INCIDENCE AND SEASONAL FLUCTUATIONS OF CARIDEAN LARVAE (DECAPODA, NATANTIA) OFF NORTHUMBERLAND (ENGLISH NORTH SEA COAST) FROM 1969 TO 1971

By

ANTENOR MARTINEZ GUERRA

Bachelor of Science

Universidad Nacional de Trujillo

Trujillo, Peru

1959

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
July, 1972

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Thesis Approved:

Troy C. Dorris
Thesis Adviser

Margaret S. Ewing

Jerry Wilhm

D. Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

I wish to express appreciation to my major adviser Dr. Troy C. Dorris for his assistance in the preparation of the manuscript and editing the final copy; to Dr. Frank Evans, of the Dove Marine Laboratory, University of Newcastle Upon-Tyne, England, for his guidance during the development of the research and writing of the first draft; to the other members of the advisory committee, Dr. J. L. Wilhm and Dr. M. S. Ewing for reading the manuscript and making valuable suggestions. Thanks are expressed to the skipper and crew of the research vessel "Alexander Meek" for their help on the sampling collections during May - December, 1971; to Karla Cooper for typing the first copy and for her help during the editing phase; and to Ruth Henry who typed the final copy.

The Fulbright commission of Peru supported part of the Master's program, and The British Council funded the residence at Dove Marine Laboratory, April, 1971 to February, 1972. To these institutions I would like to express my appreciation.

Finally a special consideration is expressed to my wife Julia, our daughter Rosa M. del Carmen, and our sons Oscar E. and Jose R. for their encouragement and many sacrifices.

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CHAPTER I

INTRODUCTION

The larvae of decapods, annelids, echinoderms, and lamellibranchs constitute the bulk of the meroplankton. A knowledge of their geographic and temporal fluctuations is important to fisheries biologists since these larvae are important in the diet of food fish.

Several works describe the distributional patterns of decapod larvae in the North Sea. The Edinburgh Continuous Plankton Recorder Survey (Glover 1967), includes papers by Henderson and Marshall (1944), Marshall (1948), and Rees (1952, 1955). However, none of them pertain to inshore waters of the Northumberland coast.

Earlier work on decapod larvae off Northumberland was undertaken by Jorgensen (1923) and Bossanyi (1957). Jorgensen reported the occurrence of 19 "kinds" of decapod larvae, from plankton collected at the surface, in mid water and at the bottom on 16 occasions in 1921 and on 12 occasions in 1922 from May to September. Among the 19 "kinds" reported were following carideans: Pandalina brevirostris (as Pandalus brevirostris), Pandalus montagui, Caridion gordoni (as Pandalus borealis), Caridion steveni (as Pandalus bonnieri), Hippolyte varians, Crangon vulgaris, Crangon allmani and Pontophilus spinosus. Bossanyi (1957) surveyed the plankton found near the sea bottom. Samples were collected irregularly from 1949 to 1952 using an apparatus constructed by him (Bossanyi, 1951) with a coarse net of 16 mesh/cm. His work

was not intended as a contribution to general plankton distribution, but he made a rough estimation of the density of 21 species of larval and adult decapods living near the bottom.

Henderson and Marshall (1944) reported the annual variation of decapod larvae from 1932 to 1937. The survey was restricted to the southern part of the North Sea, and all the decapod larvae were grouped together without precise identification of the species. Marshall (1948) reported the decapod larvae from 1938 and 1939. Decapod larvae throughout the North Sea were studied but without identification at the species level.

These early reports show that the decapod larvae as a whole remain throughout the year in the North Sea plankton and present a secondary peak of abundance in April and May and a principal peak in July and August. They also indicated variations in annual and spatial abundance in the North Sea.

Rees (1952) made a detailed survey of the abundance of 41 species of decapod larvae in the period 1947 to 1949 and stated that the main concentration of decapod larvae in the North Sea occurred south of the Dogger Bank, from the Humber to the Heligoland Bight. Comparing his results with Blass (1926), he found that "the distribution of the larvae well agrees with the accepted views on the distribution and origin of adult decapods in the North Sea". Rees (1955) considered in 1949 to 1951 only the commoner species and those of economic interest. He made a comparison of the trend of the decapod larvae through the period 1947 to 1951 which showed that the larvae were scarce in 1947 and most abundant in 1949. Basing his view on comparisons of the distributional patterns of decapod, echinoderm, and lamellibranch

larvae, he stated, "This comparison suggests that the main spawning populations of those three groups are differently distributed and do not coincide in the North Sea". His findings showed decapod spawning grounds to be centered in the Southwestern part of the North Sea.

All of these authors used horizontal hauls, either with a continuous plankton recorder, or more conventionally, by towing nets for 20 min.

A large collection of plankton from Northumberland waters deposited at the Dove Marine Laboratory of the University of Newcastle Upon-tyne was used to extend the studies to another area of the North Sea.

The objectives of the present study are to (1) report the seasonal and yearly fluctuations of the larvae of 14 species of Caridea from 1969 to 1971, (2) determine if these species follow the general pattern of the whole decapod group, (3) determine if local fluctuations reflect general changes in the greater area of the North Sea, and (4) make a summary of the main features of the different larval stages of the post-embryological development of the species collected.

CHAPTER II

MATERIALS AND METHODS

One hundred-one samples of zooplankton collected east of the Port of Blyth from January, 1969, to December, 1971, have been examined for caridean larvae. The collecting stations are as follows (Fig. 1):

Station I. About 4.6 km east of Blyth. 37 m deep.

Station II. About 9.2 km east of Blyth. 54 m deep.

Station III. About 18.5 km east of Blyth. 71 m deep.

The bottom sediment at the stations is mainly sandy-mud (Stations I and II) or mud (Station III) (Buchanan 1963). Between stations I and II a narrow tongue of sand runs from the north. The predominant animal community of the area is the Amphiura filiformis - Amphiura chajaei community. The Amphiura filiformis (typical form) sub-community predominates at Station I and II and the Amphiura chajaei sub-community at Station III. In the tongue of sand between stations I and II the Amphiura filiformis - Astrorhyza variation predominates.

At the Dove Marine Laboratory two types of nets (WP_2 and WP_3) recommended by UNESCO (1968) for vertical hauls in shallow seas have been used regularly since 1969 in the monthly plankton collections. The medium net (WP_2) for smaller mesozooplankton with size range from 200 μ to 10 mm has a cylindrical-conical shape with a length of about 2.60 m. The diameter of the mouth aperture is 57 cm giving a mouth area of 0.25 m^2. The material is Nylon Nytal 7 P. with a mesh

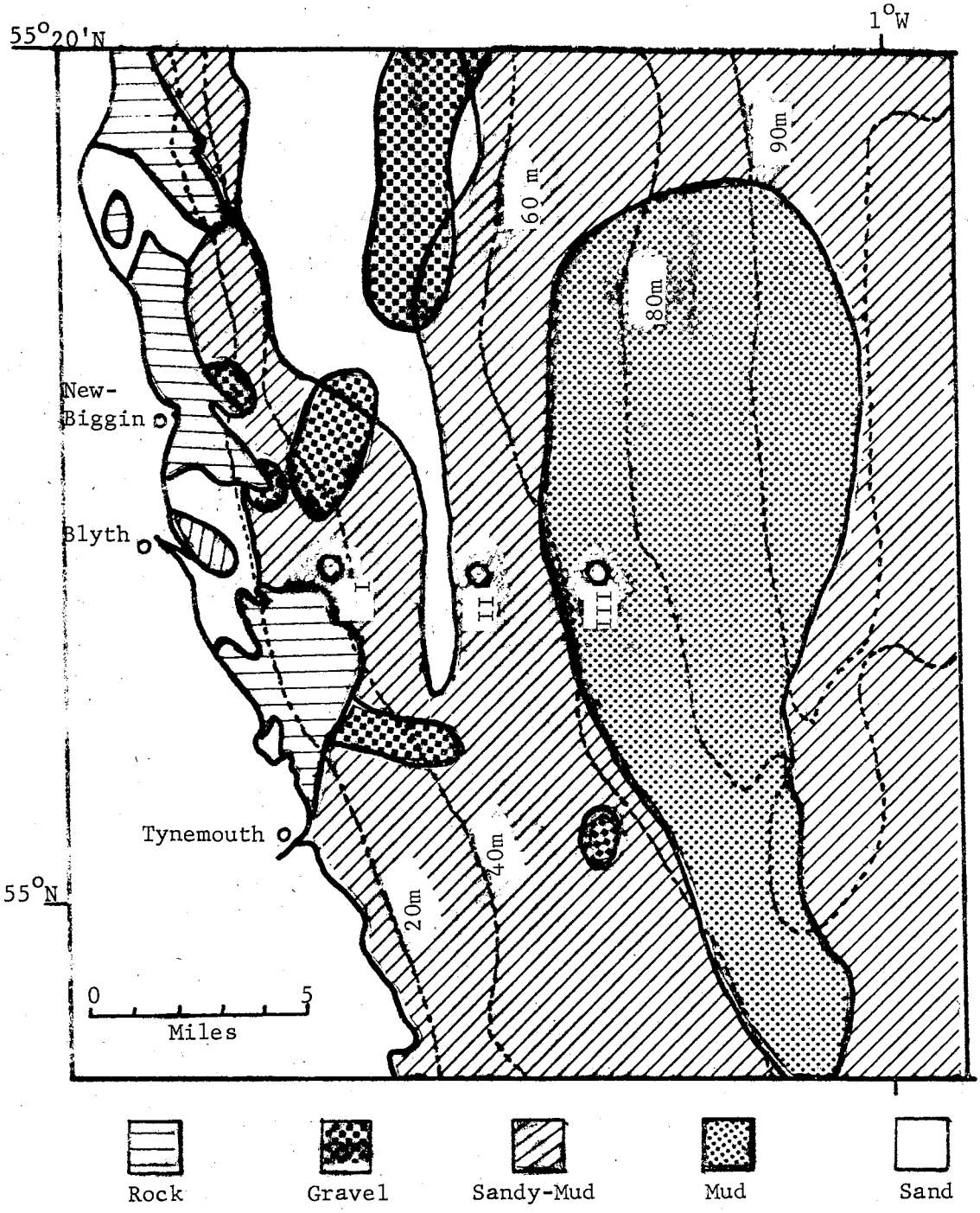

Figure 1. Chart showing position of the three sampling stations, distribution of the various sediments, and depth contours of the regions: (Adapted from Buchanan 1963 and Allen 1966)

aperture of 200 μ. At the rear end a detachable gauze bag of the same mesh as the net is secured to retain the catch. In order to maintain the net in a vertical position a lead weight of 25 kg is used.

