

Infection with the Parasitic Copepod *Clavella parva* (Lernaeopodidae) in Gold-eye Rockfish *Sebastes thompsoni* Broodstock in Japan

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(Received December 26, 2007)

ABSTRACT—Infection with the lernaeopodid copepod *Clavella parva* was found in gold-eye rockfish *Sebastes thompsoni* broodstock kept at an aquaculture institute in Aomori Prefecture, northern Japan. A description of female and male adults of *C. parva* is given. This is the first record of *C. parva* from Japan and a new host record. The parasite was likely introduced to the institute by the fish that had been reared in cages kept in natural waters. No infection was observed again after manual removal of the copepods. The species occurred most abundantly on the dorsal and caudal fins, followed by the anal fin. Literary information on the geographical distribution and hosts of *C. parva* is reviewed.

Key words: *Clavella parva*, *Sebastes thompsoni*, parasitic copepod, new host, new locality

The gold-eye rockfish *Sebastes thompsoni* is distributed in the western North Pacific Ocean and the Sea of Japan around Japan and Korea (Nakabo, 2002) and usually inhabits waters at about 100 m deep on the rocky continental shelf. In Japan, the species is important in commercial fisheries and popular in recreational fishing. It is viviparous and juveniles migrate with drifting seaweed (Nagasawa and Kobayashi, 1995; Kokita and Omori, 1998, 1999). Although the species was formerly one of the most common species in coastal waters of Honshu, the main island of Japan, its stock abundance decreased during the last three decades. In Aomori Prefecture which is the most productive area in commercial catch of the species, annual catch was as high as 1,045 metric tons (mt) in 1973 but remained at less than 500 mt in the early 2000s. Under these situations, since 2003, seed production of the species has been conducted at Aquaculture Institute, Aomori Prefectural Fisheries Research Institute, in Hiranai, Aomori Prefecture, where a parasitic infection was found on the fins of the fish kept as broodstock in July 2006. The

parasite was identified as the lernaeopodid copepod *Clavella parva*. This is new to Japan, which promotes us here to describe the species based on the specimens of this material. This paper also reports on the parasite's habitat and efficiency of manual removal as its control.

Materials and Methods

Fish

The gold-eye rockfish *Sebastes thompsoni* examined were those comprising two groups of different origins. The first group consisted of the fish that were produced at Aquaculture Institute in mid-April and early May 2004 and then reared in cages in coastal waters of the northern Sea of Japan at Kodomari (41°07'N, 140°17'E) in Aomori Prefecture from July 2004 to June 2005. The fish of the second group were sampled as juveniles in Mutsu Bay off Moura (40°56'N, 140°51'E) near the institute in June 2004 and later kept in the cages together with the fish of the first group until June 2005. After the fish of both groups were reared for growth in a land-based, closed-circulation tank at Kodomari using filtered seawater for about one year,

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they were finally transferred on June 1, 2006 to the institute, where they were held as broodstock in a large tank (30 mt in capacity, 3 m in depth) supplied with filtered seawater. Water temperature was maintained at 12–16°C.

Fish and parasite examination

A total of 115 fish were examined for copepods on July 4, 2006. The fish were anesthetized in a 0.01% solution of FA100 (Tamura-seiyaku) and measured for total length (mm) and body weight (g). When copepods were found, their locations of attachment were recorded. For control, all copepods found were carefully removed with forceps. The copepods were then fixed and preserved in 70% ethyl alcohol. For taxonomic study, the copepod specimens were cleared in lactic acid and dissected under a stereoscopic microscope. Following the wooden slide technique of Humes and Gooding (1964), body parts and dissected appendages were examined using a microscope with differential interface contrast. Measurements were made based on 10 ovigerous females and eight males, and all drawings were made with the aid of a drawing tube. All measurements are in mm with means in parentheses. The scientific names of fishes follow Froese and Pauly (2007). Voucher specimens of copepods are deposited in the crustacean (Cr) collection at the National Science Museum, Tokyo, Japan (NSMT-Cr 17989).

