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Decapod Crustaceans of Newfoundland, Labrador and the Canadian Eastern Arctic

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FOREWORD

RATIONALE FOR REVISION OF MS REPORT 810

The revision of MS Report 810 is necessary to correct and bring up to date the taxonomic and other information on the decapod crustaceans of Newfoundland, Labrador and the Eastern Canadian Arctic. In its previous condition it would have presented incomplete data -- twelve other species of decapods have been added --, some wrong spellings and some incorrect naming of species (current when the Report was written). On the other hand it contains a lot of primary data on the biology of species (sizes, stomach contents and reproductivity) that have been quoted in the literature (Cf. Williams 1984 in particular) and has been difficult to access. It was reprinted in its original form in 1970 (first printing in 1965) but copies ran out and I, for one, have had a number of requests for it, two recent ones from the Smithsonian and from Brazil.

It has been said recently that the number of taxonomists has been decreasing while the demand for taxonomic literature has been increasing. The present demand originates in the movement to computerize the data and make on-line availability for the information such as being attempted by ETI (Expert center for Taxonomic Identification) at Amsterdam University. CD-ROM databases of various animal groups are in preparation or now available for Mackintosh or Windows by ETI (1250 species of fishes of the northeast Atlantic area and the Mediterranean is an example).

The present revision of MS Report 810 gives the data in a more readily usable form than previously (also more usable than Bulletin 221 of Squires 1990). The picture of a species with its description and accompanying map of distribution in the area makes it more easily accessible for a computer database than it was before. A comparison of the revision and the original will show that the original could only be used with considerable difficulty. Its data would also be incomplete. The revision completes the taxonomic data including the drawing and a reduced map from Bulletin 221.

A new print run would therefore be desirable to supply demands for it by new database needs as well as the (increasingly fewer) taxonomists who have expressed a need for it. The revision makes it usable for these purposes.

Decapod crustaceans of Newfoundland, Labrador and the Canadian eastern Arctic

ABSTRACT

About 33,000 specimens of decapod Crustacea comprising 60 species were examined from collections made by vessels of the Fisheries Research Board of Canada during 1946-60. Most specimens of these decapods were taken incidentally in otter trawl surveys for groundfish chiefly off Newfoundland and Labrador. A number were taken in a shrimp trawl survey of the Pandalus borealis populations off Newfoundland, and during a survey of the benthos of deep water in Davis Strait, Hudson Strait and Ungava Bay by the "A. T. Cameron". Also included are decapods from "Calanus" collections in the Queen Elizabeth Islands, Foxe Basin, Hudson Bay, Frobisher Bay and Ungava Bay. The distribution of these decapods is discussed with reference to (a) their occurrence in species complexes under prevailing physical conditions and (b) the biology of individual species. The latter includes details of their food, mandible structure, size, and breeding relationships.

For each species a field identification is given and a brief account of its taxonomy.

The principle of competitive exclusion is discussed for the Pandalus borealis and P. montagui communities in particular, in which the thermophilic form of P. montagui has been supressed. The reproductive potential of these populations is thought to be a critical factor in deciding the dominance of a species or in maintaining its high numbers. The possibility of depletion of some of the P. borealis populations under future exploitation is suggested because of low breeding rates under the influence of low temperatures. Reproductive potential of other species is discussed in relation to their adaptation to temperature conditions.

The section on Homarus americanus introduces a method for estimating the exploitation rates of its fished population by noting the proportion of first year recruits in measurements of the commercial catches when the approximate growth per moult is known.

An attempt to analyze the decapod communities in this area reduces them to five major types.

In the present revision 12 species and a drawing of a specimen for each species are added. Keys to families and species and an index of scientific names are also added.

RÉSUMÉ

La présente étude examine environ 33,000 spécimens de crustacés décapodes, appartenant à 60 espèces, recueillis entre 1946 et 1960 par des navires du Conseil de recherches sur les pêcheries du Canada. La plupart de ces spécimens de décapodes ont été capturés accidentellement au chalut à panneaux à l'occasion de relevés sur les poissons de fond, surtout au large de Terre-Neuve et du Labrador. Un certain nombre ont été capturés au chalut à crevettes dans le cadre d'un relevé sur les populations de Pandalus borealis mené au large de Terre-Neuve, et d'un échantillonnage du benthos des profondeurs du détroit de Davis, du détroit d'Hudson et de la baie d'Ungava par le A.T. CAMERON. Il y a aussi des décapodes provenant des collectes du Calanus autour des îles de la Reine-Élisabeth et dans le bassin Foxe, la baie d'Hudson, la baie de Frobisher et la baie d'Ungava. La distribution de ces décapodes est étudiée en fonction (a) de leur présence en complexes d'espèces compte tenu des conditions locales dominantes et (b) de la biologie de chaque espèce, notamment de leur alimentation, de la structure de leurs mandibules, de leur taille et de leurs relations de reproduction.

Une description pour l'identification et un sommaire de la taxonomie sont présentés pour chacune des espèces.

Le principe d'exclusion compétitive est examiné, en particulier chez les communautés de Pandalus borealis et de P. montagui, au sein desquellas la forme thermophile du P. montagui a été supprimée. On croit que le potentiel reproductif de ces populations joue un rôle critique dans la position de dominance d'une espèce ou dans son maintien d'effectifs élevés. Le risque d'épuisement des populations de P. borealis par l'exploitation à venir est soulevé, vu le faible taux de reproduction de cette espéce à basse température. Le potentiel reproductif d'autres espèdces est évalué en fonction de leur adaptation aux conditions de température.

La section sur Homarus americanus propose une méthode pour estimer les taux d'exploitation de la population pêchée en enregistrant la proportion de recrues des première année dans les prises commerciales, lorsque le taux de croissance approximatif par mue est connu.

Une tentative d'analyse des groupes de décapodes de cette région permet de les classer en cinq types majeurs.

Dans la présente version, on a ajouté 12 espèces et un dessin de spécimen de chaque espèce, des clés d'identification des familles et des espèces, ainsi qu'un répertoire des noms scientifiques.

CONTENTS

Abstract 2

Contents 3

Keys to Suborders and Families 8

I. Introduction 10
1. Area of investigation 10
2. Historical notes 11

II. Methods 12
1 Exploratory fishing gear 12
2. Hydrography 12
3. Biology of species 13
i. Sampling 13
ii. Measurements 13
iii. Sexing 14
iv. Maturity 14
v. Food 14
vi. Taxonomy 14

III. Localities where collections were made 14

IV. Hydrography 18
1. The Labrador Current 18
2. Atlantic water 19
3. Summer insolation and winter cooling 20
4. Ice 20

V. Review of species collected. 21

PENAEIDEA

Aristeidae

1. Gennadas elegans 23
2. Gennadas valens 25
3. Plesiopenaeus edwardsianus 26

Sergestidae

4. Sergestes arcticus 28
5. Sergia robusta 30

CARIDEA

Oplophoridae 31

6. Acanthephyra pelagica 32
7. Acanthephyra purpurea 34
8. Oplophorus spinosus 36
9. Systellaspis debilis 37

Nematocarcinidae

10. Nematocarcinus rotundus 38

Pasiphaeidae 39

11. Parapasiphaea sulcatifrons 40
12. Pasiphaea multidentata 41
13. Pasiphaea tarda 43

Bythocarididae 46

14. Bythocaris gracilis 47
15. Bythocaris payeri 48
16. Bythocaris spinipleura 49

Alopidae

17. Caridion gordoni 50

Thoridae 51

18. Eualus fabricii 53
19. Eualus gaimardi belcheri 56
20. Eualus gaimardi gaimardi 59
21. Eualus macilentus 62
22. Eualus pusiolus 64
23. Lebbeus groenlandicus 65
24. Lebbeus microceros 68
25. Lebbeus polaris 70
26. Spirontocaris lilljeborgi 73
27. Spirontocaris phippsi 75
28. Spirontocaris spinus 78

Pandalidae 81

29. Dichelopandalus leptocerus 82
30. Pandalus borealis 84
31. Pandalus montagui 92
32. Pandalus propinquus 96

Crangonidae 98

33. Argis dentata 99
34. Crangon septemspinosa 102
35. Metacrangon jacqueti agassizi 105
36. Pontophilus norvegicus 106
37. Sabinea hystrix 108
38. Sabinea sarsi 109
39. Sabinea septemcarinata 111
40. Sclerocrangon boreas 114
41. Sclerocrangon ferox 117

REPTANTIA 119

ASTACIDEA

Nephropidae

42. Homarus americanus 120

THALASSINIDEA

Axiidae

43. Calocaris templemani 126

PALINURA

Polychelidae

44. Polycheles granulatus 128
45. Stereomastis sculpta 129

Paguridae 130

46. Pagurus acadianus 131
47. Pagurus arcuatus 132
48. Pagurus pubescens 134

Lithodidae 137

49. Lithodes maja 138
50. Neolithodes grimaldi 140

Parapaguridae

51. Parapagurus pilosimanus 141

Galatheidae 142

52. Munida tenuimana 143
53. Munidopsis curvirostra 145

BRACHYURA

Cancridae 146

54. Cancer borealis 147
55. Cancer irroratus 148

Majidae 149

56. Chionoecetes opilio 150
57. Hyas araneus 153
58. Hyas coarctatus 155

Portunidae

59. Portunus sayi 158

Grapsidae

60. Planes minutus 159

VI. Discussion 160
1. Bias of the collections 160
2. Decapods representative of areas 160
i. Ungava Bay 160
ii. Foxe Basin 160
iii. Hudson Bay 161
iv. Frobisher Bay 161
v. Labrador 161
vi. North and NE coasts of Newfoundland 162
vii. East coast of Newfoundland 163
viii. Flemish Cap 163
ix. East coast of Avalon 164
x. NW and central Grand Bank 164
xi. NE, E and SE slopes of Grand Bank 164
xii. SW slope of Grand Bank 164
xiii. St. Pierre Bank 164
xiv. St. Mary's Bay 165
xv. Placentia Bay 165
xvi. Fortune Bay 166
xvii. Hermitage Bay 166
xviii. SW Newfoundland Channel 166
xix. Gulf of St. Lawrence 167

3. Decapod communities in the area 168

VII. Biology of species 172
1. Feeding 172
2. Relation of mandibles to feeding 172
3. Types of mandible 172
4. Hatching periods in decapods 173
5. Reproductive potential 175
6. Decapods in cod stomach contents 175

VIII. Acknowledgments 176

IX. References 177

X. Appendix I, Tables 188
Appendix II, Figures 195

XI. Index of scientific names 231

The following keys refer only to species mentioned and may not key out species from other areas.

Key to Suborders and Families (Modified from Squires, 1990)

1. Body usually compressed sideways; pereopods with the basis and ischium free, one fixed point in the carpo-propodal articulation 2

   Body usually flattened dorsoventrally (depressed); pleopods almost never natatory; anterior pereopod at least with the basis and ischium fused two fixed points in the carpo-propodal articulation ..... REPTANTIA

2. Third pereopods with chelae; pleura of 2nd abdominal somite not overlapping those of first and third; gills dendobranchiate ..... PENAEIDEA

   Third pereopods without chelae; pleura of 2nd abdominal somite over-lapping first and third; gills phyllobranchiate .... CARIDEA

Key to families of PENAEIDEA

Last two pairs of pereopods well developed; branchiae numerous .. .. Aristeidae

Last two pairs of pereopods reduced in length; not more than eight branchiae on each side ..... Sergestidae

Key to families of CARIDEA

1. First pair of pereopods chelate or simple 2

   First pair of pereopods subchelate ..... Crangonidae

2. Fingers of first pair of chelae slender and long; their cutting edges pectinate ..... Pasiphaeidae

   Cutting edges of chelae not pectinate 3

3. Carpus of second pair of pereopods not segmented; first pair with well-developed chelae; some with exopods 4

   Carpus of second pair of pereopods with two or more divisions; pereopods without exopods 5

4. Last three pairs of pereopods not conspicuously lengthened; carpus of each shorter than propodus ..... Oplophoridae

Last three pairs of pereopods enormously lengthened; carpus of these legs several times longer than propodus; ischio-meral joints of all legs larger than others ..... Nematocarcinidae

5. Chelae of first pair of pereopods distinct, heavier than second pair; 6

Chelae of first pair of pereopods microscopically small or indistinct; ..... Pandalidae

6. Carpus of 2nd pair of legs with 9 divisions ... Bythocarididae
Carpus of 2nd legs with less than 9 divisions 7

7. Carpus of 2nd legs with 7 divisions ..... Thoridae
Carpus of 2nd legs with 2 divisions ..... Alopidae

Key to families of the REPTANTIA

8. Sternite of last thoracic somite free or modified from others;

Telson symmetrical, without sutures ..... Axiidae
Telson and uropods symmetrical, with sutures .... Galatheidae

Telson asymmetrical or with sutures 9

Sternite of last thoracic segment not free from others 10

9. Uropods present; abdomen soft and with reduced pleura;

Two genital openings; male without sexual pleopods .....
..... Paguridae
One genital opening in female; male with sexual pleopods .....
..... Parapaguridae

No uropods; abdomen strongly calcified and pressed against sternum as in crabs; crab-like ..... Lithodidae

10. Abdomen large, symmetrical; uropods developed into a tail fan;

First three pairs of pereopods chelate ..... Nephropidae
First four pairs of pereopods chelate ..... Polychelidae

Abdomen small, dorsoventrally flattened, symmetrical and recurved to the sternum of enlarged cephalothorax; tail fan not developed; uropods rudimentary or none 11

11. Carapace narrowed in front with distinct divided rostrum .....
..... Majidae

Carapace wide in front, rostrum reduced or absent 12

12. Fifth pair of legs flattened, paddle-like dactyl .. Portunidae
Fifth pair of legs without a paddle-like dactyl 13

13. Front of carapace with 3 or more teeth, one median .. Cancridae
No median or frontal teeth; carapace quadrate ..... Grapsidae

INTRODUCTION

The decapod Crustacea of the northwest Atlantic, seven species of which reach their most northern limit in the Newfoundland-Labrador area, comprise a few species only of the Reptantia (brachyuran and anomuran crabs, the American lobster and three deep-sea mud lobsters) but a considerable number of the Natantia (shrimps). These decapods are quite varied in form and they occupy various habitats from the shallow sub-littoral to the deep continental slopes. For quite some time only the lobster, Homarus americanus, was exploited commercially. However, since the 1970s the northern shrimp, Pandalus borealis and the snow crab, Chionoecetes opilio have been yielding greater annual values than the lobster. The northern shrimp had been fished earlier in the Georges Bank area (Wigley, 1960), and could have been fished earlier in the Newfoundland area as a result of a shrimp survey in the early 1960s (Squires, 1961). Many of the shrimps and crabs form a significant part of the food of commercial fishes and lobsters in this area. Experimental fishing for the snow crab in the Gulf of St. Lawrence showed good prospects in the early 1960s (Brunel, 1962).

The purpose of the present study is (a) to give a brief account of the taxonomy of the decapod species for field identification (a more detailed treatment suitable for laboratory work is in Squires (1990), and a brief review including species off the Nova Scotian banks has been done by Pohle, 1988); (b) to show the general distribution of the species in the northwest Atlantic but especially in the area of investigation; (c) to show that decapod complexes occur regularly in this area according to temperature, depth, and submarine topography; (d) where numbers of specimens collected are adequate to show the adaptation of each species to the prevailing conditions, particularly with respect to reproductive potential, and (e) to show type of feeding and its relation to mandible structure in each species.

AREA OF INVESTIGATION. The area investigated and to be reported on in this acccount extends from Fury and Hecla Strait (Foxe Basin), Cape Dyer just north of the Arctic Circle on the Baffin Island east coast, and Hudson Bay south to the Grand Banks and the Gulf of St. Lawrence (Figs. 1 and 2). The Nova Scotian Banks were fished only occasionally by the Station vessels out of St. John's so are not included in this study. The deep water areas of the Gulf of St. Lawrence, the Southwest Newfoundland channels and Newfoundland bays

were surveyed in detail for shrimp (Squires 1961). Also during surveys for groundfish the vessels fished to 800 m on the continental slopes off Newfoundland and Labrador, but in Foxe Basin, Hudson Bay, Ungava Bay and Frobisher Bay explorations were done usually near shore and in comparatively shallow locations by the small research vessel "Calanus" and other small boats.

Since the decapod crustacean fauna of West Greenland is similar to that of the northern part of the area (Squires, 1957), records of distribution of each species as shown and reviewed by Hanson (1908) and Stephensen (1935) are included on distribution maps. Also records within the area from various authors are included, such as Rathbun (1913, 1919), Leim (1921), Frost and Thompson (1932), Van Winkle and Schmitt (1936), Squires (1957, 1961, 1962, 1966, 1967), and Prefontaine and Brunel (1962). Rathbun (1929) included areas somewhat further south as well as this area. South of the area is treated by Pohle (1988) and the extensive work of Williams (1984).

HISTORICAL NOTES. Sabine (1824) was the first to record species of decapod Crustacea from Davis Strait. They were from the collections of the First Parry Expedition in search of a Northwest Passage to the Pacific during 1819-1820. Only 5 species were recorded and two of these, new to science, were named Crangon septemcarinatus (= Sabinea septemcarinata) and Alphaeus polaris (= Lebbeus polaris). The 2nd and 3rd Parry Expeditions in 1822-24 collected 5 species near Igloolik in Foxe Basin (Ross 1826, 1835). Pfeffer (1886) identified two species collected by the German Arctic Expedition of 1882-83 from Cumberland Sound. These were Hippolyte groenlandicus (= Lebbeus groenlandicus) and H amazo (= L. polaris). Ohlin (1895) recorded Eualus fabricii from Cumberland Sound also. These and other collections of decapod crustaceans from Davis Strait and West Greenland were reviewed by Hansen (1908), Hofsten (1916) and Stephensen (1935). Hansen also recorded the decapods collected at stations of the "Ingolf" in 1900 and Stephensen those of the "Godthaab" Expedition in 1910.

Following Ross' collections of 1822-24, no decapod crustaceans were recorded from Foxe Basin until Captain Robert A. Bartlett's voyages of 1927 and 1933 when 12 species were collected (Van Winkle and Schmitt 1936). The Canadian Arctic Expedition of 1910, however, had collected decapods near the mouth of Hudson Bay and at Port Burwell, Ungava Bay, and in Hudson Bay (Rathbun 1919). Rathbun (1913, 1919) also identified specimens from other collections from Hudson Strait and the coast of Labrador. Squires (1957) on the Calanus Expeditions of 1947-50 in Ungava Bay reviewed the collections previously made in Ungava Bay, Hudson Strait and the coast of Labrador. Also Squires (1962) recorded the species of decapods collected by the Calanus Expeditions in Frobisher Bay, in Hudson Bay (1967), the Queen Elizabeth Islands (1968) and Beaufort Sea to Cambridge Bay (1969).

The deep-sea expeditions worked a few stations at depths less than 1,000 m on the continental slope off Newfoundland, namely, the "Hirondelle" and "Michael Sars" on the Grand Banks in 1877 and 1910 respectively. Milne-Edwards and Bouvier (1894) listed 4 species and Sivertsen and Holthuis (1956) 9 species taken by these respective expeditions.

The sealing steamers "Diana" and "Neptune" were on expeditions to Hudson Bay in 1897 and 1903-4 and their collections included decapod crustaceans reported on by Rathbun (1919). Further collections were made by the "Loubyrne" expedition in Hudson Bay in 1930 (Van Winkle and Schmitt 1936). Species collected were reviewed by Squires (1967).

Among the various collections of invertebrates made in the Gulf of St. Lawrence, off Newfoundland and Labrador, Whiteaves (1901) listed those which had also taken decapods in the years 1882-85. Rathbun (1929) on re-examining these collections revised the taxonomy and gave the range in distribution of 34 species of decapods found in the Canadian maritimes.

Other collections include 7 species of hippolytids taken in the Gulf of St. Lawrence (Leim 1921), and six species taken between Cabot Strait and Bay of Islands (Boone 1930). Twenty-one species collected in invertebrate and groundfish surveys off the Newfoundland coast and on the Grand Banks were reported by Frost and Thompson (1932), and 24 species taken in the St. Lawrence estuary by Prefontaine and Brunel (1962).

A short review of more recent collections of the Department of Fisheries and Oceans and others were made by Squires (1990). Decapod larvae collected in Ungava Bay were reported on by Squires (1993).

METHODS

EXPLORATORY FISHING GEAR. For collections of decapod crustaceans reported on by Squires (1965) the following fishing gear was used by the research vessels "Calanus", "Investigator II"(1946-60), "Marinus" (1953-60) and "A. T.Cameron" (1958-60). The "Calanus" used different types of dredges, beam trawls, and plankton nets. The chartered vessel for a shrimp survey at Newfoundland was the "Fortune Breeze" (1957, 1958) that used a Norwegian shrimp net only.

The "Investigator II" used an otter trawl with 60 ft (18.5 m) head-rope and 80 ft (24.5 m) foot-rope. The cod-end was lined with nylon netting mesh of 19 mm or covered with shrimp netting of 45 mm mesh. Shrimps were also taken in some areas without lining or cover when exploratory fishing for groundfish.

The "Marinus" used an otter trawl with a 50 ft (14.5 m) headrope and 70 ft (23.5 m) footrope. This net had a nylon lining with 13 mm mesh or a cover of shrimp netting with 32 mm mesh.

The "A. T. Cameron" used an otter trawl with 70 ft (24 m) headrope and 100 ft (30 m) footrope. Nylon netting used in the cod-end had meshes of 32 mm.

Trawl doors used on these ships were respectively 350, 220 and 700 kg each.

The "Calanus" used a beam trawl about 3 m wide, 5.6 m long and 0.6 m high at the mouth with a mesh of 13 mm in the cod end. Also a dredge 0.9 m wide, 23 cm high and with a bag 1 m long. Mesh 13 mm but with a cover of jute or #0 and #6 plankton netting. Peterson and Ekman grabs were also used and plankton nets of stramin (1 mm mesh) with 1 and 2 m openings.

The "Fortune Breeze" used a Kristiansands deep-sea shrimp net with a foot-rope of 33 m and cod end with 38 mm mesh. Trawl doors were 40 kg each. The sand shrimp, Crangon septemspinosus, was taken by hand-net, the lobster, Homarus americanus and crab, Cancer irroratus by lobster traps and the spider crabs, Hyas araneus and H. coarctatus from cod traps at Labrador and from groundfish trawls elsewhere.

HYDROGRAPHY. Temperature and salinity were recorded for most trawling stations including many of those made by the "Calanus". In addition bathythermograph casts were made at each exploratory station of the "Fortune Breeze" and other research vessels after 1957. Salinities and bathythermograms were processed by the Fisheries Research Board of Canada Biological Station at St. Andrews, New Brunswick, Canada.

METHODS USED IN BIOLOGY OF SPECIES

SAMPLING. Random sub-samples of catches were taken when the catch comprised a large quantity of a single species of shrimps; otherwise all specimens were preserved for later examination at the laboratory. Preservation was in about 7 o/o formalin in seawater. Lobsters and shore crabs were trapped until about 150 lobsters were taken. They were then examined fresh. About 20 o/o of the lobsters examined in 1961 and 1962 were tested for gaffkaemia.

MEASUREMENTS. Measurements were made with 12 cm or 25 cm vernier calipers, estimating to the nearest mm the carapace length (cl) from the posterior edge of the eye socket to the posterior mid-dorsal edge (between parallels). The total length when measured was from the tip of the rostrum to the end of the telson less setal fringe. In the drawings the scale used is a solid line equalling 10 mm.

SEXING. In each specimen the carapace was cut away from its junction with the thorax and lifted for examination of the gonads. In addition an external examination was made for the presence of a petasma on the 1st pleopods in male, or thelycum at the sterna of legs 3-5 in female penaeid shrimps. And for an appendix masculina on the second pleopods in caridean shrimps. Males were distinguished in other species by examination for modification of the 1st pleopod as a penial structure in lobsters, crabs and palinurans, or by the presence of male openings on the 5th pereopodal bases in male, or female openings on the 3rd pereopodal bases in female anomurans (hermit crabs).

MATURITY. Approximations of maturity were made by measuring the diameter of ova in the ovaries and of the vasa deferentia and classifying whether large or small. The presence of sperm was noted in shrimps and spermatophores in galatheids, palinurans, brachyurans, anomurans and lobsters. The greater diameter of oval-shaped eggs was measured in water in a petri dish on a millimeter grid.

FOOD. Specimens were sub-sampled usually for examination of stomach contents. Stomachs were dissected out and food fragments scraped into a small amount of water in a petri dish. Stomach walls and intestinal contents were also examined in those with empty stomachs. Examination was made by binocular microscope. Greenish material with some diatoms, filamentous algae or dinoflagellates was called phytobenthos. Animal fragments were classified in general terms relating to phyla, genera or species.

The left mandible of several specimens of each species was dissected out and figured and described.

TAXONOMY. Each species is described briefly for field identification. In addition key characters used in more detailed taxonomy are reviewed briefly to identify the species in the laboratory.

LOCALITIES WHERE COLLECTIONS WERE MADE

Place names used in the text are in Figures 1 and 2, and the summer and winter limits of ice cover in the years 1950-58 are shown in Figure 3. Winter surveys in the area were curtailed not only because of ice cover but because the vessels usually underwent a re-fit in the period of late December - February. Also weather conditions in these months often made work at sea untenable. In all other months, but chiefly from June - September, samples were obtained throughout the area. None were taken monthly from the same place according to plan, although such regular sampling may have occurred incidentally during the fishing season.

The region was divided into unit areas sometimes for convenience but usually because these areas have fairly uniform features of depth and temperature and appear to support uniform decapod species complexes. The geography of each unit area is referred to briefly with respect to depth, bottom configuration, temperature and current influences under a discussion of the decapod species complex to be found in each. However, a brief description of the whole region follows with notes on the extent to which each area was investigated by research vessels of the Fisheries Research Board of Canada in the years 1947-60.

Cape Dyer just north of the Arctic Circle on the east coast of Baffin Island was the most northerly point reached by the "A. T. Cameron" in August, 1959, approximating the summer limit of the ice field in west Davis Strait that year (Fig. 3). This is also near the northern slope of the deep submarine rise (Cape Walsingham-Holsteinsborg Ridge) separating Baffin Bay from the Labrador Sea. The lines of stations fished by the "Cameron" extended from a depth of about 700 m offshore through depths of approximately 600, 500, 400, 300, 200 and 100 m toward the coast of Baffin Island and Labrador (Fig. 36). The shallower areas above the 100 m contour were not explored. At the depths fished the continental slope was gradual or almost level to a considerable extent off Baffin Island, but further south off the coast of northern Labrador it was considerably steeper (Templeman 1961, Figure 2; Fig.6 in this paper). The shelf off Cumberland Sound was widest of all in the north, forming a continuation of the rise separating Baffin Bay and the Labrador Sea. Cumberland Sound was not included in these investigations because of ice cover in 1959. Frobisher Bay was explored by the "Calanus" Expeditions of 1951 (Dunbar 1960, Squires 1962). It has a trough on the south side and a shelf (The Calanus Shelf) on the north side near the mouth of the bay. The shelf was the area mainly explored by the "Calanus". The extensive shallow areas of Ungava Bay were explored in 1946-50 by the "Calanus" (Squires 1957) but the deep (200-300 m) channel entering the bay on its east side and leaving on the west side of Akpatok Island was not trawled. However, the outer portion of this channel, the shelf near Akpatok Island and the deep channel of Hudson Strait (200-400 m) were trawled by the "Cameron" in 1959. During the years 1953-58 decapods were taken in explorations by the "Calanus" north of Hudson Bay and in Foxe Basin, a comparatively large but shallow depression forming the northern extension of Hudson Strait west of Baffin Island (40,000 square miles in area; Campbell and Collin, 1958). In these explorations stations were usually relatively close to shore in Foxe Basin and among the islands at the mouth of Hudson Bay (Grainger and Dunbar 1956; Grainger and Hunter 1959). Nearshore areas of Hudson Bay were explored by the "Calanus" in 1953, 1954, and 1958-61 (Squires 1967).

Along the coast of Labrador the Labrador Shelf to a depth of 200 m extends in the north to a distance of about 100 miles from the coast, but is dissected by deep channels nearer the coast.

Further south the 200 m contour is only about 50 miles from the coast, except where the large Hamilton Inlet Bank extends for 100 miles from shore and forms an oval-shaped rise about 100 miles long in its north-south axis. The slopes to the Labrador Sea are relatively steep. These slopes were investigated for commercial quantities of redfish in 1947-54 (Templeman 1959). The shallow coastal areas of the shelf, interspersed with many islands and shallow inlets were not included in these surveys, although some coastal investigations were made by the "Calanus" at Nain in 1955, and by A.M. Fleming for shore cod at Nachvak Fjord, Nain and Domino in 1947. A collection of Hyas araneus was made at several fishing stations between Nain and Battle Harbour by A. W. May in 1959. The "Investigator II" made one survey trip into Lake Melville (Hamilton Inlet) in 1952, but the deep areas of this large inlet were not explored because of unfavourable weather at the time. Evidence of a kill of shrimps was seen at the shore near Northwest River in 1962.

Off the Newfoundland coast the Northeast Newfoundland Shelf extends to depths of 200 m at about 150 miles offshore. The 200 m contour outlines submarine extensions of the Northern, Burlington and Cape Freels peninsulas, and admits deep channels into White and Notre Dame Bays (the latter in particular into Halls and Green Bays). The shelf is further broken by the long Funk Island Deep where some exploratory fishing was done in 1947-54 by the "Investigator II". Exploratory fishing on the Funk Island Bank and along the outer edge of the Shelf reached distances of 250 miles from shore. The deep water channels of Halls Bay and Green Bay were explored by the "Fortune Breeze" in 1958 (Squires 1961).

The Northeast Newfoundland Shelf is separated from the shallow plateau of the Grand Banks and Flemish Cap by deep wide channels entering Bonavista and Trinity Bays. These channels were explored by the "Investigator II" in 1947-51 and included several hauls in Trinity Bay itself. Bonavista Bay and Trinity Bay were surveyed for shrimps by the "Fortune Breeze" in 1957 and 1958. A lot of the bottom areas of these bays was too rough for the shrimp trawl used. Unlike the former two bays Conception Bay is shallower and has a small deep trough. This was fished by the "Investigator II" in 1951 and by the "Fortune Breeze" in 1957.

The Grand Banks form an extensive marine plateau roughly triangular in shape with its greatest dimension from St. John's eastward to the Flemish Cap, a distance of about 350 miles. The shallowest part of the Bank, the Southeast Shoal, lies just over 200 miles south of St. John's and is about 100 miles long and 40 miles wide with a depth of less than 50 m. The southwest slopes of the Grand Bank, about 200 miles long, are generally the best fishing areas for groundfish. Westward two smaller banks the Green and St. Pierre Banks are separated from each other and the Grand Bank by comparatively shallow channels but are separated from the Nova

Scotian Banks by the deep Laurentian Channel. The channels on both sides of Green Bank are connected with the Avalon Channel east of the Avalon Peninsula, and through these channels a considerable portion of the volume of Arctic water flows southward (see also section on Hydrography). The Grand Banks and its slopes have been surveyed for groundfish more intensively than any other part of the area of investigation (Fig. 34) and have frequently shown the presence of shrimp (Pandalus borealis) at the deeper contours all around the Banks.

The deep Laurentian Channel (greatest depth about 500 m) between the Nova Scotian Banks and the Grand Banks extends long fingers into the Gulf of St. Lawrence. These form the Esquiman Channel to the north and near the Newfoundland Northern Peninsula, as well as the Mingan or Jacques Cartier and the St. Lawrence River channels to the west. A further extension of the Laurentian Channel, the Southwest Newfoundland Channel, is found along the south coast as far as Hermitage Bay, with a possible extension into Fortune Bay. These channels were explored extensively for commercial quantities of redfish (Sebastes marinus s. l.) in 1947-54 by the "Investigator II" and the "Marinus", and by the "Fortune Breeze" for shrimps in 1957 and 1958.

In Newfoundland, bays of the northeast coast and the fjordlike bays of the southwest coast west of Fortune Bay have deep channels communicating with the deep open sea. No bays in these areas have sills such as are found at the mouths of many Norwegian fjords, but some of them have a well-defined trough. This is a deep depression greater than 200 m which is cut off from Atlantic water by a relatively shallow area often of considerable extent. The most notable of these troughs is the one in Placentia Bay. Most of the bays mentioned were surveyed for redfish in 1947-54 and for shrimps in 1957 and 1958.

In the Gulf of St. Lawrence, Port au Port Bay was chosen as a study area for lobster (Homarus americanus) in 1961. It is a very shallow bay with its greatest depth of 50 m in one relatively small trough in the eastern portion. The rest of the bay is from 5 to 20 m deep. It is about 100 square miles (260 km^2) in area and about twice as long as wide but becoming slightly narrowed at the mouth. There is little appreciable effect from the current system outside the bay, although we obtained evidence that the prevailing current sets inward on the east side of the bay and outward on the west side. We used coloured wooden drogues which were released at various sites in the bay and watched over several days. There is, however, a tendency for strong winds to override the usual pattern of circulation.

The lobster grounds are well-defined by trap distribution during the fishery and occupy little more than half the surface area of the bay. The bay supported a lobster fishery of about 200,000

lbs. (90,000 kg.) annually at the time of this study. A very shallow extension of the western part of the bay has sand and silt flats with eelgrass (Zostera) beds. Specimens of Crangon septemspinosa and Cancer irroratus were collected there during 1961 and 1962.

HYDROGRAPHY

The following is a brief account of the hydrography of the areas where decapods were collected in groundfish and other surveys. It is based partly on the review of Hachey (1951) and data collected at the FRB Biological Station at St. John's between 1948 and 1961, approximately.

The coastal areas of the northwest Atlantic are greatly affected by the Labrador Current. The variability of its flow from year to year and the presence of compensating currents of Atlantic water, including incursions of eddies from the Gulf Stream Drift, as well as various modifications of inshore waters through summer insolation and winter cooling, make for a very complex picture of sea temperatures throughout the area. A map showing the general trend of the currents of the northwest Atlantic is given by Lucas and Lee (1963).

THE LABRADOR CURRENT. The great volume of arctic water pouring outward from the Arctic Ocean through Smith, Jones and Lancaster Sounds and Hudson Strait is directed against the east coasts of Baffin Island, Labrador and Newfoundland presumably by Corioli's force. Because of its relatively low density, this homogenous mass of cold water is at first a surface current, but the forces which push it against the coast cause it to occupy the bottom and shallow inshore areas during its southward flow. When its volume is great it is possible for it to occupy much of the fishing grounds around Labrador and Newfoundland. Its temperatures are characteristically below zero degrees C. and may reach an extreme of -1.4 degrees C. according to records.

The shape of this current varies as follows: off Labrador it is deepest near the coast and becomes attenuate offshore (Fig. 6). In the northerly bays of Newfoundland it tends to build up as a total mass of cold water except where it is overlain by an insolated layer in the bays. As it moves southward around capes such as Cape Bonavista, it has a structure similar to that off Labrador (Fig.6). The seaward portion of this arctic current may overlie but does not

descend to the bottom on the continental slope, except near the coast, and it in its turn, especially in summer, is overlain by a warm layer due to summer insolation. Figures and discussion illustrating this is in Templeman's reports on Canadian research in Annual Proceedings of the International Commission for North Atlantic Fisheries, 1951-61. In the way described above two thermoclines often occur: the upper one usually the more shallow and stable, and the lower one showing considerable evidence of mixing or temperature transfer, so that relatively low temperatures may persist from off Baffin Island to the northern part of the Grand Bank (Figs. 4 and 6) for most months of the year.

The flow of arctic water over the Grand Bank produces conditions that vary seasonally from year to year. The landward portion, after traversing Trinity Bay as an intermediate layer of cold water and filling the trough in Conception Bay, flows southward in the Avalon Channel. Usually the attenuate and seaward portion of the current divides on meeting the northern edge of the Bank. Some of the current volume is added to the flow in the Avalon Channel and the rest may spread over the Bank. Sometimes it forms an intermediate but shallow cold water layer over the Bank and sometimes it forms a cold bottom layer, while a thicker branch may form along the edge of the the eastern slope of the Bank, held against the bottom by Corioli's force. There is no evidence of the water cascading over the edge of the Grand Bank into deep water. However, a process called "cabelling" is said to occur. This is described as a mixing of arctic water with incursions of Gulf Stream Drift water and, because of the greater densities of the resulting water masses, they sink (Hachey 1961). After flowing through the Avalon Channel further division of the current is less clear. The trough in Placentia Bay is almost always full of water of very low temperature (about -1 degree C.). However, the presence of arctic water becomes less evident in its progress along the southwest coast, and the last effects of its course are shown in the trough in Fortune Bay. Water movement is continued nevertheless as the current sweeps into the Gulf of St. Lawrence, north along the eastern shore of the Gulf and out through the Strait of Belle Isle. This surface current is not thought to contribute to the "intermediate (low temperature) water" of the Gulf which is said to be caused by periodic inflows of arctic water through the Strait of Belle Isle near the Labrador coast and/or as a result of winter cooling (Hachey 1961).

ATLANTIC WATER. The characteristic two thermoclines of the Gulf of St. Lawrence in summer are due to insolation forming a warm surface layer and intrusion of Atlantic water along the bottom of the Laurentian Channel and its branches. Bottom water in this channel and its extensions is approximately 5 degrees C. throughout the year (Hachey 1961). Atlantic water also enters the deep Southwest-Newfoundland Channel and penetrates as far eastward as Hermitage Bay and the inner portion of Fortune Bay. Temperatures in this channel are about 6 degrees C. throughout the year, somewhat higher than those in the bottom layer of the Gulf of St. Lawrence.

Although the Grand Banks may have a layer of arctic water at some time during the year, the presence of Atlantic water is often evident, particularly on the southwest slopes of the Bank where temperatures at least as high as 8 degrees C. may be reached. This Atlantic water influence is usually least in spring when the flow of arctic water is greatest, but in late summer or autumn the Banks may be covered with water of moderate temperatures. The eastern slopes of the Grand Bank are most frequently found to have low temperatures to considerable depths but rarely below the 200 m contour. Eastward to the Flemish Cap, however, arctic water is no longer in evidence and here the bottom temperatures are always moderate at 3 to 5 degrees C.

Off the coasts of Labrador and Baffin Island the bottom water isotherms are nearer to the coast than might be imagined (Fig. 4). The 0 degree C. bottom isotherm is usually a relatively short distance from the coast and it is followed by 1 to 4 degree isotherms. Temperatures taken in 1959 show that Atlantic water enters Hudson Strait at least as far as off Akpatok Island in Ungava Bay.

SUMMER INSOLATION AND WINTER COOLING IN COASTAL AREAS. In shallow areas particularly in sheltered bays or arms of the sea, the surface layers quickly warm up under the influence of the sun and onshore winds, and temperatures up to 19 degrees C. are common. Except in the shallowest bays this results in a very stable thermocline, and the deep layers remain unaffected. Offshore winds tend to push the warm surface layers out of the bays and, even in summer, therefore, rapid cooling of inshore water may occur especially if the water is deep. On the other hand winter cooling of surface water to sub-zero temperatures in the bays of Newfoundland and Labrador results in the elimination of shallow thermoclines and a build-up of cold bottom layers, which remain unchanged throughout the summer if depths are too great or the area enclosed and out of the influence of currents. Generally the inshore shallow waters may be subject to considerable fluctuations of temperature in summer depending upon the wind, weather and tidal exchanges.

ICE. Usually ice begins to form in Northern Newfoundland bays and along the coast of Labrador in early January. By February "pack" ice, largely originating in Baffin Bay and the coasts of Greenland and Baffin Island, has moved south off the coast of Labrador, and is augmented by "fast" ice formed at the shore and reaching a distance of about 30 miles (48 km) seaward. The floes move rapidly southward expanding to distances of 60-200 miles (97-320 km) from shore until the Grand Banks are reached in March. The maximum extension southward is reached in April (Fig. 3) and shortly thereafter the pack begins to break up and recede. In almost any year the northern bays of Newfoundland including White, Notre Dame and Bonavista bays, are filled with ice, often frozen fast for periods of 1-4 months. Mobile pack ice may be present for longer periods depending upon the duration of onshore winds, and may reach Trinity

or Conception Bays in some years. Offshore winds in spring if continuous for at least a fortnight will carry the pack far enough eastward to reach Atlantic water where it disintegrates in a short time. Even the icebergs, sometimes part of the floes, but occasionally alone, break up and are quicly melted on contact with Atlantic water over the southerly edges of the Grand Banks.

Ice reaches St. Mary's and Placentia bays only for a short period in spring if there are persistent southeast winds when the pack ice reaches the central Grand Bank. The icefield only rarely reaches the southwest coast from Fortune Bay to Ramea so that the Southwest-Newfoundland Channel is almost always free of ice cover. Also very little ice forms along the shore at the southwest coast even in the most severe winter weather.

Ice from the Gulf of St. Lawrence may be present over part of the Laurentian Channel and in Cabot Strait in February-April, but the prevailing surface currents carry it south over the Nova Scotian Banks where it rapidly disintegrates. In the Gulf the ice floes may reach a considerable extent in some years, but they tend to be mobile even at maximum formation, and may be carried out of sight of land with persistent offshore winds. The bays and inlets of the west coast of Newfoundland, however, are frozen over from February-April almost every year.

During the period 1950-58 the ice field was at its maximum in 1957 when it reached as far south as the southern Grand Bank in April, but its minimum was in 1958 when it reached only as far south as Bonavista Bay (Fig. 3).

REVIEW OF THE DECAPOD SPECIES COLLECTED

The list of authors for each species is not meant to be exhaustive but only to indicate the author or authors who provide an adequate description or a key to identify the particular species. Short descriptions are given and comprise a few outstanding features or key characters in the external morphology of each species. A drawing of a whole specimen of each species is given from Squires (1990).

The world distribution of species is outlined, and its local distribution is related to observed optima and ranges of depth and temperature (Figs. 8 and 9). Maps of distribution in the northwest Atlantic are from Squires (1990) and are inset with the drawings.

Data from subsamples are used as far as possible to estimate the averages and ranges of carapace length (here referred to as length or cl), and to estimate the age, maturity and frequency of breeding of individual decapods in populations of each species from different

parts of the area. Associated decapod species, parasites, commensals or predators are given where possible. Food contents of stomachs examined are noted, and the left mandible of each species is described. In this section "ova" refers to the ova in the ovaries and "eggs" to extruded ova on the pleopods. The greater diameter of the egg is given. Size at first maturity in males and females is estimated from sizes of vasa deferentaia or ova measured from inside the carapace.

Infraorder PENAEIDEA

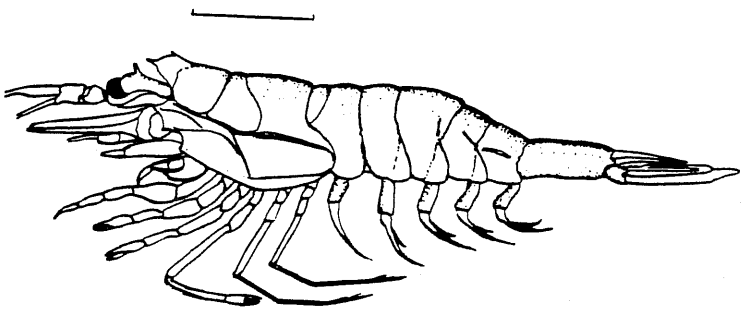
These shrimps have the first three legs chelate. Pleura of second abdominal somite do not overlap those of the first and third.

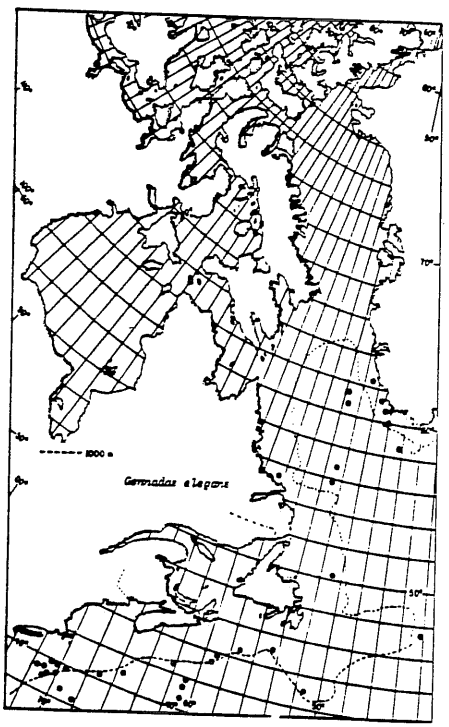
Family ARISTEIDAE Wood-Mason, 1891

Male has a petasma on the first pleopod, female a thelycum on the posterior thoracic sterna; second pleopods of male with appendices interna and masculina; body laterally compressed; first somite of abdomen not shortened.

Gennadas elegans (Smith, 1882)

Sund, 1920; Burkenroad, 1936; Squires, 1990.





A small reddish shrimp with third legs chelate. Rostrum short with sharp point, rostral crest above orbit with one spine only directed forward. Pronounced cervical and post-cervical and lateral grooves. Thelycum oval, without a median division. Merus of 3rd leg equal to or longer than the carpus. Each eye has an inner projection on the peduncle. The 4th and 5th legs are as long as the others but they are slender.

Sund (1920) says that this species is the commonest deep-sea shrimp in the Atlantic at depths over 400 m. It is not found north of the Faroe-

Iceland ridge or the northern Labrador Sea but in Greenland and many parts of the Atlantic and the Mediterranean as far as the Sea of Marmara and Egypt. Western Atlantic from Davis Strait to Cape Hatteras. Depths 400-3000 m. (Zariquiey Alvarez 1968).

Locally specimens were taken off the Northeast-Newfoundland Shelf from 695 m and south of Green Bank from 475-550 m. Temperatures 3.5 degrees C.

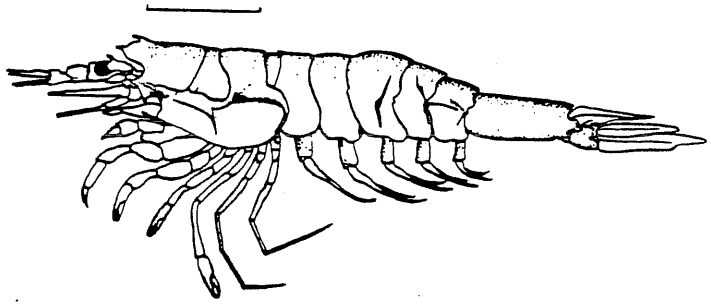
Acanthephyra pelagica and Pandalus borealis (Fig. 7) were present in the same hauls. Stomach contents were mostly amorphous, probably phytoplankton, but many partly digested fish scales and crustacean fragments were also present.

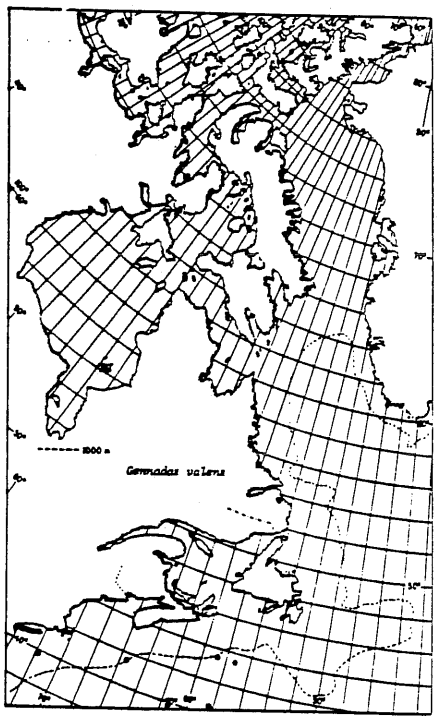
The mandible has molar and incisor processes which are confluent. The incisor has two teeth with cutting edges at the outer or anterior end. The molar a long triangular ridge with 2 pointed cusps at the base of the inner edge. Palp in two sections, large and flattened, the inner edge double and fringed by plumose setae (Fig. 10).

Average cl males 10 mm and females 11 mm.

Gennadas valens (Smith, 1884)

Burkenroad 1936; Squires 1990.





A small reddish shrimp resembling G. elegans but with merus of 3rd leg shorter than carpus. Rostrum is short, a sharp point at front of thin crest over the orbit with one forward pointing spine at the highest point; lateral ridge turned downward at posterior edge more than in G. elegans. Thelycum almost circular with median division.

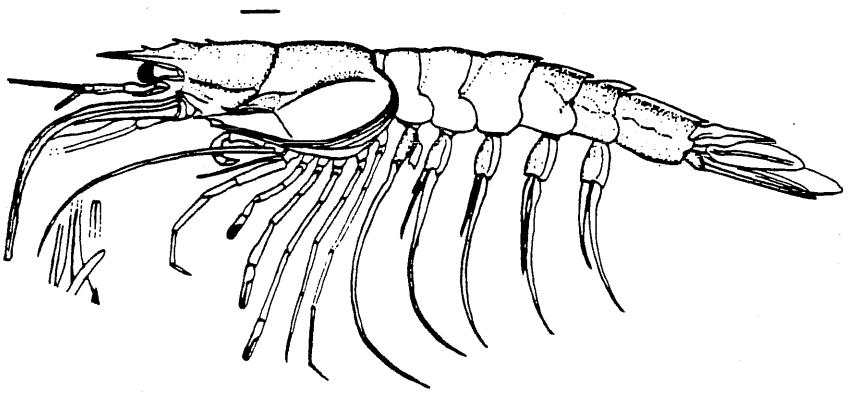
Distribution from Gulf of Mexico to 49 degrees north in the west Atlantic, and from South Africa, 35 degrees south, the Azores and Sargasso Sea to the British Isles, 51 degrees north, in the east Atlantic, and in the Mediterranean near Gibraltar. Depths 300-2,000 m (Zariquiey Alvarez 1968).

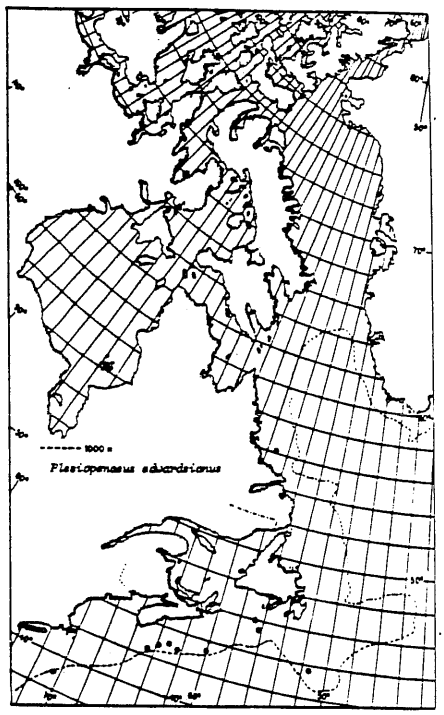
Locally from south of the Laurentian Channel.

Lengths to 9 mm cl in males and 11 mm cl in females.

Plesiopenaeus edwardsianus (Johnson, 1867)

Milne-Edwards and Bouvier, 1909;
Crosnier et Forest 1973;
Zariquiey Alvarez 1968;
Squires 1990.





A very large shrimp, intense brilliant crimson in colour with heavy fringe of gold coloured setae. Rostrum with attenuate point and three equidistant dorsal teeth, middle one over the orbit. Well-marked cervical groove and a few lateral carinae and grooves. Antennal scale with greatly extended narrow tip in males. Abdomen carinate, each carina produced as a posterior spine on 3rd to 6th somites. Telson short tapered to a sharp point and without dorsal spines.

Distribution in the west Atlantic from south of Labrador to the Gulf of Mexico, West Indies and Surinam. In the east Atlantic from Portugal to off South Africa. Indo-Pacific from east coast of Africa to Andaman Sea. Burkenroad (1936) states that this species is "in considerable abundance in the North Atlantic and a form identified with it, although apparently not by direct comparison, in the Indian Ocean".

Specimens were collected from the southwest slope of the Grand Bank in depths ranging from 365-730 m and temperatures of 4 to 8 degrees C. (Inset map).

Species also in the trawl were Sergestes arcticus and Pasiphaea tarda.

Food in stomachs was shrimp, euphausid, chaetognath and polychaete fragments.

As in other penaeid mandibles, molar and incisor are confluent. Incisor with three teeth, largest in centre, smallest at outer or anterior end, and other low obtuse between centre and molar. All have sharp cutting edges and are joined to the molar by a short blade. Molar triangular has 6 cusps, two on inner edge sharp and pointed. Large palp covered with long robust and plumose setae (Fig. 10).

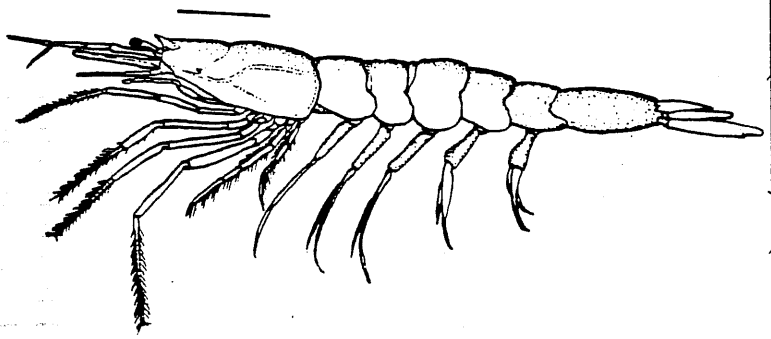
Two males 54 and 55 mm cl, 194 and 197 mm tl. Two females 39 and 74 mm cl the latter 195 mm tl.

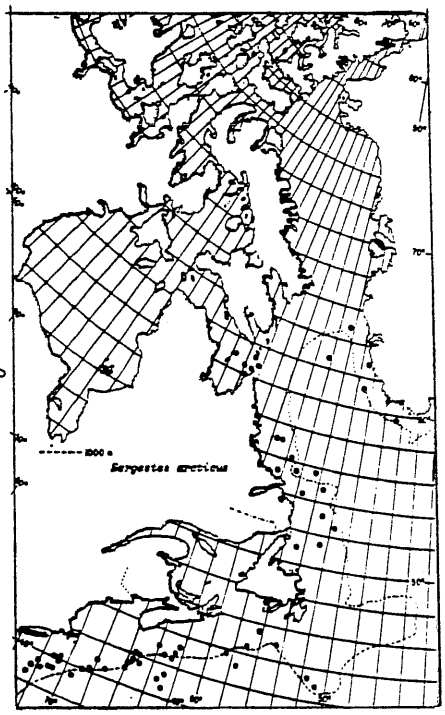
SERGESTIDAE Dana,1852

Penaeid shrimps with first legs without chelae; 4th and 5th legs much smaller than others; pereopods and maxillipeds without exopods; rostrum short.

Sergestes arcticus Kroyer, 1855

Yaldwin 1957; Zariquiey Alvarez 1968; Squires 1990.





This slender shrimp resembles a euphausid. When fresh it is whitish with intense red in gastric area. Eyestalks long. First three legs much longer than others and microscopically chelate in latter two. Terminal segments of legs annulated. Dendrobranchiate gills completely covered by carapace (not soin euphausids). Supraorbital and hepatic spines present. Telson terminally rounded.

Stephensen (1935) gave the North Atlantic distribution of this species to include many areas reaching as far north as the Faroe-Iceland ridge and about 70 degrees north off west Greenland and off Norway. Elsewhere it is found south to the western half of the Mediterranean in Europe and to the Strait of Magellan and off South Africa in the South Atlantic; also in the Indo-Pacific including off New Zealand. Depths 250-4500 m. (Squires 1990).

Collected at depths of 220-290 m in Hermitage Bay and on the Northeast Newfoundland Shelf; at 560-770 m on the southwest slopes of the Grand Bank. In temperatures of 2.1 to 8.0 degrees C. evidently restricted to warm Atlantic water (Inset map). From stomachs of cod near Port Burwell suggests incursions of Atlantic water into Ungava Bay.

Other pelagic species taken in the trawl with S. arcticus were Pasiphaea tarda and P. multidentata (Fig. 7). Large numbers of the euphausid, Meganyctiphanes norvegica, were frequently present. One exceptional sample of 700 S. arcticus had only 30 specimens of M. norvegica. Both species probably compete for food and space in Hermitage Bay and possibly other areas.

Food remains in stomachs of both species were calanoid copepods and chaetognaths.

The mandible has a molar with flat grinding surface and shearing cusp at the end. It is joined to the incisor which is curved, even, with one tooth at the centre. Palp with distal about one-quarter the length of the proximal part.

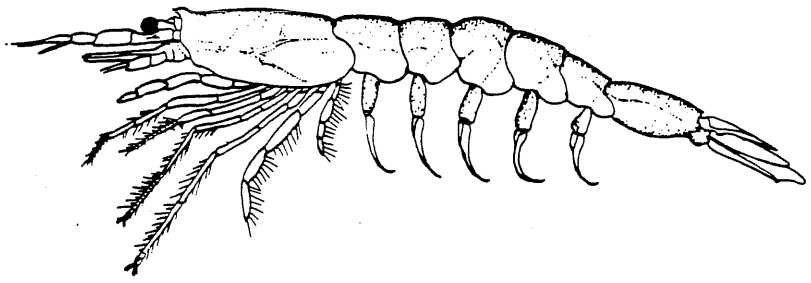
Average lengths 15 mm in males and 18 mm in females from Hermitage Bay. Sizes from Hermitage Bay, possibly in optimum temperatures and depths, were significantly larger than those from further north. North of Newfoundland and in Ungava Bay males averaged 12 and 11 mm, and females 14 and 12 mm cl, respectively. Temperatures and depths where trawling was done in these areas were probably not within the optimal range (Table 1). In Hermitage Bay males were mature at 11 mm cl but females were all immature in autumn.

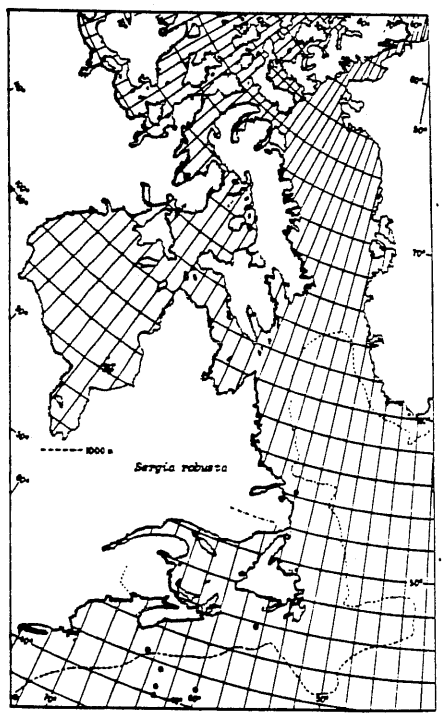
Table 1. Lengths of Sergestes arcticus collected from Newfoundland, Labrador and Ungava Bay during 1947-60.

Localities	Hermitage Bay	North of Newfoundland	Ungava Bay
Depth m	200-770	175-410	15-37
Temperature C	3.5 to 5.5	0.1 to 4.4	...
Average cl mm	M 15	12	11
	F 18	14	13
Range of cl mm	M 12-19	11-14	9-15
	F 13-20	10-17	9-16
Numbers examined	M 103	9	71
	F 104	40	81

Sergia robusta (Smith, 1882)

Crosnier and Forest 1973; Foxton 1970; Squires 1990.





This species has no supraorbital or hepatic spines but otherwise resembles Sergestes arcticus. The antennular peduncles are stout, body robust. Rostrum short, with prolonged point. Fourth and 5th legs shorter than the first three but compressed, moderately wide. Telson ending in a sharp point.

Distribution in the West Atlantic from Labrador to the West Indies and the Gulf of Mexico; in the eastern Atlantic from the Faroes to off Angola, and in the Mediterranean as far as the Aegean. Depths 0-5000 m (Crosnier and Forest 1973).

Locally taken off Hamilton Inlet and south of the Burin Peninsula (Inset map).

Lengths to 9 mm cl in males (specimens examined) and 94 mm tl in females (Crosnier and Forest 1973).

Infraorder C A R I D E A

Caridean shrimps have only the first two legs chelate. Also the pleura of the second abdominal somite overlap those of the first and third somites.

Family: OPLOPHORIDAE Dana, 1952

Reddish deep-water shrimps with exopods on all pereopods.