The coarse net (WP_3) for larger mesozooplankton is a simple unencased net, cylindrical - conical in shape with a length of about 2.60 m, with 113 cm mouth diameter giving a 1 m^2 mouth area. The fabric is of monofilament nylon with 1 mm mesh aperture.

Collections were made monthly except from July to October, 1971, when the interval was reduced to 2 weeks. Samples are available from all three stations for 1969, but in 1970 and 1971 only Station II was sampled.

At each station the nets were hauled vertically as many times as necessary to complete a total passage of 200 m. The theoretical quantity of water filtered was 50 m^3 by the WP_2, and 200 m^3 by the WP_3. The material collected in each of the groups of hauls was preserved in 4% formalin in sea water.

At the laboratory the material collected with the WP_2 net was examined using the sub-sample method (Hensen 1887 teste Wiborg 1961). The samples were made up to 250 ml, shaken, and a sub-sample of 2.5 ml taken using a "stempel" pipet was poured into a shallow Petri dish and observed under a stereoscopic microscope. From each sample 10 equal sub-samples were taken making in all 10% of the total sample. The material collected with the WP_3 net was examined in entirety in Petri dishes under the stereoscopic microscope.

In all cases the identification of the larvae was made following the zooplankton sheets (No. 67, 68, 90, and 109) published by the International Council for the Exploration of the Sea (ICES). Each

species was counted and stored separately for further examination. The separation of the larval stages was made using the best description available of each species, and each stage within the species was stored separately.

The quantities given from the samples collected with plankton net WP_2 are estimations derived from the counts of larvae found in 10 sub-samples multiplied by 10. In 1969, when less than the required hauls were taken to complete a 200 m sample, the counts were adjusted to the 250 m^3 water-filtered unit in which all the results are expressed. The quantities given for the months July to October, 1971, are the averages of two samples taken in each month.

Although megalopa stages were present they were not taken into consideration for the present report of the larvae.

CHAPTER III

POST-EMBRYOLOGICAL DEVELOPMENT OF THE SPECIES COLLECTED

The great majority of marine carideans have an extended development with pelagic larval stages. The following larval characters can be considered common for all of the section (Gurney 1942, Williamson 1957a).

1. Rostrum cylindrical or laterally compressed, never horizontally flattened throughout.
2. Antennal scale usually segmented distally, and the endopod with one long apical seta. A small spine may also be present or another seta, but never two equally long setae.
3. Maxillule rarely with exopod, the endopod usually of two segments or reduced.
4. Three pairs of maxillipeds, functional on hatching.
5. Paraeopods appearing in succession except when development is abbreviated, but the fifth may develop before the third and fourth in Alpheidae, Paleomonidae, and some Hippolytidae. Exopods on some or all of the paraeopods, endopods usually segmented and setose.
6. Telson without median spine and with 7 + 7 terminal spines in stage I.

The larvae of the 14 species collected off Northumberland belonged

to the following families:

Crangonidae (four species)

Hippolytidae (six species)

Pandalidae (three species)

Processidae (one species)

Family Crangonidae

Four species of crangonids were represented in the samples examined. The larvae of this family present the following common characters (Lebour 1931, Gurney 1942).

1. Five zoeal stages
2. No dorsal or supraocular spines in the carapace
3. Ventral-anterior margins of the carapace usually denticulate
4. Rostrum usually narrow in the first stage, tapering gradually to a point; in later stages usually broad at base, always conspicuous
5. Telson indented slightly at the hind margin, becoming nearly straight in most forms in the later stages
6. Abdomen usually with a pair of lateral spines on the fifth somite; fourth somite with or without lateral spines; third somite with or without central or lateral spines
7. Antennal scale unsegmented in all stages
8. Antennular peduncle unsegmented, short and thick
9. Maxillule without outer basal seta, palp with 1 or 2 segments
10. Maxillipeds with functional exopods from stage I onward
11. Exopods on paraeopod one or paraeopods one and two, but never on three to five; endopods without setae and probably not

functional

12. Pleopods beginning as small buds in stage III, longer in fourth and jointed in fifth stage

13. Anal spine developed in stage IV.

Crangon allmani Kinahan

Sars (1890) described stage V; H. C. Williamson (1915) described C. allmani for the Nordisches Plankton (stage V, after Sars). Lebour (1931) made a summary of the main features of the species and figured the five zoeal stages based on plankton from Plymouth.

The larvae of Crangon allmani are distinguished from those of C. crangon by the lack of a spine on the third abdominal somite, the yellow and crimson color, and larger size (2.8 mm in the first stage and 6.5 mm in the last stage). The rostrum is also larger.

Stage I. 2.8 mm. Antennal scale with nine setae (two on the outer margin). Eyes sessile, attached to the carapace. Rostrum as large as the antennular peduncle. Carapace with 4 or 5 denticles in the antero-ventral margin. Palp of maxillule one-jointed. Exopods of the maxillipeds with 4, 5, 5 setae, respectively. Paraeopods and pleopods absent. Spines of the fifth abdominal somite very long and curved. Telson shallowly indented, with 7 + 7 spines. No trace of uropods.

Stage II. 3.3 mm. Antennal scale has lost the distal outer seta. Eyes sessile, free from the carapace. Paraeopods as buds, the first pair bifid. No pleopods. Telson without trace of uropods and with a pair of extra spines (8 + 8).

Stage III. 4.2 mm. Antennal scale without outer setae, and with 12 setae on the terminal and inner margins. First paraeopod with

exopod, second to fifth rudimentary. Pleopods visible as simple buds. Telson cut off from the sixth abdominal somite, the width of the distal part reduced, being only a little wider than the proximal part. Uropods free, endopod smaller than the exopod and both with few setae. Small spines at the base of the uropods.

Stage IV. 4.8 mm. Antennal scale with 15 setae. Endopod of the first paraeopod unjointed, but the claw beginning to form, second to fifth larger but inarticulated. Pleopods larger, biramous, but inarticulated. Lateral spines of the fifth abdominal somite shorter and becoming straight. Spines at the base of the uropods larger. Small anal spine present. Telson almost parallel-sided. Both rami of uropods larger and more setose.

Stage V. 6.5 mm. Maxillipeds with exopods. Claw on the endopod of the first paraeopod fully formed. Paraeopods two to five articulated and with the structure of a walking organ. Pleopods two-articulated and with small setae. Telson parallel-sided. Anal spine larger.

Crangon crangon L. (= C. vulgaris Fabricius)

The larval stages of this species have been described by Sars (1890). Ehrembaum (1890) at Berlin determined the five zoeal stages. Williamson (1901) made a detailed account of the development of each appendage and summarized the characters (1915). Lebour (1931) figured stages I and II, and described stage I from Plymouth.

The living larvae of Crangon crangon are yellow and brown in color, with a length of 2 mm (first stage) to 4.7 mm (last stage). The third abdominal somite has a central spine overlapping the fourth

segment. The lateral spines of the fifth somite are of moderate size.

Stage I. 1.8 to 2 mm. Carapace with three denticles on its antero-ventral margin. Endopod of the antennule represented by a long seta, the exopod with three setae and one aestheta. Antennal scale unsegmented. Eyes sessile, attached to the carapace. Palp of the maxillule one-segmented. Exopods of maxillipeds with 4, 5, 5 terminal setae, respectively, and endopods 4-, 5-, and 5-jointed. Paraeopods present as buds, the first pair bifid. Pleopods absent. Telson triangular with 7 + 7 spines.

Stage II. 2.5 mm. Antennular peduncle two-jointed, exopod and endopod as distinct segments. Antennal scale with 11 terminal and inner setae. Eyes sessile, free from the carapace. Exopods of the maxillipeds with 5, 6, 6 terminal setae, respectively. Paraeopods larger and the exopod and endopod of the first pair distinctly different from one another. Pleopods not visible. Telson cut off from the sixth abdominal somite, with 8 + 8 spines and rudiments of uropods prominently visible.

Stage III. 3.7 mm. Antennal scale with 12 terminal and inner setae. Endopod of the third maxilliped with four terminal setae. Exopod of the first paraeopod with six terminal setae, endopod with a short terminal hair. Pleopods as small buds. Telson triangular, uropods free, endopod smaller than the exopod, one spine in the base of each uropod.

Stage IV. 4.2 mm. Antennal scale with 15 terminal and inner setae, endopod with two joints. Exopod of the first pair of paraeopods unchanged, the endopod four-jointed, second paraeopod cylindrical with a terminal hair; paraeopods three, four, and five beginning to assume

the shape of walking appendages. Pleopods little larger but unsegmented. Telson still triangular, uropods greatly increased in size. Small anal spine.

Stage V. 6 mm. Antennal scale with 17 setae on its inner and terminal margins. Paraeopods fully jointed; the exopod of the first paraeopod still remaining; dactylopod of endopod with a claw; second paraeopod with a rudimentary chela. Pleopods two-jointed. Telson oblong (almost quadrangular), exopod and endopod of uropods with 16 and 14 setae, respectively. Anal spine very prominent.

Philocheras bispinosus (Hailstone & Westwood)

Pike and Williamson (1961), using characters of the larvae of this species reared at Milliport Laboratory and from specimens from the plankton of the Irish sea and Firth of Clyde, established two subspecies: Philocheras bispinosus bispinosus and Philocheras bispinosus neglectus. In addition they observed that several intermediate forms between the two sub-species occur in the plankton of Firth of Clyde. In the present survey the larvae of the two subspecies and the intermediate forms have been found and the author hopes to give an account of this elsewhere. Until 1960 all the descriptions of the larvae of Philocheras bispinosus corresponded to P. b. bispinosus. Sars (1890) described the stage V and megalopa as Cheraphilus manus. Williamson (1915) gave an account of the same stages as Crangon manus (after Sars). Lebour (1931) figured stage I from hatchings at Plymouth. Pike and Williamson (1961) described stage V of P. b. bispinosus and figured the first zoea and the telson of stages II-V of P. b. neglectus.

The main difference between the larvae of the two subspecies is that those of P. b. bispinosus bear a pair of spines on the third to fifth abdominal somites, and 4 to 6 denticles on the antero-ventral mzrgin of the carapace, while the P. b. neglectus lacks both of these structures. The other known species of Philocheras without these structures is Philocheras trispinosus but this species is 50% larger than P. b. neglectus and the proportion between the antennular rami are 1:1.5 (first stage) and 1:2.5 (last stage). In P. b. neglectus the proportions are 1.1 (first stage) 1:1.5 (last stage).