The terms, *prevalence* (the proportion of infected fish of a given species in a sample as a percentage), *intensity* (the number of parasites per host infected in a sample), *mean intensity* (the mean number of parasites per host infected in a sample), *abundance* (the number of parasites per host examined in a sample), and *habitat* (a typical local environment in which parasites occur) are used according to the definitions of Bush *et al.* (1997).

Statistical analyses

Statistical analyses were performed to test whether there are any significant differences between abundance of copepods, host size and condition factor. The condition factor (CF) was calculated as follows: $CF = 10^5 \times \text{body weight (g)} / \text{total length (mm)}^3$. Results were considered statistically significant at the 5% level.

Results

Clavella parva Wilson, 1912

[New Japanese names: soi-maru-nagakubimushi for the species;
maru-nagakubimushi for the genus]
(Figs. 1–2)

Description

Female: Cephalothorax subcylindrical, slightly longer than trunk, of about same diameter throughout

(Fig. 1A). Trunk subquadrangular, slightly longer than wide, flattened dorsoventrally; posterior margin with small genital process. Egg sacs multiseriate, longer than trunk. Cephalothorax 1.20–1.46 (mean 1.31) long and 0.34–0.46 (0.41) wide, trunk 1.20–1.68 (1.34) long and 0.62–1.29 (0.99) wide, and egg sacs 0.84–2.14 (1.56) long.

Antennule (Fig. 1B) two-segmented; first segment with one distal seta; second segment with apical armature comprising tubercle 1, digitiform seta 4, bifid seta 5, and flagelliform seta 6 (cf. Kabata, 1979: 343 for the apical armature of antennule). Antenna (Fig. 1C) without exopod; basal segment consisting of two indistinct parts; distal segment small, armed with two setae and two patches of spinules.

Mandible (Fig. 1D) with nine teeth on distal margin, arranged as four distal teeth, one large primary tooth, a small secondary tooth, and three basal teeth. Maxillule (Fig. 1E) with three and one groups of denticles on dorsal margin and lateral surface, respectively; exopod with two setae; endopod with one small seta near its base and two terminal papillae, each bearing a single distal, thick seta. Maxilla (Fig. 1A) slightly flexed, short and fused at apex. Bulla (Figs. 1F, 1G) small with circular disc and short manubrium. Maxilliped (Fig. 1H) with robust corpus; myxal area with one spiniform seta and patch of denticles; subchela with cylindrical shaft with one spiniform seta on lateral surface, one distal barb and denticles on distal part of inner margin; claw slightly curved and tapering.

Male: Attached by maxillae to surface of trunk of female. Body (Fig. 2A) suboval and broadened distally, 0.24–0.30 (mean 0.27) long and 0.12–0.19 (0.16) wide.

Antennule (Fig. 2B) three-segmented; first segment with one thick distal seta; second segment unarmed; third segment apically armed with tubercles 1 and 3, digitiform seta 4, bifid seta 5, and slender seta 6. Antenna (Fig. 2C) with exopod with one distal seta; endopod two-segmented, equipped with small processes on basal segment and two setae and group of denticles on distal segment; mandible (Fig. 2D) slender without teeth. Maxillule (Fig. 2E) devoid of denticulation on dorsal margin; exopod with two setae of unequal length; endopod with two terminal papillae each mounted by a single seta. Maxilla (Fig. 2F) with strong, unarmed corpus; subchela in form of curved claw. Maxilliped (Fig. 2G) cylindrical with blunt end; subchela slightly curved.

