

# REMARKS ON THE DISTRIBUTION AND MIGRATION OF WHALES, BASED ON OBSERVATIONS FROM NETHERLANDS SHIPS

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## 1 INTRODUCTION

## 1. GENERAL REMARKS

In former days our knowledge about the distribution and migration of the big whales was based principally on logbook records of whaling vessels and land stations (TOWNSEND, 1935; KELLOGG, 1929; MACKINTOSH, 1942; OMURA, 1955), on incidental observations at sea, or on strandings (HARMER, 1927; FRASER, 1934, 1946, 1953). The publications of RAYNER (1940, 1948) and BROWN (1954) dealing with the results of whale marking give very valuable information about some aspects of the distribution and migration of Antarctic Whalebone Whales, but they give practically no information about tropical and subtropical waters. These regions are also poorly dealt with in the literature based on statistics or strandings.

In 1951 Dr. N. A. MACKINTOSH of the National Institute of Oceanography at Wormley (England) started a new scheme of obtaining information about whales by cooperation with the Meteorological Office. A number of selected British merchant ships and other vessels regularly send weather observations to the Meteorological Office. These ships were asked to record sightings of whales made during their voyages and to send the records to the National Institute of Oceanography (MACKINTOSH, 1952). The officers were instructed by a pamphlet showing the principal characteristics of the large whales (Nat. Inst. Ocean., 1952). The preliminary results of this scheme were reported in 1953 (MACKINTOSH, 1953); in 1957 and 1958 BROWN (1957, 1958) published a review of the results hitherto obtained in the Indian and in the Atlantic Ocean. At that time the N.I.O. had about 1500 observations referring to a much larger number of individual whales.

In 1954 the Netherlands Whale Research Group T.N.O. started the same kind of research with the aid of officers of the Royal Netherlands Navy and the Netherlands merchant-service. The scheme could be organised by the very valuable cooperation of Mr. H. S. DROST, Inspector of Fisheries, rear-admiraal E. A. VREEDE, secretary to the Netherlands Association of Ship-owners and the Chief of Staff of the Royal Netherlands Navy. The directors of all Netherlands shipping companies cooperated as well. To all these authorities we are greatly indebted for their benevolence and their assistance. Grateful acknowledgement is also made to more than a thousand captains and other ships officers who made the observations and filled in the forms, as well as to numerous navi-

gation inspectors and other employees of the shipping companies, who collected the forms and sent them to us. The Research Group is also very much indebted to the President of the Organization Commission of Fisheries T.N.O., Ir. G. J. LIENESCH, who provided the special funds for this research.

For the instruction of the observers a little booklet was written, dealing with the principal characteristics of the big whales and with some aspects of their behaviour and their mode of life (SLIJPER, 1954). To stimulate the scheme three articles appeared in marine journals (SLIJPER, 1955, 1955a, 1955b). On board of each ship were a copy of the booklet and a number of forms. On one type of form the noon-position of the ship and the different sightings could be filled in daily, on the other type of form every sighting could be dealt with separately with all the particulars of that special animal. Within three years the Whale Research Group received about 4500 reports with about 3500 sightings, dealing with approximately 11.000 animals. This very large number of observations enabled us to record the results on charts dealing with every month separately, whereas BROWN (1957, 1958) gives his results by periods of three months. This was a big advantage, especially with regard to migration.

The scheme worked during three years. After that period it was stopped in order to determine whether it was worth while to start again. A preliminary report, dealing with the Atlantic Ocean and especially dealing with the general biological information obtained from the forms (general behaviour, speed, sleep, locomotion, respiration, mating) was published by SLIJPER and VAN UTRECHT (1958, 1958a, 1959; see also commentary of BROWN, 1959).

During the past years a similar scheme of observations was started by J. J. WOODBURN Philadelphia, who gave us quite a number of very valuable records. It was also organized by the Division of Fisheries and Oceanography of C.S.I.R.O. (Australia) and by Dr. W. H. DAWBIN (Sydney), who has at present about 10.000 reports of Humpback sightings in the South Pacific. Results of these investigations have not yet been published, but a number of Humpback sightings was used by DAWBIN (1956) in his paper on Humpbacks off the coast of New Zealand.

Very valuable assistance to our research was obtained from Captain W. F. J. MÖRZER BRUNS who is an experienced observer of whales and dolphins and whose observations had a much greater reliability

with regard to the determination of the species than those of other observers. His data have been collected in a special table (table 5).

Grateful acknowledgment is also made to Dr. S. G. BROWN (N.I.O.-Wormley-England) who was extremely helpful in reading the manuscript and suggesting a number of corrections based on a very thorough knowledge of the subject.

## 2. DETERMINATION OF SPECIES

In the instructions given to our collaborators on board of the ships, it was asked to record sightings of all big whales, i.e. all Baleen Whales and the Sperm Whale. In the forms date, hour, position of the ship, visibility, wind and other factors influencing the reliability of the observations could be filled in, as well as the number of animals, the presence or absence of calves and the presumptive species. It was asked to record as many characteristics as possible that could be of some use to the determination of the species, as for example the estimated length, colour, height and shape of the blást, absence or presence of the dorsal fin, visibility of flukes and flippers etc. It was also asked to record some particulars about respiration, speed of swimming and behaviour of the animals.

These particulars were used by collaborators of the Whale Research Group in determining the species of the animals involved. It turned out that this was possible with a high degree of reliability in Right Whales (*Eubalaena glacialis* Bonnat.; *Eubalaena australis* Desm.), Humpback Whales (*Megaptera novaeangliae* (Borowski)) and Sperm Whales (*Physeter macrocephalus* L.). There was such a small number of sightings of Right Whales, Grey Whales and Little Piked Whales, that by charting the records on monthly maps, it was not possible to draw the same sort of conclusion about their distribution or migration as with regard to the other species. They are dealt with in separate chapters.

It was quite evident that inexperienced observers would not be able to distinguish with any reliability between Blue Whales (*Balaenoptera musculus* (L.)), Fin Whales (*Balaenoptera physalus* (L.)), Sei Whales (*Balaenoptera borealis* (Lesson)) and Bryde Whales (*Balaenoptera brydei* (Olsen)).

Just as it was done by BROWN (1957, 1958) we collected the sightings of these four species under one single heading: rorquals. And just as BROWN, we distinguished also a category "whales" for all those cases in which it was not even possible to distinguish between these four species and the other whales mentioned above.

A careful examination of the charts of "whales", however, showed that, roughly outlined, they were identical with those of "rorquals". Probably the majority of these "whales" were "rorquals". To save space it was decided not to reproduce the charts of "whales", but the arguments brought forward with regard to rorquals now and then are supported by dealing with the observations of these "whales".

In all cases in which it was possible, the conclusions drawn from the observations from the ships were compared with data in which the species could be determined with certainty, as there are the log-books of old whalers (TOWNSEND, 1935), catch statistics of factory ships and land stations, strandings, or the observations of captain MÖRZER BRUNS. In a number of cases this enabled us, for example, to draw the conclusion that probably the observations of rorquals had not to be ascribed only to Sei or Bryde Whales, but to Fin and Blue Whales as well.

Broadly outlined the results of our research corresponded with those of BROWN (1957, 1958), whereas they also corresponded with a number of generally accepted facts about the distribution and migration of the large whales. This gives a certain amount of confidence in the reliability of our conclusions, especially, with regard to those points in which they differ from the generally accepted assumptions. Nevertheless we are in any case quite aware of the fact that our conclusions are no more than indications. They may serve as a stimulus to further detailed investigations in which the species of the animals sighted at sea can be determined with certainty. Especially with regard to southern whaling problems it would be extremely useful if such observations could be made in the South Atlantic, in the Indian Ocean and in the South Pacific.

## 3. FREQUENCY OF SIGHTINGS

If the observations are simply plotted on charts, it is quite evident that practically nothing more can be seen than the course of the general shipping routes. In order to avoid this difficulty BROWN (1957, 1958) converted the number of his observations into a number per 1000 miles steamed in a ten degrees square. According to our opinion a greater degree of exactitude could be obtained if not the mileage but the number of hours steamed in a ten degrees square was used, because the velocity of the ships differs very much. Moreover it appeared to be useful if the hours of the night, in which it is almost impossible to observe whales, were left out of consideration. From the noon positions the route of each individual ship could be plotted and the number of miles steamed by that

ship in a ten degrees square could be calculated. The average speed of the ships was known and consequently the number of hours steamed in a certain square could also be calculated. Per ten degrees square and per month these numbers were added. The total monthly number of hours steamed in every ten degrees square during the period of three years than was converted into the number of hours steamed in that square by daylight, with the aid of tables about the number of monthly daylight hours provided by the Royal Meteorological Office (K.N.M.I.) at de Bilt. Then the monthly number of observations in the squares was converted into a number of animals observed per 1000 hours steamed by daylight (table 6-8).

Although this causes a greater reliability, it must be still kept in mind that a certain amount of uncertainty is caused by such factors as rain, fog, storm etc., as well as by the fact that generally the observation in the winter will be more difficult than in the summer. A very striking fact is the experience that no observations have been made during the last hours before the ports of call. Apparently the ships officers are so much engaged in navigation problems that there is no time at all to look out for whales. This

may explain why there are no observations from the North Sea (although there is a tremendous amount of shipping in that region), neither from the English Channel, nor from the Red Sea. There are only a few observations from the Mediterranean.

All observations were put on punched cards and these were dealt with further by the Statistical Department of the Organization T.N.O. Grateful acknowledgement is made to Dr. E. F. DIXON for his

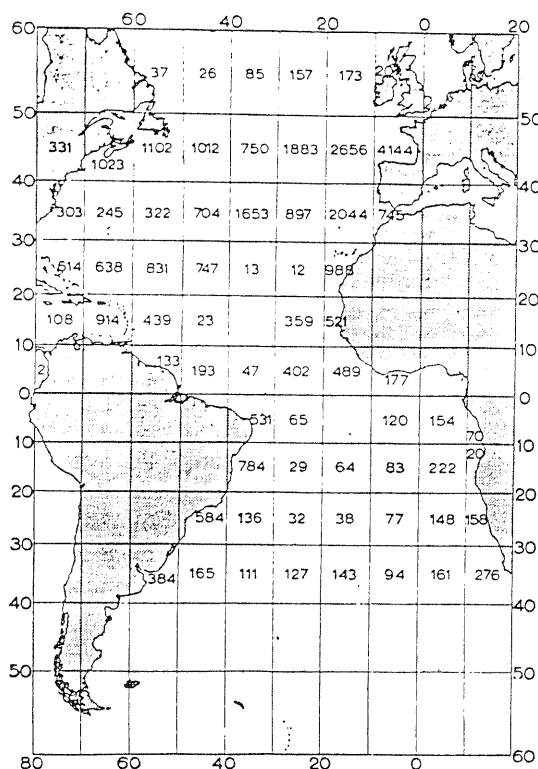


Fig. 1. Number of hours steamed in daylight in July in the different squares of the Atlantic Ocean.

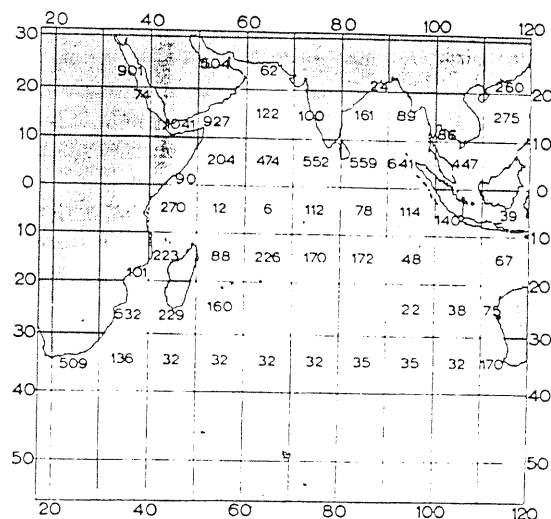


Fig. 2. Number of hours steamed in daylight in March in the different squares of the Indian Ocean.

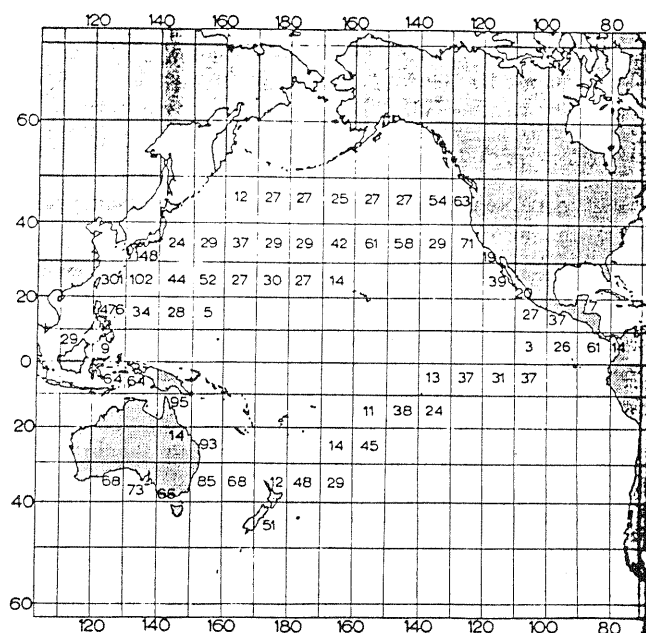


Fig. 3. Number of hours steamed in daylight in February in the different squares of the Pacific Ocean.



very valuable assistance. The converted numbers of whales sighted were plotted on charts using four different symbols (table 1). This has been done because the reliability of the converted data is not the same in the different months and squares. It depends on the total number of hours steamed by daylight in that special square and on the actual number of sightings. The greatest reliability may be ascribed to the black-dots. The squares, triangles and crosses mostly refer to ten degrees squares in which there were only a few hours steamed, but in which by chance during

these few hours also a few whales were observed. If such sightings are converted into 1000 hours steamed one can get abnormally high figures.

The monthly number of hours steamed by daylight in every ten degrees square was also plotted on charts. Of these charts only one example respectively from the Atlantic, the Indian and the Pacific Ocean has been reproduced, because broadly outlined the charts for every month show the same pattern. The charts reproduced in fig. 1, 2 and 3 therefore may be regarded as representative for the whole year.

## II RORQUALS

### A. ATLANTIC OCEAN

#### Chart 1

#### 1. GENERAL REMARKS

The total number of rorquals sighted in the Atlantic Ocean was 3393, viz. 2723 in the North Atlantic and 670 in the South Atlantic. There were 1265 sightings of "whales".

Table 2 shows that a great number of animals were seen in groups. In the groups of which the number was determined precisely, the average number was 2,38, in the groups of which the number was only estimated, the average number amounted to 12,25. These numbers are almost the same as those from the Pacific and Indian Oceans. It means that the majority of the rorquals were seen in comparatively small herds. There were some larger herds and four times a herd of more than hundred animals has been reported.

#### 2. DISTRIBUTION

If we compare fig. 4 and 5 it looks quite evident that the vast majority of the sightings is reported from the regions of the big ocean currents, the Gulf Stream, the Labrador Current, the Canarian Current, the Benguela Current, the Guinea Current and the Brazil Current. This suggests that the main migratory routes of the animals coincide with these big currents. This has already been suggested by KELLOGG (1929; see also CLARKE, 1962).

In the squares  $50^{\circ}$  N to  $60^{\circ}$  N and  $10^{\circ}$  W to  $30^{\circ}$  W (the two squares W of England) no whales have been sighted from November to April (inclusive). In January and February there were no ships in this area, but also from the other wintermonths there were no reports of sightings. On the other hand a great number

of observations were made in July, August and September. At the North American east coast great numbers of rorquals have been seen between  $30^{\circ}$  N and  $50^{\circ}$  N from April to November. The data are quite in accordance with those of KELLOGG (1929), who

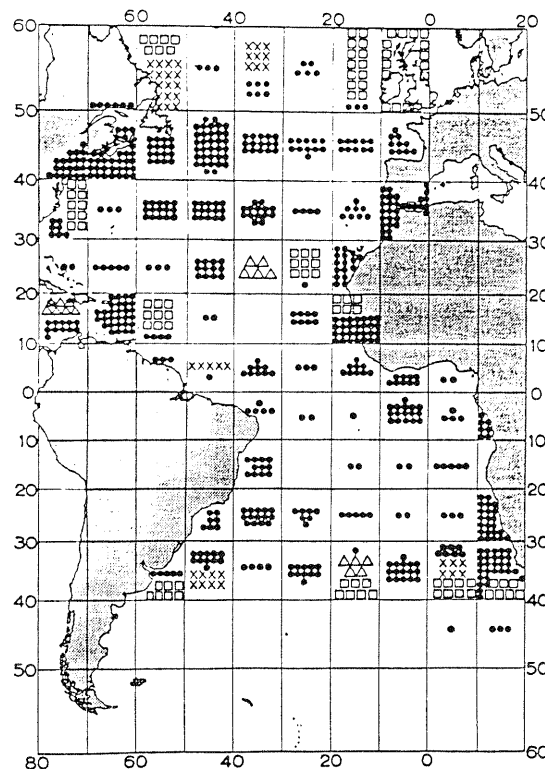


Fig. 4. Total number of sightings of Rorquals in the Atlantic Ocean calculated by adding the figures for the different months. For explanation of symbols see table 1.

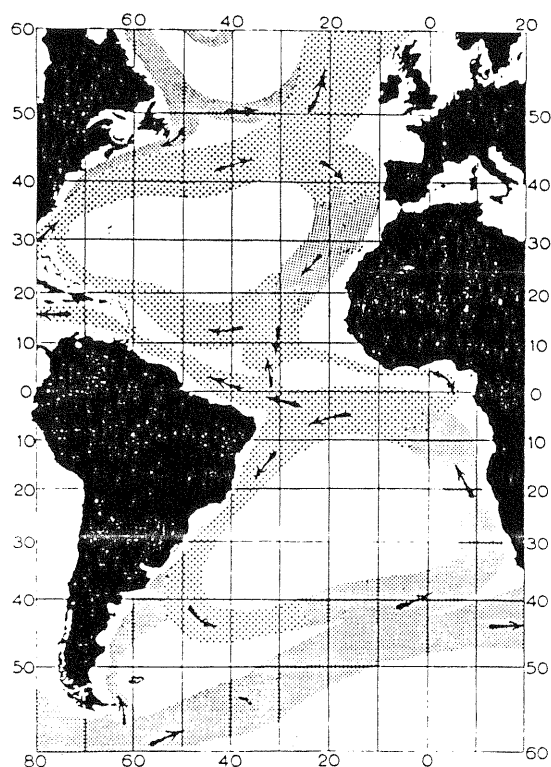


Fig. 5. Chart of the principal currents in the Atlantic Ocean.

says that in April Blue Whales are observed at the Faroes coming from the Southwest on their northward run. It is also in accordance with the statements that Blue Whales migrate northward along the west coast of Ireland and the Hebrides in May and June (KELLOGG, 1929) and that Fin Whales pass these coasts in a north east direction in May (HINTON, 1925).