The larvae of Philocheras bispinosus are the smallest of all the Crangonidae, 1.2 mm long (first stage) to 3.5 mm (last stage). The rostrum has a broad base and a sharp terminal portion, carapace with or without denticles on the ventral margin, maxillipeds with setose exopods from the first stage onwards. Paraeopods one and two with exopods. Abdominal somites three to five with or without lateral spines, those of the third somite arising in front of the somite, and those of the fifth short and stout. Pleopods appear as buds in the fourth stage.

Stage I. 1.2 mm. Endopod of antennule equal to or little longer than the exopod. Antennal scale unsegmented, about four times as long as broad, and with two outer setae. Exopods of maxillipeds setose. Paraeopods as buds. No pleopods. Telson more deeply indented than in Crangon, with 7 + 7 spines; no trace of uropods.

Stage II. 1.7 mm. Antennular endopod little larger than the exopod. Antennal scale retains the two outer setae. Exopods of the three pairs of maxillipeds and of the first pair of paraeopods setose. Exopod of second paraeopod without setae. No pleopods present. Terminal margin of the telson with the median cleft less pronounced, 8 + 8

spines. No trace of uropods.

Stage III. 2.0 mm. There is little change from the previous stage except that the paraeopods are larger, but unsegmented, the telson is shallowly indented, and with uropods present. The exopod of each uropod is setose and the endopod is not fully differentiated.

Stage IV. 2.5 mm. Antennular endopod about 1.5 times as long as the exopod. The antennal scale still retains the outer setae. Exopod of second paraeopod has become setose. Pleopods appear as small buds. Telson cut off from the sixth abdominal somite, almost parallel-sided, little wider posteriorly than anteriorly. Both rami of the uropods almost of the same size and both setose.

Stage V. 3.2 to 3.5 mm. Antennular endopod 1.5 times as long as the exopod. Antennal scale about three times as long as broad, retains one outer seta, has one terminal spine, and 17 setae on its inner and terminal margins. Paraeopods articulated, first two pairs with setose exopods. Pleopods larger, articulate, but without setae. Telson parallel-sided, about three times as long as wide, with two lateral and six terminal spines. Uropodial rami of the same length and setose.

Pontophilus spinosus (Leach)

No full description of the larval stages of this species exits in the literature. Sars (1890) described stages I and V. Williamson (1915) described the same stages as Crangon (after Sars) and Gurney (1942) figured stage I. In 1971 the five zoeal stages were obtained and some of the main characteristics of each stage are outlined below.

The larvae of this species are easily recognized for their large

size, the two lateral spines on the fifth abdominal somite, the median spine on the third abdominal somite, and the telson deeply indented with two lateral rami. The ventral margin of carapace with about five denticles behind the pterygostomian spine. Pontophilus novergicus has about 10 denticles. Ventral margins of abdominal somites one to five each with from 1 to 5 small spines or denticles, no dorsal denticles. Rostrum without denticles in all the zoeal stages. Two dorsal organs on the carapace. Paraeopods one and two with exopods. Pleopods appear in stage III.

Stage I. 5.6 mm. Antennular peduncle long, endopod with three setae and one aestheta. Antennal endopod as a rod terminating in one spine. Antennal scale not segmented, with two outer setae and 10 on the terminal and inner margins. Eyes sessile. Palp of the maxillule two-segmented. Exopods of maxillipeds with 6, 8, 9 setae, respectively. Paraeopods one and two rudimentary, bilobed. Paraeopods three to five as buds. No pleopods. Telson deeply indented with 7 + 7 spines.

Stage II. 6.6 to 6.8 mm. Rostrum as long as the antennular peduncle. Eyes free. Exopods of maxillipeds with 11, 11, 12 setae, respectively. Paraeopods one and two larger, unsegmented, third to fifth rudimentary. No pleopods. Telson with an additional spine on the external margins. Uropods visible underneath the epidermis.

Stage III. 8.3 mm. Antennular peduncle two-segmented. Antennal scale has lost the distal outer seta, with one spine on its external tip, and 13 setae on its inner and terminal margins. Paraeopods one and two segmented, the exopod of the first pair setose. Paraeopods three to five larger but unsegmented. Pleopods appear as small buds. Telson less indented. Uropods free, biramous. Uropodial endopod

small, less than half the exopod, this with setae.

Stage IV. 9 to 10 mm. Antennal endopod with a somite at its base, and almost as long as the scale. Antennal scale without outer setae, and with about 16 plumose setae on its inner and terminal margins. Paraeopods one and two functional, exopods of both pairs setose. Endopod of the first paraeopod beginning to form a claw. Paraeopods three to five larger but still unsegmented. Pleopods larger, inarticulated, those on abdominal somites four and five biramous. Telson superficially indented, one spine on the base of each uropod. Anal spine present. Uropodial rami larger and setose.

Stage V. 11.4 to 11.6 mm. Antennal endopod longer than the scale, with one somite at its base, and flagellum with indistinct segments. First paraeopod with a claw. The second paraeopod is smaller than all the others. Paraeopods three to five segmented. Exopods of maxillipeds with 16 setae. Pleopods larger, articulated, biramous, but without setae. Uropodial rami almost of the same length and with many setae.

Family Hippolytidae

The larvae of the members of this family are similar to those of the Pandalidae. The antennular peduncle is less than the width of the peduncle in the Hippolytidae. The Hippolytidae can be separated from the Processidae by the absence of a rostrum in stage I.

Within the family Hippolytidae great variations can exist. The number of zoeal stages varies from 5 (Hyppolyte) to 9 (Caridion). The rostrum may be minute (Eualus) or grossly developed (Caridion). The number of exopods in the paraeopods may be 2 (Spirontocaris, Hyppolyte)

or 3, or 4 (Thoralus, Eualus). The following notes have been found useful in the separation of these larvae.

One or more of the thoracic endopods expanded (oar-shaped), carapace with dorsal horns in one species; or none of the thoracic endopods expanded, carapace without horns. Bases of antennules separated by not more than the width of one of them, peduncles stout and almost straight. Eye stalks cylindrical.

Hippolyte varians Leach

The five zoeal stages of Hippolyte varians were described by Sars (1912b). Williamson (1915), using Norwegian plankton, described stage I and gave the others after Sars. Lebour gave an account of the first stage (1931) and last stage (1936) from the Plymouth plankton. The larvae of this species are stout with a dorsal tubercle on the antero-dorsal part of the carapace. Pterygostomian spine and 2 or 3 small denticles in the antero-ventral margin of the carapace. The supraorbital spines appear on stage IV. Paraeopods one and two with exopods. Lateral spines on the fifth abdominal somite, although they may be absent. The specimens described by Sars (1912b) did not present these spines. There are five zoeal stages.

Stage I. 1.3 mm. Short and stout, rostrum spiniform. Posterior margin of carapace slightly emarginated in the middle, exposing the dorsal part of the last segment of the trunk. Eyes large and massive, flanking the whole frontal part of the carapace. Antennular peduncle simple, endopod replaced by a long ciliated seta, exopod with two sensory filaments (aesthetascs) and 1 or 2 setae. Antennal scale with two segments at its tip. Maxillule with outer basal seta. Exopods of

maxillipeds with 4 to 6 ciliated setae. Endopods with four joints. Paraeopods and pleopods absent. Telson spatuliform, posterior margin only slightly indented, with 7 + 7 spines.

Stage II. 2.10 mm. More slender than stage I. Eyes freely movable, claviform in shape and projecting considerably beyond the sides of the carapace. Antennal scale has lost one of the outer setae and the terminal segments. Endopods of maxillipeds two and three with five joints. Two pairs of paraeopod buds. No pleopods. Telson with 8 + 8 spines. Uropods not visible.

Stage III. 2.65 mm. Antennal scale without outer setae, and with about 12 setae at the terminal and inner margins. Exopod of first pair of paraeopods functional, that of the second pair rudimentary. Paraeopods three to five as buds. No pleopods. Telson cut off from the sixth abdominal somite. Uropods free, endopod smaller than the exopod and without setae.

Stage IV. 3.23 mm. One supraorbital spine present over each eye. Exopod of second paraeopod functional. Paraeopods three to five rudimentary, digitiform. Five pairs of pleopod buds. Both rami of the uropods developed and setose.

Stage V. 4 mm. Carapace still retains the dorsal tubercle, and the rostrum remains spiniform. Antennular peduncle tri-articulated, exopod with two segments. Antennal scale with 16 to 18 setae. Flagellum (endopod) longer than the scale and with one joint at its base. Maxillipeds longer but unchanged in form. Paraeopods one and two with chelae, endopods immobile and curved, with 4 and 5 joints, respectively. Paraeopods three to five inarticulated and unarmed. Pleopods biramous, immobile, without setae. Telson quadrangular,

uropods with the branches narrow.

Caridion gordoni (Bate)

Sars (1900) described eight zoeal stages of this species as Pandalus borealis. The eighth zoeal stage is in reality the penultimate. Lebour (1930) described the nine zoeal stages from hatches at the Marine Laboratory, Plymouth (first stage), and from plankton collections. The more noticeable characteristics of this species are the great development of the rostrum, the presence of supraocular spines from stage II, lack of dorsal process on the carapace, and the oar-shape of the third maxilleped and first paraeopod. Lateral spines on the fifth abdominal somite.

Stage I. 2.6 mm. Eyes sessile. No process on the carapace. Antennal scale segmented. Endopod of third maxilliped oar-shaped. Exopod of second and third maxillipeds with four terminal setae. Telson deeply indented with 7 + 7 spines. No paraeopods or pleopods.

Stage II. 3.5 mm. Eyes stalked. Supraorbital spines present. Rudiments of paraeopods one and two present. Telson with 8 + 8 spines.

Stage III. 4.6 mm. Antennal scale with only two segments at its tip, and with 1 outer seta (Sars) or 2 (Lebour). First pair of paraeopods functional and oar-shaped, second rudimentary with exopod, third pair as knobs. Telson cut off from the sixth abdominal somite and uropods free.

Stage IV. 5.5 mm. Rostrum can present a small denticle. Second paraeopod functional with endopod oar-shaped, third bifurcate but rudimentary, and fourth as knobs.

Stage V. 6.2 mm. Similar to fourth zoea, but with the third

paraeopod functional, the fourth bifurcate, rudimentary, and the fifth as knobs.

Stage VI. 7.3 mm. All paraeopods functional except the last, which is an unjointed rudiment tucked under the body. Two denticles on the rostrum. Pleopods not yet developed but may be seen under the cuticle, sometimes represented as small buds in specimens from Plymouth.

Stage VII. 8.4 mm. All appendages present. Last paraeopod short but jointed (never has exopod). Pleopods short. Telson elongated but still deeply indented.

Stage VIII. 10 mm. Several denticles on the dorsal part of the rostrum, up to seven but usually less, and one below. First paraeopod with the beginning of a chela, the second still broadly oar-shaped. Pleopods long.