Habitat

The copepods were found attached to the dorsal, caudal and anal fins of the fish (Table 1). The dorsal and caudal fins both were more frequently and abundantly infected than the anal fin, but there was no significant difference in intensity of copepods between the dorsal and caudal fins (Mann-Whitney *U*-test, *P* =

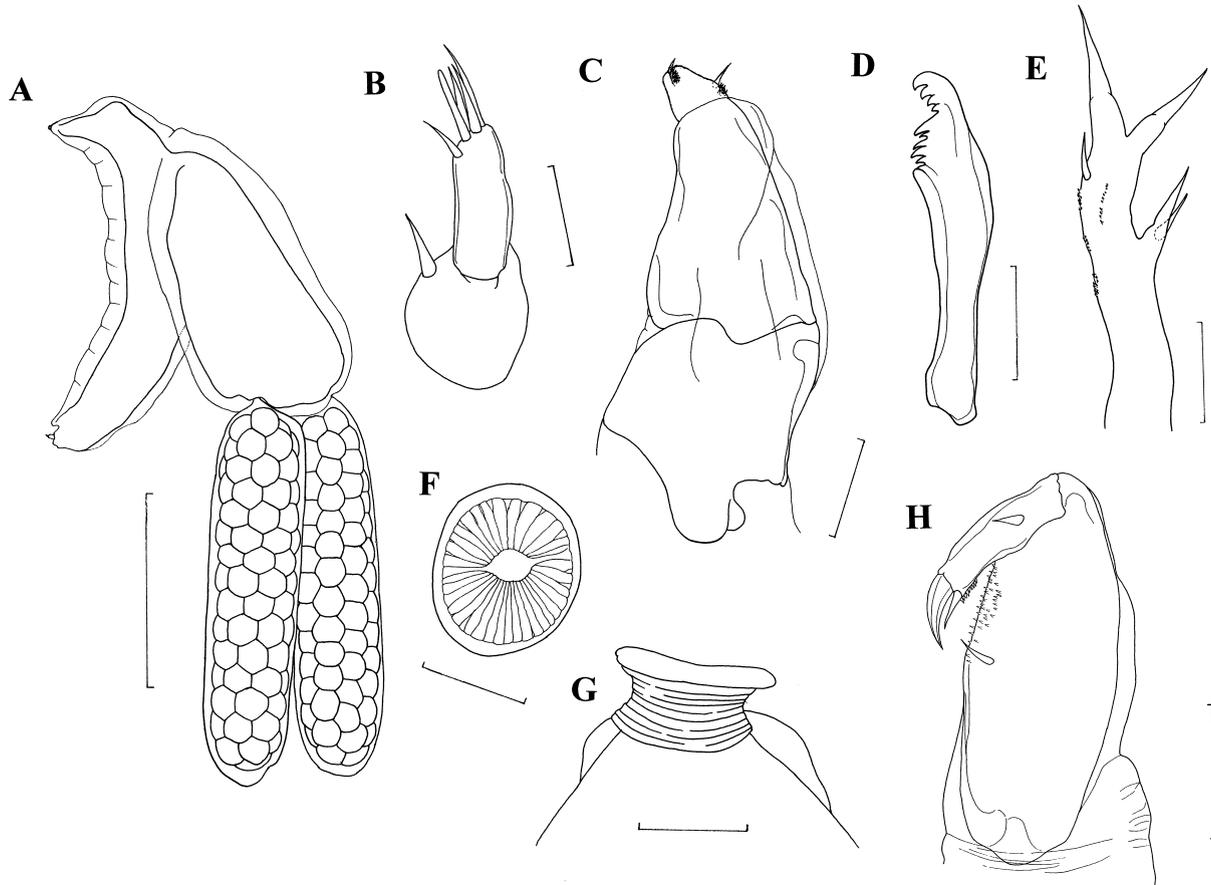


Fig. 1. *Clavella parva*, female. A, habitus, dorsolateral; B, antennule, ventral; C, antenna, ventral; D, mandible, lateral; E, maxillule, lateral; F, bulla, proximal surface; G, bulla, ventral; H, maxilliped, ventral. Scale bars: 1 mm in A; 20 μ m in B–E; 50 μ m in F–H.

