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Crustaceans Associated with Cold Water Corals: A Comparison of the North Atlantic and North Pacific Octocoral Assemblages

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Abstract. Crustaceans live on large colonial invertebrates for a variety of reasons, but in all cases must overcome the defenses of the host animal. We surveyed the crustaceans living on deep-sea octocorals collected during expeditions to the New England and Corner Rise seamounts (2003–2005) in the Northwest Atlantic and to the Aleutian Ridge (2004) in the North Pacific. Only a small number of crustacean species were found on octocorals in the Northwest Atlantic but a great many species, especially amphipods, were found on octocorals in the Northwest Pacific. We suggest that this disparity is due to both the differences in octocoral host dominance as well as differences in the available species pool between the two oceans.

Introduction

The anthozoan subclass Octocorallia comprises a large number of colonial species living in both shallow tropical as well as polar and deep-sea cold waters. Octocoral colonies are often quite large, and in many cases house symbionts belonging to multiple invertebrate phyla. Invertebrate symbionts of cold water octocorals have been documented in the North Atlantic by Buhl-Mortensen and Mortensen (2004 a, b, 2005), Watling (2010), Buhl-Mortensen *et al*. (2010), De. Clipelle *et al*. (2015), Schwentner & Lörz (2020), and on a global basis by Watling *et al*. (2011). To date, little is known about crustacean symbionts of cold water octocorals from the North Pacific Ocean.

In this paper we summarize what is known about crustaceans living on octocorals from samples that we have collected in the Northwest Atlantic and North Pacific Oceans augmented with information from published studies.

Materials and methods

Samples for this study were obtained from octocorals collected by remotely operated vehicles (ROVs) during expeditions on the New England and Corner Rise (NES&CR) Seamounts in the Northwest Atlantic (Fig. 1) during the years 2003–2005, and on the central part of the Aleutian Ridge (AR) in 2004 (Fig. 2). Samples from NES&CR were obtained with the submersible *Alvin* in 2003 and the ROV *Hercules* operated from the NOAA ship R/V *Ron Brown* during cruises in 2004 and 2005. Samples from the AR were obtained with the ROV *Jason II* operated from the R/V *Roger Revelle* in 2004. Most samples were obtained from bathyal depths (200–3500 m).

Whole octocoral colonies (in the case of small colonies, *ca.* 20 cm or less) or pieces of colonies were collected using the hydraulic manipulator of the ROV and the samples stored in moderately insulated bioboxes until the ROV was

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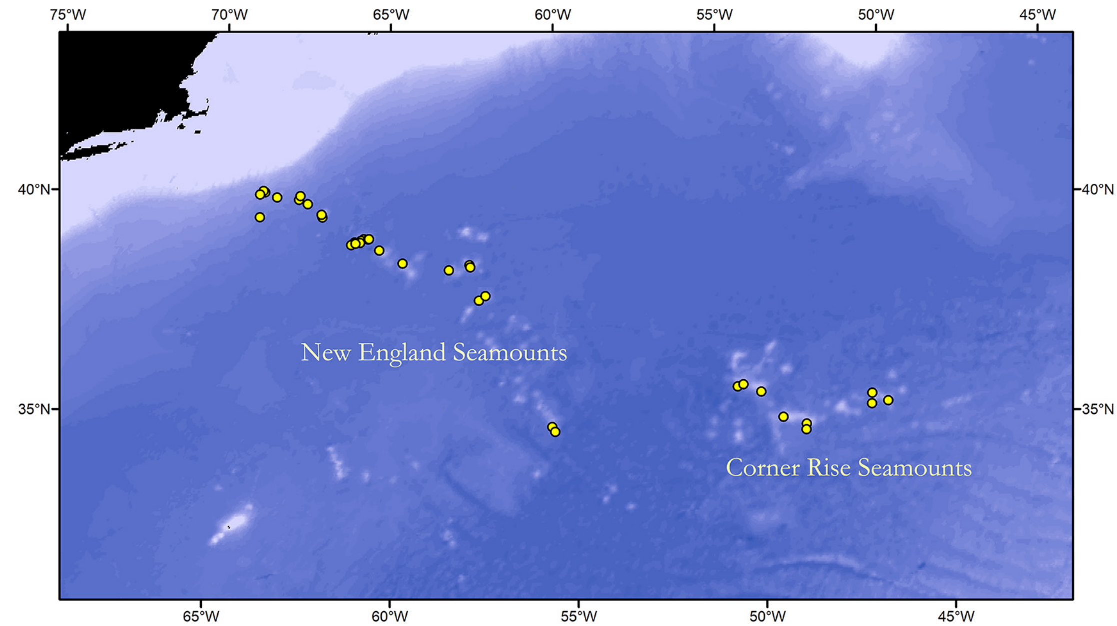

