To
Capt A.K. Totton
with best regards
and appreciation
JH Fraser

recd. ackd 16.1/67

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Siphonophora in the Plankton to the North and West of the British Isles

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I.—Siphonophora in the Plankton to the North and West of the British Isles.* By J. H. Fraser, Marine Laboratory, Aberdeen. (With Fourteen Charts and Three Tables.)

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Synopsis

The distribution of about thirty species of warm water siphonophores over the period 1947–1964 to the north-west and north of the British Isles is used to give a generalized picture of the path of the Lusitanian stream. These species, which originate much further south, are relatively intolerent to change of environment and the distances they are carried can be associated with the degree of inflow on a yearly and seasonal basis.

Grouping the findings into four series of years over the 18 year period shows an increase in their northerly distribution from 1947 reaching a maximum in 1953 and 1954. This has since been maintained, with annual variations, at least until 1963. It is hoped that the data presented here can be used when comparing future studies of climatic change with the distribution of water masses.

Introduction

There are a few species of siphonophora that are indigenous in the temperate and boreal area of the north-east Atlantic, *i.e.* north of about 53° W. Of these *Physophora hydrostatica* Forskål and *Dimophyes arctica* (Chun) have widespread distributions and *D. arctica* is not now regarded as a cold water species (Fraser 1961). *Marrus orthocanna* (Kramp) is a rare species and is associated only with cold water. Other species, although not indigenous in the north are very tolerant to changing environmental conditions and appear to survive well after having been brought into the area by the current systems, though they do not reproduce here. They are, with the names used in some of the best known older literature:

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Lensia conoidea (Kefer. and Ehlers) = *Galeolaria truncata*, Sars
Sulculeolaria biloba (Sars) = *Galeolaria australis* Bigelow
Chelophyes appendiculata (Eschscholtz) = *Diphyes bipartita* Costa
Agalma elegans (Sars) = *Agalmopsis elegans* Sars (in part)

and to a lesser extent

Nanomia cara A. Agassiz = *Cupulita sarsi* Haeckel.

Although not altogether unexpected in this area the warmer species *N. bijuga* (Delle Chiaje) = *Stephanomia bijuga* (Delle Chiaje) or *Cupulita picta* (Metschnikoff) has not so far been confirmed, and it is probable that records from the Irish Sea, Celtic Sea and English Channel should be referred to *N. cara* (Totton and Fraser 1957).

Of these introduced species *Lensia conoidea* is by far the most abundant numerically, though it is a small species. *Sulculeolaria* best survives the winter and old moribund specimens brought into the area the previous autumn may sometimes still be found in the early spring. All of these can be found, particularly in the late summer and autumn, in the north-western North Sea and are drifted southwards to various extent according to the current systems (Fraser 1965); *Agalma* reached as far as the Farne Islands, 55° 35′ N, in 1955.

The purpose of this, paper, however, is not to deal with these common species but with the much less tolerant forms that are widespread in the warmer seas, including the Mediterranean, of which about 30 species have sometimes been carried northwards in what is now known as the "Lusitanian Stream" (Fraser 1955). Over the past 18 years records of these have been accumulating at the Marine Laboratory, Aberdeen, as they are particularly useful "indicators" of Lusitanian water in the region west and north of the British Isles and in the northern North Sea. Some of the more interesting records of siphonophores and other exotic plankton species have been published from year to year by the International Council for the Exploration of the Sea in their Annales Biologiques.

In this paper the siphonophore records are brought together as they serve two useful purposes. First, the accumulated records give a more generalized picture of the pattern of the inflow of these warm water species than can the records of any individual year, and second they can be plotted to see whether there is any pattern suggesting a long term change in the distribution of warm water inflow into the boreal area.

A list of the species and details of the station positions at which the records were made have been published for the years 1947–1949 in the appropriate volumes of Annales Biologiques, and for the years 1950–1956 by Fraser (1961) who also includes a chart of the current systems. They need not be repeated here. A list of species and the details of the relevant station positions of the siphonophores taken from 1957–1964 are given in the appendix to this paper, including dates and depths. *Marrus orthocanna*, the cold water species, has been included in this list because of its rarity and consequence interest. Associated data up to the year 1956 on the temperature and salinities and the chemistry where available are published in the Bulletin Hydrographique, and for the more recent years are being issued as the I.C.E.S. Oceanographic Data Lists in mimeographic form. For the identification of species see Totton and Fraser (1957); for the Genus *Lensia* see Totton (1941) and for details of synonomy see Bigelow (1911) and Totton (1965) whose nomenclature is followed in this paper.

Distribution and Charting

Almost none of these siphonophores have previously been recorded from this area except as indicated above by Fraser (1961, and in Annales Biologiques) and by Totton (1954) referring to the same findings. Kramp (1939) does not mention any of them in his Zoology of Iceland, nor does Wiborg (1955, 1960) from Norwegian waters. The 1957 edition of the Plymouth Fauna List includes the record of a single specimen of *Sphaeronectes gracilis* in 1935 and the early records of *Muggiaea kochi* and *M. atlantica* (Russell 1934) are all further south than the area covered by this paper. *Velella*, the chondrophore, is not now regarded as a true siphonophore although Hyman (1940) includes the Chondrophorae as a group of the Physophorae and therefore in the order Siphonophora. So that the records are not lost it has been included in this paper. It is mentioned in the Manx fauna list (1937) as being found in Manx waters in 1924 and 1934; this species is also recorded by Edwards (1959) in the neighbourhood of the Clyde and he refers to other strandings off the Scottish west coast.

Most of the references in the literature refer to records from much further south, notably those of Bigelow (1911), Bigelow and Sears (1937), Haeckel (1888), Kinzer (1965), Leloup (1933), Totton (1941, 1954) and, on the western side of the Atlantic, Bigelow (1918).

The positions at which these siphonophores were found over the 18 years are plotted in Charts 1–9. In chart 10 all these data are brought together to give the overall cumulative picture, smoothing the effects of annual variations in sampling and in specific distribution although the effect of the frequent sampling between the Butt of Lewis and Faroe Bank

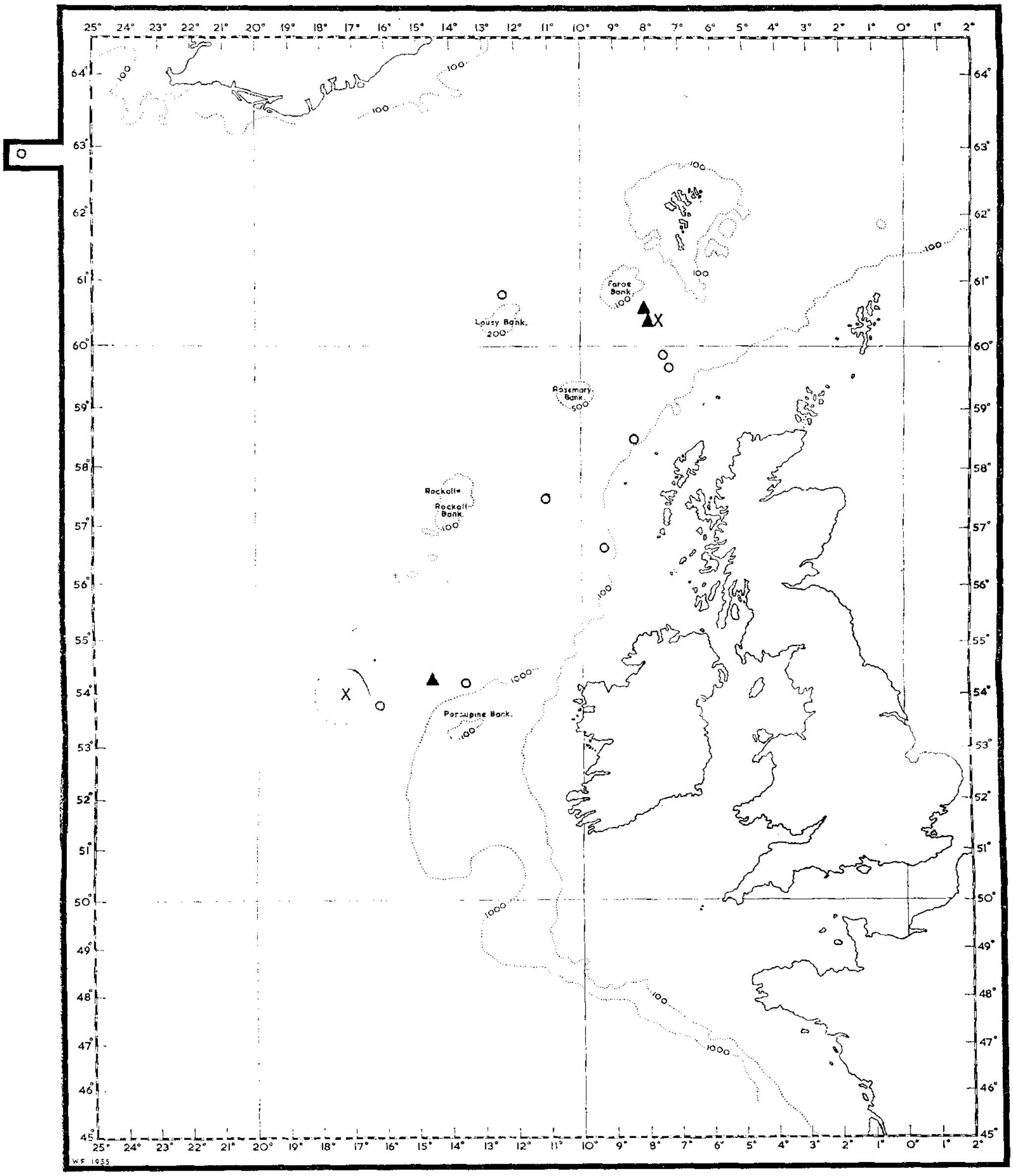

CHART 1.—The positions of capture, 1947–1964, of O = *Nectopyramis thetis*, ▲ = *N. diomedea*, X = *N. spinosa*.

is evident. The result is a general impression of the Lusitanian inflow west and north of the British Isles.