From the charts it is quite evident that there are large concentrations of rorquals in some special regions of the Atlantic Ocean, especially in certain coastal waters. These areas are: the North American east coast from New Foundland to Cape Hatteras, the Caribbean Sea, the region off Gibraltar, the African west coast between 30° N and the equator and the Atlantic coast of South Africa. A comparison of these regions with fig. 6, which is made from fig. 15 of WALFORD (1958), shows that these are regions with a great biological productivity, with the exception of the Caribbean, the productivity of which may only be indicated as moderate. It follows that the whales show a distinct tendency to concentrate in regions where there is a large amount of food. This conclusion is confirmed by the fact that in most of the re-

gions involved also large numbers of dolphins have been observed, as well as by the fact that almost no whales have been sighted in the Sargasso Sea and in the central part of the South Atlantic. These regions are indicated by WALFORD (1958) as having a very low productivity. Because of the distribution of the squares the fact is not shown as clearly on the charts as it would have been when the poor regions had been dealt with separately. Moreover it must be kept in mind that only a small number of ships have crossed these regions. On the other hand it may be remarked that the phenomenon involved has also been mentioned by Browns (1958).

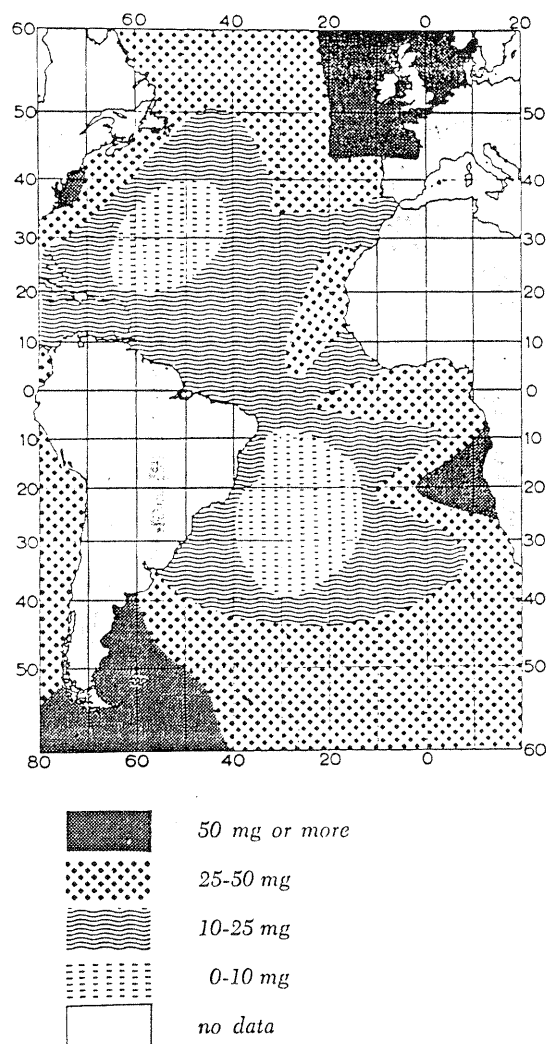


Fig. 6. Chart of the biological productivity of the sea in the Atlantic Ocean. After WALFORD (1958). The chart indicates the amount of organic matter (in milligrams) produced annually per cubic meter of sea water.

## 3. MIGRATION IN THE NORTH ATLANTIC

The annual migrations of the rorquals in the North Atlantic are clearly demonstrated in the curves of figs. 7 and 8. The curves of fig. 7 show the monthly number of rorquals sighted per ten degrees latitude, per period of 6000-8000 hours steamed at daylight. Each of these curves shows two peaks, representing the northward and the southward migration. The peak of the southward migration (autumn-migration) in the curve of  $30^{\circ}$  N to  $40^{\circ}$  N latitude is however, lacking, a phenomenon which at present must remain unexplained. Fig. 8 shows the monthly position of the peaks of the curves shown in fig. 7. It clearly demonstrates that from April to July the peaks of the curves shift from  $10^{\circ}$  N to  $60^{\circ}$  N, whereas from

September until November they shift back from  $60^{\circ}$  N to  $10^{\circ}$  N. This means that the majority of the population migrates to the North from April until July and that it moves to the South from September until November.

These data are quite in accordance with the catch figures from the land stations in the northern part of the North Atlantic (Norway, Iceland, Greenland, Faroes, Scotland, New Foundland; table 3). These figures show that the principal catches of these stations are made from June to September. The data are also quite in accordance with the statement of KELLOGG (1929), that Fin Whales pass the Gulf of Maine in March and that they are seen off Labrador and New Foundland in July and August. KELLOGG (1929) says

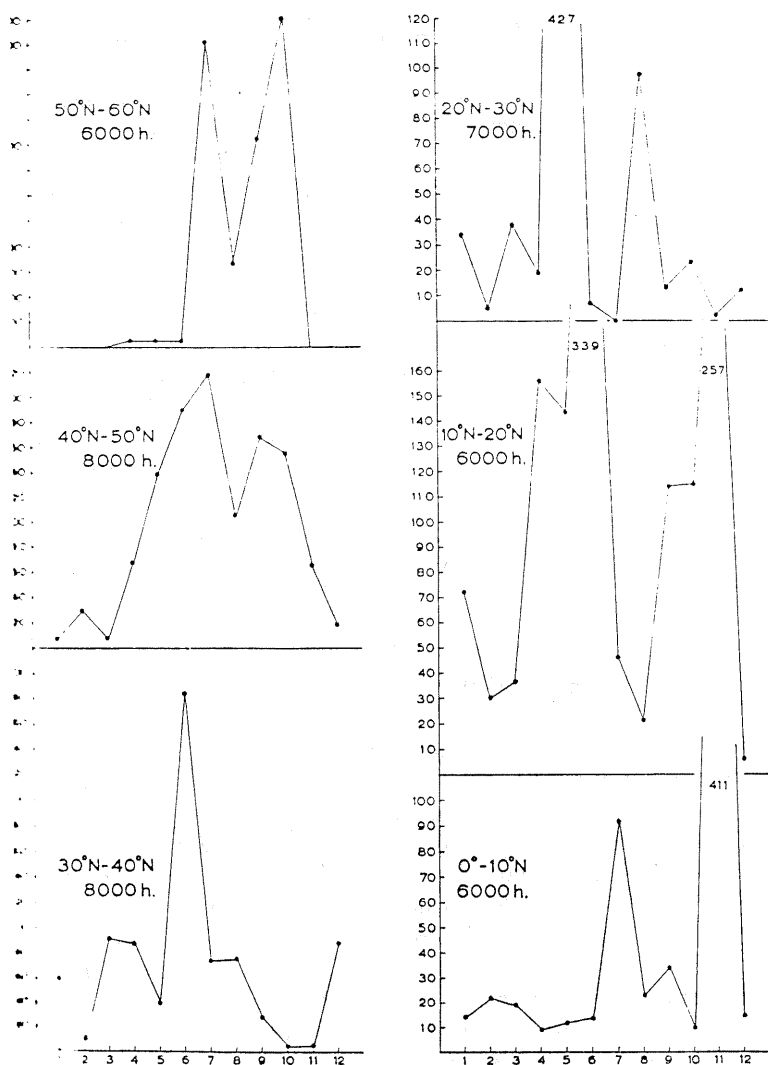
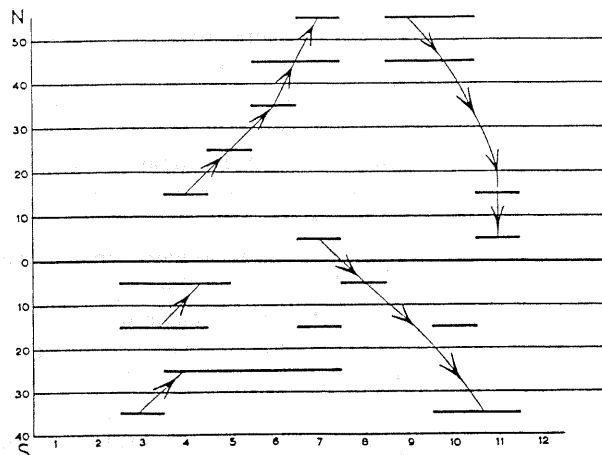


Fig. 7. Graphs of the number of Rorquals sighted monthly in the different regions of the North Atlantic Ocean calculated per 6000-8000 hours steamed in daylight. Abscis: months. Ordinate: numbers.

Fig. 8. Diagram showing the relation between the geographical latitude and the months in which the peaks in the curves of fig. 7 and 9 are found, indicated by black horizontal lines. Abscis: months. Ordinate: geographical latitude. The figure shows the migration of Rorquals in the North and in the South Atlantic Ocean. In drawing this figure principally the most reliable peaks from figs 7 and 9 are used (peaks based on dots or squares; see page 7). Moreover the diagram is not a simple summary of the data shown in figs 7 and 9 but some interpretation, given in the text, has been introduced into it.



that in September Fin Whales migrate to the South along the Irish coast and that they arrive in the Bay of Biscay in October. The charts show comparatively large concentrations of whales in August in the English waters as well as in the waters off Labrador. The data bearing on rorquals in these waters are, however, not based on a large number of observations. Those bearing on "whales" are based on a fairly large number of observations.

HINTON (1925) and KELLOGG (1929) have shown that Fin Whales appear in all seasons off the coast of Norway, but that they are rarely present in the winter on the Finnmark coast, north of 70° N. Strandings on the Scottish coast have been reported by HARMER (1927) and FRASER (1934) in January and February. In Norway, W. Greenland, Iceland, New Foundland, the Faroes and Scotland the whaling season lasts from April to November with a peak in June-September (table 3). These data suggest that during the winter comparatively few Fin Whales will be present in waters north of 60° N.

Although there has certainly not been very much shipping in the zone between 50° and 60° N during the winter and circumstances for sighting are not very favourable, the complete absence of sightings of whales in these regions between November and April suggests that the main body of the population during the winter can be found south of 50° N or maybe, even below 40 degrees N.

BROWN (1958) points to the fact that in June, July and August so many whales have been sighted between 40° N and 50° N. This phenomenon is confirmed by our observations. Moreover the charts show clearly that from July to September fairly large numbers of rorquals have also been sighted between 30° N and 40° N, i.e. in the region between Gibraltar and Cape Hatteras. This points to the fact that during the summer at least a part of the population does not migrate into northern waters but that it remains at comparatively low latitudes. That at least a part of these whales (and certainly a large part of those sighted in European coastal waters) may be Fin Whales, is demonstrated by the catches of the land stations in Portugal, Spain and Spanish Morocco (table 3 and other data from International Whaling Statistics). In 1925-1934 these stations practically only caught Fin Whales; in the ten years after the second World War they took also Sei Whales, but the main catch is still made up of Finbacks. Whales are caught in these regions during the whole year but especially between May and October. The number of Blue Whales taken is insignificant.

The presence of Fin Whales in temperate waters

during the summer is also demonstrated by strandings in June-September at the south coast of England (HARMER, 1927; FRASER, 1934), at the west coast of France (VAN BENEDEN et GERVAIS, 1880; VAN BENEDEN, 1889) at the Dutch coast (VAN DEINSE, 1931) as well as by sightings in the Mediterranean and off Gibraltar (RICHARD, 1936; observations of Captain MÖRZER BRUINS). According to ALLEN (1916) Fin Whales occur during the whole year off the coast of Maine (45° N) where comparatively large numbers have been seen during the summer. Consequently the conclusion may be drawn that a fairly large number of Fin Whales is present during the summer at least down to 30° N.

With the exception of July rorquals have been sighted off the North African west coast between 10° N and 30° N during the whole year. There is, however, a peak in the number of observations from October to May, whereas very few have been seen from June to September. Concentrations of whales in this area have also been reported by BROWN (1958). It is very difficult to decide whether at least a certain part of these whales were Finbacks, because there is no whaling in this region and because reliable indications about the species are very rare. BROWN (verbal communication) informed us about the fact that British marking expeditions frequently met Sei Whales in this region. The possibility that among them there were also Fin Whales, may however, not be excluded. On a trip in the southern part of the North Atlantic FRASER (written communication) saw a Sei Whale off the Liberian coast at 5° N 9° W (9-1-46), whereas CADENAT (1955) reports about a young Bryde Whale stranded at Dakar (15° N) in 1955. He reports also about four strandings of big whales at the coast of Senegal. Among them was an animal of about 25 m, which points to a Blue or Fin Whale. At 28-11-56 captain MÖRZER BRUINS saw two Fin Whales in this region and KNPICHNIKOV (1950) reports about Blue and Fin Whales off the African coast between 6° N and 30° N, resp. in November and May. A Sei Whale was seen in May. JONSGÅRD (Cetacean Symposium Washington, 1963) reported that at the African coast Fin Whales occur as far southward as 20° N.

Although these data are rather scanty, they nevertheless point to the fact at least a part of the north-west African whale population may consist of Fin and probably also of Blue Whales. It may not be excluded beforehand that at least during the northern summer some of these Blue and Fin Whales are animals belonging to the southern population. The fairly large concentration of rorquals in this region in

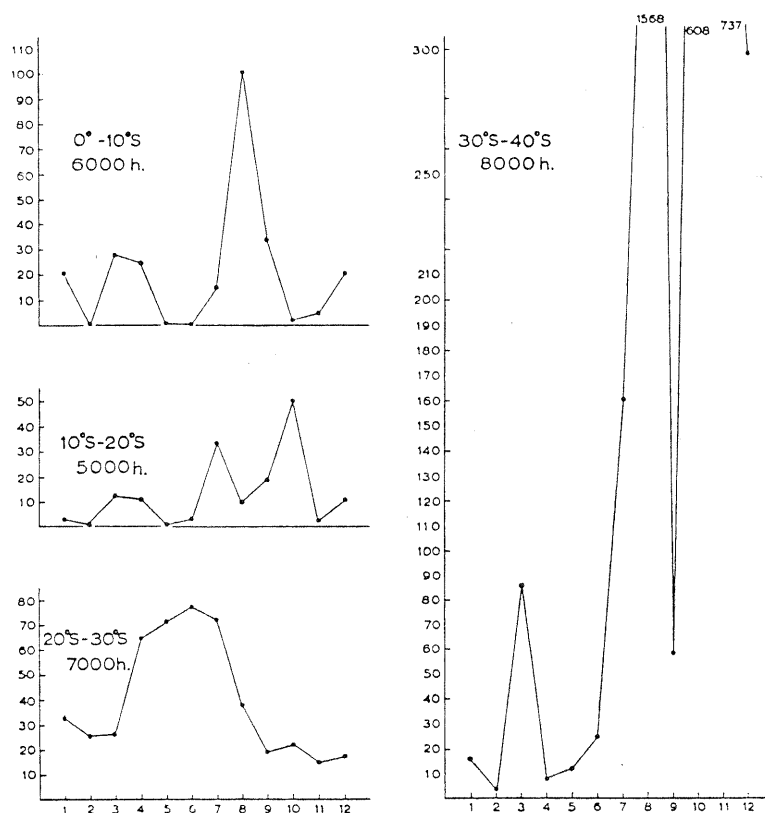


Fig. 9. Graphs of the number of Rorquals sighted monthly in the different regions of the South Atlantic Ocean calculated per 5000-8000 hours steamed in daylight. Abscis: months. Ordinate: numbers.

scribe strandings of Blue Whales near Buenos Aires ( $35^{\circ}$  S) resp. in June and October. CARRERA and YEPES (1940) report about the stranding of a Fin Whale between  $12^{\circ}$  S and  $18^{\circ}$  S. In addition to these data, Dr. FERNANDO DIAZ DE AVILA-PIRES from Museu Nacional at Rio de Janeiro kindly informed us that especially Fin Whales are often seen in waters of Southern Brazil from June to November. It is not known why this species is not caught by Brazilian land stations, although they take Sei, Humpback and Sperm Whales. Probably Blue and Fin Whales, (although migrating along the coast), travel so far outside that they are beyond the range of the catchers.

In any case these data show that at least a part of the sightings in the South Atlantic may be supposed to bear on Fin Whales. Consequently these animals are sighted into very low latitudes or even into the northern hemisphere, not only along the coasts but also in the central part of the Ocean.

A number of rorquals and "whales" have been sighted in the central part of the South Atlantic (squ-

ares  $20^{\circ}$  to  $30^{\circ}$  S;  $0^{\circ}$  to  $30^{\circ}$  W) in June and July. It is quite probable that these sightings principally bear on Fin Whales, because WHEELER (1946), who crossed the South Atlantic from West to East along the  $20^{\circ}$  parallel of latitude (and then to Cape Town; 19 Aug.-3 Sept. 1943) saw during this trip 40 whales. Eleven of them could be determined by this experienced whale biologist as Fin Whales, one was a Blue and the others only could be indicated as whales, probably rorquals. Because generally rorquals appear to be scarce in the central part of the South Atlantic this phenomenon must be carefully observed, the more so as it may be correlated with the fairly large number of sightings in the middle of the ocean between  $30^{\circ}$  S and  $40^{\circ}$  S during September, October, November and December. This fact has also been mentioned by BROWN (1958). It may indicate that there is an extensive southward migration of Fin, and probably also of Blue Whales, in the central part of the Ocean during the southern spring.

During the southern autumn (March-May) a vast

number of sightings is reported from the coast of South Africa and a minor number from the coast of South America. These facts may give at least an indication that the northward migration mainly concentrates on the coastal waters, whereas the southward migration may be spread more evenly over the entire breadth of the ocean, the coastal waters included. Catches and observations show that a part of the stock certainly migrates to the South along the coasts.

It has already been pointed out that in the zone between  $20^{\circ}$  N to  $30^{\circ}$  N very few sightings were reported from June, July, September and October. In the southern winter the northern population apparently is not (or in a very small number) present south of  $30^{\circ}$  N. The charts further show that in this period a certain number of whales has been observed between  $0^{\circ}$  and  $20^{\circ}$  N. According to BROWN (1958) a sighting of a rorqual on the Guinea coast ( $5^{\circ}$  N) would be the most northern record. The above mentioned facts, however, suggest that in the southern winter the southern stock might be found up to  $20^{\circ}$  N. The whales probably enter the Caribbean and they may be responsible for at least a part of the sightings off the North African west coast. The occurrence of Blue and Fin Whales in these waters is confirmed by data of KIRPICHNIKOV (1950) and LILLIE (1915; Fin Whale at  $4^{\circ}$  N  $21^{\circ}$  W; 17-7-1910).

There are sightings of rorquals from the whole South Atlantic (although more from coastal waters than from the central part) during the southern summer (December-March) from  $0^{\circ}$  to  $40^{\circ}$  S. This suggests that during the southern summer rorquals occur at least up to the equator. It may not be excluded that some of the sightings between  $0^{\circ}$  and  $20^{\circ}$  N bear also on southern animals but it is much more probable that they bear on the northern stock. Consequently the northern border of the southern population would be at about  $20^{\circ}$  N in the southern winter and at the equator in the southern summer.

That the sightings from low latitudes at least partly bear on Blue or Fin Whales and not exclusively on Sei Whales is not yet confirmed in a very extensive way. The Blue Whale stranded in January 1922 near Cristobal at the entrance of the Panama Canal (HARMER, 1923) could have been a northern one, and the record of BROWN (1954; Fin Whale at  $28^{\circ}$  S, coast of Brazil in October) only confirms that during the southern spring Fin Whales are present at about  $30^{\circ}$  S. MURPHY's (1947) observations at  $13^{\circ}$  S  $33^{\circ}$  W and  $17^{\circ}$  S  $33^{\circ}$  W (resp. on 22th and 24th October), however, give evidence that Fin Whales occur at least up to  $13^{\circ}$  S during the southern spring. The determination of these whales may be more reliable

than many other sightings because MURPHY was on board a whaling vessel. The fact that southern Blue and Fin Whales may remain in warm waters during the summer has also been indicated by MACKINTOSH (1942, p. 250), although he gives no opinion about the northern limit.