Stage IX. 11 to 13 mm. First paraeopod with a long incipient chela. The second paraeopod still with an oar-shaped endopod. Fifth paraeopod longer than in the preceding stage. Pleopods longer but still without setae.

Caridion steveni Lebour

The larval stages were described by Sars (1900) as Pandalus bonnieri, although not in as much detail as C. gordoni. It was recorded by Webb (1923) from Plymouth outside the Sound as Pandalus bonieri and by Jorgensen (1923) from Northumberland. Lebour (1930) made the correction, established the specific name, and described the nine zoeal stages. The first stage was described from hatchings and the others from the plankton. The main differences from C. gordoni are the lack of supraorbital spines and the presence of a pair of

dorsal horns on the carapace from stage II onwards.

Stage I. 1.8 mm. Resembling C. gordoni but smaller and not so slender. Eyes sessile. Rostrum thin and long. Antennal scale segmented at the tip, and with two outer setae. Endopod of third maxilliped oar-shaped, very conspicuous. Exopod of maxillipeds two and three with three terminal setae. Telson indented, with 7 + 7 spines.

Stage II. 2.6 mm. Carapace with dorsal horns. Eyes stalked. Antennal scale still segmented at the tip. Rudiments of paraeopods one and two present. Rostrum downward-curved at the tip. Telson with 8 + 8 spines. Trace of uropods can be seen underneath.

Stage III. 3.3 mm. Antennal scale unsegmented, outer setae lost. First paraeopod functional with endopod oar-shaped. Exopod with four setae. Second pair of paraeopods bifurcate, rudimentary. Third pair as simple buds. Telson cut off from the sixth abdominal somite. Uropods free.

Stage IV. 4.2 mm. Rostrum curving downwards into almost a hook at the tip. Second paraeopod functional with the endopod not so oar-shaped, third bifurcate but rudimentary, fourth as simple buds.

Stage V. 5.5 mm. Third paraeopod functional, endopod less oar-shaped, fourth bifurcate but still rudimentary. Fifth as a thin, curved stump.

Stage VI. 6.3 mm. Fourth paraeopod functional, fifth still unjointed, bent under the body. Endopod of the other paraeopods becoming slender. No denticles on the rostrum. Rudiments of pleopods sometimes present.

Stage VII. 7.4 mm. Fifth paraeopod jointed. No endopod oar-shaped. Pleopods present as small buds.

Stage VIII. 8.9 mm. Long incipient chela on the first paraeopod. Fifth paraeopod longer. Pleopods longer and fully developed. No denticles on the rostrum.

Spirontocaris lilljeborgii (Danielssen)

Lebour (1937) described the first stage under the name of Spirontocaris spinus var. lilljeborgii from specimens hatched at Dove Marine Laboratory by H. O. Bull. Pike and Williamson (1961) described the five zoeal stages from hatchings at the Milliport Laboratory, and from plankton from the Firth of Clyde.

The rostrum is prominent and pointed, without teeth until the megalopa stage. Supraorbital spine present in all stages (rudimentary in stage I). Carapace with anterior dorsal tubercle, with pterygostomian spine, but without denticles on its ventral margin. No outer basal seta on the maxillule. Exopods on paraeopods one and two only. Fourth abdominal somite with a tuft of setae (difficult to see in preserved material). A pair of lateral spines on the fifth abdominal somite. These spines tend to become smaller or to disappear in the later stages.

Stage I. 3.7 mm. Antennular endopod as a simple long seta, exopod with two aesthetascs and several hairs. Antennal scale with four segments at the tip, and with two outer setae, and nine at the terminal and inner margins. Exopod of maxillipeds two and three with eight setae. Rudiments of all five pairs of paraeopods. Anal spine present. Telson deeply indented with 7 + 7 spines.

Stage II. 5.2 mm. A ventral spine on the antennular peduncle. Tip of antennal scale with 2 or 3 indistinct segments, outer distal

seta replaced by a short spine. The paraeopod buds longer than in stage I. Small uniramous pleopod buds in second to fifth abdominal somites. Telson with 8 + 8 spines.

Stage III. 6.5 mm. A small antennal spine beneath the eye on either side. Segmentation of the tip of the scale less distinct. Paraeopod buds larger and indistinctly segmented. The first two pairs end in incipient chelae and their exopods are without setae. The pleopod buds on somites two to five are biramous and there are minute uniramous buds on somite one. Uropods free.

Stage IV. 7.3 mm. Small ventral spine at the base of the antennal scale, endopod larger than the scale and with one segment formed at its base. Scale not segmented. Paraeopods segmented. Exopods setose and functional. Pleopods pointed and second to fifth show appendix interna.

Stage V. 8.4 mm. Antennal endopod about 1.5 times as long as the scale. Carpus of the second paraeopod still entire. Pleopods not functional. Spines on the fifth abdominal somite very small or absent.

Eualus pusiolus (Kroyer)

Larvae of this species were first described by Frost (1936) as Sprontocaris "C". Bull (1939) at the Dove Marine Laboratory described the stage I as Spirontocaris pusiola. Pike and Williamson (1961) at Milliport and Port Erin hatched the first zoea and reared the megalopa from the last zoeal stage.

Six zoeal stages and probably intermediate stages exist; moreover, it is likely that not all pass through the same zoeal stages, depending on the food available or diet.

The rostrum is minute in stage I and small in the others. There

are two dorsal tubercles on the carapace and three denticles behind the pterygostomian spine. Abdominal somites without spines. Anal spine present from the stage I. Fifth paraeopod without exopod.

Stage I. 2.2 to 2.6 mm. A ventral spine at the base of the antennal endopod; antennal scale with up to six defined segments, with two outer setae and 10 on the terminal and inner margins. The exopods of maxillipeds one to three with 4, 5, 5 setae, respectively. No trace of paraeopods or pleopods.

Stage II. 2.6 to 3.0 mm. Four segments visible at the tip of the antennal scale. Exopods of maxillipeds with 5, 8, 8 setae, respectively. The two first pairs of paraeopods as small biramous buds, the third as uniramous buds.

Stage III. 3.8 mm. Only two segments are visible at the tip of the scale, both outer setae have disappeared, the distal one being replaced by a spine. Eleven setae on the terminal and inner margins. Paraeopods one to four as biramous rudiments, the fifth uniramous. Telson cut off from the sixth abdominal segment, being more than twice as wide posteriorly than anteriorly. Unsegmented uropods present.

Stage IV. 4.0 to 4.5 mm. The antennal endopod about 2/3 the length of the scale which is no longer segmented and bears at least 15 setae. Exopods of paraeopods one and two setose. Small pleopod buds on abdominal somites two to five. Telson almost parallel-sided, and about twice as long as wide.

Stage V. 4.5 to 4.8 mm. Antennal endopod about as long as the scale and has one segment formed at its base. The endopods of all the paraeopods are segmented, those of pairs one and two ending in small chelae, and the exopods of first to fourth setose. Pleopods of

somites two to five biramous, the first uniramous. Telson parallel-sided, three times as long as wide.

Stage VI. 4.5 to 6.6 mm. Antennal endopod longer than the scale. Pleopods jointed, with short setae and appendix interna present in each endopod. The Telson is widest at about 1/4 its length and narrowest at about 3/4 its length from anterior, about three times as long as its greatest width. 9 + 9 marginal spines.

Thoralus cranchii (Leach)

H. C. Williamson (1915) described the first stage as Hippolyte cranchii from laboratory hatchings. Lebour (1932) also described stage I from laboratory hatchings and described nine zoeal stages from the Plymouth plankton and the megalopa and first young stage reared from the last zoeal stage (1936), as Spirontocaris cranchii. Later, she showed that the zoeal stages described in 1932 actually were larvae of Eualus ocultus (1936). Bourdillon-Casanova (1960) described stage I as Thoralus cranchii in specimens from de la Manche, and Pike and Williamson (1961) made some comments on the larvae of this species from plankton taken in the Irish Sea and the Firth of Clyde.

The larvae resemble those of Eualus occultus but are slightly smaller, with a pair of lateral spines (but not denticles) on the fifth abdominal somite and usually a few small setae on the fourth. Paraeopods four to five without exopods in all stages.

Stage I. 1.52 mm. Endopod of antennule as a very long spine, and exopod with three aesthetascs and a seta at the tip. Antennal scale segmented at the tip, two outer setae; flagellum (endopod) represented by a long spine. Maxillule without outer seta. Two dorsal tubercles

on the carapace, pterygostomian spine and three denticles behind it on the antero-ventral margin. First paraeopod, and sometimes also the second pair, present as buds. No pleopods. Telson moderately indented, no trace of uropods, 7 + 7 spines.

Stage II. 2.6 mm. Eyes free. Rostrum short, with supraorbital spines. Exopods of maxillipeds two and three with six setae at the end. Paraeopods one and two rudimentary. Telson with 8 + 8 spines.

Stage III. 3.2 mm. Antennal scale unsegmented. Paraeopods one and two bilobed, paraeopods three and four as small buds. Telson cut off from the sixth abdominal somite. Uropods free, biramous, endopods unarmoured or with two small setae.

Stage IV. 3.9 mm. Exopods of the maxillipeds and those of paraeopods one and two with six setae. Third paraeopod bilobed, fourth rudimentary. Endopod of uropods with many setae.

Stage V. 4.5 mm. Antennular peduncle with three segments. Very similar to stage IV, but with the fourth paraeopod longer, not bilobed, and the fifth rudimentary. Traces of pleopods beneath the epidermis. Exopods of paraeopods one, two and three with six setae.

Stage VI. 5.2 mm. All paraeopods longer than stage V. Small pleopods beginning to appear.

Stage VII. 5.9 mm. Exopods of paraeopods two and three with eight setae and traces of chelae on the endopods of paraeopods one and two. Paraeopods four and five very short. Pleopods slightly larger. Telson with 12 terminal spines, none laterally.

Stage VIII. 7.1 mm. All paraeopods longer than stage VII. Pleopods longer and two-jointed.

Stage IX. 8.3 mm. Antennal scale without outer setae, endopod

with incipient segmentation, reaching slightly beyond the scale. Supra-orbital spine. Ventral denticles still present in the ventral margin of the carapace. Exopods of maxillipeds one, two, and three with six setae, endopods with 4, 5, 5 joints, respectively. Exopods of paraeopods one to three with eight setae, endopods of paraeopods one and two with chelae. Pleopods long, with two branches, but without setae. Uropods slightly shorter than the telson.

Family Pandalidae

The larvae of this family are very similar to both the Hippolytidae and the Processidae and there is not a single clear character that separates them. The antennules are separated at the bases by more than their width. Antennular peduncles are often slender and curved. Eye stalks usually tapering.