Key to Species (from Squires 1990)

1. Exopods of pereopods slender and flexible 2

   Exopods of first pereopod and 3rd maxilliped wide and rigid; antennal spines armed with series of spines; telson ending in sharp point ..... Oplophorus spinosus

2. Last four abdominal somites carinate 3

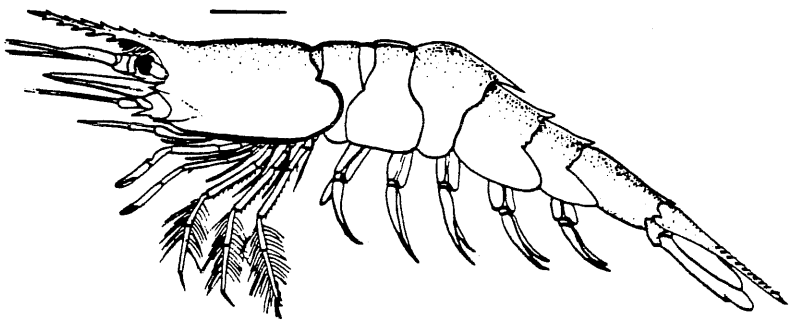
   Sixth abdominal somite not carinate; rostrum longer than carapace, forming a crest of spines above orbit ... Systellaspis debilis

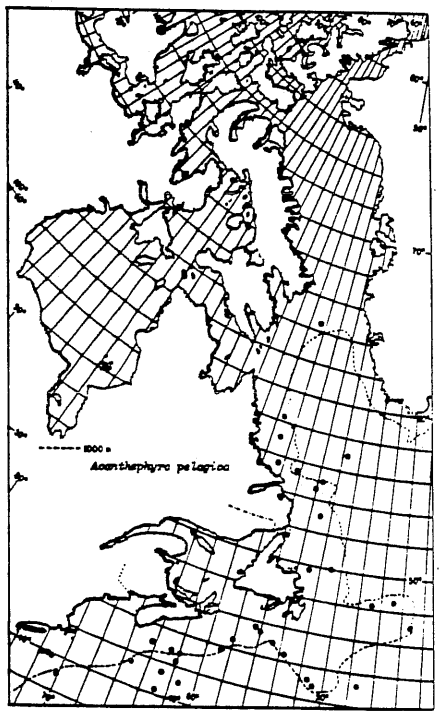
3. About 10 pairs of dorsolateral spines on telson .... Acanthephyra pelagica

   About four pairs of dorsolateral spines on telson .... Acanthephyra purpurea

Acanthephyra pelagica (Risso, 1816)

Chace 1986; Sivertsen and Holthuis, 1956; Rathbun 1929 as A. purpurea; Squires 1990.





Red deep-sea pelagic shrimps; rostrum about as long as carapace, teeth about 8/5; mid-dorsal carina reaches about two-thirds length of carapace; a short carina from branchiostegal spine; all abdominal somites except first with dorsal carina, extended as a spine over the 3rd to 6th somites; 8-11 pairs of spines on telson.

From the North Atlantic as far north as Davis Strait and Iceland and south to about 13 degrees S. Lat. including the Mediterranean. In Indian and Pacific oceans as far as 32 degrees and 57 degrees S. Lat., respectively. Depths about 500 - 1650 m and temperatures 3-12 degrees C. (Sivertsen and Holthuis 1956).

It occurred in catches from the eastern edge of the Grand Bank, off the Northeast Newfoundland Shelf and northward to the east coast of Baffin Island. Depths ranged from 640-700 m and temperatures of about 4 degrees C. The "Michael Sars" Expedition took some specimens southeast of Newfoundland at Stations 66, 67 and 70 in depths of 600-840 m (Sivertsen and Holthuis 1956) (Inset map).

Gennadas elegans and Pandalus borealis occurred in the same hauls with this species (Fig. 7).

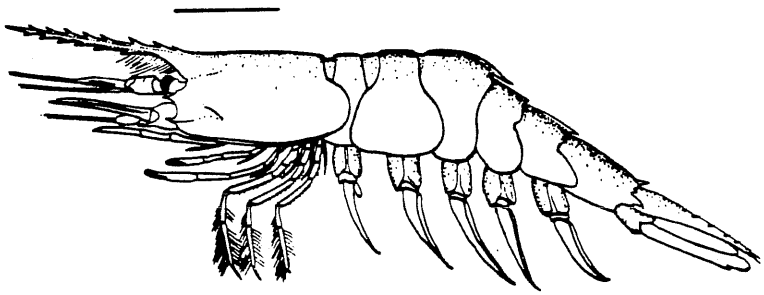
Crustacean and chaetognath fragments were common in stomach contents; eupahausids, copepods, fragments of small fish were occasionally present, and sponge spicules more rarely (Table 45).

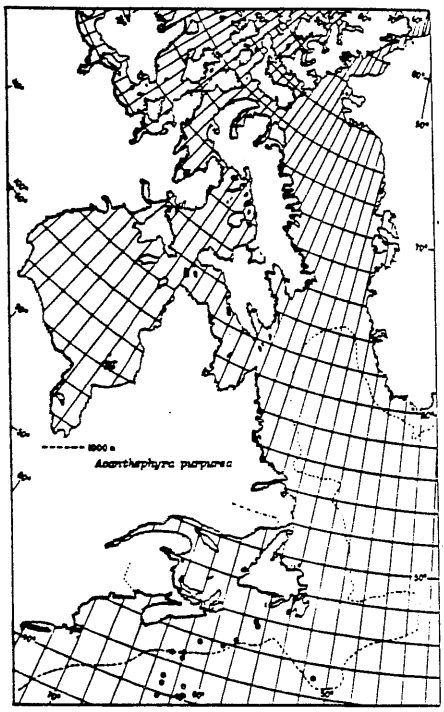
Mandible with incisor a short blade-like portion continuous with a recurved serrated edge bearing 10 teeth. Molar with inner edge and small teeth along outer half, at corner of incisor; palp of three segments, middle longest (Fig. 11).

Average length of males 21 mm (range 16-24 mm) and females 21 mm (range 15-31 mm). Ovigerous female with eyed embryos in eggs taken in May. Small ova in ovary. Other females were non-ovigerous in May but had large maturing ova, also those in August, September. However, 80 percent were ovigerous in October suggesting that there is one spawning in the population annually.

Acanthephyra purpurea A. Milne-Edwards, 1881

Chace 1940; Sivertsen and Holthuis 1956; Squires 1990.





This species is smaller than A. pelagica. Four pairs of dorsolateral spines on the telson. A small or no tooth at the posterior median carina of the 4th somite, extended as a spine over the 2nd, 3rd, 5th and 6th somites. Rostrum proportionately long, teeth about 8/6. Scale of antenna longer than carapace. Colour brilliant scarlet red (Chace 1940).

Distribution in the North Atlantic only as far north as 53 degrees N. Lat. and south to 20 degrees N., and not in the Mediterranean. Depths 100-1500 m. and temperatures 4 to 18 degrees C. (Sivertsen and Holthuis 1956).

Some specimens examined from south of the Grand Banks near the Gulf Stream Drift were ovigerous in February. Chace (1940) noted that the smallest ovigerous females were only 10 mm cl in collections near Bermuda.

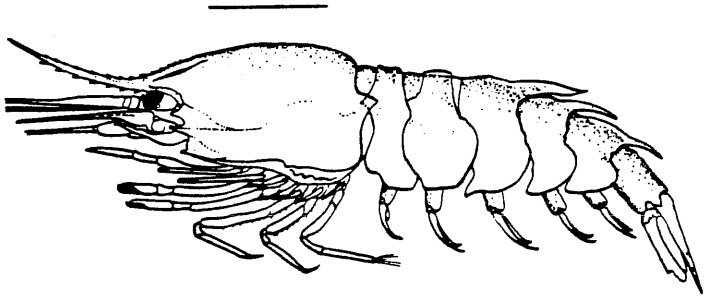
Stomach contents were crustaceans (copepods to larger shrimp-like forms), pteropods, polychaetes, radiolarians and fragments of blackish fish (probably lanternfish) (Chace 1940).

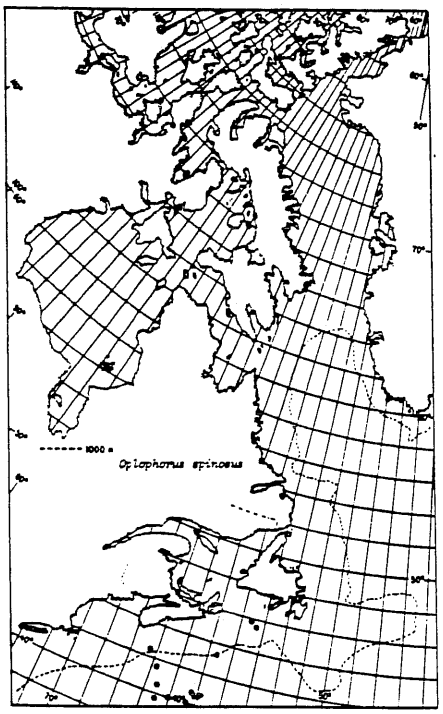
Sizes to 23 mm cl in males and females combined (Sivertsen and Holthuis 1956); males to 19 mm cl in specimens examined by Chace (1940).

Gennadas elegans, *Sergestes arcticus* and *Oplophorus spinosus* occurred commonly in catches with this species.

Oplophorus spinosus (Brulle, 1839)

Sivertsen and Holthuis 1956;
Squires 1990.





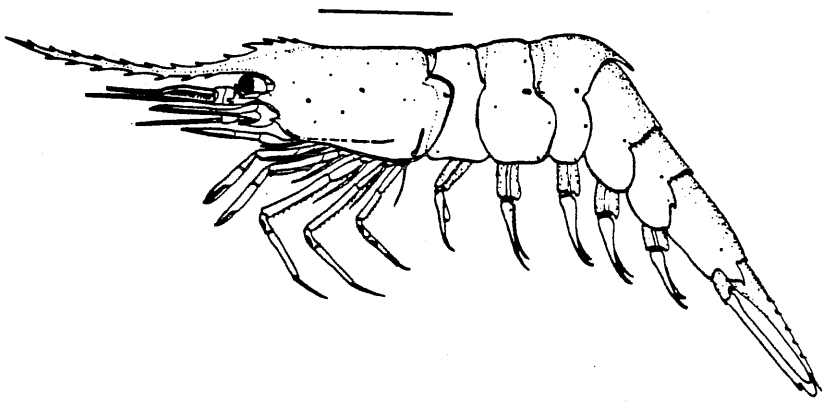
A small shrimp, whitish translucent with reddish spots. Antennal scale rigid with sharp barbed tip and about 14 strong spines along outer edge. Rostrum long, curved upward, with as many small spines dorsally as ventrally. Abdominal somite 1st rounded, 2nd with two dorsal carinae, and 3rd to 5th each with a strong dorsal carina produced as a spine posteriorly. Third maxilliped and 1st pereopod with wide flat rigid exopod.

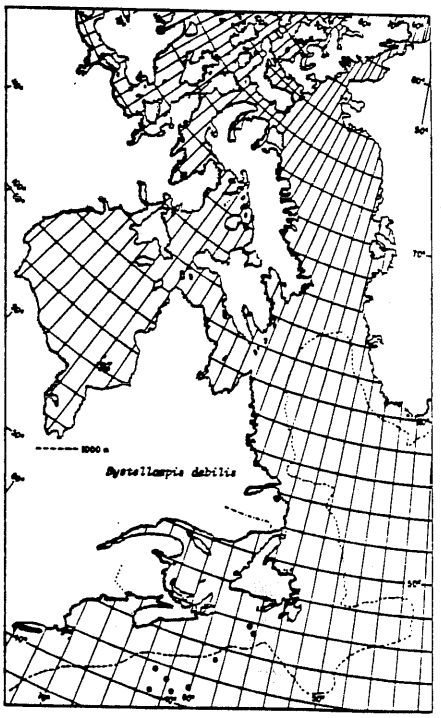
Distribution in western North Atlantic 46 degrees N. Lat. near the Gulf Stream (55 degrees W. Long.). Western and eastern subtropical North Atlantic, central South Atlantic, Indian Ocean, southern Japan, off Hawaii, Pacific seamounts west of North America and northeast of Easter Island (Chace 1986). Depths 0-1800 m (Sivertsen and Holthuis 1956). Records near this area are in inset map.

Sizes to 17 mm cl in males and to 14 mm cl in females (Sivertsen and Holthuis 1956).

Systellaspis debilis (A. Milne-Edwards, 1881)

Chace 1986; Squires 1990.





Moderately slender shrimp scarlet in colour with appendages tinged with salmon-orange and the many light organs bluish. Rostrum long and narrow with strong teeth above and below and forming a crest of 4 teeth over the orbit. Abdomen compressed, sharply carinate dorsally on 3rd somite with sharp spine posteriorly over the 4th; mid-dorsal spines on 4th to 6th also. A series of denticles on each side posteriorly at 4th and 5th somites dorsally. Also pleura of 5th has a notch with posterior spine. Telson with long sharp tail-piece with lateral spines.

Distribution in western Atlantic from just south of Greenland to the Gulf of Mexico and the Bahamas; eastern Atlantic from Faroe Islands to off Angola and South Africa. Also Indian Ocean to Indonesia, Pacific at Philipines and Hawaii. Mesopelagic between 650 and 800 m during the day and 150 m at night (Chace 1986). Recorded depths 25-3000 m (Sivertsen and Holthuis 1956). Records near this area are shown in inset map.

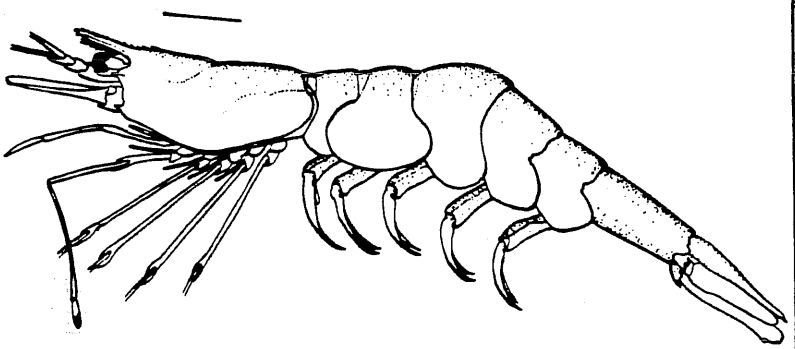
Largest males and females about 14 mm cl; females ovigerous at 11 mm cl. Eggs about 2X4 mm, fecundity about 50. Monthly sampling near Bermuda showed that more than 50 % of the females were ovigerous at any time but that only 6 % of these had eyed embryos (Chace 1940).

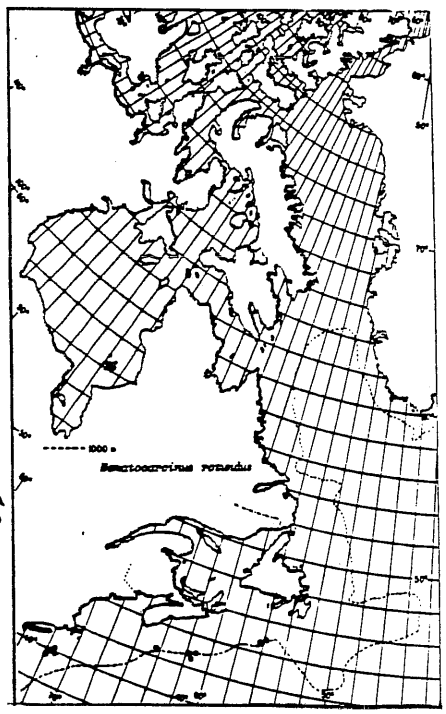
Family NEMATOCARCINIDAE Smith, 1884

Legs 3rd to 5th extremely long and slender (most likely to be broken away during capture). Joint between the ischium and merus is swollen, larger than other leg joints.

Nematocarcinus rotundus Crosnier et Forest, 1973

Crosnier et Forest 1973;
Squires 1990.





Third to 5th legs extremely long and slender, carpus several times longer than propodus, ischio-meral joint conspicuously larger than others; these legs are likely to be broken off but with the expanded joints remaining. First two legs slender the first shorter than second. Short rostrum slightly ascending, small spines close together except at tip, about 4 on rostral carina behind orbit. About 4 small dorsolateral spines on telson on distal half.

Distribution West Indies and Gulf of Mexico and east coast of the United States as far as 40 degrees N. Lat. Depths 700-1570 m. (Crosnier et Forest 1973). Also to the Nova Scotian Banks and southwest Grand Banks (Squires 1990). Local records are in inset map.

Lengths to 19 mm cl in males and 27 mm cl in females (Crosnier et Forest 1973). Specimen examined from southwest Grand Banks was a female 24 mm cl, ovigerous in May, eggs 0.8 mm in diameter, small ova in ovary.

Also present in haul were Polycheles granulatus and Stereomastis sculpta.

Family PASIPHAEIDAE Dana, 1852

First two pairs of legs larger than others with largechelaethat are pectinate or comb-like at cutting edge.

Key to Species

Rostrum a short spinous projection of the front edge of the carapace; mandible with a palp; carapace without a branchiostegal spine ..... Parapasiphaea sulcatifrons

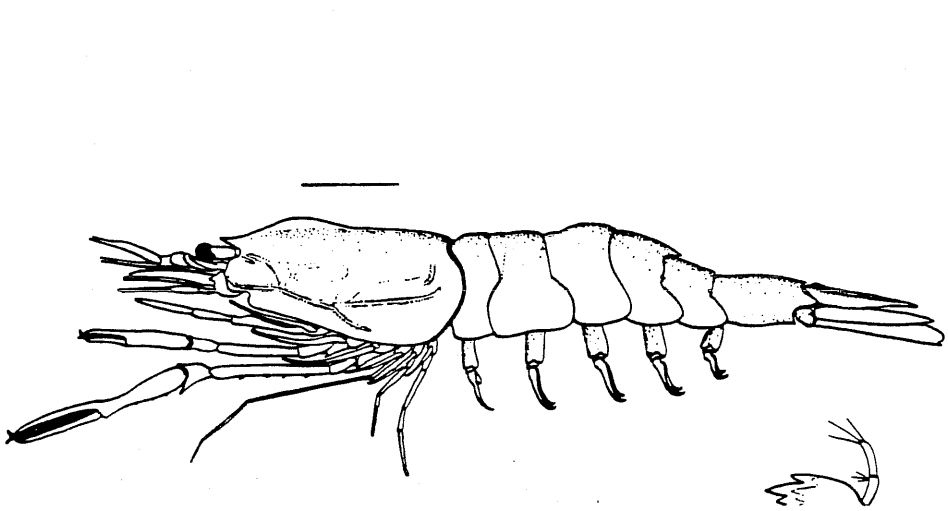
Rostrum a short post-frontal spine; mandible without a palp; carapace with a branchiostegal spine ..... Pasiphaea

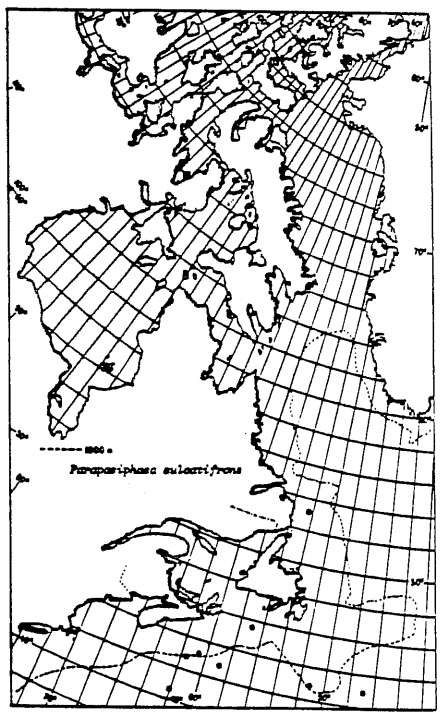
Slender almost translucent shrimps; 7-12 spines on distal lower edge of basis of 2nd legs ..... Pasiphaea multidentata

Large heavy reddish shrimps; 1-5 spines on distal lower edge of basis of 2nd legs ..... Pasiphaea tarda

Parapasiphaea sulcatifrons Smith, 1884

Chace 1940; Crosnier et Forest 1973;
Butler 1980; Squires 1990.





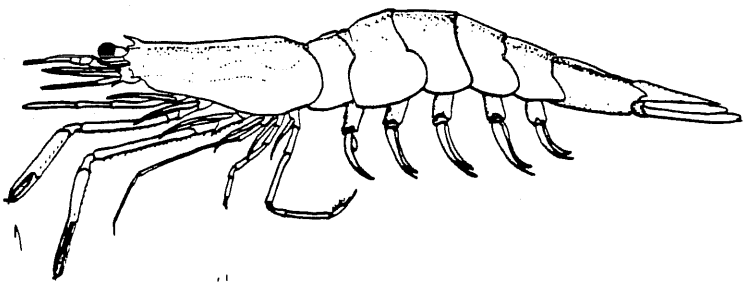
Rostrum a short sharp projection of the front of the carapace; mid-dorsal carina rising high on the front half of the carapace with a groovein it from the tip of the rostrum to just ahead of the highest point; first two legs longer and stouter than the others, both with long chelae and fingers which are pectinate on the cutting edge; abdomen with short posterior spine on carina of 4th somite; telson subtruncate at narrow tip with 4 pairs of small dorsolateral spines.

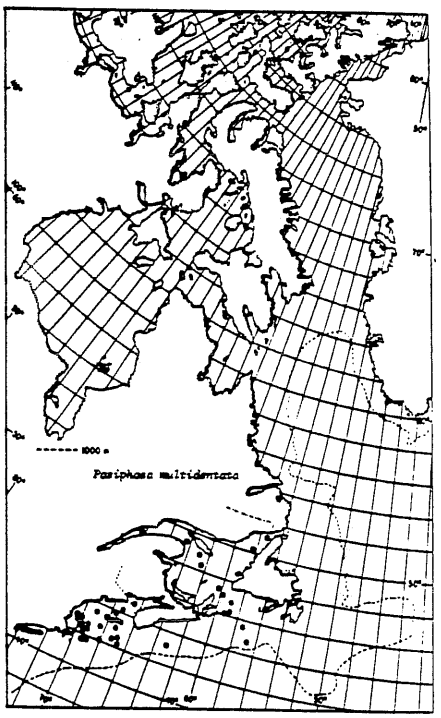
Distribution from Greeenland and Iceland to Bermuda and Gulf of Mexico in western Atlantic, and from Ireland to off Angola in Eastern Atlantic (Crosnier et Forest 1973). Also in Pacific from Queen Charlotte Islands and coast of British Columbia (Butler 1980) to off west coast of the United States (Pearcy and Fors 1966). Depths 500 - 5340 m (Smith 1884; Sivertsen and Holthuis 1956). Our records are in inset map.

Lengths to 23 mm cl in males and 26 mm cl in females. Smallest ovigerous females 22 mm cl, ovigerous in April and from June to September. Smallest number of juveniles in April to June, largest number in July and August (Chace 1940). Eggs 3.1 X 4.6 mm, about 15-20 carried (Crosnier et Forest 1973).

Pasiphaea multidentata Esmark, 1866

Rathbun 1929; Sivertsen and Holthuis 1956; Appolonio 1969; Williams 1984; Squires 1990.





"Pink glass shrimp" -- "Sivade rose".
Pinkish translucent shrimps. Rostrum represented by a post-frontal short thin spine; carapace and abdomen with sharp mid-dorsal carina; first two legs large with long chelae, cutting edges long and pectinate (comb-like); 7-12 spines on lower edge of basis of 2nd legs; telson deeply forked.

Distribution in western Atlantic from west Greenland and north of Hudson Strait to Cape Cod. Eastern Atlantic from Norway to the Mediterranean as far as the Adriatic. Depths 10 - 2000 m (Sivertsen and Holthuis 1956). Hermitage Bay (200 m) and Cabot Strait (315 m) and the Gulf of St. Lawrence are in our records (Inset map).

The pealgic shrimps P. tarda and Sergestes arcticus were also present in catches from Hermitage Bay as well as semi-demersal species Pandalus borealis and Spirontocaris lilljeborgi.

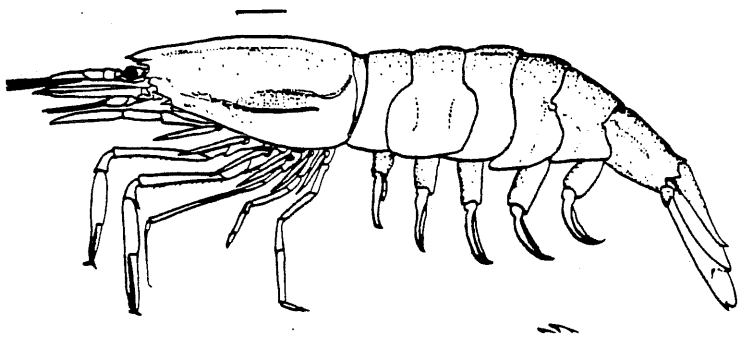
Males and females were similar in size and are compared with P. tarda in Table 2. In Hermitage Bay most females above 25 mm cl were ovigerous in December and probably spawn annually. In the Gulf of Maine at temperatures of 4.5 to 5.5 degrees C. Apollonio (1969) concluded that two clutches of eggs were produced annually, the second clutch of 40 -90

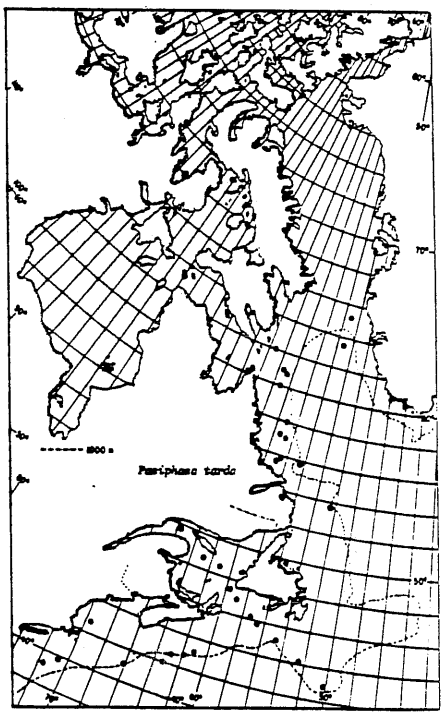
eggs and the first 60 - 120 eggs. Egg diameters were 2.2 to 2.4 mm. Males had small or medium vasa deferentia in December. A male 27 mm cl had full vas deferens in November.

Stomachs were mostly empty but crustacean fragments, probably euphausids, were found in one. Euphausids and copepods were found by Apollonio in samples from the Gulf of Maine (Apollonio 1969). Mandibles are similar to those of P. tarda (Fig. 11) but have 6 teeth following the 3rd or most posterior large tooth instead of 7 as in P. tarda. In addition the 4th tooth is almost secondary to the 3rd and slightly separated from the decreasing series.

Pasiphaea tarda Kroyer, 1845

Sund 1912; Sivertsen and Holthuis 1956; Butler 1980; Squires 1990.





Large crimson robust shrimps somewhat translucent at smaller sizes. Rostrum is only a thin post-frontal projection followed by a sharp mid-dorsal carina on carapace and abdomen. First two legs are large with long fingers pectinate on cutting edges. One to six but mostly 3 spines on lower edge of basis of 2nd legs.

Distribution in the western Atlantic from Greenland and Hudson Strait to South Carolina. In the eastern Atlantic from Jan Mayan to Angola (Crosnier et Forest 1973). Also in the Pacific from Unalaska to Oregon and off Ecuador (Faxon 1895 and Butler 1980). Depths 200-2400 m (Sivertsen and Holthuis 1956). In our records from Hermitage Bay, southwest of Grand Banks, Cabot Strait, Northeast Newfoundland Shelf, off Labrador, Hudson Strait and southeast of Baffin Island. Temperatures 1-6 degreess C.

Off Labrador 14% had rostral area infested by Ellobiopsidae; 10% on Grand Banks. Other species in hauls were Sergestes arcticus, P. multidentata, Pandalus borealis and Spirontocaris lilljeborgi, the latter two especially from Hermitage Bay (Fig. 7).

Off Newfoundland maximum tl was 59 mm compared with 30 mm for P. multidentata. Average cl for males 16 mm and females 29 mm. Off Labrador and in Ungava Bay males were larger 41 and 38 mm cl, respectively, while females were 30 and 31 mm average cl. (Table 2). Average lengths appeared to increase with depth (Fig. 13).

Eggs 3.2 mm. In May 50% of females were ovigerous, one with eyed embryos suggesting spring hatching. In the northern females 40% had large ova in ovaries in August and September. Two also had eyed embryos and large ova in ovaries (Table3) suggesting that eggs would be laid after hatching and that eggs would be carried over the winter.

Stomach contents were euphausids, chaetognaths, shrimp fragments and a beak of a small squid. Mandible an incisor with large sagittate teeth (Fig. 11).

Table 2. Lengths of Pasiphaea tarda and P. multidentata from localities in the area of investigation, 1946-60.

Localities		Newfoundland	Newfoundland and Labrador	Ungava Bay	P. multidentata (Newfoundland)
Depth m		200-640	330-770	15-79	200-380
Temperature C.		1.0 to 5.4	1.0 to 5.6	...	4.5 to 5.5
Average cl mm	M	16	41	38	23
	F	29	31	33	23
Range of cl mm	M	14-17	31-45	30-44	16-30
	F	14-59	16-43	18-42	13-30
Numbers examined	M	3	11	4	40
	F	20	22	10	48

N.B. Some from Ungava Bay were from cod stomachs.

Table 3. Maturity of *Pasiphaea tarda* collected from July to September off Labrador.

cl mm	Males		Females		
			Non-ovigerous	Ovigerous	
	Small vd	Large vd	Small ova	Large ova	large ova
14-16			2		
17-19			3		
20-22			4		
23-25			0		
26-28			1		
29-31		1	1		
32-34	3	0	1		
35-37	0	0	1		
38-40	0	1	3	2	1
41-43	3	1	3	0	0
44-46	1	2	0	1	0
47-55			1		1
Totals	7	5	20	3	2
Mature	7	5	7	3	2
% potentially breeding annually	42			42	

Family BYTHOCARIDIDAE Christoffersen, 1987

Carpus of 2nd legs has nine divisions. No mandibular palp.

Key to Species

1. Pleura of 2nd - 5th abdominal somites ventrolaterally spiniform ..... *Bythocaris spinipleura*

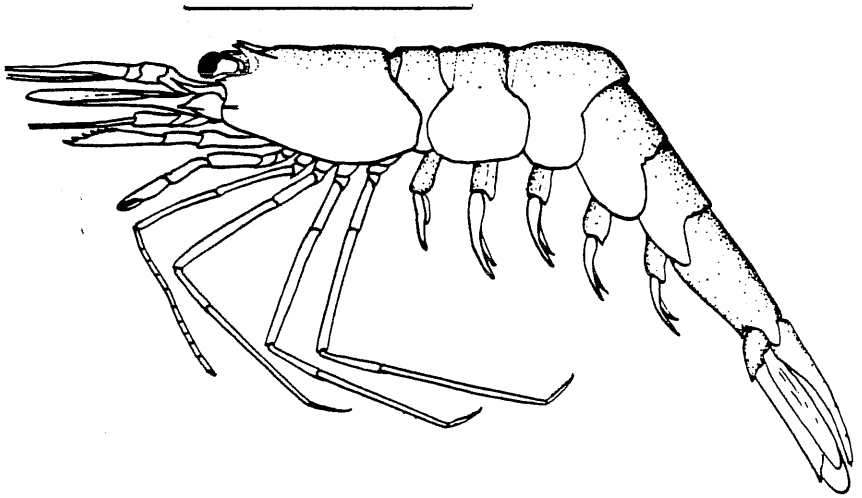
   Pleura of 2nd - 5th abdominal somites not spiniform 2

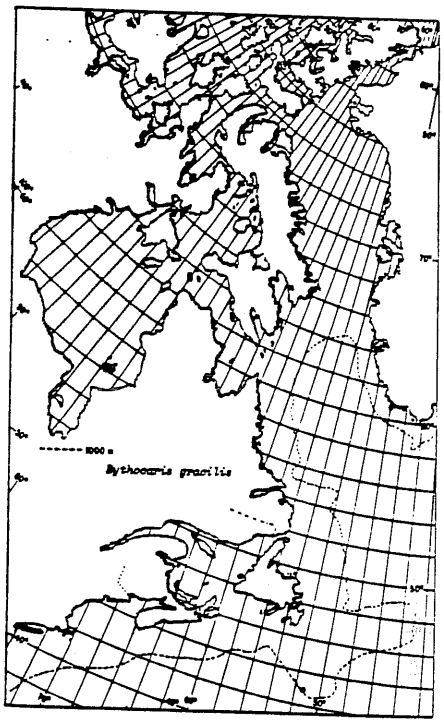
2. Peduncle of antenna less than one-half scale .. *Bythocaris payeri*

   Peduncle of antenna more than one-half scale ..... *Bythocaris gracilis*

Bythocaris gracilis Smith, 1885

Sivertsen and Holthuis 1956;
Squires 1990.





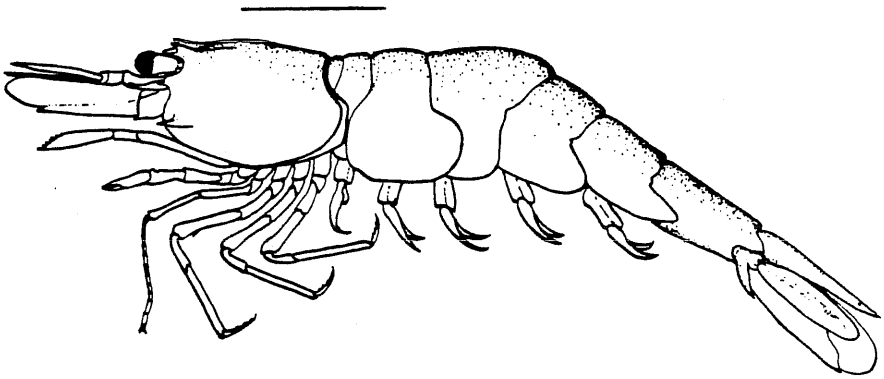
Small deep-sea shrimps. Carpus of 2nd legs have 9 segments. Rostrum very short, supraorbital spine on each side of base of rostrum; faint median carina about half carapace; mandible without palp or incisor. Peduncle of antenna more than one-half scale.

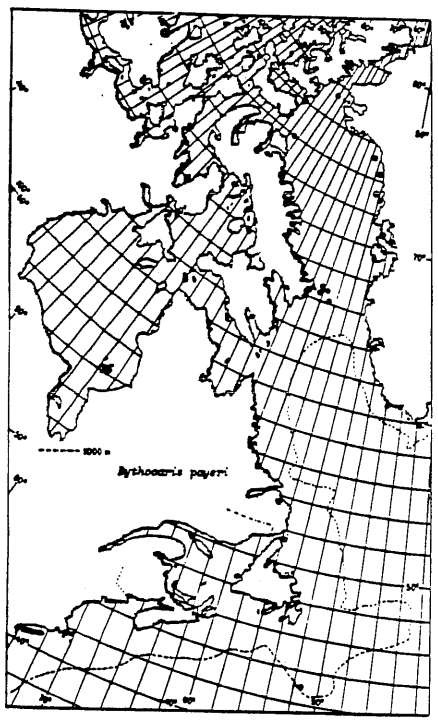
Distribution west Greenland to east coast of the United States at about 35 degrees N. Latitude in western Atlantic. Eastern Atlantic from southwest of Ireland. Depths 550-1900 m (Sivertsen and Holthuis 1956). Our records are in inset map.

To 8 mm cl. Female 7 mm cl and male 5 mm cl in specimens examined.

Bythocaris payeri (Heller, 1975)

Sivertsen and Holthuis 1956;
Bowman and Manning 1972;
Squires 1990.





Similar to B. gracilis but the antennal scale is wider and the peduncle of the antenna is less than one-half scale. It has rounded pleura. Carpus of 2nd leg has 9 segments; supraorbital spines are almost the same length as short pointed rostrum.

Distribution is from the Arctic Ocean and from Cape Dyer in Davis Strait to the Grand Banks in western Atlantic. In the eastern Atlantic from the Kara Sea and Iceland to the Faroes and Shetland Islands (Sivertsen and Holthuis 1956). Depths 180 - 1000 m. Temperatures -1.1 to 1.2 degrees C. Our records are from off Cape Dyer, Baffin Island, and on the Grand Banks (Inset map).

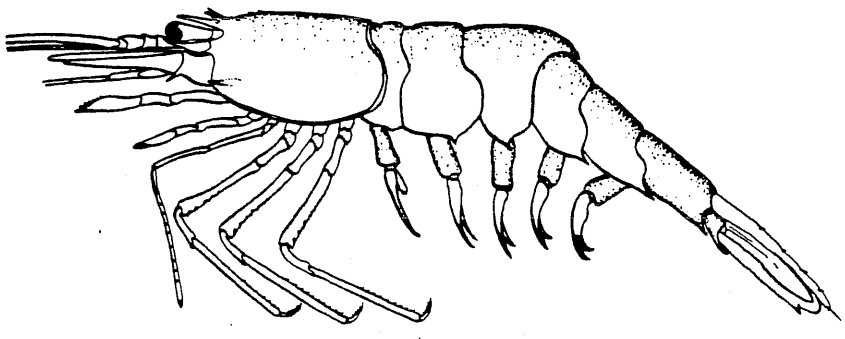
Ranges in cl 5-7 mm in males and 7-11 mm in females. All females taken in August were ovigerous, one with large ova in the ovaries also. Eggs 2.2 mm diameter, almost all with eyed embryos.

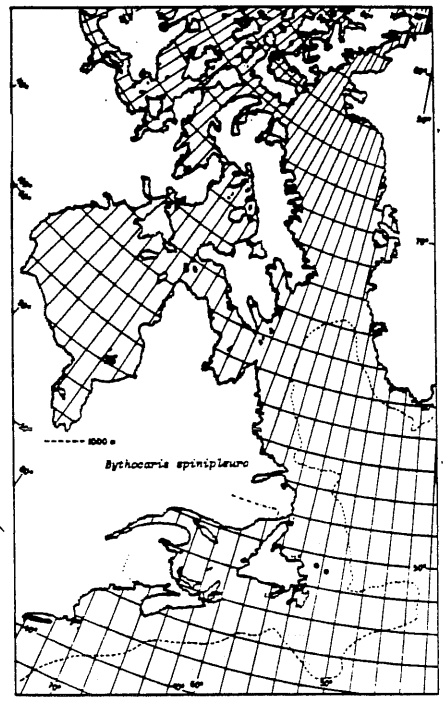
Stomach contents were crustacean remains and sponge spicules.

Mandible without incisor or palp. Molar with hollow crown; outer edge with close setal fringe, inner with cutting edge and two small cusps (Fig. 30).

Bythocaris spinipleura Squires, 1990

Squires 1990.





This species has a rostrum longer than in the previoustwo; supraorbital spines small. Carapace with short anterior median ridge with two small spines. Pleura of abdominal somites 2 - 5 with ventrolateral spinous process; telson truncate and with two long spines each with two small lateral spines and dorsolaterally four pairs of spines.

Distribution from off Bonavista Bay, Newfoundland. From stomachs of cod (Gadus morhua) in 1981 and 1986.

The two specimens examined were adult males 4.5 and 5.0 mm cl.

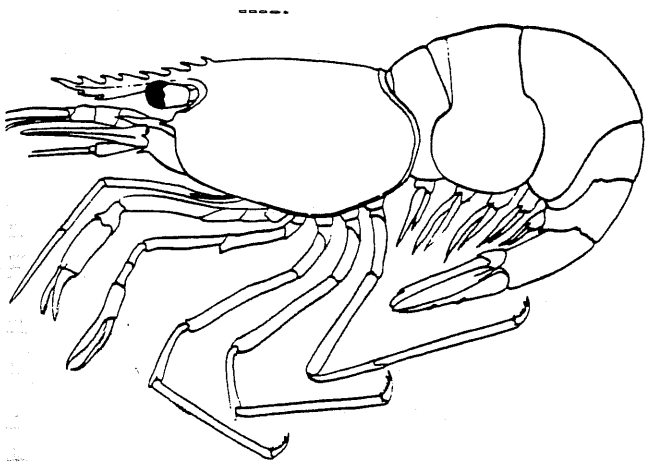
Mandible with molar only, cutting edge even with small cusps at corner.

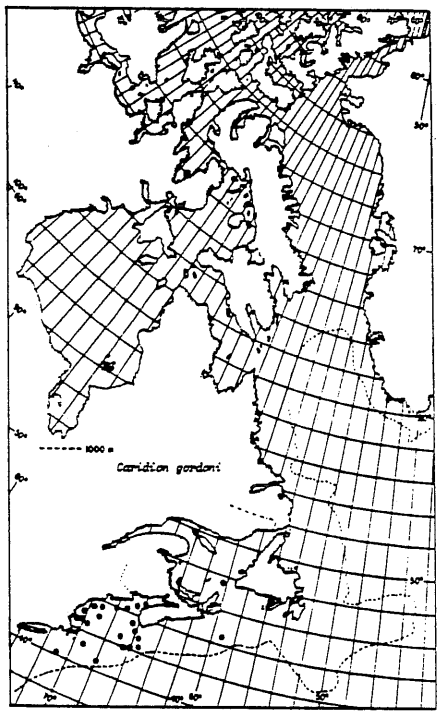
Family ALOPIDAE Christoffersen, 1987

Carpus of 2nd legs with two divisions only. Mandibular palp with three segments.

Caridion gordoni (Bate, 1858)

Allen 1967; Smaldon 1979; Squires 1990.





Small reddish translucent shrimps. Carpus of 2nd leg has 2 segments. No supraorbital spine; mandible with incisor and palp with 3 segments. Rostrum about three-quarters the length of the carapace with 6-10 dorsal teeth and 1 or 2 ventral teeth. Only an antennal spine anteriorly on carapace.

Southwestern Newfoundland to Chesapeake Bay in the western Atlantic. Eastern Atlantic from northern Europe (Rathbun 1929 and Frost 1936). Common in Clyde Sea area in muddy sand and gravel (Allen 1967); depths 10-300 m (Smaldon 1979). Our records are from the Gulf of St. Lawrence and Fortune Bay (Inset map).

From 19 to 27 mm total length (Rathbun 1929). Specimen examined 4 mm cl female. Allen (1967) refers to ovigerous females in March to Mayand October, and post-larval stages in July in the Clyde Sea. Mandible with incisor and molar and palp with three segments. Incisor thin with 4 or 5 teeth; molar with hollow crown and sharp even cutting edge and pointed cusp at each end.

Family THORIDAE Christoffersen, 1987

Carpus of 2nd leg with seven divisions; mandibular palp with two segments.

Key to Species (Adapted from Squires 1990)

1. Carapace with one or no supraorbital spine at each side 3
   Carapace with two supraorbital spines at each side Spirontocaris

   Median dorsal teeth not reaching posterior half of carapace and similar in size; one supraorbital spine smaller than the other ..... Spirontocaris phippsi

   Median dorsal teeth reaching at least posterior two-thirds of carapace and markedly different in size; supraorbital spines equal 2

2. Median dorsal teeth reaching almost the posterior margin of carapace; tergum of 3rd abdominal somite produced as a spine over 4th; apex of rostrum with 2 spinous tips ..... Spirontocaris spinus

   Median dorsal teeth reaching about two-thirds length of carapace; apex of rostrum a single long point ... Spirontocaris lilljeborgi

3. Carapace with no supraorbital spines ..... Eualus .. 4
   Carapace with one supraorbital spine at each side Lebbeus .. 7

4. Rostrum with no dorsal spines ..... Eualus fabricii
   Rostrum with dorsal spines 5

5. Rostrum longer than carapace ..... Eualus gaimardi

   Rounded lobe on 3rd abdominal somite in most but occasionally with weak hook; colour uniform ..... Eualus gaimardi gaimardi
   Lobe on 3rd abdominal somite with strong hook; abdomen striped ..... Eualus gaimardi belcheri

   Rostrum shorter than carapace 6

6. Rostrum thin and translucent with thin crest of many small teeth dorsally and rounded ventrally with one or two teeth ... .Eualus macilentus

   Rostrum thick at base, short, with few dorsal teeth ....Eualus pusiolus

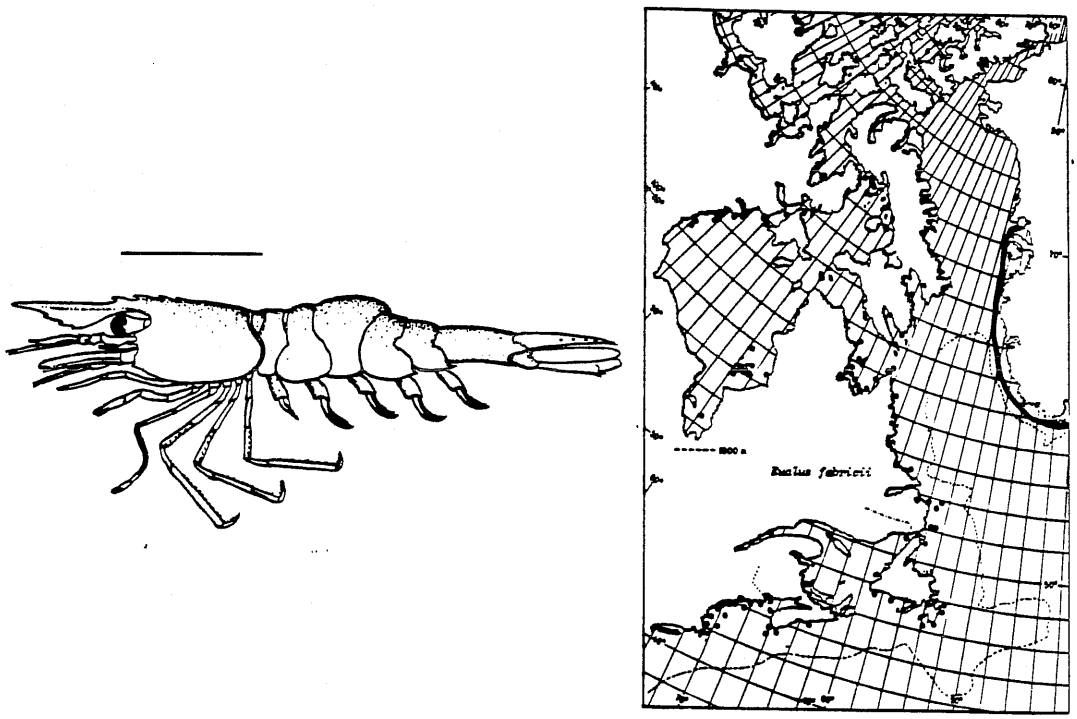
7. Rostrum short, about even with 1st article of antennule .....
..... Lebbeus microceros
Rostrum longer than 1st article of antennule 8

8. Carapace and abdomen rough, high median spines dorsally on carapace, pleura produced ventrally as strong spines Lebbeus groenlandicus

Carapace and abdomen smooth, pleura rounded .. Lebbeus polaris

Eualus fabricii (Kroyer, 1841)

Rathbun 1929; Holthuis 1947;
Squires 1990.



A small pale red shrimp. Supraorbital spine absent; 3rd maxilliped with an exopod; carpus of 2nd leg with 7 segments; rostrum longer than carapace and with no dorsal spines excepton crestabove orbit with 4 fixed spines; first leg only with epipod.

Northwest Atlantic from Hudson Bay, Foxe Basin and west Greenland to Cape Cod. Chukchi Sea and Bering Strait to British Columbia; Okhotsk Sea to Sea of Japan in the Pacific (Butler 1980; Williams 1984). Depths 4 - 275 m and temperatures -1.5 to 4.5 degrees C. Our records are in inset map.

It was trawled in small numbers throughout this area mostly in shallow water. Off Newfoundland and Labrador depths were 60-255 m, but in northern Foxe Basin 0-35 m and southern Foxe Basin 14-75 m. Temperatures -0.9 to 0.7 degrees C. in Newfoundland and Labrador and -1.5 in Foxe Basin (Table 4). Rathbun (1913) recorded it from Ungava Bay to Forteau at 6-37 m; Leim (1921) at Grand Manan; Frost and Thompson (1932) from Labrador to the Grand Banks with fewer specimens to the south; Van Winkle and Schmitt (1936) from Foxe Basin; Squires (1957, 1962, 1966, 1967, 1968 and 1969) from Ungava Bay, Frobisher Bay, Beaufort Sea to Cambridge Bay, Hudson Bay, Foxe Basin and Queen Elizabeth Islands.

Cod was an important predator on this species in Ungava Bay, Nachvak, Fogo, central Grand Bank, Ramea and Port aux Basques (Table 45). It was also present in stomachs of ringed, bearded and harbour seals from Ungava Bay.

It was taken in trawls with Pandalus montagui, Spirontocaris spinus, S. phippsi, Lebbeus polaris and L. groenlandicus (Fig. 7).

Specimens from the north were larger than those from the south (Table 4).

Almost all females from Newfoundland and Labrador were ovigerous in May, June and in October, November. In Foxe Basin only 64% of the mature females were potentially ovigerous in autumn (Table 5) indicating that spawning there took place only in altenate years.

In Foxe Basin this species appeared to feed on detritus. Most stomachs contained phytobenthos. Only a few had crustacean and polychaete fragments (Table 45).

Table 4. Lengths of Eualus fabricii from localities in the area of investigation, 1946-60.

Localities		Newfoundland and Labrador	Foxe Basin	Ungava Bay
Depth m		64-260	0-75	10-275
Temp. C.		-0.9 to 4.5	-1.5 to -1.0	-1.4 to 3.4
Average cl mm	M	7	7	7
	F	8	10	9
Range of cl mm	M	6, 7	3-10	4-12
	F	5-12	4-12	4-14
Numbers examined	M	2	40	119
	F	12	43	183

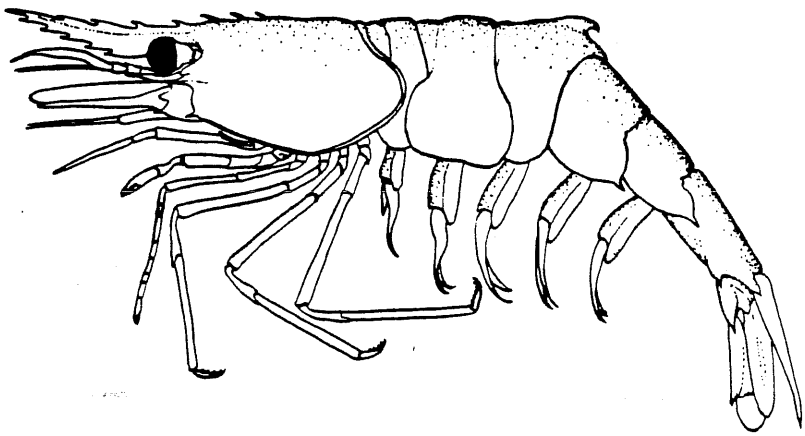
Table 5. Maturity of Eualus fabricii from Foxe Basin in August and September.

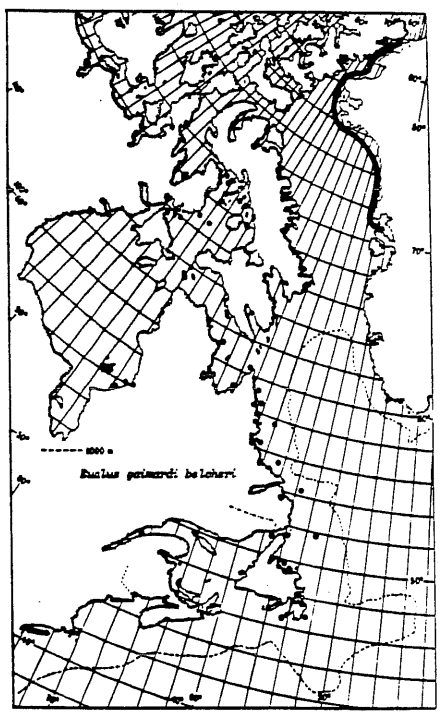
cl mm	Males		Females		
			Non-ovigerous		Ovigerous
	Small vd	Large vd	Small ova	Large ova	Small ova
4		3			
5	1	0	2	1	
6	1	2	0	1	
7	0	7	3	1	
8	1	2	3	2	
9			3	2	9
10			4	1	8
11					1
12					1
Totals	3	14	15	7	19
% potentially breeding annually		82			63

Mandibles are as in other thorids (Fig. 12). The outer division of the molar surface is larger than the inner and has 2 pointed cusps and a bristle fringe; the inner is small with a tuft of bristles. Incisor has 2 small teeth following the larger terminal one. Palp with distal part about 3 times as long as proximal. Palp is almost as long as incisor.

Eualus gaimardi belcheri (Bell, 1855)

Rathbun 1929; Heegaard 1941;
Holthuis 1947; Squires 1990.





Sub-species very similar to E. g. gaimardi but has a lobe with a very strong hook on the 3rd abdominal somite. It also has strong coloration: red stripes around the abdomen (persistent in preservative) particularly in specimens from Trinity Bay, Newfoundland. Epipods on legs 1 and 2 but missing on 2 in larger specimens. Possibly E. g. gaimardi is the more northerly. Specimens from Foxe Basin do not have such a strong hook on the abdominal lobe. Both were considered to be the same by Holthuis (1947) but were separated into two by Cuture et Trudel (1968).

World distribution of this sub-species has not been clearly separated from E. gaimardi. Our records are in map insert, but there may be some overlapping with E. g. gaimardi. Recorded from 135-190 m near Newfoundland but shallower in the north. Temperatures -1.1 to 0.5 degrees C., on the average not as cool as for E. g. gaimardi (Fig. 8). Rathbun (1913) reviewed records of occurrence from Nachvak to l'Anse au Loup, Labrador.

It was under predation by cod in the Gulf of St. Lawrence (Table 44).

E. g. belcheri was usually taken with other species that were dominant in numbers -- chiefly Pandalus montagui. However, in Trinity Bay in one haul it was the dominant species, 256 specimens compared

with 110 specimens of Pandalus montagui. Other species usually present were Eualus macilentus, Lebbeus polaris, Pandalus borealis, Sabinea septemcarinata and Argis dentata (Fig. 7).

In localities near Newfoundland males averaged 14 mm cl and females 16 mm cl. These were larger than in other localities, and were larger on the average than specimens of E. g. gaimardi from Foxe Basin (Table 6).

Females were first mature at 12 mm cl and males at 6 mm cl. In Trinity Bay at temperatures of about 1 degree C. 70% of the mature females were potentially ovigerous in autumn (Table 7) suggesting annual spawning. In Foxe Basin only 50% were potentially ovigerous suggesting that in colder situations spawning would take place only every second year.

Table 6. Lengths of Eualus gaimardi belcheri collected from localities in the area, and of E. g. gaimardi from Foxe Basin.

Localities		Newfoundland	Foxe Basin	Ungava Bay	E.g. gaimardi from Foxe Basin
Depths m		135-320	180-185	15-275	2-162
Temp. C		-1.0 to 0.5	-1.4 to 3.8	-0.5	-1.4 to 3.8
Average cl mm	M	14	9	9	7
	F	16	12	11	9
Range of cl mm	M	11-17	6-12	6-14	2-9
	F	7-21	9-14	6-14	3-14
Numbers examined	M	73	35	21	335
	F	205	9	26	139

Table 7. Maturity of Eualus gaimardi belcheri collected in Foxe Basin and Labrador in August and September.

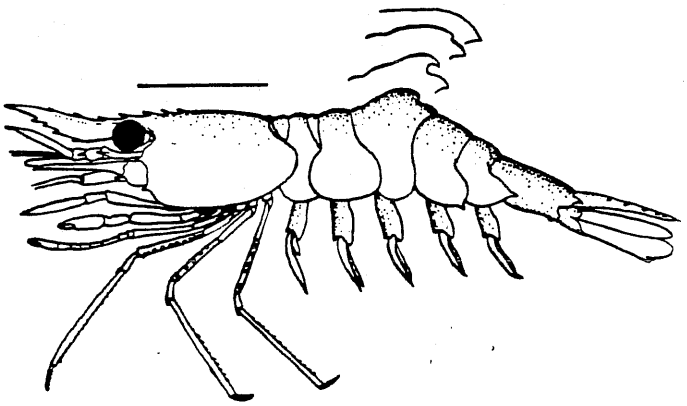
cl mm	Males		Females		
			Non-ovigerous		Ovigerous
	Small vd	Large vd	Small ova	Large ova	Small ova
5, 6	2	1			
7, 8	7	4			
9, 10	8	12	5		
11, 12	1	4	0	2	
13, 14		0	0	2	1
15, 16		3	3		0
17, 18			0		1
19, 20			1		3
21, 22					1
Totals	18	24	9	4	6
% potentially breeding annually		57			74

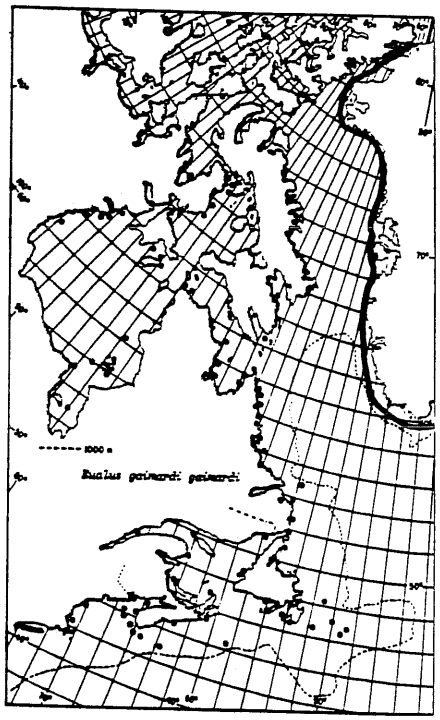
Stomach contents were similar to those found in E. g. gaimardi with phytobenthos and foraminiferans indicating bottom feeding. Also crustacean fragments, including ostracods, were common and occasionally polychaetes, euphausids and bivalves.

Outer division of molar of mandible has one pointed cusp and a small tooth is present between the divisions. Incisor has 4 teeth. Palp is a little shorter than incisor. Its distal part is shorter than the proximal.

Eualus gaimardi gaimardi (H. Milne-Edwards, 1837)

Heegaard 1941; Holthuis 1947;
Squires 1990.





This species resembles E. fabricii but its rostrum has teeth dorsally and ventrally and it is not as deep as in E. fabricii. Exopods are on 1st to 3rd maxillipeds; epipods on 1st and 2nd pereopods. In some areas a lobe is present on the 3rd abdominal segment but without a hook even at the largest sizes, especially in the north (Cf. Appellof 1908). Juveniles from Ungava Bay showed progressive development of a lobe as size increased. Specimens of both sexes from Foxe Basin show intermediates between it and E. g. belcheri but were assigned to the above subspecies (Cf. Holthuis 1947). However, the belcheri forms are treated separately here because of their occcurrence without intermediates in Trinity Bay, Newfoundland.

Distribution of this species is circumarctic in the Arctic Ocean from Siberia and Alaska, extending in the western Atlantic to Cape Cod and in the eastern Atlantic to the North Sea. Also in the Pacific to Sitka, Alaska. In our records as far north as the northwest tip of Devon Island and in Hudson Bay (Inset map). Depths from 10-900 m; temperatures -1.0 to 3.8 C. (Williams and Wigley 1977).

In our records from Hudson Bay, Foxe Basin, Ungava Bay, Frobisher Bay, northern Newfoundland bays, the Grand Banks, St. Mary's Bay, Placentia Bay, Fortune Bay, and Gulf of St. Lawrence. Depths were 59-230 m but shallower water to the north. Temperatures -1.0 to 1.6 degrees C.

It was in cod stomachs from the central Grand Bank (Table 44) and in stomachs of bearded and ringed seals from Ungava Bay.

Most frequently associated species were Pandalus montagui, Lebbeus polaris, Spirontocaris spinus, Sabinea septemcarinata, Argis dentata, and Sclerocrangon boreas (Fig. 7).

Males and females were the same size, averaging 8 mm cl (range 6-13 mm) off Newfoundland and Labrador. All were non-ovigerous in May, September and December. In Foxe Basin males averaged 6 mm cl (2-9 mm) and females 9 mm cl (5-14 mm). About 30% of mature females were ovigerous or had large ova in August and September (Table 8).

TABLE 8. Maturity of Eualus gaimardi gaimardi when collected in Foxe Basin in August and September.