It is a well-known fact that the southern border of the rorqual population during the southern summer is represented by the northern border of the pack ice.

## 5. CALVES

No records were considered as calves unless the small animals were accompanied by animals supposed to be their mothers. The majority of the sightings probably bear on fairly young calves, because the larger ones in most cases will have been reported simply as rorquals.

Fig. 10 shows that the distribution of the sightings of calves over the Atlantic Ocean is almost the same as those of the rorquals and "whales". Table 4 and

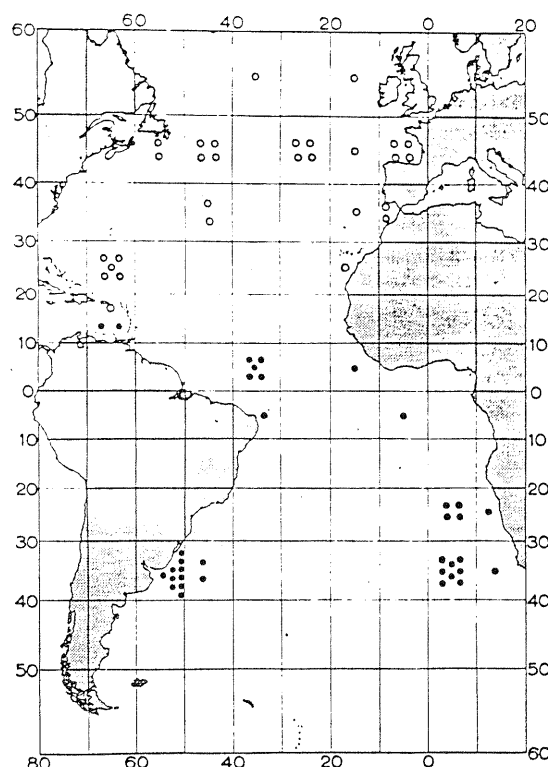


Fig. 10. Chart of the sightings of calves of Rorquals in the Atlantic Ocean. Each symbol refers to one single sighting. Open circles: northern population. Black dots: southern population.

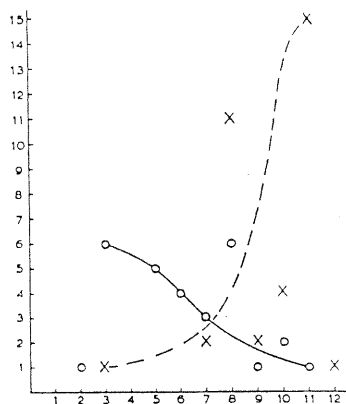


Fig. 11. Curves of the monthly number of calves of Rorquals sighted in the Atlantic Ocean. Full line and open circles: North Atlantic. Dotted line and crosses: South Atlantic. Absciss: months. Ordinate: numbers.

fig. 11 show that in the North Atlantic the greatest number of calves is observed in March with a distinct decrease of the number towards the end of the year. In the South Atlantic the smallest number is observed in March with an increase of the number towards the end of the year. This is quite in accordance with the fact shown by the International Whaling Statistics that the majority of the Fin Whale calves of the southern hemisphere is born in March-July with a peak in May-June. (NAAKTGEBOREN c.s., 1960; SLIJPER, 1958). Very little is known about the birth of Fin Whales in the North Atlantic. It is, however, supposed that the peak of births will be here in December-January and the curves of fig. 11 appear to confirm this supposition. Although the number of calves observed in August is aberrant, the general trend of the line for the North Atlantic is quite clear.

There is a remarkable difference between the curves of the Atlantic and those of the Indian Ocean (fig. 17), where the monthly number of calves observed is nearly the same during the whole year.

## 6. CONCLUSIONS AND DISCUSSION

It may be supposed that the charts of rorquals and probably also of "whales" at least partly bear on sightings of Fin Whales.

The observations point to a migration of Fin Whales which is mainly restricted to the big ocean currents. Large concentrations of whales are encountered in those regions of the Ocean where there is a large amount of food.

There are indications that the northward migration

of the southern stock almost entirely takes place in African and American coastal waters, whereas there may be a certain number of animals migrating southward in the central part of the South Atlantic.

Sightings of calves confirmed previous opinions about the season in which Blue and Fin whales are born.

During the northern winter the majority of the North Atlantic population is found between  $0^{\circ}$  and  $40^{\circ}$  N and during the summer between  $30^{\circ}$  N and the border of the pack-ice. There is a northward migration in April-July and a southward migration in September-November. In the South Atlantic there is a northward migration from March to June and a southward migration from September to December. During the southern winter the majority of the population of the South Atlantic is found between  $20^{\circ}$  N and  $50^{\circ}$  S although the animals are certainly present up to  $60^{\circ}$  S. During the southern summer the population is spread over the whole South Atlantic from the equator up to the border of the pack-ice, although it is quite evident that in this season the majority of the population will stay in Antarctic waters. Probably the northern and southern population meet in the Caribbean Sea and off the north west coast of Africa but there may also be encounters in the central part of the Ocean between  $0^{\circ}$  and  $20^{\circ}$  N.

The most striking fact that can be deduced from these data is that during the summer at least a part of the northern as well as of the southern population does not go into the Arctic and Antarctic waters, but remains in temperate or even warm waters. Unfortunately at present it can not be concluded which percentage of the stock goes to the cold waters and how many animals stay behind. Extensive observations of whales on shipping routes north of  $60^{\circ}$  N and observations south of  $40^{\circ}$  S might give a better insight into this question. Nevertheless it is obvious that it is not a very small number of animals that stay behind during the summer.

It may be supposed that the number of animals staying behind during the summer is greater in the North Atlantic than in the southern part of this Ocean, because of the fact that Fin Whales of the North Atlantic are supposed to feed on fish to a greater extent than their southern relatives, who are supposed to rely mainly on Antarctic krill. This, however, may not be quite right, because in the domain of the southern population there are apparently regions where the warm waters also contain a great amount of food. If it is true that Blue Whales feed almost exclusively on krill, the whales staying behind probably will be mainly Fin Whales, whereas in any



case a part of the sightings will bear on Sei and Bryde Whales.

It would be most interesting to know what happens exactly during migration. It might be supposed that the stock as a whole shifts to high latitudes in summer and to low latitudes in winter. In that case, however, the number of sightings in the zones between  $30^{\circ}$  N to  $40^{\circ}$  N and  $40^{\circ}$  N to  $50^{\circ}$  N would have been fairly constant during the whole year. The presence of distinct peaks in the curves of fig. 7 and 9 may be considered as an indication that most of the

animals migrate from fairly low to fairly high latitudes and that those present in warm and temperate waters during the summer are real stragglers.

The number of sightings between  $10^{\circ}$  N and  $50^{\circ}$  N during the summer is almost the same—or even a little bit larger—than the number of sightings in the same area during the winter. This might be in favour of a shifting hypothesis because, when there was a real migration, one might expect many more sightings in this region during the winter than during the summer.

## B. INDIAN OCEAN

### Chart 2

#### 1. GENERAL REMARKS

The total number of rorquals sighted in the Indian Ocean was 1618. There were 799 sightings of "whales". They show almost the same distribution as the rorquals. Table 2 shows that quite a number of rorquals were encountered in herds. The average number of animals in the herds was almost the same as in the Atlantic Ocean.

#### 2. DISTRIBUTION

The general picture of the distribution of rorquals and "whales" in the Indian Ocean (fig. 12) is more or less the same as the picture given by Brown (1957). To a certain degree it is influenced by the course of the main shipping routes, but this influence certainly is not so very important. The charts are supposed to give a fairly reliable picture of the actual distribution of the animals.

Fig. 12 clearly shows that great concentrations of rorquals have been encountered in four areas, viz.: 1. The area north of  $10^{\circ}$  S. Within this area by far the greatest concentrations are found in the Gulf of Aden and the Arabian Sea. The concentrations in the Bay of Bengal are also significant but somewhat less than in the other two areas. 2. The Indonesian Archipelago. 3. The African east coast. 4. The zone between  $30^{\circ}$  S and  $40^{\circ}$  S. In the area between  $0^{\circ}$  to  $30^{\circ}$  S and  $65^{\circ}$  E to  $90^{\circ}$  E, on the contrary almost no whales have been observed.

A comparison of fig. 12-14 shows that, just as in the Atlantic, the distribution of the animals in the Indian Ocean is influenced by the big ocean currents, as well as by the distribution of the biological productivity of the sea (WALFORD, 1958). According

to WALFORD's fig. 15 the Gulf of Aden and the Arabian Sea show a greater productivity than the Bay of Bengal. Observations of Captain MÖNZER BRUNS and others have shown that these areas are also populated by very large schools of dolphins, whereas JACOB and MENON (1947) describe the stranding of a rorqual at Naduvattam, whose stomach contained an enormous amount of fish. Because of its length (47 feet) and the number of throat grooves (42) (MATTHEWS, 1938a), this animal may be considered as a Sei Whale. Apparently the number of whales in the Persian Gulf and particularly in the Gulf of Oman is so large, that animals dozing on the surface are often

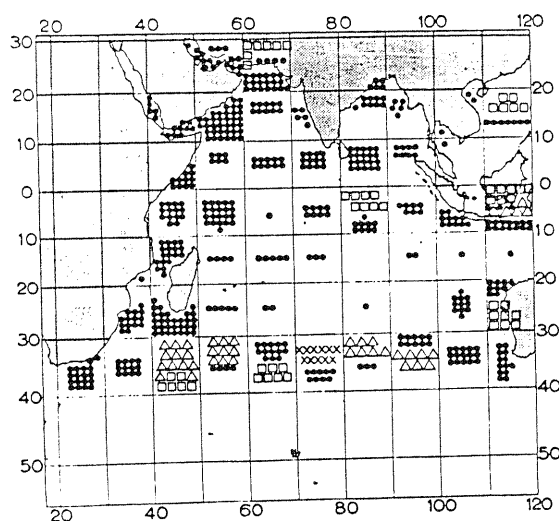


Fig. 12. Total number of sightings of Rorquals in the Indian Ocean calculated by adding the figures for the different months. For explanation of symbols see table 1.

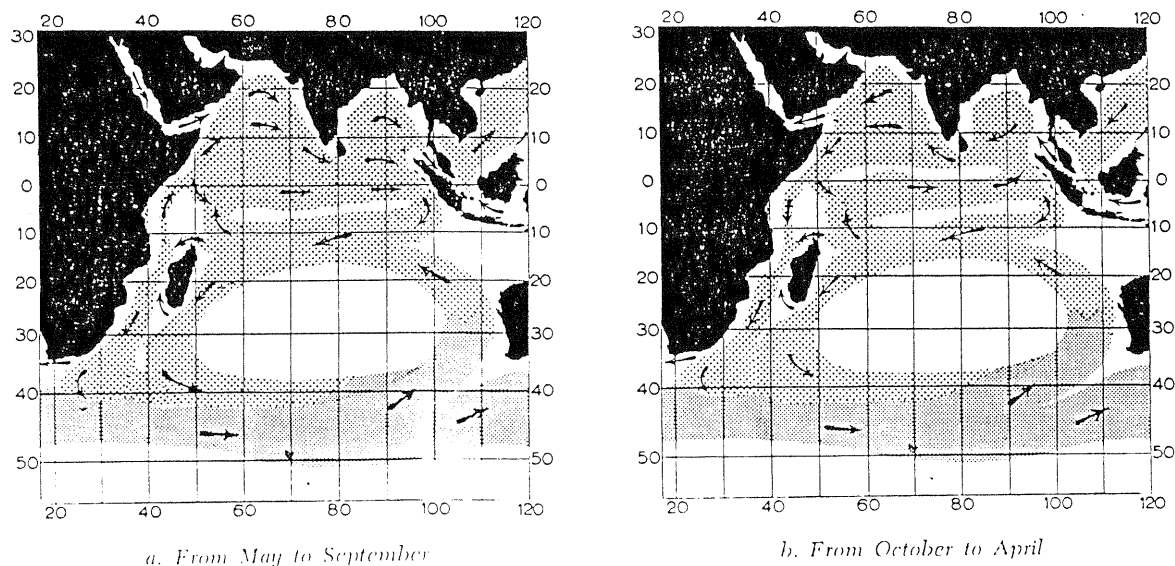


Fig. 13. Chart of the principal currents in the Indian Ocean.

hit by ships. Mr. J. J. Woodburns (Philadelphia) wrote us that fishermen of Pakistan and Iran informed Mr. DELICIOUS about whales washing ashore in these regions because they were hit by ships. The phenomenon apparently occurs very often. Strandings of whales at the coasts of the Persian Gulf have already been reported from 325 BC and from the year 922 (POUCHET, 1892, 1892a, 1893). The central part of the Ocean, where practically no whales were observed, is very poor with regard to food, whereas the In-

donesian waters and those between 30° S and 40° S are rich. The African east coast, although of lower productivity than the other areas, certainly may not be called a poor region.

It is quite certain that Sei Whales as well as Bryde Whales occur in the northern part of the Indian Ocean (for Bryde Whales see ANDERSON, 1878 and JENGE, 1950). Quite a number of Sei Whale sightings is reported from these regions by Captain MÖRZER BRUNS (table 5). This experienced observer was informed, however, about two strandings of Fin Whales near Bombay in the years after World War II. He reported personal observations of five Blue Whales in the Gulf of Aden and the Arabian Sea at 23-9-53, 24-9-53, 23-10-54, 28-10-57 and 31-10-57. ELLERMAN and MORRISON SCOTT (1951), CARTER, HILL and TATE (1946), CHASEN (1940) and WEBER (1923) mention the occurrence of Blue and Fin Whales in North Indian and Indonesian waters. Reliable strandings of Blue Whales have been reported by CHARI (1953; Bombay, 14-5-51), GIBSON-HILL (1950, 1950a; Malaya, 19-6-1892), BLANFORD (1891; Arrakan-Burma, 1851; Chittagong-India, 15-9-1842; Malabar, Ceylon, Bay of Bengal, Arabian Sea, coast of Baluchistan), DELSMAN (1951; S.coast of Java, 27-12-16; Madura, Dec. 1931) and DERANIYAGALA (1948; 10 strandings on the coast of Ceylon). The number of reliable strandings of Fin Whales is small. In the literature we could find only two records, viz.: on 7-12-37 at the coast of Java (DAMMERMAN, 1938) and on 11-12-13 near Bombay (GIBSON-HILL, 1950). Except these

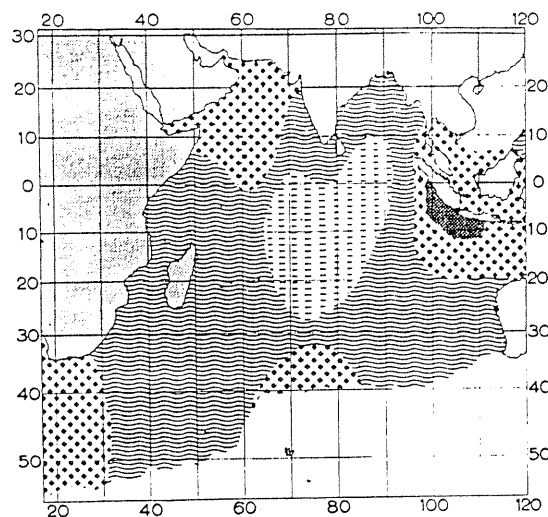


Fig. 14. Chart of the biological productivity of the Sea in the Indian Ocean. After WALFORD (1958). For explanation of symbols see fig. 6.

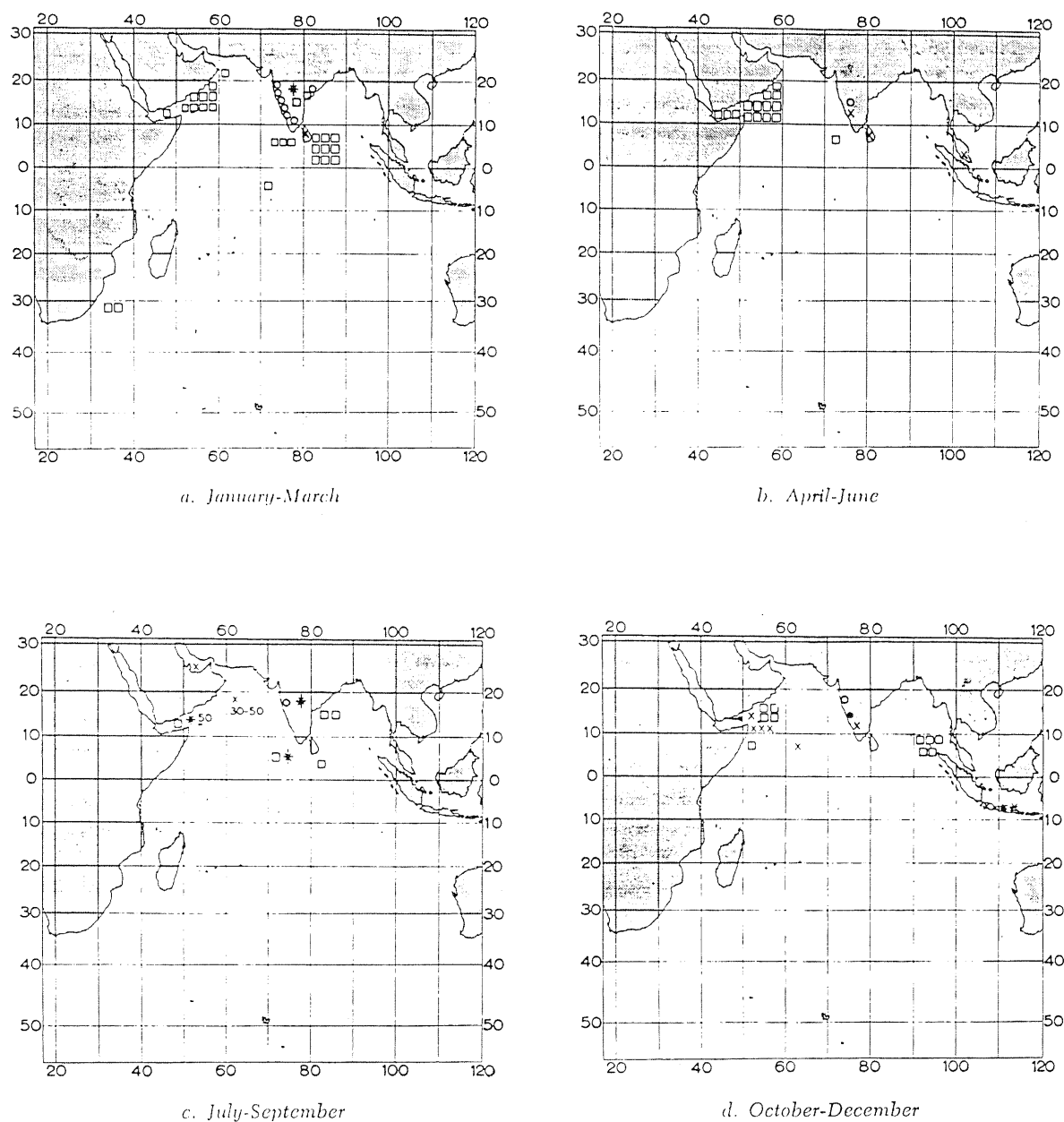


Fig. 15. Strandings of whales on the coasts of the Indian Ocean (indicated on land) and observations of Captain W. F. J. MÖRZER BRUINS (indicated in the sea) in the Indian Ocean.

