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Summary of pages included in this reproduction of the document:

Front page – pg 33 (intro); pg 54 (mention of *Munidopsis curvirostra* (spelling error)); pg 123-136 (geographical distribution)

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THE STALK-EYED CRUSTACEANS
OF THE
ATLANTIC COAST OF NORTH AMERICA
NORTH OF CAPE COD.

With five plates.

[FROM THE TRANSACTIONS OF THE CONNECTICUT ACADEMY, VOL. V.]

S. J. Smith 1877

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THE STALK-EYED CRUSTACEANS OF THE ATLANTIC COAST OF NORTH
AMERICA NORTH OF CAPE COD. BY S. I. SMITH.

THIS paper is the result of work done in preparing a more complete account of the crustaceans of the coast of northern New England for the report of the United States Commissioner of Fisheries. The study of the extensive collections of crustaceans, made during the past fourteen years by Professor Verrill and myself, and particularly during the last seven years under the auspices of the Commission for the investigation of the fisheries, promised to add so much to the knowledge of the relations of the fauna of the western side of the North Atlantic, that it has seemed desirable to publish as early as possible the results bearing upon the geographical distribution of the species. This has been long delayed, however, by the great quantity of material which has each year been added to the collections, so that the time at my disposal has been little more than sufficient properly to separate and care for the specimens themselves. In the present paper I have attempted to give these results for the species of stalk-eyed Malacostraca inhabiting the coast between Cape Cod and northern Labrador. Only a very small portion of the species composing the crustacean fauna is thus included, but it is that portion which is best known and consequently most useful in determining the relations of the fauna. Although the paper has special reference to the geographical distribution of the species, considerable matter is introduced in regard to specific variation and specific characters, and, under some of the species, to the synonymy, where it seemed necessary to the proper understanding of the geographical distribution or to show the propriety of the nomenclature adopted, or where the species is not well-known.

The practice among zoologists of neglecting to make clearly apparent what parts of their writings are based on their own observations and what on the works of others, is a frequent source of annoyance and error. This is particularly the case in the statement of the habitats of species, as often given, without the slightest indication whether the occurrence of the species, in each of the regions specified, is known to the author from personal observation or the examination of specimens collected by others, or whether the statement is based

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COLLECTION

on the writings of other observers, or whether the author has merely conjectured that the species—perhaps never seen by him—inhabits certain regions. Hitherto my own practice has not always been free from fault in this respect, but throughout the following pages I have been careful to indicate distinctly what portions of the statements are based on my own observations and what are merely copied. To do this in the paragraphs devoted to the geographical distribution of the species, I have used the mark of affirmation (!) after each region front or in which I have examined specimens; but to avoid the too frequent repetition of this mark, in cases where the enumeration of several stations or depths immediately follows the name of a special region or locality, it has been placed after the latter only, it being understood that I have examined specimens from all the stations or depths mentioned under that region or locality. The name of the collector, or of the authority for the locality of the specimens examined,—unless I have myself been collector or observer,—is either inserted in parenthesis after the locality or indicated by the date, as explained below. The authorities for all localities from which I have not examined specimens are similarly indicated in parentheses. In the synonymy, all the references given have been made by direct examination of the works quoted, unless specially indicated to the contrary by the use of quotation marks.

To avoid the repetition of the names of collectors, after the numerous localities on our coast, mentioned under the geographical distribution of the species, the year in which the collections were made is, in most cases, alone inserted; and a short statement of the principal sources whence the collections have been received, is inserted here, that portion which is subsequently referred to as authority for collections being arranged chronologically.

1864. Collections made at Eastport, Maine, on the Bay of Fundy, during September and October, by Professor Verrill and the writer.

1868. At the same locality, during August and the early part of September, also at the Island of Grand Menan and in the deep waters off Eastport; by Prof. Verrill, Prof. H. E. Webster, Rev. Geo. A. Jackson, and the writer.

1870. At the same localities and during the same season as in 1868; by Professor Verrill and Mr. Oscar Harger. Also, by myself upon the southern side of Long Island, during August and the early part of September.

1871. Professors Verrill and J. E. Todd, and the writer made collections, for a short time in April, in the neighborhood of Great Egg

Harbor, New Jersey; a special object of the excursion being the determination of the species described from that region by Say.

The systematic exploration of the waters of our coast were this year begun, in connection with the investigations concerning the coast fisheries, under the direction of Professor Baird, United States Commissioner of Fish and Fisheries. Under these auspices, the larger part of the collections referred to in this paper have been made. In 1871, this work was carried on in the region of Vineyard Sound and Buzzard's Bay, from late in June to the middle of September. The dredging operations and the care of the collections of invertebrates were in my charge during the first part of the season, later in care of Prof. J. E. Todd, and finally under the direction of Professor Verrill, more or less assisted by Professors A. Hyatt and A. S. Packard, Jr., and particularly by Prof. W. G. Farlow, who was specially engaged in collecting and studying the algæ.

1872. Under the auspices of the Commissioner of Fisheries, large collections were made, during July and August, at Eastport, Maine, and in the whole neighboring region of the Bay of Fundy. As in the succeeding years, Professor Verrill had charge of the dredging operations and the collections of invertebrates. For a large part of the season Dr. T. M. Prudden cared for the crustaceans and made valuable notes on the stations and color of the species. For a part of the season Prof. H. E. Webster was at the island of Grand Menan where he made valuable additions to the collection of crustaceans, particularly among the species of *Hippolyte*. Several other gentlemen aided in the general work of collecting, and, for a time in August, Mr. Harger and I were present and took part in the work.

During the last of August and September, a series of dredgings were made, on board the Coast Survey steamer Bache, in the region of St. George's Banks and the adjacent waters. An account of these dredgings has already appeared in the third volume of these Transactions. This, the earliest exploration with the dredge, of the region referred to, was carried out through the coöperation of Professor Baird and the Superintendent of the Coast Survey. During the first cruise, on which dredgings were made on, and east of, St. George's Banks; at Halifax, Nova Scotia; and on Le Have Bank, the dredging was in charge of Mr. Harger and the writer. On the second cruise, dredgings were made by Prof. A. S. Packard, Jr., and Mr. Caleb Cooke, in the region of St. George's Banks. In the latter region the dredgings extend from north latitude $41^{\circ} 25'$ to $42^{\circ} 11'$, and from west longitude $68^{\circ} 10'$ to $65^{\circ} 42.3'$; on Le Have Bank, in

a line about southeast from Cape Sable, Nova Scotia, and a little south of latitude 43° north. The dredgings made by Professor Packard and Mr. Cooke were at five different stations, all on, or near, the northern slope of St. George's Banks, and in 110, 85, 45, 40, and 150 fathoms.