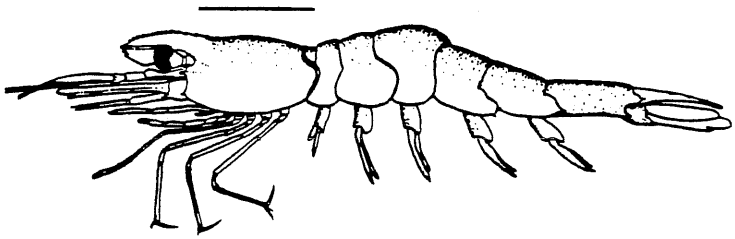
cl mm	Males	Females		
		Non-ovigerous		Ovigerous
	Small vd	Small ova	Large ova	Small ova
5		15		
6	9	21		
7	6	8		
8	0	12		
9	1	11	1	
10		20	4	2
11		11	2	6
12		9	3	4
13		2	2	1
14			1	
Totals	16	109	13	13
Probably mature	1 (with large vd)	53	13	13
% potentially breeding annually				33

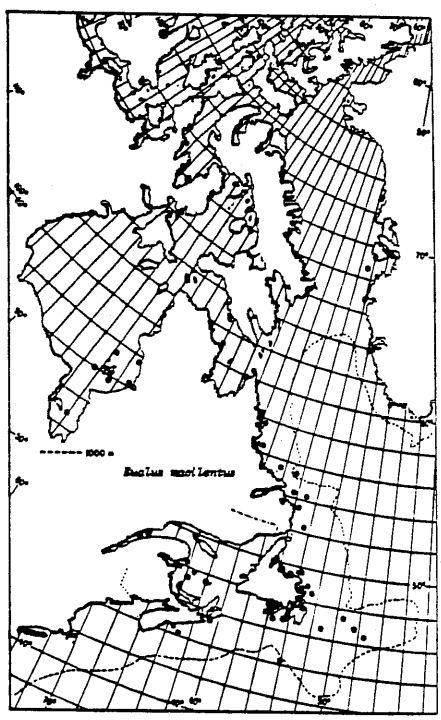
Stomach contents were mostly phytobenthos, ostracods, foraminiferans, crustacean and polychaete fragments. Hydroids, red seaweed, sponge spicules, gammarid amphipods, bivalves, and small gastropods were occasionally present (Table 45).

Mandible with large molar divided into two parts, the outer with one large and small pointed cusp at the outer edge and the inner with an inner edge of bristles. Incisor thin with two teeth at apex. Palp with two subequal parts (Fig. 12).

Eualus macilentus (Kroyer, 1841)

Rathbun 1929; Holthuis 1947;
Squires 1990.





A small whitish translucent shrimp with a short thin translucent rostrum. Rostrum has a high toothed crest and deep rounded blade below. In juveniles the rostrum is more pointed and it has erroneously been called E. stoneyi. Epipods are present on the 1st-3rd pereopods.

In west Atlantic only, from Greenland and Hudson Bay (mainly Richmond Gulf) to Nova Scotia. Also in the Arctic Ocean from Siberia and in the northern Pacific from Okhotsk and Bering Seas. In our records mostly from deep Newfoundland bays and Labrador fjords with temperatures lower than 0 degrees C. In shallower water to the north. Depths mostly 200-300 m (Squires 1957, 1961, 1967) (Figs. 8 and 9).

Rathbun (1913) reviewed the Labrador records of this species from Fish Island to Square Island in 28-137 m. In our surveys it was taken in small numbers in southern Foxe Channel and Ungava Bay. Also from Lake Melville to Fortune Bay including all the deep cold water bays of eastern Newfoundland where conditions appeared to be suitable for large numbers. Also in Bay of Islands and Bonne Bay on the west coast (Inset map). In stomach contents of cod from the Grand Bank (134-141 m), Fortune Bay (183 m) and off Bonavista (285-322 m) (Table 44).

Although E. macilentus occurred in fairly large numbers, Pandalus montagui which was invariably present (except in Richmond Gulf),

almost always was dominant in numbers. P. borealis also occurred frequently in these associations as did Argis dentata and Sabinea septemcarinata (Fig 7).

Males averaged 9 mm cl (range 5-14 mm) and females 11 mm (range 6-16 mm).

To the south females were first ovigerous at 8 mm cl in October. Almost all matures were ovigerous in November and December indicating annual spawning. A few specimens had advanced embryos in May indicating an ovigerous period of about 8 months (Table 9). Samples from the north in July to September suggest that only 62% were likely to lay eggs in the following months (Table 9).

Table 9. Maturity of female Eualus macilentus collected in July and September in Newfoundland and Labrador.

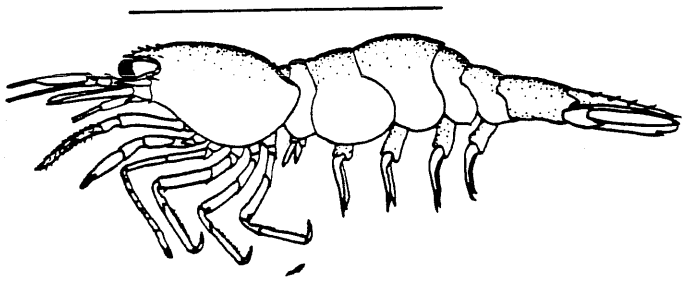
cl mm	Non-ovigerous		Ovigerous
	Small ova	Large ova	Small ova
7	1		
8	8	1	
9	19	8	
10	44	50	
11	64	56	2
12	48	119	5
13	23	72	2
14	4	21	1
15, 16		1	
Totals	221	328	10
% potentially breeding annually			62

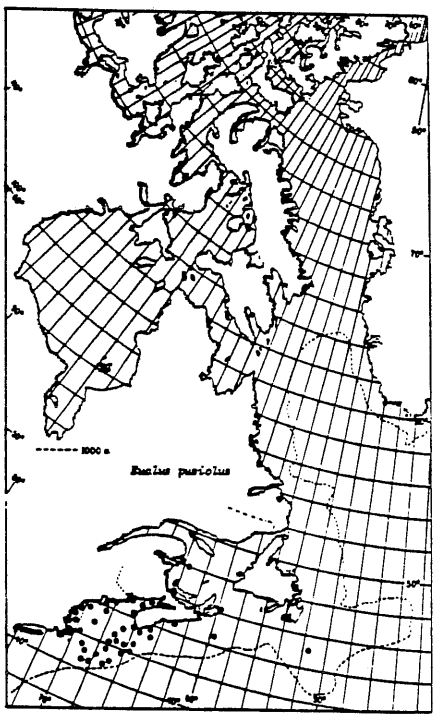
Phytobenthos was common in the stomach contents and crustacean fragments only occasionally.

Mandible similar in E. gaimardi (Fig. 12). But incisor with terminal tooth followed by three small accessory teeth. Palp shorter than incisor, with two subequal parts.

Eualus pusiolus (Kroyer, 1841)

Rathbun 1929; Holthuis 1947;
Squires 1990.





Small whitish translucent shrimp with a few reddish and orange spots. Sometimes greenish or with brownish stripes where it lives among seaweed. Rostrum shorter than eye, pointed with about 4 dorsal spines. Epipods on first 3 pereopods.

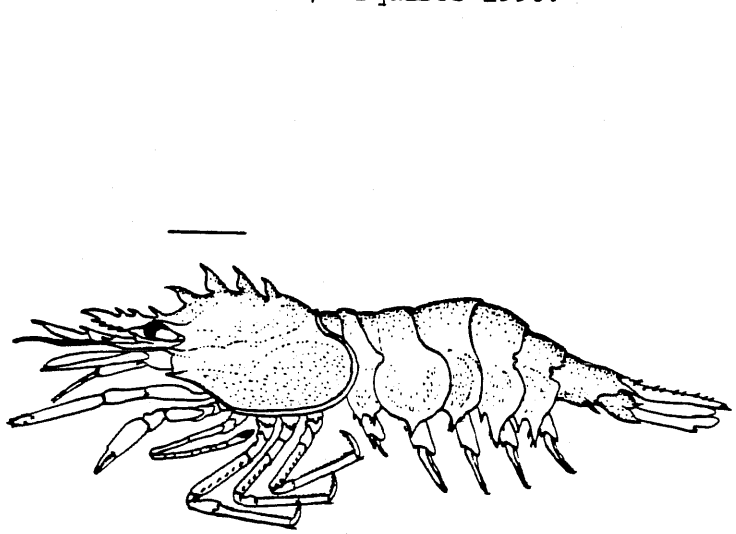
Distribution from Iceland to Virginia in western Atlantic, and from the Murman Sea to Mediterranean Spain in the eastern Atlantic. Arctic Ocean and North Pacific from Chukchi and Bering Seas to British Columbia and Washington, and from Okhotsk Sea and Sea of Japan (Butler 1980; Williams 1984). Depths 0-500 m (Holthuis 1947).

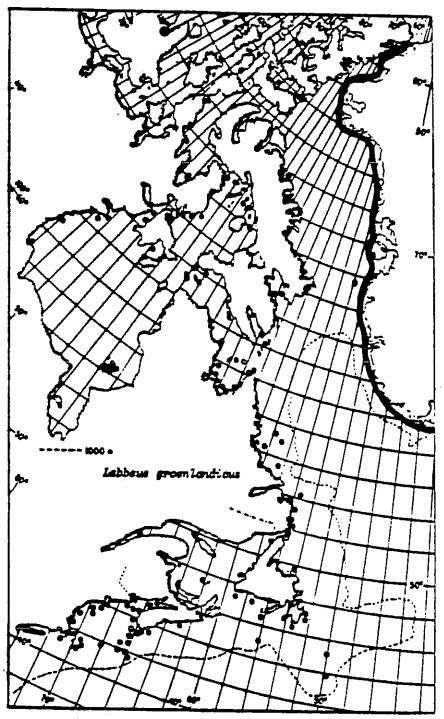
Locally a specimen was taken at Presque, Placentia Bay, in a scallop dredge, depth 9-18 m. Considerable numbers were obtained by SCUBA diving at St. Chad's, Bonavista Bay, in 1971. Also obtained from stomachs of cod from southwest edge of the Grand Banks (Inset map). Temperatures 1.3 to 6.7 degrees C.

Female ovigerous at 3 mm cl and non-ovigerous females of 4 mm cl. Egg diameter 0.6 mm.

Lebbeus groenlandicus (Fabricius, 1775)

Rathbun 1929; Holthuis 1947;
Williams 1984; Squires 1990.





Medium sized, robust, rough-looking shrimp brownish red to brownish green in colour, with 4 strong teeth on middorsal carina of carapace; one strong supraorbital spine; abdominal pleura with strong ventrolateral teeth; rostrum half length of carapace, sharp pointed with 3 strong teeth dorsally and 2-4 ventrally. Epipods on 1st-3rd pereopods, exopod on 1st and 2nd maxillipeds only.

Distribution from Hudson Bay and Greenland to Rhode Island in the western Atlantic; arctic Canada and Alaska; Chukchi and Bering Seas to Puget Sound, and Okhotsk Sea to Vladivostok in the Pacific. Depths 2-314 m and temperatures -1.4 to 9.4 degrees C. (Williams and Wigley 1977; Williams 1884). Our records are in inset map.

Records from the Labrador coast were reviewed by Rathbun (1913). Leim (1921) reported it from Grand Manan, the Bay of Fundy, etc. Frost and Thompson (1932) found it most plentiful near the Straits of Belle Isle. It was collected in Foxe Basin by Captain Bob Bartlett (Van Winkle and Schmitt 1936), and in Hudson, Ungava and Frobisher Bays by the CALANUS Expeditions (Squires 1957, 1962, 1967), and reported from the St. Lawrence estuary by Fontaine and Brunel (1962).

Our collections were from Cambridge Bay, Hudson Bay, Foxe Basin, Ungava Bay, Queen Elizabeth Islands, Frobisher Bay, Labrador, central Grand Bank, east coast of Avalon Peninsula, St. Mary's

Bay, St. Pierre Bank and northern part of the Gulf of St. Lawrence (Inset map). Temperatures were -1.3 to 4.5 degrees C. and depths less than 200 m (Figs. 8 and 9).

Predators were Cod, many from cod stomachs in southern part of the area and bearded seal in Ungava Bay (Squires 1957). Another predator was Brunnich' murre at Akpatok Island, Ungava Bay (Tuck and Squires 1955).

Only a few specimens were in catches with larger numbers of Lebbeus polaris, Pandalus montagui and Spirontocars spinus (Fig. 7).

Specimens from the north were larger than those from the south, the largest off northern Newfoundland and Labrador. In Frobisher Bay males averaged 12 mm cl and females 16 mm (ranges 10-15 mm and 7-28 mm, respectively) (Table 10).

One female was ovigerous in May and about 57% were ovigerous in August and September. Eggs had eyed embryos in September and November but were probably carried over the winter (Table 11). About 68 % were potentialy ovigerous in autumn indicating possible annual spawning (Table 11).

Table 10. Lengths of Lebbeus groenlandicus from localities in the area of investigation, 1946-60.

Localities		Newfoundland	Newfoundland and Labrador	Foxe Basin	Ungava Bay
Depths m		45-160	110-190	0-162	18-275
Temp. C		-1.3 to 4.5	-0.6 to 0.6	-1.5 to 5.5	-1.4 to 2.2
Averqage cl mm	M	10	15	12	12
	F	11	18	13	14
Range of cl mm	M	6-14	11-27	2-18	6-18
	F	8-13	8-27	3-21	4-24
Numbers examined	M	3	5	33	99
	F	8	31	20	131

Stomach contents had phytobenthos mostly but crustacean fragments, polychaetes, hydroids, euphausids, foraminiferans, ostracods, ophiurans, small bivalves, gastropods and rhodophyte fragments also were present in some (Table 45).

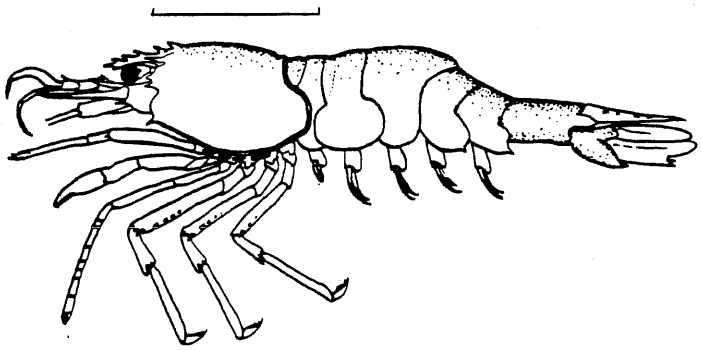
Mandible similar to those of other Thoridae (Fig. 12). Molar has shearing edge, an inner superior cusp with tuft of short setae and grinding surfaces. Incisor a thin flexible blade with 3 teeth at apex. Palp with two subequal parts.

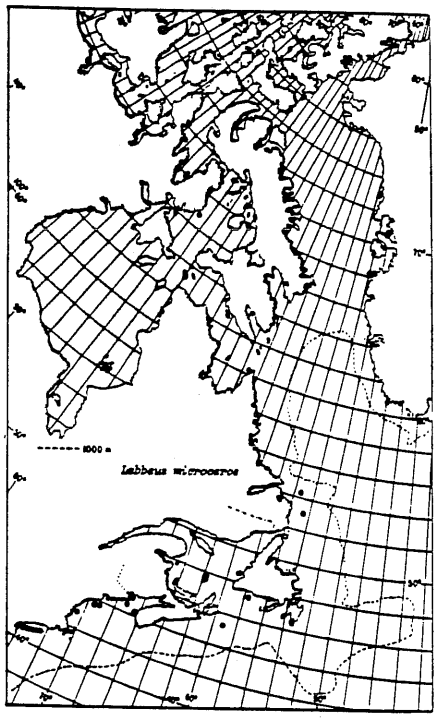
Table 11. Maturity of Lebbeus groenlandicus from Foxe Basin, Newfoundland and Labrador in August and September.

cl mm	Males		Females		
			Non-ovigerous		Ovigerous
	Small vd	Large vd	Small ova	Large ova	Small ova
7, 8	3		1		
9, 10	4		1		1
11, 12	2	3	6		0
13, 14	1	7	3		0
15, 16	0	2	2	2	1
17, 18	1	2	3	1	4
19, 20			1	5	2
21, 25			3	3	6
26, 27				1	
Totals	11	14	20	12	14
% potentially breeding annually	78			74	

Lebbeus microceros (Kroyer, 1841)

Leim 1921 as L. zebra;
Rathbun 1929; Holthuis 1947;
Squires 1990.





Small shrimp deep red in colour with orange, white and blue markings. Rostrum short pointed with 3 dorsal spines close together and 2 on carapace over orbit; one supraorbital spine; epipods on first 3 pereopods.

Distribution in northwest Atlantic only from Foxe Basin and south of Greenland to New Brunswick. Also possibly from Bering Sea to off Kamchatka. Depths 8-80 m (Holthuis 1947).

Our collections were from Trepassey Bay, Newfoundland, at 35 m and 2.5 degrees C. Also from Foxe Basin at 8-14 m (Insetmap).

Other species in the collections were Lebbeus polaris, L. groenlandicus, Eualus fabricii, E. gaimardi and Spirontocaris phippsi (Fig. 7).

Female from Trepassey Bay was 10 mm cl, nonovigerous in November. Females from Foxe Basin: immature 4 mm cl, mature 13 mm cl was ovigerous in September. Egg diameter 2.4 mm. Male 9 mm cl mature in September.

Stomach contents phytobenthos.

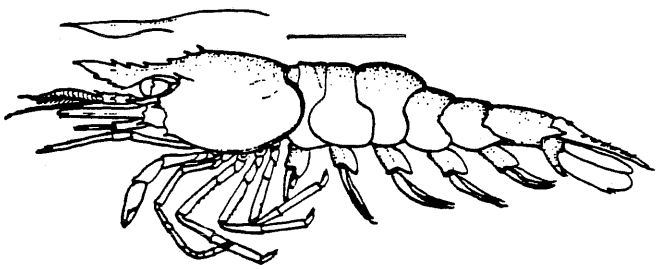
Cod was predator on juvenile at Ramea, Newfoundland. Depth 35-70 m.

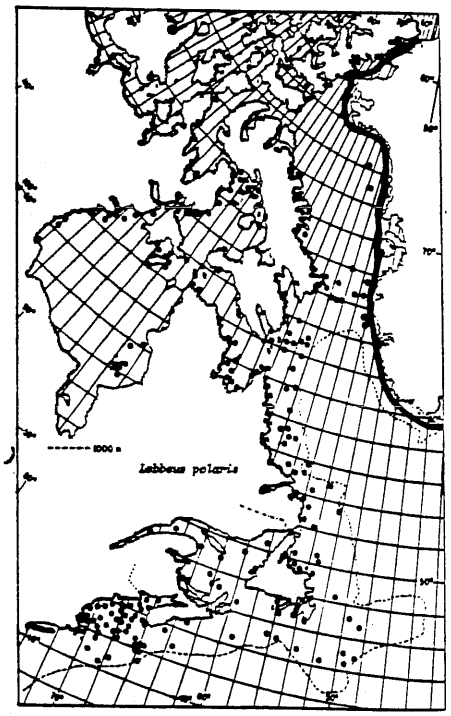
Mandible as in other thorids. Molar divided into two, outer with 2 cusps and tuft of bristles at edge. Incisor with one large and 3 small teeth longer than palp. Distal part of palp shorter than proximal (Fig. 12).

L. zebra of Leim (1921) and Makarov (1935) is synonymous with this species.

Lebbeus polaris (Sabine, 1821)

Rathbun 1929; Holthuis 1947;
Squires 1990.





Medium to small-sized shrimp; colour bright red and orange chromatophores over whitish translucent background. Rostrum almost as long as carapace with strong dorsal and ventral teeth (no teeth in some specimens: 4 out of 21 in males and 2 out of 61 in females in our collections), formula 0-8/0-5. One supraorbital spine, rounded pleura. Epipods on first 2 pereopods; exopods on first two maxillipeds.

Distribution in the western Atlantic from the Arctic to Chesapeake Bay and in the eastern Atlantic to the Hebrides; circumarctic. In the Pacific from Bering Sea to British Columbia and in the Okhotsk Sea (Williams 1984). Depths 0-930 m (Holthuis 1947).

In our collections the most common shrimp from Cambridge Bay and the northwest tip of Devon Island to Hudson Bay, Foxe Basin, Ungava Bay, Frobisher Bay, Labrador, Newfoundland bays, the Grand Banks, Gulf of St. Lawrence and south to the Nova Scotian Banks (Inset map). It was found at all depths fished from 5-720 m and temperatures of -1.5 to 4.7 degrees C. (Figs. 8 and 9).

Cod was a predator on the Grand Bank, Nachvak Fjord and Ungava Bay. Also seals and murres in Ungava Bay (Tuck and Squires 1955).

Specimens from Newfoundland and Labrador were larger than

elsewhere averaging 12 mm cl in males and 13 mm cl in females. In the north 9 and 10 mm cl, respectively (Table 12).

In one sample in October and November 50% of the eggs had advanced embryos. In May 17% were ovigerous. In other samples from early autumn occasional specimens had eyed embryos and 75% were potentially ovigerous (Table 13). These data suggest that the majority spawned annually, reached maturity early and spawned more than once. Three major year groups appeared to be present I, II and III years of age (Table 13).

Phytobenthos, crustacean fragments, ostracods and gammarid amphipods appeared in most stomachs. Polychaetes, foraminiferans, hydroids and rhodophytes occurred less frequently. Pteropods, small gastropods, bivalves, mysids and sea urchin remains occurred only occasionally (Table 45).

Mandibles are similar to those of L. groenlandicus but incisor has 4 teeth.

Table 12. Lengths of Lebbeus polaris from localities in the area of investigation, 1946-60.

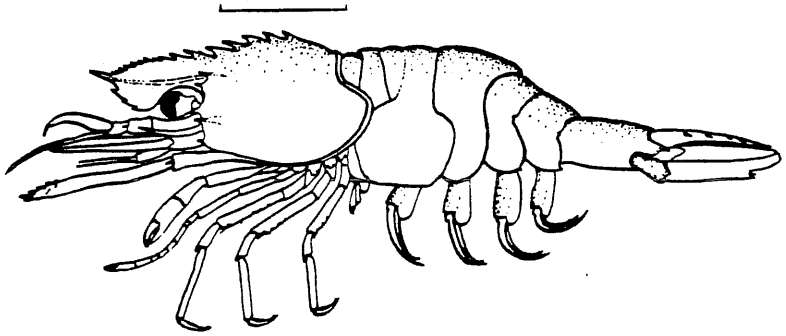
Localities		Newfoundland	Newfoundland and Labrador	Foxe Basin	Ungava Bay
Depths m		50-400	78-720	2-162	5-275
Temp. C		-1.1 to 4.7	-1.4 to 5.4	-1.4 to 3.9	-1.4 to 3.4
Average cl mm	M	7	11	9	9
	F	12	12	10	10
Range of cl mm	M	4-11	6-18	2-13	2-13
	F	5-19	7-20	4-16	2-17
Numbers examined	M	19	99	476	122
	F	61	272	137	205

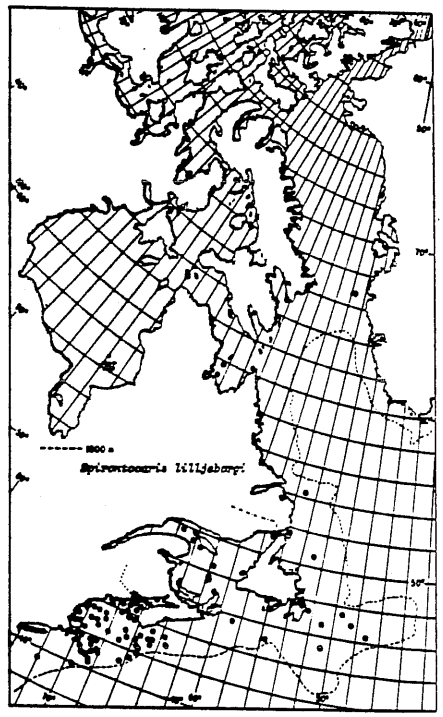
Table 13. Maturity of Lebbeus polaris collected in Foxe Basin, Newfoundland and Labrador from July to September.

cl mm	Males		Females			Estimated age years
			Non-ovigerous		Ovigerous	
	Small vd	Large vd	Small ova	Large ova	Small ova	
5	1					
6	2	7	4			
7	3	0	5			I
8	4	4	6	3		
9	6	27	11	8		
10	2	23	2	14	5	
11	1	14	22	28	15	
12	1	10	12	33	17	II
13		5	2	22	11	
14		6	4	10	6	
15		4	2	8	5	
16		1		3	7	III+
17		1		2	4	
18-20				6	7	
Totals	20	102	70	137	76	
% potentially breeding annually	84			78		
First mature	6 mm cl			8 mm cl		

Spirontocaris lilljeborgi (Danielssen, 1859)

Rathbun 1929; Holthuis 1947;
Squires 1990.





Short and robust shrimps with a serrate carina about two-thirds the length of the carapace, teeth separate and strong and continued on to the rostrum but much smaller and ending in a pointed tip; about four teeth on blade below. Two supraorbital spines on each side. Eyes large with an inner tubercle on eyestalk. Colour mottled brick red with small yellow and white spots. Epipods present on 1st to 3rd pereopods.

Distribution in western Atlantic from Foxe Basin and Davis Strait (Greenland) to Delaware Bay. In the eastern Atlantic from the Murman Sea to the south coast of Ireland and England. Also arctic Alaska but not in the Pacific. Depths 20-1200 m but mostly 35-90 m (Holthuis 1947).

In our collections from Foxe Basin (14-15 m) and from Frobisher and Ungava Bays but not in Hudson Bay; Northeast Newfoundland Shelf, central and eastern Grand Bank, Conception and Hermitage Bays and near Sable Island (Inset map). Depths 75-300 m (Fig. 9). In all but one instance temperatures were above 0 degrees C.(Fig. 8). Frost and Thompson (1932) found it common on the Grand Bank.

This species was one of a group of decapods in which Sergestes arcticus was occasionally dominant and Pasiphaea multidentata in fair

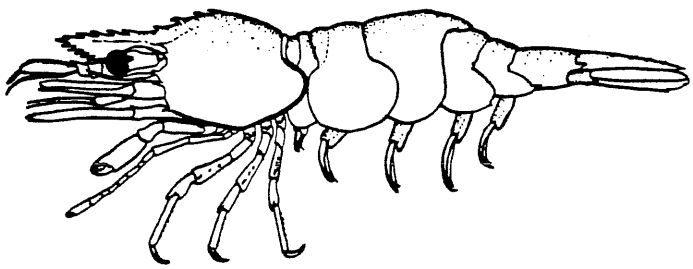
numbers. It also occurred in the Pandalus borealis community and with Pontophilus norvegicus.

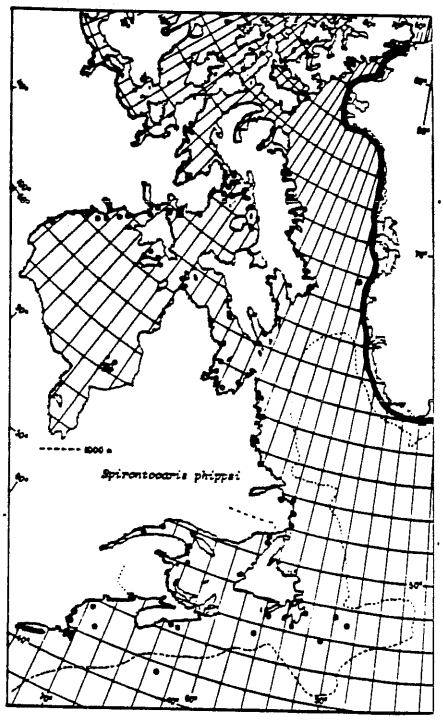
Average length of males 6 mm cl (range 5-7 mm cl) and females 12 mm cl (range 7-15 mm cl).

All females were ovigerous in May and June and one was ovigerous in July. In December 75% were ovigerous, suggesting annual spawning. Allen (1962) found that a few females survive to lay a second batch of eggs. Temperatures off Northumberland (England) are higher (6-14 degrees C.) than in our area so the species would take longer to mature here, but possibly would live longer in lower temperatures and would spawn a second time.

Spirontocaris phippsi (Kroyer, 1841)

Rathbun 1929; Holthuis 1947;
Squires 1990.





Small but robust shrimp with large triangular rostrum with several even teeth above and on the forward edge below; teeth continued on middorsal carina to about half the carapace. Two supraorbital spines. Colour mottled reddish brown on lighter background. Exopod on third maxilliped; epipods on first 3 legs.

Distribution in western Atlantic from Cornwallis Island and Hudson Bay to Martha's Vineyard; in the eastern Atlantic from Spitzbergen to Britain; Arctic Ocean north of Siberia, Beaufort Sea and Bering Sea to Siberian east coast in the north Pacific (Holthuis 1947; Allen 1967; Williams 1984). Depths 10-300 m (Squires 1990).

In our collections from the northwest tip of Devon Island to Foxe Basin and Hudson Bay in 12-110 m. and in Frobisher and Ungava Bays, off Labrador, central Grand Bank, St. Mary's Bay and St. Pierre Bank (60-300 m) (Inset map). Temperatures -1.0 to 3.8 degrees C. (Fig.8). Rathbun (1913) reviewed records from Labrador. Frost and Thompson (1932) thought the centre of distribution was on the central Grand Bank. Van Winkle and Schmitt (1936) reported it from Foxe Basin and Hudson Strait.

Cod was a predator on this species from northern Grand Bank and St. Pierre Bank.

Associated species were Spirontocaris spinus, Lebbeus groenlandicus and Eualus fabricii (Fig. 7).

Males averaged 4 mm cl and females 7 mm cl (Table 14).

In Foxe Basin about 70% were potentially ovigerous in autumn (Table 15) indicating annual spawning there. Females were first mature at 6 mm cl.

Stomach contents were phytobenthos, foraminiferans, ostracods and other crustacean fragments including mysids and copepods. Hydroids, small bivalves and rhodophytes were occasional (Table 45).

Mandibles similar in S. spinus (Fig.12) but incisor has one large and 3 small teeth. Palp shorter than incisor, the distal part longer than proximal.

Table 14. Lengths of Spirontocaris phippsi from localities in the area of investigation. 1946-60.

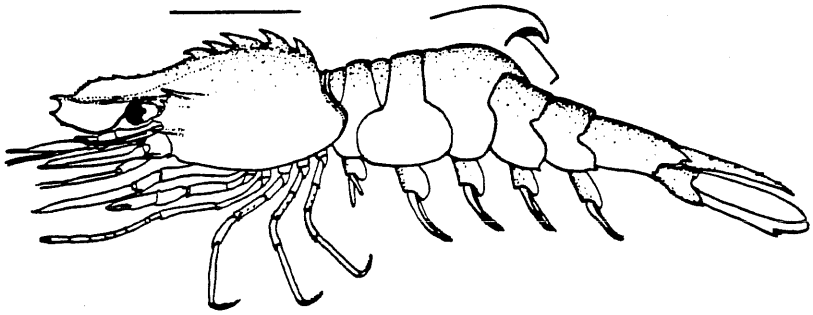
Localities		Foxe Basin	Ungava Bay	Frobisher Bay
Depths m		20-200	14-110	27-118
Temp. C.		-1.5 to 3.8	-1.4 to 2.1	about 0.0
Average cl mm	M	4	4	5
	F	7	7	7
Range of cl mm	M	2-7	2-7	4-6
	F	3-10	3-10	5-8
Numbers examined	M	28	6	16
	F	59	68	15

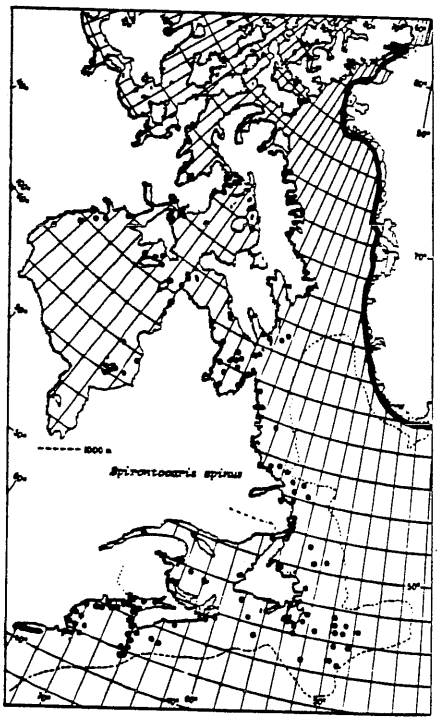
Table 15. Maturity of Spirontocaris phippsi collected from Foxe Basin in August and September.

cl mm	Males		Females			
			Non-ovigerous		Ovigerous	
	Small vd	Large vd	Small ova	Large ova	Small ova	
2	16		1			Juvenile
3	4	1	1			
4	3	3	5			"
5	4	2	2			
6	2	2	4	3		
7		1	0	5	6	
8			1	4	8	
9			1	3	4	
10					1	
Totals	29	9	15	15	19	
% potentially breeding annually		41		85		

Spirontocaris spinus (Sowerby, 1805)

Rathbun 1929; Allen 1962;
Squires 1990.





Small chunky shrimp, colour dull red with brown, bright red and green mottling on translucent background. Carapace with high dorsal carina almost reaching posterior edge and with large serrate teeth with small teeth on them. Rostrum with numerous small teeth and distally with two points, deep blade below with few teeth. Two unequal spines above orbit at each side. Third abdominal somite forms a posterior dorsal spine over the fourth. Epipods on 1st to 3rd legs and an exopod on the third maxilliped.

Distribution in western Atlantic from the high Arctic including the Queen Elizabeth Islands, northern Greenland and Hudson Bay to Cape Cod. In the eastern Atlantic from Novaya Zemlya and Spitzbergen to the Irish and North Seas. In the Pacific from Alaska to Puget Sound and Bering Sea to Sea of Japan. Depths 5-465 m (Heegaard 1941).

In our collections from Queen Elizabeth Islands, Foxe Basin, Hudson Bay, Fury and Hecla Straits, Ungava and Frobisher Bays to the Grand Banks and Gulf of St. Lawrence. Depths 10-305 m (Fig. 9) and temperatures -1.0 to 4.5 degrees C. (Fig. 8). Previous records from Labrador were reviewed by Rathbun (1913), and Leim (1921) recorded it from Passamaquoddy Bay. Frost and Thompson's (1932) records were from the Straits of Belle Isle to the Grand Bank. Van Winkle and Schmitt (1936) had records from Foxe Basin and Prefontaine and Brunel (1962) from the St. Lawrence estuary (Inset map).

Associated species were Lebbeus polaris and Sabinea septemcarinata most frequently but also other Thoridae, and Pandalus montagui in shallow situations (Fig. 7).

The parasite, Hemiarthrus abdominalis, infested 18% of the females and 3% of the males from Foxe Basin, Hudson Strait and northern Labrador, but not seen elsewhere with some exceptions on the Newfoundalnd coast.

Cod was a predator on this species on the Grand Bank, St. Pierre Bank and off Ramea and Cow Head (Table 44). Brunnich's murre was alsoa predator at Akpatok Island in Ungava Bay (Tuck and Squires 1955).

Lengths of this species appeared to be greatest from northern Newfoundland and Labrador (Table 16). Ranges of lengths were similar throughout the area, 3-12 mm cl in males and 3-17 mm cl in females.

About 70% were potentially ovigerous in autumn and would likely spawn annually especially in Foxe Basin (Table 17). Some were observed with eyed embryos in autumn indicating that eggs would be carried over the winter and be spawned in early spring. One was seen with large ova in the ovaries when carrying eggs so it would probably spawn after the eggs hatched.

Stomachs of this species with foraminiferans and phytobenthos indicated bottom feeding. Ostracods occurred frequently, but other crustacean fragments, small bivalves, hydroids and sponge spicules, polychates and gastropods were infrequent (Table 45).

Mandible with divided molar with bristles along edges. Incisor with 3-4 teeth and a terminal tooth, about equal to length of palp with distal part about 4 times the length of the proximal (Fig. 12).

Table 16. Lengths of Spirontocaris spinus from localities in the area of investigation, 1946-60.

Localities		Newfoundland	Newfoundland and Labrador	Foxe Basin	Ungava Bay
Depths m		45-304	60-230	14-162	9-275
Temp. C.		-1.0 to 4.5	-1.4 to 1.0	-1.4 to 0.7	-1.4 to 3.1
Average cl mm	M	8	10	7	8
	F	10	11	10	10
Range of cl mm	M	5-10	8-10	3-11	3-12
	F	6-12	6-17	5-17	3-17
Numbers examined	M	28	5	70	47
	F	59	40	101	87

Table 17. Maturity of Spirontocaris spinus collected from Foxe Basin in August and September.

cl mm	Males		Females		
			Non-ovigerous		Ovigerous
	Small vd	Large vd	Small ova	Large ova	Small ova
5	6				
6	11				
7	2	1	2		
8	4	10	9	5	1
9	6	11	7	3	1
10	1	11	14	12	5
11		3	1	7	4
12			0	10	3
13			1	3	0
14				5	4
15				3	
16				1	
Totals	30	36	34	49	18
% potentially breeding annually		73		68	

Family PANDALIDAE Haworth, 1825

Rostrum long and slender with spines and teeth; first leg with no or very small chela; second legs chelate, unequal, carpus with few or many divisions.

Key to Species

1. Third maxilliped with exopod ..... *Dichelopandalus leptocerus*

   Third maxilliped without exopod 2

2. Carpus of 2nd pereopod on right side with 4 or 5 divisions only ..... *Pandalus propinquus*

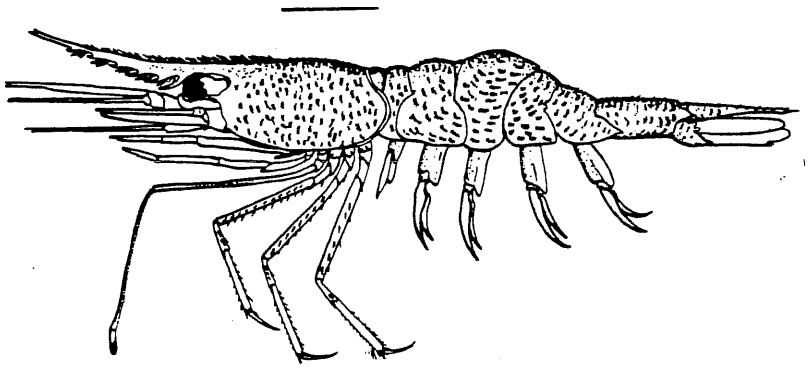
   Carpus of 2nd pereopod on right side with at least 20 divisions 3

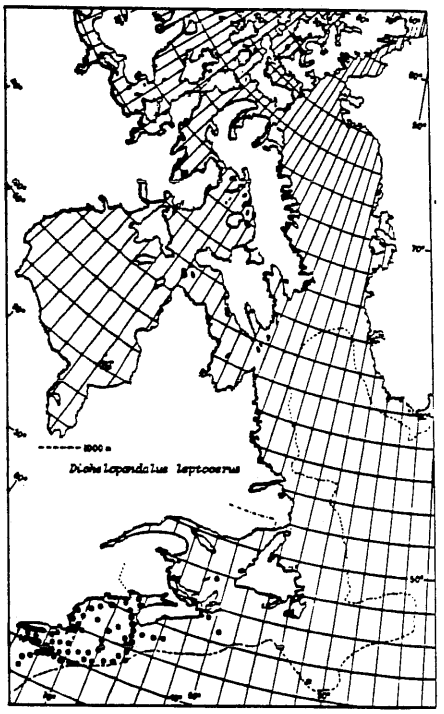
3. Prominent dorsal lobe on 3rd abdominal somite *Pandalus borealis*

   No dorsal lobe on 3rd abdominal somite ..... *Pandalus montagui*

Dichelopandalus leptocerus (Smith, 1881)

Rathbun 1929; Couture et Trudel 1968;
Williams 1984.





Moderate to large shrimp, brick red in colour covered with many small irregular ridges with short bristle-like setae which give it a roughish appearance on close examination. Second pair of legs unequal, the right with carpus divided by four annulations. Exopod on third maxilliped. Rostrum almost straight, longer than carapace, with small tooth near tip which appears bifid, dorsal spines moveable, ventral spines strong and curved forward.

Distribution in the northwest Atlantic only from the Gulf of St. Lawrence and St. Mary's Bay, Newfoundland, to North Carolina. Also in Shumagin Bank, Alaska (Rathbun 1929). Whitely (1948) states that it is recorded from Greenland but this is doubtful. In Europe it is replaced by a similar species, D. bonnieri, which is also not found in Greenland (Hansen 1908).

In our collections it was from the southern Gulf of St. Lawrence, St. Mary's Bay and the Grand Banks. In the stomach of a harp seal from the Gulf of St. Lawrence (D. E. Sergeant, personal communication). Depths 105-205 m (Fig.9) and temperatures 2.8 to 7.6 degrees C. with one exception of -0.1 C (Fig. 8).

In shallow hauls Argis dentata was present and in deep hauls Pandalus borealis and P. propinquus (Fig. 7).

Some females were still ovigerous in late June, and in two of them the embryos were eyed and would soon hatch. Later in the year 61% of mature females would be likely to lay eggs annually. Females reached first maturity at 16 mm cl (Table 18), at least a year later than Pandalus propinquus at 11 mm cl (Table 24).

Crustacean fragments, some whole euphausids and mysids and a few copepods were in stomachs examined.

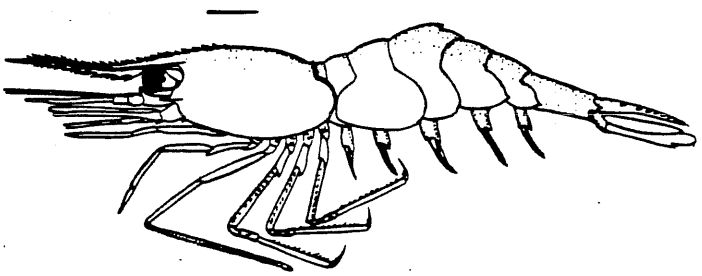
Mandible similar in other pandalids (Fig. 21); molar with hollow grinding surface and three cusps along inner edge. Incisor with five teeth the central 3 small and equidistant, the others long and pointed. Distal segment of palp about equal in length to other two segments combined. The proximal segment has an inner expanded lobe.

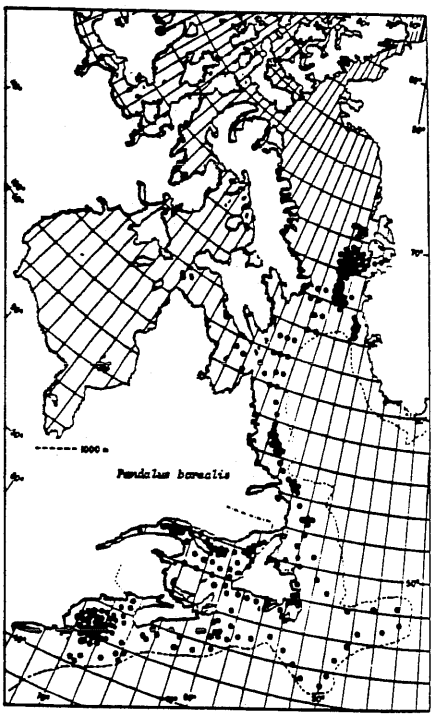
Table 18. Maturity of Dichelopandalus leptocerus collected off Newfoundland during July to December.

cl mm	Males		Females		
			Non-ovigerous		Ovigerous
	Small vd	Large vd	Small ova	Large ova	Small ova
13	3				
14	2	2	1		
15	5	6	5		
16	2	5	3	5	
17	1	1	6	6	2
18			1	7	
19			3	3	
20			2		
Totals	13	14	21	21	2
% Potentially breeding annually		58		61	

Pandalus borealis (Kroyer, 1838)

De Man 1920; Rathbun 1929;
Squires 1990.





"Pink or Northern Shrimp (Crevette nordique)". Large shrimp uniformly pink with a distinct sharp dorsal lobe in the middle of the 3rd abdominal segment. Rostrum is sharp pointed, long, narrow slightly arched above the eyes and curved but straightening out at the tip; many small dorsal spines, moveable, continued on the carapace, about 12-16 above and 6-9 fixed teeth below. Small median spine on 4th abdominal somite at posterior edge. Second pair of legs unequal, the right shorter; carpus annulated, 25 annulations on right and about 58 on left. Epipods on 1st - 4th pereopods.

Distribution in western Atlantic from west Greenland and Davis Strait to 70 N. south to Cape Cod with considerable abundance in West Greenland, off Labrador, deep channels in the Gulf of St. Lawrence and along the continental shelf of the Grand Banks and in the Gulf of Maine. In the eastern Atlantic from Novaya Zemlya and Spitzbergen to the British Isles with fishing abundance in Norwegian fjords. This species is not in the Pacific but a congener Pandalus eous Makarov (Squires 1993). Depths 10-500 m (Parsons and Frechette 1989).

Abundance of this species was demonstrated in the Gulf of St. Lawrence and around the coast of Newfoundland in 1957 and 1958 (Squires 1961) but the fishery for it was delayed until the early 1970s. Surveys also showed its presence off Baffin Island and

Labrador, off the northeast Newfoundland Shelf, the Flemish Cap and eastern edge of the Grand Banks at depths over 200 m. (Inset map).

Found in temperatures -1.4 to 7.6 C. (Fig.8), but where abundant and presently fished at temperatures from about 3 to 6 degrees C. Almost entirely absent from shallow areas to 100 m as indicated by Frost and Thompson (1932). At moderate depths from 100-175 m specimens were considerably smaller than at optimum depths. Our farthest north station off Baffin Island where taken was at 365 m. During the "Fortune Breeze" survey (Squires 1961), samples from different temperatures showed that the proportion of males to females was high where temperatures were low but about equal where temperatures were 4-6 degrees C. (Table 20). In some low temperature areas (-1.1 to 3 C) only males were caught and in others there were 3 to 19 times as many males as females.

Where this species was abundant the bottom was invariably soft mud. "Hard" bottom, even where depths and temperatures were optimal, did not support a population of this species (Squires 1961). This is in agreement with Allen (1959) who says that this species occurs only on soft mud bottom off Northumberland.

Where P. borealis occurred in large numbers and large sizes, most catches had no other species of shrimp or only a few specimens of other shrimps (Table 21). This suggests that it is able to exclude other shrimp species where optimal conditions for itself pertain (Cf. principle of competitive exclusion: Hardin 1960). One of its chief competitors, P. montagui, failed to make any real encroachment, although depths and bottom conditions were suitable for it, except in places where temperatures were quite low such as in the Placentia Bay trough and in Ungava Bay. Also under very cold water conditions another shrimp, Eualus macilentus, much smaller than either P. montagui or P. borealis, was present in considerable numbers (Fig. 7).

Occurring quite regularly in areas where optimal conditions for P. borealis prevailed was the large sea anemone, Bolocera longicornis and the sedentary squid Rossia leucopis. These areas are also frequented by the redfish, Sebastes mentella, which presumably school near the bottom yet rarely feed on adult P. borealis. Its chief predator here, however, is the Greenland Halibut (Reinhardtius hippoglossoides) and occasionally cod (Gadus morhua). Cod may have been a regular and considerable predator as shown by a population explosion of P. borealis in the early 1990s when great quantities were taken on the continental slopes off the northeastern edge of the Grand Banks following a drastic reduction in quantities of cod by overfishing in these areas.

Table 19. Lengths of Pandalus borealis at depths, temperatures and localities where captured by the "Fortune Breeze" in 1957 and 1958.

Localities	SW Nfld		Gulf S-L		N Gulf		Trinity		D'Espoir		Fortune		Placentia	
Depths m	210-270		250-370		170-220		275-315		165-210		200-230		190-260	
Temp. C.	6.0		5.1		3.4		1.0		0.7		-0.3		-1.1	
Sex	M	F	M	F	M	F	M	F	M	F	M	F	M	F
cl - mm														
10							3				2		4	
11							4				7		4	
12					1		8		1		10		10	
13					0		30		7		23		5	
14			1		1		65		5		12		20	
15			3		14		54		5		15		47	
16	1		4		35		39		22		15		30	
17	0		6		28		33		58		26		36	
18	5		7		22		16		42		14		12	
19	18		13		10		15		13		15		5	
20	12		13		9	1	17	1	11		4		8	
21	15		15		5	1	3	3	12		4		2	2
22	38	1	20	2		1	1	6	2	1	1	1	1	1
23	22	3	10	17		8		7	0	0	1	0		0
24		21		47		6		8	1	0		0		0
25		29		48		8		5		5		0		1
26		17		62		3		1		2		2		0
27		13		64		2		0		5		1		1
28		14		48		1		1		2				
29		3		33		0								
30		1		14		1								
31		2		1										
32		1												
Totals	111	105	92	336	125	32	288	32	179	15	149	4	184	5
% ovigerous		100		65		0		74		60		75		60

10 intersex in Gulf sample. 22 immature in Placentia sample.

Table 20. Ratio of males to females in random sub-samples from catches of P. borealis by the "Fortune Breeze", 1957-58, at different bottom temperatures.

Temperatures C.	Number of hauls	M / F
-1.5 to -1.1	7	8.0
-1.0 to -0.5	7	13.5
-0.4 to 0.0	4	6.7
0.1 to 0.5	2	(males only)
0.6 to 1.0	8	18.5
1.1 to 1.5	2	17.6
2.1 to 2.5	1	(males only)
2.6 to 3.0	1	8.1
3.1 to 3.5	1	2.8
4.1 to 4.5	7	0.7
4.6 to 5.0	6	0.6
5.1 to 5.5	12	1.1
5.6 to 6.0	10	1.4
6.1 to 6.5	3	1.3

Stomach contents of specimens from the north (off Labrador and Baffin Island) largely consisted of phytobenthos, crustaceans (including gammarid amphipods), polychaetes and foraminiferans. Occasional small bivalves were present and rarely ophiurids, euphausids and copepods. More southerly bivalve shells, euphausids and small shrimps were more common (Table 45). Stomachs of those captured in plankton nets attached to headropes of fishing trawls were full of undigested copepods. But no stomachs were empty. Since the usual percentage of stomachs empty were 50-70% it is likely that the copepods were eaten by P. borealis in the nets that were full of copepods when taken in.

Mandibles similar in other pandalids (Fig 21). Incisor with 6 teeth forming a blade separate from the molar. Palp 3 parts setose. Molar stout with shearing cusp along edge and large flat but irregular grinding surface.

SIZE AND AGE. Size is conditioned by its being a protandrous hermaphrodite; each is a male for the first part of its life and after functioning as a male it changes sex. The testes atrophy, the ovarian tissues (already present) develop and ova increase in size. The intersex moults result in a decrease in size and eventual loss of the apendix masculina on the 2nd pleopod and the copulatory appendix on the endopod of the 1st pleopod (Hjort and Ruud 1938; Allen 1959). Moulting into the female phase is followed by egg laying. In the abundant populations surveyed males were 9-25 mm cl, intersex 19-27 mm cl and females 19-32 mm cl (Table 22).

Table 21. Numbers of P. borealis (Pb) in subsamples from hauls made by the "Fortune Breeze" during June-September, 1957 and 1958. P. montagui (Pm) occurred in some hauls. Code numbers for areas are in Table 46.

Area	Depth m	Temp. C	Hauls with Pb only		Hauls with Pb and Pm only		Hauls with Pb and others		Totals	
			Hauls	Pb	Hauls	Pb	Hauls	Pb	Hauls	Shrimp
30	190-310	4 to 5	9	883	1	149	3	276	13	1322
30	170-180	3	...	...	1	64	...	...	1	106
33	238-394	4 to 5	9	429	...	...	6	353	15	802
28	247-448	4 to 6	1	6	1	54	4	130	6	220
27	209-271	5 to 6	5	299	...	...	2	148	7	495
31	245	2	...	...	...	...	1	23	1	98
26	192-211	0.6	...	...	...	...	1	101	1	106
26	83-165	0.5	1	93	...	...	...	...	1	93
27a	282	5	...	...	...	...	1	69	1	70
25	262-293	6	...	...	...	...	2	94	2	120
27b	137-242	5	1	59	...	...	...	...	1	59
24	198-330	-1 to 0	...	...	...	,,,	9	764	9	1077
23	183-256	-1 to 0	...	...	1	87	16	1601	17	3067
14	202-265	-1 to 0	...	...	...	...	3	224	3	378
13	253-316	0 to 1	1	386	...	...	7	1364	8	2009
10	289-317	0 to 1	...	...	...	...	3	500	3	1126
9	245-293	1	...	...	...	...	1	420	1	523
Totals									90	11671

27a = North Bay; 27b = Great Bay de l'Eau

Table 22. Subsamples of P. borealis taken from catches by the "Fortune Breeze" in 1957 and 1958 during June-September shown as totals at each carapace length.

Carapace lengths	Males	Intersex	Females	Total
mm				
9	5			5
10	31			31
11	52			52
12	129			129
13	347			347
14	474			474
15	435			435
16	433			433
17	485			485
18	424			424
19	461			461
20	463		2	465
21	278	2	22	302
22	201	15	57	273
23	95	20	187	302
24	29	16	293	338
25	6	11	365	382
26		3	258	261
27		1	227	228
28			140	140
29			63	63
30			28	28
31			4	4
32			3	3
Totals	4,348	68	1,649	6,065

Following Petersons's method of determining the ages of fish (Parrish 1956), peaks in the length-frequency histograms were interpreted as possible age groups (Fig.19). In addition all the P. borealis in a sample were separated according to sex, and size groups were selected by inspection before measurement. These groups were measured separately. The resulting histograms suggest that the males comprised three major size groups which possibly correspond to ages of 1, 2 and 3 years or each one year more if the first year group is not captured. Similar histograms for females indicated that at least three age groups were present possibly representing 4, 5 and 6 years or one year more, as for males (Fig.18). Generally the intersex phase when present was represented by one major size group which was about 4 or 5 years of age in this area. These results were obtained from one large sample taken at one time. Parsons et al (1986) estimate age and growth for a P. borealis population from northeastern Newfoundland and southern Labrador.

Rasmussen (1953) regularly sampling P. borealis in Norwegian fjords demonstrated that age and growth could be related to given temperatures. Temperatures in the Esquiman Channel of the Gulf of St. Lawrence at depths over 180 m are 4 to 5 degrees C. throughout the year (Hachey 1961). These are slightly higher than the 3 to 4 degrees C.of the Mist Fjord but lower than the 6 to 7 C. of the Ofoten Fjord. Rasmussen's estimates of age for P. borealis from these fjords are lower or higher, respectively, than those made for the Esquiman Channel in 1957 (Fig. 20). Rasmussen's cl estimates are given as average cl at each age, and the actual range of cl at each age was estimated from his tables.

Growth rates of P. borealis from southern Norway (Rasmussen 1953) and off Northumberland (Allen 1959) from relatively high water temperatures, are considerably greater than those from relatively low temperatures such as occur in Newfoundland waters. For example, in temperatures of 6-11 degrees C. off Northumberland, transition to the female phase in this species occurs at one and one-half years. This compares with an approximate age at transition of 4 years in Newfoundland at temperatures of 4 to 6 degrees C. Also primary females were found in Northumberland waters (Allen 1959). Both early transition to the female phase and primary females are adaptations to warm water stress when the life of this species appears to be shortened. At optimal conditions or under cold stress primary females are not found. In effect, in cold water growth and maturity are retarded to the extent that most individual shrimps remain as males all their lives. Natural mortality ensues before they become females (Squires 1968b).

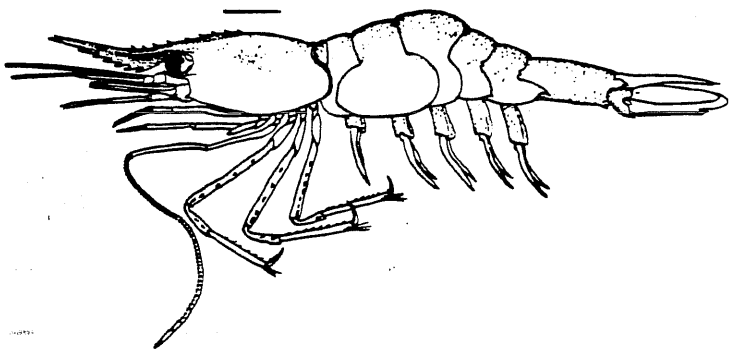
Allen (1959) suggests that at least five moults are required to pass from the male to the female phase. This change may take place over a five month period at an average temperature of 8.5 degrees C. off

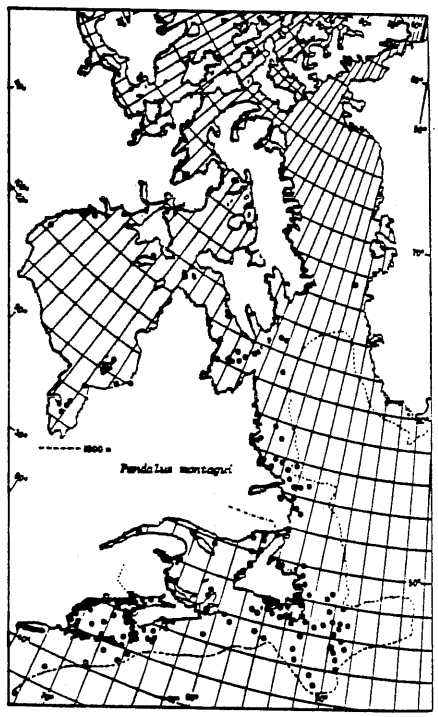
Northumberland, with average growth of 0.8 mm cl at each moult. Allen also suggests that3 moults may occur between ovigerous periods.

MATURITY. Males appeared to mature for the first time at 16 mm cl usually between July and September (Fig.15). Males appeared to be functional for at least two years (Fig. 19). In smaller females egg extrusion seemed to occur between July and September. Larger females had large ova in the ovaries at that time but most of them became ovigerous between September and December (Fig. 17). In at least one low temperature area (at 0.5 degrees C. in Bay d'Espoir in 1957) eggs were extruded in August, but a low ratio of females to males was present in this population. A high percentage of females was ovigerous in autumn in all areas of moderate or high temperatures indicating annual spawning. But in low temperature areas spawning seemed less frequent. Such an area was the trough in Placentia Bay (-1.1 to 0 degrees C.) where 40% had small ova in ovaries in autumn indicating possible biennial spawning. Generally in this species eggs were carried from September to April and hatched larvae at one time between April and June. Egg diameter 1.3 mm average in this area but off Northumberland, a warmer area, they were only 1.1 mm diameter when extruded (Allen 1959).

Pandalus montagui Leach, 1814

De Man 1920; Rathbun 1929;
Squires 1990.





Shrimp slightly smaller than P. borealis, pale translucent pink with a few reddish stripes laterally on abdomen and carapace and a short distinct white bar on the hepatic area. Rostrum without spines dorsally on anterior half and curved upward slightly, deep below with strong curved teeth, tip bifid. No lobe or spine dorsally on abdomen. Epipods on 1st four pereopods. Right leg shorter than left and with about 20 annulations.

Distribution in western Atlantic from West Greenland and Hudson Bay to Rhode Island. In eastern Atlantic from the White Sea and Iceland to the British Isles. Not in the Pacific; its congener there is P. tridens Rathbun (Butler 1980).

Except that it is usually found in shallow water, local distribution closely parallels that of P. borealis. It was in shallow water on the Grand Banks and in the Gulf of St. Lawrence where it was less than 180 m deep. Probably dominant in mixed P. borealis - P. montagui community on the cold water fringe of the homogenous P. borealis warm and deep water community. Rathbun (1913) reported it to be very common in shallow coastal Labrador. Frost and Thompson (1932) stated that it was the most abundant of any other species of shrimp in the Newfoundland area. Largest numbers and sizes were in Placentia, Conception, Bonavista and Ungava Bays where it was larger and more plentiful than P. borealis (Inset map).

In these places temperatures were -1.0 to 0.5 degrees C. and depths 90-320 m. Wherever it occurred in this area the presence of arctic water was unmistakable. More recent records (1990s) show a fishing area with substantial yeilds in Hudson Strait near Resolution Island (D. Parsons, Pers. comm.). It was also taken by Scuba diving inshore at St. Chad's, Bonavista Bay, in 1971.

Cod was a frequent predator particularly from the Grand Banks, Gulf of St. Lawrence, Greenley Island Labrador and Ungava Bay (Table 45). It was also taken by Murres off Akpatok Island, Ungava Bay (Tuck and Squires 1955), and by ringed seals; also in Beluga stomachs from Term Point, Hudson Bay (D. E. Sergeant, pers. comm.).

Table 23. Lengths of P. montagui from different temperatures, depths and localities in the area during 1957-60.

Locality	Ungava Bay		Trinity Bay		Hudson Strait		Bonavista Bay		Hudson Strait		Makkovik Labrador		Placentia Bay	
Depths m	375		250-300		105-110		280-310		270-370		145-230		185-260	
Temp. C	1.0		0.7		0.6		0.4		0.2		-0.7		-1.0	
Sex	M	F	M	F	M	F	M	F	M	F	M	F	M	F
11			2											
12	1		5				1						1	
13	2		6		4		0		1				0	
14	2		5		13		7		5		10		1	1
15	2		11		17		10		11		14			2
16	4		5		44		11	3	18		34			1
17	5		5	1	18		13	9	6		27	3		4
18	7			3	13		3	20	7		15	15		10
19	14			8	5		1	13	15		1	41		12
20	10	1		8	7	2		15	11	2		57		9
21	6	0		4	1	3		17	11	7		30		6
22	1	15		1		10		11	2	28		14		4
23		19		1		12		10		30		5		
24		14				4		5		33		1		
25		22				5		22		32		1		
26		11				1		0		25				
27		9						1		13				
28								1		2				
Totals	54	91	39	26	122	37	46	107	87	172	101	167	2	49
% potenially breeding annually	75		50		97		49		52		79		71	

12 intersex at Bonavista Bay at 17-19 mm cl

P. montagui was occasionally taken alone, once in large numbers off Ungava Bay in Hudson Strait but usually in small numbers. Small P. borealis commonly occurred in the P. montagui communities in shallower water than the main P. borealis populations. Eualus macilentus was always present in hauls with P. montagui from deep cold-water bays, and several species of Thoridae were present in hauls from very shallow water (Fig. 7). At St. Chad's Eualus pusiolus was present in greater numbers than this species in shallow inshore waters. Adaptation of P. montagui to cold water and its advantage in competition with other species in this area is evinced in the high ratio of females to males in most populations sampled (Table 48).