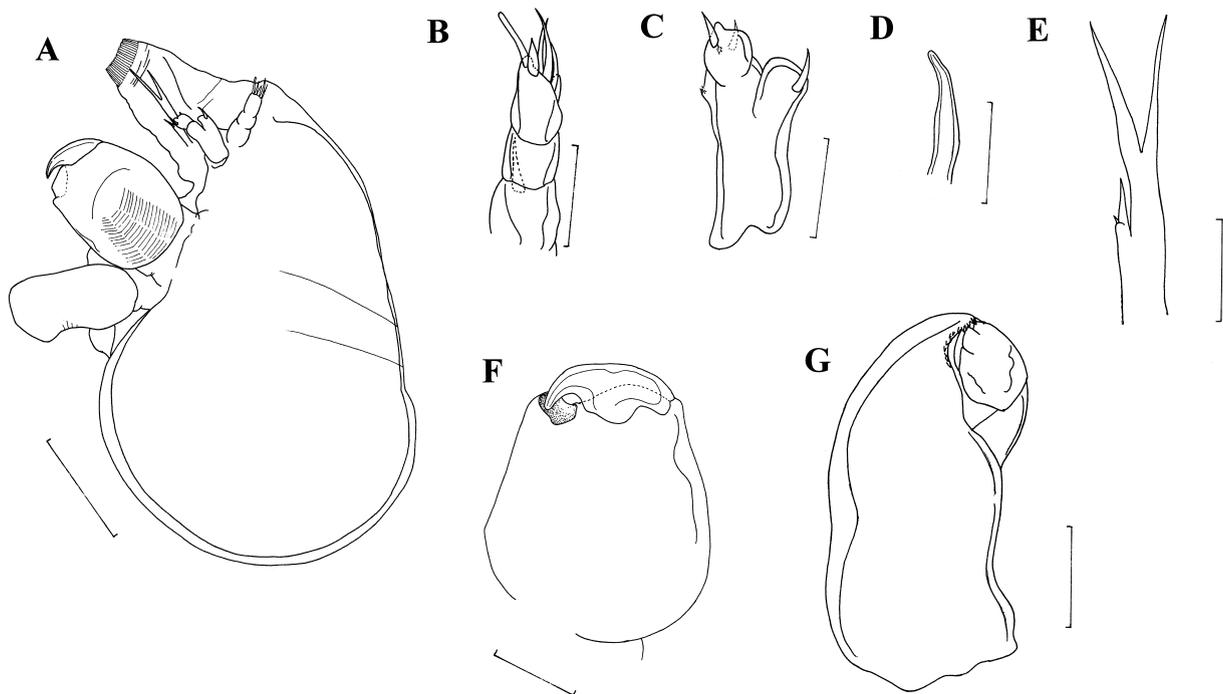


Fig. 2. *Clavella parva*, male. A, habitus, lateral; B, antennule, ventrolateral; C, antenna, lateral; D, mandible, lateral; E, maxillule, lateral; F, maxilla, lateral; G, maxilliped, medial. Scale bars: 50 μ m in A; 20 μ m in B–G; 25 μ m in F.

Table 1. Occurrence of *Clavella parva* on the fins of 115 *Sebastes thompsoni* reared at Aquaculture Institute of Aomori Prefectural Fisheries Research Institute on July 4, 2006

	No. of fish infected (%)	Total no. copepods found (%)	No. of copepods per infected fin (mean)
Dorsal fin	97 (84.4)	297 (45.1)	1–10 (3.1)
Caudal fin	99 (86.1)	258 (39.1)	1– 7 (2.6)
Anal fin	63 (54.8)	104 (15.8)	1– 5 (1.7)
Pectoral fins	0 (0)	0 (0)	0 (–)
Ventral fins	0 (0)	0 (0)	0 (–)

0.0529). On the dorsal fin, only the posterior part with rays was only infected. The bulla, an attachment organ at the top of the second maxilla, was found adhering to the fin ray, where no lesion was observed with the naked eyes.