While waiting at Provincetown, Massachusetts, for the Bache, Mr. Harger and I were able to observe a large number of the shore and shallow-water species, showing the fauna to be intermediate in many respects between the fauna north and that south of Cape Cod.

1873. Collections were made in, and off, Casco Bay, coast of Maine, during July, August, and the early part of September, under the same auspices and direction as in 1872. During the season I had charge of the crustaceans and was greatly aided by Mr. J. H. Emerton, who not only made many most excellent drawings for use in the final reports upon the crustaceans, but also assisted in the work of collecting.

Through the same coöperation as in 1872, the steamer Bache made several trips, during September, to the deeper waters of an extensive region in the Gulf of Maine, between Cape Cod and the coast of the State of Maine. On these trips, Professor Packard and Mr. Cooke took charge of the dredgings, which were made in the following distinct regions: off the coast of Maine, south and east of Penobscot Bay, in 52 to 82 fathoms; a region on and near Jeffrey's Bank, extending from north latitude $43^{\circ} 15'$ to $43^{\circ} 36'$, and from west longitude $69^{\circ} 6'$ to $68^{\circ} 25'$, and at depths from 60 to 107 fathoms; in 52 to 118 fathoms on Cashe's Ledge and to the west of it (the Ledge being in about latitude $42^{\circ} 50'$, longitude $68^{\circ} 50'$, and the dredgings extending to $69^{\circ} 35'$); on and near Jeffrey's Ledge, off the coast of New Hampshire, in 24 to 33 and 95 to 118 fathoms; in the central part of Massachusetts Bay, in 50 and 65 fathoms; in 24 to 33 fathoms on Stellwagen's Bank, the outer barrier of Massachusetts Bay, situated between Cape Cod and Cape Ann; off Massachusetts Bay, 20 to 25 miles northeast of Cape Cod, in 117 and 142 fathoms; and in shallow water just south of Cape Ann.

In April of this year, Professors Verrill and D. C. Eaton made an excursion to Watch Hill, Rhode Island, and made a small collection of special interest on account of the season of the year.

1874. The dredgings, in connection with the work of the Fish Commission, were carried on in the region about the eastern end of Long Island Sound and extended from the mouth of the Connecticut River, to Gardner's and Peconic Bays, to the waters south of Montauk Point, and to the banks south and east of Block Island.

As in 1873, the steamer *Bache* continued the dredgings in the Gulf of Maine. Professor Packard, assisted by Mr. Cooke and Mr. Robert Rathbun, had charge of the work and made large collections between Cape Ann and the Isles of Shoals, on Jeffrey's Ledge, on Cashe's Ledge, and at numerous localities in the deep waters of the Gulf of Maine.

1875. The work under the direction of the Commissioner of Fisheries was in the same region as in 1871, but the dredgings extended further to the eastward and included the region east of Nantucket.

In addition to this, Professor Verrill and Mr. C. Hart Merriam, during a short excursion to Barnstable, on the north side of Cape Cod, made collections of many of the species inhabiting the shores and shallow waters of the southern part of Cape Cod Bay.

1876. Mr. C. Hart Merriam and Mr. E. B. Wilson made some collections at Eastport, Maine, in April, and very kindly submitted the crustaceans to me. The collection was particularly interesting on account of the season at which it was made, all the other collections which I have examined from the same region having been made late in the summer or early in the autumn.

1877. The extensive collecting prosecuted under the direction of the Commissioner of Fisheries was resumed, the collections of the invertebrates being, as before, in charge of Professor Verrill, who was this year assisted by Mr. E. B. Wilson. Extensive collections were made at Salem, Massachusetts, and in the neighboring waters of Massachusetts Bay and the Gulf of Maine. During a part of the season the work was transferred to Halifax, Nova Scotia, where large collections were made and whence the dredging was extended to the deep waters one hundred and twenty miles south of that city. On the passage from Salem to Halifax, dredgings were made in the deep waters of the Gulf of Maine and off the southern portion of the Nova Scotia coast.

1878. The work in connection with the investigation of the fisheries was continued in the vicinity of Cape Ann, the field investigated being contiguous to, and partially overlapping, that in the vicinity of Salem in 1877. In addition to the material obtained upon the shores and by dredging, valuable collections were procured, at Gloucester, Massachusetts, the head-quarters of the Commission for the season, from vessels engaged in the bank-fisheries. Professor Verrill was specially assisted by Mr. Richard Rathbun and Mr. Sanderson Smith. The collections of this year came to hand too late to be used to any considerable extent in the present paper, and consequently only occasional references are made to them.

I was not able to assist in the work of collecting either in 1877 or 1878, but the crustaceans in the collections of these years have nearly all been placed in my hands in the original packages in which the specimens collected at each special locality were placed, so that I am alone responsible for the determination of the species from each of these special localities.

