A transferable predator avoidance reaction may account for the conditioned and naive coho salmon acting as a homogeneous group in the present study. Conditioned coho salmon had learned to avoid torrent sculpins through some unknown mechanism. Apparently the naive fish behaved as conditioned individuals through visual clues resulting in mimicry. O'Connell (1960) noted mimicry in sardines in a conditioned response experiment where unconditioned replacement fish performed in unison with the school of conditioned fish from the first trial. Kanid'yev et al. (1970) indicated that the consensus of Russian workers was that sight played the main role in developing the predator avoidance reaction and that reinforcement is maximal for fish that are observers.

Sculpins commonly cohabit streams with and prey on young salmon. Growth of salmon to a size too large for sculpins to successfully prey on effectively removes them from this predator predation. The maximum size of coho salmon that a torrent sculpin can catch and eat in laboratory conditions is much larger than those that are normally preyed upon in nature. This indicates that although growth is effective in limiting torrent sculpin predation on coho salmon, other factors are equally important. Among salmon, the coho has a well-developed innate predator avoidance response (Patten 1975). The response apparently can be reinforced by experience with fish predators and this conditioning probably increases their early survival in streams.

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DESCRIPTION OF MEGALOPA OF SNOW CRAB, *CHIONOECETES BAIRDI* (MAJIDAE, SUBFAMILY OREGONIINAE)

Chionoecetes bairdi Rathbun, a brachyuran crab, occurs on the continental shelf from Puget Sound in Washington State, northward into the Bering Sea, and westward along the Aleutian Islands. The species has been taken as deep as 474 m (Garth 1958), but adults commonly occur at depths less than 190 m. *Chionoecetes bairdi* may be quite abundant in inshore areas throughout its range and has become an important subsistence and commercial species because of its large size and accessibility. It supports an extensive fishery in the Bering Sea and Gulf of Alaska for three nations—the United States, the Soviet Union, and Japan.

The range of *C. bairdi* overlaps that of three other species of *Chionoecetes: C. tanneri* Rathbun, *C. angulatus* Rathbun, and *C. opilio* (O. Fabricius). *Chionoecetes tanneri* ranges from Mexico north to the State of Washington, and commonly occurs between 370 and 1,630 m on the outer slopes of the continental shelf (Garth 1958). *Chionoecetes angulatus* occurs throughout the range of *C. bairdi*, but *C. angulatus* occurs on the lower slopes of the shelf edge between 730 and 2,980 m (Garth 1958). *Chionoecetes opilio* occurs only in the Bering Sea, and its distribution is often sympatric with *C. bairdi*. Two other species of *Chionoecetes* occur in the western Pacific Ocean,

C. *japonicus* (Rathbun) and *C. opilio elongatus* Rathbun.

Since *C. bairdi* has become commercially important, its biology and distribution are receiving more attention. Descriptions of the larvae for *C. bairdi* and *C. opilio* are important because both are taken commercially and their distribution overlaps. Haynes (1973) described prezoeae and stage I zoeae of *C. bairdi* (and *C. opilio*), but stage II zoeae and megalopa have not been described.

In this paper we describe megalopa of *C. bairdi* and compare them with megalopa of *C. opilio* (Motoh 1973) and *C. opilio elongatus* (Kurata 1963b)—the only other *Chionoecetes* species for which the megalopal stages have been described.

There seems to be some lack of consistency in the literature concerning the singular and plural of the megalopal stage. The original singular was called megalops, because of the large and prominent eyes. Many authors (e.g., Kurata 1963a, b; Makarov 1967; Motoh 1973) have changed this to megalopa for both singular and plural. Others (e.g., Hart 1960; Poole 1966) have latinized megalopa in the plural to megalopae. In this manuscript both singular and plural of the megalopal stage will be referred to as megalopa since this is more widely accepted.

Methods and Materials

About 50 larvae[1] of *C. bairdi* were taken from Fish Bay near Sitka, Alaska, at lat. 57°22′N, long. 135°33′W on 14 April 1971. They were caught with 70-cm-diameter nylon bongo nets towed 8 to 9 m below the surface; mesh sizes of the nets were 0.505 and 0.333 mm. The larvae were held in a 3-liter aquarium supplied with continuous-flowing filtered seawater. The aquarium was transferred from the research vessel to the laboratory on 19 April. The water temperature fluctuated between 8° and 10°C on the vessel and 6.3° and 6.9°C in the laboratory. The *C. bairdi* larvae fed upon other zooplankton caught during the same tow until that food was gone. By then, it appeared all the larvae were at the megalopal stage, and we began feeding them finely chopped herring. Some megalopa were preserved on 19 April in 5% formaldehyde and seawater. Their identification as *C. bairdi* was confirmed by raising the remaining megalopa to the juvenile stage (maximum carapace width 13.9 mm) and comparing them with the juvenile morphology described by Garth (1958).