Infection level

Prevalence of infection was 86.1% (99 infected/115 examined), and intensity of infection ranged from one to 16 copepods per host (mean intensity = 6.7). There was no significant correlation between copepod abundance and host's total length (131–238 mm, mean 175 mm) (Spearman rank order correlation coefficient, $P > 0.05$), nor between copepod abundance and host's body weight (31.5–254.0 g, mean 98.6 g) (Spearman rank order correlation coefficient, $P > 0.05$).

Condition of infected fish

The infected fish showed no disease signs, such as abnormal swimming behavior or reduction in feeding activity. There was no significant correlation between copepod abundance and condition factor (1.39–2.13, mean 1.83) (Spearman rank order correlation coefficient, $P > 0.05$) of the fish examined.

Control

After the copepods were manually removed from the infected fish, no infection was found for 18 months from July 2006 to December 2007. When the copepods were taken, no hemorrhage was observed at the attachment sites of the fins.

Discussion

The morphological features of copepod specimens examined in this study fit well into the species diagnosis of *Clavella parva*, as given by Wilson (1912) and later by Kabata (1970), and the copepods are accordingly identified as it. This species was first described from *Sebastes* (as "*Sebastodes*") *auriculatus* at Nanaimo in British Columbia (Wilson, 1912). On the other hand, *C. recta* was later described from *Sebastes* (as "*Sebastodes*") *melanops* in Southeast Alaska (Wilson,

1915) but this taxon has been relegated to a junior synonym of *C. parva* (Kabata, 1970).

As in our female specimens from Japan, the flagelliform seta 6 was present in the second segment of the first antenna, and the exopod of the second antenna was lacking in the Korean female specimens (see Kim, 1998: Fig. 370D). There are, however, minor differences in the female morphology between East Asian specimens and those redescribed from Canada. For example, in the Canadian specimens, the seta 6 is lacking, and the exopod is vestigial (see Kabata, 1970: Figs. 25–26), suggesting that there is a close relationship between the Japanese and Korean populations of the species but that some genetic differences exist between the populations occurring off East Asia and North America. Molecular analysis will be useful to elucidate such differences.

The present finding of *C. parva* constitutes the first record of the copepod from Japan. In the North Pacific Ocean, the species has been reported from off the coast of Southeast and Southcentral Alaska, British Columbia and California on the North American side (Wilson, 1912, 1915, 1920, 1922; Fraser, 1920; Bere, 1930; Kabata, 1970, 1988; Sekerak, 1970; Sekerak and Arai, 1977; Margolis and Arthur, 1979; Moles, 1982; Love *et al.*, 1984; Kazachenko, 1986) and from off the coast of western Sakhalin and Korea (both in the Sea of Japan) on the Asian side (Gusev, 1951; Kim, 1998). In the South Pacific Ocean, the copepod is known from off the coast of Chile (Castro and Baeza, 1985). Since most species of *Clavella* are distributed only in the northern hemisphere (Kabata, 1979), *C. parva* is unusual in geographical distribution, like *C. adunca*, in that it occurs in both the North and South Pacific Oceans.

The present collection of *C. parva* from *S. thompsoni* also represents a new host record. Although copepods of *Clavella* usually parasitizes fishes of the order Gadiformes, *C. parva* is found on fishes of the orders Perciformes and Scorpaeniformes (Kabata, 1979). As in this study, the species has been reported principally from rockfishes of the genus *Sebastes* (= *Sebastodes*) (Scorpaeniformes: Scorpaenidae or Sebastidae): *S. auriculatus* (type host), *S. aleutianus*, *S. alutus*, *S. babcocki*, *S. caurinus*, *S. diploproa*, *S. elongatus*, *S. flavidus*, *S. maliger*, *S. melanops*, *S. mystinus*, *S. pinniger*, *S. rubrivinctus*, *S. serranoides* and *Sebastes* sp. from North America (Wilson, 1912, 1915, 1920, 1922; Fraser, 1920; Bere, 1930; Kabata, 1970, 1988; Sekerak, 1970; Sekerak and Arai, 1977; Margolis and Arthur, 1979; Moles, 1982; Love *et al.*, 1984; Kazachenko, 1986) and *S. taczanowskii* and *S. schlegelii* from East Asia (Gusev, 1951; Kim, 1998). The copepod is also known from *Embiotoca* (as "*Taeniotoxa*") *lateralis*, *Phanerodon furcatus*, *Rhacochilus vacca* (as "*Damalichthys argyrosomus*") (all Perciformes: Embiotocidae), *Artedius* (as "*Axyrias*") *harringtoni* and