Like P. borealis, P. montagui is a protandrous hermaphrodite. The sizes of males, intersex and females seem to overlap to a greater extent than in P. borealis. Excluding megalops and juveniles the range in cl of males was 6-20 mm cl, intersex 10-20 mm cl and females 11-25 mm cl and no primary females were found in this area (Fig.22). In this way and others the life history of P. montagui appears similar to that of P. borealis. The males appear to spend 1 year (excluding first year) as immatures followed by 2 years as functional males. From inspection of length groups it is indicated that following the 3 years as males the 4-year-olds moult through the intersex phase to become females. The females probably lay eggs at least twice at 5 and 6 years of age (Fig. 25). Primary females were found at Gaspe, Quebec, where temperatures reached 14 degrees C. in summer. Males were first mature at 13 mm cl in their second year and transformed to females at 17 mm cl the following year and maximum size was 20 mm cl (Couture et Trudel 1969a, 1969b).

Mature males with large vasa deferentia full of sperm were found between July and December (Fig.23). Considerable numbers of females were ovigerous in each month from April to December (Fig.24). The proportion ovigerous in July to September was greater than in other months and was lower in May and June. In October to December the proportion ovigerous gradually decreased to 50%, while of the non-ovigerous, 50% had large ova and 50% medium ova (Fig.22). Advanced eyed embryos were found in May only. It is possible that those with large ova extruded eggs in late December giving a larger proportion of ovigerous females in spring than in autumn.

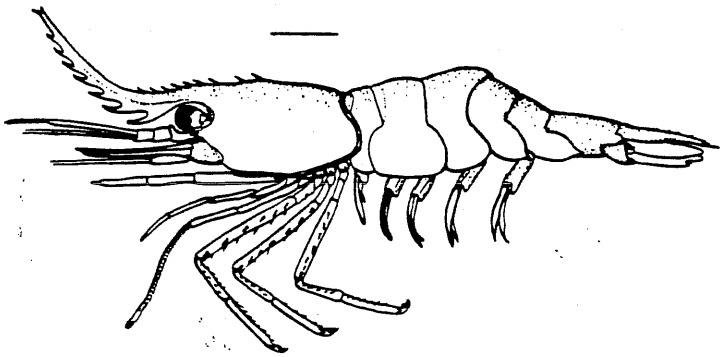
Average egg diameter in this area was 1.3 mm (1.2-1.5 mm) as compared with 0.8 mm off Northumberland (Allen, 1963).

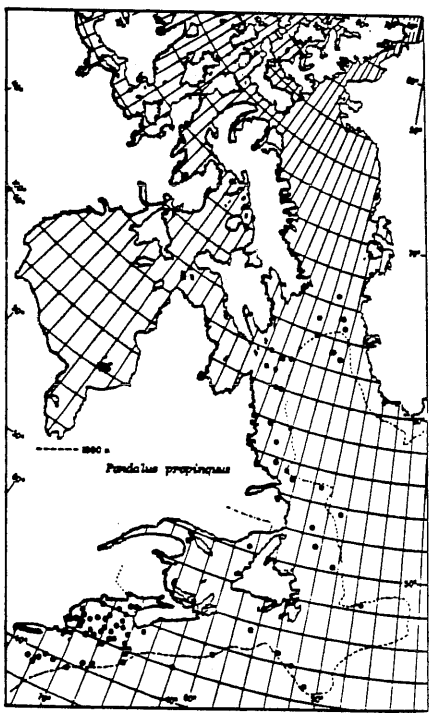
Although phytobenthos was present in many stomachs, crustacean fragments (gammarid amphipods and calanoid copepods) appeared very frequently and polychaetes occasionally. A few small bivalves, ophiurids and euphausids were also recorded (Table 45).

Mandibles are similar in P. borealis except the incisor had 5 teeth. Similarity of mandibles and food in each species suggests that they would compete for the same niche (Weatherley 1963).

Pandalus propinquus G. O. Sars, 1869.

De Man 1920; Rathbun 1929;
Squires 1990.





Moderately large shrimp, reddish in colour with smooth surface. Rostrum strongly upcurved, no dorsal spines on anterior two-thirds, ventral spines very large and curved. Carpus of right 2nd leg with only 5 divisions, right with about 25. No exopod on third maxilliped.

Distribution in western Atlantic from west Greenland and DavisStrait to Cape Cod; in eastern Atlantic from east Greenland, Iceland and northern Norway to the British Isles and Bay of Biscay (Heegaard 1941). Depths 20-2180 m and temperatures 2.6 to 9.9 degrees C. (Williams and Wigley 1977).

In our collections from the Grand Banks, in the Gulf of St. Lawrence, off the coast of Labrador and the east coast of Baffin Island (Inset map). In the south from shallow water although one was from 550 m; farther north from 280-770 m (Fig. 9). Temperatures 2.6 to 7.2 degrees C. (Fig. 8).

Present in hauls with this species was Acanthephyra pelagica, D. leptocerus and Pandalus borealis. Rarely with P. montagui.

This species is not hermaphroditic. Males were 10 - 17 mm cl and females 9-20 mm. About 80% of mature females were potentially

ovigerous in autumn indicating annual spawning. One in April had advanced eyed embryos suggesting spring hatching (Table 24). Egg diameters 1.2 mm.

Stomach contents phytobenthos and crustacean fragments, including euphausids, copepods, amphipods and isopods. Polychaetes were occasional and small bivalves rare (Table 45).

Mandibles as in P. borealis but with 5 teeth on the incisor as in P. montagui (Fig. 21).

Table 24. Maturity of P. propinquus collectd in Newfoundland and Labrador in August and September.

cl mm	Males		Females		
			Non-ovigerous		Ovigerous
	Small vd	Large vd	Small ova	Large ova	Small ova
9		1	1		
10	6	0	1		
11	10	4	3	2	
12	12	0	5	5	
13	6	7	1	5	
14	2	13	0	6	
15	3	8	1	7	
16	1	4		15	1
17	1	1		10	1
18		0		0	
19		1		1	
Totals	41	39	12	51	2
% potentially breeding annually		49		84	

Family CRANGONIDAE White, 1947

Brownish shrimps. First pair of legs subchelate, stouter than second. Second legs slender, small chelae or none. Mandible without incisor or palp.

Key to Species (from Allen 1967)

1. Second pereopods chelate 2

   Second pereopods not chelate 3

2. Dactyl of 4th and 5th legs flat and wide for swimming; no rostrum, eyes in a single socket ..... *Argis dentata*

   Dactyl of 4th and 5th legs not flat and wide; rostrum present 5

3. Rostrum obtuse ..... *Sabinea septemcarinata*

   Rostrum acute 4

4. Rostrum short, without spines ..... *Sabinea sarsi*

   Rostrum with strong spines ..... *Sabinea hystrix*

5. First pereopod without an exopod 6

   First pereopod with an exopod: two lateral carinae, first with two spines, the second with one ..... *Pontophilus norvegicus*

6. Carapace without strong sculpture ..... *Crangon septemspinosa*

   Carapace with strong sculpture 7

7. No dorsal carina on abdominal somites 3-5 .....
   ..... *Metacrangon jacqueti agassizi*

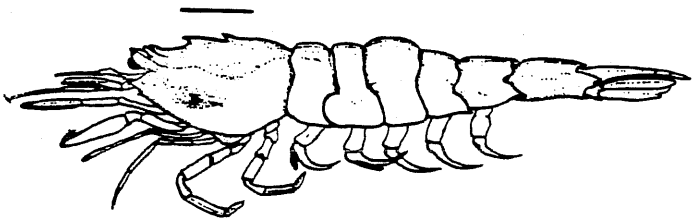
   Dorsal carina on each of abdominal somites 3-5 8

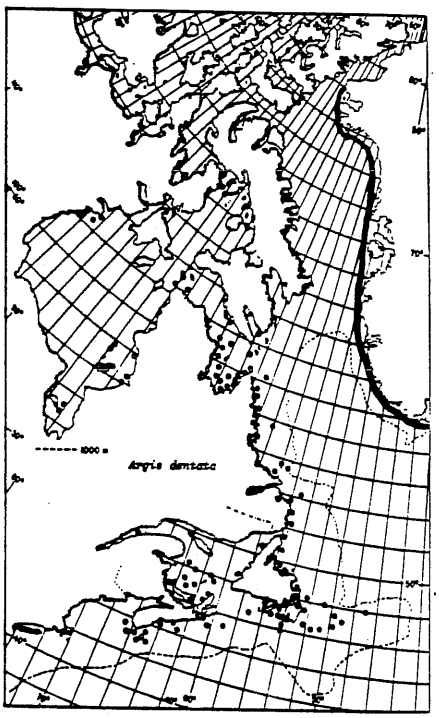
8. Rostrum short and flattened above, tip acuminate, with rounded keel ..... *Sclerocrangon boreas*

   Rostrum prominent with strong ascending spine, keel also pointed below ..... *Sclerocrangon ferox*

Argis dentata (Rathbun, 1902)

Rathbun 1929; Squires 1964;
Squires 1990.





Robust brownish shrimp. No rostrum, eyes in a single socket. Posterior ends of carinae on 6th abdominal somite produced as sharp points; mid-dorsal carina on carapace with 2 spines; abdominal somites 2-5 with mid-dorsal carina, two on 6th. First legs subchelate, stout; 2nd legs chelate slender. Dactyls of 4th and 5th legs wide and flat, shovel-like.

Distribution in western Atlantic from Canadian arctic islands and Hudson Bay to Nova Scotia; Arctic Ocean from Cambridge Bay to Beaufort Sea, and Bering Sea to Sea of Japan and San Juan Islands (Washington) in northern Pacific (Butler 1980; Squires 1965, 1967, 1968, 1969). Depths intertidal to 2,000 m (Vinogradov 1950).

In our records from Queen Elizabeth Islands, Cambridge Bay to Beaufort Sea, Hudson Bay, Foxe Basin, Ungava and Frobisher Bays, Labrador, Grand Banks, Gulf of St. Lawrence (Inset map). Temperatures ususally below 0 C. but from -1.1 to 4.6 degrees C. and depths 12-320 m (Figs. 8 and 9).

Cod was a predator at Nachvak (28-37 m), Grand Banks (60-180 m), Fortune Bay (180 m) and southwest Gulf of St. Lawrence (45-90 m) (Table 44). Brunnich's murre was a predator also at Akpatok Island, Ungava Bay; and Beluga whales in Hudson Bay, as well as ringed,

bearded and harbour seals in Ungava Bay (Squires 1957, 1965a, 1967a, and Tuck and Squires 1955).

Associated species in deep water were Pandalus montagui and Sabinea septemcarinata; in shallow water Spirontocaris spinus and other Thoridae (Fig. 7).

Stomach contents were phytobenthos, foraminiferans, crustacean fragments and small bivalves. Ostracods, gastropods and polychaetes were infrequent (Table 45).

Mandibles are as in Crangon (Fig. 26) but inner inferior cusp of molar rounded at the tip rather than sharp pointed.

In Newfoundland average cl of males was 15 mm (8-31 mm cl) and females 20 mm (9-28 mm cl). Ungava Bay and Foxe Basin specimens were smaller: males 14 mm cl and females 16 mm cl average (Table 25).

Ovigerous females had eyed embryos in autumn. Eggs would be carried through the winter. A higher percentage ovigerous in May than in June and none in July indicate spring hatching. Forty-one percent of mature females were ovigerous in autumn indicating possible biennial spawning (Table 26).

Frechette et al (1970) demonstrated that in some populations of this species it is protandrous with a change to female sex at about 2 years. Females live to about 5 years and some are primarily female. Temperatures were -0.2 to 3.2 C.

Table 25. Lengths of A. dentata collected from localities in the area of investigation from 1946-60.

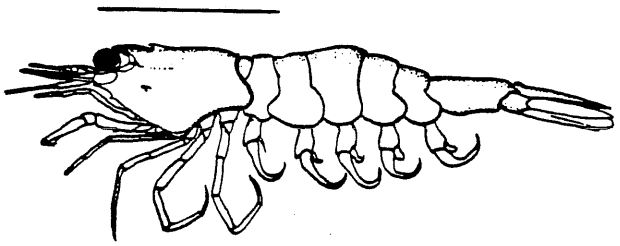
Localities		Newfoundland	Newfoundland and Labrador	Foxe Basin	Ungava Bay
Depths m		55-320	180-300	0-160	18-130
Temp. C		-1.4 to 1.8	-1.1 to 0.6	-1.5 to 0.2	-1.2 to 2.1
Average cl mm	M	15	12	12	14
	F	20	19	17	16
Range of cl mm	M	8-31	12-14	11-16	9-24
	F	9-28	14-23	12-27	7-24
Numbers examined	M	64	8	48	41
	F	269	20	35	73

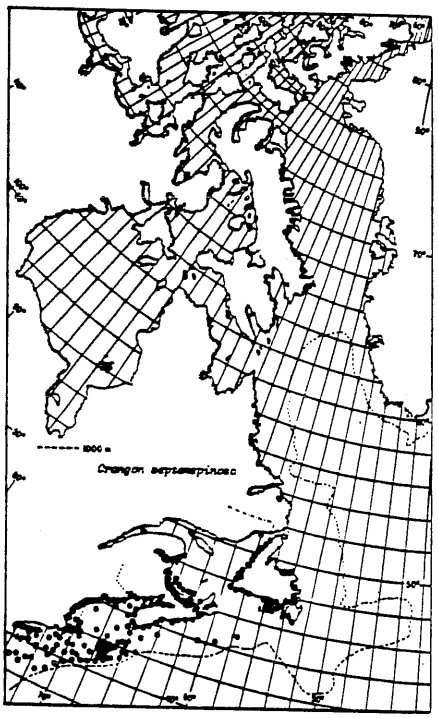
Table 26. Maturity of A. dentata collected in Foxe Basin and Newfoundland in August and September.

cl mm	Males		Females		
			Non-ovigerous		Ovigerous
	Small vd	Large vd	Small ova	Large ova	Small ova
8, 9	3		1		
10, 11	1	7	1	1	
12, 13	1	24	6	0	
14, 15		9	12	0	
16, 17		1	3	1	
18, 19			4	3	
20, 21			2	3	3
22, 23			2	2	0
24, 25			1	0	2
26, 27				2	1
Totals	5	41	32	12	6
% potentially breeding annually	95				37

Crangon septemspinosa Say, 1818.

Rathbun 1904, 1929;
Squires 1990.





"Sand shrimp" (Crevette de sable). Small brownish grey shrimp easily captured by handnet in shallow water on sandy bottom or in eelgrass beds. First legs stout, subchelate. Three conspicuous spines on carapace one median dorsal behind short rostrum others one on each side in hepatic area. Fourth and 5th legs larger than 2nd and 3rd, with dactyls flattened for burrowing in sand.

Direct comparison of specimens of C. crangon from Northumberland with C. septemspinosa from Port au Port Bay, Newfoundland (they survived a trip across the Atlantic and were kept in an aquarium for several months) revealed some minor differences (Fig.32). The tip of the antennal scale in Cs is more frequently truncate than rounded. Very few Cc were seen in which the antennal scale approached even the rounded form achieved by Cs. The apical spine of the scale in Cc is always shorter in comparison with that of Cs which always exceeds the distal end of the scale. Other constant but minor differences in the mouth parts give support to separating the species. These are:

a. The 1st maxilliped in Cs has 2 stout and long plumose setae laterally and just distal to the many shorter and thinner ones. Below the joint of the endopod with the basis there are laterally 5 plumose setae. In these positions Cc has but 1 stout and long seta and about 9 setae, respectively.

b. The 2nd maxilliped has 4 stout spines along the outer edge of its distal part in Cs while there are 5 such spines in Cc.

Incidentally, a comparison between C. septemspinosa and C. alaskensis is given by Squires and Figueira (1974).

Distribution only in the western Atlantic from the Straits of Belle Isle to Florida. Whitely (1948) gives the northern limit of this species as Baffin Bay, without reference to his source of information, but this is incorrect. Confusion with the record of Sabine (1824) of Crangon septemcarinatus = Sabinea septemcarinata and with the wrong naming of Sabinea septemspinosa by Boone (1930) is possible. Rathbun (1904) reports C. septemspinosa from the northern Pacific but this is doubtful.

In our records from many sandy or eelgrass areas around the coast of Newfoundland as far north as Notre Dame Bay on the east coast. Also from the Grand Banks. Most specimens were collected in Port au Port Bay in the Gulf of St.Lawrence (Inset map). Temperatures are very variable in the shallow waters frequented by this species, reaching at least 26 degrees C. in summer at Port au Port Bay. But these waters may be as low as -1.4 degrees C. in winter. This shrimp may therefore migrate away from the shore into deeper water in winter. Meredith (1952) states that Crangon crangon which usually migrates offshore to deeper water in winter sometimes remained in the Dee estuary even during severe winter conditions. Where fresh water is present such as in Two Guts, Port au Port Bay, temperatures remain above 0 degrees C. (0.5 C where smelt were being netted), and this may occur over eel grass beds where fresh water mixes with sea water as in barachoix ponds on the Newfoundland coast. Depths were 0-35 m.

No other shrimps were collected at the eel grass (Zostera sp.) beds investigated, but shore crabs, Cancer irroratus, were occasionally present. Mysis mixta, however, was schooling in considerable numbers and formed the principal food of C. septemspinosa, some being taken whole in stomachs. Amphipods,small gastropods (Littorina sp.) and small bivalves were also in stomachs of this species.

Mandibles have no incisor or palp in this species. Molar in two parts, the inner with 2 long equal cusps, the outer with unequal cusps the superior one smaller. All sharp-pointed (Fig. 26).

Average sizes of males 4 mm cl (range 3-12 mm) and females 5 mmcl (3-12 mm), juveniles and megalops not included (Fig.). Growth in a female specimen 9 mm cl in an aquarium at 10 to 19 degrees C. and fed mussel gonads daily was 0.5 mm cl per moult per month. This growth increment was less than in C. crangon 10 mm cl which moulted also once a month and gained 1.0 mm cl under similar conditions.

In Europe two and three annual spawnings have been observed in C. crangon (Meredith 1952). Spring and summer spawnings occurred

in the Bristol Channel, the Dee estuary and at Morecombe Bay. A resting period occurred in September to November in these areas but a few females carried eggs in winter. Lloyd and Yonge (1947) also concluded that the species spawned twice annually. Price (1962) working with C. septemspinosa in Delaware Bay found that it was not ovigerous in winter but spawned in spring and laid a second batch in summer after the first batch released larvae. Berkeley-Needler (1941) found that C. septemspinosa hatched its larvae in Mid June to July in the southern Gulf of St. Lawrence.

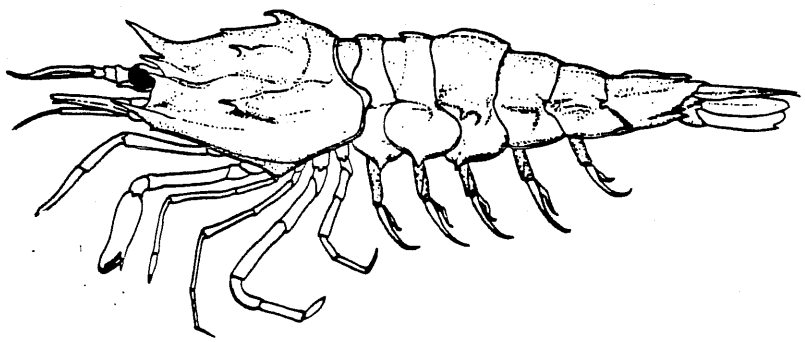
Samples of C. septemspinosa at Port au Port Bay from May to September indicated that two batches of eggs were laid and hatched (Table 27). Ovigerous females with eyed embryos had large ova in ovaries ready to be laid. Also large numbers of larvae appeared in samples in June and September but not in other months. It appeared therefore that the first batch of eggs was laid in spring or early summer and the second in August (Table 27). No eggs were carried in winter.

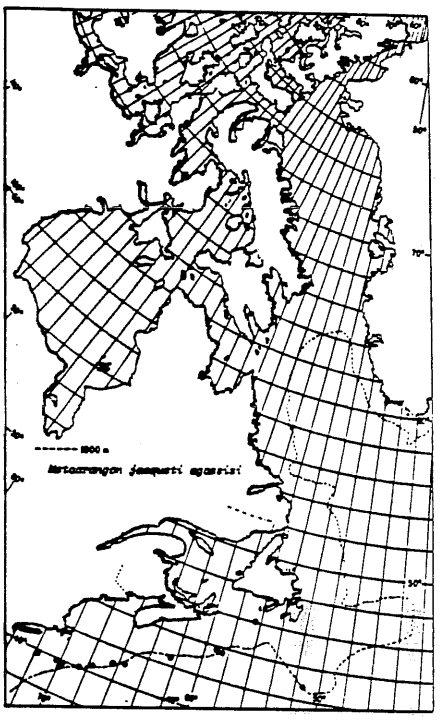
Table 27. Maturity of female C. septemspinosa in samples from Port au Port Bay, Newfoundland, May-September, 1961-62.

	May	June	July	Aug.	Sept.
Megalopas	0	0	0	0	176
Juveniles or immatures	14	65	23	0	186
Matures	10	42	18	4	94
cl (mm) when first mature	4	4	5	6	5
% ovigerous	0	41	11	50	0
% overigerous with eyed embryos		41	50	0	
% ovigerous with large ova		14	100	0	
% non-ovigerous with large ova	21	19	10	0	0

Metacrangon jacqueti agassizi (Smith, 1882)

Crosnier et Forest 1973;
Sivertsen and Holthuis 1956;
Squires 1990.





Large rough shrimp, colour light brown with yellowish markings. Carapace and abdomen srongly sculptured, carinate with very strong median frontal spine over short rostrum; 2 other median spines on carapace the middle one small, also a submedian spine on each side and a spine on the hepatic area with carina. Branchiostegal spine strong with carina also. Abdominal somites with mid-dorsal carina, the 6th somite with 2 parallel; pleura of 1st to 3rd somites with ventro-lateral spine.

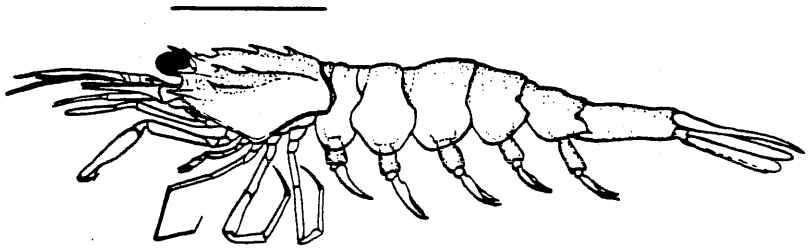
Distribution in western Atlantic only between 32 degrees N. Lat. and 48 degrees N. Lat. Depths 480-1754 m. (Crosnier et Forest 1973).

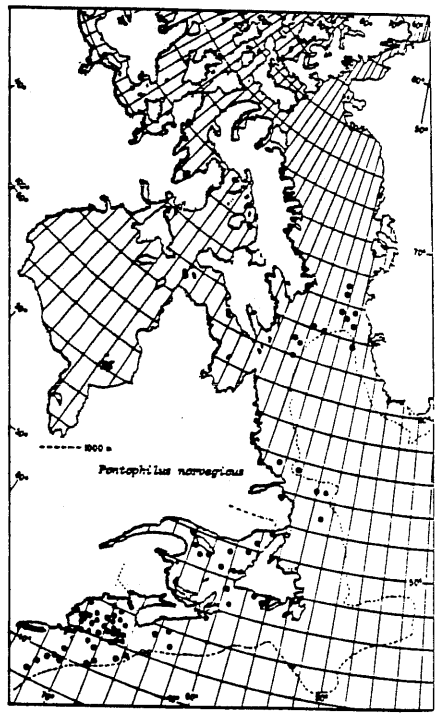
From south of the Burin Peninsula and on the Grand Banks (Inset map).

Specimens examined male 12 mm cl and female 13 mm cl. Egg diameter 2.3 mm. A specimen 9 mm cl taken southeast of Newfoundland had a bopyrid parasite in the left branchial chamber (Sivertsen and Holthuis 1956).

Pontophilus norvegicus (M. Sars, 1861)

Rathbun 1929; Williams 1984;
Squires 1990.





Medium shrimp brownish, mottled with some oblique whitish bands. Mid-dorsal carina on carapace with 3 teeth, and two lateral carinae, the upper with 2 teeth and the lower 1 tooth. Rostrum sharp not as long as eyes, pointing upwards, spine at its base on each side not as long. Abdomen with 2 carinae on 6th somite.

Distribution in western Atlantic from Greenland to Maryland, USA. In eastern Atlantic from Spitzbergen to British Isles and Balearic Islands (Forest 1965; Williams 1984). Depths 50 - 1450 m (Sivertsen and Holthuis 1956).

In our records from deep water off Labrador, Trinity Bay, southeast edge of the Grand Bank, Hermitage Bay, Southwest-Newfoundland Channel and Cabot Strait (Inset map). Depths 225-660 m and temperatures 0.6 to 5.5 degrees C. (Figs. 8 and 9).

Other species in catches were Pandalus borealis, Sergestes arcticus, Pasiphaea tarda and Sclerocrangon ferox.

Stomach contents phytobenthos, foraminiferans, crustacean fragments, polychaete remains. Large molar has two cusps only and no accessory teeth; a slight protuberance at base of outer cusp (Fig. 26).

Average cl in males 11 mm (range 9-12 mm cl) and females 14 mm (range 9-19 mm cl).

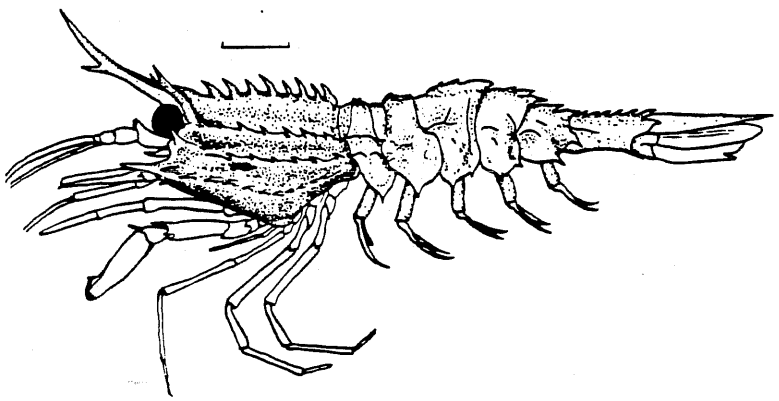
Females first reached maturity at 10 mm cl. About 90% were potentially ovigerous in autumn (Table 28). This suggests annual spawning. No ovigerous females in June and July indicating spring hatching. Eggs 1.3 mm but one with eggs 1.8 mm in November.

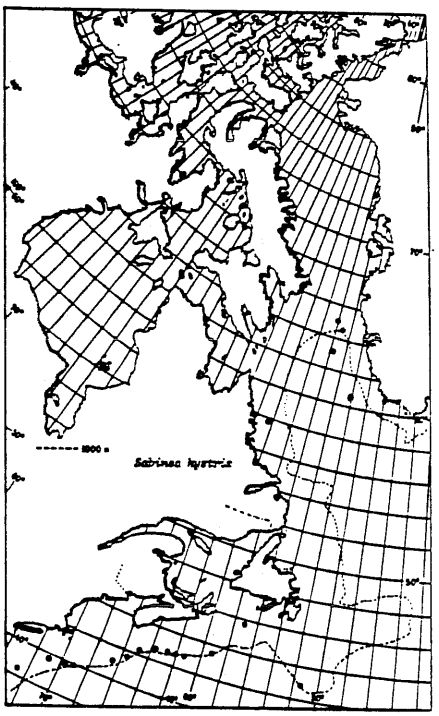
Table 28. Maturity of P. norvegicus collected in Newfoundland and Labrador from July-December.

cl mm	Males		Females		
			Non-ovigerous		Ovigerous
	Small vd	Large vd	Small ova	Large ova	Small ova
9		2	1		
10	1	0	0	1	
11	3	1	0	1	
12	1	2	2	11	2
13			1	11	0
14			3	12	1
15				16	1
16				11	0
17				3	1
18				1	
Totals	5	5	7	67	5
% potentially breeding annually		50			91

Sabinea hystrix (A. Milne-Edwards, 1881)

Crosnier et Forest 1973;
Sivertsen and Holthuis 1956;
Squires 1990.





Very rough-looking and spiny brownish shrimp; seven longitudinal carinae the mid-dorsal with about 8 strong teeth, the others with many smaller but strong teeth. Rostrum a spike, a strong ascending sharp spine with one ventral spine on distal third and two lateral spines on proximal third. Abdominal somites with spiny carinae, the 5th with two diverging and the 6th with two parallel with strong spines.

Distribution in western Atlantic only from Greenland to the West Indies in deep water. Depths 550 - 3600 m (Sivertsen and Holthuis 1956).

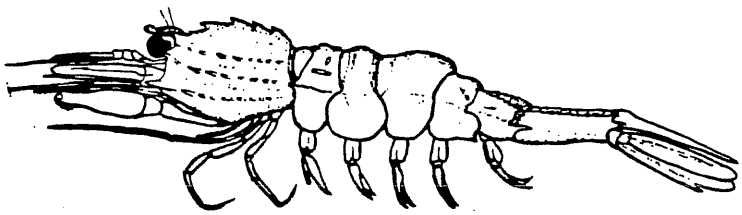
The "Michael Sars" took 3 specimens at Station 70 southeast of Newfoundland at 1100 m (Sivertsen and Holthuis 1956). In our records from Cape Mugford, Labrador in 750-770 m and temperature of 4.0 degrees C. Also south of Burin Peninsula and on the southwest edge of the Grand Bank (Inset map).

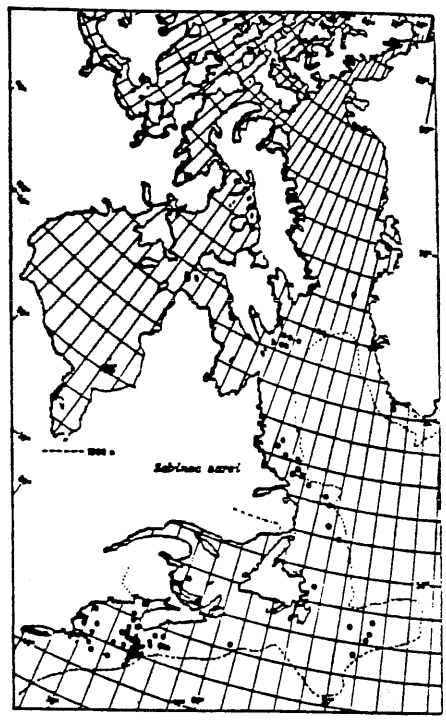
Other species present in the catch were Acanthephyra pelagica and Pasiphaea tarda.

Female 25 mm cl, ovigerous. Egg 2.3 mm.

Sabinea sarsi Smith, 1879

Rathbun 1929; Williams 1984; Squires 1990.





This species resembles S. septemcarinata with its greyish brown coloration and seven spiny longitudinal carinae on the carapace (mid-dorsal with 5 moderate teeth, others smaller teeth), but its rostrum is longer than the eyes and pointed, flattened vertically at the tip. Abdomen carinate on all somites, double on the 1st, 5th divergent and 6th parallel.

Distribution in western Atlantic from Greenland, Davis Strait to Cape Cod. In eastern Atlantic from Iceland to northern Europe (Rathbun 1929). Depths 48-710 m (Williams and Wigley 1977).

In our records from off the east coast of Baffin Island, Labrador and northeast of Newfoundland and the Grand Banks, and Hermitage Bay (Inset map). Temperatures -0.6 to 4.1 degrees C. and depths 155-550 m (Figs. 8 and 9).

Stomach contents phytobenthos, crustacean fragments including amphipods and copepods, and polychaetes.

Mandible molar with two strong fangs the inner with a subsidiary tooth and outer with cutting edge (Fig. 26).

Although the number of specimens collected was small, the breeding cycle seemed to follow the usual pattern of late summer or autumn

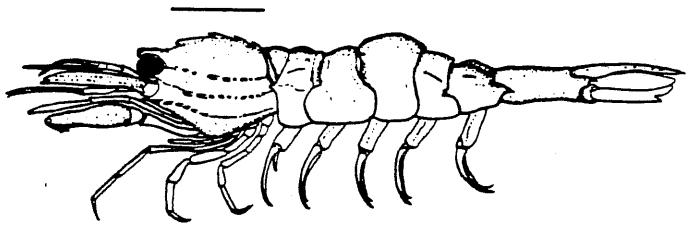
laying of eggs which would hatch in spring. About 88% were potentially ovigerous in autumn indicating annual spawning (Table 29).

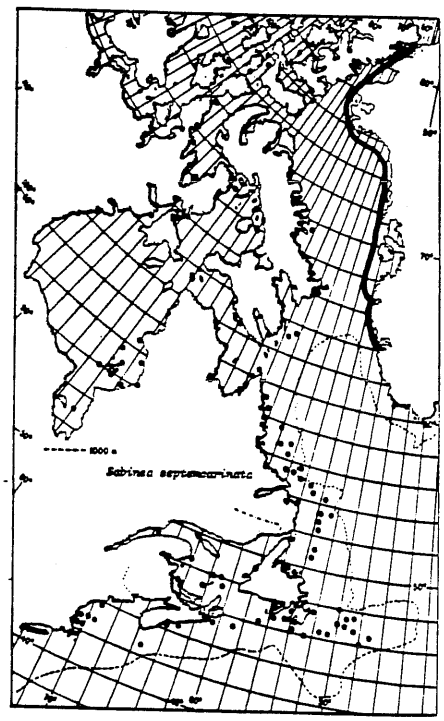
Table 29. Maturity of S. sarsi collected off Labrador in August and September.

cl mm	Males		Females		
			Non-ovigerous		Ovigerous
	Small vd	Large vd	Small ova	Large ova	Small ova
9	2				
10	0				
11	1	2			
12		1	2	3	3
13		0	1	1	6
14		1	0	2	4
15			0	0	2
16			1	1	2
17				1	4
18-20				1	
Totals	3	4	4	9	21
%potentially breeding annually	80			88	

Sabinea septemcarinata (Sabine, 1824)

Rathbun 1929; Williams 1974;
Squires 1990.





Medium shrimp, brownish red mottling on greyish background, darker than in S. sarsi. Rostrum short with rounded tip. Middorsal carina on carapace with 4 teeth and anterior tubercle; lateral carinae 3 on each side. Dorsal carinae on all abdominal somites, two divergent on 5th without teeth and two parallel on 6th with small teeth.

Distribution in Arctic Canada, Hudson Bay and Greenland to Cape Cod in western Atlantic. In eastern Atlantic from Kara, White and Barents seas to Faroe Islands and British Isles. Point Barrow, Alaska, to Chukchi Sea (Makarov 1941; Allen 1967; Williams 1984). Depths 0-406 m (Heegaard 1941).

In our records Beaufort Sea to Cambridge Bay, Queen Elizabeth Islands, Hudson Bay, Foxe Basin, Ungava Bay, Frobisher Bay, Davis Strait to the Grand Banks and in the Gulf of St. Lawrence including Bay of Islands (Inset map). Depths from 45-345 m and temperatures mostly below 0 degrees C. (Fig. 8 and 9). (Squires, 1957, 1962, 1966, 1967, 1968, 1969).

Predators were cod from Labrador, Grand Banks and northern part of the Gulf of St. Lawrence; also from bearded seals and beluga whales from farther north.

Associated species were mainly Lebbeus polaris, Argis dentata and Pandalus montagui (Fig. 7).

Stomach contents were phytobenthos and crustacean fragments (mostly gammarid amphipods and Diastylus sp.) and occasionally polychaetes from Labrador and Newfoundland; phytobenthos and polychaetes, gammarid amphipods and ostracods from Foxe Basin (Table 45).

Mandibles similar in S. sarsi (Fig.26) but outer subsidiary cusp larger and with cutting edge. Inner subsidiary cusp small and with cutting edge.

In Newfoundland and Labrador males averaged 11 mm cl and females 14 mm cl. Males were slightly smaller in Foxe Basin (Table 30).

From percentages ovigerous in spring and autumn (Table 31), egg laying appeared to be annual. Autumn samples from St. Mary's Bay and Trinity Bay had ovigerous females with eyed embryos. Spring hatching occurred in St. Mary's Bay, north of Green Bank and off Nachvak, Labrador. Eggs averaged 1.9 mm diameter.

Table 30. Lengths of S. septemcarinata collected in localities in the area of investigation during 1946-60.

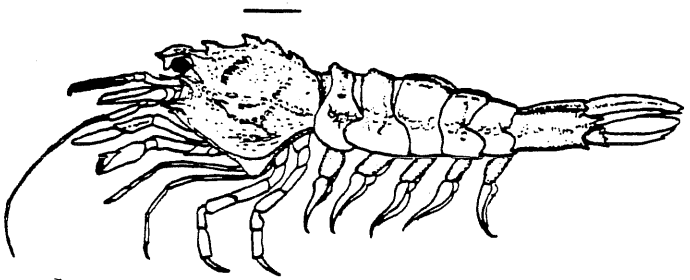
Locality		Newfoundland	Newfoundland and Labrador	Foxe Basin	Ungava Bay
Depths m.		60-350	75-315	36-160	15-130
Temp. C		-1.1 to 5.2	-1.4 to 0.9	-1.4 to 0.2	-1.2 to 3.1
Average cl mm	M	11	10	9	11
	F	14	13	14	13
Range of cl mm	M	5-18	7-16	5-12	10-13
	F	7-19	7-19	3-21	8-18
Numbers examined	M	22	43	19	4
	F	110	174	18	8

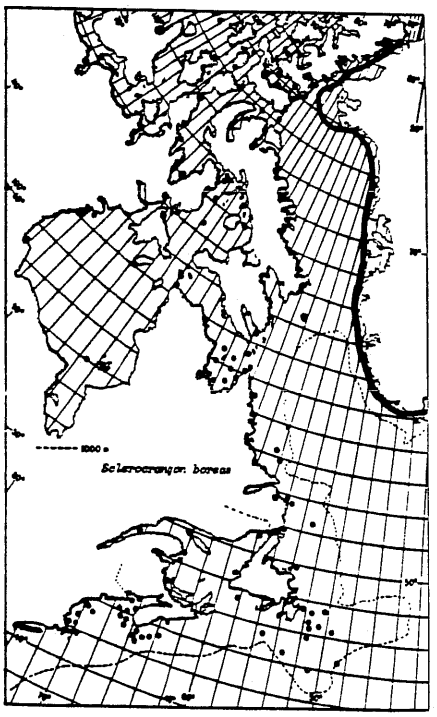
Table 31. Maturity of S. septemcarinata collected in Foxe Basin, Labrador and Newfoundland in August and September.

cl mm	Males		Females		
			Non-ovigerous		Ovigerous
	Small vd	Large vd	Small ova	Large ova	Small ova
6	1		1		
7	5		1		
8	9		2		
9	11	1	10		
10	4	14	7		1
11	2	12	12		0
12	0	5	22	2	1
13	0	1	19	9	5
14	0		5	13	3
15	0		7	12	6
16	1		3	11	5
17			2	7	1
18				6	0
19				1	1
20, 21				1	1
Totals	33	33	91	62	24
% potentially breeding annually	67			60	

Sclerocrangon boreas (Phipps, 1774)

De Man 1920; Rathbun 1929;
Squires 1957; Butler 1980;
Williams 1984; Squires 1990.





Large, chunky and rough-looking shrimp brownish in colour with darker markings. Rostrum short, hollowed above with acuminate tip and rounded below. Carapace with rough mid-dorsal carina with three low teeth, the middle one double; branchiostegal spines about even with rostrum. Second leg slender chelate about as long as 1st which is subchelate and stout. Abdomen carinate middorsally and laterally on all somites, double dorsally on3rd to 6th and without spines.

Distribution from Canadian Arctic, Hudson Bay, Foxe Basin, Queen Elizabeth Islands, Ungava Bay, Davis Strait, Greenland to Cape Cod in the western Atlantic, and from Kara and White Seas to British Isles and Faroes in eastern Atlantic. Circumpolar. Arctic Ocean from Siberia and Alaska, Bering Sea to British Columbia. Depths 0-400 m.

In our records from Cornwallis Island, other Queen Elizabeth Islands, Foxe Basin, Hudson Bay, Ungava and Frobisher Bays and northern Labrador to the Grand Banks. Gulf of St. Lawrence and southwest coast of Newofundland (Inset map). Shallow water from 12-140 m and low temperatures -1.4 to 0.6 degrees C.

Associated species Pandalus montagui, Sabinea septemcarinata, Argis dentata, Spirontocaris spinus, Lebbeus polaris and Eualus fabricii.

Predators were cod (Gadus morhua) and longhorn sculpin (Myoxocephalus octodecimspinosus).

Stomach contents were phytobenthos, foraminiferans. small bivalves, hydroids and crustacean fragments (gammarid amphipods, ostracods, isopods and copepods) (Table 45).

Mandible molar with two fangs each with one large cusp, outer with cutting edge (Fig. 26).

Specimens from deep water were larger than those from shallow areas (Table 32).

In Foxe Basin and Labrador 65% of the mature females were potentially ovigerous indicating annual spawning (Table 33).

Table 32. Lengths of S. boreas collected from localities in the area of investigation from 1946-60.

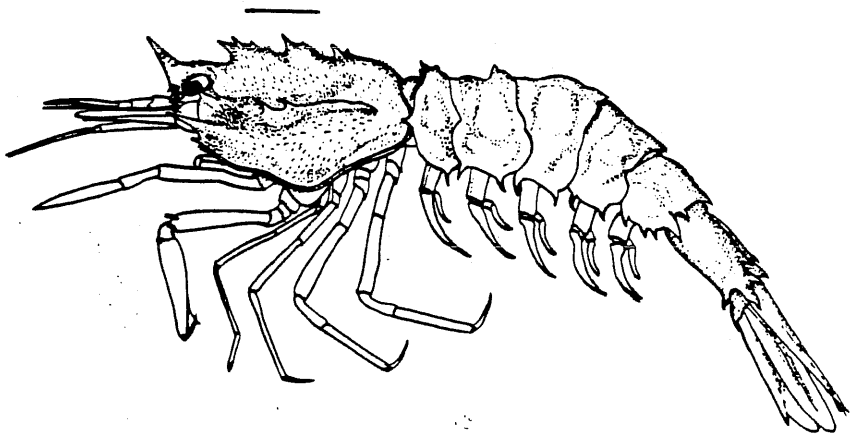
Locality		Newfoundland	Newfoundland and Labrador	Foxe Basin	Ungava Bay
Depth m		75-105	105-140	12-110	18-91
Temp. C		-0.3 to 1.2	-0.6 to 0.6	-1.5 to 3.8	1.9 to 2.1
Average cl mm	M	19	18	13	16
	F	21	27	19	22
Range cl mm	M	19	8-24	3-15	8-24
	F	15-26	11-35	5-28	7-28
Numbers examined	M	1	10	4	16
	F	6	15	7	48

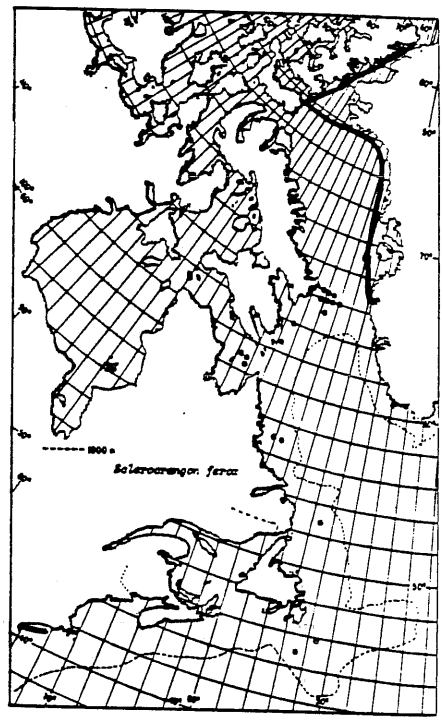
Table 33. Maturity of S. boreas collected in Foxe Basin and Labrador in August-September.

cl mm	Males		Females		
			Non-ovigerous		Ovigerous
	Small vd	Large vd	Small ova	Large ova	Small ova
5-10		1	1		
11-15		3	1		
16-20		2	3		
21-23		3	2	1	
24-26		1	0	4	
27-29			3	6	
30-32			2	4	
33-35				4	2
Totals		10	12	21	2
% potentially breeding annually		100		77	

Sclerocrangon ferox G. O. Sars, 1877

De Man 1920; Blacker 1957;
Squires 1990.





Large brownish shrimp similar in appearance to S. boreas but much more spiny. Rostrum prominent, ascending, sharp, ventral keel also pointed, deep. Carapace strongly sculptured, mid-dorsal carina with 3 strong teeth which have accessory teeth; and strong lateral carina with two spines on each side. Antennal spines long and very sharp about even with tip of rostrum. Abdominal somites carinate and spiny, pleura with strong ventral spines.

Distribution in deep water in the Arctic Ocean, reported from Siberia, probably circumpolar. In the western Atlantic from Greenland, off Baffin Island, and Ungava Bay to the eastern slope of the Grand Banks. Eastern Atlantic from Kara Sea to the Shetlands. Depths 90 - 1000 m (de Man 1920).

In our records from east coast of Baffin Island, Ungava Bay and off Cape Mugford, Labrador. Also off Hamilton Inlet Bank and on the Grand Banks near Avalon Channel. Depths 275-735 m and temperatures -0.5 to 3.6 degrees C. Blacker (1957) records all temperatures below 1 degree C. for this species in the Barents Sea.

Associated species were Bythocaris payeri, Pandalus borealis, Sabinea sarsi and Lebbeus polaris off Labrador and Pandalus montagui, Spirontocaris spinus and Lebbeus polaris in Ungava Bay (Fig. 7).

Stomach contents phytobenthos, crustacean fragments (mostly gammarid amphipods), and polychaetes. Also ophiuroids, gastropods, bivalves and sponge spicules occasionally (Table 45).

Mandible molar with 4 subequal fangs outer one with acessory cusp (Fig. 30).

Average lengths of males 18 mm cl (15-24 mm cl) and females 22 mm (12-31 mm cl).

Females first mature at 21 mm. About 50% were potentially ovigerous in autumn (Table 34) indicating annual spawning since these have late maturity. In August half the ovigerous females had eyed embryos. Egg diameter 3.1 mm.

Table 34. Maturity of S. ferox collected off northern Labrador and Baffin Island in August and September.

cl mm	Males		Females		
			Non-ovigerous		Ovigerous
	Small vd	Large vd	Small ova	Large ova	Small ova
14			2		
15		3	2		
16		9	0		
17		19	2		
18	1	5	9		
19		2	6		
20		2	1		
21		1	1	1	
22		0	3	1	
23		1	2	0	1
24		1	0	3	0
25			1	1	3
26				7	3
27				3	2
28-31				3	
Totals	1	43	29	19	9
% potentially breeding annually		98			80

Suborder REPTANTIA

These species are oriented towards walking on the substrate rather than swimming above it as in shrimps (NATANTIA).

Key to Infraorders of the Reptantia

1. Sternite of last thoracic somite free or modified from the others

   Telson asymmetrical or with sutures ..... ANOMURA
   Telson symmetrical and without sutures ..... THALASSINIDEA

   Sternite of last thoracic somite not free from others 2

2. Abdomen large, symmetrical; uropods and developed into a tail fan

   First three pairs of pereopods chelate ..... ASTACIDEA
   First four or no pereopods chelate ..... PALINURA

   Abdomen small, dorsovetrally flattened, symmetrical recurved to the sternal face of the enlarged cephalothorax and tail fan not developed; uropods rudimentary or none ..... BRACHYURA

Key to Families of the Anomura

1. No uropods; abdomen strongly calcified and pressed against sternum as in Brachyura ..... LITHODIDAE

   Uropods present; abdomen soft and with reduced pleura and terga 2

2. Uropods and telson asymmetrical; uropods modified to hold body in shell

   Two genital openings; males without sexual pleopods ..... PAGURIDAE
   One genital opening; males with sexual pleopods ..... PARAPAGURIDAE

   Uropods symmetrical, unmodified; telson sutured .. GALATHEIDAE

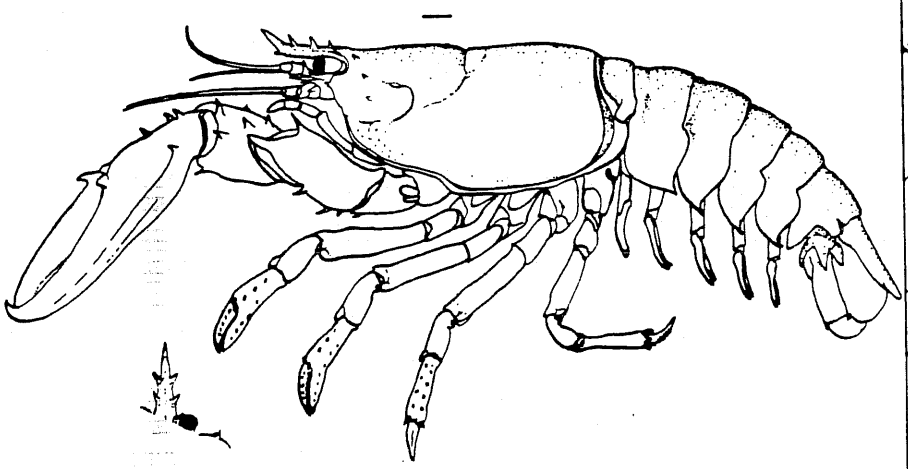
Infraorder ASTACIDEA

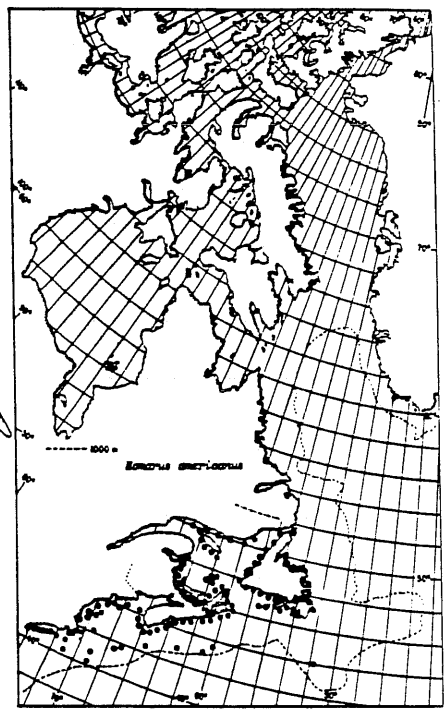
Family NEPHROPIDAE Dana, 1852

Lobsters; first legs chelate, very large, 2nd and 3rd legs chelate much smaller.

Homarus americanus H. Milne-Edwards, 1795

Holthuis 1974; Williams 1984; Squires 1990.





The American lobster (Le homard americain). Very large decapod, dark greenish above and reddish below particularly on claws; similar to the European lobster (H. gammarus) but the latter is bluish above with pale orange below and its surface texture is granulate giving it a dull finish while the former is smooth and shiny. The first legs are massive with huge claws the right and left unequal. Rostrum prominent hollowed above with strong lateral teeth. Abdomen smooth but pleura with sharp spines ventrally. Tail fan large, effective in fast swimming during escape manoeuvre.

Distribution from the Straits of Belle Isle to Cape Hatteras in the western Atlantic only. Common in all Newfoundland coastal areas except from Cape St. John to Cape Bauld. Depths 4-50 m in coastal areas but to 480 m on the edges of the continental shelf (Williams and Williams 1981).

Lobsters have occasionally been taken on the Grand Banks and St. Pierre Bank but nearshore banks in Newfoundland do not generally have any lobsters. They appear to occupy a narrow area around the coast where their migrations seem to be restricted by headlands.

Ecology. Primarily sedentary there are some reports by reliable fishermen of mass swimming "between two waters" that have been observed in the past when lobsters were very abundant. Schooling might be initiated by the attainment of threshold numbers such as occurs in fishes and probably shrimps (Dr. H. O. Bull, pers. comm.). Lobsters generally occupy shelters under rocks or hollowed out depressions in soft bottom (Wilder 1959). They appear to occupy and defend territory as demonstrated in aquaria in 1962. Dominance was apparent and a hierarchy of individuals could be worked out in the seven females of equal size used in an aquarium experiment on behaviour. This may have some consequence for lobsters tagged and released on unfamiliar grounds, since their finding new shelters might be conditioned by dominance and a newcomer might be at a disadvantage and subject to predation by fishes in the area more than others occupying the shelters.

Commensals observed were Unicalteutha ovalis, a harpacticoid copepod, on theclaws and legs ofall specimens examined. Also the bryozoan, Alcyonidium sp. on claws, antennae, etc., hydroids, Spirorbis sp., Balanus sp. and occasionally Anomia sp. on losters with shells a year old or so in Port au Port Bay (See also Dexter 1955).

Larval lobsters are under predation by fishes and probabaly sea birds (but see Mills 1956). As Stage I and II larvae they are positively phototrophic and spend some time near the sea surface during daylight (Templeman and Tibbo 1945) where they were taken with a plankton net towed at the surface. In August and September, 1962 we towed a 50 cm diameter No. 000 mesh plankton net at the surface daily, whenever weather permitted, at stations distributed over Port au Port Bay in order to determine occurrence of early stage larvae in surface currents of the bay. This work was preliminary in nature but results indicate that larvae maintained a nearshore position (distance not exactly determined but between 100 and 200 m from shore) in spite of surface currents, although subject to some wind drift. During severe onshore wind storms the breakers were repeatedly swept with a small-mesh hand net to see whether the larvae or other zooplankton would drift ashore. Although minute inanimate flotsam and jetsam were continuously brought to the shore and stranded by onshore wind currents, zooplankton including lobster larvae did not drift ashore. Debris at the landwash was examined with a microscope repeatedly and no live organisms were found.

As soon as the storm abated, however, the waves decreased quickly, a boat was able to be launched and the nearshore zone was sampled with a plankton net as soon as possible. Up to 500 lobster larvae and

considerable quantities of other zooplankton including the copepod Centropagessp. were taken invariably after these onshore winds. When winds were offshore lobster larvae were also found near shore but in much smaller numbers. Larvae were taken only rarely over the deeper water of the bay. It is suggested from these results that lobster larvae are not necessarily at the mercy of wind induced currents (Templeman and Tibbo 1945), but can maintain position by moving up or down in the water column and taking advantage of counter currents near the bottom when surface currents would sweep them offshore. It could also be stated as a principle that live zooplankton does not drift ashore. Planktonic organisms have evolved habits to avoid being cast up on the shore. Those that didn't, no longer exist, nor have they through the eons.

The method of towing a plankton net from a motorized dory was by using a long pole strapped to the thwarts with a rope reeved through a block at the tip attached to the plankton net. This allowed the plankton net to be towed ahead of the boat at the surface. Plankton would therefore not be disturbed by the boat before the net reached it.

Lobsters appear to have few parasites or disease organisms. However, a blood disease, Gaffkaemia, has been demonstrated in lobster populations of Nova Scotia by Stewart and MacDonald (1962). It is believed that unusual mortalities are not caused by Gaffkya homari in the population at large, but it has been shown (McLeese and Wilder 1964) that it may be an important causative agent for deaths in lobsters held in large numbers in storage tanks at comparativly high temperatures. Sampling the healthy population at large in Port au Port Bay during May to August in 1961 and 1962 has shown that this disease organism is most likely not present in this bay. [The ordinary methods of bacteriological technique were used but are not described here. Human blood agar plates were used to culture the lobster blood smears in 1961 and sodium-azide-dextrose broth in 1962. Slides of lobster blood smears stained in Gram's stain were also made in 1962.] In general it may be said that a natural immunity may be present in populations which have this organism present, and if these were stored with non-immune lobsters, the possibility of infection and mortality would be enhanced. A knowledge of natural incidence of Gaffkya in each area would therefore be desirable in order that non-immune lobsters could be stored separately.

Stomach contents of lobsters were Littorina sp., Cancer irroratus, fish bones, polychaete fragments (jaws, etc.), whelk remains including opercula and shell fragments, small lobster or crab, hermit crab, small bivalves, Patella sp., Mytilus sp., brittle stars, sea stars, sea cucumber, and occasional pieces of Chondrus crispus and kelp.

Mandibles massive, molar heavily calcified lying as a shelf behind chitinous capped incisor, the latter with undulations at the biting edge; palp three-segmented, the middle longest.

Size, exploitation and growth. The average size of lobsters in commercially exploited populations may be considerably different from place to place around the Newfoundland coast (Templeman and Tibbo 1945). Important factors governing these size differences are the varying rate of growth of lobsters in different areas and the equally varying rate of exploitation of these populations. In Port au Port Bay the average lengths were males 90 mm and females 87 mm cl in 1961 and 92 mm cl, 90 mm, respectively in 1962. These were measured from samples caught in commercial traps which are designed to catch lobsters greater than 81 mm cl. If exploitation and growth rates were unchanged from year to year, average lengths could be expected to remain approximately the same in a given area. However, as indicated by Templeman (1948) and Wilder (1953) growth rates vary according to temperature and would therefore vary with temperature changes from year to year. In Port au Port Bay from 1961-63 temperatures at the lobster grounds followed a regieme of approximately 0 degrees C. during January, 3 degrees C. in April, to 14 degrees C. in August, 6 degrees C. in October and 3 degrees C. in December.

About 1200 lobsters, male and female, were marked in Port au Port Bay in 1962 by punching holes in the tail fan (punched in two appendages at a time giving 10 combinations each coded to a cl group of 3 cm in range). These were released at the end of the fishing season in July just preceding the time of moulting. One hundred fourteen of those moulted were recognized and re-measured in 1963 during the fishery. Average gain in cl of males ranged from 9.3 mm cl (at 77 mm cl) to 11.7 mm cl (at 102 mm cl), and of females 8.4 mm cl (at 77 mm cl) to 9.5 mm cl (at 100 mm cl). Age and growth have been observed in hatchery-grown lobsters (Hughes and Mathiessen 1962), and estimated from lobsters marked and released in their natural environment (Wilder 1953). Wilder estimated an age of 6 years for lobsters 81 mm cl from Northumberland Strait and 8 years at 100 mm cl. In hatchery-grown lobsters ages at these sizes would be 5 and 7 years, respectively. Since both of these groups would be grown at higher temperatures than in Newfoundland, our lobsters would most likely be older at these sizes. Two years of a lobster's life relates to the fishery when the legal minimum size is 81 mm cl. Recruitment and exploitation may be estimated if the rate of growth in these years is known. A method of doing this is as follows:

A general recruitment curve can be drawn to show the large number of larval lobsters which gradually decrease in numbers each year until large enough to enter the fishery (Curve B in Fig. 29). The decrease in number under exploitation is represented by curve C, and curve A shows accumulation of lobsters at larger sizes in an unfished population since moulting at large sizes might not be annual.

The curves of Figure 29 I are superimposed on a histogram of lengths of lobsters taken in the Port au Port fishery (Fig. 29 II) without relation to the actual percentages in the histogram. Superimposing also the above data on the annual average length increment, the actual recruitment to the fishable lobster population can be envisaged. When a sufficient number of lobsters in the annual catch is measured, the proportion of 1st year recruits representing one year and two years of growth past the legal minimum size can be estimated. In data from Port au Port Bay the proportion of 1st year recruits fished was 58% of the sample total in 1962 (Fig. 29II).

Also a metal tag was fastened to the carapace of lobsters with a rubber band as described by Wilder (1953) and the lobsters were released at the beginning of the fishery. This tagging and recapture during the fishery resulted in a return of 50% , indicating a lower rate of exploitation than the previous one. Expected error in small numbers used and tagging mortalities or losses could account for the difference. The estimate of proportion of 1st year recruits in the fishery by measuring the catch and knowing annual growth rate seems a more efficient and less costly method of estimating rates of exploitation than tagging and recapture. Overfishing should show up as an increase in the proportion of 1st year recruits in the fishery.

Maturity. Various authors (Dawson 1954) have observed that lobsters carry eggs for about eleven months before hatching occurs and that egg laying in many occurs only in alternate years. Measurements of ova in ovaries of lobsters carrying eggs in samples from Port au Port Bay always showed that such ova are small, so they could not be extruded as eggs when the eggs carried hatched out. However, non-ovigerous females with large ova in the ovaries ready to be extruded comprised about 60% in autumn. This was a higher proportion than the ovigerous females found in catches the following year (Table 35). This would indicate that ova may be resorbed in some females before extrusion. On the other hand as Templeman and Tibbo (1945) suggested, ovigerous females may not trap as readily as non-ovigerous ones, so fewer than expected ovigerous females would probably be captured.