Megalopal larvae identical morphologically to those we had raised were collected in a vertical plankton haul on 21 May 1973, at the entrance to Resurrection Bay south of Seward, Alaska, at lat. 59°48′N, long. 149°30′W. These specimens were dissected and used as the basis for our illustrations of morphology, appendage setation, and other characteristics.

Illustrations (Figure 1) were prepared with the aid of a camera lucida. An ocular micrometer was used to measure body dimensions of nine of the preserved specimens. The measurements were 1) carapace length (two measurements had to be taken because the rostral tip was often damaged—straight-line distance from rostral tip to posterior median margin of carapace and straight-line distance from the notch between rostral and preorbital spine to posterior median margin of carapace); and 2) carapace width (straight-line distance between widest part of carapace).

To compare our description of megalopal larvae of *C. bairdi* with descriptions of megalopa of other species in the genus, we used our collections from the Chukchi Sea and descriptions by Motoh (1973) for *C. opilio* and descriptions by Kurata (1963b) for *C. opilio elongatus*.

Description of Megalopa

Carapace length 3.12 to 3.48 mm (mean 3.30 mm) inclusive of rostrum and 2.60 to 2.80 mm (mean 2.73 mm) from rostral notch. Carapace width 1.80 to 2.12 mm (mean 1.97 mm).

Carapace triangular shaped and bears seven major processes (Figure 1a-c). Anterior rostral region bears three sharp spines, two preorbital and one rostral. Rostral spine three times length of preorbital spines (measuring from rostral notch) and points ventrally. Frontal and rostral region slightly depressed. Pair of anterolateral spines separated by thin median ridge. Pair of cardiac dorsolateral spines sweep slightly posteriorly. Minute but conspicuous lateral spines occur in region of pterygostomial-branchial ridge. Small ridge along posterolateral margin of carapace bears a wartlike protuberance medially, directly above proximal end of abdomen. Eyes stalked.

[1]The specimens preserved 14 April were lost and could not be examined to determine their stage of development. We believe that they were stage II zoeae or megalopa or a combination of both.