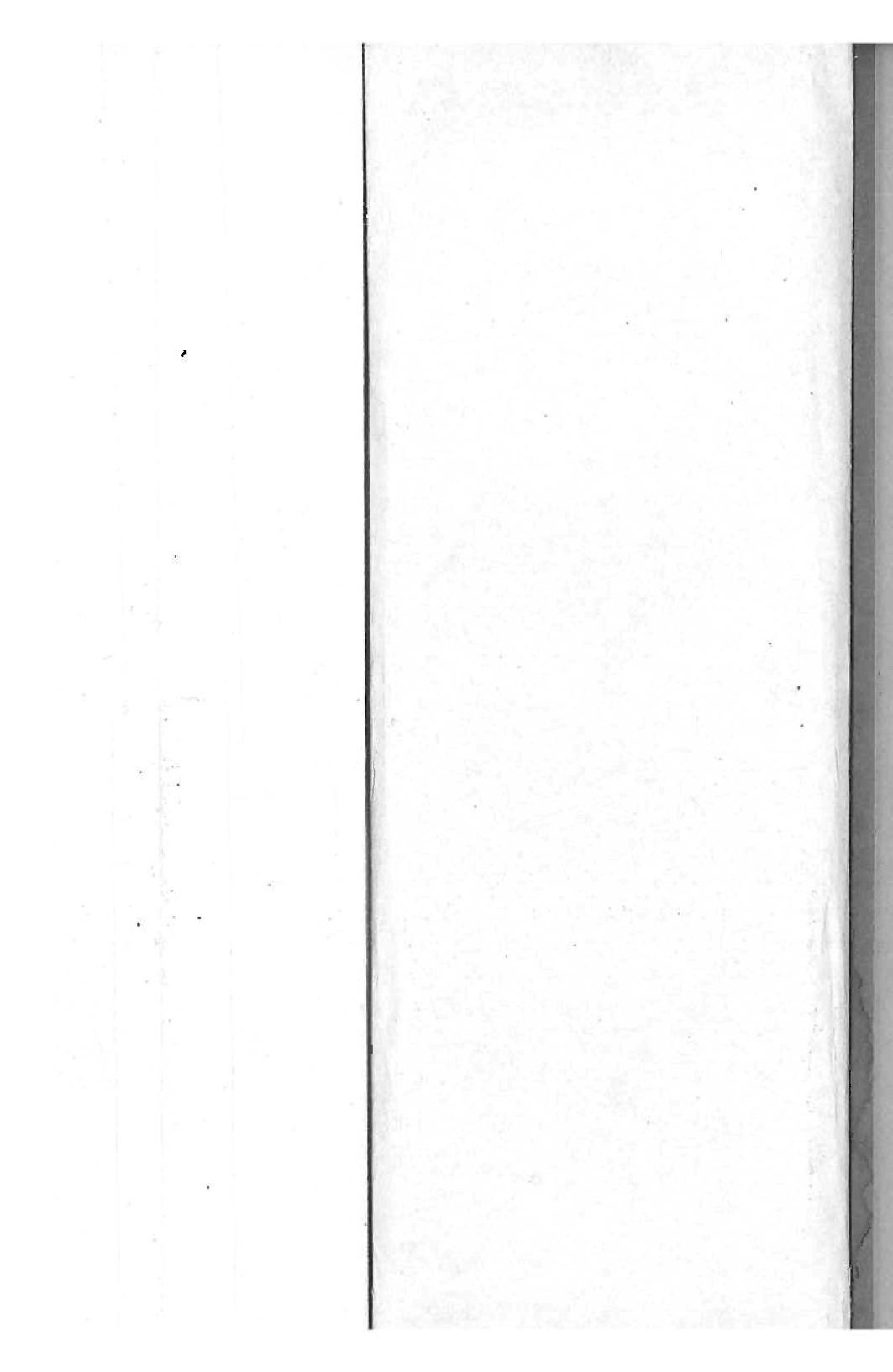
Several gentlemen, in addition to those above mentioned in connection with the work of the Fish Commission, aided in collecting during different seasons; the gentlemen who were specially engaged in investigating the fishes, also, gave every season, more or less assistance in collecting the invertebrates. Mr. G. Brown Goode, who has for several years had charge of the work upon the fishes, should be particularly mentioned in this connection.

Mention should also be made of the small collections which have, from time to time, been made, in the interest of the United States Fish Commission, by Mr. Vinal N. Edwards in the vicinity of Wood's Holl, Massachusetts (Vineyard Sound and Buzzard's Bay). These collections have been made mostly in the winter and spring and for this reason have proved of special interest, often containing species rarely or never taken in summer, and in several cases materially helping to complete the annual history of a species.

For the use of a few specimens of rare species, not fully represented in the collections above referred to, and also for the freest access to the collections under their charge, I am under obligation to the officers of the Boston Society of Natural History, the Peabody Academy of Science at Salem, and the Portland Society of Natural History. In addition to the use of the collections made under the auspices of the United States Fish Commission, I am indebted to Professor Baird for the opportunities of examining several collections from our southern coast and from Europe, for the loan of books, and for the use of several of the drawings made by Mr. Emerton, which appear in the accompanying plates. To Professor Verrill, I am indebted for the constant use of the valuable collection of crustaceans, of which I formerly had charge, in the Museum of Yale College, as well as for his advice and assistance in many ways. The Museum, in addition to the collections above referred to, contains large collections made in the vicinity of New Haven during many years; an authentic set from the collection which served as a basis for Professor Packard's work upon the invertebrate fauna of Labrador, contained in the first volume of the *Memoirs of the Boston Society of Natural History*; a very valuable series of the crustacea of the coast of Norway, received from

Professor G. O. Sars; a similar series from the British Isles, received from the Reverend A. M. Norman; and a miscellaneous collection of authentically determined species received through Professor A. Milne-Edwards, from the Jardin des Plantes at Paris. These European collections have been of the greatest service for comparison with our closely allied or identical species. The collection from the Reverend Mr. Norman, however, has been received since the following pages were written, so that it is only occasionally referred to.

To the kindness of Mr. J. F. Whiteaves of Montreal, I am indebted for the opportunities of examining very nearly all the crustaceans obtained in his extended explorations of the Gulf of St. Lawrence. Brief accounts of these explorations by Mr. Whiteaves, whose investigations have added very largely to the knowledge of the fauna of the Gulf of St. Lawrence, are contained in his several reports to the Minister of Marine and Fisheries for the Dominion of Canada.



Munadopsis curvirostra Whiteaves.

American Journal of Science, III, vol. vii, p. 212 (3), 1874; Report on further deep-sea dredging operations in the Gulf of St. Lawrence [in 1873], p. 17, [1874?].

Gulf of St. Lawrence!, 180 to 220 fathoms (J. F. Whiteaves).

On the Geographical Distribution of the foregoing species, and on the Relation of the Fauna of the Atlantic coast of North America north of Cape Cod to that of Greenland and Europe.

In order to exhibit in a connected manner the principal facts in regard to the geographical and bathymetrical distribution of the species properly belonging to the marine fauna of our coast north of Cape Cod, I have prepared the following tabular synopsis.