Table 35. Maturity of female Homarus americanus collected at Port au Port Bay during June and July from samples in lobster traps. All specimens are larger than minimum commercial size (81 mm cl).

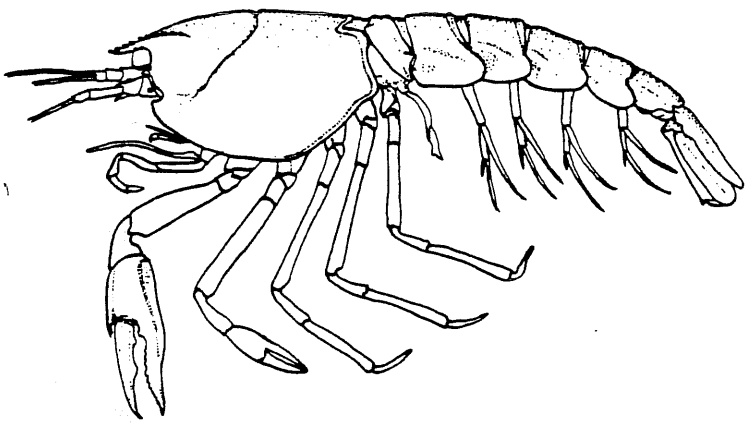
	1961		1962		1963	
	June	July	June	July	June	July
Numbers examined	79	57	39	35	46	85
% non-ovigerous with small ova	9	12	23	39	11	47
% non-ovigerous with large ova	84	74	49	40	61	29
% ovigerous	8	14	28	26	28	24

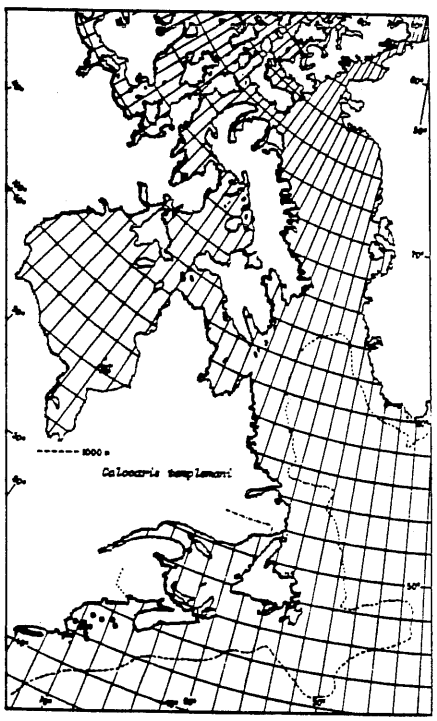
Family AXIIDAE Huxley, 1879

These "mud-lobsters" have the first two legs chelate, the first the larger. Fixed antennal thorns present.

Calocaris templemani Squires, 1965

Whiteaves 1901; Rathbun 1929; Squires 1965c; Williams 1974; Squires 1990.





Moderate-sized mud lobster, pale pink in colour. Rostrum and short spiny carinae forming a V at the front of the carapace, the rostrum sharp. First two pairs of legs chelate, the first much the larger chela. Eyes without pigment. A low carina on carapace, also a distinct cervical groove. Abdomen longer than carapace.

Distribution only in western Atlantic from Hermitage Bay in Newfoundland to the Gulf of Maine. It was previously identified as its congener in the eastern Atlantic, C. macandreae (Whiteaves 1901; Rathbun 1929).

Our record is from Hermitage Bay but the species has also been taken in the Gulf of St. Lawrence (Inset map).

Mandibles are large and heavily calcified, incisor slightly curved at the edge and with a tooth at inner corner; flat oval molar behind incisor; palp three-segmented.

Stomach contents phytobenthos, foraminiferans, small bivalve shell fragments, polychaete fragments.

The species is hermaphroditic. The one taken 14 mm cl, 44 mm tl was sexually mature with large ova 1.3 mm in diameter. Spermatophores were ready to be extruded and were attached to spermatophore ribbons at male openings. Caught in August.

It is burrowing in habit in soft mud. Depth 260 m. Temperature 4.9 degrees C.

Williams (1984) suggests that because of similarity in habit to its European congener, C. macandreae studied by Buchanan (1963) off Northumberland, it probably has the same life history given briefly as follows: eggs are carried 8-9 months. The hatched larvae are non-pelagic (Bull 1933). At 3 years it functioned as a male although the ovary was present. At 4 years the testes atrophied but the vas deferens was full of spermatophores. Eggs were laid at 5, 7 and possibly 9 years of age. After 5 years moulting was once a year and possibly it lived 10 years.

Family POLYCHELIDAE Wood-Mason, 1874

Mud lobsters. First four legs chelate. Eyes reduced. Abdomen shorter than carapace.

Key to Species (from Squires 1990)

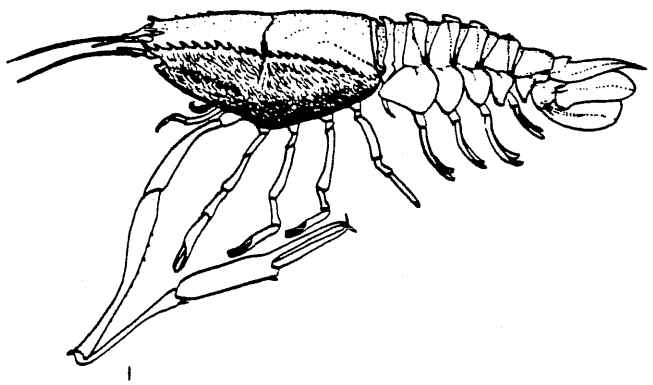
1. Carapace with well-defined pattern of spines along whole median carina; a double ridge dorsally on 6th abdominal somite 2

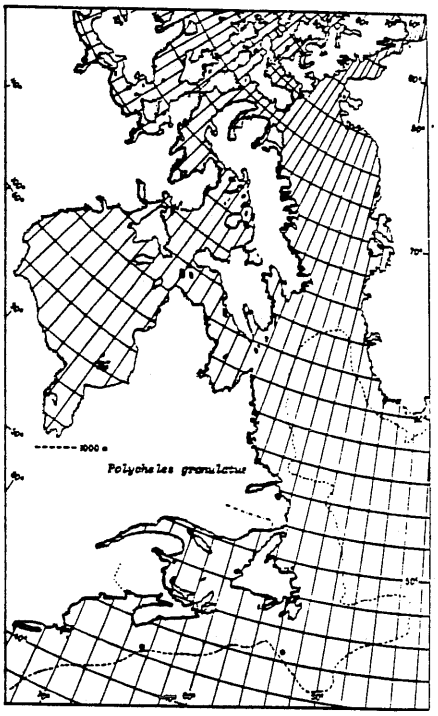
   Carapace median carina with only a few spines anteriorly at midline, the rest of the carina with granulations; no ridges dorsally on 6th abdominal somite. No spines at posterior edge of carapace ..... Polycheles granulatus

2. Posterior margin of carapace with two spines at midline; ridges on 6th abdominal somite smooth ..... Stereomastis sculpta

Polycheles granulatus Faxon, 1893

Selbie 1914; Zariquiey Alvarez 1968; Squires 1990.





Pale reddish mud lobster. Large flattened carapace with edging of small sharp spines, longer than the variously carinated abdomen. Rostrum two small spines at anterior end of median carina, the latter with few spines and many granulations and reaching the posterior edge of the carapace. Cervical groove at middle of carapace separating edge spines into three groups, the middle group of 3, anterior group of 7-10 and posterior group of 11-15 spines. Posterior edge of carapace without spines. First leg much longer than others and with large chela. No eyes but orbital notch closed.

Distribution in the western Atlantic from the southwest slope of the Grand Bank to the Nova Scotian continental shelf. In the eastern Atlantic from Ireland to the Canary Islands. Also in the Pacific from the Gulf of Panama and off Hawaii, and in the Indian Ocean off Sri Lanka. Depths 347-2505 m. (Pohle 1988). Our records are from the southwest slope of the Grand Bank (INset map).

Males and females to 50 mm cl.

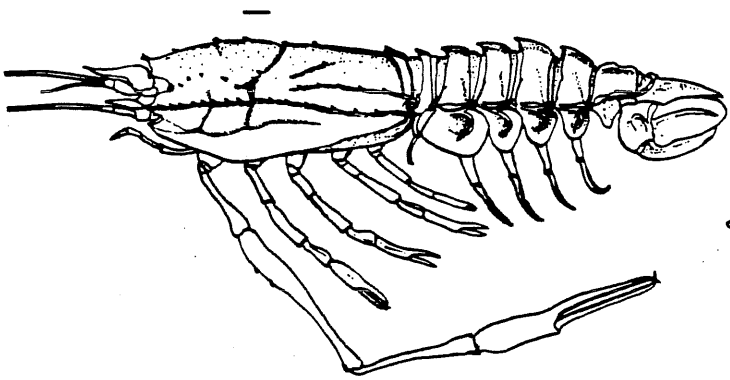
Females in May and November were ovigerous (eggs 0.8 mm average diameter). The one in November also had large ova in the ovaries so would lay eggs after the larvae hatched out of the eggs carried.

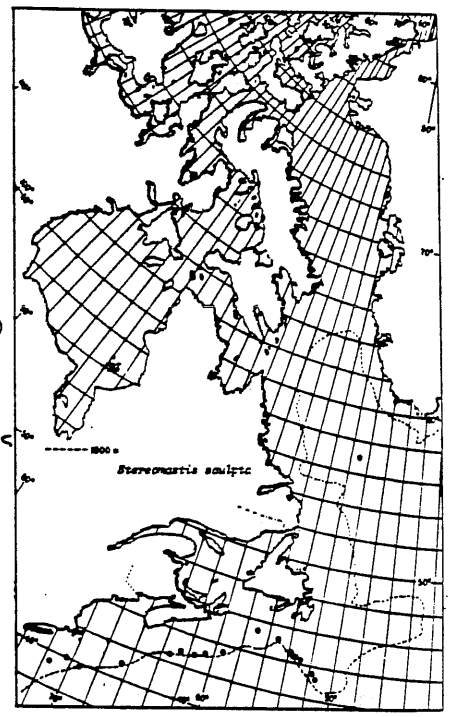
Stomach contents were fish bones and sponge spicules.

Other decapod present in catches was Stereomastis sculpta.

Stereomastis sculpta (Smith, 1880)

Sivertsen and Holthuis 1956;
Squires 1990.





Mud lobster pink on white, large. Carapace flattened dorsally and fringed laterally with small sharp spines, not more than 20 on each side. Cervical groove divides marginal spines into 3 groups, 6, 3 and 7 usually. Rostrum 2 spines the front of a median carina with regular pattern of spines reaching posterior margin where there are 2 spines. Abdominal somites carinate each with forward directed spine at front except 6th with smooth double ridge. No eyes. A small spine in orbital notch.

Distribution from Davis Strait to the Caribbean in the western Atlantic and from Iceland to Angola in the eastern Atlantic. Also in the Indian Ocean from the Arabian Sea to Malaysia. Depths 230 - 4000 m (Sivertsen and Holthuis 1956).

In our records mostly from Laurentian Channel and southwest edge of the Grand Bank. Also from the Labrador Sea (Inset map).

Species also presnt in catches were Nematocarcinus rotundus and Polycheles granulatus.

Lengths to 70 mm cl in males and females.

Most females taken were ovigerous in May, October and November and about half of these had large ova in the ovaries suggesting annual spawning. Egg diameter 0.8 mm.

Stomach contents were phytobenthos, foraminiferans, fish fragments, euphausids and polychaetes.

Family PAGURIDAE Latreille, 1803

Hermit crabs. Abdomen and tail fan asymmetrical, modified to fit in and hold animal in shell. Posterior half of carapace soft, membraneous, anterior half forming a dorsal shield.

Key to Species

1. Palm of left hand or chela with upper surface horizontal and not divided into two facets separated by a ridge ... . Pagurus acadianus

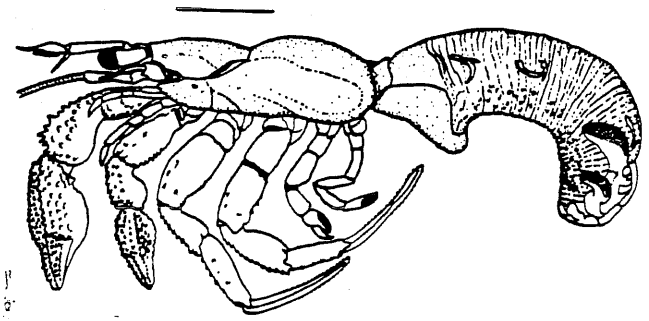
   Palm of left hand with uppr surface divided into two facets by a ridge 2

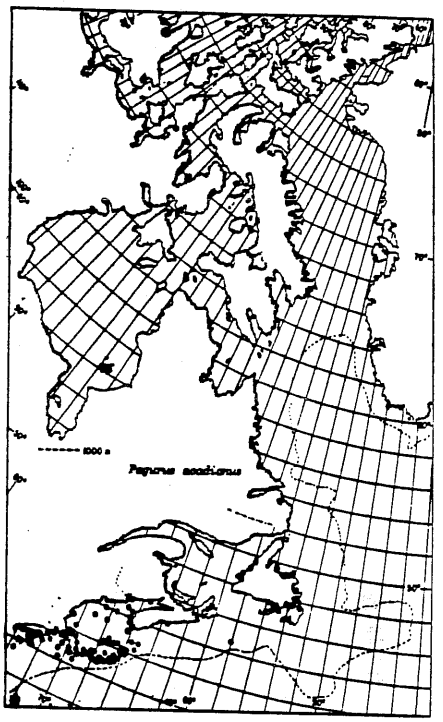
2. Palm of left chela with single row of strong spines slanted inward; anterior part of sternite of 3rd legs low, with few short setae ..... Pagurus pubescens

   Palm of left chela with double row of spines not slanted inward; anterior part of sternite of 3rd legs high, with long setae ... . Pagurus arcuatus

Pagurus acadianus Benedict, 1901

Rathbun 1929; Williams 1984;
Squires 1990.





Hermit crab with large roundish chela with an orange red stripe over light red. Anterior part of sternite of 3rd legs low but rounded and with long setae. Inner ridge on left propodus at insertion of dactyl with 3 irregular rows of spinules.

Distribution in western Atlantic only from the Straits of Belle Isle to Chesapeake Bay. Depths 0 to 485 m. (Williams 1984).

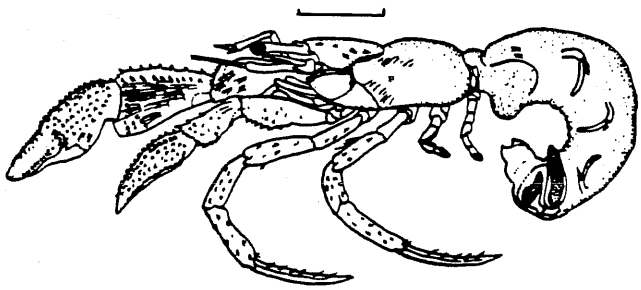
Locally in coastal areas of Newfoundalnd from Notre Dame Bay to Gulf of St. Lawrence (Inset map). Temperatures 0.8 to possibly 20 degrees C. Depths 0-48 m. In shells of Buccinum sp. and Lunatia sp.

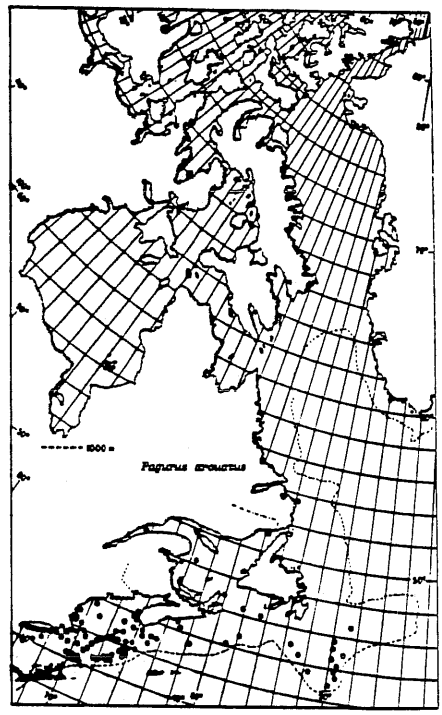
Stomach contents fragments of fish and crustaceans, foraminiferans, Mytilus sp. shell.

Mandible with calcified incisor with rounded edge separated from molar by a notch. Palp two-segmented.

Pagurus arcuatus Squires, 1964

Rathbun 1929 as P. pubescens;
Squires 1964, 1990.





Hermit crab pink or dull white with long yellowish setae. Left 1st chela with propodus divided into two facets the outer slightly rounded and narrow, the inner with 2 rows of spines at the ridge separating the facets. Narrow "V" of spines dorsally on middle of right chela. Anterior part of sternite of 3rd legs arcuate, as high as wide and with many long setae.

Distribution in western Atlantic only, from Greenland and Labrador coast to Virginia Capes. Depths 0-270 m (Williams 1974b).

Our collections from Labrador, coast of Newfoundland, Grand Bank, St. Pierre Bank, Green Bank and Gulf of St. Lawrence. Depths 0-135 m. Temperatures -0.1 to 4.6 degrees C.

Other species present in catches were P. pubescens, Spirontocaris spinus, Lebbeus polaris, Lebbeus groenlandicus and Pandalus montagui (Inset map). Only 1.4% were infested with Peltogaster paguri. Most specimens were in shells of Buccinum sp., but also shells of Colus sp., Neptunea sp. and Lunatia sp. Male and female Poderopsis sp. together were frequently found in shells with this species.

Stomach contents were phytobenthos, foraminiferans, small bivalve shells and crustacean fragments. Also small gastropods, hydroids and ophiuroids were less common (Table 45).

Mandible incisor heavily calcified, curved edge smooth; oval molar lies behind incisor. Palp two-segmented setose (Fig. 31).

Average lengths of males 16 mm cl (3-20 mm cl) and females 11 mm (3-17 mm). Total cl to shield length = y = 1.6x + 0.5 (Fig. 33).

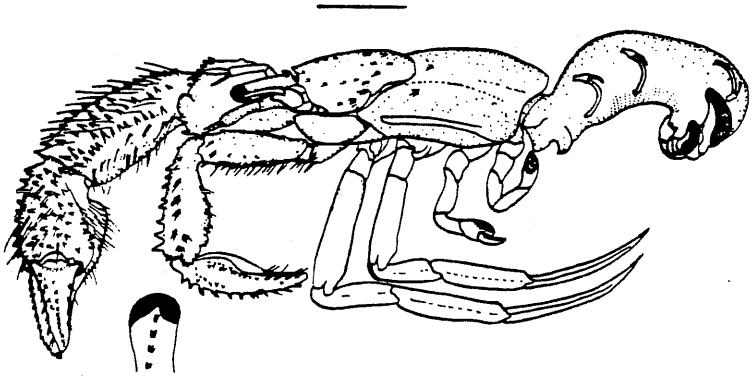
Eggs were 0.8 mm diameter. Females were first mature at 6 mm cl (Table 36).

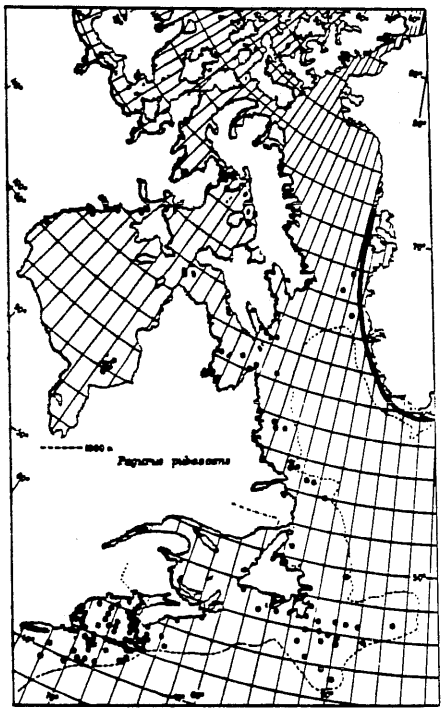
Table 36. Maturity of P. arcuatus collected from the Grand Banks during April to November.

cl mm	April - June			July - November				
	Males	Females		Males		Females		
		Non-ovig.	Ovig.			Non-ovig.		Ovig.
	Large vd	Small ova	Large ova	Small vd	Large vd	Small ova	Large ova	Small ova
6				2		2	1	
7				2		1		
8				4		3		
9	1			7	1	3		
10	0	1	1	2	0	1		
11	1	0	0	1	0			
12	0	0	0		1			1
13	0	0	1		0			2
14	0	0	0		0			
15	1	0	0		0			
16	0	0	0		0			
17	3	1	1		1			
18-20	2				1			
Totals	8	2	3	18	4	10	1	3
% potentially breeding annually				29			29	

Pagurus pubescens Kroyer, 1838

McLaughlin 1973; Squires 1964;
Williams 1984.





Hermit crab reddish to pale pink with red markings. Left first chela with single spinous ridge dividing the hand into two facets, the outer flat or slightly concave, the inner narrow and without spines. Anterior partof sternite of 3rd legs about 3 times as wide as high and with short setal fringe.

Distribution in the westen Atlantic from the Queen Elizabeth Islands, Foxe Basin, Hudson Bay, Frobisher Bay, Ungave Bay, East of Baffin Island and Greenland to Cape Hatteras. Eastern Atlantic from Novaya Zemlya, Barents Sea and East Greenland to the British Isles. Depths 4-550 m; in deeper water to the south. Temperatures -1.6 to 4.6 degrees C. (Williams 1984).

In our collections most were from the north: over 1000 specimens were from Foxe Basin and 150 specimens from Labrador southward. Depths 10-110 m in Foxe Basin and 42-460 m off Newfoundland and Labrador (Inset map). Temperatures -1.6 to 4.6 degrees C.

About 12 species of decapods occurred in catches with this species, the commonest Eualus gaimardi, Lebbeus polaris, Sabinea septemcarinata, Spirontocaris spinus and S. phippsi in Foxe Basin. Pandalus borealis, P. montagui, S. septemcarinata, L. polaris and Hyas coarctatus off Baffin Island and Labrador (Fig. 7). On the Grand Banks P. arcuatus was also present. Infestation with

Peltogaster paguri occurred in 15% of specimens from Labrador but did not occur elsewhere. Shells used by this species were Buccinum sp., and Neptunea sp., Colus sp. , Lunatia sp. and Thais sp.

Stomach contents were phytobenthos, foraminiferans, crustacean fragments (ostracods and amphipods), bivalve shell fragments, ophiurans, polychaetes, small gastropods and hydroids (Table 45).

Average total length of carapace in males 17 mm and females 14 mm from Newfoundland and Labrador, but 14 and 11 mm, respectively, from Foxe Basin (Table 37).

Table 37. Lengths of P. pubescens collected from localities in the area of investigation, 1946-60.

Locality		Newfoundland and Labrador	Foxe Basin	Ungava Bay
Depths m		40-460	10-110	15-275
Temp. C		-1.6 to 4.6	-1.5 to 3.8	-1.2 to 3.1
Average cl mm	M	17	14	13
	F	14	11	11
Range of cl mm	M	9-27	3-28	6-24
	F	9-21	6-20	4-21
Numbers examined	M	109	73	27
	F	45	46	32

Females were first mature at 7 mm cl in Foxe Basin and 6 mm cl from Labrador. About 50% of females were potentially ovigerous in deep water off Labrador, but 75% in Foxe Basin (Table 38). Apparently spawning is annual in Foxe Basin (Table 44). Eyed embryos were found in spring. Egg diameters 1.0 mm (0.8-1.2 mm). Males were first mature at 7 mm in Foxe Basin and 10 mm off Labrador. Spermatophores were present in mature males.

Conversion of cl to shield length = $y = 1.6x + .0.2$ (Fig. 33 A).

Table 38. Maturity of P. pubescens collected in Foxe Basin, Newfoundland and Labrador during Aug.-Sept., 1947-60.

	Foxe Basin				Newfoundland, Labrador			
	Males		Females		Females			
			Non-ovigerous		Ovigerous	Non-ovigerous		Ovigerous
cl mm	Small vd	Large vd	Small ova	Large ova	Small ova	Small ova	Large ova	Small ova
6			5					
7		1	1	1				
8	1	1	0	4				
9	2	1	1	1		1		
10		6	4	4	2	2		1
11		10	2	0	1	3		1
12		7	1	1	1	1		1
13		2	1	2	0	1	3	0
14		5		5	0	1	1	0
15		5		4	0	1	2	0
16		4		1	1	1		0
17		3		1	1			2
18-20		6		1	1			
21-25		9						
26-28		2						
Totals	3	65	15	25	7	11	6	5
% potentially breeding annually		96			76			52

cl = total carapace length

Family LITHODIDAE Samouelle, 1819

Anomuran crabs. Like brachyuran crabs but last thoracic somite is free, modified, behind carapace. Fifth legs very small, hidden under the carapace.

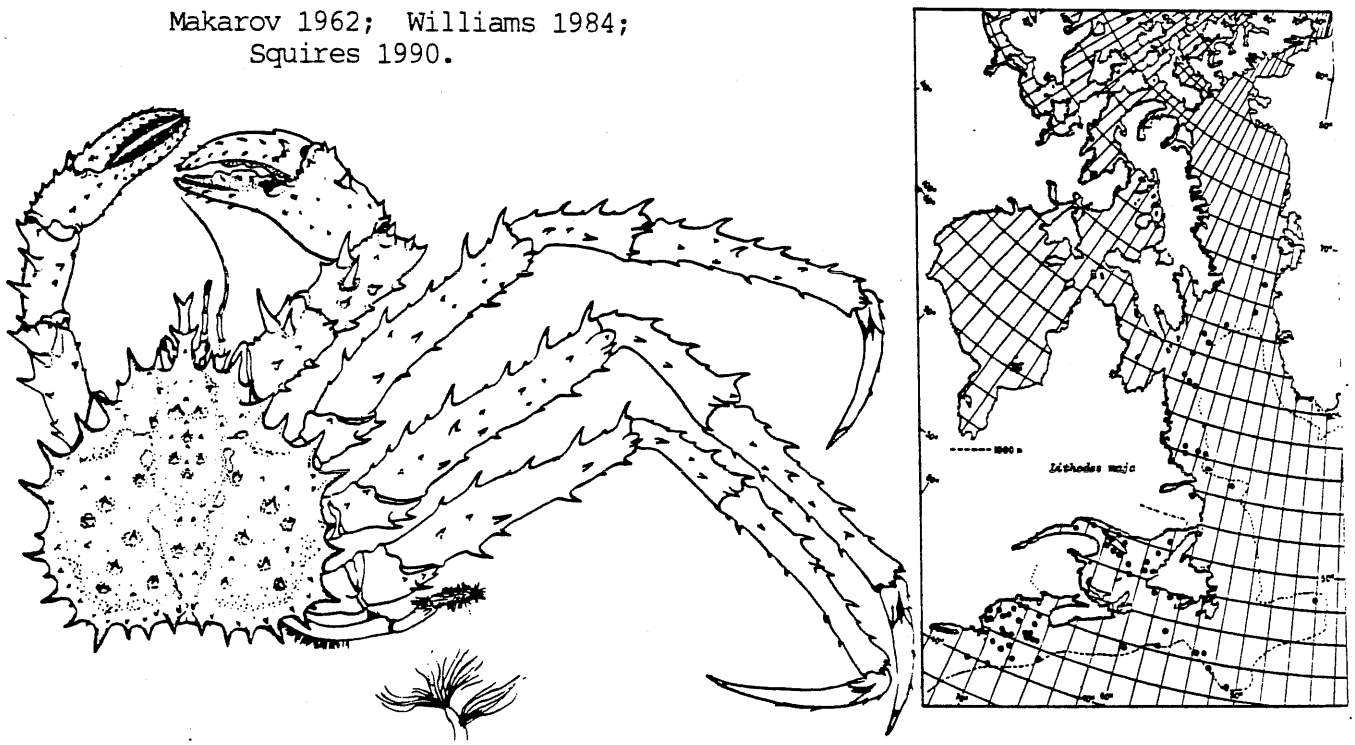
Key to species

Tip of rostrum bifid; moderate spines on carapace ... *Lithodes maja*

Tip of rostrum simple; extremely long spines all over carapace and legs ..... *Neolithodes grimaldii*

Lithodes maja (Linnaeus, 1758)

Makarov 1962; Williams 1984;
Squires 1990.



"Stone crab" (Crabe de roche). Reddish brown to brownish. Crab-like but not a true crab, related to hermit crabs. Rostrum stout, bifid at tip, with two divergent spines in the middle. Carapace pear-shaped with upturned spines along the edges, covered with short spines and tubercles. Abdomen turned under carapace and formed of calcified plates, symmetrical in males but asymmetrical in females. First legs chelate, unequal, 5th legs small hidden under the carapace.

Distribution in western Atlantic from Davis Strait to Sandy Hook, New Jersey, and in the eastern Atlantic from Spitzbergen to British Isles and the Netherlands. Depths 65-790 m (Williams 1984).

In our collections from Davis Strait to the Flemish Cap and in Hermitage Bay and Bay d'Espoir and the Gulf of St. Lawrence (Inset map). Temperatures 1.0 to 4.8 degrees C. and depths 185 - 790 m (Figs. 8 and 9).

This species was frequently a member of the Pandalus borealis community. Other species with it in catches were Lebbeus polaris, Sabinea sarsi, Chionoecetes opilio and Pandalus propinquus.

Stomach contents were phytobenthos, foraminiferans, crustacean fragments, polychaetes, ophiuroids, small bivalve and gastropod

shells and sponge spicules. Less frequently were hydroids, chiton, fish fragments and a small scallop.

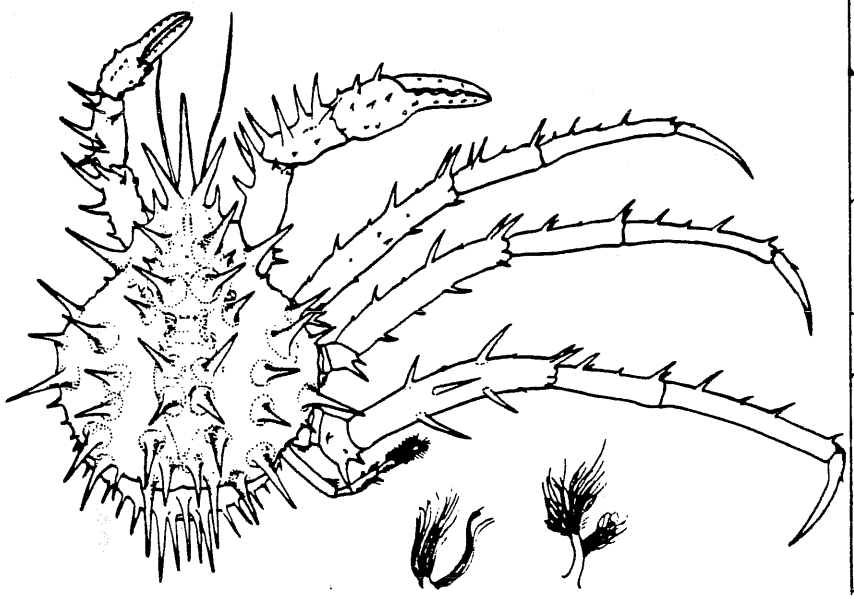
Mandible incisor large, curved edge separated by a notch from molar and with 2 teeth near one end in some. Palp has 3 segments.

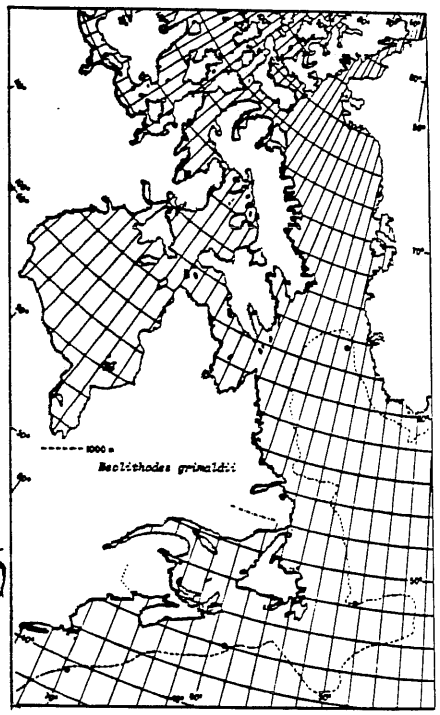
Average lengths of males 73 mm cl (33-92 mm cl) and of females 53 mm cl (37-66 mm cl). Since difficult to put into containers some large ones may have been discarded so this is not likely to be a true estimate of lengths.

About 60% of the mature females were potentially ovigerous. They were first mature at 37 mm cl. Males at 76 mm but many specimens were poorly preserved and could not be assessed for maturity. Egg diameters averaged 2.1 mm.

Neolithodes grimaldii A. Milne-Edwards and Bouvier, 1894

Sivertsen and Holthuis 1956;
Squires 1990.





Very large and crablike and with many long spines on carapace and long legs, presently called "Porcupine Crab". Intensely red in colour but claws have whitish teeth on cutting edges. Males larger than females. Rostrum is a single long spine with 2 divergent spines at its base. Only first legs chelate. Abdomen in males does not show segmentation but there are three large calcified plates on the abdomen in females. Males may exceed one kilogram in weight.

Distribution in the western Atlantic from Davis Strait to North Carolina and in the eastern Atlantic from Iceland to the Cape Verde Islands. Depths from 800 to 2000 m (Sivertsen and Holthuis 1956).

In our collections from the southwest edge of the Grand Banks at a depth of 720 m. Reported in considerable numbers off Labrador where large Greenland Halibut (Reinhardtius hippoglossoides) are fished.

Length of male 230 mm cl and female 170 mm cl, the only specimens measured. Both mature but female non-ovigerous.

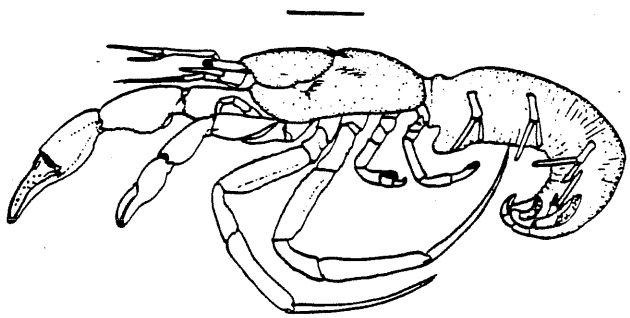
Stomach contents of 6 specimens examined in 1994 detritus and sand grains with mica as a constituent, operculum of whelk, crustacean fragments, a lot of fibrous material possibly byssus threads of large bivalves?

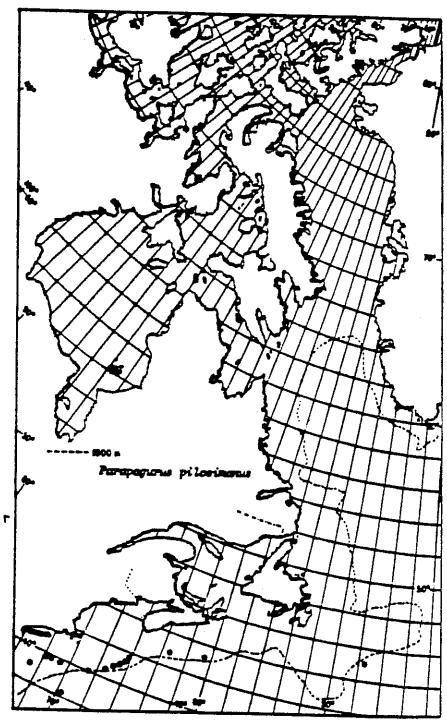
Family PARAPAGURIDAE Smith 1882

Hermit crabs but with a difference: pleopods are present on the first two abdominal somites and sexually modified in the males, unpaired in the females.

Parapagurus pilosimanus Smith, 1879

Rathbun 1929; McLaughlin 1974; Squires 1990.





Hermit crabs, colour pale dull orange red. Chelae very unequal. Males have paired pleopods, calcified and spatulate, on 1st and 2nd abdominal somites. Carapacial shield wider than long, straighter at front than in Pagurus. Telson not divided in lobes or bifurcate but rounded.

Distribution from Grand Banks to Gulf of Mexico in western Atlantic; in the Sargasso Sea and from Ireland to Sierra Leone, West Africa, in eastern Atlantic. Depths 500-4000 m (Zariquiey Alvarez 1968).

Shield length 13 mm in males and 12 mm in females examined.

Specimen examined by Smith (1879) was in a gastropod shell that had been overgrown by an actinoid polyp which extended far beyond the shell.

Family GALATHEIDAE Samouelle, 1819

Mud shrimps; shrimp-like but flattened, wide; abdomen bends at fourth somite rather than third as in shrimps; rostrum a spike; pleopods on 1st and 2nd abdominal somites sexually modified in males but absent in females.

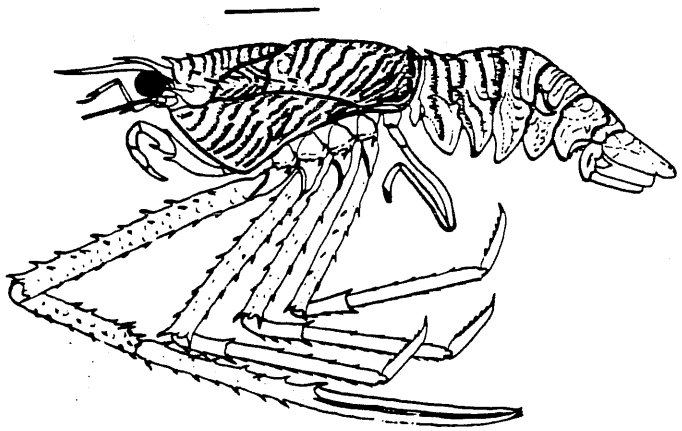
Key to Species

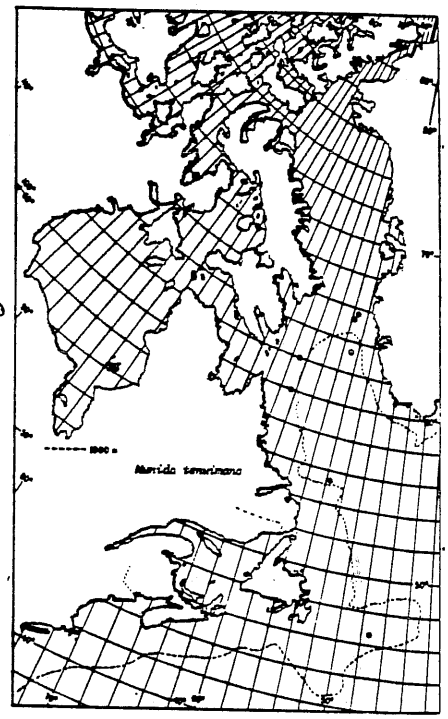
Eyes opaque, non-pigmented and without facets; exopod of 1st maxilliped without flagellum ..... Munidopsis curvirostra

Eyes pigmented and with facets; exopod of 1st maxilliped with flagellum; posterior margin of carapace with spines .....
..... Munida tenuimana

Munida tenuimana G. O. Sars, 1871.

Selbie 1914; Zariquiey Alvarez 1968;
Squires 1990.





Mud shrimp, grey-pink in colour, with three long frontal spines, the centre of which is the rostrum twice as long as the others parallel to it. Carapace covered with transverse striations and short setae. Lateral margin with about 6 spines. Abdominal somites 2-4 with spines along anterior edges. Abdomen slightly longer than carapace. Front legs very long and chelate. Telson with sutures.

Distribution in the western Atlantic from Davis Strait to the Grand Banks. In the eastern Atlantic from Iceland and Norway to the British Isles and in the Mediterranean (Selbie 1914).

In our collections from east of Baffin Island in Davis Strait, off Labrador and east of the Grand Banks in depths of 440-650 m and temperatures of 3.5 to 4.4 degrees C. (Inset map).

Stomachs mostly empty but a pycnogonid was found in one and sponge spicules.

Molar small, subtriangular with 3 rounded cusps along outer edge

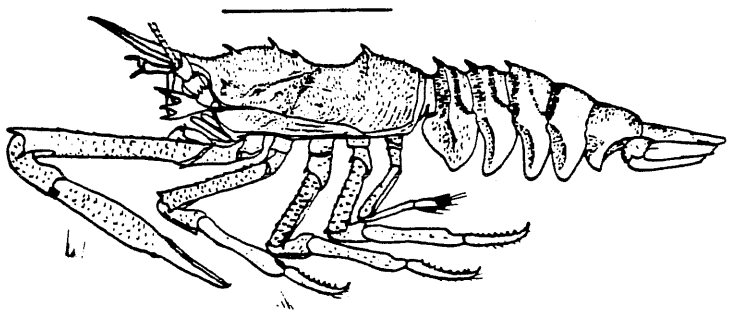
and 7 small pointed cusps along inner edge, lying behind large curved blade of incisor, the latter with rounded tooth near centre and small pointed tooth at outer corner. Palp with 3 segments (Fig. 31).

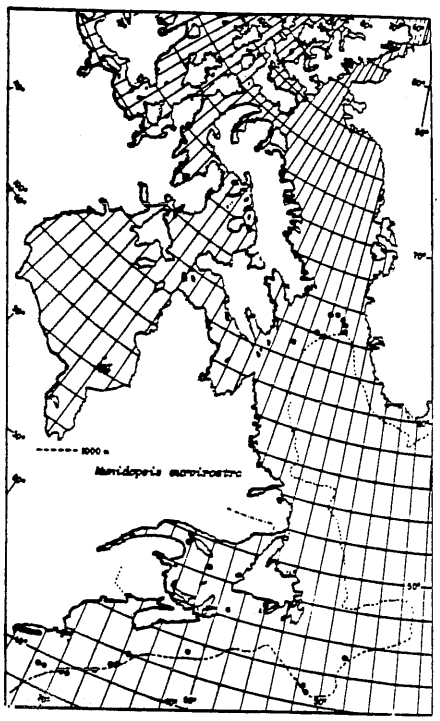
Male was 21 mm cl (up to 31 mm cl) and average for females 24 mm cl (21-31 mm cl).

Also present in catches were Lebbeus polaris, Pasiphaea tarda, Pandalus propinquus and Pontophilus norvegicus (Fig. 7).

Munidopsis curvirostra Whiteaves, 1874

Selbie 1914; Rathbun 1929;
Squires 1990.





Greyish white mud shrimp, rough-looking, rostrum spike-like, upturning, slightly flattened. Eyes without pigment or facets. Transverse ridge on cardiac area with strong forward-directed spine over hollow in carapace; 4 spines ahead of cervical groove in median line two of them near base of rostrum. First legs strongly chelate about as long as others. Telson sutured.

Distribution in western Atlantic from Davis Strait to North Carolina. In the eastern Atlantic from Iceland to northwest Africa. Depths 75 - 2325 m. (Selbie 1914).

In our records from off Baffin Island, in Hermitage Bay, Gulf of St. Lawrence and the Grand Banks (Inset map). Depths 245 -770 m and temperatures 1.5 to 3.6 degrees C. (Figs. 8and 9).

Decapod species in catches Pandalus propinquus, Acanthephyra pelagica, Pandalus borealis, Sabinea sarsi and Lebbeus polaris (Fig. 7).

Stomach contents were phytobenthos, foraminiferans and crustacean fragments. Also occasionally polychaetes and small bivalve shells.

Mandible similar in Munida but molar is larger, incisor blade without corner tooth and tooth at centre is smaller (Fig. 31).

Males and females averaged 11 mm cl, ranges 8-12 and 5-15 mm cl, respectively.

Females first mature at 9 mm cl and males 8 mm cl. All ovigerous ones had large ova in ovaries in March and August. They would lay eggs annually.

Infraorder BRACHYURA

True crabs.

Family CANCRIDAE Latreille, 1803

Carapace broadly oval or hexagonal, the front with several teeth one of which is median; antennules folded obliquely or almost vertical.

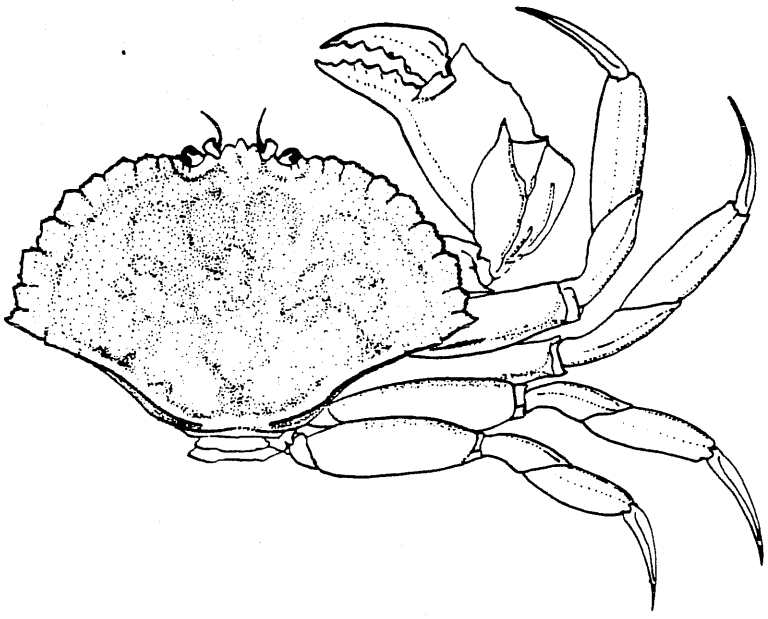
Key to Species

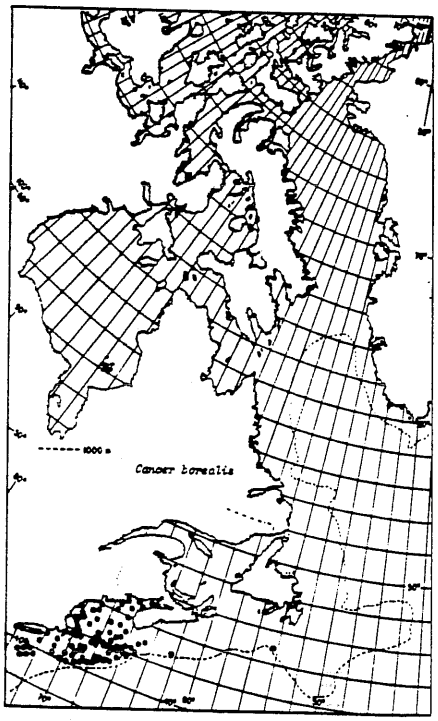
Anterolateral teeth of carapace with denticulate margins; upper surface of chela denticulate ..... Cancer (Metacarcinus) borealis

Anterolateral teeth of carapace with granulate margins; upper surface of chela granulate ..... Cancer (Cancer) irroratus

Cancer borealis Stimpson, 1859

Nations 1975; Rathbun 1929;
Squires 1990.





Crab, reddish above and pale yellow or buff below. Carapace ovate, front more arched than in C. irroratus; anterolateral teeth with denticulate margins; frontal centre tooth larger than in irroratus.

Distribution in westernAtlantic only, from Grand Banks to south of Tortugas, Florida. Depths 0-800 m (Williams 1984).

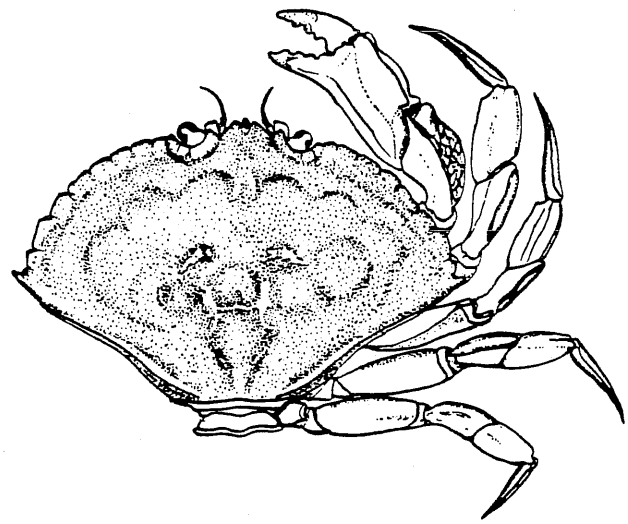
This species does not occur inshore in Newfoundland, but said to occur on the Grand Banks. To me this is doubtful.

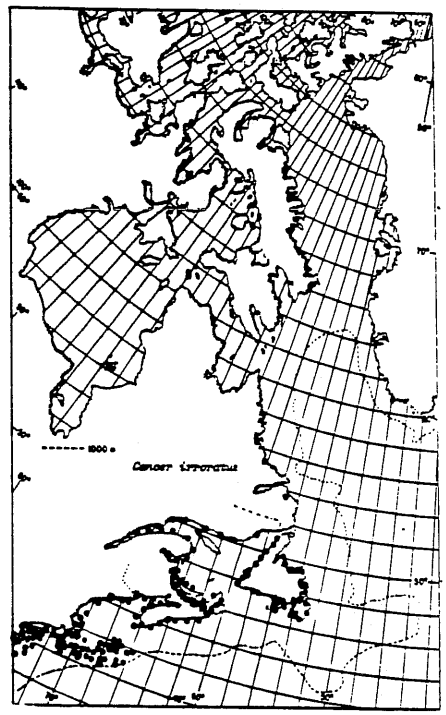
Lengths to 180 mm cw (carapace width) in males and 152 mm cw in females; weight to 0.4 kg (Elner 1985).

Females were first mature at about 21 mm cw, carrying 4,000 eggs, but at larger sizes of 88 mm cw they carry about 330,000 eggs. Eggs are carried for about 5 months through the winter (Williams 1984).

Cancer irroratus Say, 1917

Rathbun 1929; Nations 1975;
Bigford 1979; Williams 1984;
Squires 1990.





Shore Crab or Rock Crab reddish to pale purple on light yellow background. Dorsal carapace finely granulate. Anterolateral teeth are evenly rounded and granulate but not denticulate as in C. borealis. Not as large as latter. Frontal outline arcuate and not forming a semicircle as in borealis. Pale yellow or buff ventrally.

Distribution only in western Atlantic from the Straits of Belle Isle to Miami, Florida. Depths 0-575 m (Williams 1984).

In our records from around the coast of Newfoundland inshore (Inset map). Taken quite frequently in lobster traps at 5-20 m and then used for bait. Temperatures could reach about 25 degrees C. in eelgrass beds where often seen and in Port au Port Bay, for example, dropped to -1.4 degrees C. in winter.

Average lengths of males 71 mm cl (39-82 mm cl) and females 44 mm (30-47 mm cl).

Stomach contents small Littorina sp., amphipods, Crangon septemspinosa, polychaetes and small bivalves.

Mandible incisor curved edge, pointed at lower end. Palp 3-segmented.

Predators are lobsters and gulls and crows when stranded or in shallow water.

Family MAJIDAE Samouelle, 1819

Front of carapace narrow, forming a rostrum; carapace covered with short hooked setae; chelate legs shorter or equal to other legs.

Key to Species

1. Walking legs much longer than chelipeds, compressed .... *Chionoecetes opilio*

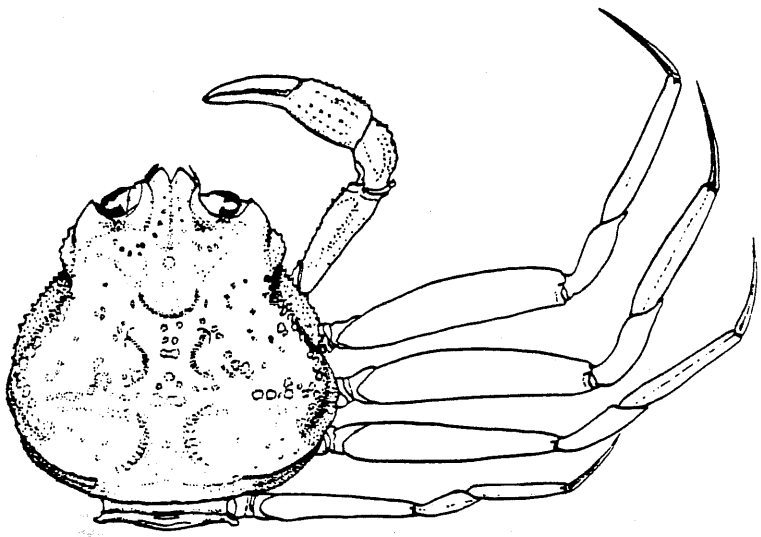
   Walking legs only slightly longer than chelipeds, rounded 2

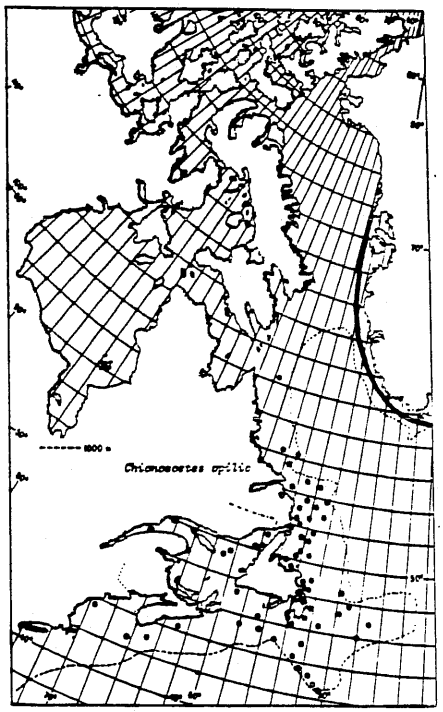
2. Carapace sub-triangular; basal article of antenna smooth and triangular in shape ..... *Hyas araneus*

   Carapace lyrate; basal article of antenna with tubercles laterally and quadrilateral in shape ..... *Hyas coarctatus*

Chionoecetes opilio (Fabricius, 1788)

Rathbun 1929; Williams 1984;
Squires 1990.





"Snow crab" (Crabe de neige). Brownish with faint greenish tinge above and pale buff below. Carapace about as wide as long, covered with hooked setae. Rostrum short, flat, divided into two triangles. Basal article of antenna narrow, tapered distally into blunt spine.

Distribution only in the western Atlantic from Greenland to the Gulf of Maine. Depths 20-310 m but mostly from 70-280 m (Elner 1985).

In our collections from the east and northeast coast of Newfoundland, the Grand Banks, Gulf of St. Lawrence and coast of Labrador (Inset map). Depths 80-310 m . Temperatures -1.0 to 2.5 degrees C. (Figs. 8 and 9).

Extensively fished since the 1960s in the Gulf of St. Lawrence and more recently off the north and northeast coasts of Newfoundland. The minimum size limit of 95 mm cw precludes catches of females which reach only 90 mm cw (Taylor et al 1985).

Other decapod species in catches were Pandalus borealis, Pagurus pubescens, Sabinea septemcarinata, Pandalus montagui, Hyas araneus and Hyas coarctatus (Fig. 7).

Cod was a very common predator on this species especially on the east coast near St. John's.

Stomach contents were phytobenthos, foraminiferans, crustacean fragments, polychaetes, bivalves and ophiuroids. Less frequently were the remains of shrimps, crabs, gastropods, gammarid amphipods, copepods, isopods and chitons. Diastylis sp., hydroids and ostracods were found infrequently.

The sizes brought to the laboratory did not exceed 61 mm cl because of difficulty in preserving large specimens so the samples are biased towards small crabs.

Maximum sizes are 150 mm cw in males and 90 mm cw in females (Elner 1985).

Females were first mature at 22 mm cl. Except for a sample from Labrador about 65% were potentially ovigerous in autumn and some already ovigerous had large ova in the ovaries. These results indicate annual spawning (Table 39). Taylor et al (1985) reports about 100% ovigerous annually. Observations of a natural population in Bonne Bay showed that small males (as small as 89 mm cw) took part in mating with females apparently as successfully as the large males (Taylor et al, 1985).

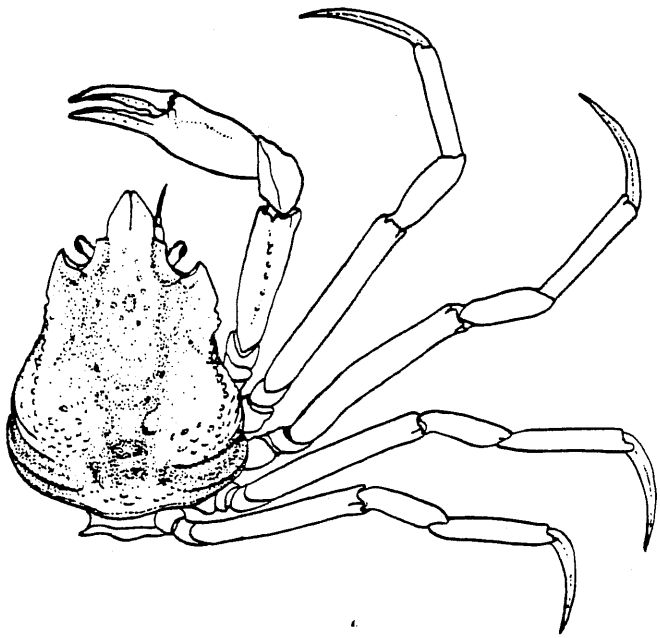
Table 39. Maturity of Chionoecetes opilio in Newfoundland and Labrador during April - December, 1947-60. (Owing to difficulty of collecting large crabs these results are biased towards small ones). Females.

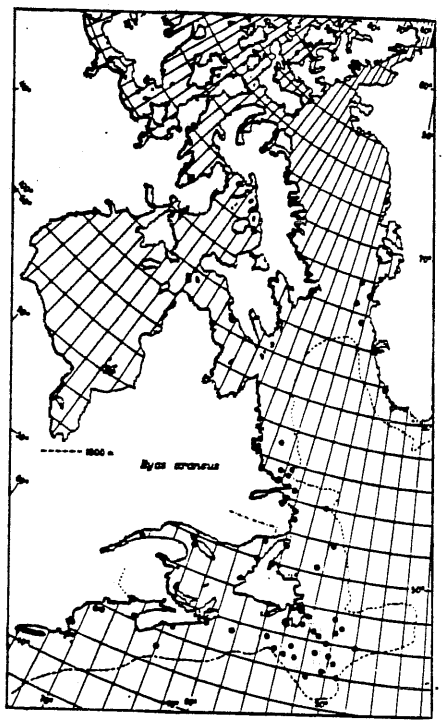
cl mm	April-June	July		August	Sept. to Dec.			
	Non-ovig.	Non-ovig.	Ovig	Non-ovig.	Non-ovig.		Ovigerous	
	Small ova	Small ova	Small ova	Small ova	Small ova	Large ova	Small ova	Large ova
9-11	1				1			
12-14	1			4	8			
15-17	0			2	0			
18-20	0			3	7			
21-23	1	1	1	26	2			
24-26		0	2	10	1			
27-29		0	1	1	3		2	
30-32		0	0	1	2		0	2
33-35		0	1		2	2	1	2
36-38		1	0		1	0	0	3
39-41		0	2			1	2	1
42-44		2a	2b				2	2
Totals	3	4	9	47c	27	3	7	10
Mature	1	4	9	33	11	3	7	10
% potentially breeding annually			69					65

a = 2 with large ova; b = 1 with large ova; c = from Labrador.

Hyas araneus (Linnaeus, 1758)

Rathbun 1929; Williams 1984; Squires 1990.





"Toad crab" (Crabe bufo). Dull reddish brown spider crab. Carapace longer than wide, subtriangular. Rostrum pointed, flat, triangular, divided by a centre slit. Basal antennal article triangular, smooth, longer than wide. Walking legs only slightly longer than chelipeds.

Distribution in the western Atlantic from Davis Strait to Rhode Island. In the eastern Atlantic from the Kara Sea to British Isles and France. Depths 0-730 m (Squires 1990).

In our records from inshore in Labrador and as far as the continental shelf to the Grand Banks. Inshore in White Bay at Spear Cove Scuba diving showed this species as the dominant decapod on grounds ordinarily dominated by lobsters. In deep water in the Gulf of St. Lawrence in Pandalus borealis community (Inset map). Temperatures -1.3 to 6.3 degrees C. Depths 3-500 m (Figs. 8 and 9).

Other species caught at the same time were Pandalus montagui, Spirontocaris spinus, Pagurus pubescens, Lebbeus polaris and Sabinea septemcarinata (Fig. 7).

Stomach contents were phytobenthos, foraminiferans, crustacean fragments (gammarid amphipods and ostracods), polychaetes, ophiuroids, and bivalves most commonly. Occasionally gastropods, chitons, sea urchins, small crabs and hermit crabs. Inshore in Labrador mostly fish remains possibly discarded fish offal (Table 45).

Average sizes of males 34 mm cl (6-78 mm cl) and females 25 mm (7-55 mm cl).

