace, Adelaide, South Australia 5005, Australia

b Discipline of Aquaculture, School of Marine and Tropical Biology, James Cook University, Townsville, Queensland 4811, Australia

ABSTRACT

Parasitic crustaceans are responsible for severe disease outbreaks in finfish aquaculture. We provide the first report of five marine ectoparasitic crustacean species including Argulus diversicolor Byrnes, 1985 (Branchiura: Argulidae), Caligus bonito Wilson, 1905, C. longipeds Bassett-Smith, 1898, C. pelamydis Hewitt, 1963, and C. punctatus Shiino, 1955 (Copepoda: Caligidae) on wild arripid hosts, Arripis georgianus (Valenciennes, 1841), A. trutta (Forster, 1801) and A. truttaceus (Cuvier, 1829) (Perciformes: Arripidae) in southern Australian waters. Caligus pelamydis and C. punctatus are new Australian records. All five crustacean species exhibit low host-specificity and Argulus spp., C. longipeds, C. pelamydis and C. punctatus have been associated with mass mortalities in cultured fishes outside Australia. Given the propensity for arripids to aggregate at sea-cage aquaculture sites, awareness of these five parasitic crustacean species may allow health managers to identify and anticipate potential outbreaks on southern Australian fish farms.

© 2010 Elsevier B.V. All rights reserved.

1. Introduction

Sea-cage farms are highly attractive to wild fishes and attract large and diverse aggregations in their immediate vicinity. Increased availability of food due to waste feed and faeces from caged fish (Fernandez-Jover et al., 2008) and the use as a refuge from predators (Castro et al., 2002) may explain the attraction of fish to floating structures. Aggregations of wild fish at individual farms have been documented in warm temperate (Mediterranean Sea, Dempster et al., 2004) and cool temperate (Norway, Dempster et al., 2009; Australia, Dempster et al., 2004) environments. Many parasite taxa may be shared between farmed and wild fishes. Parasites can have severe impacts on farmed fish production, while high densities of farmed fish may elevate parasite prevalence and intensity in surrounding wild populations, as has been observed for sea lice infestations of wild salmonids in the northern hemisphere (e.g. Krkošek et al., 2007; MacKenzie et al., 1998; Morton et al., 2005).

Parasitic crustaceans are widely recognised to cause serious problems in the culture of many fish species (see Johnson et al., 2004 for review). They are likely to establish and proliferate in aquaculture because most have direct life-cycles consisting of free-living, free-swimming and attached parasitic stages. They also may reproduce rapidly and directly reinfect their hosts. Parasitic crustaceans can act as vectors of bacterial and viral infections as well as protozoans and metazoans (e.g. Overstreet et al., 2009). Research is required to identify sources of parasitic crustaceans, to recognize taxa with low host-specificity, and to document potentially harmful species.

In Australia, fish farming is intensifying in Spencer Gulf, South Australia (SA), where southern bluefin tuna Thunnus maccoyii (Castelnau, 1872), yellowtail kingfish Seriola lalandi Valenciennes, 1833, and mulloway Argyrosomus japonicus (Temminck & Schlegel, 1843) are farmed in sea-cages. Fish species in the Arripidae have a tendency to aggregate near structure (Dempster and Kingsford, 2004; Neira, 2005) and have been observed in, and around, sea-cages in SA (KSH pers. obs.). The Arripidae comprises a single genus Arripis which includes four species. Three species comprise important commercial and recreational fisheries in southern Australian waters; Australian herring or tommy ruff Arripis georgianus; eastern Australian salmon A. trutta; and western Australian salmon A. truttaceus. Arripis georgianus and A. truttaceus share similar distributions, found in temperate waters from Western Australia (WA) through to New South Wales (NSW), and around Tasmania (Comon et al., 2008). Arripis trutta overlaps in distribution with these two species in waters off SA, Victoria, NSW and Tasmania, but is also found off the coast of New Zealand (NZ) (Smith et al., 2008). In a broad parasitological survey of the Arripidae, we made a remarkable discovery of five species of parasitic crustaceans not previously known from arripid fishes in southern Australian waters, including two new Australian parasite records. The majority of crustacean parasite species reported here have been associated with...
mass mortalities in aquaculture overseas. This study documents five parasitic crustacean species from three species of *Arripsis* in southern Australian waters, reviews associated problems with these parasite species elsewhere and draws attention to the potential threat of these species for southern Australian finfish aquaculture.

2. Materials and methods

A total of 183 *Arripsis georgianus* (mean [range] = 179 [154–220] mm fork length (FL)) and 67 *A. truttaeaeus* (350 [185–601] mm FL) obtained from Gulf St Vincent, Spencer Gulf, northern Kangaroo Island and Coffin Bay in SA waters was examined for ectoparasites (Fig. 1). Nineteen *A. truttaeaeus* (483 [400–545] mm FL) were examined from Bermagui, NSW (Fig. 1). Fish were identified using the key by Gomon et al. (2008). Fish were collected by line fishing or from fish markets, namely Safcol fish market, Mile End, Adelaide, SA, and the Sydney Fish Market, Pyrmont, NSW (University of Adelaide, Animal Ethics Committee Science project S-098-2007). Tissue samples were collected from each fish, stored in undenatured ethanol and lodged with the Australian Biological Tissue Collection (ABTC 108509–108777) at the South Australian Museum (SAMA), North Terrace, Adelaide, 5000, SA.