Open circles : Blue or Fin Whales. The length and other characteristics of the animals exclude Sei and Bryde Whales.

Black dots : Fin Whales

Crosses : Blue Whales

Squares : Sperm Whales

Asterisks : Humpback Whales.

data there are a number of strandings that either bear on Blue or on Fin Whales because Sei and Bryde Whales can be excluded because of the length of the animals or other characteristics. Such a stranding from the Bengal coast (Jan.-Febr. 1934) has been reported by JONES (1953), whereas MOSES (1947), in a very important publication about the whales of these regions, gives a record of 16 strandings on the Indian coasts between 1842 and 1947. With the sightings of Captain MÖNZER BRUINS all the above mentioned strandings have been plotted on the charts of fig. 15. They show that it may be assumed that at least a certain part of the sightings in the northern part of the Indian Ocean bears on Blue or Fin Whales.

### 3. MIGRATION

The charts (2) show that during the southern summer (October-April) large concentrations of rorquals have been encountered in the northern part of the Indian Ocean, especially in the Gulf of Aden, the Arabian Sea, the Bay of Bengal and the waters of the Indonesian Archipelago. During the southern winter, on the contrary, i.e. in May, June, July and August, the number of sightings is strikingly small. During this season there are large concentrations at Madagascar and at the west coast of Australia. In the other months the number of whales sighted in these regions is much smaller. These facts are confirmed by the number of strandings in the different seasons. In the northern part of the Indian Ocean 13 strandings have been recorded from November to March against 4 from April to October.

These data suggest that at least the majority of the whales observed in the northern part of the Indian Ocean do not belong to the southern stock as was, for example, supposed by DERANIYAGALA (1948) and BROWN (1957). If that was true, large numbers of whales would have been sighted during the southern winter and small numbers during the southern summer, whereas just the reverse happened.

The assumption that the animals involved do not belong to the southern stock is further confirmed by DERANIYAGALA (1948) who reports about a female Blue Whale giving birth to a calf on 23d January 1946 off Ceylon, i.e. in a period of the year which is very unusual for births among southern Blue and Fin Whales. The observations are quite in accordance with the opinion of HARMER (1931), who says on page 112 about southern Blue and Fin Whales: "This may be taken to mean that they do not travel much beyond Durban."

An alternative would be the assumption that the

phenomenon is caused by migrations of a large proportion of Sei Whales belonging to the "Rorqual" group. This is not very well acceptable, because the phenomenon is also shown by Humpback Whales. An other alternative is either the assumption that there is a local stock of "Rorquals" in the northern part of the Indian Ocean without migration, or the assumption that the majority of the Blue and Fin Whales observed in the northern part of the Indian Ocean belong to the northern stock of the Pacific Ocean and that they enter the Indian Ocean by passing the South China Sea, Strait Malaya, Strait Sunda or other passages in the Indonesian Archipelago. This assumption is confirmed by the sightings plotted on the charts of the Pacific Ocean (3). From March to June and from September to December, (i.e. in the northern spring and autumn), there are a great many sightings in the South China Sea and in the Indonesian Archipelago, whereas in these regions there are practically no observations in January-February and in July-August. This points to a migration of North Pacific whales during the northern spring and autumn across these regions. It is quite probable that at least a part of these animals go to the Indian Ocean. It is a remarkable fact that this migration has never been observed in the comparatively narrow passages of the Indonesian Archipelago but, although there appear to be plenty of Baleen Whales in these regions, our knowledge of them has always been very scanty. In the literature we did not find even a single record about observations of whales in Strait Malaya. The occurrence, however, of a rock called Whale rock at the Malayan coast and a rock called Walvisch Klip at the coast of Sumatra points to the fact that whales must have been observed or probably caught in these regions, although they may have been Sperm Whales. In a letter Captain W. BAKKER refers to two sightings of large whales in Strait Malaya (1932, 1933) and to a sighting of two Sperm Whales in Strait Sunda (1935).

Further it may be pointed out that migration of rorquals from the Pacific Ocean into the Indian Ocean in the northern autumn, as well as a reverse migration in the northern spring would be greatly favoured by the direction of the stream in Strait Malaya. From November to April the direction of this stream is from the Pacific to the Indian Ocean, whereas it has the reverse direction during the period from May to October (South West Monsoon). Consequently the migrating whales could swim with the stream which has a velocity of 10-40 miles per day.

On the other hand we got very definite information from Dr. M. NISHIWAKI (Tokyo) as well as from

Captain C. HOKKE that there is no migration of whales at all in Strait Malaya and Strait Sunda. Probably at least the majority of the migrating whales avoid the rather shallow waters of the western part of the Indonesian Archipelago. They probably migrate into the Indian Ocean by passing the rather deep straits between the islands of the eastern part of the Archipelago.

The conclusion of all this may be, that there are indications that during the northern winter Blue and Fin Whales of the North Pacific stocks enter the northern part of the Indian Ocean to feed on the food which is abundantly available in these regions.

It is very difficult to decide whether during the southern summer, among this population in the northern part of the Indian Ocean, there may also be found a number of stragglers from the southern population. An indication about this question can be found in investigating how far these animals go to the North during the southern winter. There are a few observations of Captain MÖRZER BRUNS and a few strandings during the period April-September, pointing to the presence of Blue and Fin Whales in the North of the Indian Ocean. These may have been stragglers from the North Pacific stock, but they may also have belonged to the southern population.

In the zone between  $0^{\circ}$  and  $10^{\circ}$  S, a few animals have been sighted from April to August whereas during this season large concentrations have been observed at Madagascar and at the Australian west coast between  $10^{\circ}$  S and  $30^{\circ}$  S. This is quite in accordance with the catches of the land station at Durban (Natal;  $30^{\circ}$  S), where rorquals are caught from April to October with a peak in July-August (table 3). It is also in accordance with a written communication from the Director of the International Bureau of Whaling Statistics at Sandefjord, E. VANGSTEIN, who informed us that the catches of Blue and Fin Whales at Madagascar in 1937-1939 were made in June and July. This suggests that HARMER's (1931) remark may be right. Probably Blue and Fin Whales do not go much farther to the North than Durban.

It may be assumed that the majority of the southern Blue and Fin Whales of the Indian Ocean do not migrate farther north than  $10^{\circ}$  S or eventually than the equator. Sightings of whales accompanied by calves in June-September (see sub 4; fig. 16), however, show that at least a certain number of these whales may enter the northern part of the ocean and go into the Gulf of Aden, the Arabian Sea and the Bay of Bengal. Some of them probably stay behind there during the southern summer and mix with the Blue and Fin Whales of the North Pacific.

In the zone between  $30^{\circ}$  S and  $40^{\circ}$  S a great number of sightings is recorded from October-December. In January and February the number of sightings is much less, but during these months there was not much shipping in this zone. In March-April the number of sightings is increased again, but it is rather small in May-September. These facts, the catches at Durban and Madagascar, as well as the concentrations of whales between  $30^{\circ}$  S and  $10^{\circ}$  S, along the African and Australian coasts during the southern winter suggest a northward migration in the southern autumn and a southward migration in the southern spring. This confirms the well known data gained in southern whaling research.

In the zone between  $30^{\circ}$  S and  $40^{\circ}$  S sightings are reported almost equally over the entire breadth of the Ocean. Between  $10^{\circ}$  S and  $30^{\circ}$  S, however, they are mainly made at the African and Australian coasts. This suggests a migration with a large frontier from the Antarctic to about  $30^{\circ}$  S. North of  $30^{\circ}$  S they obviously separate into a group going to the African and a group going to the Australian coast. Apparently they avoid the poor waters in the central part of the Ocean.

During the southern summer the majority of the rorquals certainly can be found south of  $40^{\circ}$  S and, as is generally known, principally in Antarctic waters. Nevertheless the charts clearly show that a certain part of the stock stays behind in tropical and subtropical waters and can be found up to the equator, or eventually even in the northern part of the Indian Ocean. Consequently the same phenomenon as was described from the North and South Atlantic, is also met with in the Indian Ocean. It is very difficult to make an estimation about the size of this part of the stock, but it may be assumed that at least in African coastal waters it will not be an insignificant part.

Although it is accepted that during the southern winter a certain number of Blue and Fin Whales will be present south of  $40^{\circ}$  S, this could not be demonstrated, because no reports about this region were available. It is evident, however, that in this season the majority of the rorquals will occur north of  $30^{\circ}$  S, because no sightings were reported from the zone between  $30^{\circ}$  S and  $40^{\circ}$  S in June, July and August.

#### 4. CALVES

Just as has been argued with regard to the Atlantic Ocean, it may be assumed that sightings of calves principally bear on comparatively young calves. Fig. 16 shows that in the Indian Ocean north of  $10^{\circ}$  S, calves have been encountered during the whole year

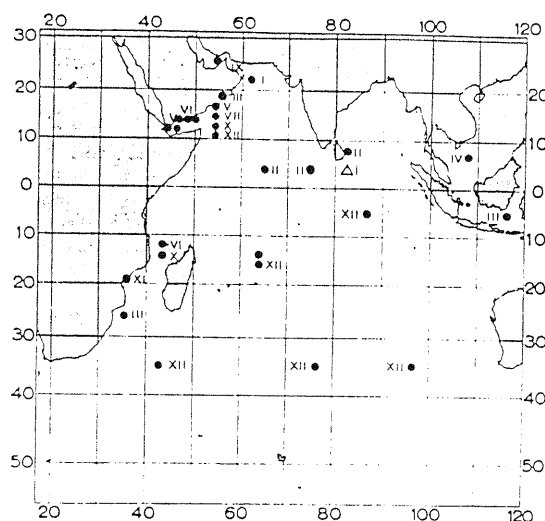
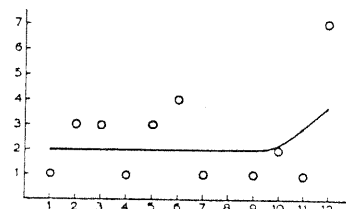


Fig. 16. Chart of the sightings of calves of Rorquals in the Indian Ocean. Each symbol refers to one single sighting, to which the month of observation is indicated. Triangle: Observation of DERANIYAGALA (1948).

Fig. 17. Graph of the number of calves sighted monthly in the Indian Ocean.



in almost equal numbers (see horizontal line of fig. 17 and compare it with fig. 11). This may be explained by assuming that in this region representatives occur both of the North Pacific stock and the South Indian stock. If there would be a local (not migrating) stock in the northern part of the Indian Ocean its breeding season would be approximately the same as that of the migrating stocks in the northern hemisphere. The majority of the observations of calves south of  $10^{\circ}$  S is made in October, November and December. Evidently these observations bear on southern whales migrating southward with their calves. GIBSON HILL (1950a) describes a stranding of a suckling Blue Whale calf (length 14 m) at Malaya on 19-6-1892. This may have been a late migrator to the North Pacific, as well as a "southern" calf.

## 5. CONCLUSIONS

It may be assumed at least a certain part of the sightings plotted on the charts refer to Blue and Fin Whales. Possibly the majority of them do so. A number of arguments is discussed, pointing to the assumption that during the northern winter the northern part of the Indian Ocean is invaded by Blue and Fin Whales of the North Pacific stocks. They presumably enter and leave the Indian Ocean by passing

the interinsular passages of the eastern part of the Indonesian Archipelago.

In the Indian Ocean the distribution of rorquals principally is determined by the distribution of food as well as by the course of the ocean currents. This causes the presence of big concentrations of whales in the Gulf of Aden, the Arabian Sea, the Bay of Bengal, the Indonesian waters and some East African waters.

The majority of the southern Blue and Fin Whales stop their northward migration at about  $0^{\circ}$  to  $10^{\circ}$  S, a certain part of the stock, however, is assumed to enter the northern part of the Indian Ocean. During the southern winter the majority of the stock is supposed to live north of  $30^{\circ}$  S, although a certain part of the population will be found in higher latitudes.

There are indications that the southern whales migrate north- and southward over the whole breadth of the Ocean in regions south of  $30^{\circ}$  S. North of this zone they appear to avoid the poor regions in the central part of the Ocean and mainly migrate along the African and Australian coasts.

During the southern summer the majority of the stock evidently has migrated into Antarctic waters but quite certainly a part of the population remains behind in tropical and subtropical waters.

## C. PACIFIC OCEAN

### Chart 3

#### 1. GENERAL REMARKS. DISTRIBUTION

The total number of rorquals sighted in the Pacific Ocean was 652, viz.: 533 in the North Pacific and 119 in the South Pacific. The chart (fig. 3) shows

that the number of hours steamed in the Pacific was significantly smaller than in the Atlantic and in the Indian Ocean. In the South Pacific there is only a reasonable number of steaming hours along the coast

of Australia. Moreover there is a certain number of observations on the route between Australia and Panama, but this route was not sailed in every month. In the North Pacific there is a large number of hours steamed between Indonesia and Japan and on the routes between these two countries on the one side and North and Middle America on the other side. Especially in the central and in the south-eastern part of the ocean there are vast areas in which there was no shipping at all.

Consequently lack of sufficient data makes it impossible to draw conclusions with regard to a correlation between the distribution of the whales and the course of the ocean currents or the amount of food available. With regard to food this is the more difficult because, according to WALFORD (1958), there are no very poor regions in the Pacific.

## 2. MIGRATION

Sightings of rorquals have been made in every month of the year off the west coast of North America between  $10^{\circ}$  N and  $50^{\circ}$  N. According to WALFORD (1958) the biological productivity of this region is large, especially between  $25^{\circ}$  N and  $40^{\circ}$  N. Evidently the sightings do not bear exclusively on Sei or Bryde Whales, because the Californian land station (table 3) as well as catchers operating at the Mexican Pacific coast in 1935 (communication from E. VANGSTEIN-Sandefjord) took only very few Sei Whales but comparatively large numbers of Blue and Fin Whales. J. J. WOODBURN (Philadelphia) informed us about a sighting of a Blue Whale by the captain of S.S. Mormacrey at 23d July 1961 in the Bay of California ( $27^{\circ}$  N). GILMORE (1961) reports the catch of 26 Blue Whales in Monterey area (Cal.,  $37^{\circ}$  N) in October 1958, and KELLOGG (1929, p. 487) says that Blue Whales occur at all seasons off the coast of California.

Although there has been shipping at the South American West coast between  $0^{\circ}$  and  $10^{\circ}$  N during the whole year (and during a number of months also between  $0^{\circ}$  and  $10^{\circ}$  S) sightings of whales from this region have only been reported from July and only between  $0^{\circ}$  and  $10^{\circ}$  N. If the whales that were sighted and caught at the Californian and Mexican coasts during the northern summer belonged to the southern stock, it might be expected that there would have been a comparatively large number of sightings between  $10^{\circ}$  N and  $10^{\circ}$  S between May and October. The animals observed in July between  $0^{\circ}$  and  $10^{\circ}$  N may have been southern whales in their most northern winter quarters. That many southern whales do not migrate into the Antarctic in the southern summer, is indicated by the catches of Chilean land

stations ( $33^{\circ}$  S), which show a peak in Blue and Fin Whale catches in January and February (table 3).

The fact that even during the northern winter no sightings were made in the zone between  $0^{\circ}$  and  $10^{\circ}$  N may indicate that the majority of the Eastern North Pacific Blue and Fin Whales do not migrate farther to the South than about  $10^{\circ}$  N. It may be supposed, however, that some go down to the equator and mix with their southern relatives in the zone between  $0^{\circ}$  and  $10^{\circ}$  N, the more so as this region is rather rich with regard to food.

KELLOGG (1929) says that especially Blue Whales occur at the Californian coast during the northern summer, whereas table 3 shows that the Californian Fin Whale season (at about  $37^{\circ}$  N) lasts from April to October with a peak in August. The catches at the Mexican Pacific coast were made in April-June. These data and the charts suggest that during the northern summer comparatively large numbers of Blue and Fin Whales do not migrate to the North. Obviously they stay in warm and temperate waters up to about  $20^{\circ}$  N.

This, however, does not mean that there is no migration at all. KELLOGG (1929) says that there is a distinct migration of Fin Whales along the North American west coast from Lower California to the Bering Sea. On their route northward they pass Vancouver Island in March. On the other hand KELLOGG (1929) reports that individual Fin Whales are commonly taken at the Californian and Oregon coasts in May, June, July and August. A significant migration into northern waters is also indicated by the catches of Blue and Fin Whales in these regions, i.e. at British Columbia, at the Kurilles, in the Bering Sea, at Kamchatka and at Japan (table 3). In all these regions the whaling season is from April to October with peaks in June-August.

Without doubt the major part of the North Pacific stock will stay during the summer in these northern waters. OMURA (1955) has shown that Blue Whales do not migrate into regions North of the Aleutians (about  $52^{\circ}$  N), whereas Fin Whales go into the Arctic Ocean north of  $65^{\circ}$  N. Consequently during the northern summer the situation with regard to the North Pacific stocks of Blue and Fin Whales will be more or less the same as has been described with regard to the North Atlantic.

Because there is no whaling in California ( $37^{\circ}$  N) and in Japan ( $35^{\circ}$  N) from November to March it is quite evident that during the northern winter at least the majority of the North Pacific whales will stay at comparatively low latitudes, probably between  $10^{\circ}$  N and  $30^{\circ}$  N, whereas a certain number of the ani-



mals may go as far as the equator. This is quite in accordance with the fact that in the zone between  $30^{\circ}$  N and  $40^{\circ}$  N in the central part of the ocean rorquals have been sighted practically only during the northern summer. That at least a part of these summer-sightings bears on Fin Whales, is confirmed by an observation of Captain MÖRZER BRUINS on 25-6-57 in the square  $20^{\circ}$  N to  $30^{\circ}$  N  $150^{\circ}$  W to  $160^{\circ}$  W. Some observations along the North American east coast between  $30^{\circ}$  N and  $40^{\circ}$  N, show that at least a certain part of the stock may be present up to about  $40^{\circ}$  N even during the northern winter. Unfortunately the number of hours steamed south of  $30^{\circ}$  N is so small that the supposed occurrence of large numbers of whales between  $30^{\circ}$  N and  $40^{\circ}$  N could not be demonstrated.

It has already been discussed that during the northern winter a great number of Blue and Fin Whales belonging to the western part of the North Pacific population probably migrate into the northern part of the Indian Ocean, whereas it may be assumed that another part of this stock will stay in the waters of the Indonesian Archipelago. In Indonesian waters rorquals have been observed during the whole year. Strandings at Java, Madura and near Singapore (see sub B) confirm the occurrence of Blue and Fin Whales in these regions. Sightings on the Australian east coast in August-October and in May suggest a migration from the Antarctic to Indonesian waters during the southern autumn and back during the southern spring. The situation with regard to the Australian land stations probably will be the same as at the Atlantic coast of S. America (see sub A), although between 1948 and 1958 one Blue Whale has been caught at Tangalooma. It may be supposed that the northern and southern populations meet in Indonesian waters.

### 3. CALVES

That northern as well as southern rorquals migrate into the Indonesian Archipelago is confirmed by sightings of calves in these waters, which have been made in January, April, May and November (table 4).

The sighting of a calf south of Australia in September is in accordance with the generally accepted opinion about the migration of southern rorquals. This sighting of a calf in the Gulf of Panama in October may be an indication that southern rorquals migrate northward into these regions ( $9^{\circ}$  N). Apart from the above mentioned data, the number of sightings of calves is too small to draw further conclusions.