The headings of a part of the eleven columns, in which the geographical distribution is indicated, do not state fully the region included, so that the following explanations are necessary. Under "South of Cape Cod," all those species are included which are found

anywhere near the south coast of New England or the coast still further south, whether they properly belong to the fauna south of the Cape or are northern species which occur only in exposed situations, in deep water, or in winter; but to distinguish these two classes of species, the northern ones are indicated by an asterisk (*). Under "Massachusetts Bay," two or three rare species taken off Cape Ann, but not as yet actually in the Bay, are included. Under "Nova Scotia," only those species which have been observed on or near the southeast coast are included; the species of the northern, or Gulf-of-St. Lawrence, coast being included in the eighth column, while a few species taken only in deep water (one hundred or more fathoms) far off the Atlantic coast, are included in the seventh column. Under "Gulf of Maine, etc.," are included the species found in the Gulf of Maine proper (the great region of comparatively deep water, but with numerous banks and "ledges," between St. George's Banks and the shallow waters of the coast from Cape Cod to Nova Scotia), and also the species found on St. George's Banks, LeHave Bank, etc., and the deep waters outside of them. Under "Gulf of St. Lawrence and Labrador," are included the species found in the Gulf and on the east, or Atlantic, coast of Labrador, though in the present list all the species known from the east coast of Labrador have been found also in the Gulf. A few species which have been found in the shallow southwestern part, including Northumberland Straits and the Bay of Chaleurs, and not in other parts of the Gulf, are indicated by a dagger (†). Under "Bering Sea," species known from any part of the North Pacific or from the Arctic Ocean immediately north of Bering Straits are included. The number of species common to this region and the North Atlantic will undoubtedly be very largely increased by subsequent investigation.

In checking in the table the occurrence of the species, a mark of affirmation (!) is used, as in the previous pages, when I am myself responsible for the identification of the species; the plus sign (+), when the species has not been seen by me but has been recorded on good authority; and by a mark of interrogation (?), when there is doubt in regard to the identification of the species.

In the bathymetrical distribution, under "Fathoms," the depths within which the species have been found upon our coast only are given.

	S. Cape Cod.	Cape Cod Bay.	Mass. Bay.	Casco Bay.	Bay of Fundy.	Nova Scotia.	C. of Maine, etc.	C. St. Lav. and Lab.	Greenland.	Europe.	Bering Sea.	Fathoms.
<i>Gelasimus pugnax</i>	!	!										Shore.
<i>pugillator</i>	!	!										"
<i>Callinectes hastatus</i>	!		+									0- 2
<i>Platyonichus ocellatus</i>	!	!										0- 10
<i>Carcinus mænas</i>	!	!								!		0- 2
<i>Geryon quinquedens</i>							!					100-160
<i>Panopeus depressus</i>	!	!										0- 5
<i>Sayi</i>	!	!										0- 5
<i>Harrisii</i>	!	!	!									0-
<i>Cancer irroratus</i>	!	!	!	!	!	!	!	!				0- 50
<i>borealis</i>	!	!	!	+	+							0- 10
<i>Chionocetes opilio</i>							!	!	+		!	88-101
<i>Hyas araneus</i>							!	!	!	!	!	16- 60
<i>coarctatus</i>	!*						!	!	!	+	!	0-150
<i>Libinia emarginata</i>	!	!	!	!	!	!	!	!	+			0- 5
<i>Lithodes maia</i>							!	+	?	!		50-250
<i>Bupagurus bernhardus</i>	!*						!				!	0-150
<i>longicarpus</i>	!	!	+	!								0- 10
<i>pubescens</i>	!*						!	!	!	+	+	0-150
<i>Krøyeri</i>							!	!	!	+	!	8-430
<i>Parapagurus pilosimanus</i>							!					250
<i>Munidopsis curvirostra</i>								!				180-220
<i>Homarus Americanus</i>	!	!	!	!	!	!	!	!				0- 10
<i>Axius serratus</i>			+				!					20- 40
<i>Calocaris Macandreae</i>								+		+		190-
<i>Crangon vulgaris</i>	!	!	!	!	!	!	!	!		!		0- 48
<i>boreas</i>			!	!	!	!	!	!	+	!	+	0- 33
<i>Sabinea septemcarinata</i>			!	!		!	!	!	!	!	?	26- 68
<i>Sarsii</i>						!	!			!		60-112
<i>Pontophilus Norvegicus</i>						!	!			!		101-115
<i>Nectocrangon lar</i>						!		!	+		+	29- 59
<i>Caridion Gordoni</i>				!	!	!	!			!		27-110
<i>Hippolyte Fabricii</i>				!	!	!	!	!	+		-	0- 64
<i>Gaimardii</i>			+	!	!	!	!	!	+	!	+	0- 57
<i>spinus</i>			!	!	!	!	!	!	+	!	+	0- 90
<i>securifrons</i>			!		!	!				!		27-190
<i>macilenta</i>					!		!	+				26- 70
<i>Phippsii</i>			!	!	!	!	!	!	+	!	+	10-125
<i>pusiola</i>	!*		!	!	!	!	!	!		!		0-105
<i>polaris</i>			!	!	!	!	!	!	+	!	+	10-100
<i>Greenlandica</i>			!	!	!	!	!	!	+	!	+	6- 33

	Σ. Cape Cod.	Cape Cod Bay.	Mass. Bay.	Casco Bay.	Bay of Fundy.	Nova Scotia.	G. of Maine, etc.	G. St. Law. and Lab.	Greenland.	Europe.	Bering Sea.	Fathoms.
<i>Pandalus borealis</i>		!			!	!	!		+	!	+	40-160
<i>Montagui</i>	!*	!	!	!	!	!	!		+	!		10-430
<i>Palaemonetes vulgaris</i>	!	!										
<i>Pasiphaë tarda</i>							!		+	!		140-175
<i>Thysanopoda Norvegica</i>		!	!	!	!	!	!		+	!		0-430
<i>inermis</i>	!*	!	!	!	!	!	!		+	!		0-220
<i>Erythrops Goësi</i>		!								!		20-48
<i>Meterythrops robusta</i>		!					!					33-70
<i>Pseudomma roseum</i>							!	!		!		105-210
<i>truncatum</i>							!					45-70
<i>Heteromysis formosa</i>	!	!										0-10
<i>Mysis mixta</i>		!	!	!	!	!			+?	!		20-90
<i>stenolepis</i>	!	!	!		!							0-18
<i>oculata</i>				?			!	+	+			0-
<i>Americana</i>	!	!	!									0-5
<i>Diastylis Rathkii</i>					!	!	!	!	!	!		20-57
<i>politus</i>	!	!	!			!	!	!	!	!		0-190
<i>sculptus</i>	!	!	!	!	!	!	!	!	!	!		0-190
<i>luciferus</i>	!			!	!	!	!	!		!		60-97
<i>quadrispinosus</i>	!*	!	!	!	!	!	!	!	!	!		2-190
<i>abbreviatus</i>	+	!	!									17-35
<i>Leptostylis longimanus</i>			!							+		
<i>ampullaceus</i>						!				+		52-90
<i>Leucon nasicus</i>							!	!	+	!		50-70
<i>nasicoides</i>				!			!	!	+	!		
<i>Pandorella emarginata</i>					!	!	!	!		!		52
<i>hispida</i>	+	!	!	!	!	!	!	!				1-54
<i>pusilla</i>	!	!	!	!			!	!				1-25
<i>deformis</i>	+*	!							+	+		25
<i>integra</i>					!	!	!					42-110
<i>Lamprops quadriplicata</i>		!	!									0-10
<i>Campylaspis rubicunda</i>		!	!						+	+		35