Some further characters of this family are: Rostrum in all stages usually long (but rather short in Pandalina), toothed in late stages. Antennal scale usually segmented at the tip (not in P. borealis) in early stages. No exopod in paraeopod five. Paraeopod one simple or with rudimentary chela. Paraeopod two chelate in late stages. Paraeopods three to five ending in simple dactylopods.

The larvae of three species of pandalids have been found off Northumberland.

Pandalus montagui Leach

Sars (1900) described stages III and last zoea (as stage V and post larva). H. C. Williamson (1915) reported the same stages (after Sars). Webb (1921) described stage I at Plymouth. Lebour (1940) made

a summary of the panadalids from Plymouth and described stage I. Pike and Williamson (1964) reared P. montagui from the egg to the megalopa on a diet of Artemia nauplii at Milliport and at Port Erin.

The zoeal stages may be characterized as follows: the rostrum is longer in proportion to the body than in Pandalina brevirostris, with both dorsal and ventral teeth in the last stage. There are no denticles on the margins of the carapace and neither spines nor denticles on abdominal somites one to five. There are six zoeal stages.

Stage I. 3.6 mm. Antennular endopod represented by a seta, exopod with three aesthetascs and a short seta. Antennal scale with six segments at its tip, two outer setae and 9 or 10 setae on its inner and terminal margins. Maxillule with an outer basal seta. Maxillipeds fully segmented and exopods bear 4, 9, 9 setae, respectively. Paraeopods unsegmented and without setae, three first pairs with exopods, other pairs uniramous. Pleopods absent. Telson deeply indented, with 7 + 7 spines.

Stage II. 4.3 mm. Antennular peduncle two-segmented and more distinctly curved, and endopod one-segmented. The proximal seta of the scale is lost and the distal one replaced by a spine. There are 12 setae. The exopod of the first maxilliped with five setae, those of two and three and first paraeopod with 8 to 10 setae. Paraeopods unsegmented. There are no traces of pleopods, but uropods are clearly visible inside the telson. Telson with 8 + 8 spines.

Stage III. 5.2 mm. Rostrum relatively shorter than in the preceding stages. Antennular peduncle three-segmented. 1 or 2 segments are still visible at the tip of the scale. Seta of the maxillule reduced. The setation of the exopods of the maxillipeds and first

three pairs of paraeopods is 5, 10, 10-12, 10-12, 0-6, respectively. Fifth paraeopod unsegmented and held close to the ventral surface of the thorax. Pleopods in segments two to five represented by uniramous buds. The exopod of each uropod with about 15 setae, the endopod slightly more than half as long again as the exopod, and bearing three terminal setae. Sixth abdominal somite articulated with the telson and bearing a ventral anal spine and a spine at the base of each uorpod. Telson rather longer than broad.

Stage IV. 6.5 mm. Rostrum in some specimens with two dorsal teeth. Antennal endopod about as long as the scale, and with incipient segments in its distal half. No basal seta in the maxillule. Maxillipeds and paraeopods fully segmented. Exopods setation 6, 10, 10-12, 14, 12, 6. Pleopods biramous. Endopods of uropods 3/4 the length of the exopods and both with many setae. Posterior width of the telson less than twice the anterior width and the length more than twice the posterior width.

Stage V. About 8.3 mm. Occasionally three dorsal teeth on the rostrum. Antennal endopod about 1.5 times as long as the scale and divided into about 15 segments. Pleopods distinctly segmented with an indication of an appendix interna on each endopod. Telson almost parallel-sided and nearly three times as long as wide.

Stage VI. About 9.8 mm. The rostrum bears 5 to 7 dorsal teeth and 2 to 3 ventral ones. Antennal endopod (flagellum) at least twice as long as the scale. The second paraeopod chelate and the left longer than the right, but no subdivision of the carpus. The pleopods bear a few short setae on each ramus. The telson narrows slightly towards the posterior end and is more than four times as long as its

posterior width.

Pandalus borealis Kroyer

Stephensen (1912) described five zoeal stages as Pandalus propinquus. H. C. Williamson (1915) mentioned the same zoeal stages as P. propinquus (partially after Stephensen 1912). Stephensen (1916) described stage III as Spirontocaris larva IV. Lebour (1940) summarized the characters of the larvae. Sars (1900) described the larvae of C. gordoni as P. borealis. Berkeley (1930) described the zoeal stages from hatches and plankton in British Columbia.

The larvae have the rostrum shortest in stage III, longest in stage I and the last stage. No ventral teeth in the zoeal stages. No denticles on the carapace. Antennal endopod with spine but no setae in stages I and II. Antennal scale never segmented and without outer setae. Paraeopod buds present from stage I. All exopods functional from stage II. Six zoeal stages.

Stage I. 5 mm. Very slender. Rostrum long, slender, spiniform, and without denticles. Eyes immobile. Antennal endopod shorter than the scale and tipped with a simple spine. Antennal scale unsegmented at the tip, without outer setae and with 15 plumose setae on the terminal and inner margins. Maxillule without outer basal seta. Five pairs of paraeopods present but poorly developed, first to third biramous, fourth to fifth uniramous. Telson indented. 7 + 7 spines. No free uropods but traces underneath.

Stage II. 7 mm. Antennular peduncle with three segments and the exopod with two groups of olfactory setae. Antennal endopod with two segments at its base. Eyes stalked. One supraocular spine over

each eye. Second maxilliped with endopod distinctly segmented. All paraeopods segmented, although the joints in the fifth are very indistinct. Exopods with plumose setae. Pleopods as simple buds. Telson still not cut off from the sixth abdominal somite.

Stage III. 8 to 9 mm. The rostrum usually has two little teeth at the base. Paraeopods longer in proportion to the body and definitely jointed, the propod of the second showing the beginning of a claw. Telson cut off from the sixth abdominal segment. Uropods free, endopod much smaller than the exopod.

Stage IV. 9 to 10 mm. Rostrum with four small denticles at its base. Pleopods longer, biramous but without joints or setae. Telson with the sides almost parallel, 5 + 5 spines at the terminal margin and 3 + 3 laterally. Both rami of uropods well developed.

Stage V. 14 mm. Rostrum with 11 to 12 denticles, 4 or 5 of which are on the carapace. Flagellum (endopod) of antenna fairly long and segmented throughout its length. Second paraeopod with a well developed claw. Pleopods articulate with few setae but no appendix interna.

Stage VI. 14 to 15 mm. Rostrum with 14 dorsal teeth and one near the acute tip. Pleopods longer with more setae, appendix interna present from the second to the fifth. The first pleopod has the inner ramus much smaller than the outer. Telson with four pairs of lateral spines.

Pandalina brevirostris (Rathke)

Sars (1900) described stage V and stage VI. H. C. Williamson (1915) described the same stages (after Sars 1900). Lebour (1940)

defined stage I and characters of the species from Plymouth. Gurney (1942) figured stage I. Bourdillon-Casanova (1960) described last zoea and megalopa and Pike and Williamson (1964) made a detailed account of the different larval stages and the megalopa from hatchings at the Marine Station, Milliport (stage I and II) and from plankton from both the Firth of Clyde and the Irish Sea.

Pandalina brevirostris passes through seven stages (Pike and Williamson, 1964) in the Irish Sea, or nine stages in Plymouth (Lebour 1940), and Mediterranean Sea (Bourdillon-Casanova 1960).

There is a definite rostrum but it is considerably shorter than in the other pandalids, with dorsal teeth in the later zoeal stages, but the ventral tooth does not appear until the megalopa stage. Some specimens in all stages have two small denticles behind the pterygostomian spine. Carapace with both posterior and anterior tubercles (dorsal organs). The sixth abdominal somite with a spine in the base of each uropod from stage III, and an anal spine from stage IV onwards.

Stage I. About 1.9 mm. Endopod of antennule represented by a plumose seta and the exopod by a single segment terminating in three aesthetascs and a seta. Antennal scale with two outer setae and nine on the terminal and inner margins, four free segments at the tip. Maxillule with outer basal seta. Exopods of maxillipeds with 4, 5, 5 setae, respectively. Endopods fully segmented. There are neither paraeopods or pleopods. Telson deeply indented. 7 + 7 spines.

Stage II. 2.2 mm. Eyes free. Supraorbital spine present. Antennular peduncle usually divided in two segments. Antennal scale with three segments at its tip. Exopods of maxillipeds with 5, 7, 7

setae, respectively. Paraeopods as buds, three first pairs biramous, the other two uniramous. Telson with 8 + 8 spines.

Stage III. About 2.8 mm. Antennular peduncle slightly curved and with 2 or 3 segments. Tip of antennal scale with 1 or 2 segments. Paraeopod buds larger and the two posterior pairs uniramous. All are segmented but without setae. Telson cut off from the sixth abdominal segment. Uropods free, endopod less than half as long as the exopod, 2 and 6 setae, respectively.

Stage IV. About 3.4 mm. Antennal scale unsegmented, the proximal outer seta has disappeared and the distal one replaced by a spine, about 13 setae on the terminal and inner margins. The maxillule has lost its outer basal seta. Two first pairs of paraeopods with endopods segmented and exopods setose. There are very small pleopod buds in some specimens, none in others. Anal spine small. Telson slightly wider posteriorly than anteriorly, rami of uropods with about 11 and 13 setae, respectively.

Stage V. About 4.2 mm. Rostrum usually with a dorsal tooth, just in front of the anterior dorsal tubercle, and occasionally a small second denticle farther forward. Antennal endopod at least 3/4 the length of the scale with one fully formed segment at its base and the distal part indistinctly segmented. All thoracic exopods setose and the endopods at least partly segmented. The fifth paraeopod not functional and lies close to the ventral surface of the thorax, pointing forward. Pleopods biramous. Telson parallel-sided and 2 to 3 times as long as broad.

Stage VI. About 5.1 mm. Rostrum with two distinct dorsal teeth and usually a third smaller one. Antennal endopod longer than the

scale and divided into seven segments. All paraeopods functional. Pleopods with appendix interna. Telson 3 to 4 times as long as broad.

Stage VII. About 6.0 mm. The rostrum bears about 5 or 6 dorsal teeth, none of which shows a basal articulation. Antennal endopod about twice as long as the scale and almost completely segmented. Pleopods with a few short setae. The anterior half of the telson is slightly wider than the posterior, and the length of the telson is 4 to 5 times its posterior width.

Family Processidae

The larvae resemble closely those of Hippolytidae and Pandalidae but the following characters may be used in making a distinction.