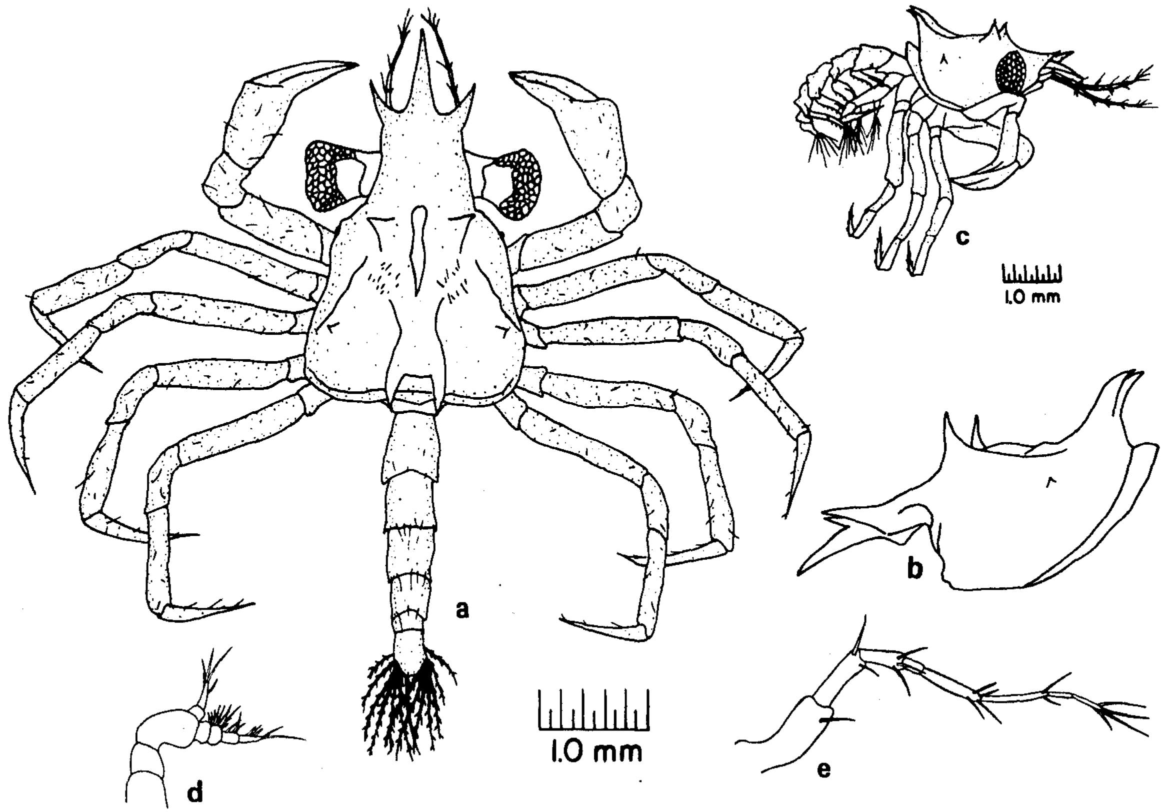

FIGURE 1.—Megalopa of *Chionoecetes bairdi;* antennule and antenna from right side of specimen (a) dorsal view of entire specimen; (b) lateral view of carapace; (c) lateral view of entire specimen; (d) antennule; (e) antenna.

ANTENNULE (Figure 1d)—Three-segmented peduncle has terminal pair of segmented rami. Smaller ramus has two segments. Distal segment has four setae, proximal shorter segment naked. Second terminal ramus has four segments. Number of setae per segment, beginning distally, 5, 3, 10, and 0.

ANTENNA (Figure 1e)—Antenna has eight segments. Setation formula is 4, 0, 2, 4, 0, 3, 2, and 1. Setae located on distal ends of segments.

MANDIBLE (Figure 2a)—Mandibular palp has three segments. Distal segment has about 10 setae; middle and proximal segments naked.

MAXILLULE (Figure 2b)—Endopodite has one hook-shaped segment with two terminal setae. Basipodite has 20-23 coarse plumose setae. Smaller coxopodite has 13-16 coarse plumose setae.

MAXILLA (Figure 2c)—Exopodite (scaphagnathite) outer margin lined with 38 plumose setae. One endite naked and ends in a point. Two endites heavily bifurcated. Lobes of basal endite distally bear 10 and 8 plumose setae, respectively, and lobes of coxal (proximal) endite bear 6 and 10 plumose setae.

FIRST MAXILLIPED (Figure 2d)—Epipodite has eight long hairs. Exopodite is two segmented with six heavily plumose setae; setation formula is 5 and 1. Broad endopodite has three spines on distal end. Basal endite bilobed with 22-29 plumose setae on larger lobe and 11-14 plumose setae on smaller.

SECOND MAXILLIPED (Figure 2e)—Epipodite has three hairs. Exopodite has two segments with five heavily plumose setae on distal segment. Endopodite has four segments; setation formula 9, 4, 1, and 1.

THIRD MAXILLIPED (Figure 2f)—Epipodite well developed with several nonplumose hairs. Exopodite two segmented with five terminal setae. Endopodite has five large segments with numerous spines on all segments; setation formula 8, 15-17, 8-10, 8, and 30-34.