These charts show the northerly trend of the Lusitanian fauna largely to the west, but partly also east, of Porcupine Bank and thence mostly east

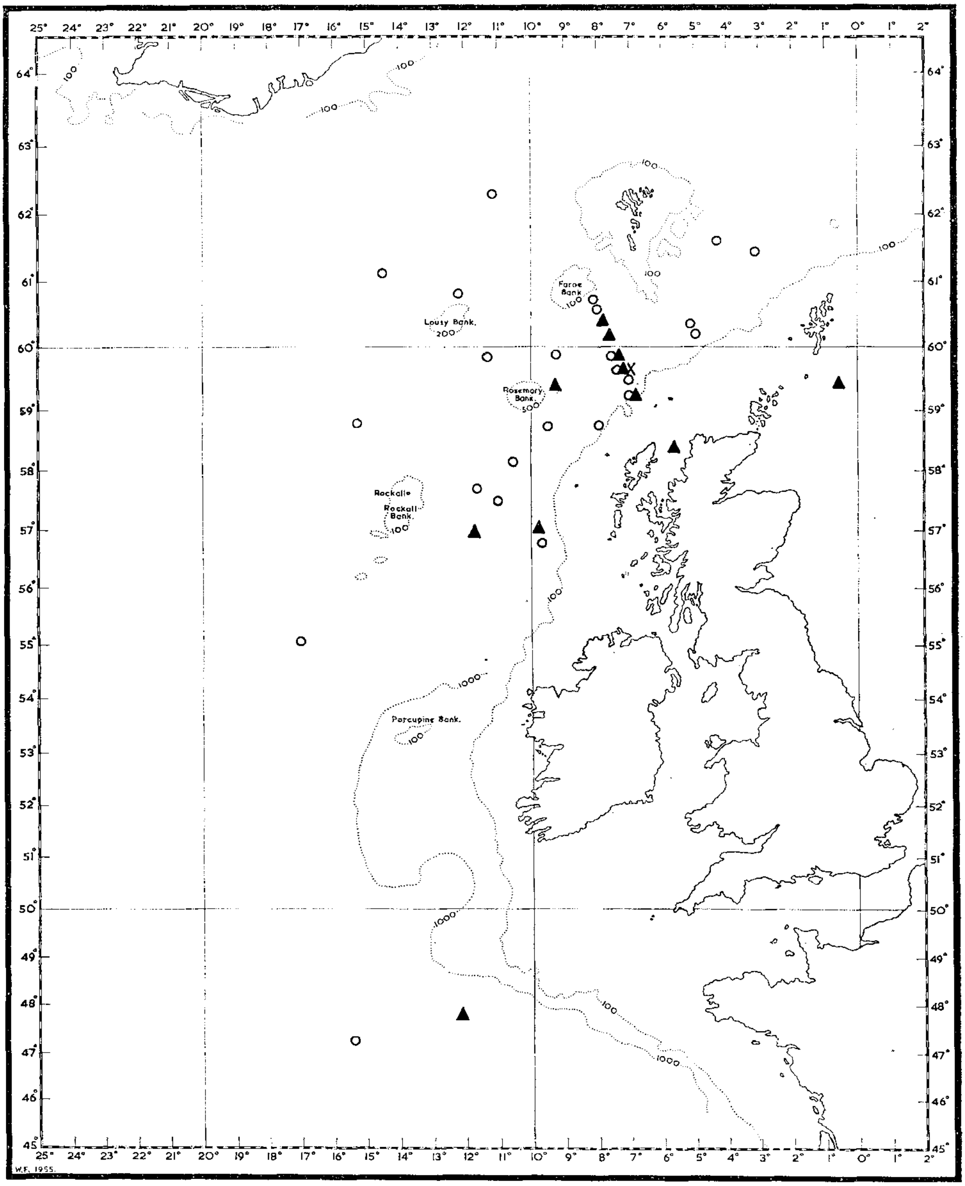

CHART 2.—O = *Rosacea plicata*, ▲ = *R. cymbiformis, dubia*, X = *Praya dubia*.

of Rockall, concentrating mostly towards the edge of the Scottish continental shelf. It continues through the Faroe-Shetland Channel, again concentrated more against the edge of the Scottish shelf than elsewhere. There is little evidence of any Lusitanian fauna overflowing on to the relatively shallow water of the shelf to the west of Scotland as there it is

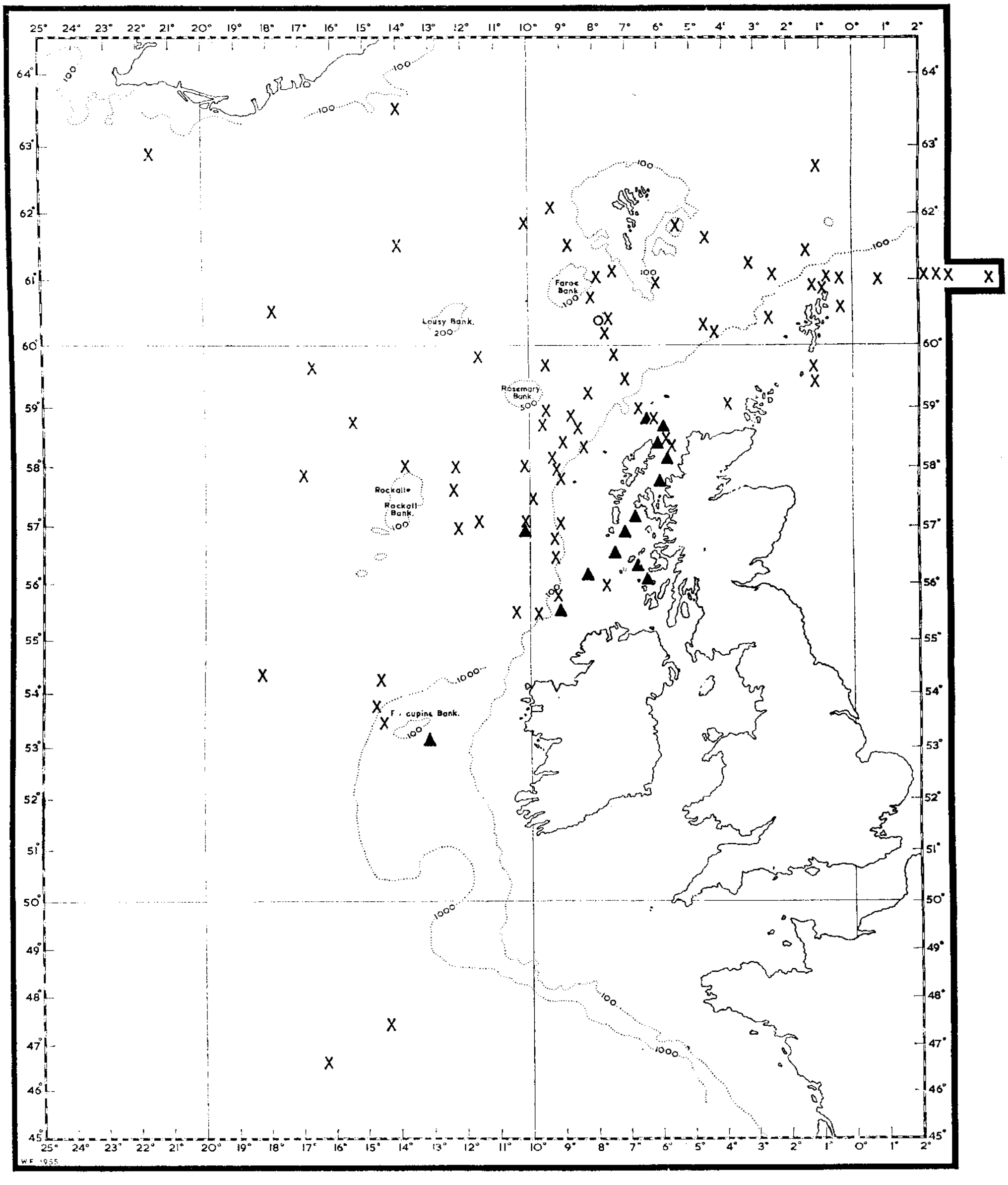

CHART 3.—O = *Amphicaryon acaule*, ▲ = *Sphaeronectes gracilis*, X = *Hippopodius hippopus.*

normally found too deep in the water. The main exceptions are first, the wind blown surface species *Velella* (Chart 9) and second, in 1964, the only year when *Muggiaea kochi* (Chart 7) and *Sphaeronectes gracilis* (Chart 3) were carried over and quite exceptionally distributed in the Minch together

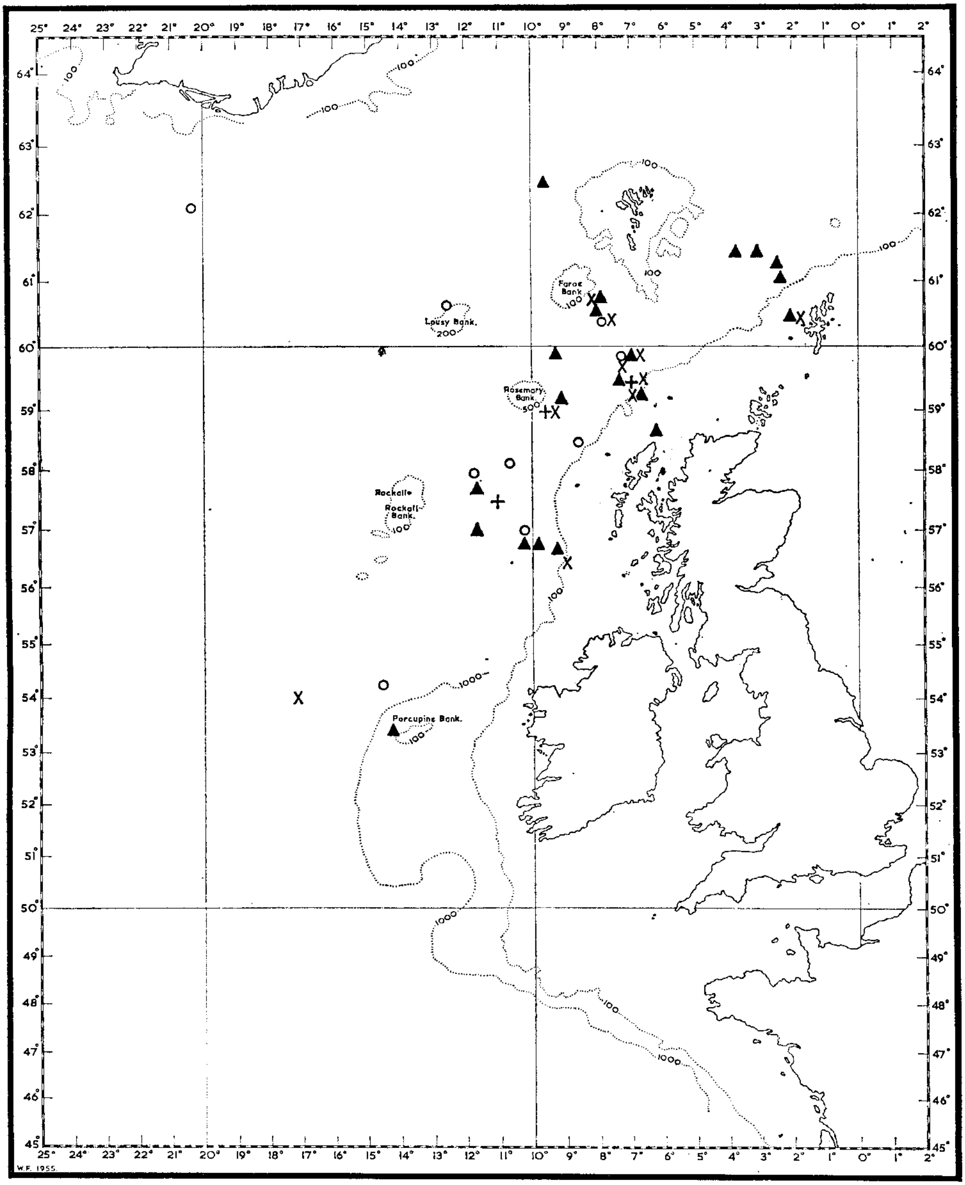

CHART 4.—O = *Vogtia glabra*, ▲ = *V. spinosa*, X = *V. pentacantha*, + = *V. serrata*.