Chitonotus pugetensis (both Scorpaeniformes: Cottidae) from Canada (Fraser, 1920; Bere, 1930; Margolis and Arthur, 1979; Kabata, 1988), *Citharichthys xanthostigma* and *C. stigmaeus* (Pleuronectiformes: Paralichthyidae) from U.S.A. (Kalman, 2006), and *Pinguipes* (as “*Mugiloides*”) *chilensis* (Perciformes: Pinguipedidae) from Chile (Castro and Baeza, 1985). Based on the host range and geographical distribution, *C. parva* is regarded as a parasite of a wide variety of rockfishes and some other teleosts in subarctic and temperate waters. At least 29 species of *Sebastes* have been recorded from Japanese waters (Nakabo, 2002) and it is highly probable that *C. parva* occurs on other rockfishes of the genus in Japan as well.

Since the fish examined were reared in cages in the coastal Sea of Japan together with individuals caught in nearby Mutsu Bay, it is very probable that the fish got infected with *C. parva* in both or either location(s). There is also a possibility that, before the fish final transfer to Aquaculture Institute, the copepod had enhanced its population size in the land-based tank at Kodomari: the water was circulated in a closed system, which might have provided favorite conditions for the copepod reproduction. The personnel who took care of the fish paid almost no attention to parasites, then the copepod must have been brought to the institute without any caution. It is really essential to examine the fish before transfer to prevent parasites from their introduction to aquaculture facilities, and if the parasites are found, it is very important to completely remove them or not to use those infected fish.

It is unlikely that the copepod increased in number in the broodstock tank of Aquaculture Institute because the fish-infecting copepods found were all manually removed one month after the fish transfer and no infection was followed. Similar efficiency of manual removal to eliminate parasitic copepods at fish rearing facilities are also known for other lernaepodids, such as *Salmincola salmoneus*, *S. californiensis*, and *S. taimen*, parasites of freshwater salmonids (McGladdery and Johnston, 1988; Higgins *et al.*, 1993; Nagasawa *et al.*, 1994), indicating that this method is very useful to control both marine and freshwater lernaepodid copepods.

In Japan, *Sebastes schlegelii* and *S. inermis*, in addition to *S. thompsoni*, are currently reared as broodstock at some aquaculture centers for seed production used for aquaculture and stock enhancement. However, knowledge of parasitic infections in these fishes is quite limited and there is only one report about copepod parasites, in which Kusakari *et al.* (1985) found *Lepeophtheirus* sp., *Clavella* sp., *Peniculus* sp. on and *Sarcotaces* sp. in wild captive broodfish and/or produced juveniles of *S. schlegelii* in Hokkaido. Since the copepod reported as *Clavella* sp. was found on the caudal, anal and ventral fins, it is likely identifiable as *C. parva* although there is no information on its morphology in the

report. The same host species has been reported to harbor *C. parva* in Korea (Kim, 1998).

It is known that *C. parva* is attached to the fins of the host fish (Wilson, 1912, 1915; Sekerak, 1970; Love *et al.*, 1984; Castro and Baeza, 1985). Likewise, our copepods of the species were found on the dorsal, caudal and anal fins. Of these fins, the copepods were most abundantly found on the dorsal and caudal fins, indicating that the species has a site preference for these fins although the reason is unknown.

