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Parasitic Crustaceans and Marine Invasions: Two Case Studies from Kuroshio Region (extended abstract of the 7th Kuroshio Symposium)

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ABSTRACT

Parasitic crustaceans are ubiquitous in marine environment. They have negative effects on host individuals and populations, and even on the ecosystem where the host species plays a great role. In this short review, we show two case studies of marine invasions related with parasitic crustaceans from Kuroshio Region. One is the native pinnotherid crab parasitizing introduced mussels and the other is the bopyrid isopod introduced from Asia to US Pacific Coast. The green mussel *Perna viridis*, native to the tropical Indo-Pacific region, has recently been introduced worldwide. Although the native mussel populations in India suffer from parasitic effects of the pinnotherid crab *Arcotheres placunae*, mussels are relatively free from parasitic crabs in invaded regions (parasite escape). We investigated pea crab infections in *P. viridis* in Uranouchi Inlet, Kochi Prefecture, Japan. Results showed that the native generalist pea crab *A. sinensis* utilized the non-indigenous mussel *P. viridis*, though the prevalence is much lower. The introduced Asian parasitic bopyrid isopod, *Orthione griffenis*, was first discovered on the Pacific coast of North America ca. 25 years ago. High prevalence of *Orthione* infestations decreased many local populations of the host mud shrimp *Upogebia pugettensis* as well as the diverse symbiotic fauna in the host burrows. We investigated the distribution and host specificity of the bopyrid in western Japan. Results showed that *O. griffenis* was a rare species in Japan. Further ecological studies on parasitic crustaceans are needed in both native (source) and introduced (recipient) habitats.

Keywords : crustacean parasite, invasion, pinnotherid crab, *Perna* mussel, bopyrid isopod, *Upogebia* shrimp

Introduction

Parasitic crustaceans are ubiquitous in marine environment (Rohde, 2005). They have negative effects on host individuals and populations, and even on the ecosystem where the host species plays a great role. Parasites present several aspects to marine invasions.

The enemy release hypothesis (ERH) or parasite escape can sometimes explain the success of introduced species (Torchin *et al*., 2002; Torchin and Lafferty, 2009; Blakeslee *et al*., 2013). That is, many introduced species lack natural enemies and parasites in non-native (recipient) habitats, thus giving them an advantage over native species. However, some native parasites may utilize the introduced species over time. Reports of marine parasites invading marine environments are few (Torchin *et al*., 2002; Rohde, 2005). When parasite invasion is successful, the effect on the new hosts in recipient habitats is often deleterious (Griffen, 2009).

In this short review, we show two case studies of marine invasions related with parasitic crustaceans from Kuroshio Region. One is the native Japanese pinnotherid crab parasitizing introduced tropical mussels and the other is the bopyrid isopod introduced from Asia to US Pacific Coast.

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Case study 1: Utilization of the non-indigenous green mussel by the native pinnotherid crab in Japan

The green mussel *Perna viridis* is native to the tropical Indo-Pacific region, but has recently been introduced worldwide (Baker *et al*., 2007). Pea crabs of the family Pinnotheridae are often found living together with mussels worldwide, and in some cases parasitic effects of the crabs on the host have been confirmed (Haines *et al*., 1994). In the case of *P. viridis*, native populations suffer from pea crabs (Rajagopal *et al*., 2006). Jose and Deepthi (2005) reported that about 6% of the *P. viridis* population in Kerala, India, was parasitized by the pea crab *Arcotheres placunae* (= *Pinnotheres placunae*) and infested mussels showed significant reductions in shell length and live weight.

Yamada et al. (2009) showed utilization of *P. viridis* by the native pinnotherid crab *Arcotheres sinensis* (Shen, 1932) (= *Pinnotheres sinensis*) in Uranouchi Inlet, Kochi Prefecture, southwestern Japan (Yamada *et al*., 2009). In Uranouchi Inlet, *P. viridis* is densely distributed in both artificial and natural habitats (Figure 1), where many individuals can overwinter (Yamada *et al*., 2010; Ueda *et al*., 2013). About 30 *P. viridis* individuals with shell lengths from 70 to 95 mm were collected at random monthly from February 2008 to January 2009 from the undersurfaces of raft floats. Consequently, 1.8% of 340 green mussels were parasitized by *A. sinensis* (Figure 2). Infected mussels had lower Condition Index values, indicating parasitic effects by the crabs.