Figure 1. Remotely operated vehicle (ROV) dive locations in the New England and Corner Rise seamount groups, NW Atlantic, during cruises in 2003–2005.

retrieved on board the ship. For the most part the samples were not isolated from each other, but we noted that most symbionts were still associated with their coral host when the biobox was opened. In the lab on the ship the coral and its symbionts were photographed together as much as possible. All octocoral material was subsampled with pieces stored in 95% ethanol for future genetic work, and the remainder of the colony given a bath in 4% formalin for 12 hours followed by storage in 70 or 95% ethanol. All symbionts were preserved in 95% ethanol, with the exception of some taxa, such as polychaetes (not dealt with in this paper) that were initially fixed in formalin. All specimens either have been or will be deposited in the Yale Peabody Museum, New Haven, Connecticut, or the Bernice P. Bishop Museum, Honolulu, Hawaii, USA.

Results

From the NES&CR expeditions, 35 submersible and ROV dives were conducted on 12 seamounts (details of sample locations in Appendix Table 1A). A total of 348 octocoral colonies were collected representing 46 species mostly from the families Chrysogorgiidae, Primnoidae, Keratoisididae, Coralliidae, Paragorgiidae, Paramuriceidae, and Acanthogorgiidae. In all, 18 invertebrate species were found inhabiting some of the collected octocorals. Of these, five are crustaceans: an ascothoracid barnacle, stalked barnacles, the shrimp *Bathypalaemonella serratipalma* Pequenat, 1970, an unknown galatheid, and the chirostylid *Uroptychus* (Table 1). Other species found on the octocoral colonies included anemones, brittle stars and polychaete