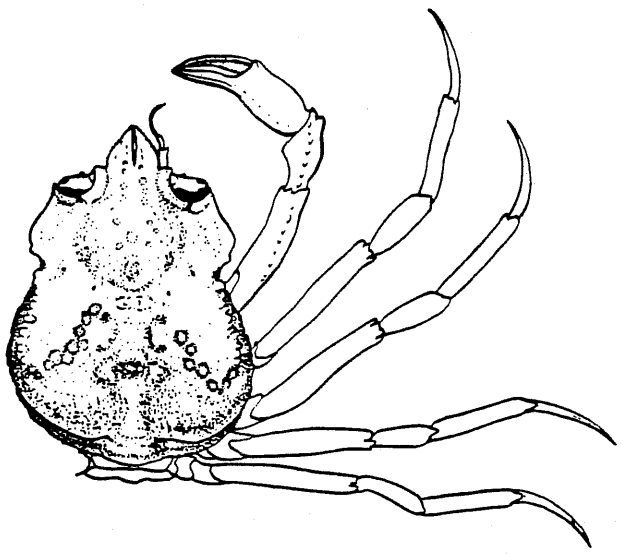
Ovigerous females in spring had large ova in ovaries. Representing about 60% of mature females these would hatch larvae during the summer and lay eggs shortly afterwards. Eggs were carried for about 10 months but spawning was annual (Table 40). Eggs 0.7 mm diameter.

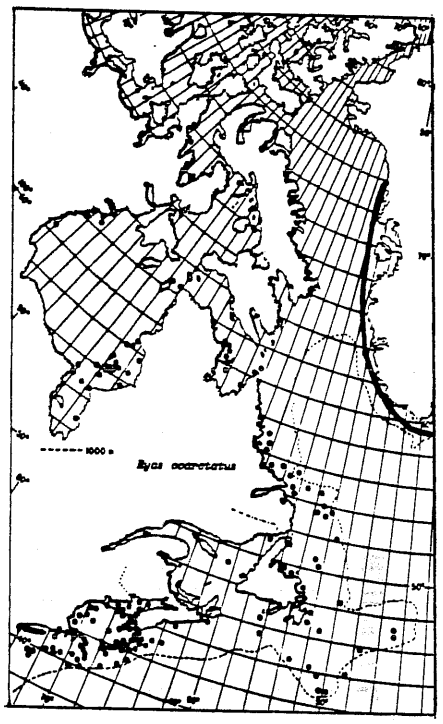
Table 40. Maturity of female Hyas araneus in Newfoundland and Labrador, April to November, 1947-60.

cl mm	April - June				July - November			
	Non-ovigerous		Ovigerous		Non-ovigerous		Ovigerous	
	Small ova	Large ova	Small ova	Large ova	Small ova	Large ova	Small ova	Large ova
7-18	4				8			
19-21	3	1		2	0	1		
22-24	3	3		6	4	3	4	2
25-27		2		10	0	1	1	1b
28-30				5	3	1	0	0
31-39			1	1	0	0	4	0
40-55					3	2		1
Totals	10	6	1	24	18	8	9	4
% potentially breeding annually							68	

Hyas coarctatus Leach, 1815.

Rathbun 1929; Williams 1984;
Squires 1990.





Spider crab, light purplish red above and light buff below. Carapace lyrate, somewhat triangular, covered with tubercles and short hooked setae. Basal article of antenna is quadrate and has tubercles along edges. Rostrum is triangular but split in the middle, shorter than in H. araneus. Spine on eyestalk more prominent.

Distribution from West Greenland, Hudson Bay, Ungava Bay (not taken in Foxe Basin) and south to Cape Hatteras in the western Atlantic. In the eastern Atlantic from Murman Sea to the British Isles. The subspecies H.c.alutaceus occurs in the Arctic from Siberia, the Beaufort Sea, and the northern Pacific to Korea. Pohle (1991) believes that this subspecies occurs in the western Atlantic. Depths 0-550 m.

In our records H. coarctatus was caught on the Grand Banks (paticularly on the eastern edge), fishing grounds off St. John's, east coast bays of Newfoundland, Gulf of St. Lawrence, Labrador coast, Ungava Bay, Hudson Strait and Hudson Bay (No records from Cambridge Bay, the Queen Elizabeth Islands and Frobisher Bay). (Inset map). Depths 0-550 m and temperatures -1.4 to 3.8 degrees C. (Figs. 8 and 9).

Other decapods in catches were Lebbeus polaris, Spirontocaris spinus, Chionoecetes opilio, Hyas araneus and Pandalus montagui (Fig. 7).

Stomach contents were phytobenthos, foraminiferans, crustacean fragments, ophiuroids, bivalve shells, crabs, sea urchin remains, and gastropods (Table 45).

Mandible incisor blade large and curved, a pointed lower corner. Molar a shelf behind incisor. Palp three-segmented .

Average lengths males 28 mm cl and females 29 mm from Newfoundland and Labrador (probably a bias against large specimens) and 40 mm cl and 37 mm cl, respectively, from Ungava Bay (Table 41).

Females potentially ovigerous were 62% of those mature. Eyed embryos were seen in spring and autumn. Some ovigerous had also large ova. Annual spawning is indicated by these observations (Table 42).

Table 41. Lengths of H. coarctatus collected from localities in the area of investigation during 1946-60.

Locality		Newfoundland and Labrador	Ungava Bay
Depth m		55 - 550	0 - 130
Temp. C		-1.4 to 3.8	-1.4 to -1.2
Average cl mm	M	28	40
	F	29	37
Range of cl mm	M	7 - 72	9 - 87
	F	6 - 49	17 - 47
Numbers examined	M	89	17
	F	107	18

Table 42. Maturity of female *H. coarctatus* in Newfoundland, Labrador and Hudson Strait, May to November, 1946-60.

cl mm	May - July				August - November			
	Non-ovigerous		Ovigerous		Non-ovigerous		Ovigerous	
	Small ova	Large ova	Small ova	Large ova	Small ova	Large ova	Small ova	Large ova
7-18					11			
19-21			1		3	2		
22-24					6	2		
25-27					6	2		1
28-30	1	3		1	4	2	1	2a
31-33				3	1	4	4	3
34-36					0	2	7	3
37-39					0	5	4	0
40-42					1		4	2
43-45							0	2
46-48							0	1
49-51							2	
Totals	1	3	1	4	33	19	22	14
% potentially breeding annually							65	

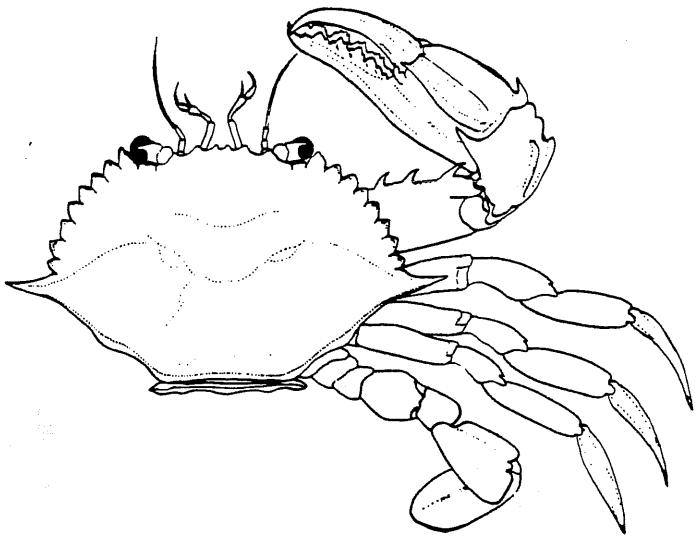
a = with eyed embryos in September

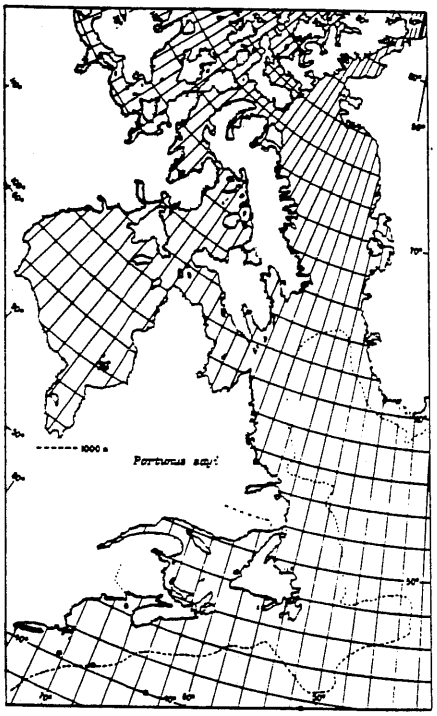
Family PORTUNIDAE Rafinesque, 1815

Swimming crabs; 5th legs with oval-shaped dactyl or last segment of leg and other segments flattened. Carapace much wider than long each end with sharp spine.

Portunus sayi (Gibbes, 1850)

Rathbun 1929; Williams 1984.





Small Sargassum crab, motled green or purplish with yellow-brown and white markings. Carapace widest at last anterolateral sharp long spine, front between antennae with 3-6 teeth, anterolateral edge forming a semicircle with nine even teeth. Pattern on back makes a face. Large chelae on 1st legs. Fifth legs with flattened dactyls, paddle-like for swimming.

Distribution from off the Grand Banks to the gulf of Mexico, the Canaries and Morocco -- essentially the Gulf Stream and Sargasso Sea, in floating Sargassum seaweed.

Picked up near the Grand Banks in floating seaweed (Inset map).

Sizes to 31 mm cl (61 mm cw) in males and 31 mm cl (64 mm cw) in females.

Ovigerous females are known from most months in the year (Williams, 1984).Egg diameter 0.2 mm.

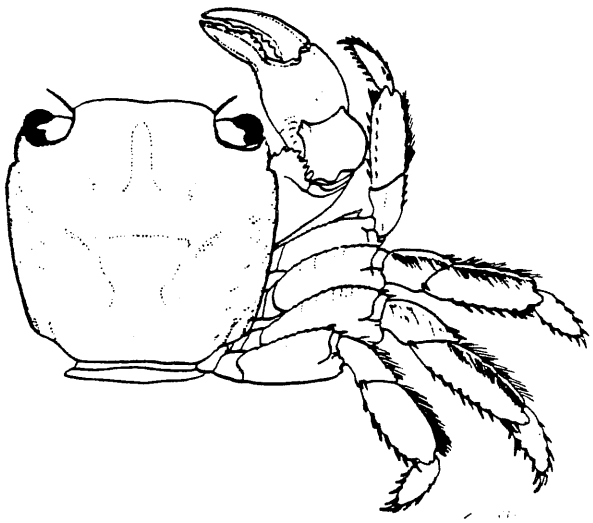
Mandible incisor forming a sharp point at centre of blade, well-defined pointed corner below. Palp with 3 segments.

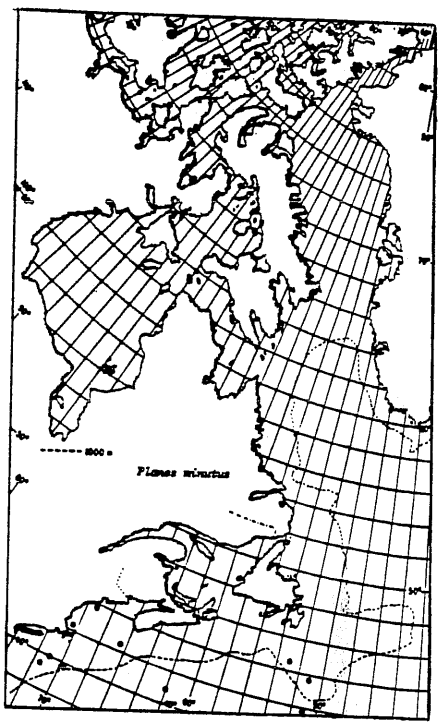
Family GRAPSIDAE MacLeay, 1838

Small quadrate-shaped crabs. Legs adapted for grasping.

Planes minutus (Linnaeus, 1758)

Chace 1951; Ingle 1980;
Williams 1984.





Small Sargassum crab, mottled light greenish yellow, or reddish fawn colour with dark brown and white spots. Carapace almost square in outline, about as wide as long. Orbits large at front corners. Chelae large equal. Other legs flattened with fringes of spines and setae.

Distribution off the Grand Banks to the southern North Sea and essentially the Sargasso Sea and part of the Caribbean but not in the Gulf of Mexico. Also in the Mediterranean (Williams 1984).

Picked up in Sargassum seaweed on the Grand Banks in July. Water temperature 15.8 degrees C. (Inset map).

Length to 19 mm cl (19 mm cw) in males, to 15 mm in females examined.

Ovigerous females seen throughout the year (Williams 1984).

Stomach contents crustacean fragments, probably shrimp.

Mandible incisor curved forming small tooth at centre, pointed at lower corner. Palp with 3 segments.

DISCUSSION

BIAS OF THE COLLECTIONS. Collections of decapod Crustacea examined havebeen taken mostly with otter trawls during surveys for groundfish or shrimps(except the CALANUS Expeditions collections in Ungava Bay, Foxe Basin, Hudson Bay, Beaufort Sea to Cambridge Bay, Queen Elizabeth Islands, and Frobisher Bay where several types of gear were used. Also the collection of lobsters and sand shrimps in Port au Port Bay, by lobster trap or plankton net. And Hyas collection in Labrador by hand or fishing gillnet. Collections from the fish and shrimp surveys have concentrated on fishable areas in deepwater channels, shallow bank areas, etc., offshore, and have largely ignored inshore areas or untrawlable grounds. Inshore areas generally are thought to consist of a mosaic of communities, and fishing trawls would be less likely to catch representative species than would be sampled from more uniform communities of deep water or smooth bottom (Morgans, 1949).

DECAPODS REPRESENTATIVE OF CERTAIN AREAS. Kendeigh (1960) states that "... in the ocean the important organisms that define biomes are usually the predominant animals ... characteristic combinations of animal species". While this refers to any animal phylum or phyla, the idea is here restricted to decapod crustaceans. The diversity of decapod species (Russell 1962) and their adaptability to various habitats make them particularly useful to characterize habitat types. In the area of investigation reported on, given a set of environmental conditions such as depth, topography and temperature, a particular complex of decapod species will be present. The following unit areas are reviewed to show what complexes of decapod species may occur in each (See also Table 46).

UNGAVA BAY. CALANUS collections of decapods have been studied by Squires (1957). Characteristic species present in the relatively shallow inshore area were Argis dentata, Lebbeus polaris, L. groenlandicus, Eualus fabricii, Spirontocaris spinus, Pagurus pubescens and Hyas coarctatus. Ten other species were also taken in small numbers. However, in depths of 105-370 m at the mouth of the bay (trawled by the A.T. CAMERON in 1959) the dominant species was Pandalus montagui with small numbers of P. borealis. Numbers of decapod larvae in this bay gives greater importance to Hyas coarctatus and Pagurus pubescens than the benthic collections would indicate (Squires 1993). Hyas coarctatus takes over from H. araneus north of Cape Mugford, Labrador, and is the only crab in the eastern Canadian Arctic.

FOXE BASIN. In the northern part of this area four species occurred in 50% or more of the catches, namely, Eualus gaimardi, Lebbeus polaris, Spirontocaris phippsi and Pagurus pubescens. These had

been collected also by Captain Robert A. Bartlett in 1927 and 1933 in this area. Nine other species were present. In the more southerly part including the western end of Hudson Strait, only three species occurred in 50% of the catches, Lebbeus groenlandicus, L. polaris and Spirontocaris spinus. Thirteen other species were present including Hyas coarctatus taken at the shore by hand, as well as in depths up to 90 m by dredge but in small numbers.

HUDSON BAY. There were some differences in parts of this very large bay or inland sea. Around the islands at the mouth of the bay the species occurring most frequently were Lebbeus polaris, L. groenlandicus, Spirontocaris spinus, S. phippsi, Eualus fabricii, E. gaimardi and Pagurus pubescens. Four other species were present. Along the northwest coast the commonest species were: Lebbeus polaris, Eualus fabricii, E. gaimardi, Spirontocaris phippsi and S. spinus. Six other species were present. Around the Belcher Islands and along the east coast: Hyas coarctatus, Eualus macilentus, E. fabricii, Argis dentata and Sabinea septemcarinata. Eight other species were present. Richmond Gulf could be characterized by Eualus macilentus, Pandalus montagui, Argis dentata and E. gaimardi. No other species were present. James Bay had Hyas coarctatus, Argis dentata, Pandalus montagui and Eualus gaimardi. Three other species were present (Squires 1967).

FROBISHER BAY. Decapod species characteristic of the Calanus Shelf were Pagurus pubescens, Lebbeus polaris, L. groenlandicus, Spirontocaris spinus and Argis dentata. Six other species were present (Squires 1961).

LABRADOR. In the north Atlantic water incursions into Hudson Strait at depths of 200-700 m bring Pasiphaea tarda and Sergestes arcticus as far as the mouth of Ungava Bay (Squires 1957). Arctic water exerts only a minor influence at these depths off the Labrador coast and temperatures of 3 to 4 degrees pertain. There is an abundance of Pandalus borealis on these grounds (channels) at 200-400 m. From 300-550 m P. propinquus is found. In water shallower than 200 m Pandalus montagui and Pagurus pubescens are common and temperatures reach -1.5 degrees C. where Arctic water influence is greatest. Lebbeus polaris occurs at all depths and temperatures fished in this area.

Further south, from Cape Mugford to Hamilton Inlet Bank, Sabinea sarsi appeared in the P. borealis communities at depths of 230 -375 m and temperatures of -0.6 to 3.5 degrees C. However, P. borealis was dominant in the hauls, and in 25% of the hauls it was the only decapod present. In deeper hauls, 450-750 m, and temperatures of 3 to 4 degrees C. P. propinquus and occasionally Acanthephyra pelagica appeared but no P. borealis. In shallower hauls from 20-180 m and temperatures of -0.8 and 1.0 degrees C. P. montagui was the dominant decapod, and in the deeper part of this range Sabinea septemcarinata was common.

The shallow sublittoral zone on the coast of Labrador is occupied by the spider crab Hyas araneus as far north as Cape Mugford. It is then replaced by Hyas coarctatus whose distribution extends into the Arctic. Both species of Hyas were present in depths of 320 m at offshore Labrador, sometimes taken together in catches.

The five hauls made in Lake Melville, Labrador, in 1952 could not be considered as representative since no trawling was done deeper than 140 m and there are many areas deeper than 200 m. A few P. borealis were taken at 90-130 m (1 specimen only at 26-29 m). They were all males 13-21 mm cl. Temperatures were below 0 C in October except at the shallower hauls.

Such low temperatures appear to supress sex change so a population in this area may not be self-propagating (Squires 1968b). However, a report of large numbers of shrimps found dead at a beach near Goose Bay suggests that a population build-up could occur and cold-water kills may occur as in Greenland fjords (Horstad and Smidt 1956). Other species present in hauls in Lake Melville were P. montagui, Eualus macilentus, Argis dentata and Sabinea septemcarinata.

NORTH AND NORTHEAST COASTS OF NEWFOUNDLAND. The slope off this coast, including the Northeast Newfoundland Shelf, at depths of 200-400 m varies in width from 30 to 100 miles and extends southeastwards until it reaches the Grand Banks. This area has predominantly temperatures of 1.2 to 3.6 degrees C. P. borealis was present in most of the hauls sometimes exclusive of other species of decapods. Sabinea sarsi too was present but in relatively fewer hauls than off Labrador. In deeper hauls on these slopes from 500-700 m Acanthephyra pelagica and Gennadas elegans appeared in the catches. In hauls shallower than 250 m P. montagui occurred frequently. When temperatures in shallower areas were at 0 degrees C. or below, Eualus macilentus was present with P. montagui. A few Spirontocaris spinus, S. lilljeborgi and Lebbeus polaris were also taken.

In contrast to the deep waters of the offshore slopes, the deep water of White Bay and Notre Dame Bay usually had bottom temperatures below 0 degrees C. Here the dominant species was P. montagui larger and in greater numbers than P. borealis when present in most hauls. Also occurring were large numbers of Eualus macilentus and Argis dentata. Small numbers of Lebbeus polaris, Sabinea septemcarinata, E. gaimardi belcheri and Hyas coarctatus were common in these mixed catches. In the deep fjord-like arms of Notre Dame Bay (Badger Bay, New Bay, Green Bay and Halls Bay) good catches of P. borealis were made with the groundfish trawl. Temperatures were moderate and the shrimps formed local and perhaps isolated communities.

The characteristic decapods of the offshore slope fauna were P. borealis and Sabinea sarsi while the inshore bays support mixed P. montagui, P. borealis and E. macilentus communities.

At the shore Homarus and Cancer are at the limit of their distribution northward between Notre Dame and White bays as far as their usual large numbers are concerned. A sizeable fishery for lobster exploits the sublittoral population in the summer insolated area of Notre Dame Bay, but no lobsters are fished in White Bay. The persistence of low temperatures of arctic water filling this bay acts as a barrier to the movement of lobsters northward or to the settlement and success of lobster larvae coming southward after egress from the Gulf of St. Lawrence or Pistolet Bay. Lobsters may be present but not in sufficient numbers to support a fishery. A rockfish, Tautogalabrus adspersus, also appears in reduced numbers in White Bay compared with other inshore areas of Newfoundalnd.

EAST COAST OF NEWFOUNDLAND. Bonavista and Trinity bays are without sills or shallow rises where thay open to the sea, and consequently they have communication with deep slope water. This causes bottom water in these bays to have temperatues above 0 degrees C. (0.2 to 1.3 degrees C.). In Bonavista Bay there was evidence of mixing of Atlantic water with arctic water. Salinities were lower (33.8%) than Atlantic water and temperatures were lower than the optima for P. borealis (Fig. 8 and 9). Therefore although P. borealis was present, its numbers were exceeded by P. montagui which was also larger in size. In Trinity Bay where temperatures at the bottom were above 0 C., some hauls in 260-420 m took P. borealis exclusively (in three hauls out of seven), but P.montagui and E. macilentus were present in others. In two hauls at 210-250 m P. montagui was more abundant than P. borealis , but in one haul both these species were outnumbered by Eualus gaimardi belcheri. Since the greater part of this bay is deeper than 260 m, its decapod fauna is mostly a P. borealis-P. montagui type, although in the shallow parts of the bay a P. montagui -thorid complex could be expected.

The lobster landings in recent years have become large in Bonavista Bay. It is presumed that this fishery has developed only because of recent organization rather than a new availability. In both Trinity and Conception bays, however, the lobster landings have remained comparativley small (Templeman and Tibbo 1945). Conception Bay is different from both Trinity and Bonavista bays because it has a deep trough, and therefore less connection with deep slope water in that area. Temperatures in the trough were below 0 C. and salinities of 33.3% indicating mixed water but with a strong arctic influence. The decapod fauna was dominated by P. montagui in the trough but almost equalled in numbers by E. macilentus, the deep and cold water shrimp. Three other species were also present, P. borealis, A. dentata and E. gaimardi belcheri.

FLEMISH CAP. Pandalus borealis was taken exclusively of other shrimp species in eleven hauls at depths of 200-550 m in this area. Greatest numbers occurred at 290 m. Bottom temperatures were just

over 3 degrees C. In one haul over 720 m one specimen of Lithodes maja and one of P. borealis were taken. Lithodes maja and H. coarctatus occurred in catches from this area at other depths.

NORTHEAST, EAST AND SOUTHEAST SLOPES OF THE GRAND BANK. On the outer slopes of the Bank in depths of 220-330 m the P. borealis, P. montagui and Sabinea sarsi combination was present as it was on the more northerly offshore slopes. However, some catches were exclusively of P. borealis. These findings were substantiated in the 1990s by experimental fishing for this shrimp in this area. Chionoecetes opilio occurred occasionally also, as in the north, showing a preference for deeper water than Hyas araneus or H. coarctatus. At 550 m the depth range of P. borealis seemed to be exceeded and Acanthephyra pelagica and Pasiphaea tarda appeared. On the Southeast Shoal at depths less than 55 m Pagurus arcuatus was very common and this is its new type locality. Lebbeus polaris and Hyas araneus were also present.

NORTHWEST AND CENTRAL PARTS OF THE GRAND BANK. This area is continuous with the Avalon Channel and is 55-105 m deep. Decapods were dominated by P. montagui although it did not occur in some hauls. Possibly it occurs in discrete or mobile communities over the Bank. Other species which occurred frequently but not in large numbers were Spirontocaris spinus, Argis dentata, Sabinea septemcarianta, Hyas araneus, H. coarctatus and Pagurus pubescens. H. coarctatus occurred more commonly near the coast.

EAST COAST OF THE AVALON PENINSULA. In depths of 130-165 m P. montagui was dominant in catches which included L. groenlandicus, S. spinus, E. fabricii, E. gaimardi belcheri and Argis dentata. Stomachs of cod from the Torbay and St. John's fisheries had several species of shrimps including the above and also the crabs Chionoecetes opilio, Hyas araneus and H. coarctatus. Lobsters are too few on this part of the coast to support a fishery.

SOUTHWEST SLOPE OF THE GRAND BANK. At depths less than 200 m the decapod fauna of this part of the Bank differed from other parts. An incursion of relatively warm water was evident from temperatures of 1.3 to 7.2 degrees C. About half the hauls had P. montagui present but in small numbers and one-quarter of the hauls took Pandalus propinquus and Dichelopandalus leptocerus. A few Pagurus arcuatus and Hyas araneus were in the shallow areas. Only a few hauls were deeper than 200 m, and P. borealis appeared at 280-330 m, Pasiphaea tarda and Pontophilus norvegicus at 410-480 m and Sergestes arcticus and Plesiopenaeus edwardsianus at 710-770 m, all in small numbers. Neolithodes grimaldii was also taken in this area where it had been first taken by the 'Hirondelle' in 1877.

ST. PIERRE BANK. At depths less than 200 m P. montagui occurred in greater numbers than other species, except in one haul where

Spirontocaris spinus was more plentiful. In addition S. phippsi, S. lilljeborgi, L. polaris, L. groenlandicus, Sabinea septemcarinata and A. dentata occurred in small numbers. At 200-284 m on the slopes of this Bank P. borealis occurred in greater numbers than P. montagui the only other species present.

Generally the Grand Banks do not support any abundance of decapods at shallow depths as shown by many hauls for groundfish during seasonal surveys. The percentage of hauls with decapods was low (Fig.48, Table 47). The outer slopes of the banks, however, is a different story. The more constantly higher temperatures favour species such as P. borealis. Also possibly lower current speeds than on the banks permit more sediment to settle with the consequent suitable habitat for microphagus feeders. Wigley (1961) has shown considerable variation in sediments on Georges Bank. A similar picture of the Grand Banks would possibly show variability in gravels, sands and rocks on ridges and sediment accumulation in depressions, etc., which could support variations in faunal elements such as decapods which depend partly upon sediments for feeding. There could be therefore small, discontinuous or mobile populations of shrimps and crabs as a result. On the Grand Banks such populations would be subjected to flooding periodically with water below 0 degrees C.

ST. MARY'S BAY. Various depths over short distances and temperatures influenced by arctic water result in a complicated picture of shrimp populations in this bay. At depths of 90-185 m and temperatures above 0 degrees C. P. borealis appeared in most hauls (7 out of 11), but was numerically less than Argis dentata, and in one there were more P. montagui. At similar depths but with temperatures below 0 degrees C. the usual combination for cold deep bays appeared; P. montagui was dominant in a complex of almost equal numbers of P. borealis, E. macilentus, S. septemcarinata and Argis dentata.

PLACENTIA BAY. Low temperatures in the deep and large trough in this bay appeared to favour P. montagui. It was in competition with P. borealis and was larger in average size. The extent of the P. borealis community, however was greater than that of P. montagui in depths over 200 m. It was present in 95% of the hauls compared with 26% for P. montagui (Squires 1961). E. macilentus was in 50% of the hauls. At depths less than 200 m P. montagui was dominant in a complex of species including S. septemcarinata, A. dentata and L. polaris. In every haul the bottom temperature was below 0 degrees C.

Since this bay receives a continuous flow of arctic water from the Avalon Channel, it is possible that the P. borealis community is maintained by expatriate larvae coming largely from the east coast bays (Conception, Trinity and Bonavista bays). It may also be partly self-propagating but in such a low temperature area the

proportion of females to males is low and the population has low reproductive potential. Although P. borealis maintains itself in competition with P. montagui at depths over 200 m, fishing would most likely reduce its numbers in a short time.

FORTUNE BAY. The influence of arctic water in this bay was still considerable in 1957 when 8 hauls with a shrimp trawl were made there. Temperatures were from -1.1 to 0 degrees C. and salinities 32.0 and 32.6 ‰ at the bottom. However, the cold deep water complex of E. macilentus, P. montagui, A. dentata and small P. borealis occurred in the outer part of the bay. From Garnish inward there were continuous catches of P. borealis, most of them small males where the water was cold. The proportion of males to females was 3:1 and 5:1. About 70% and 50% of these respective females were ovigerous indicating that the population was possibly self-propagating, although its reproductive potential was low.

HERMITAGE BAY. This deep-water bay is not influenced by arctic water apparently and it has a connection with Atlantic water through the Southwest Newfoundland Channel. Bottom temperatures were 5.9 degrees C. and salinities 34.5 ‰ . P. borealis, however, apeared to be scattered, occurring in only 20% of the hauls. They were taken where temperatures were close to 2 degrees C. at depths of 130-220 m. Further at depths of 200-370 m a complex of species occurred among which Sergestes arcticus and Pasiphaea multidentata (pelagic forms) and S. lilljeborgi, P. borealis and Lithodes maja (benthic forms) were in considerable numbers. A specimen of the burrowing axiid, Calocaris templemani, was also taken here in a fish trawl. It was a new species and this is its type locality.

Bay d'Espoir is a deep, narrow and long inland extension of Hermitage Bay but separated from its deep channel. Bottom temperatures were low (0.5 C) with salinities of 32.3 ‰ . These conditions are not necessarily due to arctic water influence but might result from very stable summer thermoclines in fjordlike circumstances with severe winter cooling and outflow of fresh water from rivers. Templeman and Tibbo (1945) recorded low surface salinities in this area in summer. Hauls with a shrimp trawl revealed a P. borealis community with a low proportion of females about 50% of which were ovigerous in August. A few E. macilentus were also in the catches. Such a community could sustain only a very limited fishery.

THE SOUTHWEST NEWFOUNDLAND CHANNEL. This an extended deep-water channel communicating with the Laurentian Channel to the west and lying close to the Newfoundland coast from Hermitage Bay to Rose Blanche. It has a muddy bottom and is fully one hundred miles (160 km) long and about ten (16 km) miles wide on the average. Bottom temperatures were the highest in Newfoundland waters, about 6 degrees C., and salinites were 34.6 ‰ . It seemed to offer

a good prospect for shrimp fishing. The P. borealis community was large in extent and in individuals (Squires 1961). No other species of decapod were present except occasional specimens of Pontophilus norvegicus and Lithodes maja. Efforts to establish a fishery here later were not successful.

A number of fjord-like bays without sills communicate with this Channel. Such are North Bay, Facheux Bay, Aviron Bay, La Hune Bay, Garia Bay, Bay de Vieux and La Poile Bay. Cliffs here rise to at least 800 feet (244 m) and reach back inland to form a rocky plateau. In some of these bays the bottom was too rough for the warp and trawl used in a shrimp survey in 1957 (Squires 1961). However, North Bay maintains a shrimp population of P. borealis at 280 m with temperatures of 5.2 degrees C. and salinities of 34.5 ‰ . However, the ratio of males to females was 5:1 compared to the 1:1 ratio of the main Channel nearby. One specimen of L. polaris was obtained in a random sample of the catch.

GULF OF ST. LAWRENCE. This large area particularly in the Esquiman and Mingan Channels at depths greater than 200 m supports an apparently continuous one-species population of P. borealis. Bottom temperatures were 4 to 5 degrees C. and salinities 34.9 ‰. A "fringe" population seems to exist above the 200 m depth where P. montagui was dominant, although the individuals were smaller than the P. borealis present. Temperatures were relatively low at these depths (above 200 m), 2.8 degrees C. at 170 m, and the ratio of males to females in one sample was 8:1 (see also Table 20). Since this population is close to the main P. borealis community, it is likely that it contains a lot of young shrimps which will migrate to the deeper areas as they grow. P. montagui adapted to cold water, and/or because it is excluded from the P. borealis community, is not likely to take part in such a migration. Lithodes maja is present in the P. borealis community but not in large numbers. Although my paper of 1961 encouraged a fishery in this area, it was not followed up by industry until the 1970s. Since then the shrimp fishery in this area has been very successful especially in the Esquiman and Mingan Channels.

In Bay of Islands a cold water bay with a deep trough separated by a wide shallow area from the Gulf channels, a species complex of P. montagui, P. borealis, E. macilentus and Argis dentata occurred. Temperatures were 0.2 to 0.5 degrees C. at 240 m and the salinity was 32.3 ‰. As in Bay d'Espoir, there may not be arctic water influences in this bay but that conditions are caused by severe winter cooling and a large outflow of fresh water from the Humber River, and a stable thermocline in summer because of the small size of the area affected by winds.

The shallow waters of the Gulf of St. Lawrence are notable for their large sublittoral populations of lobster, Homarus americanus, and the shore crab, Cancer irroratus. There are a few more

or less enclosed populations such as in Port au Port Bay and North Arm, Bay of Islands, but most of the west coast population of lobsters are on the open coast. This is fished intensively between Bonne Bay and Flowers Cove (Strait of Belle Isle). However the few shallow rocky shelves extending from the coast for several miles, such as the shoal off Sally's Cove, do not have lobsters except near the coast or around islands. On the sandy shores, especially where there are eelgrass beds, considerable numbers of the sand shrimp, Crangon septemspinosa, may be found.

DISTINCT DECAPOD COMMUNITIES IN THE AREA OF INVESTIGATION. The attempt to characterize each of these unit areas by combination of species of decapods leads to the conclusion that the types of species communities are relatively few. They include the following:

I. The major Pandalus borealis communities: (a) in the Gulf of St. Lawrence and the Southwest Newfoundland Channel, and (b) along the 200-440 m deep continental slope off the coast from Baffin Island to the Grand Banks. These are soft sediment bottom areas with a layer of Atlantic water which has high salinities and moderately high temperatures (Figs. 8 and 9). Pandalus borealis here has high productivity. It has a high proportion of females, grows fairly fast, matures comparatively early and spawns annually.

II. The mixed P. borealis - P. montagui communities which are found as (a) "fringe" populations to the major P. borealis communites and (b) in deep cold bays containing mixed Atlantic and arctic water just above 0 degrees C., and (c) in the bays of the coast with deep cold water below 0 degrees C. where E. macilentus occurs as one of the predominant species. In these areas the reproductivity of P. borealis is low (there is a low proportion of females, growth is slow, maturity is late and spawning occurs probably in alternate years). But apparently the reproductivity of P. montagui and E. macilentus is high in these areas. In (a) some P. borealis may be recruited from so-called fringe populations because of larval drift and because of migration of larger individuals to deeper water as they grow. In (b) and (c) low reproductivity may still enable P. borealis to survive in small numbers, but in competition with other species and under exploitation by a fishery they would be less likely to survive.

It is possible that "competitive exclusion" can explain why P. borealis can maintain its large single species populations throughout the area. Because of similar functional morphology and feeding habits, P. montagui appears to be a competitor although it does not grow as large (mature females are 17-23 mm cl in the latter and 23-31 mm in the former). Eggs of both species are the same size but there is greater production of eggs in P. borealis than in P. montagui (Jensen 1958 and Price 1962) which gives it a competitive advantage. P. montagui in the eastern Atlantic is moderately thermophilic in temperature of 3 to 20 degrees C.

(Allen, personal communication), while in the western Atlantic it seems to prefer cold arctic water where it can maintain high reproductivity (Table 23). It seems possible, therefore, that the thermophilic form of this species has been eliminated in this area through competition with P. borealis in the warm water situations. The form of P. montagui now surviving has adapted well to arctic water. Apparently it has not changed morphologically, perhaps because it has not become discontinuous in geographical distribution. There has been no evolution of cold-water forms of P. borealis because of its dominance in its large warm water communities, and perhaps because of competition with the cold-adapted P. montagui. There are records of mass mortalities of P. borealis when subjected to long periods of low temperature (Horsted and Smidt 1956).

III. Multi-species communities. A few of these are recognizable from trawl or dredge hauls. It is possible that they may be representative of a mosaic of communities (Morgans 1959) rather than all being present together in single communities. (a) The Ungava Bay group of L. polaris, L. groenlandicus, E. fabricii, S. spinus, P. pubescens and H. coarctatus which is typically found in cold and shallow water, occurs with minor variations and additions from Foxe Basin to the Grand Banks at depths of 20-95 m.
(b) The St. Mary's Bay group of Argis dentata, Sabinea septemcarinata, E. gaimardi belcheri and L. polaris which occurs usually at medium depths of 70-145 m and moderately low temperatures in more restricted areas than the former as in an enclosed bay like Bay of Islands.
(c) The Placentia Bay group of E. macilentus, P. montagui and P. borealis found in deep, 150-250 m, and cold water troughs such as also in Conception Bay. All these groups are likely to have P. montagui present, and in some instances it will be the dominant species.

These multispecies communities are usually subject to either considerable seasonal variation in temperature, influenced by variations in the flow of arctic water, or they are continuously in cold water. Since these species have apparent flexibility or variability in food and/or shelter requirements, they may not be in direct competition. Some of them have only moderate reproductive potential and are small, such as E. fabricii. These features may indicate their lack of capacity to compete successfully with P. borealis, P. montagui or some other species, and may account for their present distribution. On the other hand species with apparently high reproductive potential and large size, such as Sclerocrangon boreas, may have become adapted to specialized feeding or habitat and their small numbers may be due to dependance on density of their own kind in limited space or available food supplies.

IV. Lobster - shore crab (Homarus - Cancer) community. In comparatively shallow water these decapods have to contend with seasonal changes which at the most can be moderated by short-distance migrations. Most parts of the Newfoundland coast provide a suitable environment for those two species, but the grounds are limited in extent and more or less discontinuous at least for the adults. Population numbers are conditioned by the area available for shelter and feeding.

Preliminary studies with lobsters in small aquaria in Port au Port Bay in 1962 (Squires 1970) suggest that individuals of the same size may show dominance over each other and may compete for shelter. Further studies are needed to determine the extent of density dependance, for it may be possible to increase the size of the population by increasing the amount of shelter available on otherwise suitable grounds. Scarrett (1962-63) reports that experiments with providing shelters for lobsters (drainage tiles) show possiblities for increasing the productivity of lobster grounds.

The reproductive potential of individual lobsters may appear low in comparison with Pandalus borealis, but this is offset by the longer life and the greater number of broods produced by the lobster. Commercial exploitation has led to considerable reduction of numbers in lobster populations, particularly in areas where only a limited amount of suitable lobster grounds are available, such as in Conception and Trinity bays. Templeman and Tibbo (1945) state that, neglecting growth rates, the average length in a lobster population depended upon the intensity of fishing in any area, and on the nearness of the area to the place where most larvae settle. They chose North Arm, Bay of Islands, to illustrate the latter point. Abundant larvae drifting into the Arm was demonstrated, and the size of the lobsters in the Arm was shown to be small. However, these two circumstances may be unrelated. Lobsters are known to be small in Middle Arm also, although the numbers of larvae drifting into this Arm are not as great as into North Arm. While any lobster population must be recruited from a nearby settlement of larvae, it is not known to what extent small lobsters can survive when settling among adults. As in other late developed larvae they will have some choice in where they settle (Thorson 1946). Preliminary studies on larval drift in Port au Port Bay in 1962 suggest that settlement may be shoreward from the adult population. Overproduction of larvae in marine invertebrates is common, and the number produced in any year is not an assurance of year-class success. Settlement is critical and often dependant on density (Moore 1958). This would seem to apply to lobster larvae, and Wilder's (1953) figures from the capture by dredging of early settled stages of lobsters would seem to be more effective for year-class predictions than numbers taken in planktonic stages. Trancept counts of early settled stages by diving would probably be still more effective.

On the other hand several factors may contribute to the smallness of lobsters in North Arm:
(a) There may be good annual survival of larvae and juveniles;
(b) moulting and growth in a particualar year may be supressed especially at a size just below the minimum legal size because (i) small lobsters are released from capture after being held too long in sun and wind; (ii) small lobsters in shallow water are subjected periodically to large volumes of fresh water from the Humber River during the moulting period, and (iii) in some years temperatures may remain low on the narrow lobster grounds in the Arm throughout the summer. Also (iv) this area may be subject to poaching in late autumn so there would be fewer large ones left for the spring fishing season. Investigations are needed to determine which of these or other reasons apply to any extent.

North Arm, Bay of Islands, is an area where experimental ranching could be undertaken. There is limited opportunity for emmigration out of the Arm because the population is distributed in a narrow band along shore and because the slope into deep water is steep and there is a lot of scree from the cliffs which provide ample shelters. Lobsters would have to go around the steep headlands to escape. These lobsters have been shown to trap readily, indicating that they would feed avidly on fish offal in autumn when they are recovering from moulting. They also characteristically have larger chelae for their size than other west coast populations (Squires et al, 1973).

The role of Cancer irroratus in the Homarus-Cancer community is not well understood. Cancer is subject to depredations in the lobster fishery since it is frequently caught in lobster traps and then used as bait. This procedure may deter other crabs from entering the trap (Hancock and Simpson 1962). Generally Cancer occupies a zone nearer the shore than the lobster, but there must be considerable overlap according to the numbers taken in traps. Stomach contents of lobsters show that crabs form a major part of their diet. However, the crab competes with lobster for other food items such as polychaetes and periwinkles. Cancer has a higher reproductive potential than Homarus but its subordinate position in the community can be accounted for by the predator-prey relationship in which it is much smaller than the lobster at a comparable age.

V. Sergestes-Pasiphaea community. Populations of these species are present in the Southwest Newfoundland Channel and Laurentian Channel at depths of 200-400 m. Since they are pelagic, only small numbers would be expected in bottom trawling. The even ratio of males to females and the maturity of specimens collected indicate that these populations are self-propagating. Where they have been taken on the slopes offshore from Baffin Island to the Grand Banks, the few specimens like those of other deep-sea decapods are

probably representative of a much more extensive deepsea community. Acanthephyra pelagica and Gennadas elegans are also trawled in the fringe areas of a similar deep sea population.

BIOLOGY OF SPECIES

FEEDING. Stomachs of all penaeid and many caridean shrimps have a gastric mill (Icely and Nott 1992) and there is also a complex pyloric filter. In all palinurans, anomurans, astacideans and brachyuran stomachs there is a more highly developed gastric mill. It functions to crush and triturate food into small particles. Sand was present in almost all decapod stomachs examined. It may be taken inadvertently with benthic food organisms, but may be important in breaking down food. Even those shrimps considered to be pelagic had sand in stomachs so must reach bottom occasionally.

RELATIONSHIP OF MANDIBLES TO FEEDING. The generalized form of a decapod mandible consists of a cutting or shearing edge -- the incisor, and a grinding surface -- the molar. The right incisor shears past the left on the outside and the two molars occlude. A palp when present is of at least two parts attached to the mandible to guide the food for cutting or crushing. Food is brought to the mandible by the maxillae and maxillipeds. These are variously modified to function as sifting baskets with many setae or with less setae as spiny grasping or holding appendages.

TYPES OF MANDIBLE. In each species the left mandible was described and figured; it differed only slightly from the right in most cases. The closest to the generalized mandible is in the species of penaeids with a cutting incisor closely joined to the molar and with a palp (Fig. 10). There is little difference between the mandibles of pelagic species. The palp is large and would probably be used to assist in capturing prey. The oplophorid mandible (in Acanthephyra) is similar in the penaeid but the palp is smaller and could be used only in adjusting food to the mandible (Fig. 11).

The pasiphaeid mandible does not have a palp or molar and the sagittate incisor (Fig. 11) could only capture and hold prey while it is swallowed whole. Among the other caridean shrimps examined the pandalid and thorid mandibles are somewhat similar. The incisor is widely separated from the molar forming a thin flexible blade with some small teeth at an apex. This blade projects among the mouth parts and would help to hold prey and bring it towards the molar. The molars have shearing edges and cusps and their effectiveness would be in crushing and grinding with large irregular surfaces. These shrimps are therefore equipped to feed on phytobenthos and small benthonic animals. Some selective feeding is still present in individual species such as Spirontocaris spinus which is microphagus on small hard-shelled animals (See also Allen 1962).

Similarly P. montagui is partial to gammarid amphipods in this area and polychaetes in Britain (Mistakidis 1957). Similarity of mandibles in species such as P. montagui and P. borealis suggests that they may feed on the same prey.

The mandible of Bythocaris sp. has no incisor or palp (Fig.30). The molar has a sharp ridge and sharp cusps which may be used for capture and holding in a pelagic venue. It may be a secondary adaptation to feeding pelagically on active prey.

The crangonid mandible also has no incisor or palp. The molar is modified as a holding or shearing instrument with long pointed cusps or fangs and no crushing surface is evident. The molar varies in form. In Sclerocrangon boreas 2 large and 2 small subsidiary cusps; in S. ferox 4 long pointed cusps; Crangon has 4 cusps, 3 of which are long; Sabinea 2 large and 2 small; and in Pontophilus the number of cusps is reduced to 2 only (Fig. 26). The more efficient for holding would probably be the latter, while forms as in S. boreas and Crangon would probably be used for triturating as well. However, Crangon was found to have large prey whole in stomachs.

The deep-sea palinurans, Polycheles and Steromastis have mandibles with no molar (Fig. 30) but the large saggitate incisors would be effective for holding and cutting prey.

The anomuran mandibles are similar. Pagurus and Lithodes have heavy but sharp incisor blades for cutting and large molars for crushing (Fig. 31). Munida, Munidopsis and Calocaris are different from the anomurans but still have mandibles with cutting and crushing surfaces and bristled palps to bring food particles into the mouth. Calocaris would seem to have adapted to feeding on detritus (Buchanan 1963). Homarus (Fig. 30) has a type of mandible similar to the anomuran but the incisor edge is blunter and capped with thick corneus edge. This is probably an adaptation to feeding on large hard materials. In the brachyuran crabs the incisor is a curved calcified blade for cutting with a smaller molar shelf behind it. Homarus, Hyas and Cancer are able to cope with large pieces of fish offal as well as small live prey.

HATCHING PERIODS IN DECAPODS. Among decapod crustaceans more than one hatching of larvae per season have been observed for Crangon crangon, Philoceras nanus, Leander adspersus and L. squilla in northern Europe (Thorson 1946), C. allmani off Northumberland (Allen 1960) and Crangon septemspinosa in Chesapeake Bay (Price 1962). Evidence of monthly hatching of larvae from April to September, at least, has been observed in a more stable (subtropical and bathypelagic) environment (Dunbar 1960) near Bermuda in the species Acanthephyra purpurea, Systellapsis debilis and Stylopandalus richardi (Chace 1940).

This has been demonstrated also for Panulirus argus of the Guajira Peninsula of Colombia (Squires and Riveros 1978) and hypothesized for shrimps of the Pacific and Caribbean coasts of Colombia (Squires 1973).

In most species of decapods in the present area of investigation one hatching per year is common. Eggs were laid in late summer or early autumn and some embryo development took place, particularly in the warm month of September, so that in some ovigerous specimens eyed embryos occurred such as in Spirontocaris spinus, Lebbeus groenlandicus, L. polaris, Sabinea septemcarinata and Argis dentata from St. Mary's Bay to Notre Dame Bay in October and November. Low temperatures supressed embryo development and eggs were carried through the winter and hatched out in spring or summer. Hatching of eggs in early spring and laying eggs later in the summer was observed in species such as Pandalus borealis and P. montagui and most of the other species mentioned above (Fig. 14).

In more arctic areas such as Foxe Basin hatching of larvae occurred only once in the year as shown by the presence of larvae of the various speciesin the plankton with gradual development to megalopa stage during the short summer and autumn (Squires 1993). In females of many species eggs were laid during the summer and carried through the following winter so that hatching in individuals occurred only once every two years (Squires 1967). This may have happened in most species since few were seen with large ova in the ovaries that would be laid after the eggs carried had hatched out.

In Crangon septemspinosa from Port au Port Bay, however, hatching took place in the spring as the inshore eelgrass beds warmed up, but ova developed in the ovaries and a second batch of eggs was laid later in the summer with a second hatching in August (Table 27). Many of the specimens examined already had large ova in the ovaries when carrying eggs. Larvae of advanced stages were seen before the appearance of early stages later in the summer. This species therefore produced two broods per mature individual each year (Squires 1970).

On the other hand the lobster, Homarus americanus, carries eggs through the winter but hatch larvae late in summer and few were observed capable of laying eggs in the same year of hatching larvae. Most specimens examined had small ova in the ovaries when carrying eggs. Embryo or ova development is slowed by the low temperatures of winter and larvae when hatched are relatively large. It appears, therefore, that individual mature females lay eggs only every second year (Squires 1970).

REPRODUCTIVE POTENTIAL. In this area full reproductivity of decapod species was considered to be shown in hatching at least one batch of larvae per year. Since low temperatures slow up development of embryos or ova, some species in cold water localities hatch larvae or lay eggs in every second year. Species such as Eualus macilentus are an exception. Even in low temperature deep bays high percentages potentially ovigerous each year showed that they spawned annually. They appear sufficiently cold-adapted to override the low temperature conditions. Because temperatures are predominently low in this area, many decapod species live longer than in warm water areas and individuals may spawn more than once in a lifetime.

Percentages of mature females found to be potentially ovigerous in random samples of decapods taken in autumn from this area have been adopted as an indication of annual or biennial spawning. Potentially ovigerous is defined as already carrying eggs or with large ova in the ovaries ready to be laid. For example, if the percentage of mature females expected to carry eggs in late autumn were 100% it could be said that they spawned annually, but if only 50% were potentially ovigerous they would spawn only every second year. Because of sampling error such ideal percentages are not likely to occur. Approximations to either percentage may indicate possible spawning incidence, either annual or biennial.

DECAPODS IN COD STOMACH CONTENTS. In frequency of occurrence decapods form a significant part of the diet of cod (Gadus morhua) throughout Newfoundland and Labrador (Tables 43, 44). About 40% of the stomachs examined contained shrimps in some areas and in others about 40% contained crabs. In general fish represented a greater proportion in places or times in the year when they (chiefly capelin) were available.

Shrimps were about 40% of stomach contents in the following areas: southwest Gulf of St. Lawrence, Port au Port Bay, Port aux Basques, Ramea, Fortune Bay, Off Cape Pine (St. Mary's Bay), central Grand Bank, Northern Grand Bank, off St. John's, Trinity Bay, northeast of Bonavista Bay, Greenly Island and Domino, Labrador (Table 44). Species most commonly occurring were Pandalus montagui, Spirontocaris spinus, Lebbeus polaris, L. groenlandicus, P. borealis, Sabinea septemcarinata and Eualus fabricii.

Spider crabs, Hyas spp. and snow crabs, Chionoecetes opilio, occurred frequently also in cod stomachs from many samples examined at many places throughout the area. The highest frequency (about 40%) occurred in samples from St. Pierre Bank, the northern Gulf of St. Lawrence, off St. John's and off the southwest coast (Table 43).

In all areas the lowest incidence of decapods in cod stomachs was during April - August, and the highest in September - December.

This difference may have been caused by the cod feeding heavily on capelin, Mallotus villosus, in the spring and early summer (Fig. 34). In a few areas where capelin were not available at any time cod foraged to a considerable extent on decapods, and to a smaller extent on other benthonic fauna throughout the year. The occurrence of decapods throughout the area is indicated by the percentage of trawl captures during surveys for groundfish (Table 47). The numbers of specimens of each species of decapod examined and included in this paper are shown in Table 48, and a summary of comparative sizes of species from various localites in Table 49.

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A P P E N D I X

Table 43. Occurrences of spider crabs in cod (Gadus morhua) stomachs taken in 1947-53 as a percentage of the number of stomachs examined from each locality.

Locality	No. of stomachs examined	Depths m	C. opilio %	Hyas spp %
Southeast Grand Bank	388	62-183	0.3	18.8
Northern Grand Bank	849	75-430	8.5	9.3
Southern Grand Bank	244	66-205	0.4	20.1
Flemish Cap	48	130-190	...	10.4
St. Pierre Bank	91	40-175	1.1	36.3
Labrador	219	200-340	15.5	5.5
NE Nfld coast offshore	200	209-331	27.5	8.0
NE Nfld coast inshore	364	13-92	2.8	5.2
St. John's inshore	481	25-130	11.2	15.4
Cape Race to C. St. Mary's	142	64	11.3	7.8
Cape St. Mary's to Pass I.	60	...	11.7	...
Pass Island to Cape Ray	209	10-20	...	35.4
S. Gulf of St. Lawrence	99	55-90	1.0	1.0
N. Gulf of St. Lawrence	94	7-92	...	39.4

Table 44. Percentage of cod stomachs in which shrimps occurred in collections from 1947-53 (some identified to family only).

Locality	No. of stomachs	Depth m	Pandalidae				Thoridae					Crangonidae			All
			Pb	Pm	P	%T	Ef	E	Sp	L	%T	A	Sa	%T	%A
Nachvak	51	30-35	-	-	-	0	+	-	+	+	4	+	+	10	29
Domino	226	15-20				...					...			...	37
Greenly I.	64	80-90	-	+	-	17	-	-	+	+	13	-	-	3	63
Labrador	224	200-340	+	-	-	5	-	-	+	-	0	-	+	2	12
Englee	256	90				...					...			...	16
NE Shelf	78	300	+	-	-	18	-	-	-	+	1	-	-	0	28
Fogo	198	15-45	-	+	+	2	+	-	-	+	3	-	-	0	6
Bonavista	246	210-330	+	+	+	20	-	+	+	+	5	-	-	3	36
Bonavista	332	20-35	-	-	-	0	-	-	-	-	0	-	-	1	1
Trinity	207	55-185	-	-	-	0	-	-	-	-	1	-	-	1	7
Bauline, CB	29	40				...					...			...	4
St. John's	822	55-130	-	+	-	9	-	-	-	-	5	-	-	0	45
St. John's	154	23-30				...					...			...	9
N. Gr. Bank	469	75-165	-	+	-	17	-	+	+	+	7	-	+	2	35
N. Gr. Bank	264	140-430	+	+	-	10	-	-	+	-	3	-	-	1	28
NE Gr. Bank	120	130	-	-	-	0	-	-	-	-	1	-	-	2	3
Flemish Cap	136	130-190	-	-	+	1	-	-	-	-	0	-	-	0	8
C. Gr. Bank	328	60-80	-	+	-	11	+	+	+	+	25	+	+	1	54
SW GR. Bank	347	80-200	-	-	+	3	+	-	-	-	2	-	-	0	6
S. Gr. Bank	218	45-85	-	-	-	0	-	-	-	-	2	-	-	0	10
Cape Pine	96	65	-	-	+	24	-	-	-	-	23	-	-	11	67
St. M. Bay	55	105-140	-	-	-	4	+	-	-	-	0	-	-	11	29
Burin	76	90				...					...			...	7
Green Bank	33	120-150				...					...			...	3
St. P. Bank	144	40-175	-	+	-	7	-	-	+	-	10	-	-	0	30
Fortune Bay	62	185	+	+	-	16	-	+	-	-	8	+	+	5	58
Ramea	110	35	-	-	+	4	+	-	+	+	36	-	+	3	44
Banquereau	111	45				...					...			...	2
Cape Breton	79	90-185	+	+	+	8	-	-	+	-	4	-	+	8	23
Port aux B.	108	20-50	+	-	-	3	+	-	-	-	24	-	-	2	45
Port au P.	5	25-45				...					...			...	40
Lark Hr.	214	35-65				...					...			...	9
Cow Head	145	35-45	-	-	+	3	-	-	-	-	1	-	-	1	6
SW Gulf SL	70	50-90	-	+	-	3	-	-	-	-	0	+	-	18	40
N. Gulf SL	88	85-230	+	-	+	8	-	-	-	-	8	-	+	8	22

Pb =P. borealis; Pm = P. montagui; P = Pandalus sp.;
Ef = E. fabricii; E = Eualus sp.; Sp = Spirontocaris sp.
L = Lebbeus sp.; A = A. dentata; Sa = Sabinea septemcarinata;
%T = percent of total stomachs with shrimps.

NE Shelf = Northeast Newfoundland Shelf; N. Gr. Bank = Northern Grand Bank; NE Gr. Bank = Northeast Grand Bank; C. Gr. Bank = Central Grand Bank; St. M. Bay = St. Mary's Bay; St. P. Bank = St. Pierre Bank; Port aux B. = Port aux basques; Port au P. = Port au Port; Gulf of SL = Gulf of St. Lawrence.

Table 45. Occurrence of principal food elements in stomachs of decapods as a percentage of the stomachs examined.

Species	E %	Ph %	C %	OG %	Eu %	P %	F %	H %	Ps %	Ga %	Ss %	Op %	Total stomachs
A. pelagica	37	5	76		7						2		41
E. fabricii	59	40	9	3		6	4	1	3		1		68
E. gaimardi	31	69	23	16		8	16				4		165
Eg belcheri	33	65	17	20	2	12	10		2		4		52
S. phippsi	17	77	31	14			31	6	3		3		60
S. spinus	19	78	8	24		2	64	5	8	6	3		160
L. groenlan.	22	65	17	3	8	10	8	15	3	3	5	3	41
L. polaris	39	57	16	3		4	9	4		1	6		578
P. borealis L	74	25	9	5			3		1			1	480
" " Gulf	52	59	40			6	9		4				80
P. montagui	68	33	13	6	2	10	2						527
P. propinquus	69	14	14	8	3	1	1						135
S. sarsi	67	23	10	10		18	3						39
S. septemcar.	61	21	13	19		7	2						188
A. dentata	80	22	7	1		3	4		7	1			75
Sc. boreas	73	27	11	4	18	20	9		3			2	45
Sc. ferox	77	14	11	1		9			1	1	2	1	102
P. pubescens	10	70	21	3		1	27	18	1		5		122
P. arcuatus	7	94	30	1		3	14	2	19			4	73
L. maja	17	47	43			27	17	7	13	17	17	13	30
H. araneus	43	43	40	1	3	18	15	1	9	2		17	170
H. coarctatus	62	35	31			7	13	2	8	3		10	130
C. opilio	33	67	37	2		29	15	1	16	3		14	195

E = empty; Ph = phytobenthos; C = crustacean; O = ostrocod; G = gammarid; Eu = euphausid; P = polychaete; F = foraminiferan; H = hydroid; Ps = pelycopod; Ga = gastropod; Ss = sponge spicules; Op = ophiuroid.

Table 46. Unit areas of investigation with depth and temperature ranges, number of hauls and percent of hauls in which decapod crustaceans were taken during survey cruises by the CALANUS (1946-58), INVESTIGATOR II (1947-54) and A. T. CAMERON (1959: Cape Dyer to Cape Chidley only).

Unit area No.	Area	No. of hauls	% with d'pods	Depth range m	Temperature range C
1	Foxe Basin, Hudson Strait	94	80	0-160	-1.5 to 5.5
2	Ungava Bay	68	95	0-275	-1.4 to 3.4
3	Frobisher Bay	17	65	15-190	-1.2 to 0.1
4	Cape Dyer to Cape Chidley	40	55	50-770	-1.1 to 4.0
5	Cape Chidley to Belle Isle	100	68	10-190	-1.0 to 4.5
6	Lake Melville	8	63	25-140	-0.5 to 1.0
7	NE Newfoundland Shelf	40	85	105-710	-1.1 to 3.6
8	White Bay	8	88	250-270	-0.7 to 0.0
9	Notre Dame Bay	25	100	185-370	-1.1 to 1.0
10	Bonavista Bay	5	20	280-320	0.2 to 0.6
11	NE Edge of the Grand Bank	149	20	70-650	-1.1 to 4.0
12	Flemish Cap	52	25	290-730	3.4 to 3.9
13	Trinity Bay	31	90	1-420	0.3 to 1.3
14	Conception Bay	3	67	195-265	-0.9
15	Off Avalon east coast	14	79	25-160	-0.9 to 1.3
16	Central Grand Bank	69	46	60-145	-1.6 to 2.6
17	SE Slope of Grand Bank	88	25	50-375	0.1 to 4.7
18	Southern Grand Bank	132	8	45-800	1.2 to 7.6
19	SW Slope of Grand Bank	223	12	65-770	1.3 to 7.2
20	Green Bank	10	30	75-690	-1.0 to 4.5
21	St. Pierre Bank	190	28	40-300	-0.2 to 4.9
22	St. Mary's Bay	22	68	50-210	-1.4 to 2.3
23	Placentia Bay	6	17	10-260	-1.1 to 0.0
24	Fortune Bay	33	100	185-320	-1.1 to 1.2
25	Hermitage Bay	16	50	130-290	1.5 to 5.9
26	Bay d'Espoir	3	100	130-210	0.5 to 2.0
27	SW Newfoundland Channel	81	32	210-335	4.5 to 6.4
28	Nova Scotian Banks	26	23	25-730	0.7 to 4.9
29	S. Gulf of St. Lawrence	6	50	55-530	0.0 to 5.9
30	Esquiman Channel	57	65	145-300	0.1 to 4.7
31	Bay of Islands, Bonne Bay	5	60	100-260	-1.0 to 0.4
32	Mingan Channel	31	65	210-280	3.2 to 5.2
33	Laurentian Channel	13	38	240-390	4.2 to 6.2
34	N. Gulf of St. Lawrence	4	100	35-110	-1.0 to 2.0

Table 47. Percentage occurrence of decapods (reported as shrimp, spider crab or spiny crab) in groundfish trawling during March-December, 1950-60. Trawls with small-meshed liner or cover.