with a few *Abylopsis tetragona* (Chart 8), a very rare species in this area. Mauchline (1965) reported the deep-water euphausid *Stylocheiron longicorne* from Loch Ewe in the north-west of Scotland in 1964. Some *Eudoxoides spiralis* (Chart 6) were found west of Uist in 1959 and *Hippopodius* (Chart 3) north of Ireland in 1961. Confirmation of the concentra-

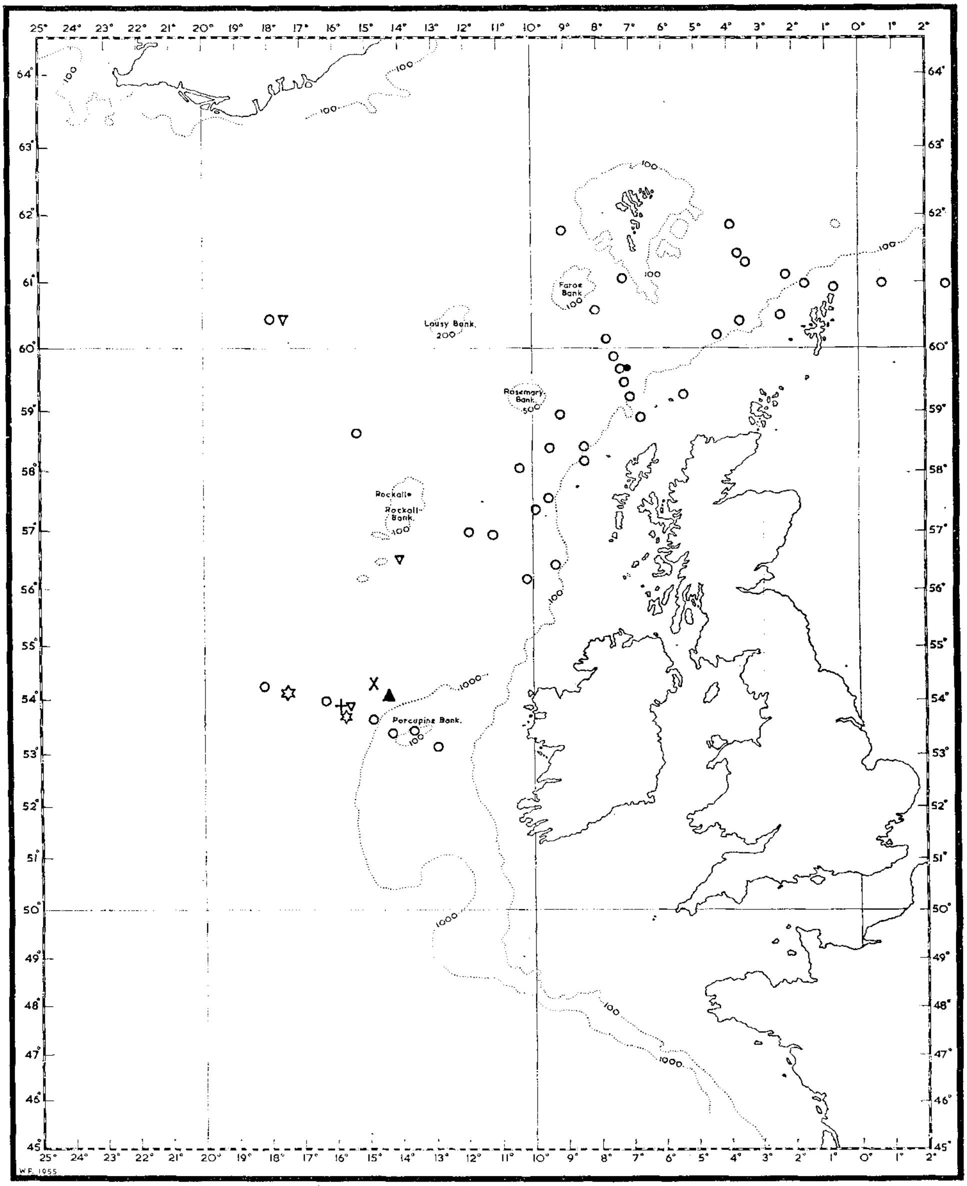

CHART 5.—O = *Lensia fowleri*, ▲ = *L. lelouveteau*, X = *L. multicristata*, + = *L. ajax*, ● = *L. hotspur*, ▽ = *L. cossack*, ✧ = *L. achilles*.

tion over the deeper water beyond the edge is given by other oceanic species (Fraser 1961).

This concentration of oceanic species over the edge of the deep water west of Scotland, with comparatively little overflow on to the shelf, also

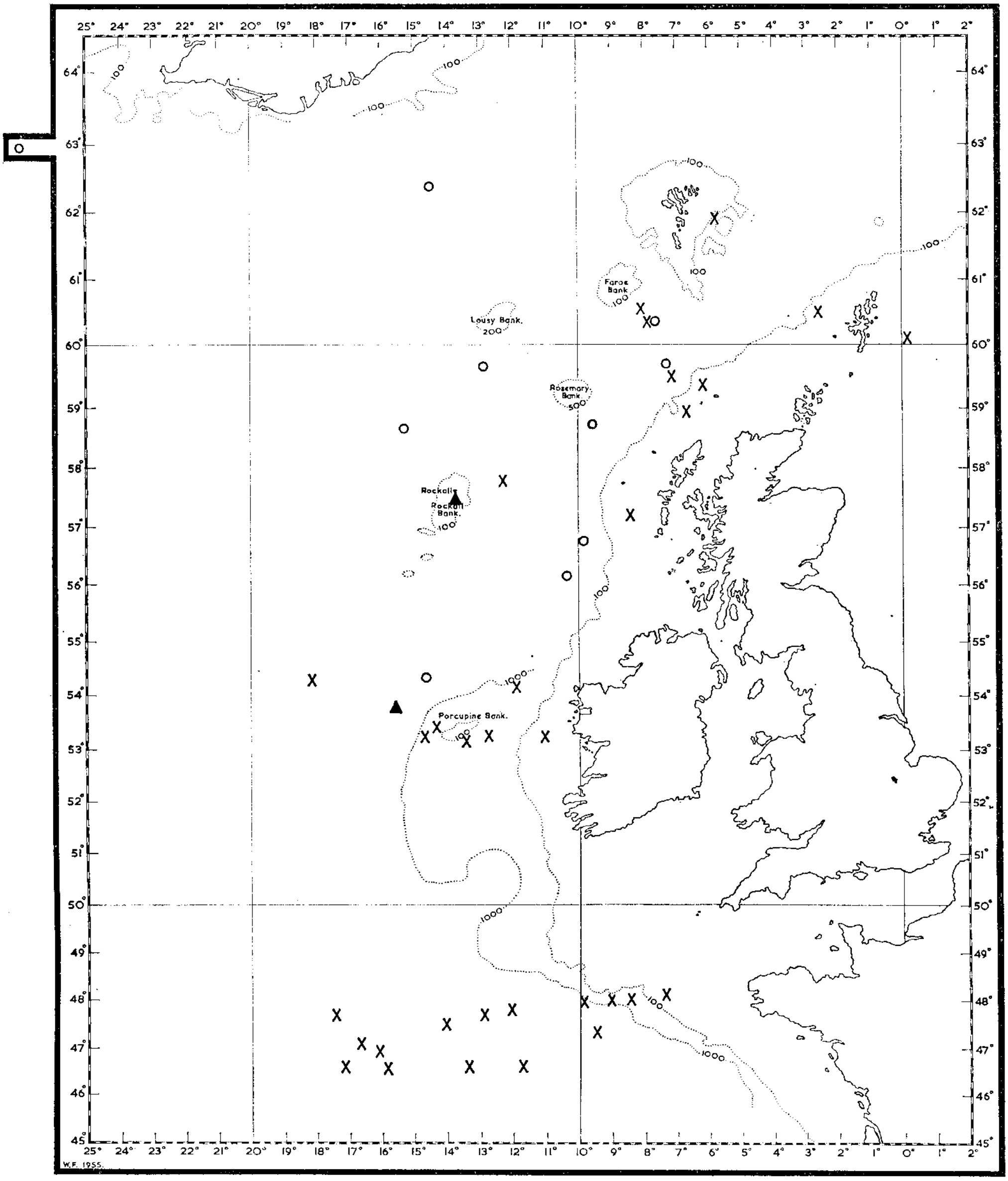

CHART 6.—O = *Chuniphyes multidentata.* ▲ = *Thalassophyes crystallina,* X = *Eudoxoides spiralis.*

applies to plankton near the surface, as illustrated in the distribution of oceanic organisms taken by the Continuous Plankton Recorder at 10 metres depth notably the copepods *Pleuromamma robusta, Rhincalanus nasutus* and *Actidius armatus* (Colebrook, John and Brown 1961), the Thaliacea

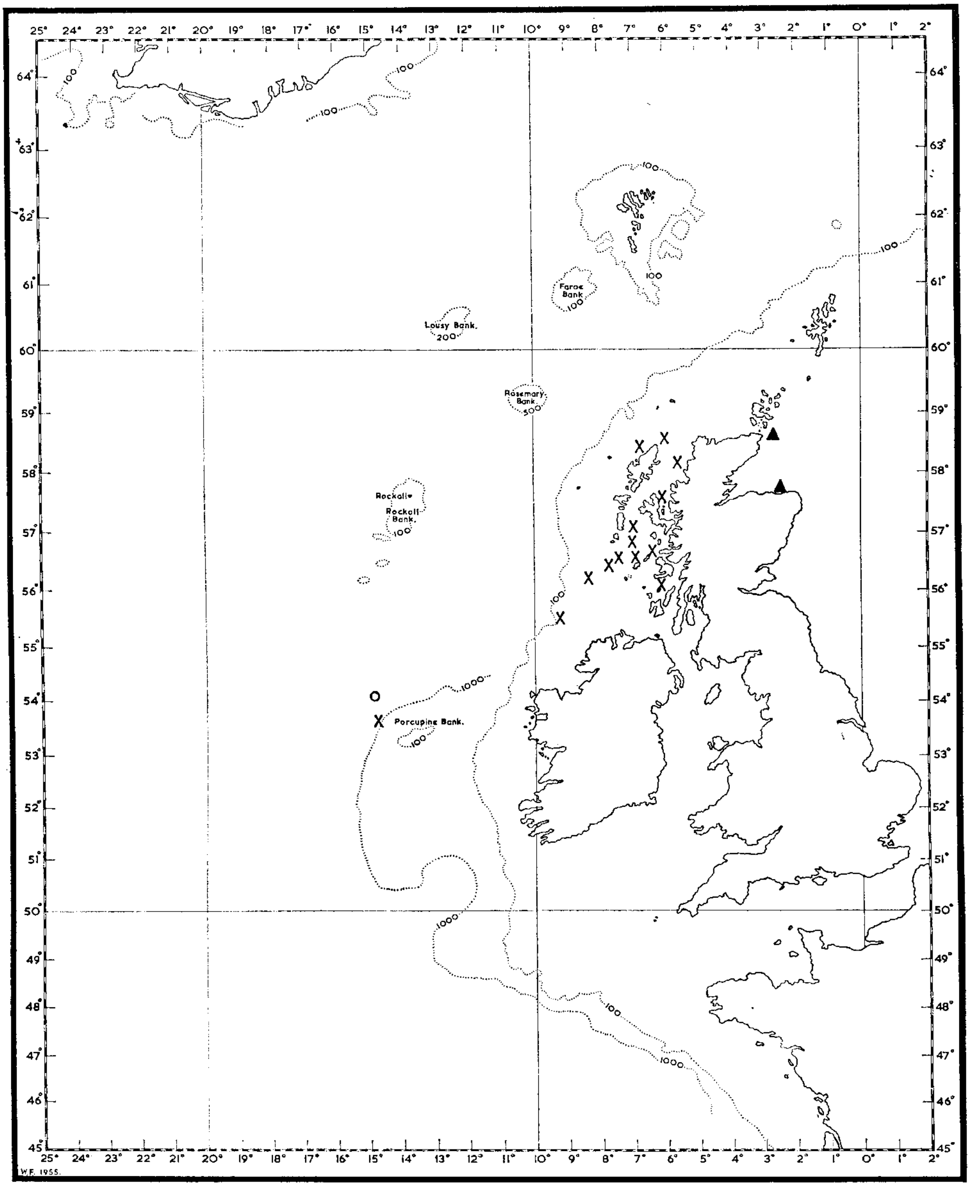

CHART 7.—O = *Heteropyramis maculata*, ▲ = *Muggiaea atlantica*, X = *M. kochi*.