A simple summation of the column of the above table gives the following as the number of species found in the whole region under discussion, and the number of these species recorded from the regions specified :

	Number of species in list.	S. Cape Cod.	Cape Cod Bay.	Mass. Bay.	Casco Bay.	Bay of Fundy.	Nova Scotia.	G. of Maine, etc.	G. St. Law. and Lab.	Greenland.	Europe.	Bering Sea.
Brachyura,	15	12	8	7	5	4	4	5	4	3	3	2
Anomura,	7	3	1	5	5	3	3	5	4	2	4	3
Maerura,	23	5	2	16	13	12	17	17	15	13	16	9
Total Decapoda,	45	20	11	28	23	19	24	27	23	18	23	14
Schizopoda,	11	4		8	4	3	2	4	6	4	6	
Cumacea,	17	7		9	9	6	6	6	10	4	9	
Total,	73	31	11	45	36	28	32	37	39	26	38	14

This summation, however, does not fairly represent the Thoracostracan fauna of our northeastern coast, since it takes no account of the rare or accidental occurrence of species outside their regular habitats, and, in particular, because it takes no account of the occurrence of species, under favorable local conditions, far north and south of their ordinary limits.

As has been previously remarked, the fauna of Cape Cod Bay is an extension of the southern, or Virginian, fauna across Cape Cod, and should properly be excluded from the fauna of the coast of northern New England. Although the crustacean fauna of Cape Cod Bay is very poorly represented in the previous list, the number of species recorded is sufficient to illustrate its southern character, which is abundantly proved by the other classes of its inhabitants. Of the eleven species recorded from Cape Cod Bay, the following have not been recorded from elsewhere north of the Cape and do not, in any sense, belong to the fauna of northern New England :

Gelasinus pugnax.		Carcinus mænas.	(L.)
G. pugilator.		Panopeus depressus.	
Platyonichus ocellatus.		P. Sayi.	

With the single exception of the apparently cosmopolitan *Carcinus*, these species represent the extreme northern limit, on our coast, of the genera to which they belong, and of the genera themselves none

appear to be represented in the European Seas. Of the five other species recorded from Cape Cod Bay, all are common far to the south and none of them are truly arctic species, although a single one, *Crangon vulgaris*, extends north to the Gulf of St. Lawrence and to Europe.

The following, in addition to list (1), are southern species occurring north of Cape Cod Bay only accidentally or in exceptionally protected localities: 7

Callinectes hastatus.		Palæmonetes vulgaris.	(2.)
Panopeus Harrisii.		Heteromysis formosa.	
Libinia emarginata.		Mysis Americana.	
Eupagurus longicarpus.			

Excluding the species in lists (1, 2), there are left eighteen northern species which extend south of Cape Cod. Of these,

Hyas coarctatus,		Pandalus Montagu,	(3.)
Eupagurus bernhardus,		Thysanopoda inermis,	
E. pubescens,		Eudorella deformis.	
Hippolyte pusiola,			

are northern and European species which extend but a short distance south of Cape Cod, where they are found usually only in cool waters of exposed localities, or, in the case of *Thysanopoda inermis*, only in winter.

Of the eleven remaining species which occur both north and south of Cape Cod,

Cancer irroratus,		Crangon vulgaris,	(4.)
C. borealis,		Mysis stenolepis,	
Homarus Americanus,			

have about equally extensive ranges and are about equally common both north and south of Cape Cod, and must be regarded as belonging properly to both faunæ. The others,

Diastylis politus,		Diastylis abbreviatus,	(5.)
D. sculptus,		Eudorella hispida,	
D. quadrispinosus,		E. pusilla,	

are all Cumacea which may fall in the same category as the four preceding species, although it is probable that some or perhaps all of them will be found to belong more exclusively to the northern fauna. None of the species in the last two lists are known to extend far north, nor, with the exception of *Crangon vulgaris*, to Europe, although they all belong to genera well represented in European seas.

Excluding, from the number of species recorded from both north and south of Cape Cod Bay, the seven southern species (2) which

occur locally or accidentally north, and the seven southern species (3) which occur similarly south of Cape Cod, there are left only eleven species (4, 5) which can be properly regarded as common to two regions of the New England coast. This fairly represents, I think, the marked difference between the two faunæ; a difference due principally to the difference in the temperature of the water, but partially undoubtedly, to the different structure of the coast and to the different nature of the shore and bottom in the two regions.

That there is no similar change in the fauna of the coast and shallow waters from Massachusetts Bay to Labrador is well shown by a comparison of the fauna of Massachusetts and Casco Bays with the fauna of the Gulf of St. Lawrence at similar depths. Omitting the southern species of lists (1, 2) and also the deep-water species (8) which are ordinarily not found at depths less than fifty fathoms, the following species are left recorded from Massachusetts and Casco Bays; those not yet recorded from the Gulf of St. Lawrence being prefixed by an asterisk:

Cancer irroratus.	Hippolyte Grœnlandica.	(6.)
*C. borealis.	*Pandalus borealis.	
Hyas araneus.	P. annulicornis.	
H. coarctatus.	Thysanopoda Norvegica.	
*Mupagurus bernhardus.	T. inermis.	
E. pubescens.	*Erythrops Goësii.	
E. Krøyeri.	Meterothrops robusta.	
Homarus Americanus.	*Mysis mixta.	
*Axius serratus.	*M. stenolepis.	
Crangon vulgaris.	Diastylis politus.	
C. boreas.	D. sculptus.	
Sabinea septemcarinata.	D. quadrispinosus.	
*Caridion Gordoni.	*D. abbreviatus.	
Hippolyte Fabricii.	*Leptostylis longimanus.	
H. Gaimardii.	*Eudorella hispida.	
H. spinus.	E. pusilla.	
*H. securifrons.	*E. deformis.	
H. Phippsii.	*Lamprops quadruplicata.	
H. pusilla.	*Campylaspis rubicunda.	
H. polaris.		

