

Parasitic Cirripedia (Rhizocephala) and Isopoda from Brachyuran and Anomuran Crabs of the Pacific Coast of Northern Honshu, Japan

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Abstract. Four species of Rhizocephala were found on crabs from the intertidal rocky shore of Sanriku, northern Honshu: *Sacculina yatsui* Boschma, 1936 from *Pachygrapsus crassipes*; *Sacculina* sp. from *Hemigrapsus sanguineus*; *Peltogaster paguri* Rathke, 1842 from *Pagurus maculosus* (new host); and *Peltogasterella gracilis* (Boschma, 1927) from *Pagurus filholi* (new host), *P. maculosus* (new host) and *P. middendorffii*. The bopyrid isopod *Athelges takanoshimensis* Ishii, 1914 also occurred on *P. filholi* and *P. maculosus* (new host). These parasitic crustaceans are recorded for the first time from the Pacific coast of northern Honshu.

Key words: Rhizocephala, parasitic Isopoda, crabs, North Pacific Ocean, northern Japan

Introduction

The rhizocephalan fauna of Japan is comparatively well known in the southwestern region (e.g., Shiino, 1943), but little information is available on this group in the northeastern region. In particular, there have been no studies on the fauna of rhizocephalans along the Pacific coast of northern Honshu. The aim of the present paper is to clarify the fauna of rhizocephalans on the intertidal rocky shore in Sanriku, Iwate Prefecture, northeastern Honshu, and to provide information on their occurrences on various crabs. This paper also reports on the occurrence of the bopyrid isopod *Athelges takanoshimensis* Ishii that was found together with on the crabs.

Materials and Methods

Crabs were collected by hand at low tide from the intertidal rocky shore of Sanriku (39°06'N, 141°52'E), Iwate Prefecture. Six species of brachyuran crabs [*Pachygrapsus crassipes* Randall (N=117), *Hemigrapsus sanguineus* (De Haan)(N=73), *Gaetice depressus* (De Haan)(N=76), *Pugettia quadridens quadridens* (De Haan)(N=6), *Sphenocarcinus stimpsoni* (Miers)(N=2), *Cancer amphioetus* Rathbun (N=1)] were sampled in June of 1994 and 1995. Four

species of anomuran crabs [*Pagurus filholi* (De Man)(N=87), *P. maculosus* Komai and Imafuku (N=297), *P. middendorffii* Brandt (N=3), *Hapalogaster dentata* (De Haan)(N=2)] were also taken in June 1995. These crabs were brought alive to the laboratory, where they were measured for carapace width (CW) or carapace length (CL) and then examined for the presence of rhizocephalan and isopod parasites. When parasites were found, they were fixed in 10% formalin and preserved in 70% alcohol. Sacculinid rhizocephalans were fixed in Bouin's fluid and examined for the structure of the outer cuticle.

Scientific names of crabs are those given by Miyake (1982, 1983), except for those of *P. filholi* and *P. maculosus* (see Sandberg and McLaughlin, 1993; Komai and Imafuku, 1996). Voucher specimens of the parasites and hosts are deposited at the Natural History Museum and Institute, Chiba (CBM-ZC 2949 for *Peltogaster paguri* and *Pagurus maculosus*; CBM-ZC 2950 for *Peltogasterella gracilis* and *Pagurus filholi*; CBM-ZC 2951 for *Athelges takanoshimensis* and CBM-ZC 2952 for *Pagurus maculosus*) and at the Institute of Zoology, University of Copenhagen (*Sacculina yatsui* and *Sacculina* sp.).

Results and Discussion

1. *Sacculina yatsui* Boschma, 1936 (Rhizocephala: Sacculinidae)

Two (9.5%) of 21 *Pachygrapsus crassipes* (20.0-39.0 mm CW) collected in June 1994 were infected with this parasite. Three (3.1%) of 96 *P. crassipes* (7.0-45.0 mm CW) taken in June 1995 were also parasitized. Four of these infected crabs carried a single ovigerous externa and the fifth a scar. The infected hosts ranged from 22.0-23.5 mm CW for males (N=2) and from 22.0-34.0 mm CW for females (N=3). No other crabs were infected.

The outer cuticle of the parasites in our material is typical of the species, as it was all over provided with spines arranged in groups and in which a number of close-set groups were isolated from similar areas by a reticular system of non-spinous passages. This arrangement differs widely from the cuticle of the two other species of *Sacculina* parasitizing *P. crassipes*, *S. confragosa* Boschma, 1933 and *S. imberbis* Shiino, 1943, which are completely devoid of spines.

Our finding constitutes the northernmost record of *S. yatsui*. This species is so far known to infect *P. crassipes* in Sagami Bay (Misaki, Aburatsubo, Shimoda) and at the Ryukyu Islands (reported as "Ryūkyū" or "Okinosima") and further to occur on *Metopograpsus quadridentatus* Stimpson* at unknown locality in Japan (Boschma, 1935, 1936, 1949; Shiino, 1943). From outside Japan, Boschma (1949) reported *S. yatsui* from Indonesia: Kambang near Timor, and Tukang Besi Islands [from *Metopograpsus messor* (Forskål)]; Tanah Djampea (from *M. oceanicus* Jacq. and Luc.); and Halmahera (from *M. quadridentatus*).