### 4. CONCLUSIONS

The number of sighting of rorquals in the Pacific Ocean is too small to draw definite conclusions about the distribution of these animals. Some data, however, lead to the assumption that their distribution is especially influenced by the biological productivity of the sea.

During the northern summer the major part of the northern population lives in cold waters, but a significant number of animals apparently stay in warm and temperate waters, just as it has been pointed out with regard to the Atlantic Ocean. The southern border of the population is estimated at about  $20^{\circ}$  N, although some individuals may stay farther to the south.

During the northern winter the majority of the northern population apparently live south of  $30^{\circ}$  N, although some animals may stay as far north as about  $40^{\circ}$  N. The southern border is supposed to lie at about  $10^{\circ}$  N at the American side of the ocean, although a certain number of whales will go farther down where they are supposed to meet the southern population.

At the Asiatic side of the ocean a certain part of the whales is supposed to migrate into the northern part of the Indian ocean, whereas others will pass the winter in the waters of the Indonesian Archipelago as far as about  $10^{\circ}$  S.

Very little can be concluded about the southern stock. There are, however, indications that during the southern winter they go northward as far as  $10^{\circ}$  N in American waters and probably also as far as this latitude in waters of the Indonesian Archipelago.

## III HUMPBACK WHALES

### A. ATLANTIC OCEAN

#### Chart 4

#### 1. GENERAL REMARKS

There have been reported 502 sightings of Humpbacks from the Atlantic Ocean, viz.: a total of 364 animals sighted in the North Atlantic and 138 in the

South Atlantic. Compared with the rorquals this number is very small, but it must be kept in mind that "rorquals" represent three species, although the majority of them may be Fin Whales. On the other

hand it may be accepted that the population of Humpbacks in the Atlantic in reality is small. The decreasing catches of this species in the North Atlantic obliged the International Whaling Commission to forbid the taking of Humpback Whales. Moreover, MACKINTOSH (1942) calculated that about 1940 the Southern Ocean population of Blue, Fin and Humpback Whales consisted of only 10% Humpbacks. In recent years certain measures were taken to restrict the catching of these southern Humpbacks as well.

The average number of animals in herds, the number of which could be determined exactly, was 2.40, the average of the not quite so reliable observations amounted to 9.47. This means that Humpbacks were often sighted in rather small groups. Some groups contained more than 10 animals and once a herd of more than 100 has been reported. It may be supposed that the determination of the species is fairly reliable.

## 2. DISTRIBUTION

There is a general belief that, at least on their migration routes to and from the tropics, Humpbacks principally keep to coastal waters. It has even been shown that the distribution of Humpbacks in the Antarctic is highly influenced by this migration along the coasts of the continents. It is not yet known whether this type of migration is based on the course of the big ocean currents along these coasts, or on other factors. In fig. 2 of KELLOGG (1929) the migration of Humpbacks in the North Atlantic is restricted to those currents that run along the coasts, whereas, for example, no migration is indicated in that part of the Gulf Stream that crosses the Atlantic from West to East.

Our charts, however, show that a number of Humpbacks have been sighted in this crossing part of the Gulf Stream (North Atlantic Current), even in the central part of the North Atlantic. The observations in this region have been made from June to October (especially in July and August), between 30° N and 50° N (especially between 40° N and 50° N). In this respect it may also be pointed out that, according to the data in International Whaling Statistics, the land stations in Spain, Portugal and Spanish Morocco never took one single Humpback. On our charts there are also very few sightings from this region, although a great many rorquals have been observed. Probably they avoid the coasts in these regions rather than keeping to coastal waters.

KELLOGG (1929) indicates that Humpbacks cross the South Atlantic in the Southern connection between the Brazil current and the Benguela current from

South America to South Africa and backward. In this zone, however, no sightings were reported from the central part of the ocean, although there are quite a number of sightings of rorquals. This is confirmed by the charts of TOWNSEND (1935). These charts show that American whalers took no Humpbacks at these latitudes in the central part of the South Atlantic, although they caught a great number of Right and Sperm Whales. The fact that migration of Humpbacks was not indicated by CLARKE (1957; fig. 2) in the above mentioned part of the Benguela Current, may also point to the fact that KELLOGG's figure is not correct with regard to this special point.

With the exception of the crossing part of the Gulf Stream no sightings have been reported from the central part of the Atlantic Ocean. BROWN (1958), however, mentions three observations off St. Helena (16° S), west of the Benguela Current, in December, April and June.

Probably animals staying in comparatively low latitudes during the summer season, may not strictly keep to coastal waters.

## 3. MIGRATION

### North Atlantic

KELLOGG (1929) describes a very distinct migration of Humpbacks from tropical waters to the Arctic Ocean and back. In our charts this migration does not stand out very clearly, because no Humpbacks were sighted north of 50° N, although a great number of rorquals was observed at these latitudes.

MÖRCH (1911) and KELLOGG (1929) say that Humpbacks go far to the North. They have been sighted off Bear Island and Spitzbergen. Large schools were seen passing the Scottish and Norwegian coasts. According to VAN BENEDEN (1889) the ratio between the number of Humpbacks and the total number of whales taken off the coast of Finmarken was 1:8 in the second part of the 19th century. Without doubt this ratio is influenced by the fact that in those days Humpbacks were selected, because they are much easier to take than other rorquals. Nevertheless there is a great difference with recent catches. In 1950-1955 the land stations in Norway, Iceland and the Faroes show a ratio of about 1:100, indicating that nowadays the number of Humpbacks passing the northern part of the North Atlantic and migrating into Arctic waters is very small. Whether this phenomenon is caused only by the general depletion of the Humpback stock in the North Atlantic or also by other factors will be discussed later on.

At the American coast the situation evidently is

more favourable (ratio of about 1:15). This, however, may be at least partly ascribed to the fact that the land station at New Foundland is situated farther to the South ( $46^{\circ}$  N) than the European land stations (all above  $60^{\circ}$  N). VAN BENEDEN et GERVAIS (1880) say that Humpback Whales of the American coastal waters migrate into Davis strait at least up to  $64^{\circ}$  N, but WILLIAMSON (1961a) describes large concentrations of Humpbacks in New Foundland waters in June-September. Probably the majority of these animals do not migrate to the North nowadays.

VAN BENEDEN et GERVAIS (1880, p. 123) and ALLEN (1916, p. 305) have pointed to the fact that Humpback Whales, although occurring in coastal waters, apparently very rarely wash ashore. Nevertheless some strandings of Humpbacks on European coasts have been reported by VAN BENEDEN et GERVAIS (1880; 17-8-1866, mouth of the Elbe; 9-4-1851, Reval, Baltic; Firth of Forth; Newcastle; Berwick; Dec, 1863), VAN BENEDEN (1889; 1824 mouth of Elbe; 1819 coast of Holstein; Greifswald, Stettin, Reval), TURNER (1912; 1-4-1871, Wick Bay; 7-1863, Mersey), FREUND (1932; 1803 Göteborg), LILLJEBORG (1862; April 1846, Stavanger), VAN BENEDEN (1889; 6-1-1877; Noirmoutier, Vendée; 11 January 1884, Tay estuary; March 1545 Greifswald; 1628 Stettin) and MOHR (1935; 11-1824, Elbe; 2-9-1905, West coast of Jutland). VAN BENEDEN et GERVAIS (1880) write about the distribution of the Humpback: "accidentellement dans la mer du nord". These data show that in former days there have been strandings of Humpbacks, even during the winter season between  $50^{\circ}$  N and  $60^{\circ}$  N. It is a remarkable fact, however, that although the information with regard to strandings has much improved during the 20th century, and although some authors carefully collected the available data, neither HARMER (1927), nor FRASER (1934, 1953), nor VAN DEINSE (1931, 1946) reported even one single stranding on the British and Dutch coasts. As far as we know, no strandings north of  $50^{\circ}$  N happened since 1905. This may be caused by the general decrease of the Humpback stocks, but it may also be caused by a change in migratory habits of the animals.

In any case it may be assumed that at present the northern border of the majority of the Humpback stock in the North Atlantic during the summer lies at about  $50^{\circ}$  N, although it is quite certain that at least a number of animals go farther northward and even may go into Arctic waters as in former times.

During the winter the majority of the Humpbacks certainly stay farther to the South. From December to March no Humpbacks were sighted between  $40^{\circ}$

N and  $50^{\circ}$  N, in November and April their number is small, in May, September and October it is a little bit larger, whereas in these zones fairly large numbers have only been reported in June, July and August. This suggests a northward migration in the spring and a corresponding southward migration in the autumn. VAN BENEDEN et GERVAIS (1880) and KELLOGG (1929) say that some animals may be found during the winter at high latitudes, even in the open Arctic waters. MÖRCH (1911) describes their occurrence off the Finmark coast in January and February, and VAN BENEDEN et GERVAIS (1880), TURNER (1912) and MOHR (1935) report about strandings in January 1884 (Firth of Tay), and November 1824 (mouth of the Elbe). Apparently, at least in former days, a certain number of Humpbacks stayed in northern waters during the winter. It may be stated, however, that at present,  $40^{\circ}$  N may be considered as the northern border of at least the majority of the Humpbacks during the winter.

In June, July and August there are practically no sightings south of  $30^{\circ}$  N. Arguments in favour of the assumption that the sightings of September between  $20^{\circ}$  N and  $30^{\circ}$  N bear on southern animals, will be adduced further on. Apparently the majority of the Humpback Whales of the North Atlantic live during the summer between  $30^{\circ}$  N and  $50^{\circ}$  N, although some animals may go farther to the North, even into Arctic waters.

It is possible that in former times the Humpback population lived farther northward than nowadays. This may not only be deduced from what has already been mentioned with regard to strandings and catches north of  $50^{\circ}$  N, but also from the fact that the charts of TOWNSEND (1935) do not show even a single capture of a Humpback in the North Atlantic north of  $35^{\circ}$  N. Exactly in the zone between  $30^{\circ}$  N and  $50^{\circ}$  N, from which a great number of sightings is reported all over the ocean, American whalers of the 19th century took a great number of Sperm Whales, but no Humpbacks at all.

It has already been pointed out that the northern border of the majority of the Humpbacks during the winter may be found at about  $40^{\circ}$  N. With regard to the southern border during the winter, it can be said that sightings from January to April have been reported from the Caribbean as well as from the North African west coast. This is quite in accordance with what is known from literature. GRAY (1866), COPE (1871), VAN BENEDEN et GERVAIS (1880), MÖRCH (1911), ALLEN (1916) and KELLOGG (1929) mention the occurrence of Humpback Whales in the Caribbean Sea and at Bermudas from January to May.

They give birth to their young in these regions and start migrating to the North along the American east coast in May. TOWNSEND's (1935) charts confirm these data. The sighting and capture of a Humpback at Bermudas on 14-11-42 apparently bears on an early visitor (WHEELER, 1943).

The same behaviour of Humpbacks has been reported by VAN BENEDEN (1889), KELLOGG (1929), TOWNSEND (1935) and NORMAN and FRASER (1948) with regard to the North African west coast, the Azores and the Cape Verdian Isles. CADENAT (1955) records a stranding at Port Etienne ( $21^{\circ}$  N) in February 1954 and says that Humpbacks occur and are caught in great numbers on the coast of French Equatorial Africa.

In November, December, February and March sightings have been reported between  $0^{\circ}$  and  $10^{\circ}$  N, whereas there are sightings between  $0^{\circ}$  and  $10^{\circ}$  S in January, February and March. It is unlikely that these sightings bear on southern Humpbacks, because the whaling season at Gaboon (nearly at the equator) lasts from June to October, and because there are no sightings of Humpbacks during the southern summer (December-February) between  $10^{\circ}$  S and  $30^{\circ}$  S. Consequently we may assume that the sightings involved bear on northern animals, the more so as the occurrence of representatives of the North Atlantic stocks in these regions has also been demonstrated with regard to rorquals. Consequently the southern border of the northern population during the winter can be determined at about  $10^{\circ}$  S, although it is quite probable that the majority of the stocks does not go so far to the South.

#### South Atlantic

It has already been pointed out that during the northern summer (i.e. the southern winter) there are no or at least practically no northern Humpbacks south of  $30^{\circ}$  N. Consequently we may assume that the Humpbacks sighted off the North African west coast between  $0^{\circ}$  and  $10^{\circ}$  S in August belong to the southern stock. KELLOGG (1929) writes that southern Humpbacks do not migrate farther to the North than  $7^{\circ}$  N, but our charts show quite a number of sightings in September, up to  $20^{\circ}$  N. Apparently they reach their most northern border in this month.

During the southern winter no sightings have been reported from the Caribbean, nor from the South American east coast, north of the equator. This may point to the fact that at the western side of the South Atlantic Humpbacks do not migrate as far to the North as at the eastern side. All Humpbacks visiting the Caribbean apparently are northern animals.

Catches of Humpbacks off the Brazilian coast (table 3) and observations made by MURPHY (1947) during a trip on a whaling vessel (sightings at  $13^{\circ}$  S  $33^{\circ}$  W, and  $17^{\circ}$  S  $33^{\circ}$  W) confirm the assumption that at this side of the ocean the southern Humpbacks migrate during the southern winter as far as the equator.

The charts show that during the southern winter (June-September) the southern border of the population is found at about  $30^{\circ}$  S. There were 4723 hours steamed in daylight in June-September between  $30^{\circ}$  S and  $40^{\circ}$  S, but no Humpbacks were sighted in this zone, indicating that at least the majority of these animals live north of  $30^{\circ}$  S.

In December, January and February no sightings were reported from the zone between  $10^{\circ}$  S and  $30^{\circ}$  S. This may indicate that during the southern summer the northern border of the Humpback stock lies at least at  $30^{\circ}$  S. Catches in the Antarctic, however, make it clear that the majority of the stock live at comparatively high latitudes, the southern border being the border of the pack ice.

#### 4. CALVES

Data given by VAN BENEDEN (1889), ALLEN (1916), KELLOGG (1929) and NORMAN and FRASER (1948) indicate that the Humpbacks of the North Atlantic stock give birth to their calves during the northern winter at comparatively low latitudes, the observation of WILLIAMSON (1961a) of a Humpback with a suckling calf on 8-3-61 at  $42^{\circ}$  N, certainly being an exception. Most of the calves would be born in April. All sightings of calves, that have been reported to us (fig. 18, table 4), are from May, June and July, and all have been made at latitudes where in these months calves had to be expected, those between  $10^{\circ}$  N and  $10^{\circ}$  S included (see sub 3). Consequently, the sightings confirm the above-mentioned opinion.

Seven calves of the southern population were sighted in September between  $30^{\circ}$  N and  $20^{\circ}$  S, 5 off the African and 2 off the American coast. This is quite in accordance with the data of NORMAN and FRASER (1948). They say that the majority of the southern Humpbacks are born in September and that quite a number of newborn animals were observed at the North African west coast. Apparently the Humpbacks give birth to their young shortly before they leave their winter quarters.

#### 5. CONCLUSIONS

The number of sightings of Humpbacks in the Atlantic Ocean is comparatively small because at present the stocks are small.

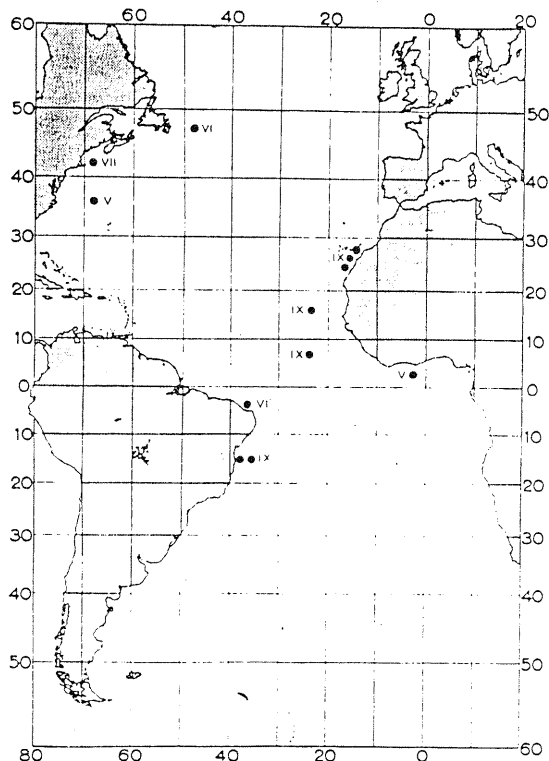


Fig. 18. Chart of the sightings of calves of Humpback Whales in the Atlantic Ocean. Each symbol refers to one single sighting to which the month of observation is indicated.

Apparently Humpbacks live and migrate principally in coastal waters, but a number of those animals, which stay during the summer in low latitudes, also go to the central part of the ocean, especially to the crossing part of the Gulf Stream.

Some indications point to the supposition that in former days at least the majority of the Humpback stock in the North Atlantic lived farther to the North

than at present, during the summer as well as during the winter. This does not only bear on the northern but also on the southern border of the population in both seasons. The reason of this phenomenon is yet far from clear. One might think that feeding conditions have changed during the last 150 years because of the rise of the temperature of the Atlantic Ocean. One might also think that by the general decrease of the North Atlantic whale stocks Humpbacks are no longer forced to go as far to the North as in former days because they can find plenty of food in lower latitudes.

Distinct seasonal migrations of Humpback Whales could be demonstrated in the North as well as in the South Atlantic. Apparently there is always a certain distance between the southern border of the northern population and the northern border of the southern population. This means that the chance of an exchange of animals between the northern and the southern stock is much less than it is supposed with regard to Blue and Fin Whales.

The majority of the northern stock can be found between 30° N and 50° N during the northern summer and between 10° S and 40° N during the northern winter. During the winter season the animals especially concentrate in the Caribbean and off the North African west coast.

The majority of the southern population is found during the southern winter between 30° S and the equator at the western side of the ocean and between 30° S and 20° N at the eastern side. Southern Humpbacks apparently do not enter the Caribbean Sea. During the southern summer the Humpbacks live between 30° S and the border of the pack ice.

Sightings of calves confirm the opinion that those of the northern Humpbacks are mostly born in April and those of the southern population in September, both at fairly low latitudes.

## B. INDIAN OCEAN

### Chart 5

#### 1. GENERAL REMARKS; DISTRIBUTION

The total number of sightings of Humpbacks in the Indian Ocean amounts to 500. The general picture of the distribution of the sightings agrees with that of Browns (1957), whose charts show 15 observations referring to some 61 animals. The comparatively small number of Humpback sightings may be explained in the same way as has been done sub A with regard to the Atlantic Ocean.

Just as in the Atlantic, the majority of the animals were observed in coastal waters. This confirms the generally accepted opinion about the migration and distribution of this species. Some observations in the northern part of the Indian Ocean, however, point to the fact that in their winter quarters the animals also spread over the central part of the ocean.

A large number of sightings was reported from the Arabian Sea, the Gulf of Aden and the Bay of Ben-

gal, just as was the case in rorquals. In literature Humpbacks have been reported from these regions by POUCHET (1892, 1892a; animal stranded in 325 B.C.), VAN BENEDEN et GERVAIS (1880; skeleton in the Calcutta Museum), VAN BENEDEN (1889; animal entangled in a cable in the Persian Gulf), GERVAIS (1883; skeleton from the Bay of Bassora, Persian Gulf), BLANFORD (1891) and CARTER, HILL and TATE (1946). A stranding at Pekalongan (north coast of Java) which bears on a Humpback according to VAN BENEDEN et GERVAIS (1880), took place on 12-4-1863 (ANONYMOUS, 1864). Captain MÖRZER BRUINS reported some sightings of Humpbacks from the northern part of the Indian Ocean (September 1953).