Dolioletta gegenbauri and *Ihlea asymmetrica* (Barnes 1961), the diatoms *Rhizosolenia alata f. indica* and *Dactyliosolen mediterraneus* the dinoflagellate *Ceratium lineatum* (Robinson 1961) and the young stages of the fish *Gadus poutassou* (Henderson 1961).

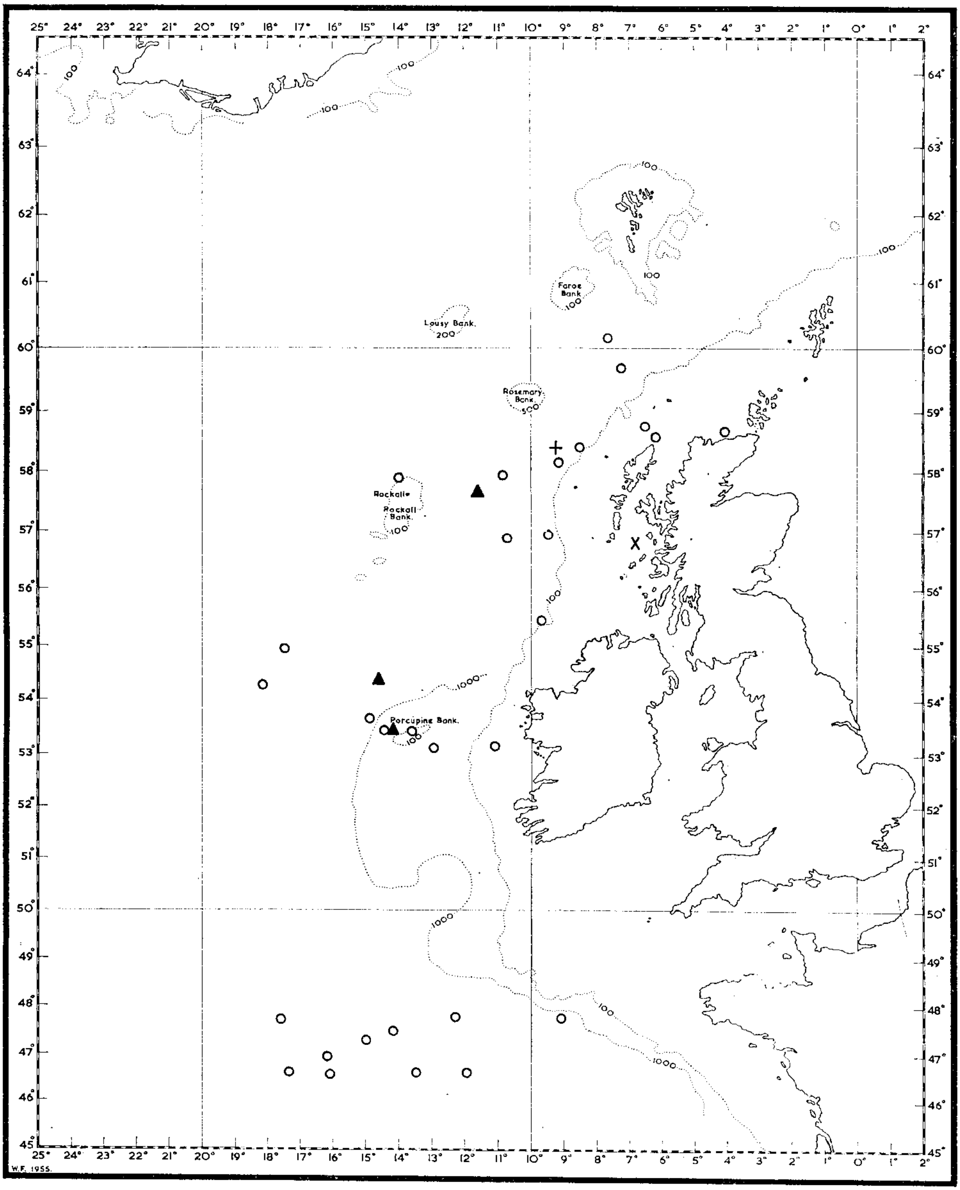

CHART 8.—O = *Bassia bassensis*, ▲ = *Ceratocymba sagittata*, X = *Abylopsis tetragona*, + = *Enneagonum hyalinum*.

Based on hydrographical evidence from the year 1951 only, an overflow of surface oceanic water on to the shelf west of Scotland has also been shown by Tulloch and Tait (1959) to have occurred at about 58° N. The planktonic evidence suggests that 58° 30′ N–59° N would be a more

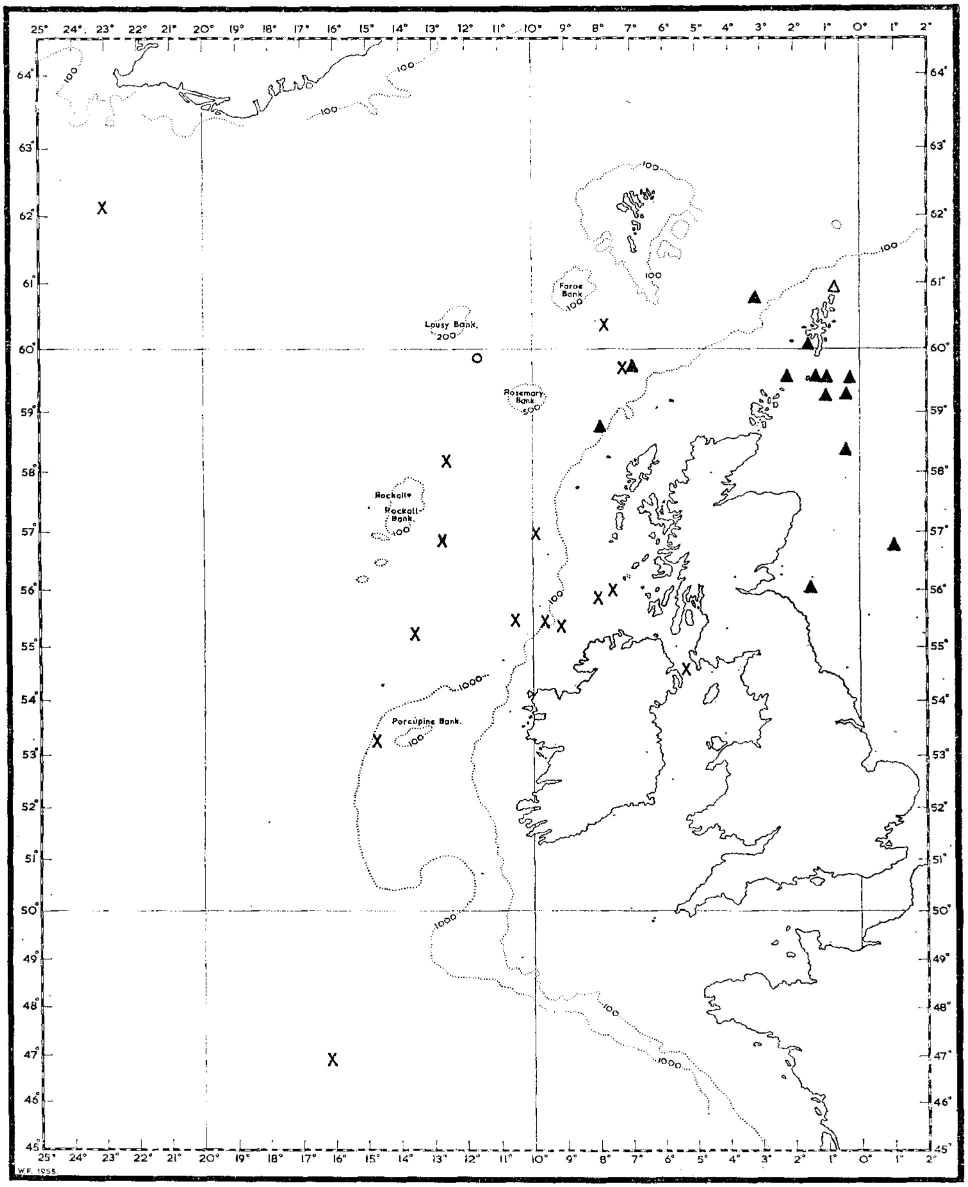

CHART 9.—O = *Marrus orthocanna*, ▲ = *Apolemia uvaria*, X = *Velella velella*.

average position, but the difference is small and well within the range of the annual fluctuations which might be expected to occur.