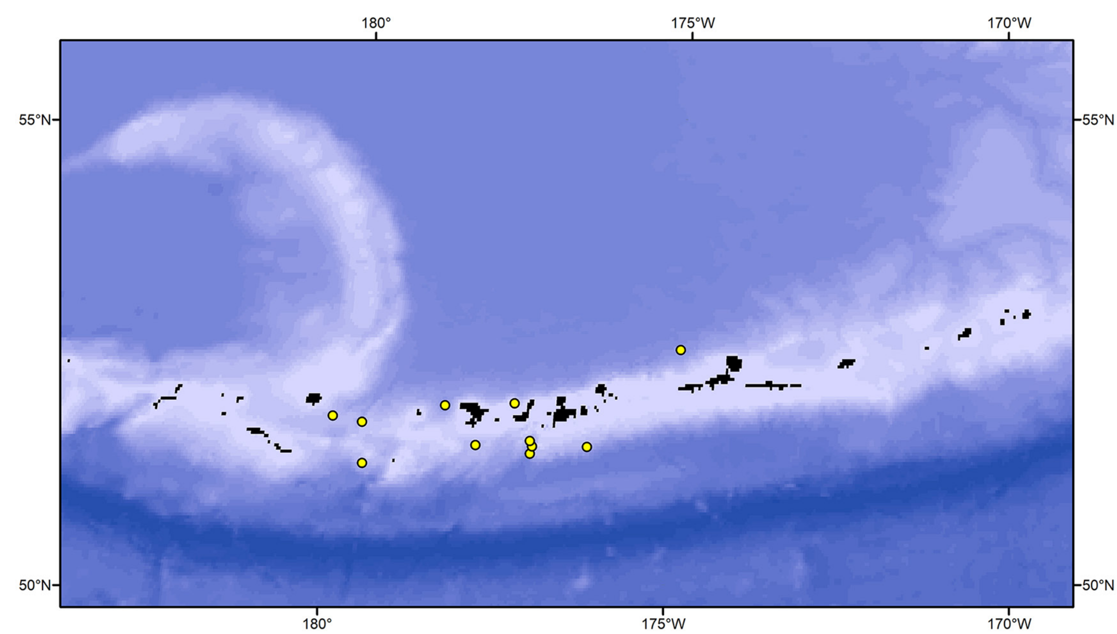

Figure 2. ROV dive locations along the Aleutian Ridge, central Aleutian Islands, Alaska, during a cruise in 2004.

Table 2. List of crustacean commensals found living on octocoral hosts during the Aleutian Ridge expedition, 2004.

Crustacean associate / **Coral host**	*Acanthogorgia* sp.	*Arthrogorgia kinoshitai*	*Arthrogorgia otsukai*	*Arthrogorgia* sp.	*Calcigorgia beringi*	chrysogorgiid small	*Clavularia* sp.	*Fanellia compressa*	Keratoisididae Bxc	*Muriceides* blue	*Muriceides* purple sp. x	*Muriceides* purple sp. 1	*Paragorgia* sp.	*Parastenella ramosa*	Plexauridae golden	*Plumarella aleutiana*	*Plumarella echinata*	*Plumarella hapala*	*Plumarella robusta*	*Plumarella*-like	*Primnoa pacifica*	*Primnoa wingi*	*Radicipes* sp.	*Swiftia* sp.	*Umbellula* sp.
Acanthopleustes annectens	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•
Aegidae	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—
Amatiguakius forsberghi	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Antarcturus ?acutispinus	•	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	•	—
Antarcturus sp. A	—	•	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—
Arcturus sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	•	—	—	—	—	—
Bonnierella sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	•	—
Caprella sp. A	•	—	•	•	—	•	—	—	—	—	—	•	—	•	—	•	—	—	•	—	—	—	—	•	—
Chromopleustes sp. A	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—
Chromopleustes sp. B	—	•	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—
Erichthonius sp. A	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—
Eurycopidae sp.	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hippolytidae sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—
Ischyrocerinae sp. A	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—
Ischyrocerinae sp. B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—
Janira sp.	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—
Metopa sp.	•	—	—	—	•	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—
Munna sp.	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	•	—	—	—	—	—	—	—	—	—
Munnidae	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Neopleustes euacanthoides	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Neopleustes sp. C	•	—	—	—	•	—	—	—	—	—	—	—	•	•	—	—	—	—	—	—	—	—	—	—	—
Neopleustes sp. D	—	•	—	—	—	—	—	—	—	—	—	•	—	—	•	—	—	—	—	—	•	—	—	—	—
Pleustid A	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pleustid G	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pleustid I	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—
Pleustid sp.?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—
Stenothoidae B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—
Stenothoidae C	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Stenothoidae D	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Stenothoidae E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—
Thaumatotelsoninae A	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—

worms. The vast majority of coral species (33) had no invertebrate associates present, which was usually confirmed by the video analysis of the coral before collection.

During the Aleutian expedition, 12 dives were conducted at depths ranging from 176 to 2947 m (Appendix Table 1B). A total of 35 octocoral colonies were collected representing 22 species primarily from the families Primnoidae, Acanthogorgiidae, Plexauridae, and Keratoisididae. In all, 48 invertebrate species were found inhabiting most of the octocoral species, of which 31 species were crustaceans: 22 amphipods, 8 isopods, and 1 decapod (Table 2). The amphipod families Pleustidae and Stenothoidae were the most diverse, with 10 and 6 species, respectively. *Caprella* sp. and two undescribed species of *Neopleustes* were

Table 1. List of crustacean commensals found on living octocorals during the New England and Corner Rise Seamounts expedition, 2004–2005.