## 2. MIGRATION

The charts clearly show that the majority of the sightings from the northern part of the Indian Ocean, have been made either in August-November or in January-April.

Especially in June the number of sightings is significantly small. This phenomenon points to the fact that the animals sighted in January-April do not belong to the southern stock, or that at least the majority of them do not belong to that stock, as was suggested by BROWN (1957). BROWN considers the animals sighted in the northern part of the Indian Ocean during the southern summer as stragglers of the southern stock. This, however, is not in accordance with the small numbers observed in June, July and December.

If it is taken into account that staying behind at low latitudes during the summer of Atlantic Humpbacks is much less pronounced than in rorquals, it may be assumed that the majority of the Humpbacks in the northern part of the Indian Ocean, observed during the southern winter, belong to the southern stock, whereas those observed during the northern winter belong to the population of the North Pacific. This is quite in accordance with our opinion on the migration of rorquals (see sub II B). Unfortunately there are no sightings of Humpbacks in the South Chinese Sea or in the Indonesian Archipelago which could support this assumption.

The large number of Humpbacks observed in the area of Madagascar in June, July and August (but only in these months; there are practically no sightings in the remaining part of the year) is quite in accordance with the data of TOWNSEND (1935), with those of table 3, and with some data provided by Mr. E. VANGSTEIN (Sandefjord) about catches off the coast of Madagascar in 1937-1939. They all refer to catches in June-September only, with a peak in July-August. The whaling season at Durban lasts from May to

October with a peak in June-July. There is a quite remarkable number of sightings in the area between  $50^{\circ}$  E and  $70^{\circ}$  E and  $0^{\circ}$  to  $10^{\circ}$  S (area of the Seychelles) in April and August. They suggest a northward and a southward migration of southern animals. TOWNSEND (1935) reports large catches of Sperm Whales from this region, but no Humpbacks.

Catch figures of the West Australian land stations Point Cloates and Carnarvon (table 3), as well as data given by TOWNSEND (1935), are in accordance with our sightings in this area. The whaling season in this region lasts from June to October with a peak in July-September.

With regard to the southern population the charts suggest that during the southern winter Humpbacks live between the Asiatic continent and about  $30^{\circ}$  S. During the southern summer the northern border of the population is supposed to lie south of  $40^{\circ}$  S, probably even south of  $50^{\circ}$  S. Sightings in November and March off the African coast between  $20^{\circ}$  S and  $30^{\circ}$  S probably refer to early, resp. late migrators. The southern border of the stock during the summer obviously lies at the pack ice.

Just as it has been pointed out with regard to the Atlantic Ocean, there are indications that Humpbacks show a more complete migration than rorquals, i.e. that the number of animals staying behind in warm waters is significantly smaller than in rorquals.

## 2. CALVES

Fig. 19 shows that the number of calves sighted in the Indian Ocean is small. All observations were

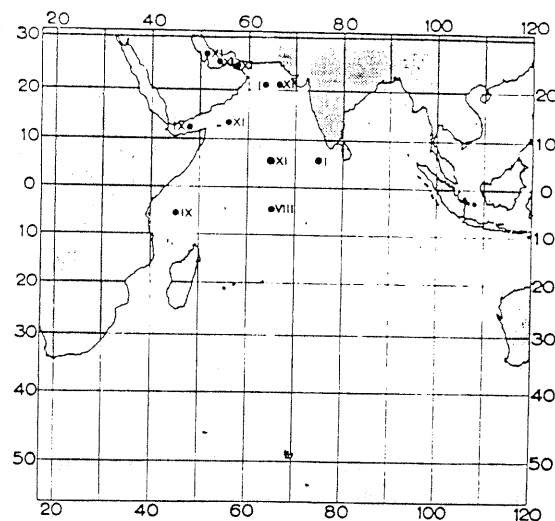


Fig. 19. Chart of the sightings of Calves of Humpback Whales in the Indian Ocean. Each symbol refers to one single observation. All observations were made between August and January.

made between August and January, all were made north of  $10^{\circ}$  S and all were made west of  $80^{\circ}$  E, i.e. in the N.W. part of the Indian Ocean. The fact that in this region calves have been encountered in the northern as well as in the southern winter, points to the fact that Humpbacks belonging to the North Pacific population enter the Indian Ocean during the northern winter.

#### 4. CONCLUSIONS

The conclusions that can be drawn from the sightings of Humpbacks in the Indian Ocean confirm those of the Atlantic with regard to the small number of observations, the migration in coastal waters, the

spreading in the winter quarters as well as with regard to the fact that the number of stragglers in warm waters during the summer is significantly smaller than in rorquals.

Just as has been pointed out with regard to rorquals, there are strong indications that North Pacific Humpbacks migrate into the northern part of the Indian Ocean during the northern winter. Apparently they give birth to their young in these regions.

A definite migration of the southern population could be determined. During the southern winter the majority of the population lives between the Asiatic continent and  $30^{\circ}$  S. During the southern summer they can be found principally between  $40^{\circ}$  S or  $50^{\circ}$  S and the pack ice.

### C. PACIFIC OCEAN

#### Chart 6

##### 1. GENERAL REMARKS; DISTRIBUTION

There were available 302 sightings of Humpbacks in the Pacific Ocean, viz.: 116 in the North Pacific and 186 in the South Pacific. For such a vast area the number of observations is very small. They do not offer a very safe basis for conclusions. Nevertheless it may be concluded from the charts that nearly all Humpbacks were encountered in coastal waters. Although there has been some shipping in the area of the South Sea Islands, no Humpbacks have been reported from this region. It is, however, known that Humpbacks are frequently seen in this part of the Ocean and that they are caught by the local inhabitants of these isles (TOWNSEND, 1935; DAWBIN, 1956; SLIJPER, 1958). Some sightings made in July and August in the North Pacific between  $30^{\circ}$  N and  $40^{\circ}$  N, suggest that probably here Humpbacks are more evenly distributed over the Ocean than in other parts of the Pacific.

##### 2. MIGRATION

Sightings of Humpbacks off the Australian east coast appear to be restricted to the period of June to October. This is quite in accordance with the data of table 3, which show that the whaling season of the East Australian and New Zealand land stations lasts from May to October with a peak in July-August.

In the waters of the Indonesian Archipelago Humpbacks were encountered in January, March, April, June, July, September and December. This suggests that, just as was concluded with regard to

rorquals, representatives of both the northern and southern stocks migrate into these waters. The communication of VAN BENEDEN et GERVAIS (1880) about the frequent occurrence of Humpbacks at New Caledonia, the Loyalty Islands and the New Hebrides, apparently bears on southern animals, whereas catches reported by TOWNSEND (1935) near the Marianas and the Carolines in February and April apparently bear on representatives of the northern stock. KELLOGG (1929) mentions the occurrence of Humpbacks at the Marshall Isles and the Marianas during the northern winter. According to VAN BENEDEN et GERVAIS (1880) the whale stranded at Pekalongan (Java) on 12-4-1863 (ANONYMOUS, 1964) was a Humpback. Other strandings of Humpbacks from this area are not known.

Apart from a few sightings in other months, Humpbacks were only seen in large numbers at the North American east coast between  $20^{\circ}$  N and  $50^{\circ}$  N during July. Captain MÖRZER BRUINS saw some 45 Humpbacks in July 1958 in the square  $30^{\circ}$  N to  $40^{\circ}$  N  $120^{\circ}$  W to  $130^{\circ}$  W and two animals at  $20^{\circ}$  N  $90^{\circ}$  W on 20-8-61, whereas table 3 shows that the season of the Californian land stations lasts from May to October. TOWNSEND (1935), reports catches of Humpbacks from these regions in January-March but practically only off Baja California ( $20^{\circ}$  N to  $30^{\circ}$  N). GILMORE (1957) writes about large quantities of Humpback Whales, calving and mating off Baja California during the northern winter. KELLOGG (1929) says that they are seen off the Mexican coast in December (at about  $20^{\circ}$  N); they would go northward along the Californian coast in March. SCAMMON



(1874) reports about a large number of Humpbacks with calves at  $24^{\circ} 30' N$  off the Californian coast, in December. Apparently during the summer the situation with regard to Humpbacks is almost the same in this part of the North Pacific as it is in the North Atlantic where the majority of the animals live between  $30^{\circ} N$  and  $50^{\circ} N$ . During the winter the North Atlantic Humpbacks mainly live between  $40^{\circ} N$  and  $10^{\circ} S$ . At present there are no indications that they go as far to the South in the Pacific. The sighting of a Humpback in February between  $40^{\circ} N$  and  $50^{\circ} N$  points to a northern border which is farther to the North than in the North Atlantic. It should, however, be kept in mind that WILLIAMSON (1961a) saw a female Humpback with a suckling calf off New Foundland in March, indicating that single animals may occur farther to the North than the majority of the stock.

A great number of Humpbacks was sighted in the Bay of Panama ( $0^{\circ}$  to  $10^{\circ} N$ ) in August. This is quite in accordance with the observations of SCAMMON (1874) (large numbers in the Gulf of Guayaquil in July and August at  $3^{\circ} S$ ), with the catches reported by TOWNSEND (1935; Bay of Panama, July-September), with KELLOGG (1929) and with the statement of CLARKE (1962) that southern Humpbacks appear at the coast of Ecuador from June to November. Apparently all these animals are southern Humpbacks in their winter quarters.

### 3. CALVES

Nearly all calves were observed between June and October off the Australian coast (fig. 20), which is quite in accordance with the generally accepted opinion about migration and breeding of the southern Humpbacks. The calves observed in Indonesian waters in April and June may have belonged resp. to the northern and to the southern population.

## IV SPERM WHALES

### A. ATLANTIC OCEAN

#### Chart 7

#### 1. GENERAL REMARKS

The total number of Sperm Whales sighted in the Atlantic Ocean was 1198, viz. 1013 in the North Atlantic and 185 in the South Atlantic. It may be supposed that the determination of the species will be fairly reliable, because the animals involved are easy

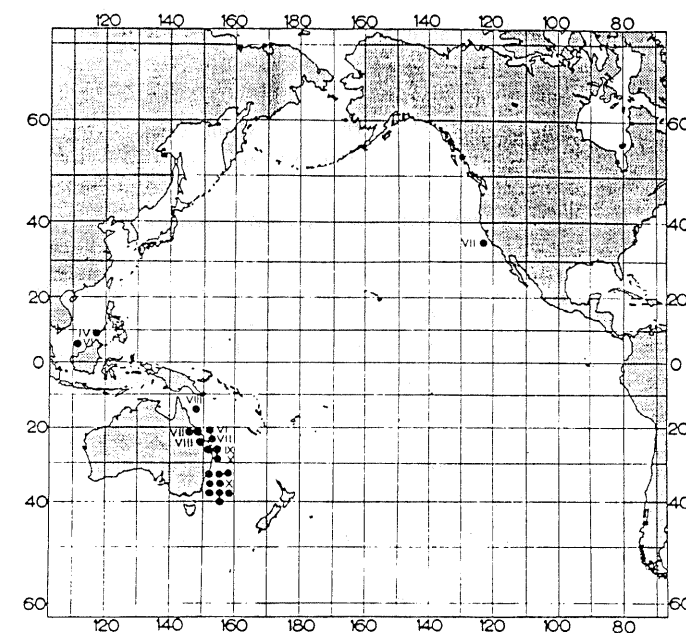


Fig. 20. Chart of the sightings of calves of Humpback Whales in the Pacific Ocean. Each symbol refers to one single sighting to which the month of observation is indicated.

### 4. CONCLUSIONS

The observations point to the fact that also the Pacific Humpbacks live and migrate principally in coastal waters.

Apparently northern as well as southern Humpbacks have their winter quarters in the waters of the Indonesian Archipelago.

The eastern stocks of North Pacific Humpbacks apparently live between  $30^{\circ} N$  and  $50^{\circ} N$  (or even farther to the North) during the summer and at least principally between  $10^{\circ} N$  and  $30^{\circ} N$  during the winter. Southern Humpbacks migrating northward along the South American west coast may go as far north as about  $10^{\circ} N$ .

to recognize as Sperm Whales. The average number of animals in the herds, the number of which could be determined exactly, was 2,73; the average of the herds whose number could only be estimated, was 10,51 (see table 2). These numbers are almost the same as those of Rorquals and Humpbacks. It means

that the herds were rather small. Only one big herd has been sighted.

## 2. DISTRIBUTION AND MIGRATION

The charts show that the whole year round there is a fairly constant concentration of Sperm Whales in latitudes between  $30^{\circ}$  N and  $10^{\circ}$  S. This agrees quite well with the generally accepted opinion (c.f. CLARKE, 1956) that Sperm Whale herds are present in tropical waters all the year round. The number of animals in the eastern (African) part of the Ocean is significantly larger than in the western (American) part. This can also be deduced from the charts of TOWNSEND (1935).

### North Atlantic

In April and May there is an increase in the number of sightings between  $30^{\circ}$  N and  $50^{\circ}$  N with a maximum in June, July and August. In July Sperm Whales have also been observed between  $50^{\circ}$  N and  $60^{\circ}$  N, but they are not mentioned by BROWN (1958, fig. 3) from there, although he reports some shipping in this region. In September and October the number of sightings in the region between  $30^{\circ}$  N and  $50^{\circ}$  N decreases and there are no observations north of  $50^{\circ}$  N in any month except July. There are two observations north of  $40^{\circ}$  N between November and March. In these months there are only a few sightings between  $30^{\circ}$  N and  $40^{\circ}$  N. During the summer there is a larger number of sightings between  $30^{\circ}$  N and  $40^{\circ}$  N than between  $40^{\circ}$  N and  $50^{\circ}$  N. The statements of BROWN (1958, fig. 3), TOWNSEND (1935) and CLARKE (1957), that during the summer season Sperm Whales are abundant in the region of the Gulf Stream (just as rorquals) could be confirmed.

These data point to the fact that in the North Atlantic the Sperm Whale shows a very distinct migration to the North during the spring, whereas the animals return to lower latitudes and especially to the tropics during the autumn. The fact that the number of observations between  $30^{\circ}$  N and  $40^{\circ}$  N, is larger than north of this area, may point to the fact that the majority of the females do not migrate further northward than about  $40^{\circ}$  N, whereas males may even go into Arctic regions. This is quite in accordance with the fact that the land stations in the northern part of the N. Atlantic (with New Foundland at  $50^{\circ}$  N as the most southern station) only take male Sperm Whales, whereas the stations of Spain, Morocco, the Azores and Madeira (all south of  $40^{\circ}$  N) take females as well. Only two strandings of females have been reported from regions north of  $40^{\circ}$  N, viz.: at Audierne (Brittany) at  $48^{\circ}$  N (14-3-1784) and at Neuwerk (near

Hamburg) at  $54^{\circ}$  N (Dec. 1723) (SLIJPER, 1962; BOSCHMA, 1938). According to MOHR (1935) the description of the stranding at Neuwerk is very accurate and one may be sure that about half of the herd were females. TOWNSEND (1935) and CLARKE (1957), however, report catches of females from the Commodore Morris grounds at  $50^{\circ}$  N. This is quite in accordance with the fact that our reports show a number of sightings of calves during the summer between  $40^{\circ}$  N and  $50^{\circ}$  N. This points to the fact that at least a minority of the females may go as far north as  $50^{\circ}$  N. In the Pacific Ocean female Sperm Whales are caught by land stations on San Francisco Bay ( $37^{\circ}$  N; ROSENBLUM, 1962). They are, however, also caught at Kamchatka ( $50^{\circ}$  N to  $60^{\circ}$  N) and (in small numbers) even in the Bering Sea.

The observation of a male and a female Sperm Whale made by Captain MÖNZER BRUNS on the 3d of April 1956 in the square  $30^{\circ}$  N to  $40^{\circ}$  N  $40^{\circ}$  W to  $50^{\circ}$  W, indicates that the migration to the North may start as early as the first part of April. The charts of TOWNSEND (1935) show only very few catches from latitudes north of  $40^{\circ}$  N from November until March (inclusive). This and the very small number of sightings on our charts in this region during that season point to the fact that during the winter probably all females and at least the majority of the males live south of  $40^{\circ}$  N. Probably the majority of the stock is found below  $30^{\circ}$  N because the land stations between  $30^{\circ}$  N and  $40^{\circ}$  N take Sperm Whales during the whole year, but they have small catches from December until March. According to CLARKE (1956) the majority of the Sperm Whales which are off the Azores during the summer, stay off the Canary and Cape Verde Isles (at  $10^{\circ}$  N to  $30^{\circ}$  N) during the winter. Our reports point to observations of calves in October and November in the region of the Cape Verde Isles. The American population is probably in the Caribbean Sea during the winter.

Newfoundland and the European land stations north of  $40^{\circ}$  N have a Sperm Whale season from May until October (inclusive) with peaks in June, July and August (table 3). This, however, does not mean that there are no Sperm Whales north of  $40^{\circ}$  N or even north of  $50^{\circ}$  N during the winter. VAN BENEDEN en GERVAIS (1880) report some strandings during the winter season from the Scottish coasts whereas FRASER (1953) has shown that the number of strandings at the British coast (as far north as the Shetlands at  $60^{\circ}$  N) is even larger in the winter than in the summer. VAN DEINSE (1931) found peaks in the number of strandings at the Netherlands coast in

January-February, as well as in July, whereas the famous stranding of males and females at Neuwerk (Hamburg) happened in December. All this points to the fact that at least a certain number of male Sperm Whales remain behind in waters north of  $40^{\circ}$  N during the winter.

### South Atlantic

The fact that many more Sperm Whales are sighted at the African rather than at the American side of the South Atlantic, is quite in accordance with the catches reported by TOWNSEND (1935) during the southern winter season (April-November). During the summer, however, the logbooks recorded by TOWNSEND (1935) show a large number of catches off the South American east coast and off Tristan da Cunha. The fact that also practically no Sperm Whales have been sighted off the South American east coast during the southern summer season is the more surprising as from this season there are many reports of sightings of rorquals in these regions. It is, however, quite in accordance with the data of the International Whaling Statistics (1948-1958 see table 3). These statistics report only 8 Sperm Whales from the Brazil coast during 10 years. They are all males and they are all caught during the southern winter. At Saldanha Bay (South Africa), however, males as well as females are caught during the southern winter (April-November). At Gaboon they are taken from August until October. The small number of observations off the American coast also agrees quite well with the data of BROWN (1958) who reports only a few Sperm Whales and exclusively in the southern winter.

Fig. 15 of WALFORD (1958) shows that the biological productivity of the South American waters between  $40^{\circ}$  S and  $10^{\circ}$  N is not as large as the productivity of the African Atlantic coast. It is, however, by no means a poor region, neither are there marked differences in temperature between both sides of the South Atlantic. Maybe the Sperm Whales have changed their migratory habits during the past 200 years with the result that at present occasionally a single Sperm Whale could be sighted during the southern summer in a region where they were abundant some two centuries ago during the period October-March. An other explanation is that the stocks have been exploited too heavily.