2. *Sacculina* sp. (Rhizocephala: Sacculinidae)

Among 17 *Hemigrapsus sanguineus* (14.5-32.5 mm CW) collected in June 1994, one male (5.9%) possibly was internally infected with this parasite, as it had an unusually broad abdomen. A single, young,

*As this species is not distributed in Japan (Dr. Tomoyuki Komai, Chiba, personal communication), the material reported by Boschma (1949) was probably collected outside Japan.

but oviparous externa was found on one female (1.8%) of 56 *H. sanguineus* (8.0-32.0 mm CW) sampled in June 1995. The infected hosts were 22.0 and 21.0 mm CW for the male and female, respectively. No other crabs were infected.

In Japanese waters, three species of *Sacculina* are known from *H. sanguineus*. *Sacculina senta* Boschma, 1933 has many close-set cuticular papillae each terminating in a characteristic bundle of stiff little spines. *Sacculina nigra* Shiino, 1943 has a nearly oval body, one half of which is more expanded than the other; the external cuticle bears no papillae, but is composed of two layers of which the outer one has well-developed ridges and contains pigment displaying an irregular arborescent pattern. The present specimen is different from these two species in that the body is symmetrical, the cuticle colorless and has neither papillae nor ridges. It matches, however, the brief characterization of an undescribed species of *Sacculina* which is locally very common on *H. sanguineus* on the west coast of Kyushu (Yamaguchi et al., 1987, 1994).

The present finding of *Sacculina* sp. extends its distribution from Kyushu to northern Honshu. In Kyushu, Yamaguchi et al. (1994) studied its prevalence and frequency of multiple infections in relation to the topography and openness of the habitat. Takahashi (1991) and Takahashi and Matsuura (1994) examined the growth, reproduction, longevity and regeneration of the externae of *Sacculina* sp., although the latter authors erroneously identified it as *S. senta*.

3. *Peltogaster paguri* Rathke, 1842 (Rhizocephala: Peltogastridae)

This species occurred on 14 (4.7%) of 297 *Pagurus maculosus* in June 1995 but was not found on the two other hermit crabs. The infected hosts ranged from 9.0-14.0 mm CL.

The species was easily distinguished by its reddish color and by the fact that it normally, and in contrast to *Peltogasterella gracilis* (see below), occurred singly on its host. Two and three parasites co-occurred on one and three of 14 infected hosts,

respectively. In all these cases of multiple infection, the parasites were virginal or immature and of exactly the same size. This agrees to the theory that two or more rhizocephalans may usually only develop when infection is simultaneous and that in the opposite case that, which arrives first, exerts an immunizing effect on later arrivals (Høeg and Lützen, 1995).

The majority of the parasites (N=18) were virginal or immature with a length up to 4.0 mm; only three were mature, two non-ovigerous (6.5 and 12.0 mm) and one ovigerous (16.0 mm). This suggests that early summer is the season of emergence of the externae in this species at the study site.

Pagurus maculosus is a new host. In Japanese waters, *Peltogaster paguri* is known to infect seven other species of hermit crabs [*Clibanarius virescens* (Krauss), *Dardanus crassimanus* (H. Milne Edwards), *Pagurus dubius* (Ortmann), *P. filholi*, *P. gracilipes* (Stimpson), *P. lanuginosus* De Haan, *P. ochotensis* Brandt] in Hokkaido (Akkeshi, Atsuta, Oshoro, Shirikishinai), Honshu (Oga Peninsula, Tobi Island, Nezugaseki, Sado Island, Manazuru, Seto) and Kyushu (Tomioaka) (Krüger, 1912; Shiino 1943; Yamaguchi and Yamada, 1955; Oguro, 1956; Ichikawa and Yanagimachi, 1960; Ichikawa, 1961; Utinomi and Kikuchi, 1966; Suzuki, 1979; Takeda, 1994). In the North Pacific Ocean, it also occurs along the Alaskan Peninsula and the Aleutian Islands (Reinhard, 1944). It is a frequent parasite on various hermit crab species on both sides of the North Atlantic Ocean (Høeg and Lützen, 1985).

4. *Peltogasterella gracilis* (Boschma, 1927) (Rhizocephala: Peltogastridae)

This species was a common parasite at the study site, as it occurred on 18 (20.7%) of 87 *Pagurus filholi*, 9 (3.0%) of 297 *P. maculosus* and 2 (66.7%) of 3 *P. middendorffii* in June 1995. The infected hosts ranged from 5.0-9.0 mm CL for *P. filholi*, from 8.5-12.5 mm CL for *P. maculosus* and was 8.0 mm CL for *P. middendorffii*.