Fish were examined for ectoparasites with the naked eye on all exterior surfaces, including branchiostegal membranes, fins, fin sulcus, mouth and operculum. The gills were removed, placed in seawater and examined under a dissecting microscope for ectoparasites. Parasitic crustaceans were removed with fine forceps, fixed in 70% ethanol and cleared in lactophenol prior to morphological examination using a compound microscope. All parasitic crustaceans were identified from their original published descriptions, redescriptions and reference to information in Ho and Lin (2004). Identities were confirmed by Prof Geoff Boxshall, Natural History Museum, London (NHM). Voucher specimens were lodged in the SAMA Crustacean collection (SAMA C) and at the NHM.

3. Results and discussion

Five species of parasitic crustaceans were recorded from arripid hosts; *Argulus diversicolor* (Branchiura: Argulidae), *Caligus bonito*, *C. longipeds*, *C. pelamydis* and *C. punctatus* (Copepoda: Caligidae). Microhabitat, host species, host localities and museum accession numbers are shown in Table 1. This is the second record of *A. diversicolor* which was originally described from the sparid *Acanthopagonus latus* (Houttuyn, 1782) from Point Samson, WA (Byrnes, 1985). Although *C. pelamydis* and *C. punctatus* are cosmopolitan caligid species (see Hewitt, 1963; Ho and Lin, 2004), this is the first time they have been recorded in Australian waters.

*Argulus* spp. infect fish hosts distributed on and around all continents, except Antarctica, in marine and estuarine (n=44) and freshwater (n=85) habitats (Poly, 2008). *Argulus* spp. are problematic ectoparasites in freshwater fish culture and several epizootics have occurred in wild freshwater fisheries (e.g. Hakalahti-Siren et al., 2008; Hewlett et al., 2009; Menezes et al., 1990). *Argulus japonicus* (Thiele, 1900) has been introduced all over the world, primarily due to stockings of goldfish *Carassius auratus* (Linnaeus, 1758) and carp *Cyprinus carpio* Linnaeus, 1758 which may also parasitize brown trout *Salmo trutta* Linnaeus, 1758, as well as stickleback *Gasterosteus aculeatus* Linnaeus, 1758, roach *Rutilus rutilus* (Linnaeus, 1758), perch *Perca fluviatilis* Linnaeus, 1758, tench *Tinca tinca* (Linnaeus, 1758), pike *Esox lucius* Linnaeus, 1758 and bream *Abramis brama* (Linnaeus, 1758) (see Poly, 2008). *Argulus* have also been reported from marine fish farming facilities in Chile, Canada and Norway and can cause mortality in farmed salmonid stocks (Boxshall, 2005; Schram et al., 2005). *Argulus* attach to fish skin by means of suckers and spines and feed on blood and external tissues (Boxshall, 2005). They are capable of changing their position on their host as well as changing their host individual (Pasternak et al., 2000, 2004), and may enhance severity of bacterial infections (Bandilla et al., 2006; Cusack and Cone, 1986). Although there is no published record of *A. diversicolor* from farmed fishes in SA, a photograph of this species (or a similar species) is
presented on the cover of an illustrated guide to the parasites of wild and captive southern bluefin tuna *Thunnus maccocyiii* (*Scombriidae*) from SA (Rough, 2000). However, there is no further reference to the cover image or to an *Argulus* species in the publication. The presence of *A. diversicolor* on arripids is a cause for concern for farmed southern Australian fishes given the likely similarities in pathology to other *Argulus* spp. and its report from two fish families (i.e. *Arripidae* and *Sparidae*).

Of the four caligid copepod species identified here, three are recognised as being problematic in aquaculture: *Caligus longipenis*, *C. pelamidys* and *C. punctatus*. *Caligus longipenis*, which infested *Arripis truttaceus* in SA, can cause bruising to the body of farmed striped jack *Pseudocaranx dentex* (Bloch & Schneider, 1801) (*Carangidae*) in Japan and make it unmarketable (Ogawa, 1992). Also, Madinabeitia et al. (2009) demonstrate that *C. longipenis* could act as a potential vector for the transmission of the bacterium *Lactococcus garvieae*, which has caused severe mortalities to *Seriola spp.* (*Carangidae*) and *P. dentex* in Japan. Although *C. longipenis* primarily infects carangids, it has been reported previously from 18 fish species representing 10 fish families including acanthurids, carangids, haemulids, monacanthids, ostraciids, paralichthyids, pomacanthids, scards, serranids and trichurids (see Ho and Lin, 2004). We provide the second record of this species in Australian waters. *Caligus longipenis* was documented previously by Heegaard (1962) in NSW (as *C. lucidus*; verified by Ho and Lin, 2004) from the Chinaman-leatherjacket *Nelusetta ayard* (Quoy & Gaimard, 1824) (*Monacanthidae*) (as *Cantherhines ayard*).