Locality	No. of hauls	% with decapods	Month
Labrador	5	100	July
	56	89	August
	38	46	September
Lake Melville	8	88	October
NE Newfoundland Shelf	84	72	Aug.-Oct.
"	2	0	December
White Bay	14	86	October
Notre Dame Bay	12	75	November
Bonavista Bay	6	83	July
" "	8	63	November
Flemish Cap	24	83	March, Nov.
"	37	42	June-August
Central Grand Bank	106	8	April, May
"	20	0	June
Off Avalon East Coast	11	54	April
Eastern Slope Grand Bank	12	5	June, Nov.
"	110	38	July-Sept.
Southeast Grand Bank	135	6	Apr.-July
"	13	38	September
Southwest Grand Bank	24	3	Mar., Apr.
"	189	23	May-Oct.
St. Pierre Bank	82	2	May, Oct.
"	119	17	June, July
Placentia Bay	5	60	June
"	2	100	July
Fortune Bay	7	57	December
Hermitage Bay	15	100	November
Southwest Nfld Channel	5	40	June
Gulf of St. Lawrence	60	5	October
"	100	65	Nov., Dec.
Bonne Bay, Bay of Is.	6	83	December

Table 48. Species and number of specimens collected by vessels of the FRB Biological Station, St. John's, in 1946-60, and FRB Arctic Unit, Montreal, 1n 1953-58 (the latter in Foxe Basin and Hudson Strait). Homarus, Cancer and Crangon were collected in Port au Port Bay in 1961-62. All were examined for this paper.

Species	No. of specimens M	No. of specimens F	Species	No. of specimens M	No. of specimens F
1. Gennadas elegans	2	4	32. Homarus americanus	302	361
2. Plesiopenaeus edwardsianus	1	2	33. Polycheles granulatus	0	2
3. Sergestes arcticus	117	142	34. Stereomastis sculpta	6	9
4. Acanthephyra pelagica	39	39			
5. Nematocarcinus rotundus	0	1	35. Calocaris templemani	..	1
6. Pasiphaea multidentata	42	79			
7. Pasiphaea tarda	17	49	36. Munida tenuimana	1	3
8. Bythocaris payeri	2	5	37. Munidopsis curvirostra	16	8
9. Eualus fabricii	42	55			
10. Eualus gaimardi gaimardi	336	144	38. Pagurus acadianus	8	0
11. E. gaimardi belcheri	108	214	39. Pagurus arcuatus	46	25
12. Eualus macilentus	315	843			
13. Eualus pusiolus	0	3	40. Pagurus pubescens	109	45
14. Lebbeus groenlandicus	41	59	41. Lithodes maja	13	13
15. Lebbeus polaris	594	470			
16. Lebbeus microceros	1	4	42. Neolithodes grimaldii	1	1
17. Sprontocaris lilljeborgi	3	66	43. Cancer irroratus	9	1
18. Spirontocaris phippsi	90	33			
19. Spirontocaris spinus	103	300	44. Chionoecetes opilio	146	157
20. Dichelopandalus leptocerus	39	45	45. Hyas araneus	137	95
21. Pandalus borealis	8,355	3,974	46. Hyas coarctatus	89	107
22. Pandalus montagui	1,251	1,787			
23. Pandalus propinquus	90	89	47. Geryon quinquidens	1	0
24. Argis dentata	120	324	48. Planes minutus	6	5
25. Crangon septemspinosa	599	329			
26. Sabinea hystrix	0	1			
27. Sabinea sarsi	17	128			
28. Sabinea sepemcarinata	84	202	TOTALS Males	13,373	
29. Sclerocrangon boreas	15	29			
30. Sclerocrangon ferox	41	66	Females	10,324	
31. Pontophilus norvegicus	19	83			

Table 49. Summary of average and range of cl of principal decapods from Newfoundland and Labrador (NL) Ungava Bay (UB) and Frobisher Bay (FB).

Species		Average cl-mm			Range of cl - mm			Nos. examined		
		NL	UB	FB	NL	UB	FB	NL	UB	FB
S. arcticus	M	15	11	-	12-19	9-15	-	103	71	-
	F	18	12	-	13-20	9-16	-	104	81	-
P. tarda	M	28	37	-	14-45	30-44	-	14	4	
	F	30	33	-	14-59	18-42	-	42	10	
E. fabricii	M	7a	7	6	3-10	4-12	5-9	42a	119	12
	F	10a	9	10	4-12	4-14	4-12	55a	183	31
E. gaimardi belcheri	M	14	9		11-17	6-14		63	21	
	F	16	11		7-21	6-14		195	26	
L. groenlandicus	M	13	12	12	6-17	6-18	10-15	8	99	68
	F	17	14	16	8-27	4-24	7-28	39	131	124
L. polaris	M	10	9	9	4-18	2-13	6-14	118	122	23
	F	12	10	13	5-20	2-17	5-15	333	205	40
S. spinus	M	10	8	9	5-10	3-12	7-11	33	47	27
	F	11	10	11	6-17	3-17	8-15	99	87	40
S. phippsi	M	4b	4	5	2-7	2-7	4-6	28b	8	16
	F	7b	7	7	3-10	3-10	5-8	59b	68	15
A. dentata	M	15	14	13	8-31	9-24	6-16	72	41	28
	F	20	16	17	9-28	7-24	6-26	289	73	26
S. septemcarinata	M	10	11	9b	5-18	10-13	5-12	65	4	19b
	F	14	13	14b	7-19	8-18	3-21	284	8	18b
Sc. boreas	M	18	16	17	8-24	9-25	6-16	11	16	5
	F	25	22	21	11-35	7-28	11-29	21	48	14
P. pubescens	M	17	14	14	9-27	3-28	5-26	109	100	29
	F	14	11	10	2-21	4-21	4-18	45	78	22
H. coarctatus	M	28	49	-	7-72	9-87	-	89	17	-
	F	29	37	-	6-49	17-47	-	107	18	-

a = including Foxe Basin; b = Foxe Basin only.

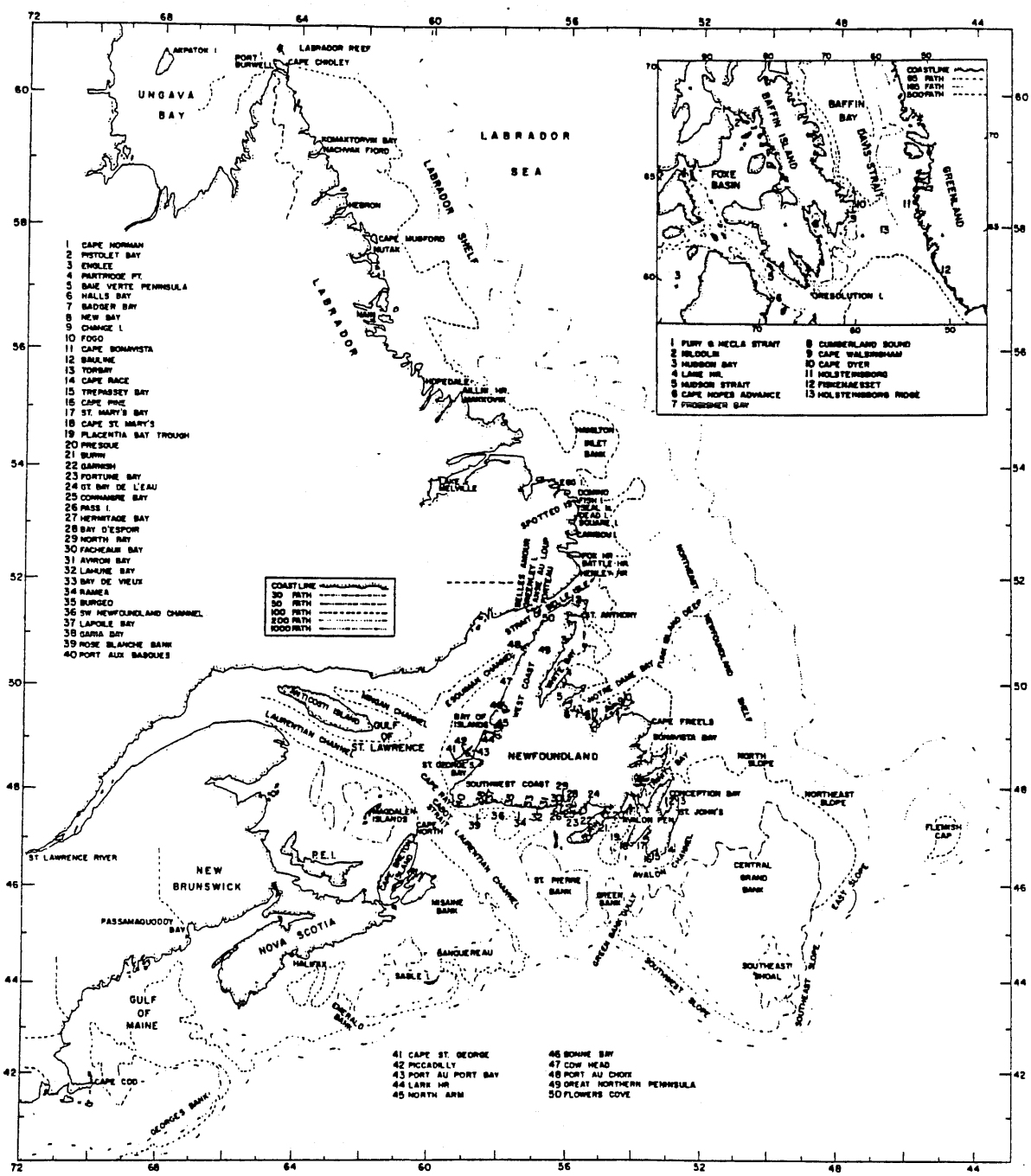


Figure 1. Map of place names mentioned in the text. (Inset of Foxe Basin and Davis Strait).

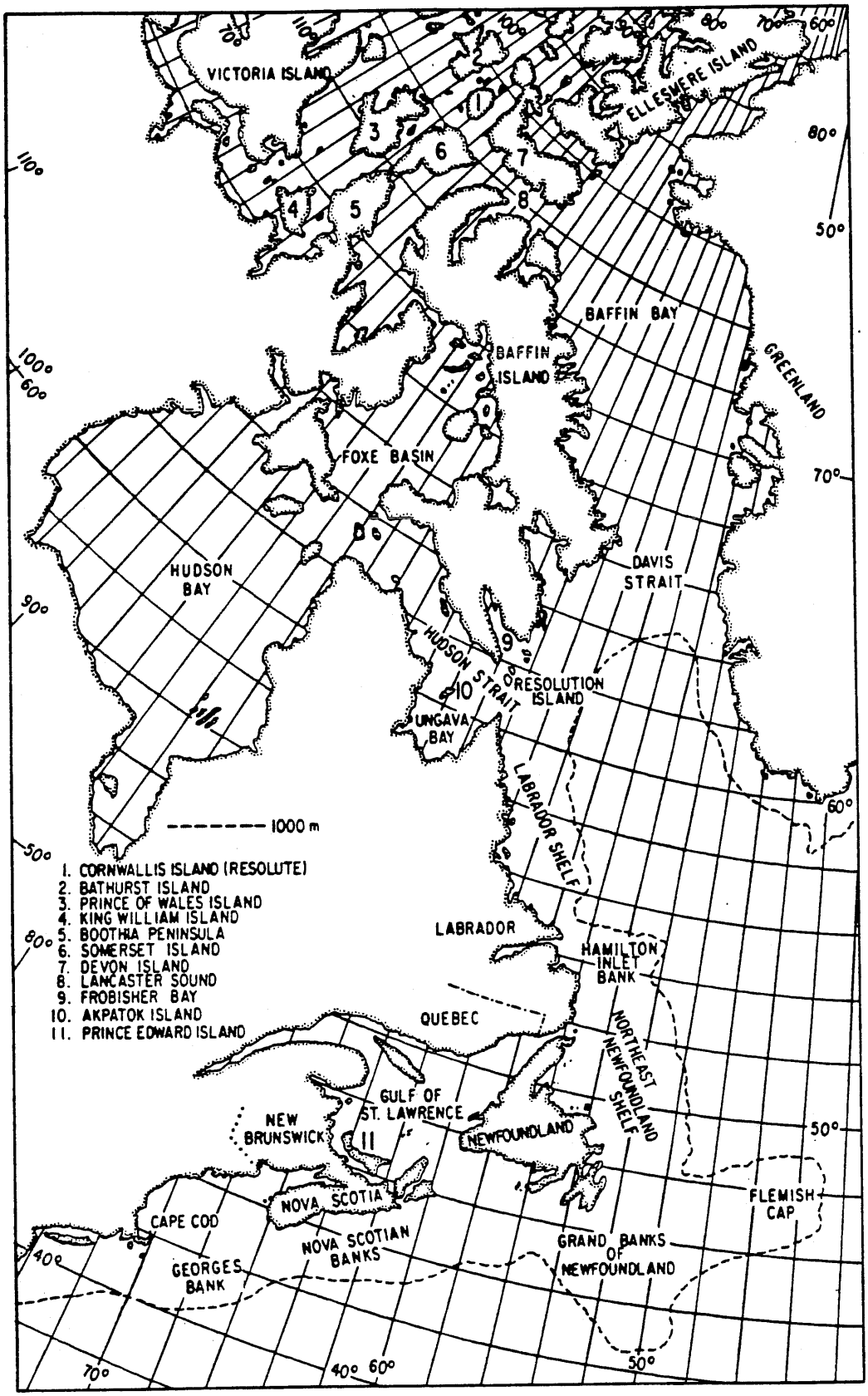


Figure 2. Revised map of species distribution in area of investigation with names referred to in text. From Squires 1990.

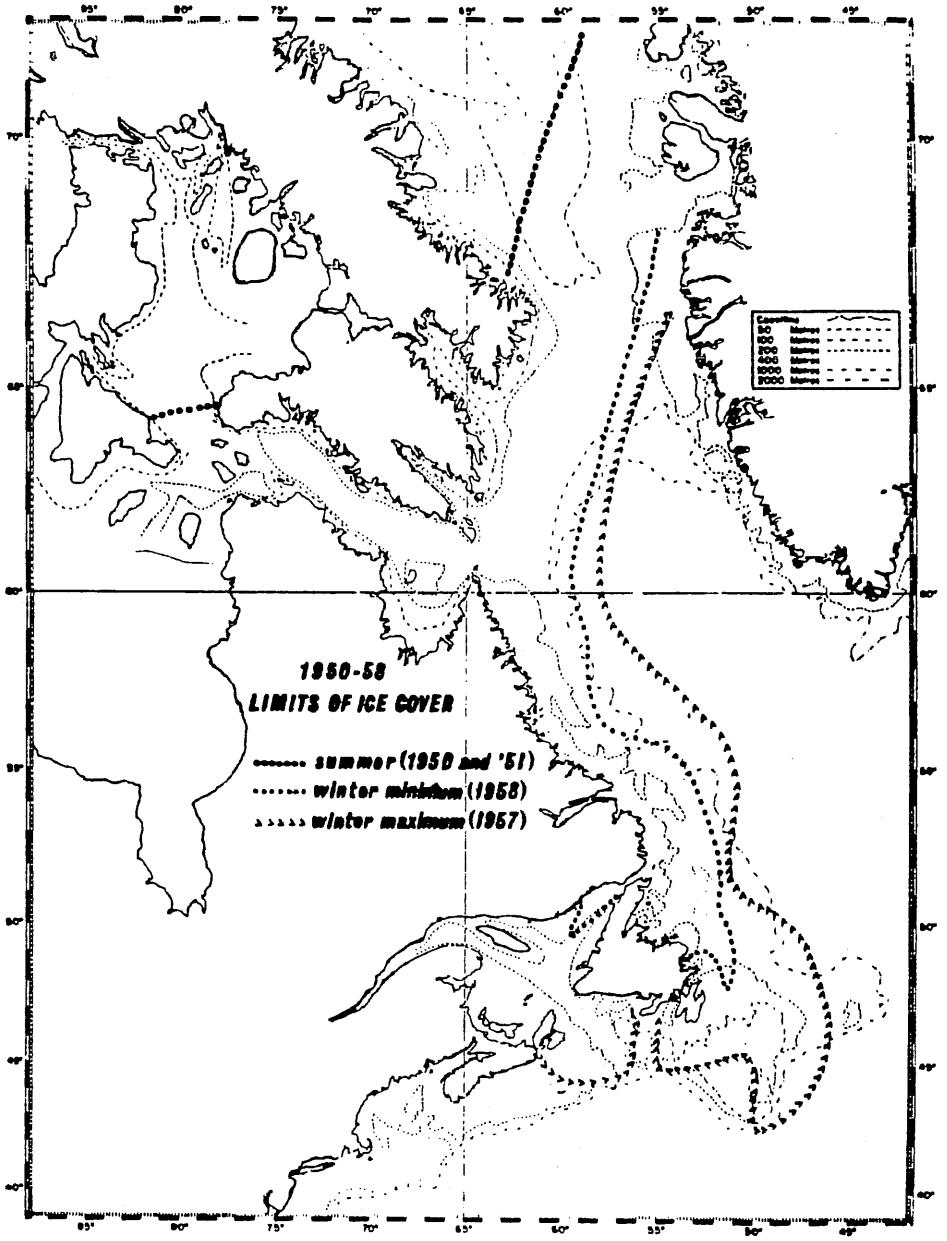


Figure 3. Summer and winter limits of ice cover in northwest Atlantic in 1950-58 (Dansk Met. Inst. 1950-56; and Canada Dept. Transport Ice Forecasting Service 1956-58.

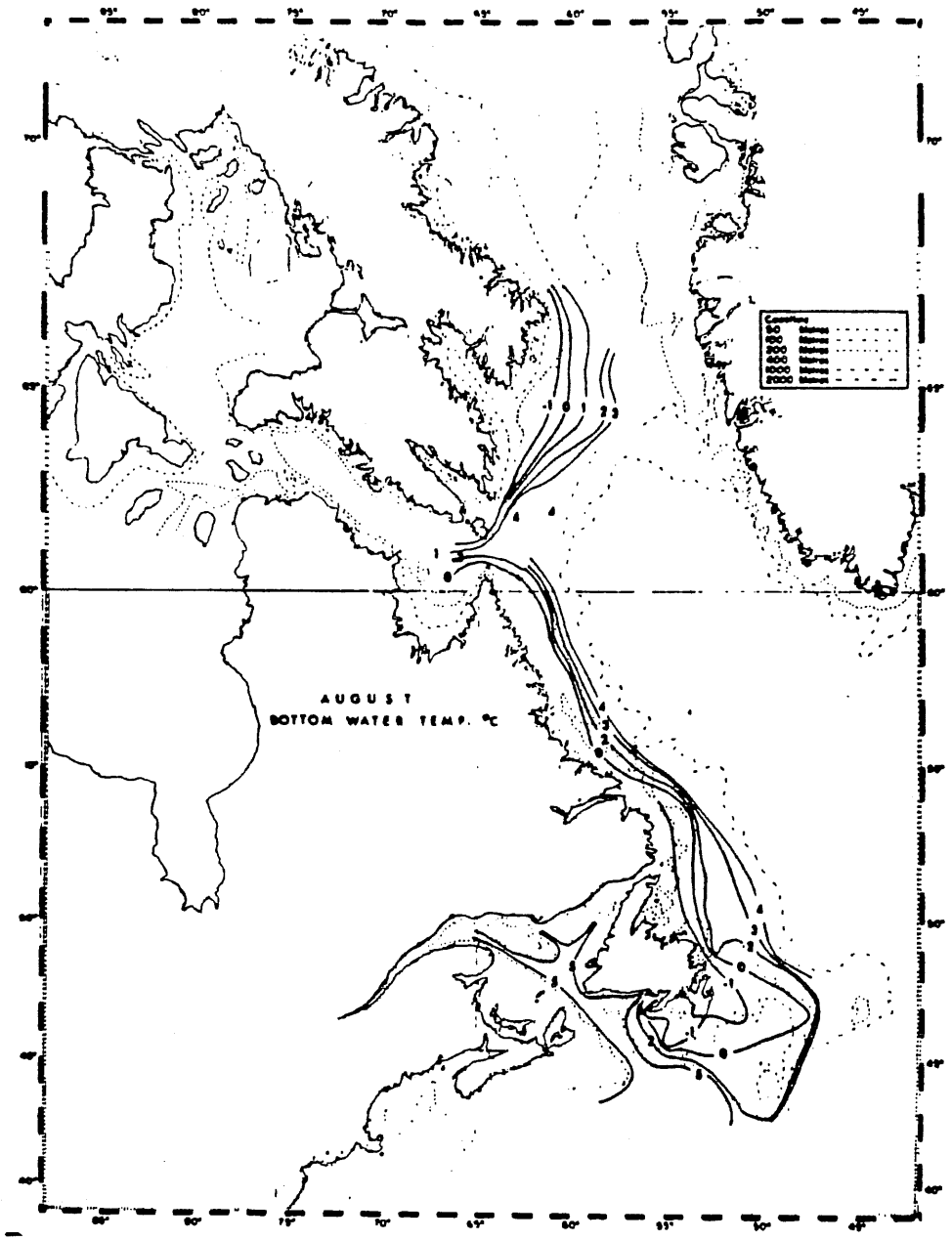


Figure 4. Bottom water isotherms for August. Baffin Island 1960; northern Labrador, 1950; southern Labrador to Grand Banks, 1957; southwest Newfoundland and Gulf of St. Lawrence 1957 and 1958.

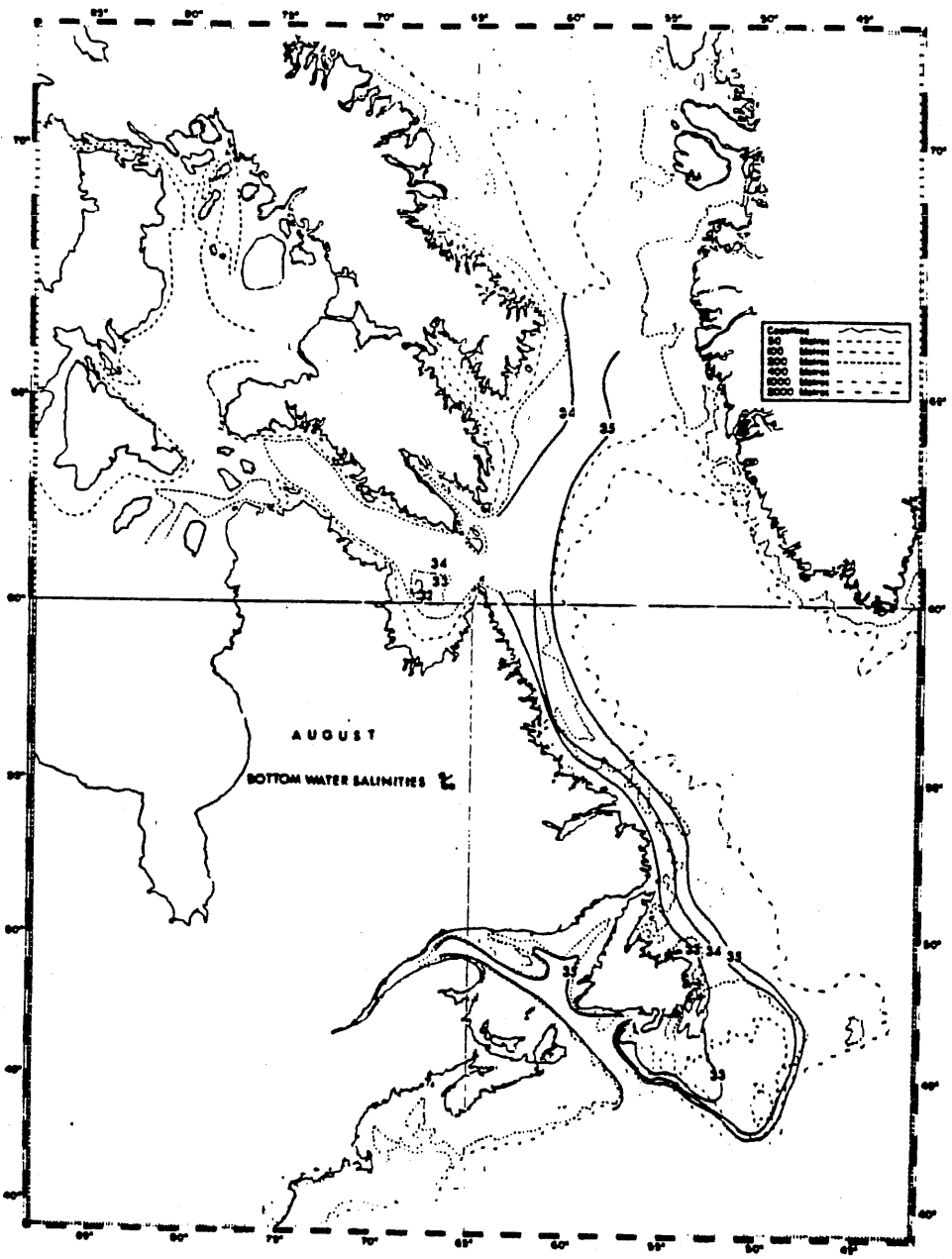


Figure 5. Bottom water isohalines in area of investigation for August. Data obtained concurrently with those in Figure 4.

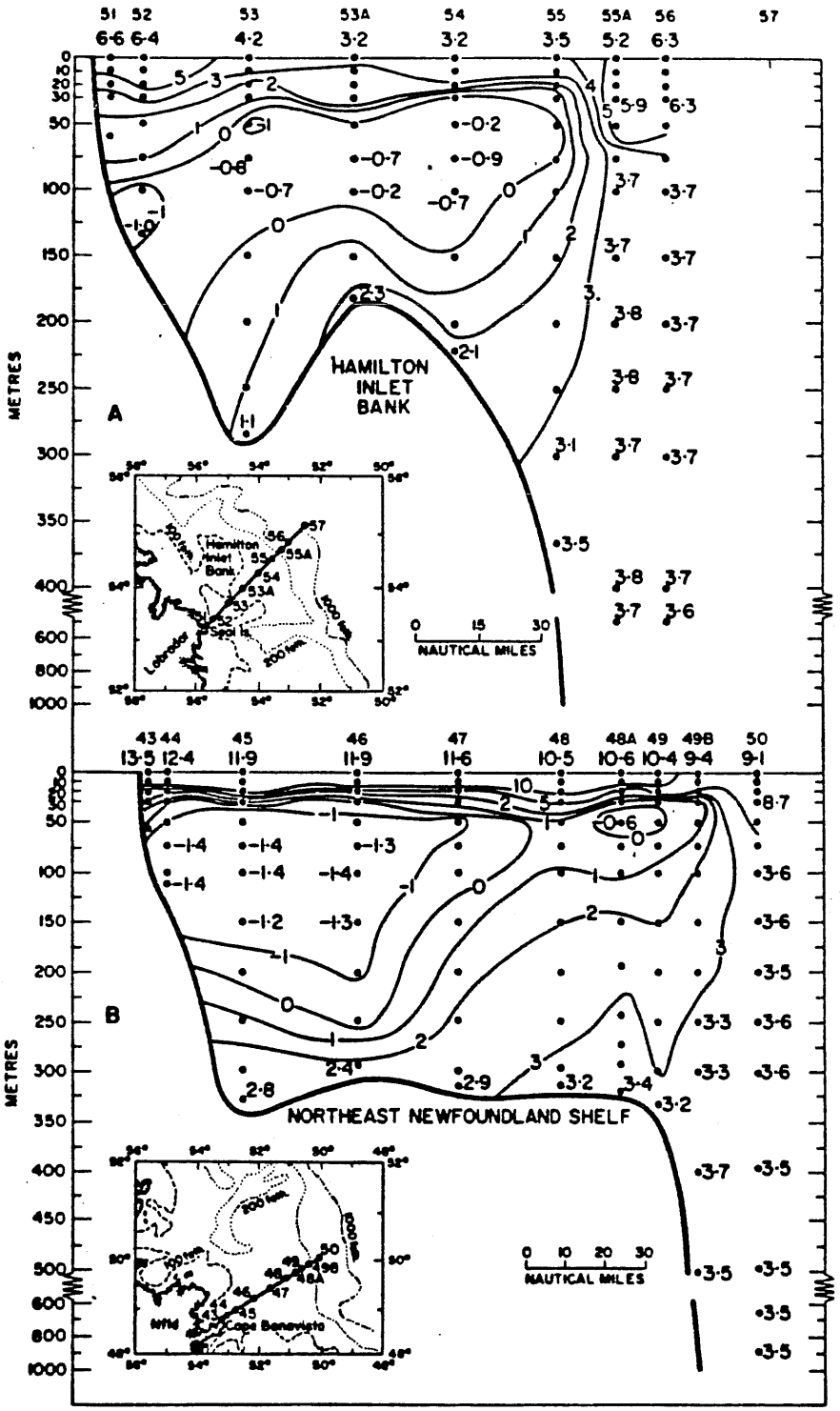


Figure 6. Cross-section of water columns showing extent of arctic water A. Off Seal Is. Labrador, and B. Off C. Boanvista, Newfoundland. July 27- Aug. 1, 1961 (Templeman 1962).

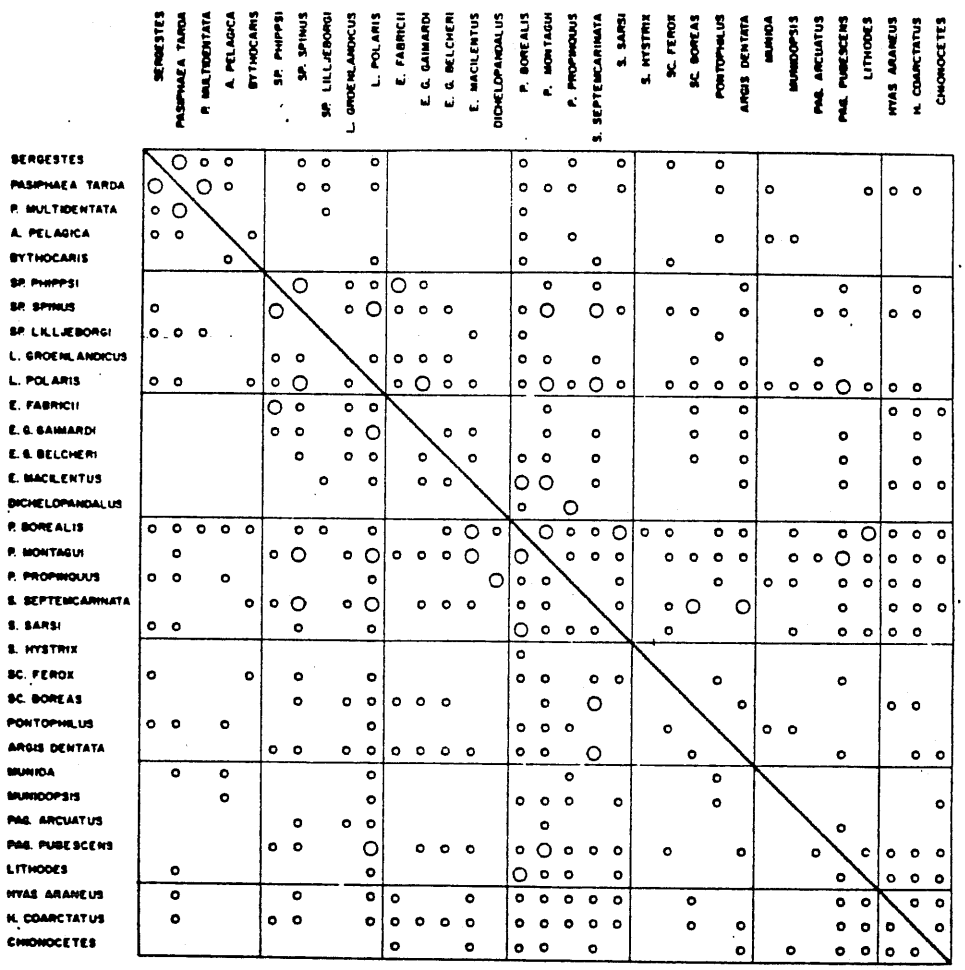


Figure 7. Diagram of occurrence of decapod species in same hauls (0 = frequently and o = occasionally occurring together).

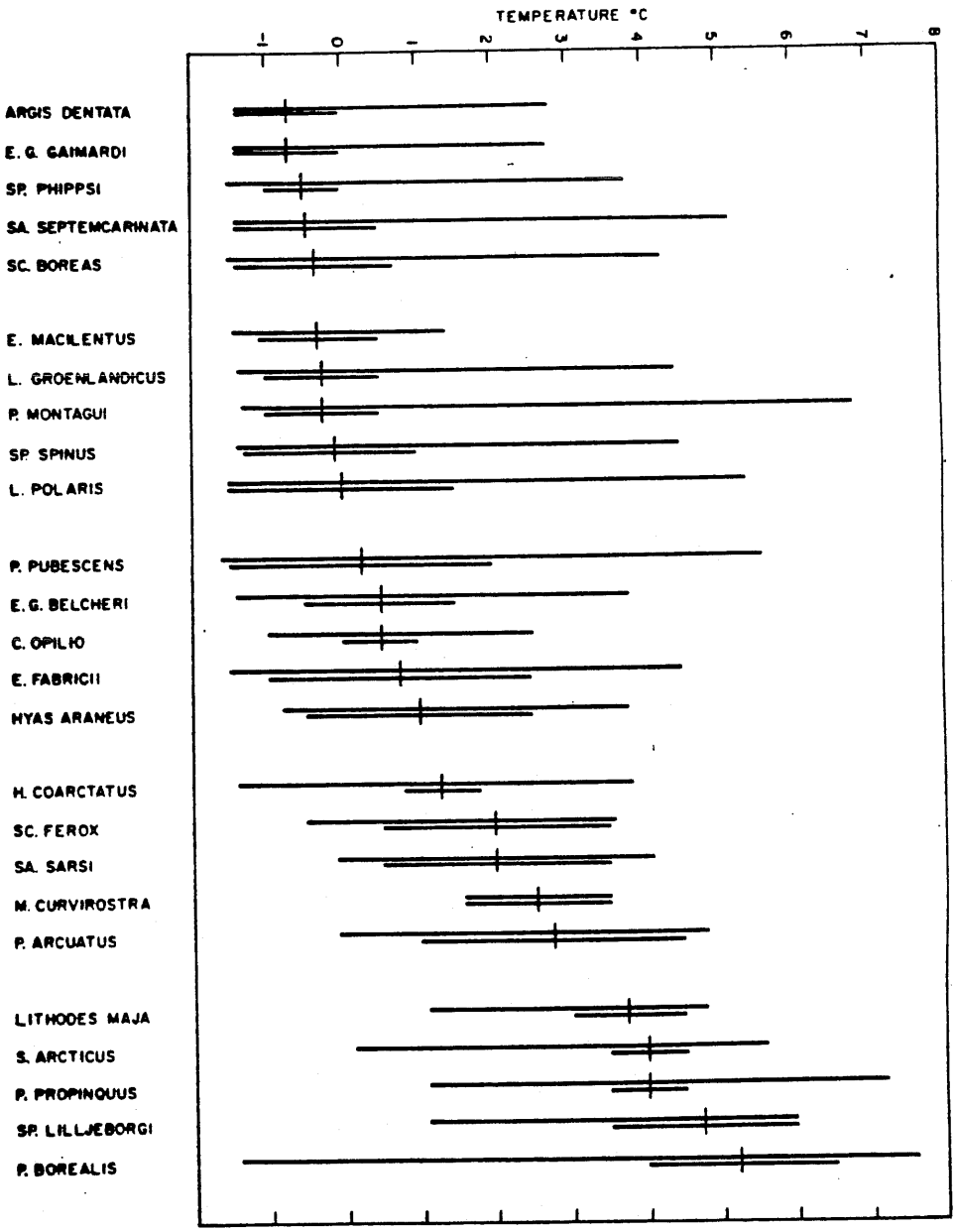


Figure 8. Temperature range of decapod species in area of investigation. Double line = where 80% or more sepcimens were taken.

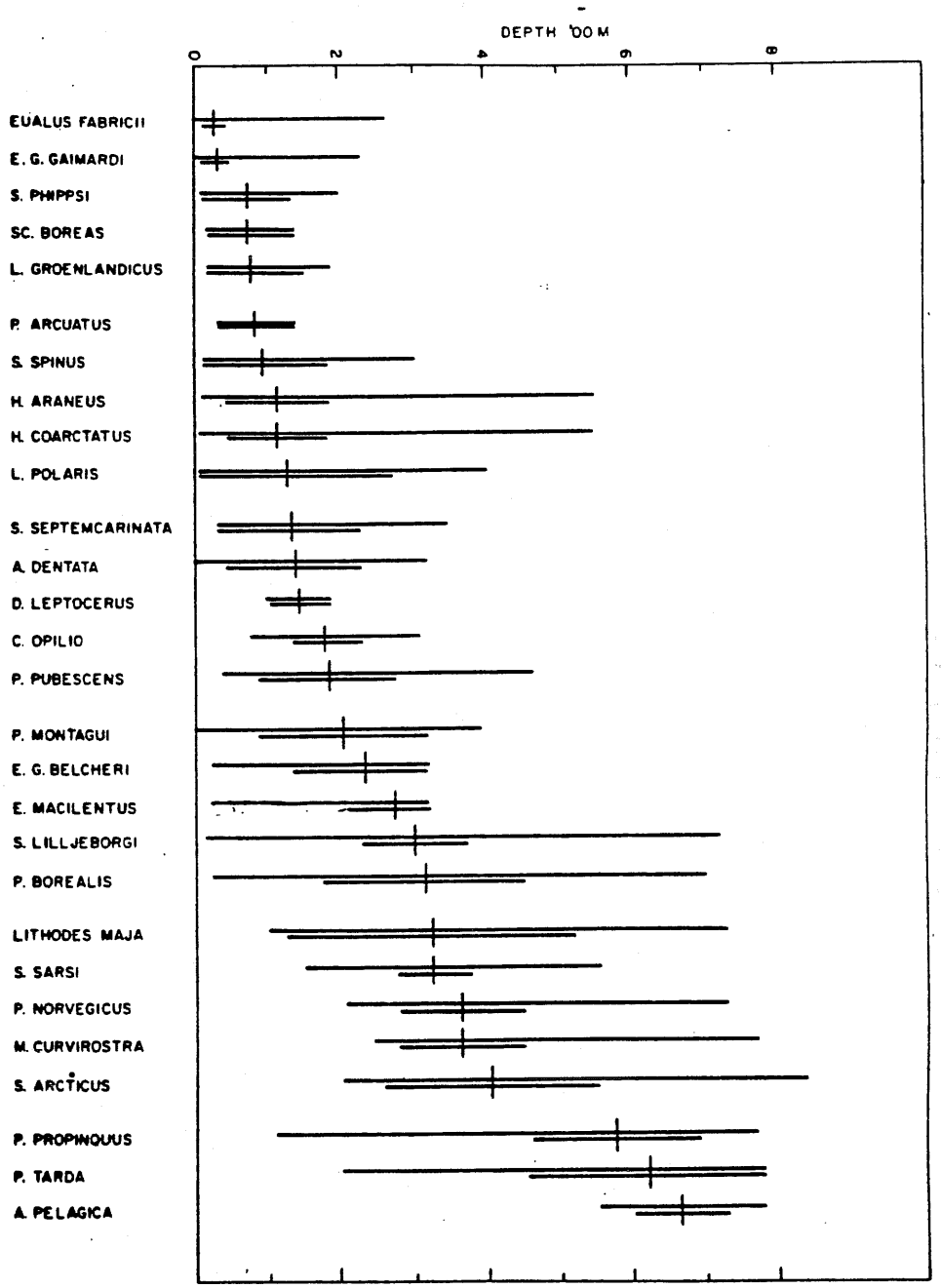


Figure 9. Depth range of decapod species in area of investigation. Double line = where 80% or more specimens were taken.

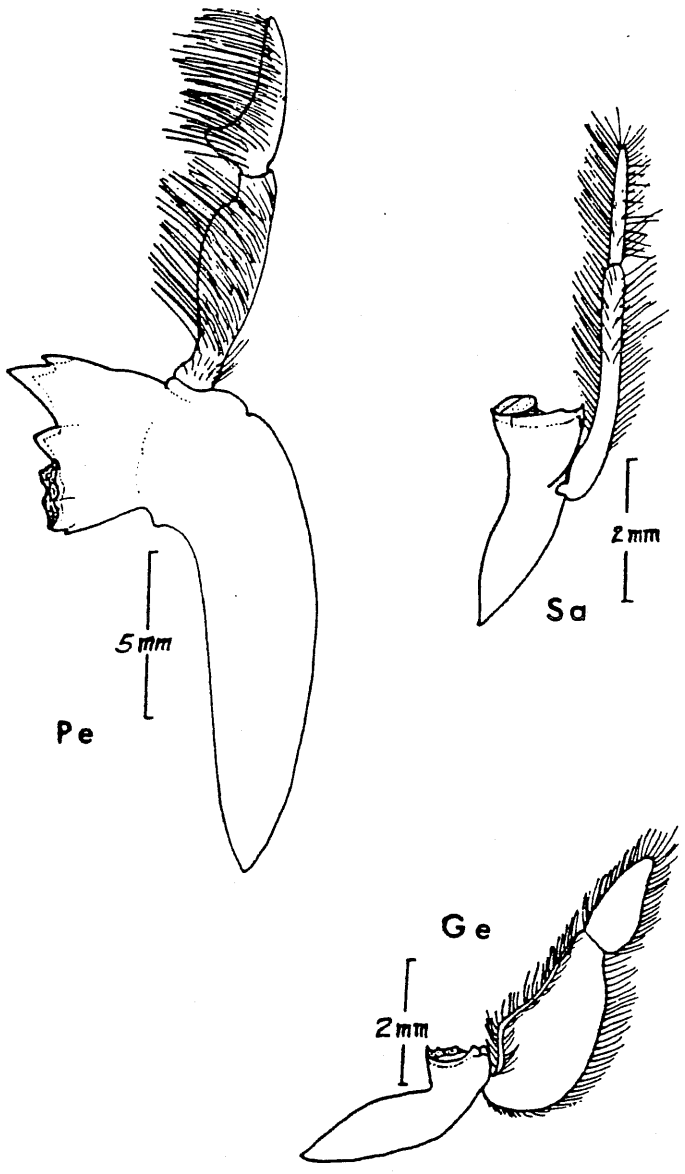


Figure 10. Mandibles of Plesiopenaeus edwardsianus (Pe), Sergestes arcticus (Sa) and Gennadas elegans (Ge).

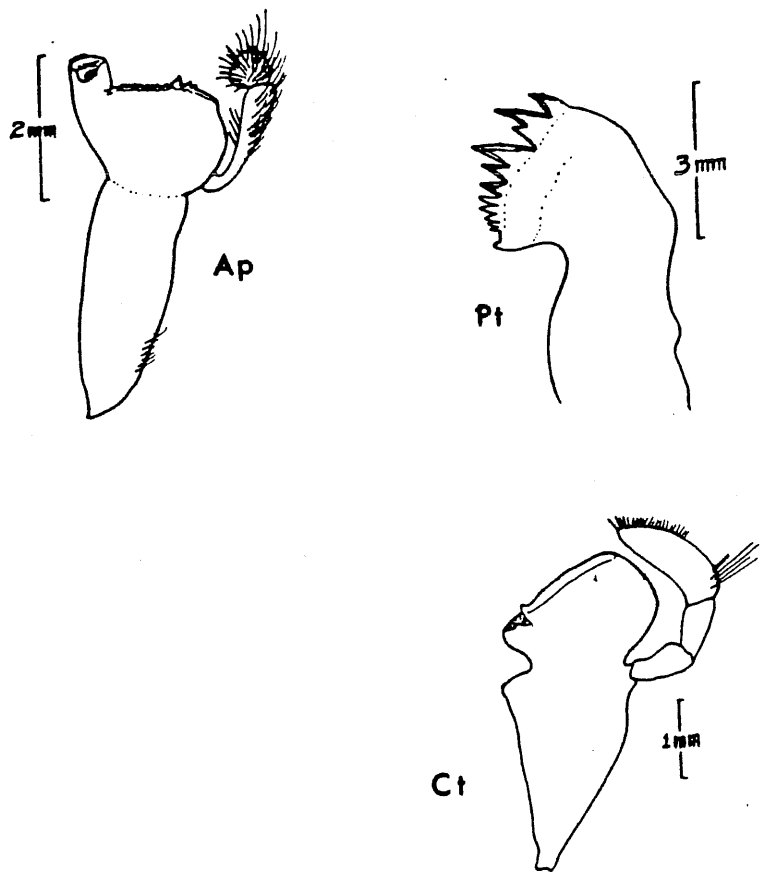


Figure 11. Mandibles of Acanthephyra pelagica (Ap), Pasiphaea tarda (Pt) and Calocaris templemani (Ct).

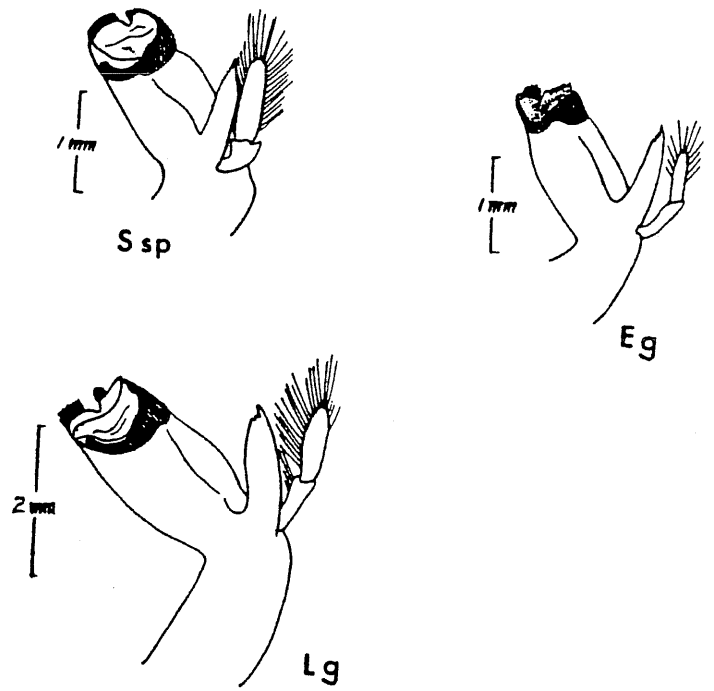


Figure 12. Mandibles of Spirontocaris spinus (Ss), Eualus gaimardi gaimardi (Eg) and Lebbeus groenlandicus (Lg).

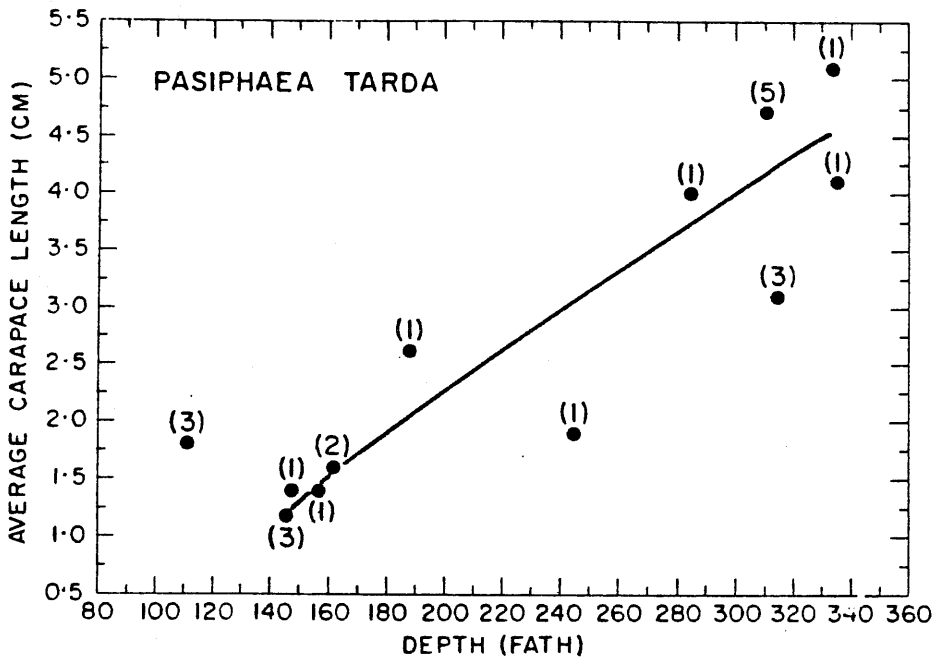


Figure 13. Carapace lengths of Pasiphaea tarda with realation to depth of capture, 1947-57.

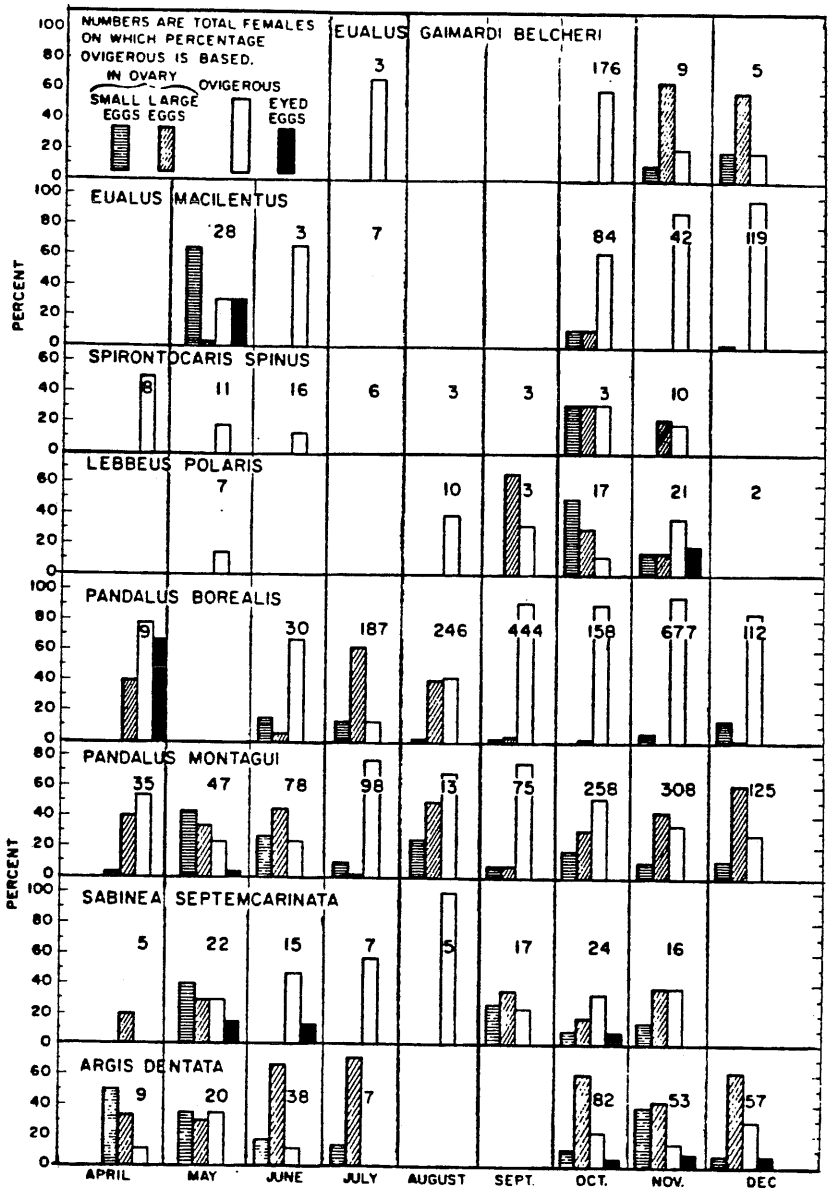


Figure 14. Percent of females nonovigerous with small or large ova, ovigerous with small ova, and with eyed embryos. Specimens collected April-December, 1947-57, in Newfoundland.

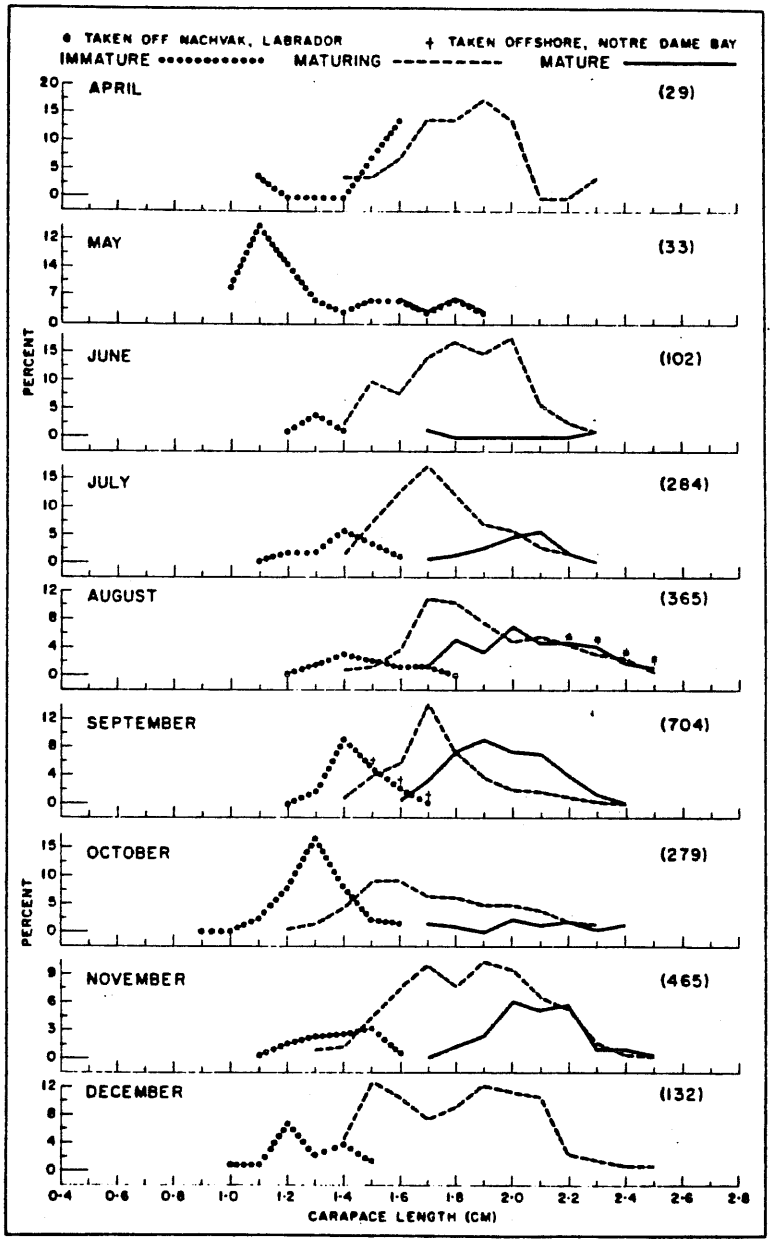


Figure 15. Maturity of male Pandalus borealis from Labrador and Newfoundland, April-December 1947-57. Numbers examined in parentheses.

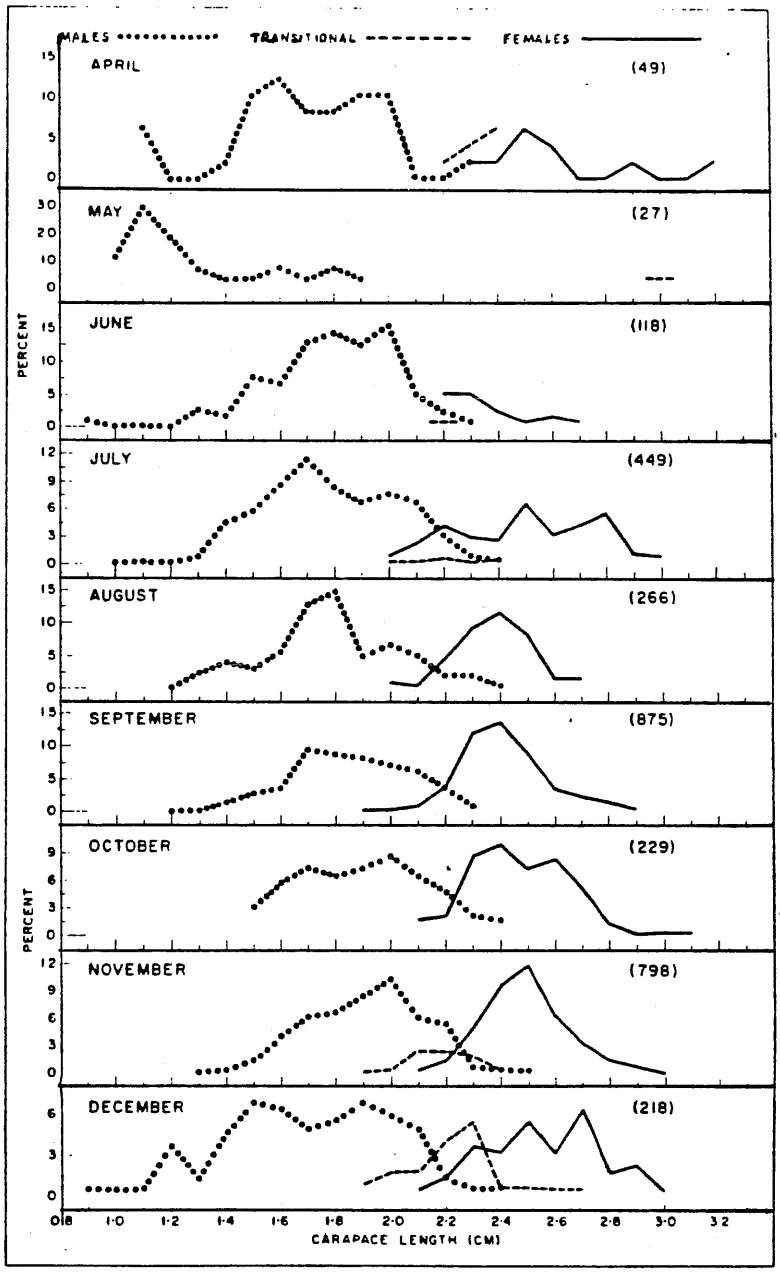


Figure 16. Male, intersex and female Pandalus borealis April-December, 1947-57, from several localities in the area. Numbers measured in parentheses.

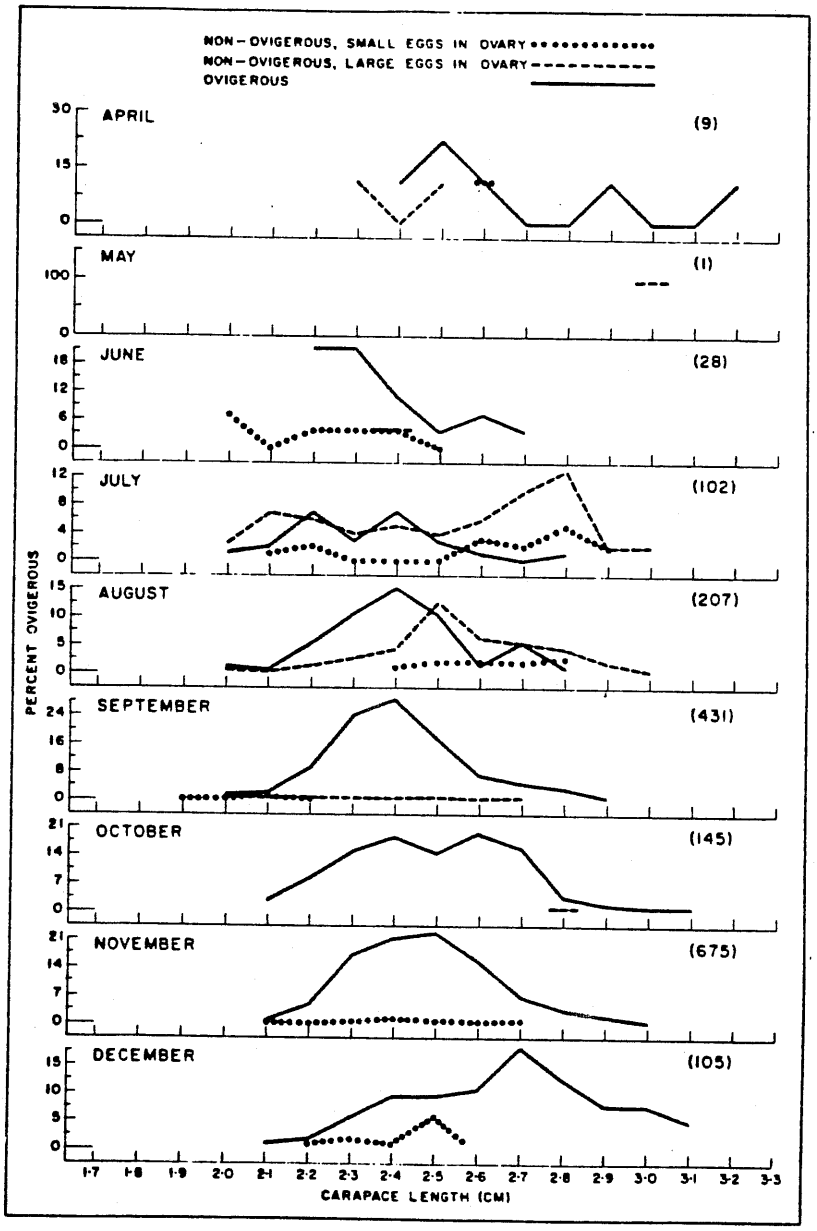


Figure 17. Maturity of female Pandalus borealis from Labrador and Newfoundland in April-December, 1947-57. Numbers in parentheses.