It has already been pointed out that a large number of Sperm Whales is present up to  $10^{\circ}$  S, the whole year round. Off the African coast there is quite a number of sightings between  $10^{\circ}$  S and  $50^{\circ}$  S from October until April, whereas this number is very small from May until September. This is quite

in accordance with the charts of TOWNSEND (1935). They show that south of  $20^{\circ}$  S Sperm Whales were almost exclusively caught during the southern summer (October-March). All this suggests a shifting to and from the equator during the summer, just as has been encountered in the northern hemisphere.

The land stations of the South African west coast, take Sperm Whales from April until November (in former days March-December; MATTHEWS, 1938) with peaks in May-June and October-November (table 3). Obviously the big catches are made when the males migrate to and from the Antarctic. In July-September the catches probably are smaller because the males are farther to the North. The number of sightings during this season is, however, large, probably because the females with their calves migrate into South African regions. During 1948-1958 the percentage of female Sperm Whales taken by the land stations in Cape Province fluctuated between 9 and 43 with an average of 28. This probably explains why in July-September there are many sightings although the catches are low. The presence of the females is confirmed by an observation of a large herd with about 14 calves in June off the African coast between  $30^{\circ}$  S and  $40^{\circ}$  S. Everything points to the fact that during the southern summer a great many females migrate southward until about  $30^{\circ}$  S. A small number of females, however, is probably also found in these regions during the southern winter.

### 3. CONCLUSIONS

All data collected about Sperm Whales are in favour of the opinion that a certain amount of animals is present in tropical waters between  $30^{\circ}$  N and  $10^{\circ}$  S all the year round. During the spring there is a very distinct shifting to the North (northern spring) as well as to the South (southern spring). In the autumn the animals concentrate into tropical waters.

Probably the majority of the females do not migrate further than  $40^{\circ}$  N and  $40^{\circ}$  S although a limited number may go at least as far as  $50^{\circ}$  N, even with calves. During the winter the majority of the males probably live in tropical waters, but a certain number may remain behind in higher latitudes as far as  $50^{\circ}$  N and  $40^{\circ}$  S. In exceptional cases females may be present in these regions during the winter.

The Sperm Whale population of the eastern part of the Atlantic appears to be much larger than the population in the western part. Especially in South American Atlantic waters the population is very small, even during the southern summer, during which large catches were reported about two centuries ago.

## B. INDIAN OCEAN

## Chart 8

## 1. GENERAL REMARKS

A total number of 728 Sperm Whales has been reported from the Indian Ocean. The average number of animals in herds was resp. 2.13 (accurately) and 12.15 (estimated).

## 2. DISTRIBUTION AND MIGRATION

If our charts are compared with those of WALFORD (1958), it is quite evident that—just as forquals—Sperm Whales are principally found in regions with a great biological productivity. An exception must be made for the poor regions in the northern area of the central part of the ocean, where a comparatively large number of Sperm Whales was observed in March, April and especially in May. It may be, however, that these were migrating animals or it may be that during these months the feeding conditions in this region are better than during the remaining part of the year.

The charts show some special phenomena pointing to the fact that the migratory movements of the Sperm Whale in the Indian Ocean differ from those in the Atlantic and probably also from those in the Pacific Ocean.

In the first place there are very few sightings north of the equator during the northern summer, especially in June, July, and August. This is quite in accordance with the charts of TOWNSEND (1935), from which it can be concluded that in this part of the Indian Ocean very few Sperm Whales were caught from May to August. It is also in accordance with the fact that the number of forquals and Humpbacks sighted in these regions in the northern summer is less than in the northern winter, whereas Captain MÖNZER BRUNS saw no Sperm Whales in June and July and only a few in August and September. In the remaining part of the year he saw a large number of Sperm Whales in the northern part of the Indian Ocean, just as is shown on our charts. Three big herds were reported from this region and all calves except two were observed here during the northern winter (October-April, fig. 21).

In the second place it may be stated that our charts show no distinct signs of a southward migration during the southern summer (November-March). According to MATTHEWS (1938; fig. 64) the catches at Natal show a large peak in August-October for males and females and a small peak in May-June for males only. Postwar catches, however, show a high peak in May-June and a much lower peak in September

(table 3). In any case it is obvious that the number of Sperm Whales taken in these waters is small from December to April and this is quite in accordance with our records and with TOWNSEND's (1935) charts. This is the more remarkable because his charts show very large catches from the Atlantic whaling grounds off Tristan da Cunha during the southern summer. The peaks in the catches of the Durban land station may have been caused by migrating males, just as at the Atlantic side of South Africa (see sub A). The poor catches and the small number of sightings during the southern summer point, however, to the fact that the migratory movements of female Sperm Whales in the Indian Ocean differ from those in the Atlantic.

In the third place we are struck by the fact that in the region between  $30^{\circ}$  S and  $40^{\circ}$  S only a few Sperm Whales were sighted, although a large number of observations of forquals was reported from this area. The fact agrees quite well with TOWNSEND (1935) who reports only very small catches from this region. Forquals were sighted principally during the spring and during the autumn. This may be an indication that they pass the region on their migration to the South and to the North, but that the region itself does not show very favourable feeding conditions.

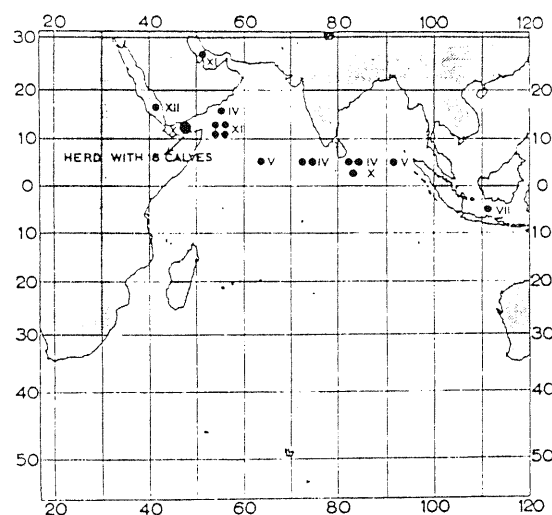


Fig. 21. Chart of the sightings of calves of Sperm Whales in the Indian Ocean. Each symbol refers to one single observation to which the month of sighting is indicated.

According to WALFORD (1958), however, it would not differ from the waters at Madagascar or in the Bay of Bengal.

In any case it is obvious that the migratory movements of the Sperm Whale in the Indian Ocean and especially the migration of the females, differ from the situation in Atlantic waters. Apparently there are certain areas, as for example the waters off Madagascar, off Zanzibar, and those of the Seychelles and the Indonesian Archipelago where Sperm Whales live the whole year round. This may be also concluded from the charts of TOWNSEND (1935). With regard to our charts it must be kept in mind that the main shipping routes do not pass the Seychelles. If southern herds are present in the northern part of the Ocean from November until May they probably migrate to the South in the southern winter, on the understanding that they avoid the central part of the Ocean and travel mainly along the African coast and into the Indonesian Archipelago.

These migratory movements may be connected with certain changes in food supply of the different regions, which in their turn may be influenced by certain hydrographical conditions which are encountered especially in the Indian Ocean, as for example the fact that the Monsoon-stream in the northern part of the Ocean flows from S.W. to N.E. from May to

September, and in the opposite direction during the remaining part of the year.

It may be also noted that practically no sightings were reported from the Australian west coast, where, —according to TOWNSEND (1935)—in former days large catches have been made. The International Whaling Statistics show that from 1955 onwards Sperm Whales have been taken by Australian land stations.

### 3. CONCLUSIONS

There are certain indications that the distribution and migration of the Sperm Whale in the Indian Ocean differs from the distribution and migration in the Atlantic and the Pacific Ocean. In certain tropical areas the animals appear to be present the whole year round. During the southern summer a very large population can be found in the northern part of the Ocean, but in the southern winter they migrate either into the North Pacific Ocean or into the previously mentioned tropical areas of the Indian Ocean. A number of males certainly migrate into Antarctic waters. The remarkable situation in the Indian Ocean probably is connected with differences in feeding conditions between summer and winter, correlated with a difference in the direction of the Monsoon-stream.

## C. PACIFIC OCEAN

### Chart 9

#### 1. GENERAL REMARKS

There were a total number of 250 sightings in the Pacific Ocean, viz.: 183 in the North Pacific and 67 in the South Pacific. The number is too small to draw definite conclusions with regard to the distribution of the animals.

#### 2. DISTRIBUTION AND MIGRATION

Nevertheless it may be pointed out that the whole year round sightings have been reported from the Indonesian Archipelago. Apparently there is a constant population of Sperm Whales in this area. This is quite in accordance with the records of TOWNSEND (1935) and with the fact that this is a region with a great biological productivity of the sea (WALFORD, 1958). The number of shipping hours in the area of the Galapagos Isles apparently was too small to report the herds of Sperm Whales that are said to live in these regions (TOWNSEND, 1935). The majority of

the calves were sighted in the Indonesian Archipelago.

By lack of shipping the more or less equal distribution of Sperm Whales from east to west in equatorial waters, which appears from TOWNSEND's (1935) charts, could not be demonstrated. The absence of observations on the shipping route between Australia and Panama may have been caused by the fact that in this part of the Pacific the distribution of the Sperm Whale is restricted to certain special areas, as may be deduced from the charts of TOWNSEND (1935).

At the west side of the Pacific migratory movements corresponding with those in the Atlantic can be deduced from the fact that the majority of the observations in this area between 20° N and 40° N has been made from May to October. The same phenomenon is shown by the charts of TOWNSEND (1935). J. J. WOODBURN reported a female with calf from the east coast of Australia (30° S, 153° E) on 9-2-1962; they swam with a speed of 4 knots.

## V LITTLE PIKED WHALES

## Chart 10

## 1. GENERAL REMARKS

The total number of animals sighted amounted to 765, viz.: 561 in the Atlantic Ocean (75 observations), 159 in the Indian Ocean (30 observations) and 45 in the Pacific Ocean (9 observations). The average number of animals in herds, the number of which could be determined exactly amounted to resp. 3.68, 1.79 and 2.50. The average number in the other herds was resp. 17.24, 19.33, 10.00. These data are almost the same as those for rorquals, Humpbacks and Sperm Whales. A very large herd was seen in the North Atlantic (square  $50^{\circ}$  N to  $60^{\circ}$  N  $10^{\circ}$  W to  $20^{\circ}$  W). Obviously the statement of ARSENIYEV (1961) that in the northern hemisphere Little Piked Whales occur only in very small groups, is not correct. Probably the determination of this species will show a varying degree of reliability because the species is not always easy to recognize. In a number of cases the white band on the flipper could be recognized. Some other animals, however, may not have been determined as Little Piked Whales because they did not possess the white band on the pectoral fin (see WILLIAMSON, 1959, 1961 and VAN UTRECHT and VAN DER SPOEL, 1962).

## 2. DISTRIBUTION

Although TURNER (1880) described some ear-bones of the Little Piked Whale, dragged by the Challenger Expedition in the central part of the Pacific, a few degrees south of the equator, although ELLIOTT (1904) mentions the species from the coast of Mexico and although ELLERMAN and MORRISON SCOTT (1951) say that it occurs in the Bay of Bengal as well as in Indian and African seas, there is still a general belief that this species is scarce in warm waters and that it avoids tropical regions. MOORE (1953), GUNTER (1954), MOORE and PALMER (1955) and HALL and KELSON (1959) describe a few strandings at the coast of Florida up to  $25^{\circ}$  N, whereas NORRIS and PRESCOTT (1961) describe a number of strandings at the Californian coast (about  $35^{\circ}$  N). They say that the species also occurs off Baja California (up to about  $25^{\circ}$  N), but they have no exact data from this region. There are two records from Cape Town ( $35^{\circ}$  S; BARNARD, 1954) and one from Buenos Ayres ( $35^{\circ}$  S; BURMEISTER, 1867; CABRERA and YEPES, 1940), but all these regions are outside the tropics.

It is very striking that the species has never been recorded from the Senegal coast ( $15^{\circ}$  N) by CADENAT, that it was not encountered by WEBER (1923) during the Siboga-expedition and that it has never been reported from Indonesian waters (VAN BALEN; DELSMAN, 1951). NORMAN and FRASER (1948) do not speak about its occurrence in warm waters, CLARKE (1957) says that it is not often encountered in warm waters and JONSGÅRD (1951) writes with regard to the North Atlantic population: "migrates in autumn to unknown breeding grounds in temperate waters". In fact there are only two exact descriptions of strandings in tropical waters, viz. that at Mannar (N.W. Ceylon; 19-5-1937) by DERANIYAGALA (1948) and the strandings at the coast of N.W. Ceylon in 1948, 1954 and July 1962 (5 carcasses) mentioned by DERANIYAGALA (1963). Quite recently, however, Dr. D. C. GEIJSKES (Paramaribo) informed us about the stranding of a Little Piked Whale on 28-10-63 in the Coppename river (Surinam;  $6^{\circ}$  N  $56^{\circ}$  W) 50 km from the mouth.

The occurrence of Little Piked Whales in tropical waters of the Indian Ocean is confirmed by observations of Captain W. F. J. MÖRZER BRUNS at 17-9-1960 (twice a single animal off Ceylon), at 19-9-1960 (one single animal at  $15^{\circ}$  N  $82^{\circ}$  E, Bay of Bengal) and at 21-9-1960 (six animals at  $19^{\circ}$  N  $88^{\circ}$  E, Bay of Bengal). He observed a herd of about 30 animals on 14-11-1961 in the Pacific Ocean close to the coast of Middle America at  $10^{\circ}$  N  $95^{\circ}$  W. The occurrence in tropical waters is further confirmed by a number of sightings recorded on chart 10 and in fig. 22-23.

Sightings in tropical waters of the Atlantic Ocean have been reported from March, April, July, August, September, October and November, at the African and American side of the Ocean as well as in its central part. Moreover there is a number of sightings from subtropical regions. In the Indian Ocean the species is encountered the whole year round in the tropics, especially in the Indonesian Archipelago, the Arabian Sea and off Madagascar. Special attention should be paid to the photographs taken by Captain PEETERS in November 1958, just outside the harbour of Réunion (SLIJPER and VAN UTRECHT, 1958, 1959; fig. 13). In the Pacific Ocean the species was sighted in tropical waters at the American coast in March and November. These data point to the fact that the Little Piked Whale is far from scarce in tropical waters. There are no clear indications that it avoids

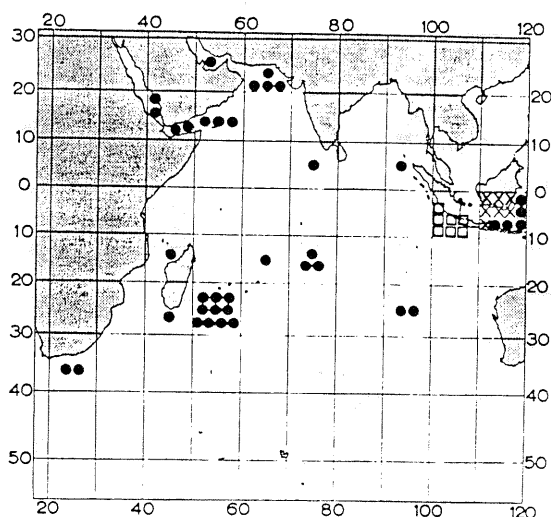


Fig. 22. Chart of the total number of sightings of Little Piked Whales in the Indian Ocean, calculated by adding the figures of the different months. For explanation of symbols see table 1.

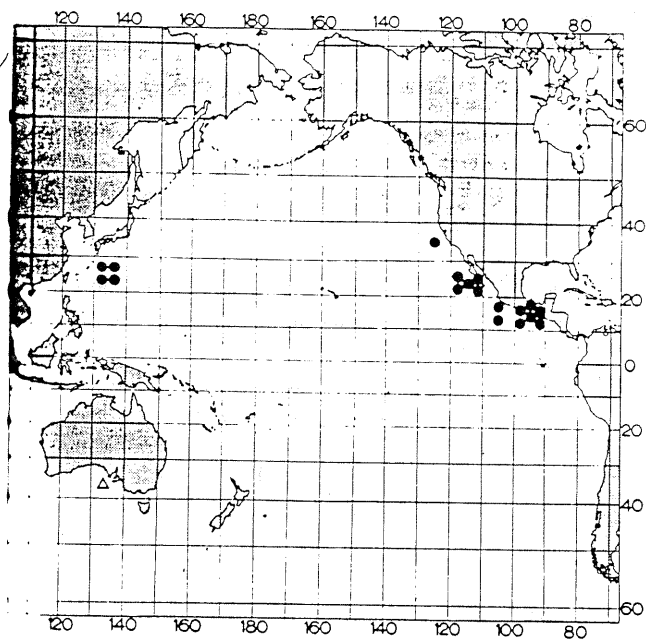


Fig. 23. Chart of the total number of sightings of Little Piked Whales in the Pacific Ocean, calculated by adding the figures for the different months. For explanation of symbols see table 1.

these waters or that a smaller part of the population goes to the tropics than for example in Blue or Fin Whales.

With regard to the Atlantic Ocean no distinct relations between the number of sightings and the biological productivity of the sea can be demonstrat-

ed, but with regard to the Indian Ocean (fig. 22) it is quite evident that the animals concentrate in areas where there is a large amount of food, as for example in the Gulf of Aden, in the Indonesian Archipelago (especially February, July, December) and off Madagascar (May). The number of sightings in the Pacific is too small to draw any conclusions.

### 3. MIGRATION

Although the number of data is still very small, the charts of the Atlantic Ocean (chart 10) allow us at least to draw some preliminary conclusions with regard to the migration of the species. With regard to the North Atlantic JONSGÅRD (1951) states that in the spring and in the autumn there is a migration along the Norwegian coast. The animals migrate far into Arctic waters, but those which are in their first year apparently do not go farther than the Lofoden.

Our charts show that in the region between 30° N and 50° N there are only three sightings from November to February, whereas there are quite a number of sightings from March to October. In July, August and October there are also sightings between 50° N and 60° N, which is quite in accordance with the fact that from March to September 1961, 3219 Little Piked Whales were caught by Norwegian whalers, mostly between 65° N and 75° N (peak in June; Editor, 1962). This suggests a migration, just as it has been described by JONSGÅRD (1951). Unfortunately the charts do not show clearly where the animals pass the winter. The chart of November suggests that they live then between 30° N and 10° S, but because there are no observations at all in this region from December to February, a definite conclusion must be postponed until more data are available.

If we assume that the majority of the stock of North Atlantic Little Piked Whales during the northern winter live in tropical and subtropical waters, we must keep in mind that a part of the stock at least does not go so far to the South. This appears from strandings reported by VAN DEINSE (1931, 1945), HARMER (1927), and FRASER (1946, 1953) from the Dutch and the British coasts (50° N to 60° N) from November to March. Sightings between 0° and 10° N and between 20° N to 30° N in July and August point to the occurrence of stragglers in warm waters during the summer. It may not yet, however, be excluded at present that these animals belonged to the southern population.

The number of sightings in the South Atlantic is too small to draw any conclusions with regard to migration. The sighting in March off Cape Town (BAR-



NARD, 1954) and the stranding off Buenos Ayres in February 1867 (BURMEISTER, 1867) are quite in accordance with the fairly large number of sightings off the South African coast (between 30° S and 40° S) in March and April (chart 10).