Further north than about 58° 30′ N, however, the Lusitanian fauna is nearer the surface, and overflow is much more general towards the northern

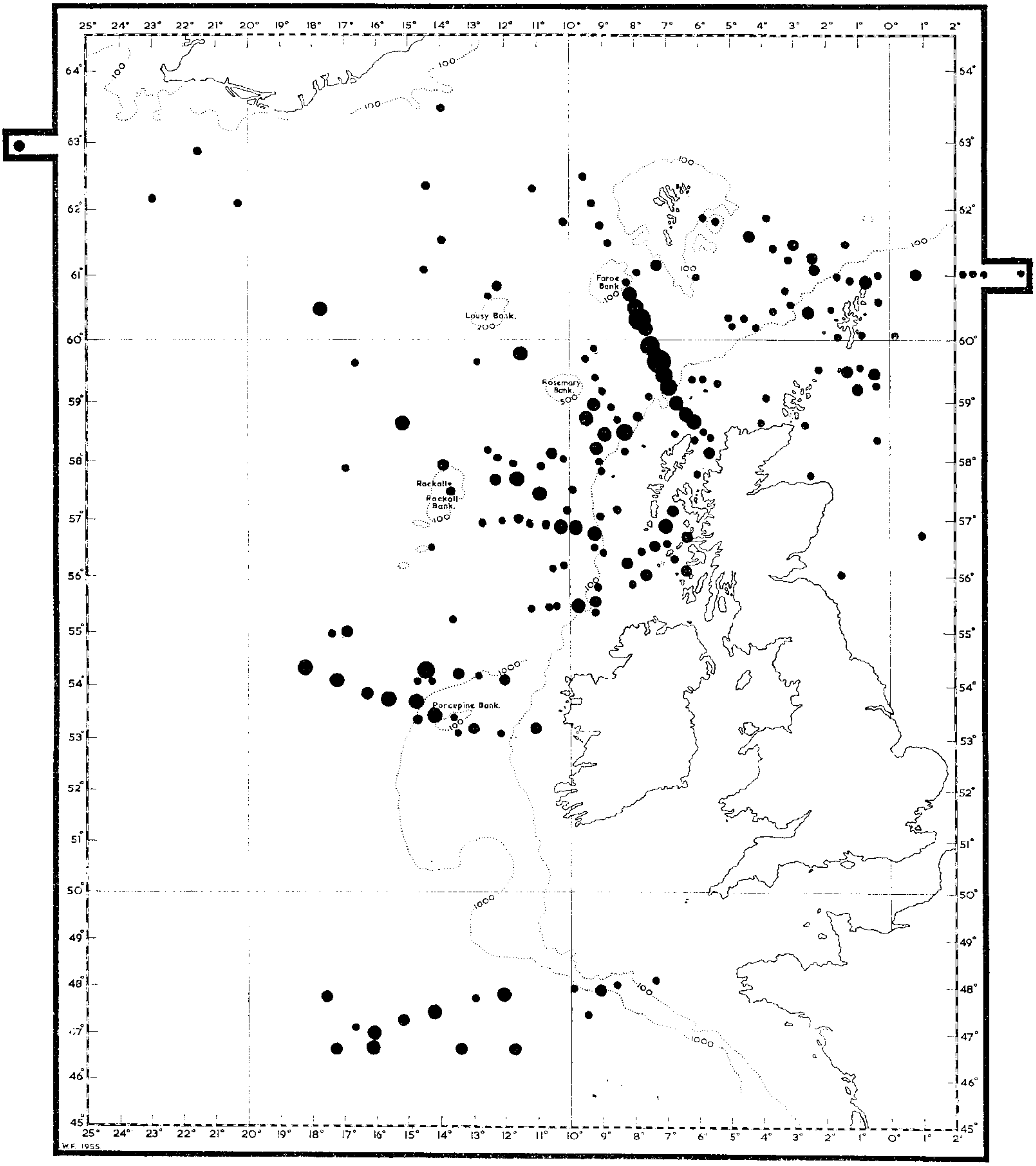

CHART 10.—The cumulative positions of capture, 1947–1964, of all thirty-three species figured in Charts 1–9. The size of the symbol is proportional to the number of species found at each position (1–12) not to the number of individuals.

Minch thence eastwards towards Orkney and so to the Moray Firth and north-western North Sea. Tait and Martin (1965), referring to this, point out that the Lusitanian water seldom, if ever, occurs at the immediate surface of the Faroe-Shetland Channel. The main path of the inflow continues via the Faroe-Shetland Channel over deep water, at the edge of the shelf, towards Shetland and the Norwegian Sea, with further overflow on to the shelf in the vicinity of Shetland and thence to the North Sea via the north of Shetland. By this time the environmental conditions have usually changed so much that these exotic species can no longer survive and few are found in the North Sea, but *Hippopodius*, *Rosacea cymbiformis*, *Lensia fowleri* and *Eudoxoides spiralis* have been found, with *Muggiaea atlantice* in 1949. *Apolemia uvaria* (Chart 9) deserves special mention. It was first found in the northern North Sea in 1959 where it was associated with other oceanic species which were presumed to have entered as a community. However it was again found in 1960, not associated with an oceanic community, with the inference that it had been able to survive in the North Sea and become established there (Fraser 1961).

There is also distinct evidence of infiltration of Lusitanian fauna further northwards, to the west of Faroe and into the south-western Faroe Channel, and there are interesting records between Rockall and Iceland and between Lousy Bank and Iceland which are not quite so simple to explain. Tait (1957) discusses the hydrographic evidence of Gulf of Gibraltar water in the Faroe Shetland Channel and Cooper (1955) the southern movement of deep water in the Faroe-Iceland area. Hermann and Thomsen (1946) deal with the current systems in this area but the distribution of siphonophores here does not conform with the pattern expected from their data. Dietrich (1957) however does show such a current in his Tafel 5 and it could be in keeping with the eddy system illustrated by Einarsson (1954) between Iceland and Faroe. It is also possible that the siphonophores recorded between Rockall and Iceland—those to the north of Lousy Bank and Faroe Bank, and those to the immediate west of Faroe—had no direct connection with an inflow east of Rockall but came with the North Atlantic Drift from the Faraday Bank area (see chart in Fraser 1958). Although the evidence at present available suggests that these warm water siphonophores are being brought into the area to the immediate west of the British Isles with the Lusitanian Stream, and that sampling to the west of Rockall rarely finds them, this does not mean that they can originate only from the Biscayan and Gibraltar area. They probably have a widespread distribution in the warm Atlantic from whence they could be carried, if the environmental characters of the water mass are sufficiently unchanged on the way, to the south of Iceland and Faroe. The longer distance to travel and the generally cooler conditions of the North Atlantic Drift would cause the less tolerant species to die out early and so they would not normally reach so far.

Annual Variations in Distribution

In charts 11–14 the station positions at which these siphonophores were found have been re-plotted according to the year, in four groups of years. This arrangement should reveal if there has been any clear cut long-term change over the 18 years covered by the data. As the data south of 53° N included in Charts 1–10 were confined to 1953 this area has been omitted from Charts 11–14.

No records of Lusitanian siphonophores were made in 1947 so that Chart 11 starts with 1948. There were two records only for that year, both of *Hippopodius* although one of these had been carried a few miles to the north of Fair Isle by 7th November. The degree of penetration was probably associated with the time it took to travel and as this record is not supported by a whole community of oceanic species 1948 can be considered a year of poor Lusitanian representation.

The year 1949 shows a distinct increase in the numbers of Lusitanian siphonophores and there were records of *Hippopodius*, *Rosacea cymbiformis*, *R. plicata*, *Vogtia serrata* and *Chuniphyes multidentata* off the west and north coasts of Scotland, *Hippopodius* reaching the north of Shetland, with a late influx of *Muggiaea atlantica* to the Moray Firth in November and December.

The northerly extension of this fauna to the north-west and north of the British Isles was even more marked in 1950 and 1952, though a little less marked in 1951, and in 1950 there was the first evidence of it to the west of Faroe and north-west of Lousy Bank. In these years there was very little oceanic fauna entering the North Sea, although in 1950 there was a rich community of oceanic species west of Faroe, including the Lusitanian chaetognath *Sagitta lyra* (Fraser 1952). *Hippopodius* reached as far as the east and north-east of Shetland in 1951 and 1952 and, although not realised at the time, these years were probably the forerunners of the later years of much greater inflow.

Charts 12–14 show that this northerly extension increased markedly in 1953 and that it was maintained at least until 1963. There were signs of a change in 1964 as the penetration through the Faroe Channel in that year included large numbers of oceanic forms from the open Atlantic (such as *Salpa fusiformis*) but few Lusitanian species. Lusitanian species were, however, prolific off the Scottish west coast and quite exceptionally distributed over the shelf and within the Minch and Scottish inshore waters in November 1964, the main indicator species in this connection being *Sphaeronectes gracilis* and *Muggiaea kochi*.

Preliminary evidence from 1965 suggests that the change noted in 1964 was not the beginning of a new long-term trend but was merely an annual variation. Although *Salpa fusiformis* was as abundant in 1965 as in 1964, a Lusitanian community was found in the Faroe-Shetland Channel reaching as far as Shetland by the autumn. The siphonophores in the Faroe-

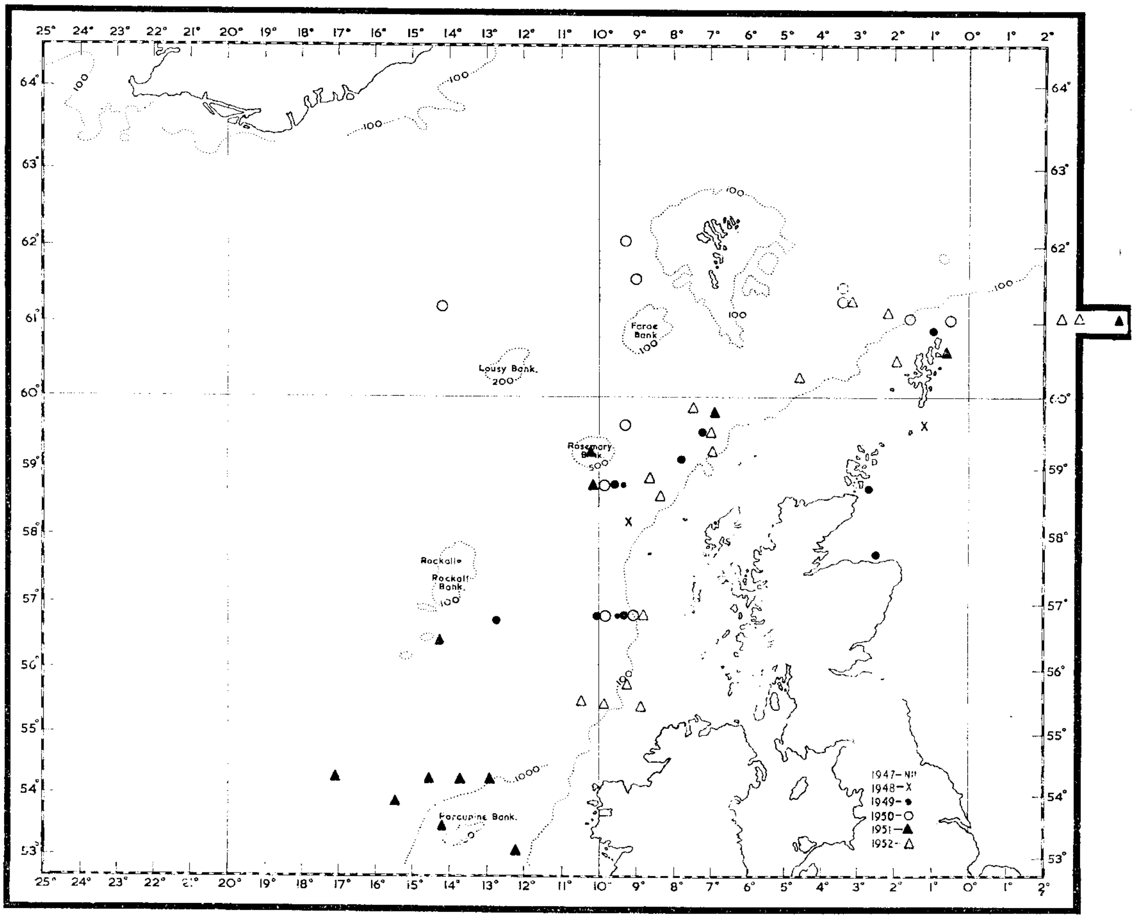

CHART 11.—The combined distribution of the siphonophores given in Charts 1–9 for the years 1947–1952.