Crustacean associate	*Paragorgia johnstoni*	*Acanella arbuscula*	*Candidella imbricata*	*Chrysogorgia averta*	*Chrysogorgia tricaulis*	*Iridogorgia splendens*
Ascothoracica sp.	—	—	—	—	•	—
Stalked barnacles	•	—	—	—	—	—
Bathypalaemonella serratipalma	—	•	—	•	•	•
Uroptychus sp.	—	•	—	—	•	—
Unknown galatheid	—	—	•	—	—	—

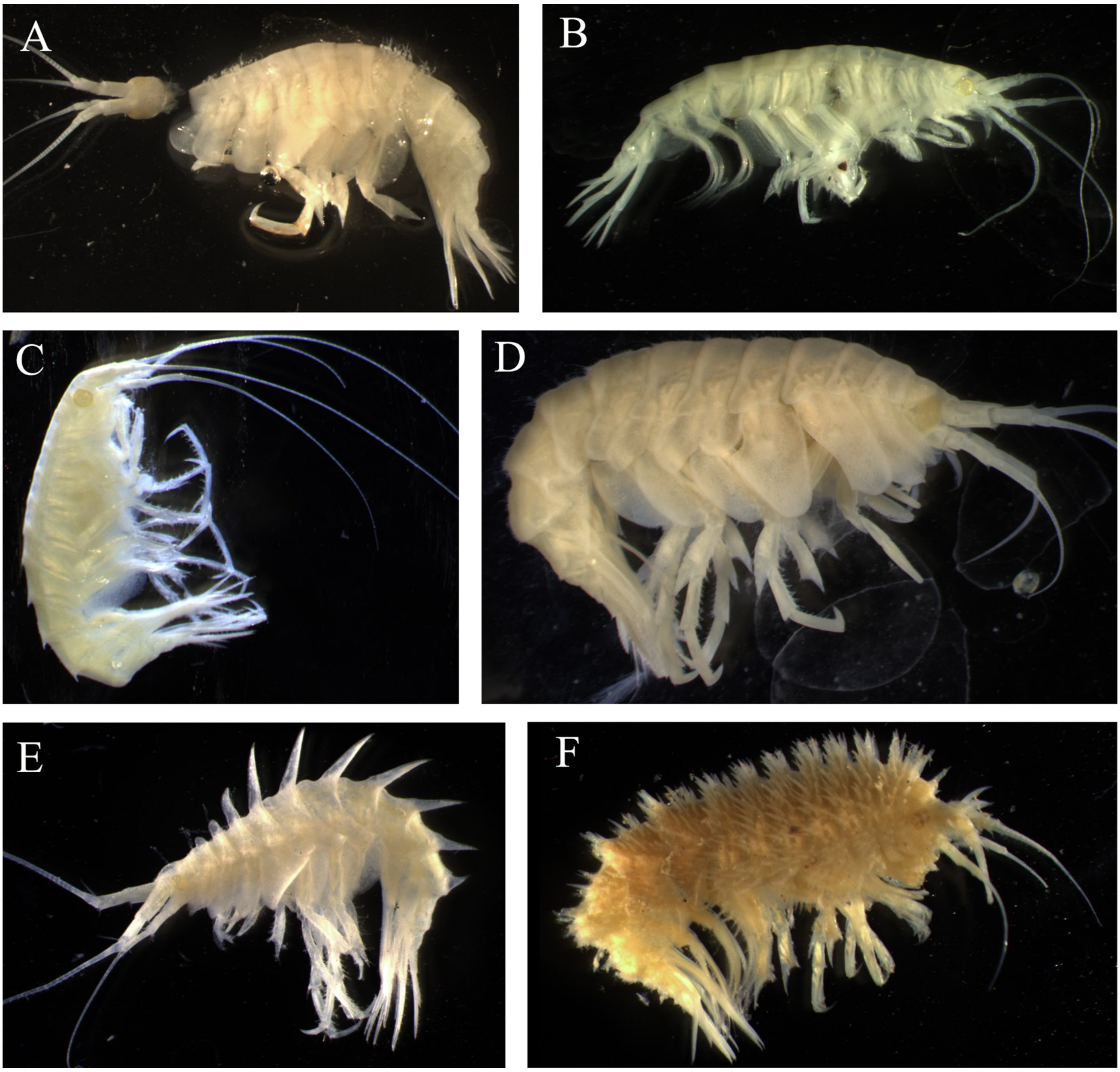

Figure 3. Photos showing some of the amphipod species found associated with deep-sea gorgonians, of which many where undescribed species belonging to the pleustid group. (*A, B*) the undescribed pleustids, *Chromopleustes* sp. A_J2099 and sp. B_J2103 respectively; (*C*) *Neopleustes* sp. C_J2098, all associated with deep–sea gorgonians occurring below 1000 m depth (e.g., *Acanthogorgia*). (*D*) *Neopleustes* sp. D_J2103 occurred on octocorals of the family Plexauridae at 400 m. (*E*) *Neupleustes eucanthoides* Gurjanova, 1972 was also from an unidentified species of *Acanthogorgia*. (*F*) the extremely well armoured *Uschakoviella echinophora* belonging to the family Epimeriidae was observed associated with the coral *Plumarella* collected at 100 m.

associated with the broadest ranges of hosts. The octocorals *Acanthogorgia* sp. 1_Aleutians_2004, *Muriceides* purple sp. 1_Aleutians_2004, and *Swiftia* sp. were inhabited by the largest number of crustacean species (Table 2).

Discussion

The results reported here are admittedly small samples of data, especially for the North Atlantic (there is only one other, as yet unpublished, set of samples for the North Pacific). Nevertheless, we suggest that these results represent the overall general pattern of octocoral-associated crustaceans for the two oceans.