This list contains all the species recorded from less than fifty fathoms in the Bay of Fundy (unless *Mysis oculata* or *Leucon nasicooides* may prove to be exceptions), and is, as far as known, a complete list of the species which should be regarded as the regular inhabitants of the coast region of northern New England. Only six species additional to this list are recorded from the Gulf of St. Lawrence; they are the following:

Nectocrangon lar.		Mysis oculata.	(7.)
Hippolyte macilentæ.		Diastylis Rathki.	
Pseudomma truncatum.		Leucon nasicoides.	

With the exception of the new species of *Pseudomma*, these are all thoroughly arctic species, and show a slight increase in the arctic character of the fauna of the Gulf of St. Lawrence over that of northern New England. The *Nectocrangon*, the *Hippolyte*, and the *Diastylis* were found also upon the Atlantic coast of Nova Scotia and may, very likely, yet be found on the New England coast; while the *Leucon* is already known from the Bay of Fundy and will doubtless yet be found in Casco and Massachusetts Bays.

The fifteen species from Massachusetts and Casco Bays (6) not yet recorded from the Gulf of St. Lawrence afford very little evidence in regard to the relations of the fauna of the Gulf, for some of them are known to be arctic and will undoubtedly be found in the Gulf, and the distribution of most of the others is not sufficiently well ascertained to be used as evidence. The absence of *Eupagurus bernhardus* from the Gulf of St. Lawrence and Greenland, while it occurs on the New England coast, in Europe, and in the North Pacific is, however, an interesting fact which should not be overlooked.

The shallow southwestern part of the Gulf of St. Lawrence, including the region of Northumberland Straits, etc., as shown particularly by its Molluscan fauna, is much more southern in its character than the rest of the Gulf; but too little is known of the stalk-eyed crustaceans of this region to illustrate the fact, or to affect the statements above made in regard to the fauna of the Gulf as a whole, for the species which are recorded from this part of the Gulf only are all Cumacea of which the distribution is not sufficiently known to make their occurrence here evidence in regard to the character of the fauna.

The deep-water species, or those which have not been recorded from less than fifty fathoms on our coast, and which are not inserted in lists (6, 7), are the following; those known from the Gulf of Maine, from off the coast of Nova Scotia, etc., being indicated by an M; those from the Gulf of St. Lawrence, by an L:

M Geryon quinquedens.		M Pasiphaë tarda.	(8.)
M L Chionocetes opilio.		M Pontophilus Norvegicus.	
M L Lithodes mala.		M L Pseudomma roseum.	
M Parapagurus pilosimanus.		M L Diastylis luciferus.	
L Munidopsis curvirostra.		M Leptostylis ampulaceus.	
L Calocaris Macandreae.		M L Leucon nasicus.	
M Sabinea Sarsii.		M L Eudorella emarginata.	

The differences between the deep-water faunæ of the two regions, as shown in this list, are probably wholly accidental, the species which are not known to be common to both regions, being new or, at least on the western side of the Atlantic, little known species which will, most likely, eventually be found to inhabit both regions.

The facts above presented show conclusively, I think, that, as far as the Thoracostraca are concerned, the fauna from Cape Cod Bay to Labrador is essentially a continuous one, or at least that there are no changes in it comparable with the differences between the fauna south and that north of Cape Cod Bay. An uncompleted investigation of the distribution of the Amphipoda sustains these conclusions, which appear to be essentially in harmony with the facts at present known in regard to the distribution of the Mollusca and of other groups of the better known marine animals of the region in question.

Of the fauna of the east, or Atlantic, and of the north coast of Labrador, very little is at present known, but I believe no species of crustaceans, which are not found also in the Gulf of St. Lawrence or further to the south, have been recorded from this region, and the very close resemblance between the fauna of the northern part of the Gulf and that of the Greenland seas (to which I shall presently allude) renders it very improbable that the fauna of the east and north coasts of Labrador differs essentially from that of the northern part of the Gulf of St. Lawrence. The close relationship existing between the marine fauna of Greenland and that of northern Europe has long been observed and fully admitted by European zoologists, but the similarly close relationship between the marine fauna of Greenland and that of the coasts of the continent of North America itself, as well as the similar relationship between the fauna of the latter region and that of the seas of northern Europe, has not been so generally recognized by them and has recently been strenuously controverted.* This has probably been largely due to the fact that

* Dr. J. Gwyn Jeffreys: Preliminary Report of the Biological Results of a cruise in H. M. S. *Valorous* to Davis Strait in 1875, Proceedings Royal Society, London, vol. xxv, p. 188, 1876.

The Rev. A. M. Norman, however, appears to have fully recognized the true relation between the faunæ of the eastern and western sides of the North Atlantic, and also the American rather than the European character of the fauna of the Greenland seas; and in this very report arrives at conclusions the reverse of those of Mr. Jeffreys. Mr. Norman has, in a letter received since these pages were written, very kindly communicated to me his general conclusions in regard to the fauna of the North Atlantic, and I am pleased to find that his investigations in nearly all the classes of marine Invertebrata, have led to conclusions essentially the same as those resulting from my special study of the Thoracostraca.

the Greenland fauna has been studied almost exclusively by European zoologists to whom the fauna of our coast has usually been very little known. The earlier American zoologists fell into the same error, and, being without specimens of the known European species for comparison, and without sufficiently accurate figures or descriptions, described as new species already known from European and Greenlandic seas. This process has sometimes been reversed, however, the species being first described from our coast and later from the European. But the crustaceans have been more fortunate in this respect than some other classes of animals.

Further on, I have discussed the facts in regard to the geographical distribution of the Thoracostraca of Greenland, and need not specially allude to them here. The relation of the Thoracostracan fauna of the region between Cape Cod and Labrador to that of Greenland, that of Europe, and that of the region of Bering Sea, is shown in a general way in the summary, previously given, of the table of distribution (A), but is better shown if we omit from the summary the southern species (1, 2) which properly have no place in the fauna. Rejecting these, there are left belonging to the fauna between Cape Cod Bay and Labrador, sixty species, of which twenty-six are known in Greenland, thirty-seven in Europe, and fourteen in the region of Bering Sea. This is shown for different groups of Thoracostraca, in the following table:

(B.)	Cape Cod to Labrador.	Greenland.	Europe.	Region of Bering Sea.
Brachyura	6	3	2	2
Anomura	6	2	4	3
Macrura	22	13	16	9
Total Decapoda	34	18	22	14
Schizopoda	9	4	6	
Cumacea	17	4	9	
Total	60	26	37	14

This shows that a little more than three-fifths (sixty-one per cent.) of the species known to our northern marine fauna are common to the European fauna, while over two-fifths (forty-three per cent.) are found in Greenland, and that the proportions are very nearly the same if

the comparison be restricted either to the Decapoda proper, the Schizopoda, or the Cumacea.