Shetland Channel in 1965 included *Ceratocymba sagitta*, *Amphicaryon acaule*, *Rosacea cymbiformis* and *Muggiaea atlantica*. On the west-coast Scottish shelf *Sphaeronectes gracilis* was found in the autumn of 1965 with abundant *Muggiaea atlantica* as distinct from *M. kochi* which occurred there in 1964.

The plankton of 1953, which brought many other Lusitanian species as well as siphonophores much further north than previously, has been described by Fraser (1955). This was the first year of the 18 years included in this paper, *i.e.* since adequate records were started in 1947, that the Lusitanian influence had been strongly in evidence off the north of Scotland, and in some ways it can with 1954 be regarded as the peak period.

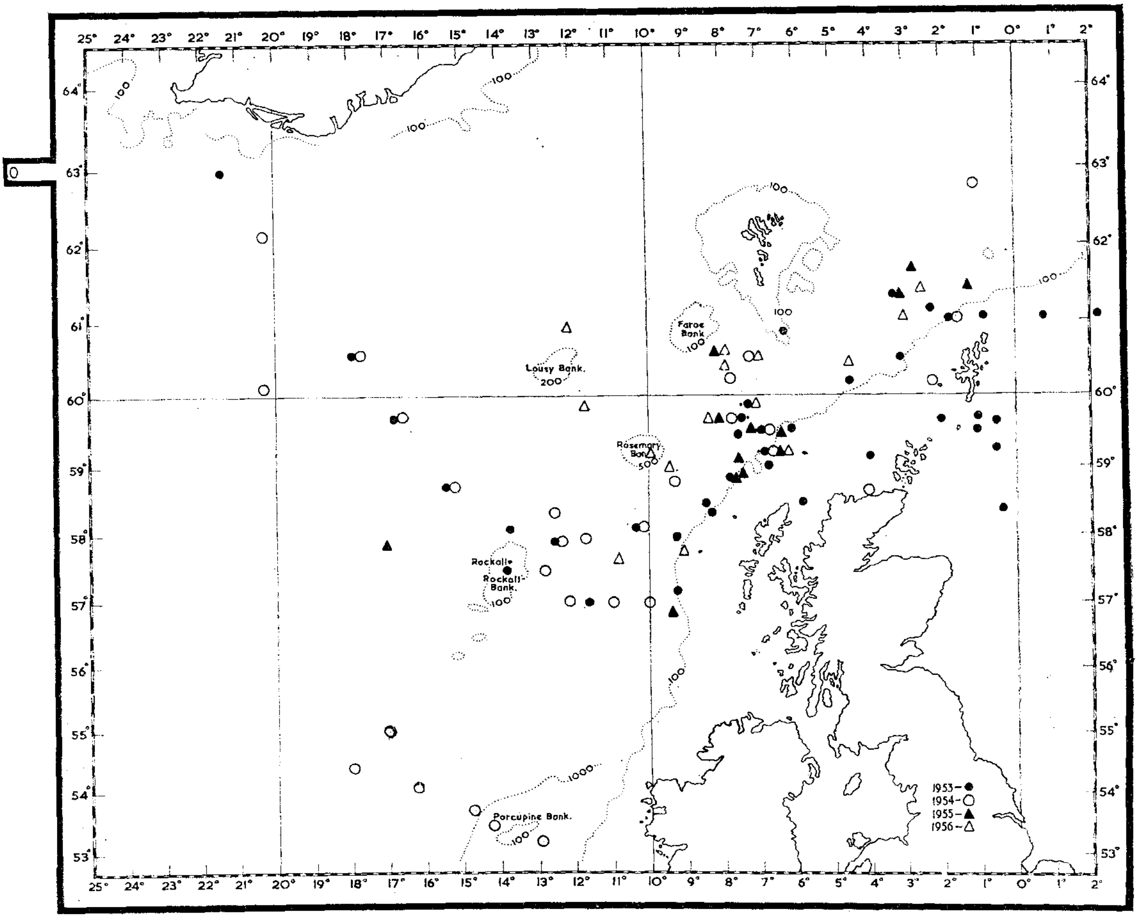

CHART 12.—The combined distribution of the siphonophores given in Charts 1–9 for the years 1953–1956.

The records in 1953 to the west of the English Channel were made by the survey ship *H.M.S. Challenger* and their restriction in this paper to that year cannot be taken to mean that records would not have been made in other years if they had been sampled. Although the northerly spread of these exotics was maintained in the following years there were some interesting changes of emphasis. Penetration into the Fair Isle area was most marked in 1960 (the records of *Apolemia* in 1959 can be ignored as explained on p. 14) and 1960 was also the peak year to the west of Faroe, but records were noted nearer Iceland in 1957 than in any other year since 1953 and 1954. (Although it should be noted that sampling in this area has not been so frequent as it was between Faroe and Scotland, and data

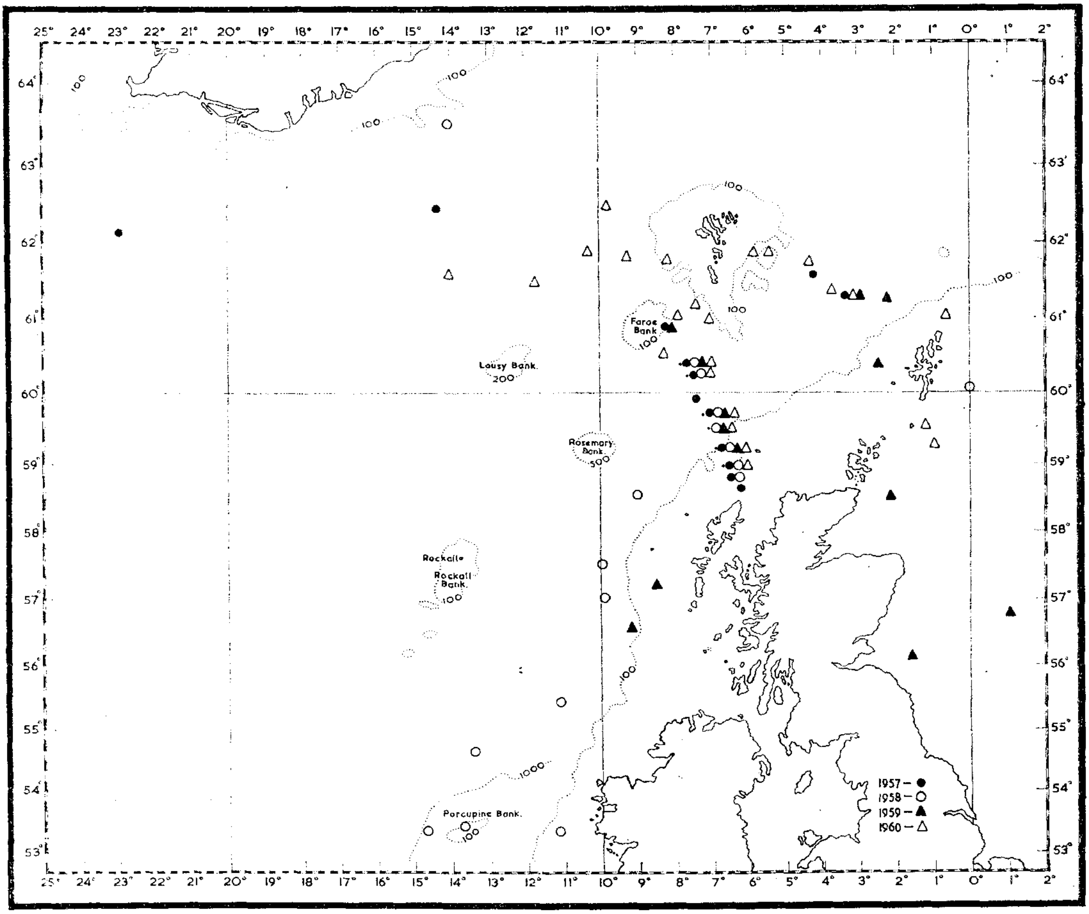

CHART 13.—The combined distribution of the siphonophores given in Charts 1–9 for the years 1957–1960.

are available only for the years 1950-51-52-53-54-56-57-58-58-60 and 1963).

Sampling to the west of Faroe has been adequate from 1947 onwards except in the years 1956, 1961, 1962 and 1964. West of Rockall sampling has been sparse, with some in 1951, 1953, 1954 and 1955, but to the east of Rockall there has been fairly adequate sampling in most years (not in 1957 or 1960 and not over the deep water in 1952, 1959 and 1961).

In the Faroe-Shetland Channel, on the Scottish shelf and in the north-western North Sea sampling has been frequent and adequate. In those years when sampling in the Rockall region was inadequate the exotic siphonophores and other warm water plankton organisms had fortunately

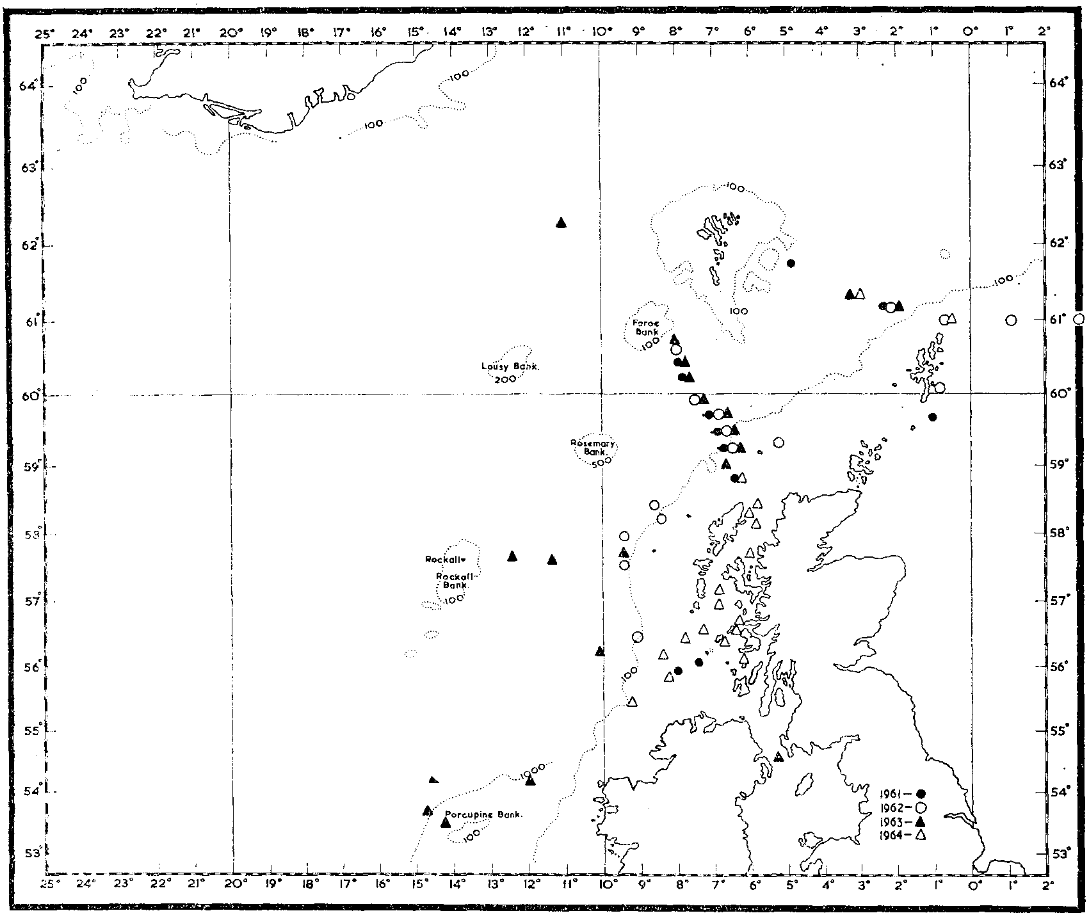

CHART 14.—The combined distribution of the siphonophores given in Charts 1–9 for the years 1961–1964.

been carried further north so that lack of sampling in the intermediate position has not therefore been of such great importance.