In the North Atlantic, Buhl-Mortensen & Mortensen (2004a, b, 2005), working in upper bathyal waters off the Canadian province of Nova Scotia, examined the suite of invertebrates found on two large octocoral species, *Paragorgia arborea* (Linnaeus, 1758) and *Primnoa resedaeformis* (Gunnerus, 1763). Crustaceans present on *P. arborea* were considered to be either commensals or parasites and dominated other invertebrate groups in both numbers of species as well as numbers of individuals. Six of the 14 species were amphipods, three were copepods (all parasitic) including the gall-forming lamippid copepod *Gorgonophilus canadensis* Buhl-Mortensen & Mortensen, 2004, and one species each of a tanaid, an ostracod, an isopod, a decapod, and a cirripede were represented. In Norwegian waters, amphipods of the family Stegocephalidae were found in large numbers on *P. arborea* (De Clippele *et al*., 2015). Of the crustaceans, only the copepods are likely to have an obligate relationship to the octocoral. In contrast to *P. arborea*, the colonies of *P. resedaeformis* had significant areas of exposed calcareous axis that attracted many groups of invertebrates, most of whom were using the coral as a substrate for various reasons (Buhl-Mortensen *et al*., 2010) and were not likely to have a commensal relationship with the host octocoral. Those included the stalked barnacles *Ornatoscalpellum stroemii* M. Sars, 1859, and *Heteralepas cantelli* Buhl-Mortensen & Newman 2004 attached to the axis, and the isopod *Munna boeckii* Krøyer, 1839, and amphipods *Metopa bruzelii* (Goës, 1866) and *Stenopleustes malmgreni* (Boeck, 1871) lurking among the hydroids also attached to the exposed axis. As with *P. arborea*, the parasitic copepod *Enalcyonium* cf. *olssoni* (Zulueta, 1908) was found living in some of the polyps. In addition, a male-female pair of the decapod *Dorhynchus thomsoni* Thomson, 1873 and the shrimp *Pandalus propinquus* G. O. Sars, 1870 were found among the branches, but both are widespread elsewhere in the upper bathyal benthos. The gall-forming endoparasitic copepod *Gorgonophilus canadensis* described from Atlantic Canada was later observed on *Paragorgia* colonies off northern Norway (Buhl-Mortensen *et al*., 2022).