Despite the fact that *S. thompsoni* is a rather common species in northern Japan and also occurs in Korean waters, the parasite fauna of this fish is poorly known in both countries. *Clavella parva* is the first species of parasitic copepod recorded from *S. thompsoni*. As for other parasites, there is only one paper reporting the morphology of metacercariae of the trematode *Stephanostomum hispidum* found in the flesh of the fish (Ohnishi *et al.*, 1991).

All of the previous papers dealing with *C. parva* focused on the taxonomy and morphology. Much work is needed on the biology of the species, including the life history, host range, and effects on the host fish.

Acknowledgments

We thank Dr. Mary N. Arai, Pacific Biological Station, Canada, Dr. Hans-Peter Fagerholm, Åbo Akademi University, Finland, and Dr. Tor A. Bakke, Natural History Museum, University of Oslo, Norway for assisting in obtaining the literature. We are grateful to Dr. Il-Hoi Kim, Kangnung National University, Korea and Heihachi Kondo, Sapporo, Japan for translation of the Korean and Russian literature, respectively. Part of the study was supported by a Grant-in-Aid for Scientific Research (B) (No. 18380116) from the Japan Society for the Promotion of Science.

References

- Bere, R. (1930): Parasitic copepods from the Vancouver Island region. *Fish. Res. Board Can. MS Rep. (Biol.)*, **259**, 1–3.
- Bush, A. O., K. D. Lafferty, J. M. Lotz and A. W. Shostak (1997): Parasitology meets ecology on its own terms: Margolis *et al.* revisited. *J. Parasitol.*, **83**, 575–583.
- Castro, R. R. and K. H. Baeza (1985): Two new species and one new record of *Clavella* (Copepoda: Lernaepodidae) from inshore fishes of Antofagasta, Chile. *Syst. Parasitol.*, **7**, 103–110.
- Fraser, C. M. (1920): Copepods parasitic on fish from the Vancouver Island region. *Proc. Trans. Roy. Soc. Can. Ser. 3*, **13**, 45–67.
- Froese, R. and D. Pauly (eds.) (2007): FishBase. World Wide Web electronic publication. Available from URL: www.fishbase.org, version (09/2007).
- Gusev, A. V. (1951): Parasitic copepods of some marine fishes. *Parasitol. Sb.*, **13**, 394–463. (In Russian).
- Higgins, M. J., L. Margolis and M. L. Kent (1993): Arrested development of a freshwater myxosporean, *Myxidium*