The numerical distribution of the above twenty-six species known to be Greenlandic, along the western side of the North Atlantic is shown in the last five columns of table (D) beyond.

The similar distribution of the thirty-seven species common to our fauna and that of the European seas, and also the whole number of species recorded from each of the regions included in the second, third, fourth and fifth columns, is given in the following table, in which the fifth column is made to include the number of species found at less than fifty fathoms along the New England coast north of Cape Cod, while the other columns include the same regions as in table (A):

(C.)	Europe.	Greenland.	G. St. Lawrence.	G. of Maine, etc.	N. Eng. coast north Cape Cod.	South of Cape Cod.	Region of Bering Sea.
Brachyura	2	2	2	2	2	1	1
Anomura	4	2	3	4	4	1	3
Macrura	16	9	10	14	12	3	6
Total Decapoda	22	13	15	20	18	5	10
Schizopoda	6	4	4	4	4	1	
Cumacea	9	4	5	1	6	1	
Total European	37	21	24	25	28	7	10
Whole no. recorded		36	39	37	42		

Comparing the number of European species found in each of the four regions north of Cape Cod, with the whole number of species recorded from each of these regions, as given in the last line of the table, it will be seen that the proportion of European species is very nearly the same in each of the regions, while south of Cape Cod there is a very sudden diminution in the number of European species.

Thirty of the thirty-seven species common to the two sides of the North Atlantic are known to occur on our coast in fifty fathoms or less, while some of the remaining species are recorded from equally shallow water in the European seas. This is a smaller proportion of deep-water species than is found among the species which are left as peculiar to the fauna between Cape Cod and Labrador, which shows that the species common to Europe and America are not predominantly deep-water species.

In the following list of the twenty-three species belonging to the fauna between Cape Cod and Labrador and not known to be European, those which are known to be true arctic species are indicated by an A; those which extend south of Cape Cod and appear to have their center of distribution on the New England coast are indicated by an S, but some of the Cumacea thus indicated may very likely prove to be arctic species.

Geryon quinquedens.	A Hippolyte Groenlandica.	(9.)
s Cancer irroratus.	Meterythropros robusta.	
s C. borealis.	Pseudomma truncatum.	
A Chionocetes opilio.	s Mysis stenolepis.	
Parapagurus pilosimanus.	s Diastylis politus.	
Munidopsis curvirostra.	s D. sculptus.	
s Homarus Americanus.	s D. quadrispinosus.	
Axius serratus.	s D. abbreviatus.	
A Nectocerangon lar.	s Eudorella hispida.	
A Hippolyte Fabricii.	s E. pusilla.	
A H. macilenta.	E. integra.	
	s Lampropros quadriplicata.	

Excepting *Axius serratus* (which will very likely prove to be specifically identical with the European species), the species not prefixed by either A or S, are all new or recently described and little is yet known of their geographical range, but they are probably arctic species. It is worthy of notice that, of the five species known to be arctic and not known to be European, all are Greenlandic and all but one (*Hippolyte macilenta*) are also known to occur on the western coast of North America, in the region of Bering Sea. These four species, common to both the northern Atlantic and northern Pacific coasts of North America are all conspicuous forms not likely to escape detection, and their geographical distribution apparently indicates that there are a certain number of arctic American species which are not European—perhaps because they are too arctic to be European.

The relation of the Thoracostracan Fauna of Greenland to that of the rest of North America and to that of Europe.

In order to exhibit clearly the similarity of the relation of the Thoracostracan fauna of Greenland, on the one hand, to the fauna of the rest of the North American seas, and, on the other hand, to that of the European seas, I have compiled the following list of the species of Thoracostraca known to inhabit the Greenland coast, and have given in foot-notes the principal synonyms, the most important refer-

ences, and the geographical distribution, for the species not known from the region between Cape Cod and Labrador, and consequently not treated of in the foregoing pages, where the geographical distribution of all the other species is given. The species known from the eastern coast of North America are indicated by the letters E. A. (all these occur in the Gulf of St. Lawrence or further south); those from the western coast (the region of Bering Sea, etc.) by the addition of the letter W.; those from the European coast by the letter E.

Chionæcetes opilio,	E. & W. A.		H. macilentæ,	E. A.	
Nyas araneus,	E. & W. A.	E.	H. Phippsii,	E. & W. A.	E.
H. coarctatus,	E. A.	E.	H. polaris,	E. & W. A.	E.
Eupagurus pubescens,	E. & W. A.	E.	H. Grœnlandica,	E. & W. A.	
E. Krøyeri,	E. & W. A.	E.	H. microceras,†		
Crangon boreas,	E. & W. A.	E.	H. Panschii,‡		
Sabinea septemcarinata,	E. & W. (?) A.	E.	Pandalus borealis,	E. & W. A.	E.
Nectocrangon lar,	E. & W. A.		P. Montaguï,	E. A.	E.
Hippolyte Fabricii,	E. & W. A.		Hymenodora glacialis,§		E.
H. Gaimardii,	E. & W. A.	E.	Pasiphaë tarda,	E. A.	E.
H. incerta,*			Sergestes arcticus,		
H. spinus,	E. & W. A.	E.			

* HIPPOLYTE INCERTA Buchholz, Zweite deutsche Nordpolfahrt, ii, p. 272, 1874.
East Greenland (Buchholz). Perhaps only a variety of *H. Gaimardii*.

† HIPPOLYTE MICRO CERAS Krøyer, Naturhistorisk Tidsskrift, iii, p. 578, 1841; Monografisk Fremstilling af Slægten Hippolyte's nordiske Arter, Kgl. danske Vidensk. Selsk. Skr., naturvidensk. mathem. Afh., ix, p. 341 (*microceros*), pl. 5, fig. 105-109 (*microceras*), 1842.—Lütken, list of Crust. of Greenland, in Manual of Instructions for the [British] Arctic Expedition, 1875, p. 148.
Greenland (Krøyer).

‡ HIPPOLYTE PANSCHII Buchholz, Zweite deutsche Nordpolfahrt, ii, p. 277, pl. 1, fig. 1, 1874.—Kingsley, Bulletin Essex Institute, Salem, x, p. 62, 1878.
East Greenland (Buchholz).

§ HYMENODORA GLACIALIS G. O. Sars.