Several of the associations found in the North Atlantic samples do seem to be obligate symbionts of the octocorals with which they occur. The shrimp, *Bathypalaemonella serratipalma* is found only within the branches of some chrysogorgiid species (in both the genera *Chrysogorgia* and *Iridogorgia*) and the keratoisid, *Acanella arbuscula* (Johnson, 1862). The strong association that this shrimp has with these corals was documented by Watling (2010). A few colonies of chrysogorgiids also had ascothoracicans attached to the branches. Grygier (1984) noted that ascothoracids were common on chrysogorgiids and referred to them as parasites. Grygier (1981) also described a lamippid copepod from the keratoisid, *Acanella arbuscula*, suggesting along with Buhl-Mortensen & Mortensen (2005), that such relationships might be more widespread than realized. Only one obligate association of an amphipod with an octocoral is known from the North Atlantic, that being a species of pleustid, *Pleusymtes comitari* Myers & Hall-Spencer, 2003 from *Acanthogorgia* sp. sampled at bathyal depths off Ireland (Myers & Hall-Spencer, 2003). Watling & Maurer (1973) described a small pleustid, *Incisocalliope aestuarius* (Watling & Maurer, 1973), living among the hydroids of the fouling community.

In our North Pacific samples, we found a large number of crustacean species associated with the octocorals, but missing were decapods, i.e., shrimp and galatheoid squat lobsters that were common, if not especially diverse, in the North Atlantic. The greatest diversity of species in the North Pacific samples were pleustid amphipods (Fig. 3). Because many of these species are new and undescribed, it is difficult to know whether they have strong associations with the octocorals on which they were found. We note, however, that the pleustid fauna of the North Pacific is quite well known from the papers of Bousfield & Hendrycks (1994a, b; 1995), and in their distributional notes are some comments about faunal and floral associations where they are known.

Bousfield & Hendrycks (1994a, b; 1995) and Hendrycks & Bousfield (2004) undertook a major revision of the family in the North Pacific and made a few comments on species from the North Atlantic. From the cursory ecological data provided one can see that North Pacific pleustids occupy three major habitat types: open rocky, sandy or muddy bottoms at all depths; algal or seagrass areas, primarily intertidal or shallow subtidal; and living sessile colonial organisms, either in a loose association or as obligate symbionts. Those associated with colonial animals are species in the subfamilies Parapleustinae, Pleusymtinae, and Neopleustinae, and the three known species of obligate symbionts are members of the Parapleustinae, Dactylopleustinae and Atylopsinae.

The subfamily containing the most species associated with colonial animals is the Parapleustinae with 8 of 28 listed species described as living with sponges, coelenterates, bryozoans, and tunicates, and one species, *Commensipleustes commensalis* (Shoemaker, 1952) inhabiting the pleopods of the decapod *Panulirus interruptus* (Randall, 1840). It is not known whether those living in association with the colonial invertebrates are eating the tissue of the species they are living with or whether there is some other habitat advantage being provided by the "hosts." For example, Kumagai (2008) suggests that in an area where fish predation is intense, the pleustid *Incisocalliope symbioticus* (Gamo & Shinpo, 1992) actively chooses to live in association with the octocoral *Melithaea flabellifera* Kükenthal, 1908, taking advantage of the protection provided by chemicals produced by the octocoral that deterred fish predation.