Rostrum small (absent in stage I), never toothed, carapace with supraorbital and pterygostomian spines, denticles on the antero-ventral margin. Antennal scale never segmented. Maxillule with outer basal seta. Exopods of maxillipeds in the stage I, with three terminal setae. First paraeopod without chela, and exopods in paraeopods one to four in late stages. From the Northumberland coast only one species, Processa canaliculata, has been reported. The larvae were very scarce in numbers and seasonally variable.

Processa canaliculata Leach

Gurney (1923) described the nine zoeal stages of this species from hatchings (Stage I) and from the plankton of Plymouth, but Lebour (1936) found the larvae of another species which lives inshore, and thought that Gurney had confused the larvae of Processa edulis and P. canaliculata in his description. In fact, the larvae of both species

are much alike, the principal distinction being the P. canaliculata presents dorsal spines on the fourth and fifth abdominal somites, and P. edulis only on the fifth.

The larvae of P. canaliculata are slightly larger. Late larvae with a golden-yellow ground color and pink stripes, dorsolateral spines in abdominal somites four and five, and more setae on the exopods of later stages. Nine zoeal stages.

Stage I. 2 mm. Rostrum absent, carapace with pterygostomian spine and two small denticles on the anterior-ventral margin. Exopods of maxillipeds with 5, 5, 5 terminal setae, respectively. Endopod of the antennule with a long ciliated seta, and the exopod with one ciliated seta and three aesthetascs. Antennal scale unsegmented, with two outer setae and 10 on its terminal and inner margins. Exopods of maxillipeds with 5, 5, 5 terminal setae, respectively. Buds of the first two pairs of paraeopods visible. No pleopods. Telson triangular deeply indented, and with 7 + 7 spines.

Stage II. 2.3 mm. Rostrum present, although very small. Supraocular spines small. A dorsal tubercle near the base of the rostrum on the carapace. Eyes stalked. First paraeopod functional, setation of exopods 5, 5, 6, 6, respectively. Second paraeopod rudimentary, third to fifth as buds. Telson with 8 + 8 spines.

Stage III. 2.53 to 2.65 mm. Antennular peduncle two-jointed. Antennal scale without outer setae and with a terminal spine. The maxillule has lost its outer basal seta. Second paraeopod functional. Setation of exopods 5, 6, 6, 6, 6, respectively. Endopods of paraeopod one and two five-jointed. No pleopods. Uropods developed, the endopod with two terminal setae and the exopod with six inner setae.

Anal spine still not present.

Stage IV. 2.8 mm. Antennal endopod has lost its terminal spine. Third paraeopod fully developed and functional. Exopods with 6, 6, 6, 8, 8, 6 setae, respectively. Telson about twice as long as broad. Uropods with several setae in each branch. Anal spine present.

Stage V. 3.95 to 4.8 mm. Antennal endopod with two joints, and nearly half as long as the scale. Paraeopods one to four developed, biramous, the fifth usually as a long unjointed rod, bent forward and without setae. Setation on the exopods 6, 6, 8, 8, 8, 6, 4, respectively. Pleopods as small buds, simple or bilobed. Telson narrow and parallel-sided.

Stage VI. 3.85 to 5.38 mm. Rostrum curved down. Antennal flagellum (endopod) about 2/3 as long as the scale. Fifth paraeopod fully developed and very long, reaching as far forward as the eye. There are some indications of the chelae in the first two pairs of paraeopods. Pleopods as short, curved, bilobed rods. Telson narrow, about five times as long as wide.

Stage VII. 6.3 mm. Flagellum little longer than the scale. First two pairs of paraeopods subchelate. Pleopods longer but without setae.

Stage VIII. 5.7 to 7.2 mm. Flagellum greatly longer than the scale and may be jointed. First paraeopod short and stout, and chelate on the right side, but the chela is not quite fully developed and retains the larval spines. Setation of the exopods 8, 10, 12, 12, 10, 8, 6 (7 or 9) to 8, 10, 12, 12, 10, 10, 8, respectively. Pleopods without setae (Gurney 1923) or with setae on the exopods (Lebour 1936).

Stage IX. 7.5 to 9.5 mm. Rostrum down-curved, constricted at the

tip where it bears two setae. Telson long and narrow, usually more than four times as long as wide, with 6 + 6 terminal and 2 + 2 lateral spines. Antennular peduncle three-jointed. Paraeopods one to four with the exopods shorter than the endopods. Second paraeopod chelate with carpus undivided. Setation of exopods 8, 10, 12, 12 (13) 12, 10, 8, resepectively. Pleopods large with very short setae.

Lebour (1936) believed that stage V can change indistinctly into stages VI or VII, and that stage VIII usually changes into the post-larva or megalopa.

CHAPTER IV

INCIDENCE AND FLUCTUATIONS OF THE CARIDEAN LARVAE OFF NORTHUMBERLAND FROM 1969 TO 1971

The caridean larvae remain 8 months in the plankton of Northumberland waters, from April to November (Table I). In April only two species were present (Table II). A small peak in numbers of species and individuals in May was followed by a steady decrease during June and July and a sharp increase in August-September. Larvae of 13 species were present in September. No larvae were taken between November and April. The caridean larvae contribute to the April-May and the August-September peaks generally reported for the decapod larvae. Annual distribution is not uniform. The larvae first appeared in May in 1969 and in April in 1970 and 1971. In 1969 and 1970 they were present until November, but they were not found after October in 1971. In 1971 more than twice as many larvae were found than in the two other years at Station II (Table III). Larvae of Crangon allmani and of Pandalina brevirostris were more abundant in 1969 and 1971, while in 1970 Pandalus montagui was most abundant (Table III).

Larvae of six of the 14 species were present at all three stations, one species was found at Stations I and II, three at Stations II and III, three only at Station II, and Pandalus borealis only at Station III (Table III). The inshore Caridion steveni was found at Station II but not at Station I. Spirontocaris lilljeborgii, usually

TABLE I

SUMMARY OF THE OCCURRENCE OF CARIDEAN LARVAE OFF THE NORTHUMBERLAND COAST, 1969-1971

Month -	J	F	M	A	M	J	J	A	S	O	N	D
Crangon allmani	-	-	-	X	X	X	X	X	X	-	-	-
Crangon crangon	-	-	-	-	X	-	-	X	X	-	X	-
Philocheras bispinosus	-	-	-	-	X	X	X	X	X	X	X	-
Hippolyte varians	-	-	-	-	X	-	X	X	X	X	-	-
Caridion gordoni	-	-	-	-	X	-	X	X	X	X	-	-
Caridion steveni	-	-	-	-	-	-	-	-	X	X	-	-
Spirontocaris lilljeborgii	-	-	-	-	-	-	-	-	X	X	-	-
Eualus pusiolus	-	-	-	-	X	X	X	X	X	-	X	-
Thoralus cranchii	-	-	-	-	-	-	-	X	X	-	-	-
Pandalus montagui	-	-	-	X	X	-	-	X	X	-	-	-
Pandalus borealis	-	-	-	-	X	-	X	-	-	-	-	-
Pandalina brevirostris	-	-	-	-	X	X	X	X	X	-	-	-
Processa canaliculata	-	-	-	-	-	-	-	X	X	-	-	-

X = present

TABLE II

NUMBERS OF SPECIES AND SPECIMENS OF CARIDEAN LARVAE COLLECTED OFF NORTHUMBERLAND, 1969-1971

Stations		Years	Months											
			J	F	M	A	M	J	J	A	S	O	N	D
I	Species	1969	0	-	0	0	4	-	0	6	6	-	0	0
	Individuals		0	-	0	0	34	-	0	194	66	-	0	0
II	Species	1969	0	-	0	0	4	-	1	8	8	-	0	0
	Individuals		0	-	0	0	58	-	22	165	104	-	0	0
II	Species	1970	0	0	-	2	2	3	4	11	10	0	2	0
	Individuals		0	0	-	72	38	31	22	130	59	0	2	0
II	Species	1971	0	0	0	1	7	5	7	11	12	4	0	0
	Individuals		0	0	0	12	71	27	135	173	229	16	0	0
III	Species	1969	0	-	0	0	4	-	4	6	6	-	1	0
	Individuals		0	-	0	0	70	-	17	71	46	-	3	0

(-) no sample taken

TABLE III

TOTAL NUMBERS OF CARIDEAN LARVAE COLLECTED OFF NORTHUMBERLAND, 1969-1971

Station -	I	II			III		
Year -	1969	1969	1970	1971	1969	Total	%
Crangon allmani	68	111	96	166	19	460	22.71
Crangon crangon	61	4	8	14	3	90	4.44
Philocheras bispinosus	40	13	40	52	3	148	7.31
Pontophilus spinosus	0	3	2	10	3	18	0.88
Hippolyte varians	0	0	10	31	1	42	2.17
Caridion gordoni	0	4	12	18	5	39	1.92
Caridion steveni	0	0	1	1	0	2	0.10
Spirontocaris lilljeborgii	0	1	0	3	0	4	0.20
Eualus pusiolus	20	36	31	82	34	203	10.02
Thoralus cranchii	0	2	1	34	0	37	1.82
Pandalus montagui	41	47	92	50	69	299	14.76
Pandalus borealis	0	0	0	0	19	19	0.93
Pandalina brevirostris	54	126	49	350	51	630	31.11
Processa canaliculata	10	0	12	12	0	34	1.68
Total	294	347	354	823	207	2025	
%	14.67	17.13	17.48	40.59	10.22		100.05

a deep-water species, was absent from Station III.

Crangon allmani (Table IV, Appendix)

This was the second most abundant species with 460 larvae obtained from the three stations during the 3 years. It occurred from April to September with a peak in August. At Station II it was more abundant in 1969 and 1971 than in 1970, but appeared earlier in 1970.

Previous records:

From May to July in large numbers at Blyth and Newbiggin, Northumberland, (Jorgensen 1923)

From April to July 1.5 miles offshore in Cambois Bay, Northumberland, at 23 to 27 m (Bossanyi 1957)

From mid April to late July in the Kattegat (Thorson 1946)

From July to October in the Kattegat and in the summer months in west Norway (teste Allen 1960)

Early stages from January to June and late stages during spring-summer in Plymouth (Lebour 1931)

In February and April in the inshore plankton of Plymouth (Lebour 1947)

From February to September, with a peak in June throughout the North Sea (Rees 1952)

Crangon crangon (Table V, Appendix)

Ninety larvae of this species were obtained in the 3 years. One larva was found at Station III in November, 1969. Since the adult is an inshore species and the larva was a stage IV, it is most likely that it was carried by currents from Station II. It seems that the normal occurrence of larvae in Northumberland waters may be from May

to September, with a gap in June-July. The greatest numbers were found in August, 1969, at Station I.