PEREIOPODS (Figures 1a, 2g)—Pereiopods

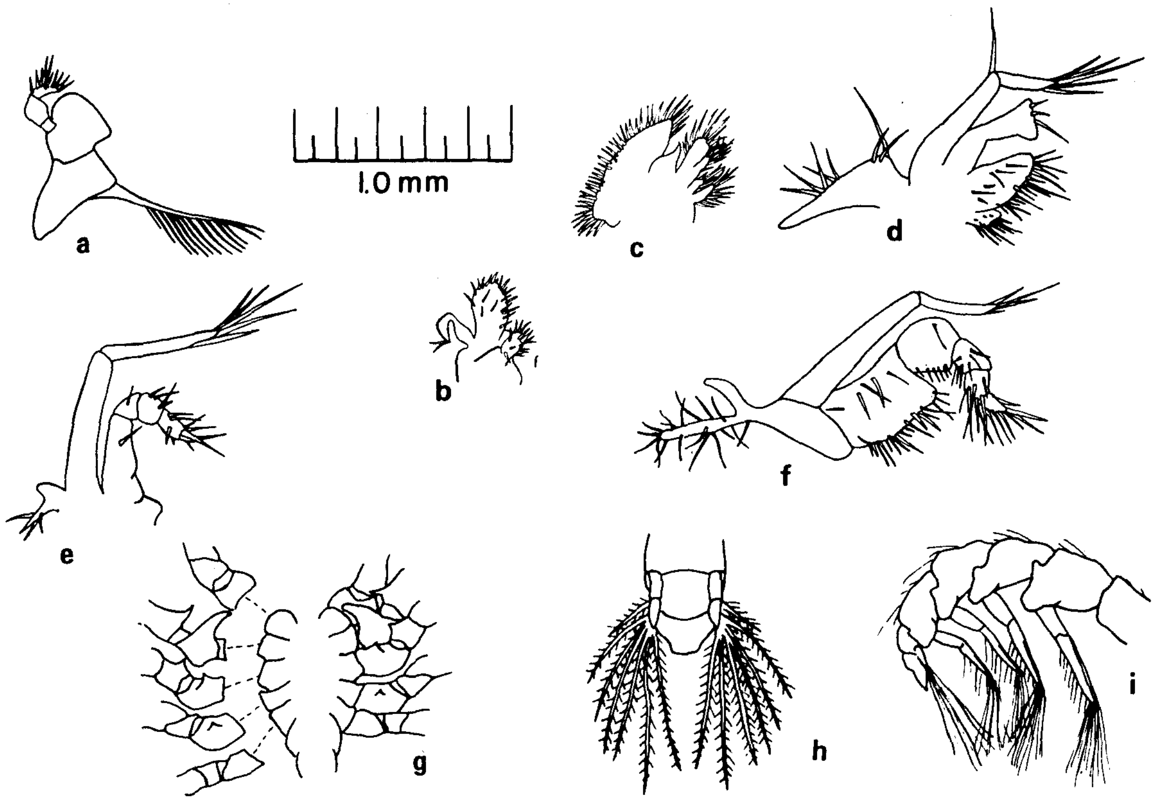

FIGURE 2.—Mouthparts from right side of megalopa of *Chionoecetes bairdi* (a) mandible; (b) maxillule; (c) maxilla; (d) first maxilliped; (e) second maxilliped; (f) third maxilliped; (g) ventral view of sternum and pleopod attachment; (h) ventral view of telson and uropods; (i) lateral view of abdomen.

closely resemble those of adult. Coxopodite and basipodite spines, one each, located ventrally on chelipeds and ambulatory legs except for fourth leg. First ambulatory leg spines especially long. Cheliped and third ambulatory leg spines minute. Dactylopodites of ambulatory legs one, two, and three have conspicuous spine projecting from tip.

ABDOMEN AND TELSON (Figure 2h, i)—Abdomen six segmented. Sixth segment and telson small. No spines present. Segments two through five have long setae on dorsal surface.

PLEOPODS (Figure 2i)—Pleopods present on abdominal segments two through five. A single-segmented endopodite (not shown in figure) arises from proximal segments of each pleopod. Endopodites have four hooked setae on distal end of first three pairs of pleopods and three hooked setae on distal end of last pair of pleopods. Exopodites of pleopods two and three have variable numbers of plumose setae, 15 through 18. Exopodites of pleopods four and five have 17 and 15 plumose setae, respectively.

UROPODS (Figure 2h)—Uropods two segmented and have seven plumose hairs arising from each distal segment.

How to Distinguish Megalopa of *Chionoecetes bairdi, C. opilio,* and *C. opilio elongatus*

Megalopa of *C. bairdi* are similar to megalopa of *C. opilio* and *C. opilio elongatus* in major carapace spination and size. The characteristics which separate these species can be determined without dissection. The four most useful characteristics are: 1) *C. bairdi* has a minute lateral spine in the region of the pterygostomial-branchial ridge while the others do not (see Kurata 1963b; Motoh 1973); 2) *C. bairdi* has a more pronounced ridge along the posterior margin of the carapace than *C. opilio* and *C. opilio elongatus* (Kurata 1963b; Motoh 1973); 3) the rostral spine of *C. bairdi* is three times the length of the preorbital spines, whereas the rostral spine on *C.*

opilio is 1.5 to 2.0 times the length of the preorbitals (from our samples from Chukchi Sea); and on *C. opilio elongatus* all three spines are nearly the same length (Kurata 1963b); 4) *C. bairdi* has a rudimentary spine immediately posterior to each eye; in *C. opilio* and *C. opilio elongatus* this spine, though still minute, is quite conspicuous.

Key to Megalopa of Some Common Brachyuran genera of the Northwest

The following key is to provide a means of identification of some common Brachyura megalopa of the northwest to the generic level. As only characteristics which can be determined without dissection have been used, the key should be used for preliminary sorting. The present state of knowledge of these megalopa comes from six sources (i.e., Hart 1960; Kurata 1963a, b; Poole 1966; Makarov 1967; Motoh 1973). Key modified after Makarov (1967).

A. Carapace bears dorsal spines
  B. Posterior part of carapace bears one spine .... *Hyas; Oregonia; Cancer*
  B′. Posterior part of carapace bears two spines .... *Chionoecetes*
A′. Carapace bears no dorsal spines
  B. Angles of posterior margin of abdominal somite 5 reach beyond somite 6 .... *Telmessus*
  B′. Angles of posterior margin of abdominal somite 5 reach to middle of somite 6 .... *Erimacrus*

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