In our deep-water samples, we found undescribed species of *Chromopleustes* (subfamily Parapleustinae) and *Neopleustes* (subfamily Neopleustinae), and four other species of pleustids with uncertain subfamily affiliations living in association with a small number of octocorals, primarily the more fleshy species, viz., the primnoids *Arthrogorgia kinoshitai* Bayer, 1952, and *Primnoa pacifica* Kinoshita, 1907, and the plexaurid *Muriceides* purple sp. 1_Aleutians_2004. Whereas one species of *Chromopleustes* has been found living in association with sponges and coelenterates in the North Pacific, the species of *Neopleustes* are generally considered to occupy open rocky, sandy, or muddy bottom areas (Labay, 2021). In contrast, we found two species of *Chromopleustes* and three species of *Neopleustes* living on a wide variety of octocoral species.

At present it is difficult to determine what is the exact nature of the relationship between the amphipods and other crustaceans and the octocorals on which they have been found. While it is tempting to suggest that there is a symbiotic association, it is equally possible that the crustaceans are using the octocorals merely as a substratum to elevate themselves above the slower waters of the benthic boundary layer (Buhl-Mortensen *et al*., 2010). That would be an advantage to species such as the arcturid isopods that are known suspension-feeders. It is also possible, as suggested by Kumagai (2008), that the octocoral may provide the crustacean with some type of chemical refuge from predation. That might be the case for the species living on the plexaurids as they are known, at least in shallow water, to secrete various terpenoid compounds (Almeida *et al*., 2014). A third explanation, which might benefit many smaller crustacean species, such as the pleustid amphipods, especially in the subfamilies such as Parapleustinae where the mandible molar is degenerate, is that the amphipods are taking advantage of the octocoral mucous secretions laden with organic detritus. These mucophagous species would not need the large, grinding molar found in species ingesting sediment or algal tissue (Watling, 1993). In the first instance, the crustaceans are facultatively using the octocoral colony, but in the following two cases, a more obligative relationship could have evolved.

The other question this study poses is: why are there so many crustaceans associated with deep-water octocoral colonies in the northern North Pacific in contrast to what was found on the seamounts of the Northwest Atlantic? We suggest two possible reasons. First, the overall species pool of crustaceans is much higher in the North Pacific than in the North Atlantic. For example, of the 143 species listed for the Pleustidae in WoRMS (Horton *et al*., 2022), only a small number, 23, are known from the Atlantic, while most of the others, 106, are from the North Pacific and/or Arctic.

Second, the octocoral fauna is quite different in the two locations. There is an abundance of fleshy octocoral species in the northern North Pacific, as exemplified by some of the primnoids and plexaurids (e.g., *Primnoa wingi* Cairns & Bayer, 2005, *Muriceides* sp.). Those taxa are largely missing from the North Atlantic deep waters. There is also a large difference in the dominant octocoral families, with the Northwest Atlantic being characterized by species in the families Coralliidae, Keratoisididae, and Chrysogorgiidae, the latter two families being represented by numerous species (Lapointe & Watling 2021). Coralliidae were not present in the Aleutian samples, and only two species of Keratoisididae and one of Chrysogorgiidae were found (unpublished observations). Both areas had several species of Primnoidae, but as noted, some of those in the Aleutian area were more fleshy, that is, the coenenchyme of the colony was much thicker. Also, plexaurids were common in both areas, but the muriceids were present only in the North Pacific.

Conclusions

Crustaceans are common associates of octocorals in the deep sea of both the North Atlantic and North Pacific, but the number of species of crustaceans living in or on octocoral hosts is far greater in the North Pacific. We hypothesize that this difference is due both to the differences in the octocoral fauna, which comprises more species that have fleshy tissue in the North Pacific vs. a higher proportion of species with thin axial tissue in the North Atlantic, as well as to the higher species richness, particularly of the amphipods and isopods, in North Pacific deep waters.

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This paper is dedicated to the memory of our dear friend and colleague, James (Jim) Lowry who was always interested in whatever crustacean endeavors we might be involved with. Jim provided a welcoming research base at his home and lab in Australia and we were very pleased to return the favor in Maine and Hawaii. Jim was always enthusiastically supporting young taxonomists and providing important training in the use of the DELTA taxonomy program.