Previous records:

From May to September (sparsely) (Jorgensen 1923) and from May to July, Northumberland (Bossanyi 1957)

From mid May to early October in Danish waters (Thorson 1946)

Present practically all the year and may be numerous in any month from April to August at Plymouth (Lebour 1947)

From December or January to August, with a peak in January and another in April in the southern part of the North Sea. The first peak probably related to the great numbers found off the Dutch coast (Rees 1952).

Philocheras bispinosus (Table VI, Appendix)

During the 3 years 148 larvae were obtained. This species occurred from June to October, being more numerous in August and September, and was most abundant in 1971 (102 specimens). It seems that the two subspecies have different hatching seasons, as in the Firth of Clyde (Pike and Williamson 1961). P. b. neglectus hatches in spring (probably in May), and P. b. bispinosus in August and/or September.

Previous records:

From July to September in Danish waters (Thorson 1946)

From March to October at Plymouth (Lebour 1947)

As Pontophilus bispinosus throughout the North Sea, more common in the North (Rees 1952)

P. b. neglectus from May to June in the Irish Sea and spring-summer in

the Firth of Clyde; P. b. bispinosus May occasionally, September-October very common in the Irish Sea; first appearance in September in the Firth of Clyde (Pike and Williamson 1961)

Pontophilus spinosus (Table VII, Appendix)

Eighteen specimens were obtained from Stations II and III during the 3 years, from May to September in 1971 and from July to August in the other 2 years. Little monthly difference in numbers was observed.

Previous records:

Rather rare from May to July (Jorgensen 1923), and from May to June (Bossanyi 1957)

A single specimen in May, 1948, off the Aberdenshire coast (Rees 1952)

Hippolyte varians (Table VIII, Appendix)

This species occurred mainly at Station II, although in 1969 one specimen was found in September at Station III. It occurred from May to October but was absent in June. Thirty-one of the 42 larvae were obtained in 1971. No distinct peak existed, although larvae were more numerous in the summer months.

Previous records:

From May to July in small numbers, disappeared in July, and appeared again in August in great numbers; some in September in Cullercoats (Jorgensen 1923), and from May to June in Station I, Northumberland (Bossanyi 1957)

Larvae present throughout the year, the largest number in September and October at Plymouth (Lebour 1947)

From July to January with a peak in October at Humber (Rees 1952)

Caridion gordoni (Table IX, Appendix)

Thirty-nine larvae were obtained from Stations II and III. It occurred from May to October, but not in June (Table I). In 1971 the largest number occurred in August. In 1969 and 1970 it was found only from July to September.

Previous records:

As Pandalus borealis, rare from May to July, Northumberland (Jorgensen 1923)

Common in June, July and August in waters from 18 to 54 m at Plymouth (Lebour 1930)

In July and August, 1947, on the Aberdeen-Lerwick line (North Sea) (Rees 1952)

Caridion steveni

Two larvae were obtained at Station II, one stage V on 11 September, 1970, and one stage VI on 5 October, 1971. The adult is an inshore species (Allen 1966) and as the larvae were in late stages, it is probable that they were brought by currents.

Previous records:

As Pandalus bonnieri, one larva (stage VIII) in August in the middle waters of Cullercoats, Northumberland (Jorgensen 1923)

From March to the middle of August at Plymouth (Lebour 1930)

From April to June and in October but never in large numbers at Plymouth (Lebour 1947)

Spirontocaris lilljeborgii

Only four larvae were obtained at Station II, one stage IV in September, 1969, two stage V in August and one stage V in September, 1971. Off the Northumberland coast the adults of S. lilljeborgii are found in depths greater than 36 m. Allen (1966) found them in 80% of the hauls taken in depths more than 72 m, but in only 17% of the hauls between 36 and 72 m. Thus, it might be assumed that the larval density ought to be greater at Station III, but no larvae were found there. It seems that the larval occurrence off Northumberland coast may be from April or May to August or September.

Previous records:

Newly hatched larvae from the end of February to the second week of March at Cullercoats, Northumberland (teste Lebour 1937)

All year except December at Plymouth, but apparently confused with Thoralus cranchii, and Eualus occultus (Lebour 1947)

Eualus pusiolus (Table X, Appendix)

Two hundred three larvae of this species were obtained, being more abundant at Stations II and III than at I (Table III). Almost three times as many larvae were found in 1971 as in the other years. They occurred from May to September, being more abundant in September. One stage IV was recorded on 4 November, 1970.

Previous records:

As Spirontocaris pussiola, a post-larva in June 1950 at Station I, Northumberland (Bossanyi 1957)

From February to August or September in the Irish Sea and Firth of

Clyde (Pike and Williamson 1961)

Thoralus cranchii (Table XI, Appendix)

Thirty-seven larvae were obtained from Station II. In 1971, 34 larvae were found from the beginning of August to the middle of September, (Table IX, Appendix) but from records of hatching it is obvious that their occurrence is earlier in the year. Allen (1954-61) did not find any adults.

Previous records:

From January to November (with Eualus occultus as Spirontocaris sp., most common in August to October at Plymouth (Lebour 1947)

Pandalus montagui (Table XII, Appendix)

Two hundred ninety-nine larvae were obtained at the three stations during the 3 years. They were most numerous at Station III in 1969 and at Station II in 1971. With two distinct periods, April-May and August-September, at the three stations in 1969, and at Station II during all 3 years.

Previous records:

From July to August (Jorgensen 1923) and from May to July, Northumberland (Bossanyi 1957)

From mid-May to October in Danish waters (Thorson 1946)

From February to October, except April, in Plymouth (Lebour 1947)

From March to September, sometimes also in November, with a peak in April and another in August through all the North Sea (Rees 1952)

Pandalus borealis (Table III)

Only 19 larvae were obtained at Station III in 1969, 9 in May, and 10 in July. This is the most numerous species off the Northumberland coast (Allen 1959, 1966). The scarcity of larvae may be explained by the fact that it is a deep-water species, and Station III is situated just within the shallow limit of its distribution.

Previous record:

From April to August in British Columbia, Canada (Berkeley 1930)

Pandalina brevirostris (Table XIII, Appendix)

More than 600 larvae (31.1% of the total caridean larvae) were obtained at the three stations during the 3 years. It was most common in 1969 and 1971. The numbers at Stations I and III were almost the same in 1969 (Table III). The larvae were present from May to September.

Previous records:

From May to July as Pandalus brevirostris, Northumberland (Jorgensen 1923)

From mid-July to September in Danish waters (Thorson 1946)

From January to October, very numerous in spring and summer at Plymouth (Lebour 1947)

From March to December with peak in August throughout all the North Sea (Rees 1952)

From April to September in the Irish Sea and Firth of Clyde (Pike and Williamson 1964)

Processa canaliculata (Table XIV, Appendix)

Thirty-four larvae of this species were obtained from Stations I and II in August and September. This species has an irregular distribution and has never been caught in large numbers. In the preserved larvae it was impossible to see the lateral spines on the fourth abdominal somite, and it is not certain whether they were larvae of P. canaliculata or P. edulis. The former is the only species reported from the zone (Allen 1961), although Allen himself had doubts about the identification.

Previous records:

From March to November at Plymouth (Lebour 1936)

From April to September at Plymouth (Lebour 1937)

Two specimens were found in 3 years, one on the Aberdenshire coast in April 1947, and the other in the Forth in September, 1948 (Rees 1952).

CHAPTER V

DISCUSSION

Of the 15 caridean species reported by Allen (1966), larvae of Palaemon squilla and Spirontocaris spinus have not been found in the present survey. Palaemon squilla is known to live intertidally, and it is possible that the larvae are not carried far offshore by the currents, or that they complete the larval development before reaching the collecting stations.

The absence of the larvae of Spirontocaris spinus may be due to its habit of living only on a substratum of gravel covered with zoophytes which are outside the three sampling stations (Fig. 1). Larvae of bottom invertebrates tend to remain in the area of the parents (Johnson 1955).

The presence of the bottom invertebrate larvae in the plankton depends both on the reproductive characteristics of the adults and the environmental conditions. The carideans of Northumberland show three main patterns of reproductive behavior (Allen 1966).

1. Those species restricted to one type of substratum, e.g., Spirontocaris spp., Pontophilus spinosus, and Caridion gordoni. They lay eggs in November or December, the larvae hatch by April, and with the exception of C. gordoni, only one brood of eggs is produced per year.

2. Those species with a regular onshore-offshore movement, e.g.,

Crangon allmani, Hippolyte varians, Eualus pusiolus. These lay more than one brood of eggs in each breeding season. Breeding begins in December or January and extends throughout the summer months.

3. Those species with a non-return type of migration such as Pandalus borealis and Pandalus montagui. Only one brood of eggs occurs per year. Egg-laying occurs synchronously or almost so (Allen 1959, 1963a) in November or early December, and the eggs hatch in April or May. This has a profound effect on the migration of Pandalus montagui. Males that do not transform to females after fertilization migrate to deeper water soon after the eggs are laid in March (Allen 1966). Most of the females do not migrate until after the end of the breeding season in October. This is markedly different from Crangon allmani, in which more than one brood is laid and egg-laying times vary, so that males and females remain together throughout the breeding season.

In general, the results obtained in the present survey agree with the patterns outlined above. However, two species, Philocheras bispinosus and Pandalus montagui, do not fit the pattern exactly. The subspecies of Philocheras bispinosus are separated precisely on their different breeding periods. As in the west coast of Scotland, in Northumberland waters the subspecies neglectus breeds in winter and hatches in spring. The bispinosus subspecies breeds in spring and hatches at the end of August or early September. Two breeding periods must exist for the species as a whole and not one as registered by Allen (1966).

The larvae of P. montagui showed two distinct periods of occurrence, one in April-May, and another in August-September (Table I). This distributional pattern is similar to those species regarded as

having two broods per year, e.g., C. gordoni (Allen 1966). Allen (1963, 1966) reported only one brood per year, although he says that there were some small ova after the hatching in the 0-year group females off Northumberland. Mistakidis (1957) reported a breeding season from November to April for the populations of Pandalus montagui of the Thames estuary, but he also found some ovigerous females in June 1956. Jagerston (1936 teste Mistakidis 1957) found five specimens from the west coast of Sweden carrying relatively freshly laid eggs on 18 July 1935. It seems that Pandalus montagui in the Northumberland waters either has two broods of eggs per year, or if one, the breeding season is longer than that hitherto recognized.

CHAPTER VI

CONCLUSIONS

1. The incidence and fluctuations of the larvae of 14 species of carideans from the Northumberland Coast from 1969 to 1971 were surveyed. The dynamics of seven species is reported from this region for the first time.