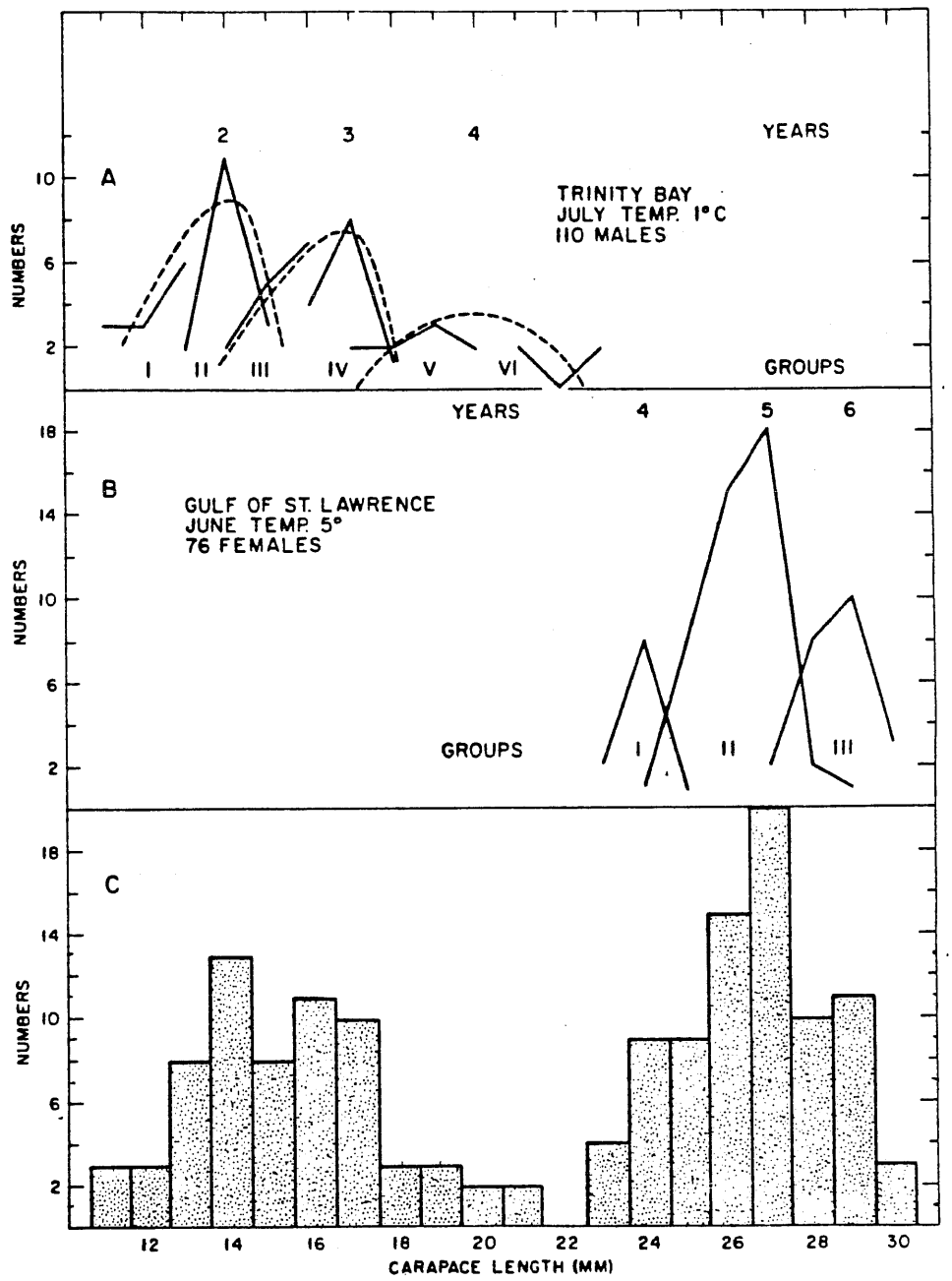


Figure 18. Pandalus borealis groups selected by eye before measuring, measured and curves interpolated to estimate ages. A, males from Trinity Bay. B, females from Gulf of St. Lawrence. C, combined cl frequency of A and B.

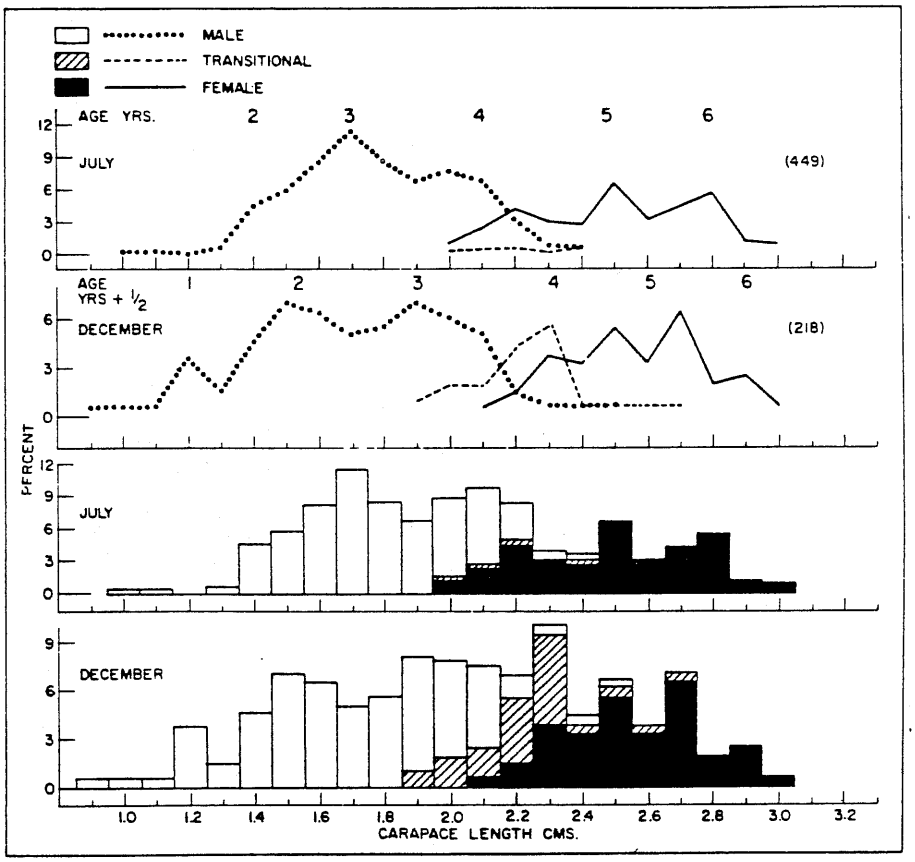


Figure 19. Estimation of age in Pandalus borealis. Lengths of specimens from several localities combined. Data repeated from Figure 14.

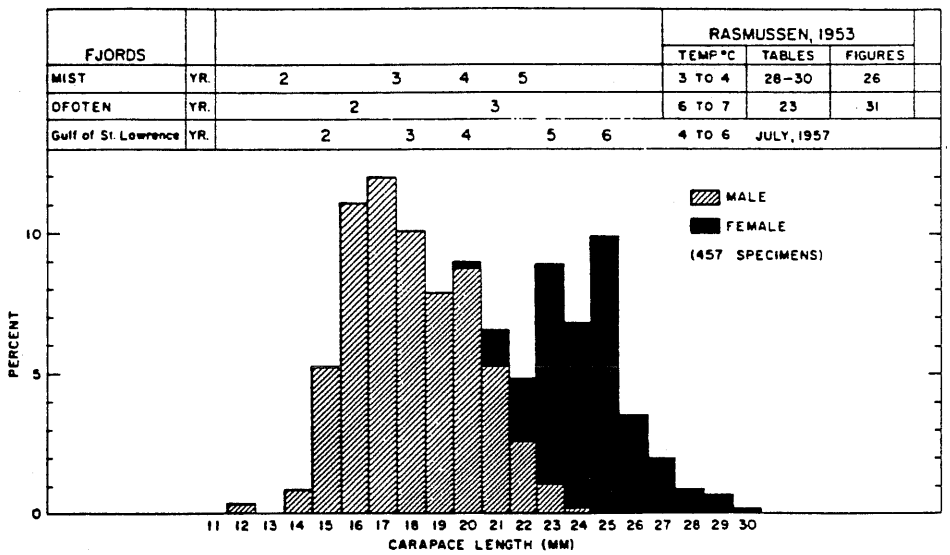


Figure 20. Estimated ages of Pandalus borealis from Gulf of St. Lawrence (temperatures 4 to 5 C) compared with those from Mist and Ofoten Fjords, Norway (Temps. 3 to 4 and 6 to 7 C, respectively) (From Rasmussen 1953).

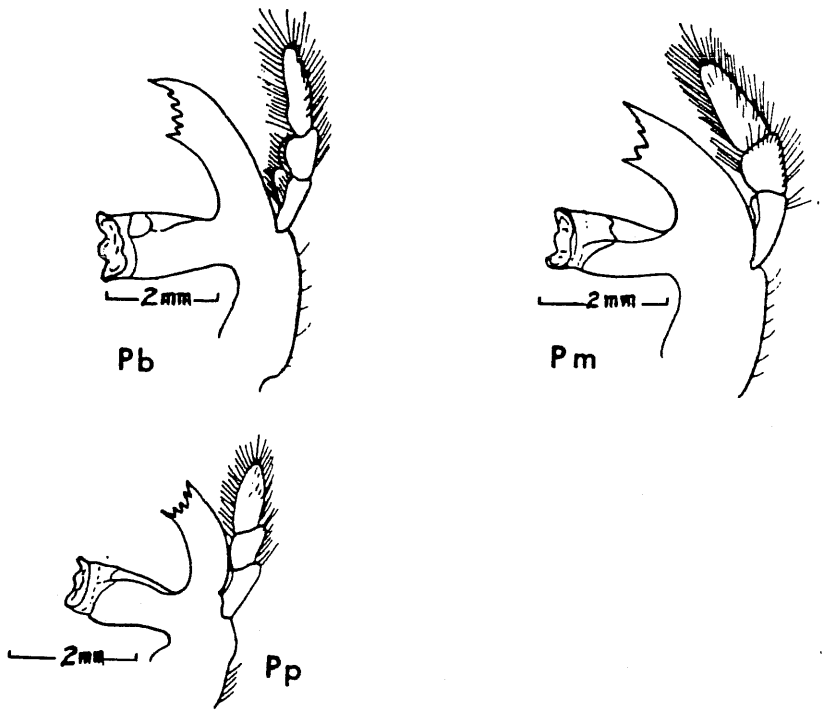


Figure 21. Mandibles of Pandalus borealis (Pb), P. montagui (Pm) and P. propinquus (Pp).

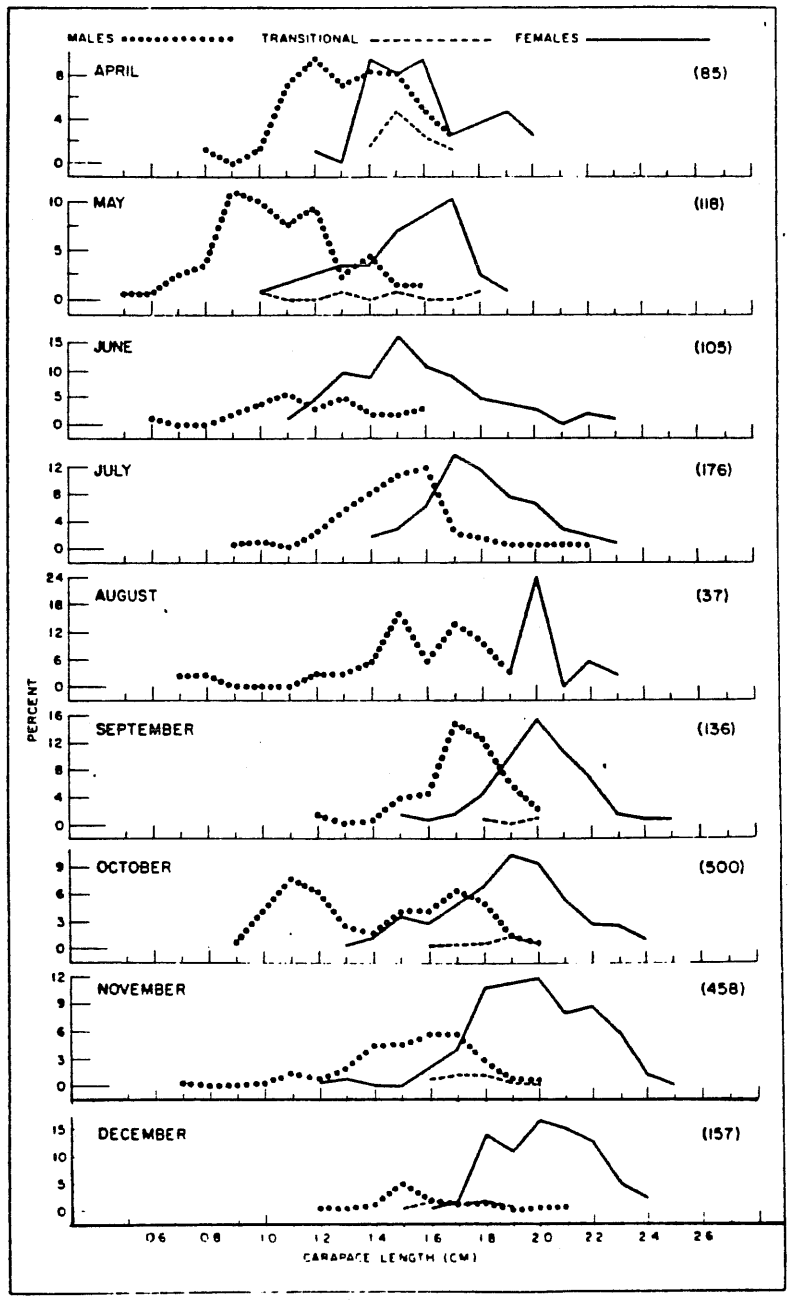


Figure 22. Cl of Male, intersex and female Pandalus montagui April-December, 1947-57, from several localities in area. Numbers in parentheses.

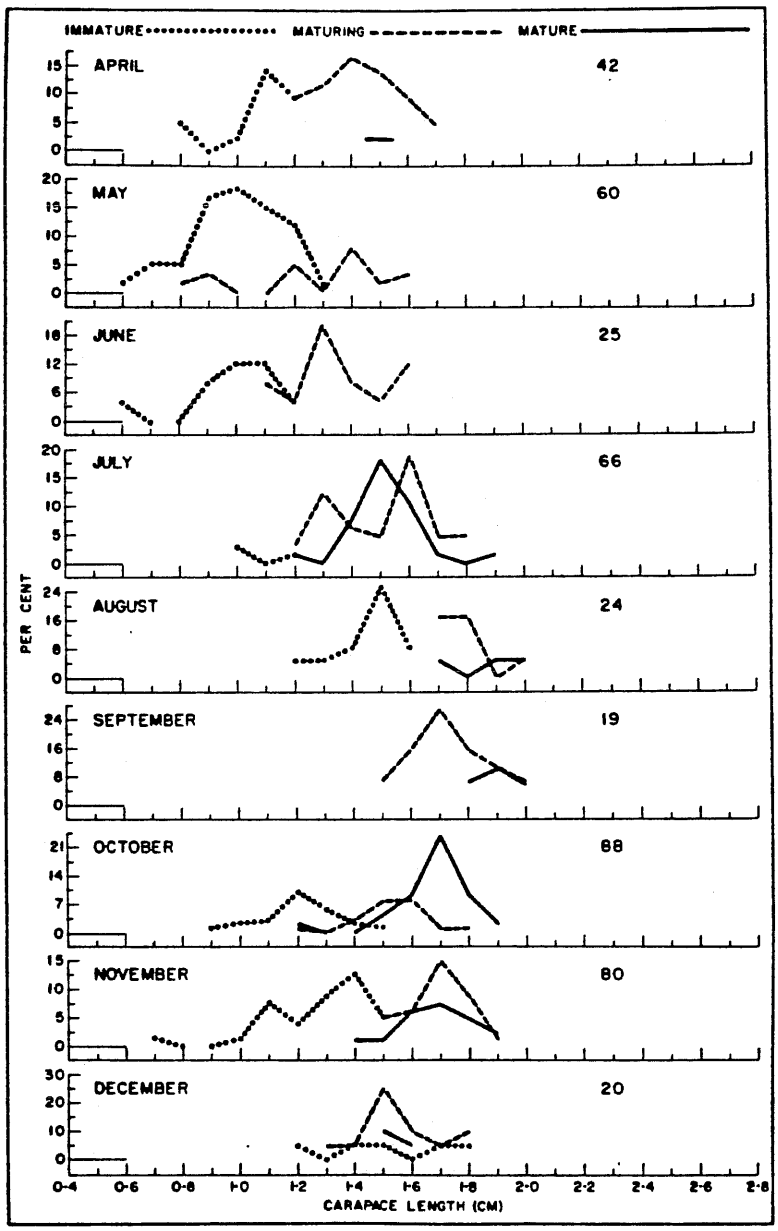


Figure 23. Maturity of male Pandalus montagui from Newfoundland in April-December, 1947-57. Numbers in parentheses.

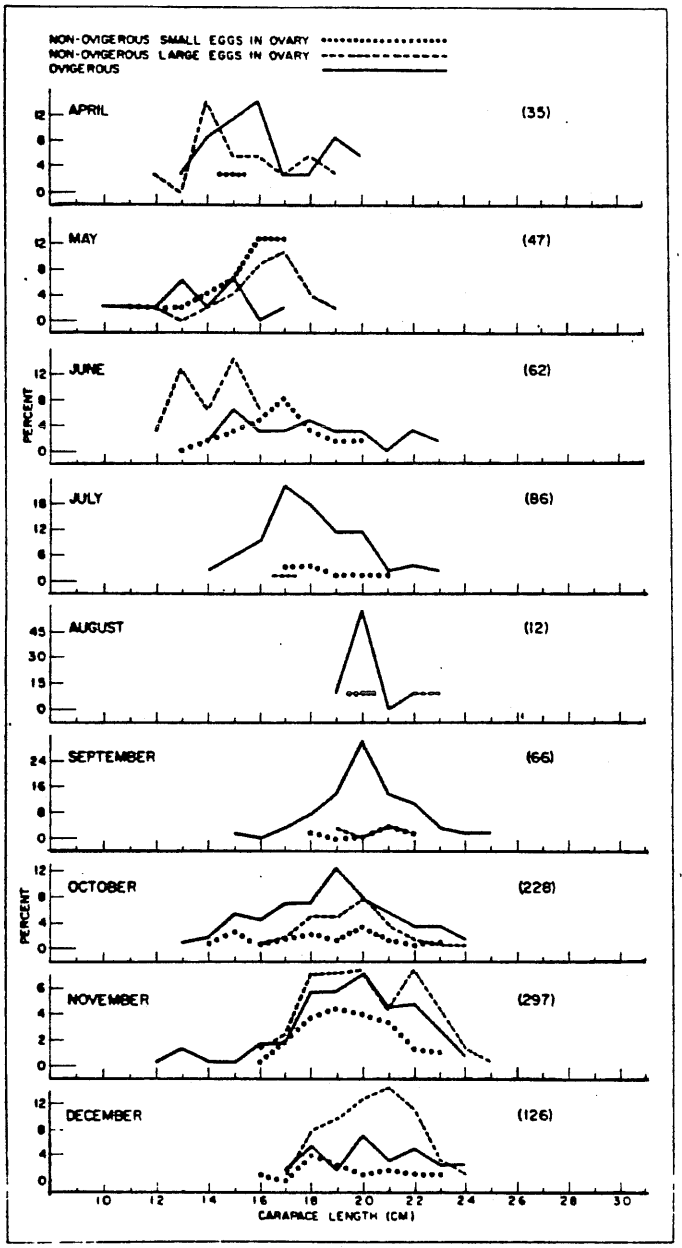


Figure 24. Maturity of female Pandalus montagui from Newfoundland in April-December, 1947-57. Numbers in parentheses.

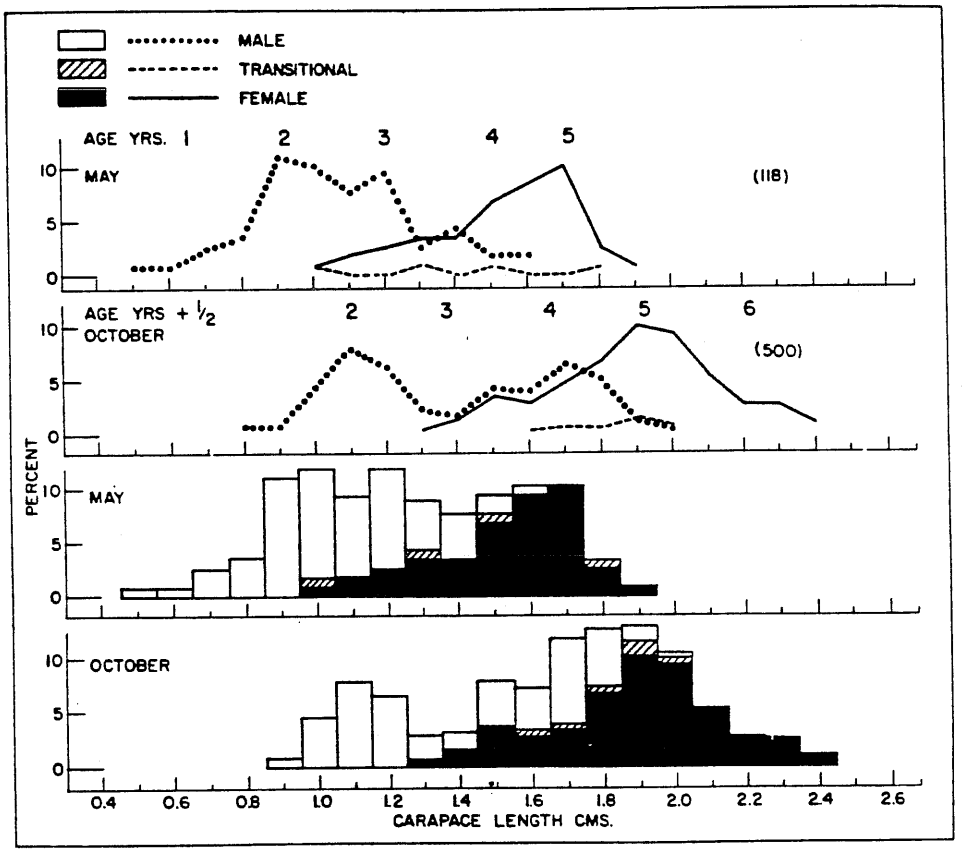


Figure 25. Estimation of age in Pandalus montagui. Lengths from several localities in area combined. Data are repeated from Figure 20.

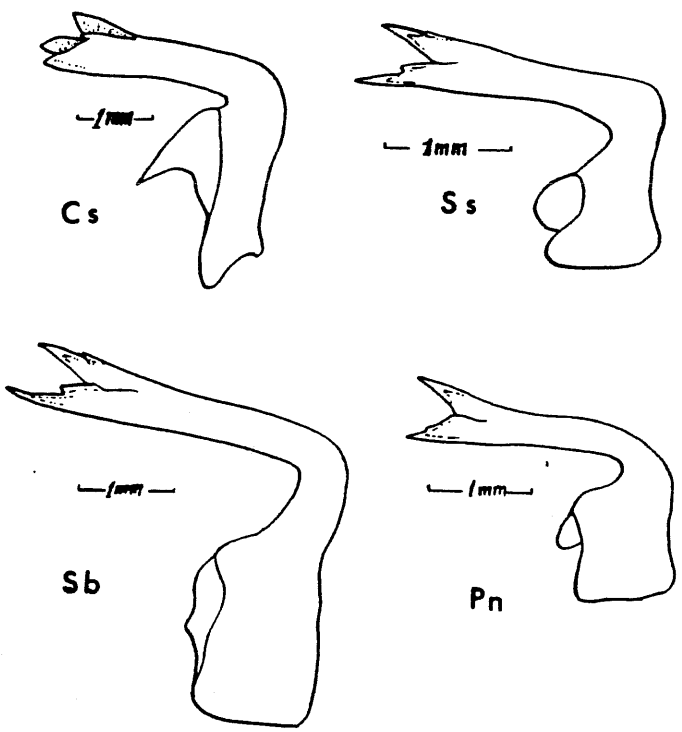


Figure 26. Mandibles of Crangon septemspinosa (Cs), Sabinea sarsi (Ss), Sclerocrangon boreas (Sb) and Pontophilus norvegicus (Pn).

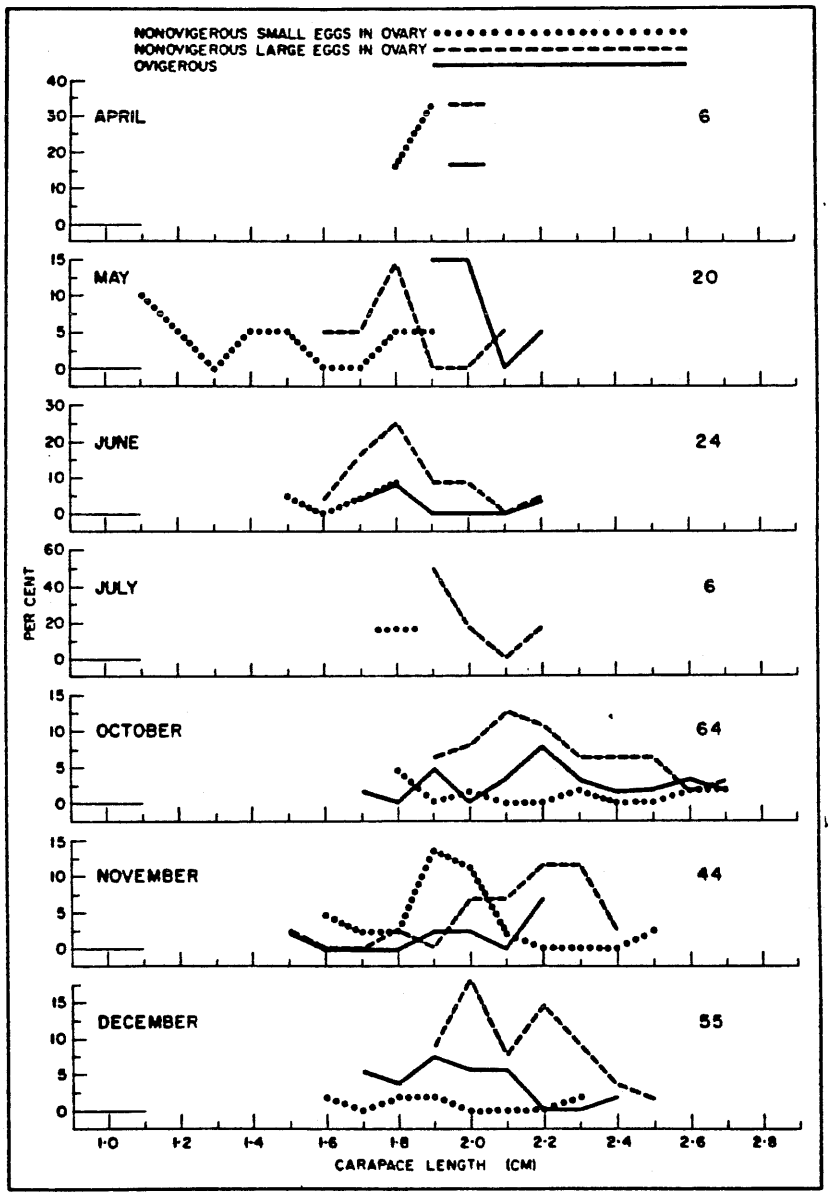


Figure 27. Maturity of female Argis dentata from the area in May-December, 1947-57. Numbers at right.

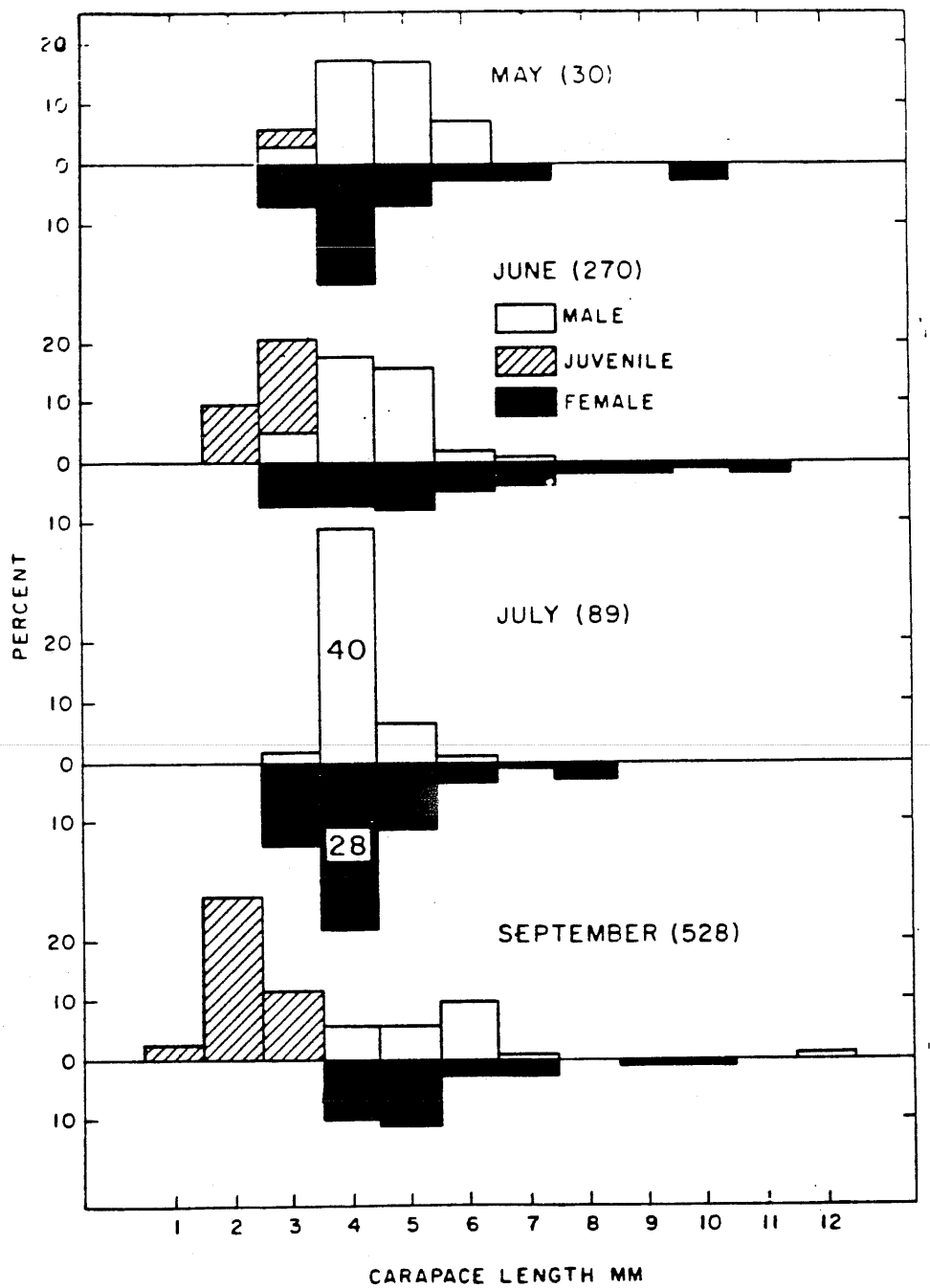


Figure 28. Lengths of Crangon septemspinosa from Port au Port Bay, Newfoundland, May-September, 1962.

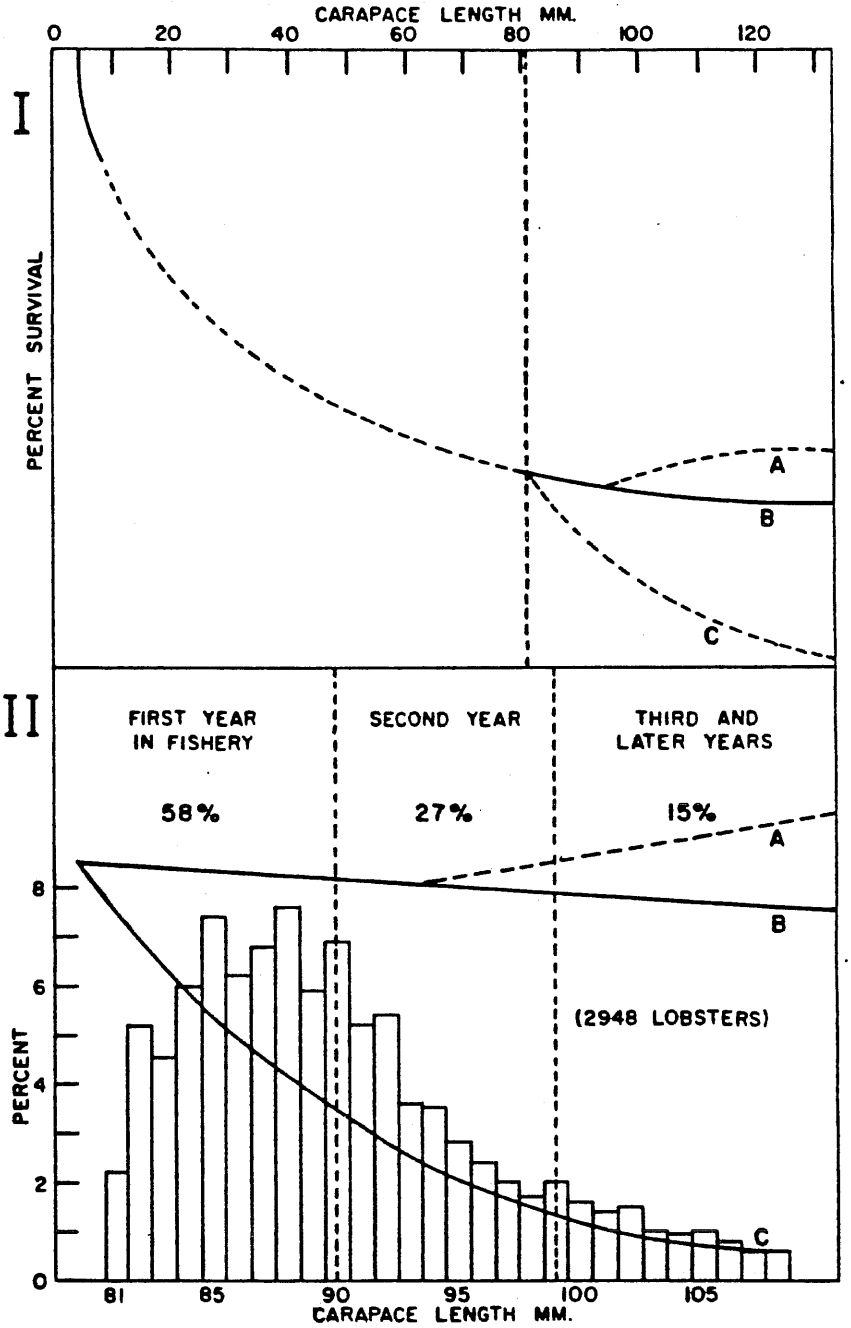


Figure 29. I. Hypothetical recruitment of lobsters (Homarus americanus): A. Accumulation in unfished populations, B. Rate of recruitment and C. Exploitation in a fishery.
II. Curves of I superimposed on commercial catch histogram of cl of lobsters from Port au Port Bay in 1962.

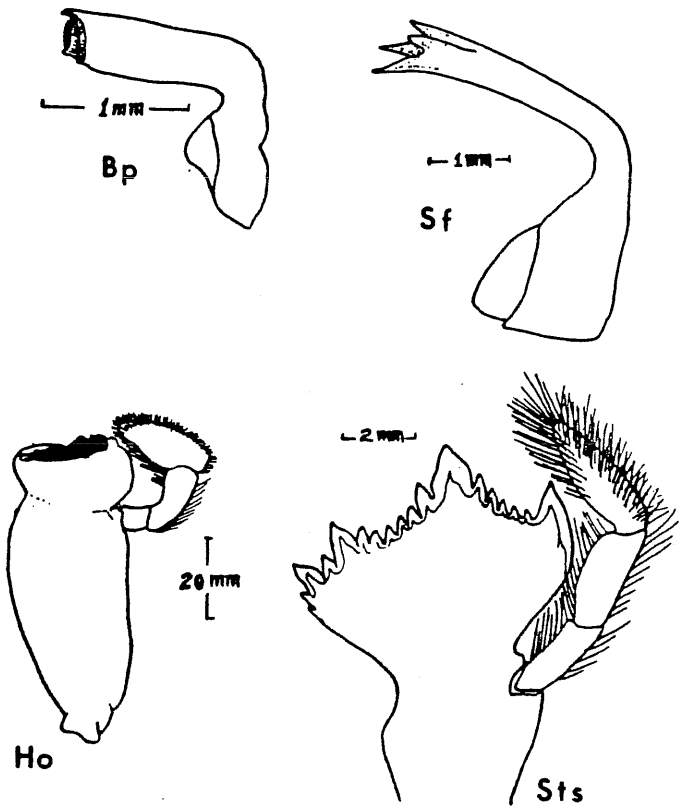


Figure 30. Mandibles of Bythocaris payeri (Bp), Homarus americanus (Ha), Sclerocrangon boreas (Sb) and Stereomastis sculpta (Sts).

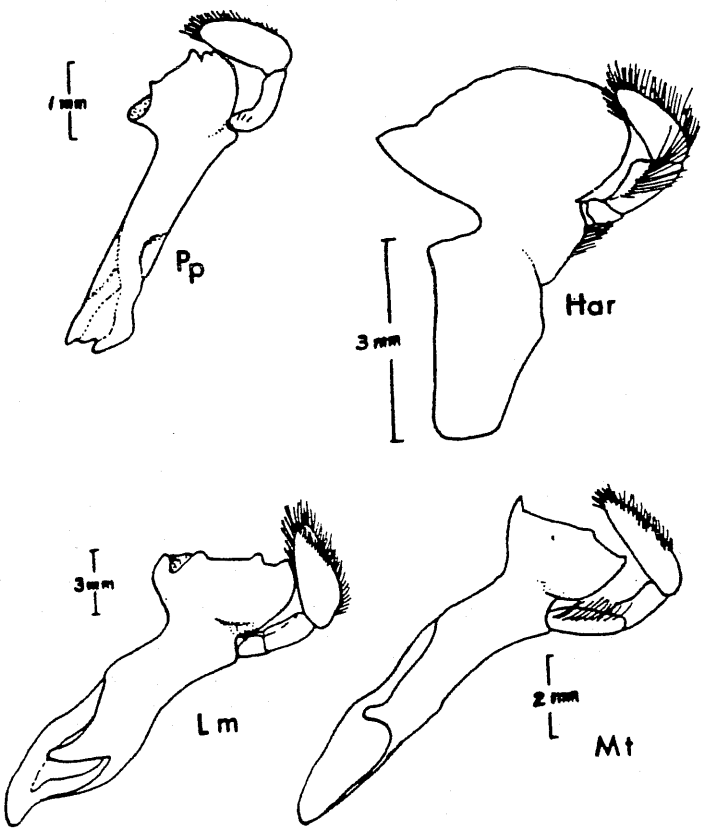


Figure 31. Mandibles of Pagurus pubescens (Pp), Hyas araneus (Har), Lithodes maja (Lm) and Munida tenuimana (Mt).

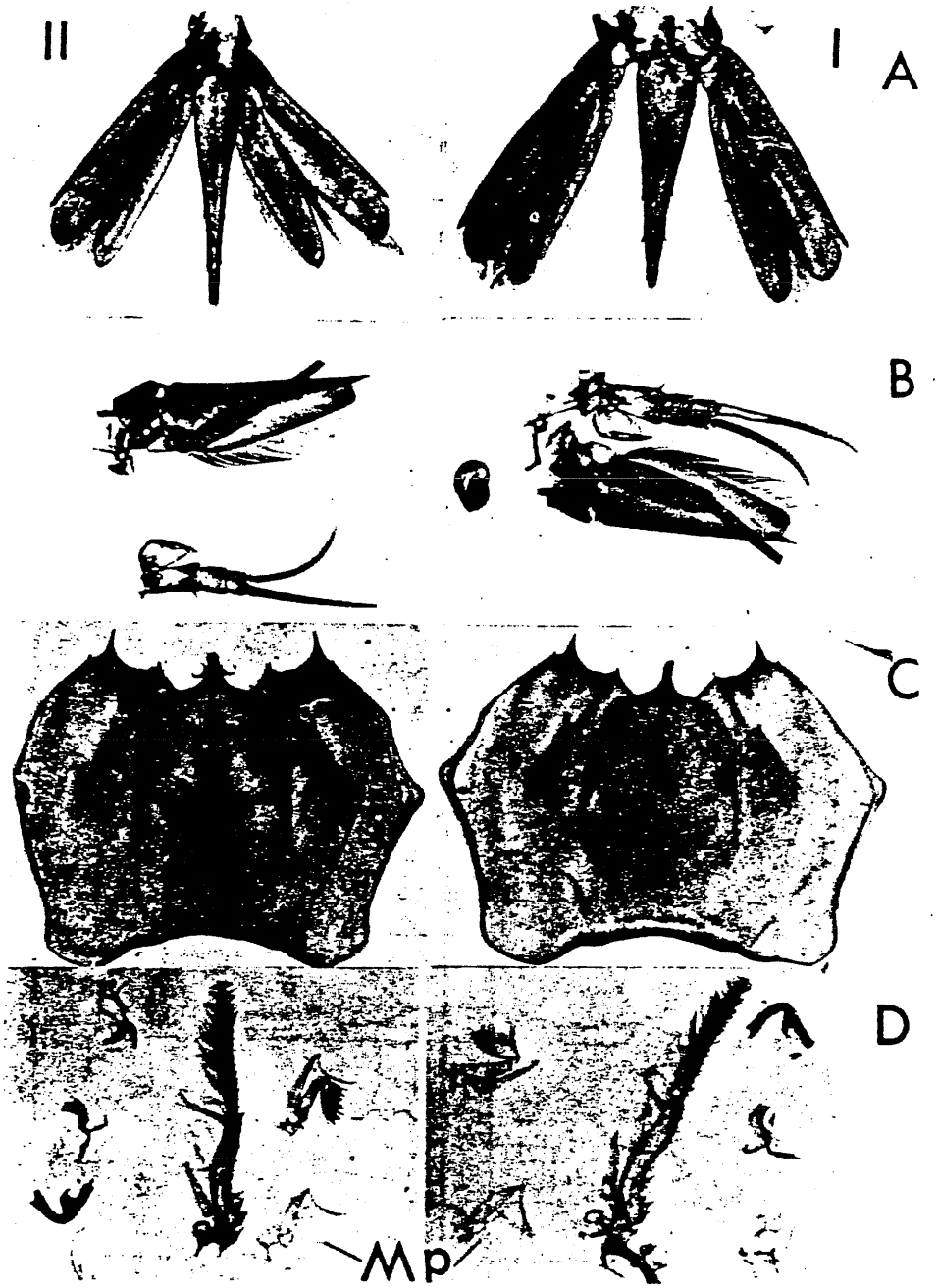


Figure 32. Photographs of whole mounts of (A) telson, (B) 1st and 2nd antennae, (C) carapace and (D) mouth parts of I. Crangon crangon and II. Crangon septemspinosa. (Mp = 1st maxilliped).

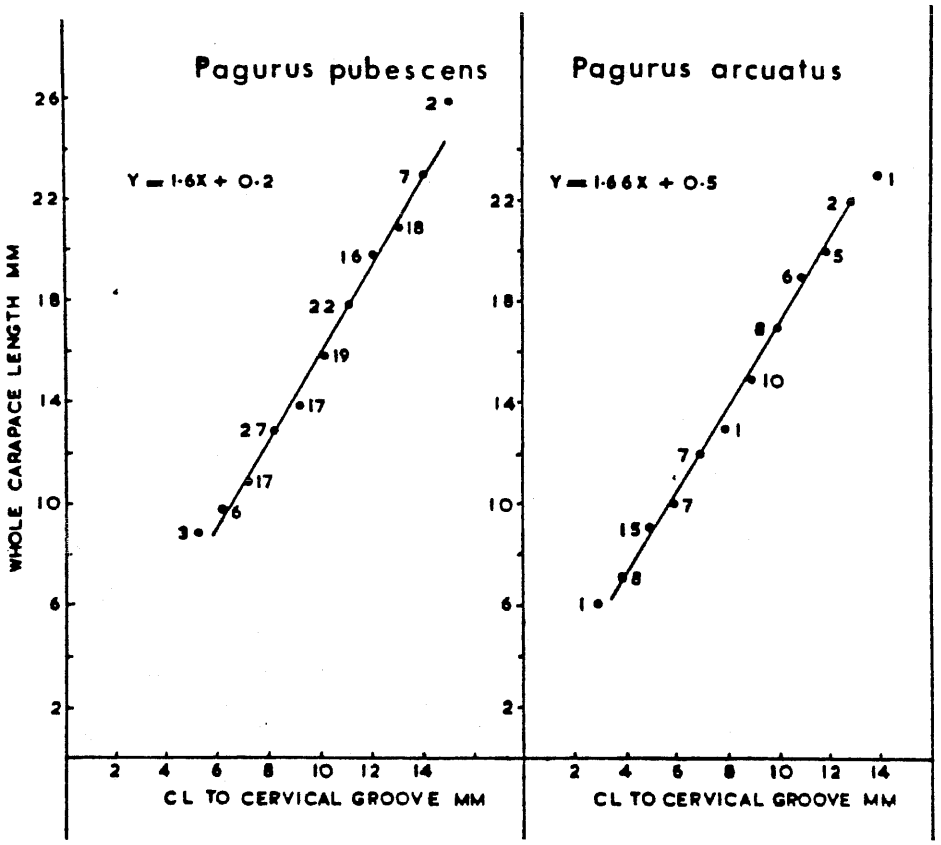


Figure 33. Regression equations for converting length of shield to total carapace length in Pagurus pubescens and Pagurus arcuatus.

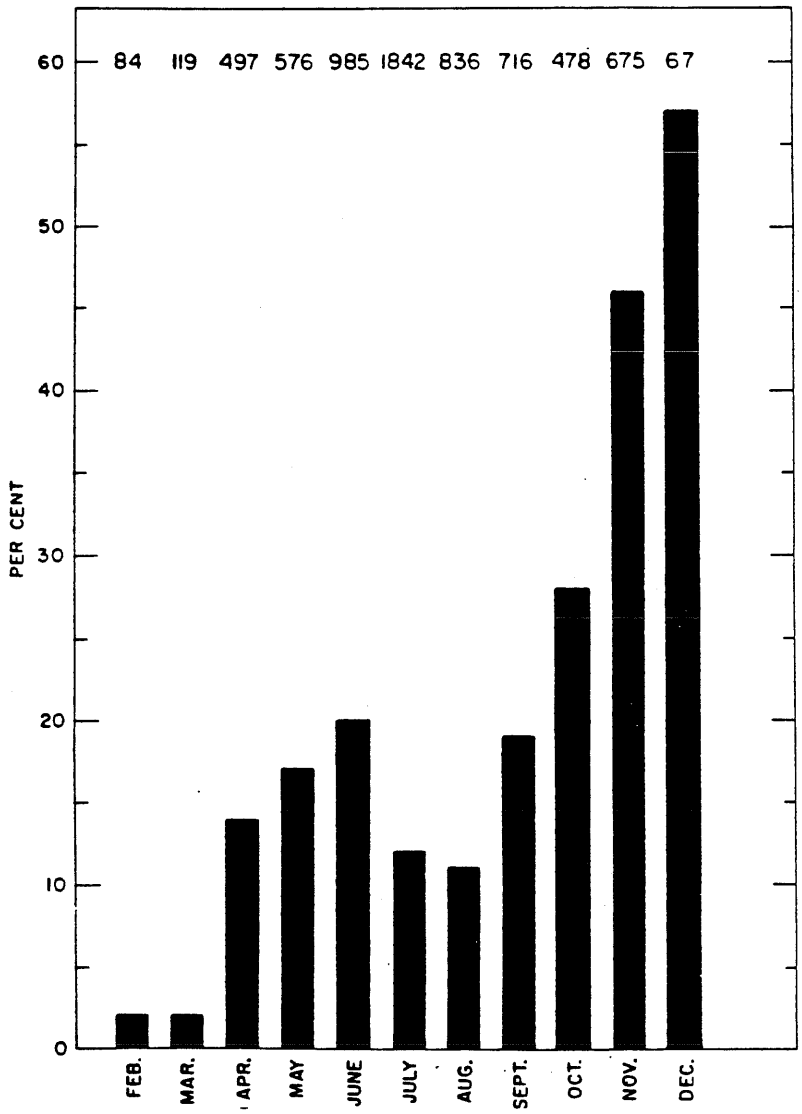


Figure 34. Percentage incidence of shrimp in stomachs of cod (Gadus morhua) from coast of Newfoundland (1950-60). Numbers of stomachs examined are shown.

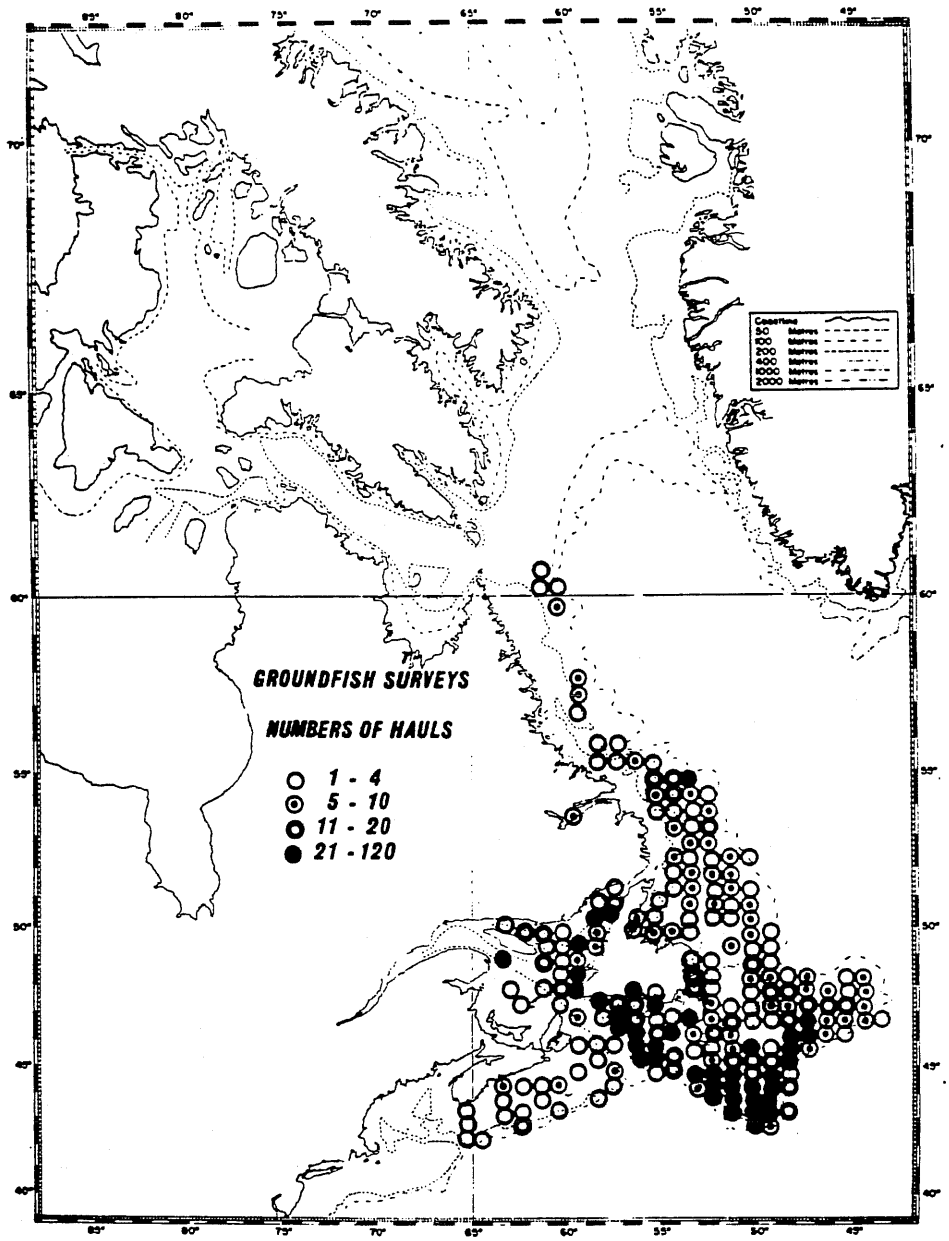


Figure 35. Numbers of hauls during groundfish surveys in area by "Investigator II" in 1946-60 and "A.T. Cameron" in 1958-60 (except cruises 12 and 26 in Figure 33).

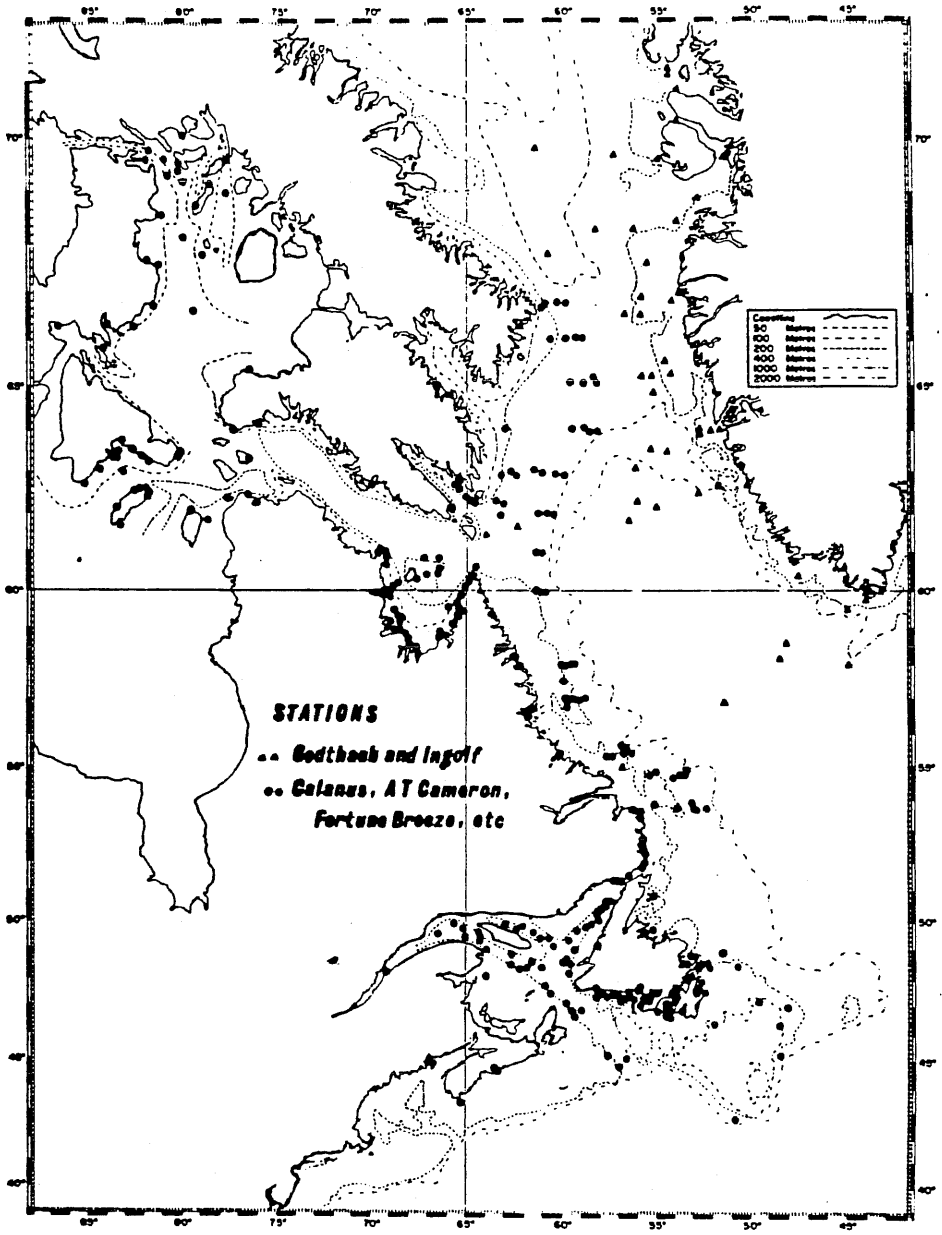


Figure 36. Stations of "Calanus" (1946-58), "Fortune Breeze" (1957-58), "A.T. Cameron" (1959-60) (cruises 12 and 26 only), and the "Ingolf" (1896) and "Godthaab" (1910) expeditions.

INDEX OF SCIENTIFIC NAMES

Acanthephyra 31
pelagica 32
purpurea 34
Alopidae 50, 9
Argis 98
dentata 99
Aristeidae 8
Astacidea 119, 120
Axiidae 126, 9

Brachyura 119, 145
Bythocarididae 46, 9
Bythocaris 47
gracilis 47
payeri 48
spinipleura 49

Calocaris 126
templemani 126
Cancer 147
borealis 147
irroratus 148
Cancridae 146, 9
Caridea 8
Caridion 50
gordoni 50
Chionoecetes 150
opilio 150
Crangon 102
septemspinosa 102
Crangonidae 98, 8

Dichelopandalus 82
leptocerus 82

Eualus 51
fabricii 53
gaimardi belcheri .. 56
Gaimardi gaimardi .. 59
macilentus 62
pusiolus 64

Galatheidae 119, 142, 9

Gennadas 23
elegans 23
valens 25

Homarus 120
amèricanus 120
Hyas 153
araneus 153
coarctatus 155
c. alutaceus 155

Lebbeus 51
groenlandicus 65
microceros 68
polaris 70
zebra 68
Lithodes 137
maja 138
Lithodidae 119, 137, 9

Majidae 149, 9
Metacrangon 105
jacqueti agassizi .. 105
Munida 142
tenuimana 143
Munidopsis 142
curvirostra 145

Nematocarcinidae 9
Nematocarcinus 38
rotundus 38
Neolithodes 140
grimaldii 140
Nephropidae 9

Oplophoridae 31, 8
Oplophorus 31
spinosus 36

Paguridae 119, 130, 9
Pagurus 130
acadianus 131
arcuatus 132
pubescens 134
Pandalidae 81, 9
Pandalus 81
borealis 84
montagui 92
propinquus 96
Parapaguridae 119, 9
Parapagurus 141
pilosimanus 141
Parapasiphaea 39
sulcatifrons 40
Pasiphaea 39
multidentata 41
tarda 43
Pasiphaeidae 39, 8
Penaeidea 8
Planes 159
minutus 159
Plesiopenaeus 26
edwardsianus 26
Polycheles 128
granulatus 128
Polychelidae 128, 9
Pontophilus 98
norvegicus 106
Portunidae 158, 9
Portunus 158
sayi 158

Reptantia 119, 9

Sabinea 98
hystrix 108
sarsi 109
septemcarianta 111
Sclerocrangon 98
boreas 114
ferox 117
Sergestes 28
arcticus 28
Sergestidae 8
Sergia 30
robusta 30

Spirontocaris 51
lilljeborgi 73
phippsi 75
spinus 78

Stereomastis 129
sculpta 129

Systellapsis 31
debilis 37

Thalassinidea 119
Thoridae 51, 9