Figure 1. Invaded green mussel, *Perna viridis*, in natural rocky habitats at Uranouchi Inlet, Kochi, Japan.

Figure 2. A native pinnotherid crab, *Arcotheres sinensis*, parasitizing *Perna viridis* collected at Uranouchi Inlet, Kochi, Japan.

Yamada *et al*., (2009) revealed that the newly invaded mussel *P. viridis* in Japan is not parasitized by the original parasite *A. placunae*, but parasitized by a native generalist parasite *A. sinensis* in the recipient habitats. This is a similar situation to that recorded from New Zealand, where the invasive mussel *Musculista senhousia* was parasitized by the native generalist pea crab *Pinnotheres novaezelandiae* (Miller *et al*., 2008). The relatively low prevalence of *A. sinensis* in *P. viridis* in Yamada *et al*. (2009) indicates that the parasitic effect of pea crabs on the green mussel population in Japan is low. However, the reduced condition index means that the parasite can cause negative effects to the host individual. Future studies must investigate whether *A. sinensis* comes to utilize *P. viridis* more often over time, reducing the impacts of mussel invasion to the native environment, as discussed by Mouristen and Poulin (2002). In addition, ecological studies of parasites in *P. viridis* in native (source) habitats are still limiting. Further ecological studies on parasitic crustaceans are needed in both native (source) and introduced (recipient) habitats.

Case study 2: An introduced Asian bopyrid isopod threatens northeastern Pacific estuarine ecosystems

Bopyrid isopods are parasites that castrate host decapod crustaceans (Williams and Boyko, 2012). The introduced Asian parasitic bopyrid isopod, *Orthione griffenis* (Figure 3), was first discovered on the Pacific coast of North America ca. 25 years ago (Markham, 2004; Chapman *et al*., 2012). High prevalence of *Orthione* infestations decreased many local populations of the host mud shrimp *Upogebia pugettensis* as well as the diverse symbiotic fauna in the host burrows (Griffen, 2009; Dumbauld *et al*., 2011; Chapman *et al*., 2012). Chapman *et al*. (2012) revealed using six criteria that *Orthione* is introduced to North America: "its conspecificity with disjunct Asian populations, its earliest collec-

Figure 3. Invaded bopyrid isopod, *Orthione griffenis*, collected at Yaquina Bay, Oregon, USA. A female (larger) and a male (on the female abdomen).

tions in Asia, its late discovery among symbiotic species associated with *Upogebia*, its historical absence, and its appearance in North America coincident with extensive new ballast water traffic from Asia".

Itani (2004) investigated the distribution and host specificity of the bopyrid isopods infesting upogebiid shrimps in western Japan. As a result, nine species (*Gyge ovalis*, *Progebiophilus villosus*, *Progebiophilus* sp. 1, *Progebiophilus* sp. 2, Pseudioninae sp. 1, Pseudioninae sp. 2, *Procepon insolitum*, *Upogebione* sp., and *Phyllodurus* sp.) were collected (Itani, 2004), although Pseudioninae sp. 1 was later identified with *Orthione griffenis* (Chapman *et al*., 2012). *Orthione griffenis* was collected from various localities, parasitizing *Upogebia major*, *U. issaeffi*, and *Austinogebia narutensis* (Itani, 2004). Our unpublished researches (by GI, YH, and HK) suggested that prevalence of *O. griffenis* was extremely low compared to the commonest species *Gyge ovalis* in Japan. Future studies must explain why *O. griffenis* was successfully invaded to North Eastern Pacific, instead of *G. ovalis*, abundant in Japanese waters. Further ecological studies on *O. griffenis* are needed in both native (source) and introduced (recipient) habitats, as well as on many other bopyrid isopods.

We must take the greatest care not to let bopyrid isopods invade, considering the deleterious effects of this parasite on the host decapod crustaceans (Griffen, 2009; Dumbauld *et al*., 2011; Chapman *et al*., 2012). Bopyrid isopods of the subfamily Orbioninae are parasites of penaeid prawns (Figure 4) that are not distributed

Figure 4. A penaeid prawn with Orbioninae parasite in the left branchial chamber, bought in a supermarket at Kochi, Japan.

in American continents (Markham, 1986). When one of the Orbioninae species is introduced to America, it will damage penaeid shrimp populations and shrimp industries in American continents. Ecology and life history of bopyrids including Orbioninae species should also be investigated.

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