2. The caridean larvae are found in the plankton from April to November. This distributional pattern differs from that of the other decapod groups from Northumberland waters and also from that of Caridea of other areas of the North Sea where they are reported to occur throughout the year.

3. The larvae of those five species occurring at all three collecting stations made up more than 70% of the total larvae. Pandalina brevirostris (31%) and Crangon allmani (23%) were the most abundant.

4. The caridean larvae were more common in 1971 than in 1969 or 1970.

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APPENDIX

TABLE IV

NUMBERS OF DIFFERENT LARVAL STAGES/250 M^3 OF CRANGON ALLMANI OFF NORTHUMBERLAND, 1969-1971

Stage	1969 Station - I Date - 12/5	18/8	17/9	Station - II Date - 12/5	9/7	19/8	17/9	Station - III Date - 12/5	9/7	19/8	17/9
I	4			10		4				1	
II	10 4	10	10	1	20 1	14	2	1			
III	1	3				22	6		1	3	2
IV	1	10			1	12	2			1	2
V		15				14	2		1	4	4
Totals	20	38	10	11	22	66	12	1	2	9	8

Stage	1970 Station - II Date - 14/4	5/5	15/6	28/7	10/8	11/9	1971 Station - II Date - 14/5	21/6	8/7	21/7	3/8	20/8	6/9	20/9
I	10 3	2			7			10	20 2	1	10 16	10	1	
II	3	2	10 6	10	10 2			1	2	10 15	20 8	1	20 7	
III					10 1				1	21	5	10 6	9	4
IV					2	3	1		1	6	10 11	10 14	6	3
V					9	6			1	4	9	14	10 7	3
Totals	16	4	16	10	41	9	1	11	27	57	89	65	60	10

Underlined numbers = samples taken with WP_3 net

Other numbers = samples taken with WP_2 net

TABLE V

NUMBERS OF DIFFERENT LARVAL STAGES/250 M^3 OF C. CRANGON OFF NORTHUMBERLAND, 1969-1971. LEGEND AS IN TABLE IV

	1969						1970		1971			
Station -	I			II		III	II		II			
Stage / Date -	14/5	19/8	17/9	14/5	19/8	4/11	10/8	11/9	14/5	3/8	6/9	20/9
I	2	10		1								
II											1	
III				1			2				2	2
IV		3			2	3			2			2
V		10	33 3				5	1	5	1	3	2
Totals	2	56	3	2	2	3	7	1	7	1	6	6

TABLE VI

NUMBERS OF DIFFERENT LARVAL STAGES/250 M^3 OF *PHILOCHERAS BISPINOSUS* OFF NORTHUMBERLAND, 1969-1971. LEGEND AS IN TABLE IV

	1969						1970				
Station -	I		II		III		II				
Stage / Date -	19/8	17/9	19/8	17/9	19/8	17/9	15/6	28/7	10/8	11/9	16/11
I			10						10		
II	10						2	10	10 1	1	
III							2				1
IV					1						
V	10	20		3		2	1		2		
Totals	20	20	10	3	1	2	5	10	23	1	1

	1971								
Station -	II								
Stage / Date -	21/6	8/7	21/7	3/8	20/8	6/9	20/9	5/10	25/10
I	1					10		10	10
II			10			1			
III			1						
IV			4			1	20 1		
V		1	5	1	3	8	15		
Totals	1	1	20	1	3	20	36	10	10

TABLE VII

NUMBERS OF DIFFERENT LARVAL STAGES/250 M^3 OF PONTOPHILUS SPINOSUS OFF NORTHUMBERLAND, 1969-1971. LEGEND AS IN TABLE IV

		1969			1970		1971					
	Station	II	III		II		II					
Stages	Date -	19/8	19/7	19/8	10/8	11/9	14/5	21/6	8/7	3/8	20/8	6/9
I							1	3				
II		3					2			1		
III			1						1			
IV								1				
V				2	1	1					1	1
Totals		3	1	2	1	1	3	4	1	1	1	1

TABLE VIII

NUMBERS OF DIFFERENT LARVAL STAGES/250 M^3 OF HIPPOLYTE VARIANS OFF NORTHUMBERLAND, 1969-1971. LEGEND AS IN TABLE IV

	1969	1970			1971				
Station	II	II			II				
Stage / Date	17/9	28/7	10/8	11/9	14/5	8/7	6/9	20/9	5/10
I					1	10			
II									10
III									
IV									
V	1	1	6	3			10 2	8	
Totals	1	1	6	3	1	10	12	8	10

TABLE IX

NUMBERS OF DIFFERENT LARVAL STAGES/250 M^3 OF CARIDION GORDONI OFF NORTHUMBERLAND, 1969-1971. LEGEND AS IN TABLE IV

	1969			1970		1971						
Station -	II		III	II		II						
Stage / Date -	19/8	17/9	19/8	28/7	10/8	14/5	21/7	3/8	20/8	6/9	20/9	5/10
I					10							
II	2			1	1	10		1				
III			1					1	1			
IV		2	2				2	1		1		
V								2				
VI								1			1	1
VII			2									
VIII											1	
Totals	2	2	5	1	11	10	2	6	1	1	2	1

TABLE X

NUMBERS OF DIFFERENT LARVAL STAGES/250 M^3 OF *EVALUS PUSIOLUS* OFF NORTHUMBERLAND, 1969-1971. LEGEND AS IN TABLE IV

	1969								1970		
Station	I	II		III					II		
Stage / Date -	19/8	19/8	17/9	12/5	19/7	19/8	12/9	10/8	11/9	4/11
I			10							
II	10			1		10 1	10		20	
III	10	2	10 6			2		3	1	
IV		4	2		1	1		2		1
V					2	1	2	2		
VI		2			1		2	1	1	
Totals	20	8	28	1	4	15	14	8	22	1

	1971						
Station -	II						
Stage / Date -	21/6	8/7	21/7	3/8	20/8	6/9	20/9
I							
II		20		10	20		
III	10		3			10 6	
IV				2	1	8	2
V				2	2	20 11	3
VI				2	2	10 5	5
Totals	10	20	3	16	25	70	10

TABLE XI

NUMBERS OF DIFFERENT LARVAL STAGES/250 M^3 OF THORALUS CRANCHII OFF NORTHUMBERLAND, 1969-1971. LEGEND AS IN TABLE IV

	1969	1970	1971	
	Station II	II	II	
Stage	Date - 17/9	10/8	3/8	6/9
I				
II				20
III				
IV				10
V		1		2
VI				
VII				
VIII			1	
IX	2			1
Totals	2	1	1	33

TABLE XII

NUMBERS OF DIFFERENT LARVAL STAGES/250 M^3 OF PANDALUS MONTAGUI OFF NORTHUMBERLAND, 1969-1971. LEGEND AS IN TABLE IV

	1969							
Station -	I			II			III	
Stage / Date -	12/5	19/8	17/9	12/5	19/8	17/9	12/5	17/9
I	10	10	20	5			1	
II				10 10	2	10	37	10
III	1			9			20	
IV				1			1	
V								
VI								
Totals	11	10	20	35	2	10	59	10

	1970			1971				
Station -	II			II				
Stage / Date -	14/4	5/5	10/8	21/4	14/5	3/8	20/8	6/9
I	22	5		10				10
II	3	14		2	1		10	
III	30 1	13	2		6	10		
IV					7			1
V		2			3			
VI								
Totals	56	34	2	12	17	10	10	11

TABLE XIII

NUMBERS OF DIFFERENT LARVAL STAGES OF PANDALINA BREVIROSTRIS OFF NORTHUMBERLAND, 1969-1971. LEGEND AS IN TABLE IV

	1969									1970		
Station -	I			II			III			II		
Stage / Date -	12/5	19/8	17/9	12/5	19/8	17/9	19/8	17/9		15/6	10/8	11/9
I	1					10				10		
II		10		10		2					10	
III					8	20	10	2			6	10
IV		10 6	3		20 18		10 5				3	
V		3			10 8	4	2	4			5	
VI		12			8		8	3			2	
VII		9				8	5	2			3	
Totals	1	50	3	10	72	44	40	11		10	29	10

	1971						
Station -	II						
Stage / Date -	14/5	21/6	21/7	3/8	20/8	6/9	20/9
I	20	1	1	10		20 1	
II	10		10	10	10 1	20 2	
III			10 2		10	30 4	3
IV	1		20 11	10 2	5	10 12	5
V	1		30 27	7	5	37	12
VI			14	5	20	20	27
VII			4		19	13	10 25
Totals	32	1	129	44	70	169	92

TABLE XIV

NUMBERS OF DIFFERENT LARVAL STAGES/250 M^3 OF *PROCESSA CANALICULATA* OFF NORTHUMBERLAND, 1969-1971.
LEGEND AS IN TABLE IV

	1969	1970		1971	
	Station I	II		II	
Stage	Date - 17/9	10/8	11/9	3/8	20/9
I	10	1	10		
II				2	10
VII					
VIII			1		
Totals	10	1	11	2	10

VITA

Antenor Martinez Guerra

Candidate for the Degree of

Master of Science

Thesis: INCIDENCE AND SEASONAL FLUCTUATIONS OF CARIDEAN LARVAE (DECAPODA, NATANTIA) OFF NORTHUMBERLAND (ENGLISH NORTH SEA COAST) FROM 1969 TO 1971

Major Field: Zoology

Biographical:

Personal Data: Born in Cajamarca, Peru, 30 November 1934, the son of Ernesto Guerra and Rosa Martinez, both deceased.

Education: Graduated from San Juan High School, Trujillo, Peru in 1953; received the degree of Profesor de Educacion Secundaria en la especialidad de Ciencias Biologicas, Universidad Nacional de Trujillo, Trujillo, Peru, December, 1959; received the degree of Bachiller en Ciencias Biologicas, (U.N.T.), April, 1969; received the degree of Biologo, (U.N.T.), May, 1969; completed requirements for the Master of Science Degree in July, 1972, at Oklahoma State University.

Professional Experience: Undergraduate teaching assistant, Departamento de Zoologia, U.N.T., 1957-1958; profesor instructor, Departamento de Zoologia, U.N.T., 1959-1962; profesor auxiliar, Departamento de Zoologia, 1963-1968; profesor asociado, Departamento de Ciencias Biologicas, U.N.T., 1969-1972; Coordinador de la seccion de Zoologia, Departamento de Ciencias Biologicas, U.N.T., 1968-1971; visiting researcher at the Dove Marine Laboratory, Department of Zoology, University of Newcastle Upon Tyne, Newcastle, England, April, 1971 to February, 1972.

Member: Asociacion Nacional de Biologos del Peru, Lima, Peru; Asociacion de Biologos del Norte, Trujillo, Peru; Sociedad Entomologica del Peru, Lima, Peru.