Discussion

There is abundant evidence in the literature of a general warming up of the northern seas over the past few decades—see for example Smed

(1949→1964) Goedecke (1952) Brown (1953) Dunbar (1954) Cooper (1955) Blacker (1957) Beverton and Lee (1965). This warming up process increased in the Faroe area from about 1930 onwards, and according to Goedecke continued until his sampling ended in 1950. Dunbar, commenting on a more generalized area of the arctic Atlantic suggested the increase of the warm North Atlantic drift continued only until 1945. In his series of reviews in Annales Biologiques Smed (1949→) gives anomalies from the average over a succession of years. His areas J (Faroe), K (North of Scotland) and L (West of Ireland) are particularly relevant to this paper, and the average positive temperature anomalies for these areas are

1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
1·4	0·9	0·8	0·4	0·6	0·6	0·3	0·2	0·8	0·4	0·6
1956	1957	1958	1959	1960	1961	1962				
0·4	0·6	0·7	0·9	1·1	0·6	0·2				

This shows that positive anomalies have been maintained here since 1945 but that there was then a diminution until perhaps 1956 with an increase thereafter almost to the 1945 level in 1959–1960.

Cooper (1955) puts forward a very acceptable hypothesis about the effect of the warming up on water movements and water displacement in the area to the west of the British Isles, involving the production of internal waves which can change the level of the nutrient rich deep layers, and the way in which these waves strike the continental shelf has a profound influence on the homogenization of the water. These waves are caused by the intermittent transport of cold water to the deep layers, below the warm water which is moving into the cold area and maintaining the balance. He also states (p. 217) that "Changes in the heat balance would be expected to produce some local changes in winds, weather and currents, so that in places this generalization may not apply." This means that more sinking of cold water in the boreal area will permit more warm water to flow north, but that this will come mainly from the waters of the North Atlantic Drift and need not necessarily flow through the Faroe-Shetland Channel. The amount of Lusitanian water flowing northwards could be dependent on slight variations of the angle of approach of Cooper's internal waves. One would therefore not expect the amount of Lusitanian fauna to vary annually in direct proportion to temperature changes, although there might be some general agreement.

Martin (1966) gives details of the nature and volume transport of the bottom waters of the Faroe-Shetland Channel over the period 1902–1964 and the importance of their origins and their dilution of the Atlantic water. He shows a general overall picture of gradual transition between Arctic and non-Arctic regimes and that, after a period of recession, Arctic bottom water had returned by 1946. It reached a maximum in 1954 thereafter becoming reduced until it was absent from 1958 onwards until 1964. Martin also emphasizes that he has no evidence to suggest that any relationship exists between the volume transports of surface and bottom water throughout the period.

The present paper shows that the Lusitanian fauna was slight in 1947 and thereafter increased until 1953 and 1954, and that similar conditions have been maintained since then, with annual fluctuations. The Lusitanian increase until 1954 thus coincided with an increase of cold bottom water in the Faroe-Shetland Channel, although the Lusitanian fauna did not show any general recession after that date. Influxes of Lusitanian fauna probably occurred in previous years, as Tait (1957) gave hydrographic evidence of an increase in the Gulf of Gibraltar water into the Faroe-Shetland Channel in 1933 and 1934 which thereafter waned and Martin (1966) showed that arctic bottom water was also present in 1934.

Appendix

Table I gives a list of the siphonophores relevant to this paper and the stations at which they were found, 1957–1964. Species marked * were found prior to 1957 and the details of these records are given in Fraser (1961). Station details are given in Table II, each station number is preceded by the year and by a letter, 'E' denoting "Explorer"; S, "Scotia" and C, "Clupea".

As *Hippopodius* was not included in the 1961 list the full range of records from 1950–1964 is given in Table I for this species, and station details are given in Table III for positions not included in the 1961 list. Details of records for 1948 and 1949 are included in Annales Biologiques for these years. There were no relevant records in 1947.

Table I

* *Velella velella* (L.), E57/531, E58/891, E59/933, 942, E61/20, 24, E63/46.
* *Marrus orthocanna* (Kramp), E58/888.
* *Apolemia uvaria* (Lesueur), E59/365, S59/655, 656, 672, E60/349, S60/416, 424.
* *Sphaeronectes gracilis* (Claus), E58/877, E64/207, 208, 209, 210, 211, 212, 213, 214, 216, 223, 228, 229.
* *Nectopyramis thetis* Bigelow, E59/589, E63/143.
* *N. diomedeae* Bigelow, E59/367.
* *N. spinosa* Sears, E59/367.
* *Rosacea cymbiformis* (Delle Chiaje), S57/20, E58/834, 838, E59/367, 598, E60/7, 172, E61/79, 397, 405, E62/123, 195, 223, E63/590, 597.

TABLE I (*continued*)

* *R. plicata* Q. and G., S57/18, 23, 37, 41, E58/894, E59/365, 367, E60/205, E61/96, E63/95, 122, 136, 137, 138, 143, 148, 190, 404, 498, 510, 523, 600, E64/48.
Praya dubia (Q. and G.) E61/87.
Amphicaryon acaule Chun, E58/835.
Hippopodius hippopus (Forskål), E50/992, 1000, S50/54, 227, 773, 867, 954, S51/310, 364, 918, 1078, E52/1162, 1187, 1194, 1196, 1198, 1302, 1305, 1311, 1318, 1342, 1753, 1756, S52/876, 885, 975, S53/6, 15, 20, 26, 27, 209, 218, 275, 282, 291, 555, 583, 693, 695, 703, 910, 922, 923, 929, 932, 934, 935, 958, 1598, 1599, 1600, 1604, 1637, 1638, 1657, 1663, 1667, 1689, 1698, *Ch* 53/9, 12, S54/339, 453, 461, 476, 684, 826, 960, 987, 991, 1181, S55/198, 721, 723, 742, 841, 867, E56/72, S56/311, 317, 320, 321, E58/40, 398, 846, 875, 893, 894, S58/1181, 1182, E59/357, 365, 496, 524, 593, 597, 598, 602, 686, 692, 935, 951, S59/530, E60/9, 12, 20, 23, 29, 33, 36, 40, 97, 100, 126, 172, 180, 188, 196, 205, E61/13, 20, 32, 90, 91, 95, E62/27, 138, E63/100, 145, 190, 497, 514.
* *Vogtia spinosa* Kefer. and Ehlers, E57/1001, S57/7, 12, 17, 19, 20, 22, E58/45, 46, 894, E59/365, 598, 936, E60/213, E61/87, 397, E62/127, 187, 195, 196, E63/95. 488, 497, 504, 552, 614.
* *V. pentacantha* Kölliker, E58/46, E60/7, 129, 189, E61/79, 87, E62/224, 225, E63/492.
* *V. serrata* (Moser), E61/400.
* *V. glabra* Bigelow, S57/16, E60/179, E63/148.
* *Lensia fowleri* (Bigelow), E57/992, 1002, S57/10, 12, 17, E58/43, 55, 58, 845, 846, 862, 875, 893, 894, 897, E59/5, 357, 365, 931, S59/531, E60/6, 7, 14, 26, 34, 35, 43, 45, 46, 47, 51, 52, 53, 184, 217, E61/95, 397, 441, E62/180, 187, 190, 194, 205, 225, 230, 236, 243, S62/33, 42, 47, 49, 57, E63/122, 488, 492, 590, 593, 598, 599, 600, 601, 610, E64/47, S64/34.
L, hotspur Totton, E61/400.
[*L. cossack, L. multicristata, L. achilles, L. lelouveteau,* and *L. ajax*, see Fraser 1961].
Muggiaea kochi (Will), E63/148, C64/1199, 1201, 1204, E64/207, 209, 210, 211, 212, 213, 214, 215, 216, 223, 228, 229.
[*M. atlantica* see Annales Biologiques for 1949].
* *Eudoxoides spiralis* (Bigelow), E58/890, 892, 894, 904, S58/1179, 1213, E59/256, E60/8, 17, 18, 22, 34, 51, 52, E63/138, 151.
Chuniphyes multidentata Lens and Van Riem., E57/95, E59/365, 367, E63/122, 143.
[*Thalassophyes crystallina* Moser, see Fraser 1961].
[*Heteropyramis maculata* Moser, see Fraser 1961].
Abylopsis tetragona (Otto), E64/213.
* *Bassia bassensis* (Q. and G.), S57/5, 7, 8, E58/835, 891, 892, 893, 894, 896, 904, E62/223, E63/120, 145, 148.
Enneagonum hyalinum Q. and G., E60/12, E62/23.
Ceratocymba sagittata (Q. and G.), E63/95, 143.

TABLE II.—POSITIONS OF STATIONS GIVEN IN TABLE I. ONE METRE NON-CLOSING NETS WERE USED.