*Caligus pelamidys*, documented on *A. trutta* in this study, has been associated with mass mortalities of cultured Japanese sea perch *Lateolabrax japonicus* (Cuvier, 1828) (*Lateolabracidae*) in South Korea (Choi et al., 1995). This widely distributed species has been reported from eight fish species in five families (arripids, gempylids, lateolabracs, sciaenids and scombrids) from NZ, the Mediterranean, the Arabian Sea and Indian Ocean (see Ho and Lin, 2004). This parasite species is particularly problematic due to its low host-specificity (21 species in 14 families) and its ability to survive in the plankton (Ho and Lin, 2004). This species is known from Taiwanese, Japanese and Korean waters and is reported here from Australian waters for the first time.

*Caligus punctatus*, which we documented on all three arripid species, has caused mass mortality of cultured fish species in Taiwan including carangids, charsids, cichlids, lateolabracs, latid, mugilids, serranids, spardis, and terapontids (see Ho and Lin, 2004). This parasite species is problematic in aquaculture due to its low host-specificity (21 species in 14 families) and its ability to survive in the plankton (Ho and Lin, 2004). This species is known from Taiwanese, Japanese and Korean waters and is reported here from Australian waters for the first time.

*Caligus bonito* is a cosmopolitan caligid that primarily infects scombrids (10 species) but has also been recorded from a carangid, coryphaenid, mugilid, pomatomid, serranid and two lutjanids (see Ho and Lin, 2004). In Australia, it has been previously reported from three wild scombrids including *Euthynnus affinis* (Cantor, 1849) and *Sarda australis* (Macleay, 1881) in NSW, and *A. alletteratus* (Rafinesque, 1810) from Queensland (reported as *C. kuroshio* by Kabata (1965), verified by Ho and Lin, 2004). There is no recorded pathology associated with *C. bonito* in the literature.

Although the parasite species identified in this study have not been recorded on farmed Australian fishes to date, an epizootic of *Caligus chiastos* Lin & Ho, 2003 was recently documented on farmed southern bluefin tuna *Thunnus maccocyiii* (*Scombriidae*) in southern Spencer Gulf, SA (Hayward et al., 2008). Infestations by *C. chiastos* were associated with cornea damage of farmed *T. maccocyiii* and peaks in infection occurred in summer months (Hayward et al., 2009). *Caligus chiastos* has also been detected on the gills of farmed *Argyrosomus japonicus* (*Scombridae*) and *Seriola lalandi* in the same region (Hayward et al., 2007). As no attached chlaminus stages of any caligids have been detected on *T. maccocyiii*, Hayward et al. (2008) suggested that *C. chiastos* infections are transmitted to tuna from other species of infected wild fish that are attracted to tuna cages. Indeed, the only previous record of *C. chiastos* in Australia is on wild snapper *Chrysophrys auratus* (Forster 1801) (*Sparidae*) from eastern Australia (Ho and Lin, 2004) (as *Pogrus auratus*), a fish species that is known to associate with sea-cage sites in SA (KSH pers. obs.).

Given the low degree of host-specificity exhibited by parasitic crustaceans detected in this study and the tendency for arripids to aggregate at sea-cage farms, it is highly likely that, in suitable conditions, the argulid and caligid species reported here may establish and proliferate in farmed fish populations in southern Australia.

4. Conclusion

Discovery and documentation of parasite fauna of wild and farmed fish should be incorporated into an ongoing sampling program for effective parasite management and risk assessment. Effective mitigation of parasite species infecting fishes in sea-cage farms can only be achieved through reliable parasite identification, knowledge of their biology and assessment of appropriate management methods. Recognition of parasite species that may decrease profitability through mortality, morbidity and reduced marketability of stocks is crucial. Considering the previous history of *Argulus spp.* (*Caligus longipenis, C. pelamidys* and *C. punctatus* in finfish farming overseas, these parasites are of immediate priority for research into their biological attributes. This will enable development of the most suitable management strategies to avoid outbreaks in southern Australian aquaculture.

Acknowledgements

We are grateful to Prof Geoff A. Boxshall (GAB) from the Natural History Museum, London, UK, for assistance with parasite identifications. Thank you to Leonie Barnett, Kieran Brazell, Dr Mieke Burger, Angelo, Domenico, Margaret and Pepperoni Catalano, Bruce Jackson, Dr Matt Padula, Dr Richard and Brian Saunders, Pep Severino, and Dr Mike Steer for assistance in the field. Dr Terry Bertozzi and Dr Thierry Laperousaz from the South Australian Museum and Miranda Lowe from the NHM kindly curated accessioned material. Assoc Prof Ian D. Whittington (IDW) from the South Australian Museum and the University of Adelaide, kindly read and commented on the manuscript. Scholarship support for SRC was provided from Unibooks (University of Adelaide) and Playford Memorial Trust. This research was funded by an Australian Biological Resources Study (207-44) and Fisheries Research and Development Grant (207/225) awarded to KSH and IDW. Travel funds were awarded by the Australian Research Council and the National Health and Medical Research Council (ARC/NH&MC) Research Network for Parasitology to KSH for travel to London to work with GAB.