The color of *P. gracilis* was milky-white or faintly yellowish, but it depended on the age and stage of maturity and also on whether it was ovigerous or not;

with advancing development of the embryos, the color gradually changed to light brown because of increasing pigmentation of the brood. Maximum length recorded (on *P. maculosus*) was 12.0 mm, but the great majority were virginal (1.5-2.5 mm), immature (up to 4.0 mm) or, even if mature, rarely more than 8 mm long. Minimum length of ovigerous specimens was 5.0 mm. One of the largest *P. gracilis* had a *Liriopsis* sp. (parasitic isopod) protruding from the mantle cavity.

This species is usually colonial and occurs in a number of up to a dozen or more per infected host. All externae are believed to be budded at the same time from a common root system derived from infection by a single cyprid larva and therefore represent a clone (cf. Yanagimachi, 1961b). There is only one or two ovipositions and then the parasites die and drop off to be replaced through budding by a new generation. This may be repeated several times. In our material, any number of externae between 1 and 10 occurred on a single host, and 15 parasites were recorded from one host. However, the frequent occurrence of scars left by died externae indicates that the original number was somewhat higher in most cases. Ichikawa and Yanagimachi (1957) have demonstrated that growth of virginal externae is dependent on whether cell material from male cyprids is deposited in their male receptacles and that, if this does not happen, the parasites will die and drop off (leaving a scar). Since male cell deposition within members of the same clone may occur over a period, there is no synchrony of externa development. This is also apparent in our material, as the state of maturity varied considerably among parasites co-inhabiting the same host, virginal, immature and non-ovigerous and/or ovigerous externae often occurring together.

Pagurus filholi and *P. maculosus* are new hosts. *Peltogasterella gracilis* is locally a very common parasite of Japanese hermit crabs and has been recorded from three other species (*Pagurus lanuginosus*, *P. ochotensis*, *P. middendorffii*), but most often from *P. lanuginosus*. It has been found most often on the Pacific and Japan-Sea coasts of Hokkaido (Akkeshi, Atsuta, Otaru, Oshoro) (Hiro,

1935; Yamaguchi and Yamada, 1955; Oguro, 1956; Shirase and Yanagimachi, 1957; Ichikawa and Yanagimachi, 1957, 1958; Ichikawa, 1961; Yanagimachi, 1961a), its distribution extending to Kanagawa (Sagami Bay)(Krüger, 1912). Other records from the North Pacific are summarized by Reischman (1959), and the species also occurs frequently at Vladivostok, Russia (Dr. A. V. Rybakov, Institute of Marine Biology, Far Eastern Branch, Academy of Sciences of Russia, Vladivostok, personal communication).

5. *Athelges takanoshimensis* Ishii, 1914 (Isopoda: Bopyridae)

This species was found on one (1.1%) of 87 *Pagurus filholi* and 8 (2.7%) of 297 *P. maculosus*. The infected hosts of the latter species ranged from 4.5-10.5 mm CL.

The species was milky-white to pink in color. Most female specimens were 7-9 mm CL. Almost all had a single pygmy-male attached to the abdomen and embryos in various stages of development in the brood pouch. In one instance, a single *A. takanoshimensis* occurred together with six small externae of *Peltogasterella gracilis* on *Pagurus maculosus*. Shiino (1958) also found a juvenile female *A. takanoshimensis* co-occurring with a single *Peltogaster paguri* on *Pagurus japonicus* (Stimpson) from Kominato.

Pagurus maculosus is a new host. *Athelges takanoshimensis* is known to occur on three or four other species of hermit crabs [*P. filholi*, *P. japonicus*, *P. pectinatus* (Stimpson), *P. sp.*] in Hokkaido (unknown locality), Honshu (Takanoshima, Kominato, Misaki, Wakayama, Seto, Kasaoka) and Kyushu (Kashii)(Ishii, 1914; Shiino, 1934, 1936, 1937, 1939, 1958; Imahara, 1996).

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本州北部の北太平洋沿岸の短尾類と異尾類に寄生する根頭類と等脚類

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北太平洋に面する岩手県三陸町吉浜湾船作海岸の潮間帯から採集した短尾類と異尾類に寄生する根頭類と等脚類を調べた。イワガニにヤツフクロムシ(新称) *Sacculina yatsui*, イソガニにフクロムシ属の1種 *Sacculina* sp., ホンヤドカリ属の1種 *Pagurus maculosus* (新宿主) にナガフクロムシ *Peltogaster paguri*, ホンヤドカリ(新宿主)・テナガホンヤドカリ・*P. maculosus* (新宿主) にフサフクロムシ *Peltogasterella gracilis*, ホンヤドカリと *P. maculosus* (新宿主) にヤドカリノハラヤドリ *Athelges takanoshimensis* を認めた。これらの寄生虫は本海域から初記録であり、その出現状況, 形態, 分布を記述した。

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