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Appendix

Location data for dives conducted on seamounts along the New England and Corner Rise (NES&CR) seamount chains (Table 1A), and along the Aleutian Ridge (Table 1B).

Table 1A. New England and Corner Rise (NES&CR) dives.

Dive Name	Date	Minimum Depth (m)	Maximum Depth (m)	Latitude	Longitude
MAN100	13-Jul-03	1451	1734	38.26°	-60.55°
MAN200	14-Jul-03	1325	1415	38.22°	-60.51°
KEL100	15-Jul-03	1781	2073	38.79°	-64.13°
KEL200	16-Jul-03	1857	2184	38.86°	-63.90°
BEA100	17-Jul-03	1419	1781	39.93°	-67.35°
BEA200	18-Jul-03	1299	1644	39.90°	-67.35°
BEA300	18-Jul-03	1376	1435	39.87°	-67.42°
BEA400	11-May-04	1566	1632	39.95°	-67.41°
BEA500	12-May-04	1395	1869	39.88°	-67.48°
MAN300	14-May-04	1369	1250	38.22°	-60.51°
MAN400	15-May-04	1662	1933	38.15°	-61.10°
MAN500	15-May-04	1543	1786	38.15°	-61.10°
KEL300	17-May-04	3481	3935	38.73°	-64.20°
KEL400	18-May-04	1712	1781	38.82°	-63.96°
KEL500	19-May-04	2245	2427	38.77°	-63.97°
KEL600	20-May-04	1931	2125	38.85°	-63.76°
BAL100	22-May-04	1542	1933	39.36°	-65.36°
RET100	23-May-04	1979	3881	39.75°	-66.25°
LYM100	13-Aug-05	1376	1760	35.12°	-48.11°
LYM200	13-Aug-05	1943	2412	35.19°	-47.67°
LYM300	15-Aug-05	1426	1653	35.37°	-48.16°
MIL100	17-Aug-05	1280	1690	34.82°	-50.51°
VER100	18-Aug-05	1083	1318	34.66°	-49.82°
VER200	19-Aug-05	1498	2132	34.53°	-49.79°
GOO100	20-Aug-05	1851	2156	35.39°	-51.27°
KUK100	21-Aug-05	706	936	35.51°	-51.96°
KUK200	23-Aug-05	1210	1870	35.56°	-51.81°
NAS100	24-Aug-05	1775	2253	34.58°	-56.84°
NAS200	25-Aug-05	2097	2567	34.47°	-56.73°
MAN600	27-Aug-05	1320	1340	38.22°	-60.51°
REH100	29-Aug-05	1805	1936	37.46°	-59.95°
REH200	30-Aug-05	1278	1686	37.56°	-59.81°
KEL700	31-Aug-05	1829	2607	38.76°	-64.09°
BAL200	1-Sep-05	1684	1930	39.42°	-65.41°
PIC100	28-Oct-05	1943	2087	39.65°	-65.94°

Table 1B. Aleutian Ridge dives.

Dive Name	Date	Minimum Depth (m)	Maximum Depth (m)	Latitude	Longitude
J2095	25-Jul-04	840	2827	51.72°	-173.78°
J2096	27-Jul-04	2141	2947	52.50°	-174.92°
J2097	28-Jul-04	1720	1734	51.46°	-176.24°
J2098	29-Jul-04	2069	2514	51.39°	-177.08°
J2099	30-Jul-04	1269	2120	51.47°	-177.05°
J2100	1-Aug-04	1690	1802	51.53°	-177.09°
J2101	2-Aug-04	485	1341	51.48°	-177.89°
J2102	3-Aug-04	176	1386	51.29°	-179.54°
J2103	4-Aug-04	399	1348	51.80°	179.96°
J2104	5-Aug-04	395	1011	51.73°	-179.60°
J2105	6-Aug-04	889	2308	51.91°	-178.39°
J2106	7-Aug-04	937	1176	51.93°	-177.36°