- salvelini*, following transfer of its host, the sockeye salmon (*Oncorhynchus nerka*), to sea water. *J. Parasitol.*, **79**, 403–407.
- Humes, A. G. and R. U. Gooding (1964): A method for studying the external anatomy of copepods. *Crustaceana*, **6**, 238–240.
- Kabata, Z. (1970): Some Lernaepodidae (Copepoda) from fishes of British Columbia. *J. Fish. Res. Bd. Canada*, **27**, 865–885.
- Kabata, Z. (1979): Parasitic Copepoda of British fishes. Ray Society, London. 468 p., 199 pls.
- Kabata, Z. (1988): Copepoda and Branchiura. In: L. Margolis and Z. Kabata (eds.), Guide to the parasites of fishes of Canada. Part II—Crustacea. *Can. Spec. Publ. Fish. Aquat. Sci.*, **101**, 3–127.
- Kalman, J. E. (2006): Ectoparasites of demersal marine fishes in Santa Monica Bay, California, U.S.A., with 31 new host records and three range extensions. *Comp. Parasitol.*, **73**, 201–213.
- Kazachenko, V. N. (1986): Parasitic copepods (Crustacea: Copepoda) on fish of genus *Sebastes* (Scorpaenidae). *Acad. Sci. USSR, Proc. Zool. Inst.*, **155**, 155–169. (In Russian with English abstract).
- Kim, I.-H. (1988): Illustrated encyclopedia of fauna & flora of Korea, Vol. 38. Cirripedia, symbiotic Copepoda, and Pycnogonida. Ministry of Education, Seoul. 1038 p. (In Korean).
- Kokita, T. and M. Omori (1998): Early life history traits of the gold-eye rockfish, *Sebastes thompsoni*, in relation to successful utilization of drifting seaweed. *Mar. Biol.*, **132**, 579–589.
- Kokita, T. and M. Omori (1999): Long distance dispersal of larval and juvenile rockfish, *Sebastes thompsoni*, with drifting seaweed in the Tohoku area, northwest Pacific, estimated by analysis of otolith microstructure. *Bull. Mar. Sci.*, **65**, 105–118.
- Kusakari, M., Y. Mori and H. Miura (1985): Rockfish *Sebastes schlegelii*. *Annu. Rep. Hokkaido Inst. Maricult. Fiscal 1984*, p. 15–24. (In Japanese).
- Love, M. S., K. Shriner and P. Norris (1984): Parasites of olive rockfish, *Sebastes serranoides*, (Scorpaenidae) off central California. *Fish. Bull.*, **82**, 530–537.
- Margolis, L. and J. R. Arthur (1979): Synopsis of the parasites of fishes of Canada. *Bull. Fish. Res. Board Can.*, **199**, 1–269.
- McGladdery, S. E. and C. E. Johnston (1988): Egg development and the gill parasite, *Salmincola salmoneus*, on Atlantic salmon kelts (*Salmo salar*) exposed to four different regimes of temperature and photoperiod. *Aquaculture*, **68**, 193–202.
- Moles, A. (1982): Parasite-host records of Alaskan fishes. *U.S. Dep. Commer., NOAA Tech. Rep. NMFS SSRF-760*. 41 p.
- Nagasawa, T. and T. Kobayashi (1995): The early life history of the rockfish, *Sebastes thompsoni* (Scorpaenidae), in the Sea of Japan. *Japan. J. Ichthyol.*, **41**, 385–396.
- Nagasawa, K., J. R. Watanabe, S. Kimura and A. Hara (1994): Infection of *Salmincola stellatus* (Copepoda: Lernaepodidae) on Sakhalin taimen *Hucho perryi* reared in Hokkaido. *Bull. Fac. Fish. Hokkaido Univ.*, **45**, 109–112.
- Nakabo, T. (2002): Scorpaenidae. In: T. Nakabo (ed.). Fishes of Japan with pictorial keys to the species, English edition. Tokai Univ. Press, Tokyo. p. 565–595.
- Ohnishi, Y., T. Ono and T. Kifune (1991): Metacercariae of *Stephanostomum hispidum* (Yamaguti, 1934) (Trematoda, Digenea: Acanthocolpidae) found in the marine goldeye rockfish, *Sebastes thompsoni*. *Japan. J. Parasitol.*, **40**, 432–436.
- Sekerak, A. D. (1970): Parasitic copepods of *Sebastes alutus* including *Chondracanthus triventricosus* sp. nov. and *Colobomatus kyphosus* sp. nov. *J. Fish. Res. Bd. Canada*, **27**, 1943–1960.
- Sekerak, A. D. and H. P. Arai (1977): Some metazoan parasites of rockfishes of the genus *Sebastes* from the northeastern Pacific Ocean. *Syesis*, **10**, 139–144.
- Wilson, C. B. (1912): Parasitic copepods from Nanaimo, British Columbia, including eight species new to science. *Contr. Can. Biol. 1906–1910*, p. 85–191.
- Wilson, C. B. (1915): North American parasitic copepods belonging to the Lernaepodidae, with a revision of the entire family. *Proc. U. S. Nat. Mus.*, **47**, 565–729, 32 pls.
- Wilson, C. B. (1920): Report on the parasitic Copepoda collected during the Canadian Arctic Expedition, 1913–1918. *Rep. Can. Arct. Exped., 1913–1918, Vol. 7, Part L: Parasitic Copepoda*, p. 1–16.
- Wilson, C. B. (1922): Parasitic copepods in the collection of the Zoological Museum, Kristiania. *Med. Zool. Mus. Kristiania*, **1922(4)**, 1–7.