Pasiphaë glacialis Buchholz, Zweite deutsche Nordpolfahrt, ii, p. 279, pl. 1, fig. 2, 1874.—Kingsley, Bulletin Essex Institute, Salem, x, p. 69, 1878 (*Pasiphaë*).
Hymenodora glacialis G. O. Sars, Archiv for Mathematik og Naturvidenskab, Kristiania, ii, p. 341, 1877.

East Greenland (Buchholz). Deep water off the coast of Norway (G. O. Sars).

|| SERGESTES ARCTICUS Krøyer, Oversigt Kgl. danske Vidensk. Selsk. Forhandling, Kjöbenhavn, 1855, p. (6); Forsög monog. Fremstil. Kræbsdyrslægten Sergestes, Kgl. danske Vidensk. Selsk. Skr., V, naturvidensk. mathem. Afh., iv, pp. 240, 276, pl. 3, fig. 7, pl. 5, fig. 16, 1859.
Greenland (Krøyer).

Thysanopoda Norvegica,	E. A.	E.	Diastylis Rathkii,	E. A.	E.
T. inermis,	E. A.	E.	D. Edwardsii, §		
T. longicaudata,*			D. resimus, §		
T. Raschii, †		E.	Leucon nasicus,	E. A.	E.
? Mysis mixta.	E. A.	E.	Eudorella deformis,	E. A.	E.
M. oculata,	E. A.	E.	Campylaspis rubicunda,	E. A.	E.
Boreomysis arctica, ‡		E.			

The following table gives a numerical summary of this list, and also the numerical distribution of the species in several regions along the eastern coast of the continent of North America.

* THYSANOPODA LONGICAUDATA Krøyer, in Gaimard, Voyages en Scandinavie, en Laponie, etc., pl. 8, fig. 1, 1849.—Lütken, list of Crust. of Greenland, in Manual of Instructions for the [British] Arctic Expedition, 1875, p. 148.
Greenland (Reinhardt, Lütken).

† THYSANOPODA RASCHII Sars, Christiania Videnskabs-Selskabs Forhandling, 1863, p. 83.—Buchholz, Zweite deutsche Nordpolfahrt, ii, p. 285, 1874.
Coast of Norway (Sars). East Greenland (Buchholz).

‡ BOREOMYSIS ARCTICA G. O. Sars.

Mysis arctica Krøyer, Et Bidrag til Kundskab om Kiebsdyrfamilien Mysidae, Naturhistorisk Tidsskrift, III, i, pp. 34, 42, pl. 1, fig. 5, 1861.

Boreomysis arctica G. O. Sars, Christianiafjordens Dybvandsfauna, p. 26, 1869 (extr. Nyt Magazin for Naturvidenskaberne); Christiania Videnskabs-Selskabs Forhandling, 1871, p. 264 (21).—Metzger, Jahresbericht der Comm. zur wissenschaft. Untersuchung der deutschen Meere für 1872, 1873, Nordsee, p. 288, 1875.
Greenland (Krøyer). West coast of Norway (G. O. Sars, Metzger).

§ DIASTYLIS EDWARDSII Krøyer.

Cuma Edwardsii Krøyer, Naturhistorisk Tidsskrift, iii, pp. 504, 531, pl. 5, figs. 1-16, 1841; op. cit., II, ii, pp. 128, 207, pl. 1, figs. 1, 3, 5, 9-14, 1846; in Gaimard, Voyages en Scandinavie, etc., pl. 4, 1849 (♀).

Cuma brevisrostris Krøyer, Naturhistorisk Tidsskrift, II, ii, pp. 174, 208, 1846; Voyages en Scandinavie, etc., pl. 5A., fig. 1, 1849 (adult ♂).

Diastylis Edwardsii G. O. Sars, Kongl. Vetenskaps-Akad. Handlingar, Stockholm, ix, no. 13, p. 5, 1871.—Norman, Proceedings Royal Soc., London, xxv, p. 209, 1876; Annals and Magazin Nat. Hist. V, iii, p. 61, 1879.

Greenland (Krøyer, Norman).

|| DIASTYLIS RESIMUS G. O. Sars.

Cuma resima Krøyer, Naturhistorisk Tidsskrift, II, ii, pp. 165, 206, 1846; Voyages en Scandinavie, etc., pl. 3, fig. 1, 1849.

Diastylis rasima G. O. Sars, Kongl. Vetenskaps-Akad. Handlingar, Stockholm, ix, no. 13, p. 5, 1871.

Greenland (Krøyer).

(D.)	Greenland.	Europe.	Eastern coast of North America.	G. St. Lawrence.	G. Maine, etc.	N. Eng. coast north Cape Cod.	South of Cape Cod.	Region of Bering Sea.
Brachyura.....	3	2	3	3	3	2	1	1
Anomura.....	2	2	2	2	2	2	1	3
Maerura.....	18	10	13	11	11	9	1	6
Total Decapoda.....	23	14	18	16	16	13	3	10
Schizopoda.....	7	6	4	3	3	2	1	
Cumacea.....	6	4	4	2	1	2		
Total.....	36	24	26	21	20	17	4	10

Of the thirty-six Greenland species, six are not yet recorded from outside the Greenland seas, so that out of thirty species, twenty-six, or about eighty-seven per cent., are known upon the eastern coast of North America from the Gulf of St. Lawrence southward; while twenty-four species, or eighty per cent., are known in the European seas. An uncompleted examination of the Amphipoda gives results entirely in harmony with those above derived from the Thoracostraca, so that it is certainly safe to assert that, at least as far as the Malacostraca are concerned, the marine fauna of Greenland is essentially the same as that of the arctic seas of both Europe and America, or, in other words, it is only a part of the great arctic, circumpolar fauna. That the fauna of the Greenland seas should have its closest relations with the fauna of the North American coast proper, rather than with that of Europe, is what might be expected from the geographical position of Greenland and the fact that the waters of the northern part of the North American coast are more arctic in temperature than the waters upon the coast of Europe.

ERRATA.

Page 31, 2d line, for 'Robert,' read 'Richard.'

" 54, for 'Munadopsis,' read 'Munidopsis.'

" 61, 6th line from bottom, for 'Mere,' read 'Meere.'

" 69, 9th line from bottom, for 'Tynside,' read 'Tynesido.'

" 105, 3d line from bottom, insert 'of' before '*M. oculata*.'

" 115, 1st line, for 'nasicoidis,' read 'nasicoides.'

" 120, 16th line, for '*Pseudopleuronectes*,' read '*Pseudopteuronectes*.'

NEW HAVEN, May 1, 1879.