Haul No.	Date	Position		Depth (m)
E57/				
95	6 Apl	62°28′ N	14°23′ W	1450–0
531	4 July	62°09′	22°58′	0
992	30 Nov	59°17′	6°53′	550–0
1001	,,	59°44′	7°15′	1000–0
1002	,,	59°56′	7°27′	250
1013	,,	60°54′	8°16′	0
S57/				
5	20 Feb	58°40′	6°10′	90
7	21 Feb	58°50′	6°26′	0
8	,,	,,	,,	20

TABLE II (*continued*)

Haul No.	Date	Position		Depth (m)
10	21 Feb	59°00′ N	6°40′ W	100
12	,,	59°17′	6°53′	530–0
16	,,	59°44′	7°15′	757–0
17	,,	,,	,,	0
18	,,	,,	,,	20
19	,,	,,	,,	250
20	,,	59°56′	7°27′	250–0
22	,,	60°12′	7°40′	250–0
23	21/22 Feb	60°23½′	7°49½′	790–0
37	25 Feb	61°35′	4°15′	750–0
41	,,	61°21′	3°10′	785–0
E58/				
40	17 Mch	58°50′	6°26′	20
43	18 Mch	59°17′	6°53′	582–0
45	,,	59°31′	7°05′	20
46	,,	,,	,,	250
55	,,	60°12′	7°40′	250
58	19 Mch	60°23½′	7°49½′	20
398	,,	63°30′	14°00′	20
834	23 Sep	60°12′	7°40′	0
835	,,	,,	,,	20
838	,,	59°44′	7°15′	50
845	,,	59°31′	7°05′	250
846	,,	59°17′	6°53′	550–0
862	29 Sep	58°31′	9°01′	20
875	30 Sep	57°31′	9°55′	250
877	,,	57°01′	9°55′	250
888	1 Oct	55°28′	11 05′	1660–0
889	,,	54°35′	13°20′	250
890	2 Oct	53°20′	14°40′	50
891	,,	,,	,,	0
892	,,	,,	,,	20
893	,,	,,	,,	250
894	,,	,,	,,	900–0
896	,,	,,	13°35′	0
897	,,	,,	,,	20
904	3 Oct	,,	11°10′	100
S58/				
1179	11 Nov	59°00′	6°40′	140
1181	,,	59°31′	7°05′	20
1182	,,	,,	,,	250
1213	24 Nov	60°01′	0°00′	100
E59/				
5	7 Jan	58°30′	2°00′	0
256	18 Mch	57°15′	8°30′	115–0
357	10 May	59°17′	6°53′	600–0
365	,,	59°44′	7°15′	1000–0
367	11 May	60°23½′	7°49½′	900–0
496	23 June	58°29′	8°57′	0
524	25 June	56°34′	9°06′	100

TABLE II (*continued*)

Haul No.	Date	Position		Depth (m)
E59/				
593	14 July	59°31′ N	7°05′ W	250
597	15 July	59°44′	7°15′	250
598	,,	,,	,,	1000–0
602	,,	60°12′	7°40′	250
686	31 July	61°21′	3°10′	250
692	1 Aug	61°08′	2°10′	250
931	4 Oct	59°31′	7°05′	250
933	,,	59°44′	7°15′	0
935	,,	,,	,,	100
936	,,	,,	,,	250
942	5 Oct	60°23½′	7°49½′	0
951	,,	60°54′	8°16′	100
S59/				
530	10 Oct	60°25′	2°27′	20
531	,,	,,	,,	100
655	22 Nov	56°50′	1°02′ E	20
656	,,	,,	,,	85
672	23 Nov	56°10′	1°30′ W	45
E60/				
6	12 Jan	59°00′	6°40′	100
7	,,	59°17′	6°53′	560–0
8	,,	59°31′	7°05′	0
9	,,	,,	,,	20
12	,,	59°44′	7°15′	0
14	,,	,,	,,	250
17	13 Jan	60°23½′	7°49½′	20
18	,,	,,	,,	250
20	,,	60°45′	8°08′	250
22	,,	60°34′	8°16′	0
23	,,	,,	,,	20
26	,,	61°02′	7°03′	20
29	,,	61°09′	7°24′	250
33	27 Jan	61°54′	5°45′	0
34	,,	,,	,,	20
35	,,	,,	,,	100
36	,,	61°49′	5°21′	100
40	,,	61°45′	4°15′	900–0
43	28 Jan	61°28′	3°42′	250
45	,,	61°21′	3°10′	0
46	,,	,,	,,	20
47	,,	,,	,,	250
51	,,	61°08′	2°10′	0
52	,,	,,	,,	20
53	,,	,,	,,	250
97	2 July	59°17′	6°53′	560–0
100	,,	59°31′	7°05′	250
126	13 July	61°02′	7°05′	100
172	22 Sep	59°17′	6°53′	550–0
179	,,	59°44′	7°15′	250
180	,,	,,	,,	1000–0

TABLE II (*continued*)

Haul No.	Date	Position		Depth (m)
E60/				
184	23 Sep	60°12′ N	7°40′ W	250
188	,,	60°23½′	7°49½′	250
189	,,	,,	,,	850–0
196	10 Oct	61°38′	14°00′	1500–0
202	11 Oct	61°30′	11°40′	1200–0
205	,,	61°52′	10°15′	850–0
213	18 Oct	62°31′	9°46′	250
217	,,	61°48′	9°06′	659–0
349	15 Dec	59°17′	0°55′	20
S60/				
416	14 Sept	61°01′	0°35′	100–0
424	19 Sept	59°38′	1°10′	100–0
E61/				
13	11 Mch	58°50′	6°20′	20
20	19 Mch	56°00′	7°32′	0
24	20 Mch	55°54′	8°03′	0
32	5 Apl	61°08′	2°10′	20
43	6 Apl	61°42″	4°51′	50
79	5 Aug	59°17′	6°53′	565–0
87	6 Aug	59°44′	7°15′	900–0
90	,,	60°12′	7°40′	20
91	,,	,,	,,	250
95	,,	60°23½′	7°49½′	250
96	,,	,,	,,	850–0
241	5 Sept	59°45′	1°00′	100
397	30 Sept	59°17′	6°54′	625–0
400	,,	59°31′	7°05′	250
405	1 Oct	59°44′	7°15′	1000–0
441	13 Oct	61°08′	2°10′	250
E62/				
23	18 Mch	57°59′	9°30′	250
27	19 Mch	58°28′	8°47′	20
123	30 June	59°44′	7°15′	1000–0
127	1 July	59°17′	6°53′	530–0
138	13 July	61°08′	2°10′	250
180	21 Aug	58°17½′	8°28′	100
187	12 Oct	59°17′	6°53′	571–0
190	,,	59°31′	7°05′	250
194	,,	59°44′	7°15′	250
195	,,	,,	,,	1000–0
196	,,	59°56′	7°27′	250
205	13 Oct	60°35′	8°00′	250
223	12 Nov	56°29′	9°02′	0
224	,,	,,	,,	20
225	,,	,,	,,	200
230	20 Nov	57°36′	9°26′	254–0
236	21 Nov	58°26′	8°43′	200
243	22 Nov	59°19½′	5°18′	0

TABLE II (*continued*)

Haul No.	Date	Position		Depth (m)
S62/				
33	11 Mch	60°03′ N	0°55′ W	110–0
42	,,	61°01′	0°30′	100
47	12 Mch	,,	1°00′ E	0
49	,,	,,	,,	100
57	,,	,,	3°00′ E	250
E63/				
46	19 Mch	54°35′	5°15′	110–0
95	15 Apl	57°40′	11°21′	2000–0
100	16 Apl	,,	12°20′	20
120	25 Apl	,,	9°27′	250
122	,,	56°16′	10°05′	1730–0
136	27 Apl	54°15′	12°00′	0
137	,,	,,	,,	20
138	,,	,,	,,	250
143	28 Apl	,,	14°32′	1940–0
145	,,	53°41′	14°44′	20
148	,,	,,	,,	250
151	,,	53°34′	14°12′	20
190	25 May	61°21′	3°10′	250
404	23 July	60°45′	8°08′	250
488	8 Sept	59°17′	6°53′	580–0
492	,,	59°31′	7°05′	250
497	,,	59°44′	7°15′	250
498	,,	,,	,,	960–0
504	,,	60°12′	7°40′	250
510	,,	60°23½′	7°49½′	850–0
514	9 Sept	60°45′	8°08′	250
523	23 Sept	62°19′	11°04½′	750–0
552	29 Sept	61°08′	2°10′	250
588	6 Dec	59°00′	6°40′	140–0
590	,,	59°17′	6°53′	540–0
593	,,	59°31′	7°05′	250
597	7 Dec	59°44′	7°15′	1490–0
598	,,	,,	,,	0
C64/				
1199	3 Nov	56°47′	6°12½′	117–0
1201	6 Nov	56°35′	6°21′	38–0
1204	11 Nov	56°02½′	6°08′	49–0
E64/				
47	25 June	61°21′	3°10′	250
48	,,	,,	,,	1300–0
207	17 Nov	58°25′	5°50′	245–0
208	,,	58°20′	6°07′	113–0
209	,,	58°06′	5°48′	225–0
210	18 Nov	57°46′	6°00′	275–0
211	,,	58°49′	6°20′	275–0
212	20 Nov	57°09½′	6°52′	330–0
213	,,	56°58′	6°59′	275–0
214	21 Nov	56°33′	7°19′	430–0
215	,,	56°27′	7°50′	365–0

TABLE II (*continued*)

Haul No.	Date	Position		Depth (m)
E64/				
216	21 Nov	56°15′ N	8°25′ W	365–0
223	22 Nov	55°28′	9°15′	230–0
227	,,	55°52′	8°09′	430–0
228	,,	56°24½′	6°43′	165–0
229	23 Nov	56°07′	6°20′	95–0
S64/				
34	10 Mch	61°01′	00°35′	20

TABLE III.—STATIONS 1950–1956 CONTAINING *Hippopodius* AND NOT INCLUDED IN FRASER (1961).

Haul No.	Date	Position		Depth (m)
E50/				
992	12 Nov	61°01′ N	1°30′ W	120–0
1000	,,	,,	0°30′	20
S50/				
773	11 Sept	62°02′	9°18′	0
954	7 Nov	61°21′	3°10′	100
S51/				
310	19 June	59°15′	10°10′	250
918	30 Oct	60°37′	0°25′	0
1078	11 Dec	61°01′	4°00′ E	0
E52/				
1187	12 June	55°48′	9°05′ W	0
1194	,,	55°30′	10°21′	20
1302	24 June	58°38′	8°21′	0
1753	29 Aug	61°01′	3°00′ E	100
S52/				
885	6 July	59°56′	7°27′ W	100
975	18 July	61°08′	2°10′	100
S53/				
6	7 Feb	59°05′	3°46′	0
15	10 Feb	59°00′	6°40′	20
20	,,	59°31′	7°05′	250
27	,,	59°50′	7°27′	250
218	17 Mch	59°30′	6°00′	100
275	4 Apl	61°01′	2°14′ E	130
291	5 Apl	,,	0°44′ W	20
583	23 May	61°21′	3°10′	0
693	13 June	60°12′	4°18′	0
703	,,	60°57′	6°18′	0
910	27 June	62°58′	21°30′	250
923	28 June	62°32′	17°55′	0
958	30 June	58°22′	8°15′	100
1598	14 Aug	59°31′	1°05′	0
1599	,,	,,	,,	20
1600	,,	,,	,,	250
1604	,,	59°26′	7°27′	20

TABLE III (*continued*)

Haul No.	Date	Position		Depth (m)
S53/				
1638	17 Aug	61°01′ N	1°36′ W	150
1663	23 Aug	57°57′	9°17′	100
1689	29 Aug	57°01′	11°30′	250
S54/				
339	17 Apl	59°17′	6°53′	600–0
476	15 May	59°43′	16°42′	250
684	12 June	60°12′	7°40′	0
826	8 July	62°47′	1°00′	470–0
S55/				
198	23 Apl	59°17′	6°53′	575–0
742	19 July	57°55′	17°00′	250
841	31 Aug	59°06′	7°27′	250
867	5 Sept	61°21′	3°10′	250
E56/				
72	13 Mch	61°01′	0°30′	100
S56/				
311	22 July	59°49′	11°27′	250
317	23 July	59°12′	10°00′	100
320	24 July	59°01′	9°25′	100

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