Nothing can be said about migration in the Indian Ocean except for the fact that in the northern part of this Ocean Little Piked Whales have been observed the whole year round (fig. 22). Just as with regard to rorquals and Humpback Whales this fact suggests that there are local stocks or that animals belonging to the North Pacific stock migrate into the Indian Ocean during the northern winter. They were sighted in the northern part of this Ocean in December, January and March, a part of the year in which the southern population is supposed to live far more to the South. OMURA and SAKIURA (1956) describe a northward migration along the Japanese coast in the spring and a southward migration in the autumn. The sightings made in March (fig. 23) south of Japan are quite in accordance with these facts, but unfortunately there are no other sightings from the supposed migratory route into the Indian Ocean.

Fig. 23 shows that Little Piked Whales have been observed off the North and Middle American west coast in March and November. There was one sighting off the Australian coast (in February).

#### 4. CALVES

Table 4 and fig. 24 show that 11 out of 18 calves sighted in the North Atlantic were seen in April between 40° N and 60° N. This and the sighting of a calf in June confirms the opinion of JONSGÅRD (1951) that the calves of the North Atlantic population are born from November to March in temperate waters and that they migrate northward with the herds in the spring.

There were no sightings of calves in the Indian

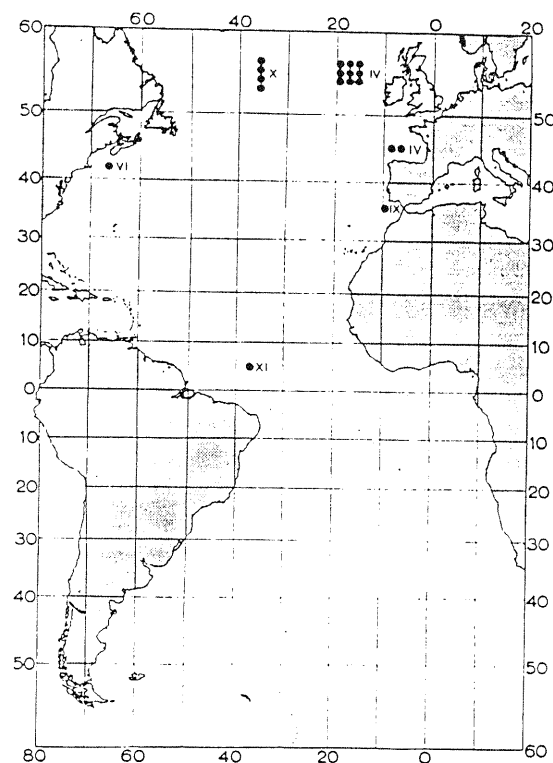


Fig. 24. Chart of the sightings of calves of Little Piked Whales in the Atlantic Ocean. Each symbol refers to one single sighting to which the month of observation is indicated.

and Pacific Ocean. Consequently nothing can be said about the opinion of OMURA and SAKIURA (1956) that in the North Pacific births take place in all months of the year. With regard to the southern stock, however, DAVIES and GILMER (1958) suggest that the calves are born in warm waters during the southern winter, although they may be also born during this season in Tasmanian waters (about 45° S).

## VI CALIFORNIAN GREY WHALES

Four sightings of Californian Grey Whales have been reported from the North American west coast, viz.:

Date	Position	Region	Number of animals
9-9-55	47° N 124° W	Washington	5
28-7-55	43° N 124° W	Oregon	1
24-3-56	33° N 118° W	California	1
23-5-57	27° N 115° W	Baja California	10-15

According to SCAMMON (1874) and GILMORE (1960) the American Grey Whale population migrates as far to the South as the tip of Baja California. They leave this region from February to May. Apparently the animals observed at 23-5-57 were rather late. GILMORE (1960) says that the main body of the population passes Cape Flattery and Vancouver (49° N) in April and May on its way to the Arctic. They return at this latitude in November-December. The observations of July and September do not fit into

this general scheme but they may bear on a small part of the population that does not go into Arctic

waters but passes the summer in the Gulf of Alaska, as has been pointed out by GILMORE (1960).

## VII RIGHT WHALES

### 1. GENERAL REMARKS

All sightings of Right Whales refer to the North Atlantic Right Whale, the Southern Right Whale and their Pacific relatives. There were 24 sightings in the Atlantic Ocean, referring to 59 animals, 5 of which were observed in the South Atlantic. In August a herd of 22 animals with a calf was observed between  $10^{\circ}$  N and  $20^{\circ}$  N near the Cape Verde Isles. The average number of animals in the herds observed in the Atlantic Ocean amounted to 1.60 (the herd of 22 not included). There were 4 sightings, referring to 9 animals in the Indian Ocean and 2 sightings referring to 5 animals in the Pacific. Because of the double blást, the absence of a dorsal fin and other characteristics, Right Whales are comparatively easy to recognize. Consequently we may assume that the determination of these animals will be fairly reliable.

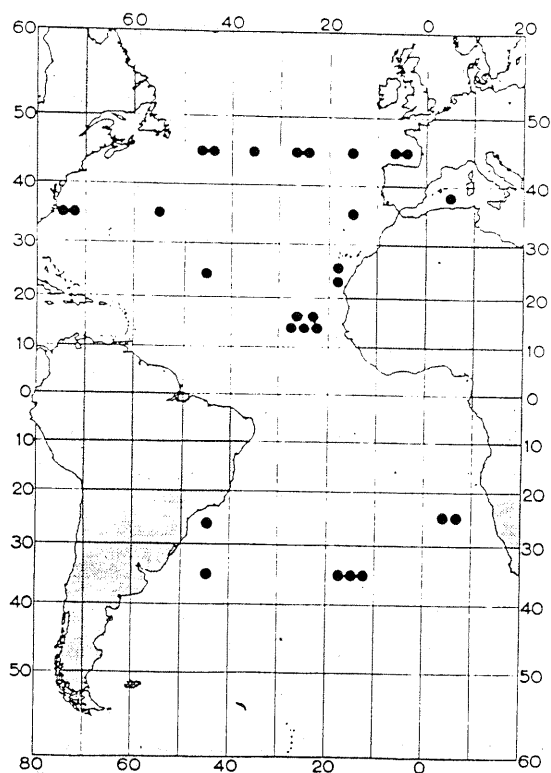


Fig. 25. Chart of the total number of sightings of Right Whales in the Atlantic Ocean calculated by adding the figures for the different months. For explanation of symbols see table 1.

### 2. ATLANTIC OCEAN (fig. 25)

According to VAN BENEDEN (1889) and ALLEN (1908) the distribution of North Atlantic Right Whales would be restricted to the Gulf Stream and this is quite in accordance with the observations reported to us, the majority of which indeed have been made in the area of the Gulf Stream.

Captain MÖRZER BRUNS reported a herd of 12 animals off New Foundland (square  $40^{\circ}$  N to  $50^{\circ}$  N  $50^{\circ}$  W to  $60^{\circ}$  W) in May (table 5). ALLEN (1908) mentions its occurrence in the Mediterranean and says that the southern limit of this species is found at about  $35^{\circ}$  N at the European side of the Ocean, whereas on the American side the southern border is found at about  $25^{\circ}$  N (Florida and Bahamas). MOORE (1953) reports its occurrence in Florida waters in March at  $26^{\circ}$  N and  $29^{\circ}$  N. TOWNSEND (1935) reports no catches from the North Atlantic and says that,—just as in the Pacific—the species is not present between  $30^{\circ}$  N and  $30^{\circ}$  S with the exception of some stragglers and of a number of animals taken at Walvisch Bay ( $22^{\circ}$  S).

The Brazilian land station at about  $20^{\circ}$  S, however, caught 6 Right Whales between 1948 and 1958 and our figure 25 shows some sightings between  $20^{\circ}$  N and  $30^{\circ}$  N, as well as between  $20^{\circ}$  S and  $30^{\circ}$  S. This demonstrates that in any case the region in which the animals do not occur is restricted to the zone between  $20^{\circ}$  N and  $20^{\circ}$  S. The sighting between  $10^{\circ}$  N and  $20^{\circ}$  N gives an indication that occasionally they may be even found in tropical waters.

Some observations were made in the crossing part of the Brazil current in the South Atlantic, i.e. in the region of Tristan da Cunha. BROWN (1959) reports two sightings from this region. TOWNSEND (1935) refers to a very large number of catches over the entire breadth of the Ocean and ELLIOTT (1954) says that off Tristan da Cunha the Southern Right Whale is very abundant from July to December with a peak in October. "They are becoming increasingly numerous and almost a pest". The animals are supposed to calve in this area (LAWS; personal communication).

Because in the old days North Atlantic Right Whales were caught in the Bay of Biscay during the northern winter and in the Arctic Ocean during the northern summer (ALLEN, 1908), one might suppose that they showed migratory movements resembling

those of Blue and Fin Whales. CLARKE (1957), however, supposes that they show only rather limited movements to the North and to the South and this is confirmed by the fact that we did not get a single report of a sighting from regions north of  $50^{\circ}$  N, whereas quite a number of sightings between  $50^{\circ}$  N and  $20^{\circ}$  N was reported from May, June, July and August. Probably this may give us some indication that the North Atlantic Right Whale changed its migratory habits in the same way as it was supposed with regard to Humpback Whales (see sub III), probably as a consequence of the diminution of the stocks. It must, however, be kept in mind that in the old days they were caught in large numbers between  $30^{\circ}$  S and  $50^{\circ}$  S during the southern summer (TOWNSEND, 1935).

### 3. INDIAN OCEAN (fig. 26)

There were 4 sightings in the Indian Ocean; one of them refers to a herd of 6 animals. Three sightings were reported from the region between  $25^{\circ}$  S and  $40^{\circ}$  S (September and November), where in the old days a great many Right Whales have been caught (TOWNSEND, 1935). The other sighting is from the square  $0^{\circ}$  to  $10^{\circ}$  N by  $70^{\circ}$  E to  $80^{\circ}$  E, south of India (October). As far as we know, no Right Whale has ever been reported from this region, and certainly this sighting needs qualifying. According to TOWNSEND (1935) no catches were made north of  $25^{\circ}$  S.

### 4. PACIFIC OCEAN

Two sightings have been reported from the Pacific Ocean, viz.: 4 animals in June in the square  $40^{\circ}$  N

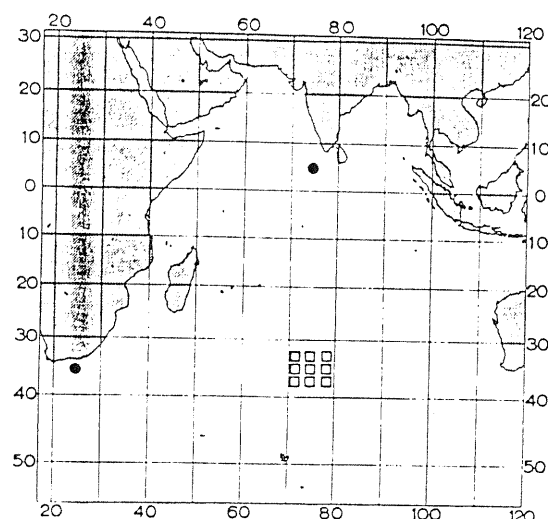


Fig. 26. Chart of the total number of sightings of Right Whales in the Indian Ocean calculated by adding the figures for the different months. For explanation of symbols see table 1.

to  $50^{\circ}$  N by  $170^{\circ}$  W to  $180^{\circ}$  W and one animal in July in the square  $0^{\circ}$  to  $10^{\circ}$  S by  $130^{\circ}$  E to  $140^{\circ}$  E in the Indonesian Archipelago. TOWNSEND (1935) says that Right Whales do not occur in the Pacific Ocean between  $30^{\circ}$  N and  $30^{\circ}$  S except for a few stragglers. According to GILMORE (1956) an animal was observed at the Californian coast at  $33^{\circ}$  N. HALL and KELSON (1959) mention Baja California as the southern limit of the northern population. Certainly also these sightings need qualifying.

## VIII GENERAL CONSIDERATIONS

MACKINTOSH (1942, p. 250) supposed that a certain number of Blue and Fin Whales stay at comparatively high latitudes during the winter and that some animals might pass the summer in warm or temperate waters. Especially the latter supposition has been confirmed by the present investigation. We got very strong indications that a significant, though unknown, percentage of rorquals (the majority of them probably being Fin Whales) during the summer do not migrate into Arctic or Antarctic waters, but that they are staying in warm or temperate waters. With regard to rorquals the phenomenon could be shown in the Atlantic, the Indian and the Pacific Ocean. With regard to Humpbacks it could be shown in the Atlantic and in the Indian Ocean, although it was less pronounced.

With regard to the Pacific Ocean it may be supposed that the annual variation in blood type of the Ryukyuan Humpback population (at  $25^{\circ}$  N; NISHIWAKI, 1960) is connected with annual variations in the groups of Humpbacks migrating to the North or to the South.

For a long time it has been generally supposed that southern Blue, Fin, and Humpback Whales do not feed in warm waters (MACKINTOSH, 1942; SLIJPER, 1958; CLARKE, 1962). This assumption was supported by the fact that, according to MACKINTOSH and WHEELER (1929), the stomachs of whales taken at South African land stations are practically always empty, whereas DALL and DUNSTAN (1957) and OMMANNEY (1933) showed the same phenomenon with

regard to Humpbacks taken at Australian and New Zealand land stations (in New Zealand at least with regard to North bound Humpbacks, the South bound animals having a certain quantity of food in their stomachs).

These observations, however, indicate only that the animals involved do not feed in those special parts of their migratory routes. On the other hand the publication of BODEN (1955) has shown that in the Benguela current (20° S to 30° S) there are plenty of Euphausiids. CLARKE (1962) suggests that Fin Whales are feeding during the Southern winter off the coast of Chile. The very significant correlation between the distribution of whales and the biological productivity of the sea, as shown in the present paper, indicates that in warm waters there are at least certain regions where the whales can find plenty of food and where they can stay the whole year round. The food may be Crustaceans as well as fish. The fact that the presence of rorquals in warm waters during the summer is more pronounced in the North than in the South Atlantic, may be connected with the fact that Fin Whales are supposed to feed on fish in North Atlantic waters.

Although we do not know how long Blue, Fin and Humpback Whales can stay in warm waters, it is in any case obvious that estimations of the Antarctic whale population never include the total number of animals present in the southern hemisphere, as has also been indicated by MACKINTOSH and BROWN (1956.)

The indication that every year a certain percentage of the stock of these whales do not migrate into Arctic or Antarctic waters, may also lead to certain consequences with regard to the age-determination of the animals.

RUUD (1940) based his age-determination of Blue, Fin, Sei and Humpback whales, with the aid of sudden alterations in the thickness of the baleen plates, on the assumption that the majority of individuals in a stock of whales take part in a regular annual migration between breeding waters and feeding grounds. The migrating animals would be exposed to enormous fluctuations in supplies of food, from a period of surfeit on the feeding grounds to one of starvation in breeding waters. The idea was already suggested by ESCHRICHT and REINHARDT (1866). According to RUUD (1945) the periods are annual.

In his paper on age-determination with the aid of the ear plugs PURVES (1955) also suggests, that these laminations may be connected with annual migratory movements. It should be either a six-monthly or an annual event (resp. two or one lamination per an-

num). LAWS and PURVES (1956) and PURVES and MOUNTFORD (1959) point to a six-monthly event representing the two migratory periods. Similar explanations are given by SCHEFFER (1950) and LAWS (1952, 1962) in discussing the cause of the laminations in the dentine layer of teeth in Pinnipedia.

Periodic laminations, however, have also been found in the ear plugs of Bryde Whales (CHITTLEBOROUGH, 1959; BEST, 1960), although these animals do not show the extended migratory movements of Blue, Fin and Humpback Whales. OMURA and NEMOTO (1953), however, reported about local seasonal movements in the region of the Bonin Islands, whereas CHITTLEBOROUGH (1959) supposes that there are fluctuations in the presence of food. BEST (1960) points to temperature changes in the water and also says that in Bryde Whales the laminations are difficult to read and that they show no correlation with the condition of the genital organs. This might be caused by the fact that there is no restricted breeding season.

The periodicity in baleen plates, teeth and ear plugs appears to be present in immature whales, although in these animals the phenomenon is less pronounced than in adults. This may be an indication that periodical changes in food supply are the principal cause of the periodicity in these organs and that cyclic sexual events are superimposed on it.

If it is true that the periodicity in baleen plates and ear plugs of Blue, Fin and Humpback Whales is mainly caused by migratory movements, no laminations will appear—or at least an irregularity in the process of formation of these laminations will appear—, when an animal stays in warm waters during the summer. If the animals living in warm waters during the summer season do not live there permanently, but if their sojourn in these waters is alternated by sojourns in the Arctic or Antarctic, it may be supposed that the number of laminations does not correspond with the actual age of the animals. In this case the number of laminations is probably less than the actual age.

Up to this moment three cases are known in which the number of laminations could be determined in marked whales, of which at least a minimum age is known. The data of DAWBIN (1959) bear on very young Humpbacks, whereas the animal described by CHITTLEBOROUGH (1960) had an estimated age of 6 years and pointed to two ear plug laminations annually. This animal is also rather young with regard to a probable missing of laminations. Moreover in Humpbacks the phenomenon probably will not be as distinct as it is supposed to be in Blue and Fin Whales.

OHSUMI (1962) however, reports about five marks fired in 1935 and recovered by Japanese floating factories in Antarctic Fin Whales in 1960. They had an estimated minimum age of 27 years. Their number of ear plug laminations varied from 28 to 38. This may point to the formation of one single lamination per annum, but it may also mean that, with an annual increase of two laminations, from time to time

no lamination was formed because the animals stayed in warm waters during the summer.

In any case the indications gained in the present research give a warning that we must be very careful in correlating the number of laminations in baleen plates, ear plugs and teeth with the actual age of the animals.

## IX SUMMARY

### A. GENERAL REMARKS

During three years 4500 reports of whales sighted from Netherlands ships were collected, bearing on approximately 11,000 individual animals. Most of the observations were made in the Atlantic and Indian Ocean. It was supposed that the species could be determined with a fairly high degree of reliability in the case of Humpback Whales, Sperm Whales and Right Whales. No distinction could be made between Blue, Fin, Sei and Bryde Whales. They were collected under the heading Rorquals. Catches of land stations and strandings of whales, however, indicate that in all areas, at least a part of these Rorquals must have been Blue or Fin Whales. Probably the majority of this part were Fin Whales.

*Nevertheless it must be emphasized that the observations give no exact figures but only indications.* It would be highly desirable if the results could be controlled by observations made by experienced whale biologists or gunners, especially in tropical and subtropical waters. We have the impression that for the time being no better results can be obtained with the present type of research. On the other hand, the fact that the generally known facts about the annual migration of the big whales were also clearly shown by this research, may be an indication for a certain degree of reliability of the research. The monthly number of animals of each species observed per 1000 hours steamed in daylight was plotted on charts in ten degrees squares. The reliability of the converted data is highest in the black dots.

### B. RORQUALS AND HUMPBCKS

#### 1. Distribution

The animals involved are not evenly distributed over the Oceans. There are big concentrations in certain areas, whereas in other areas practically no whales occur. Broadly outlined the highly populated areas coincide with the areas of greatest biological productivity of the sea, as shown by WALFORD (1958).

In the tropics and subtropics important areas with a great number of sighted whales are: the Caribbean, the North African west coast, the Atlantic coast of South Africa, the Arabian Sea, the Gulf of Aden, the Bay of Bengal, the Indonesian Archipelago and the African east coast between 30° S and 40° S. It could be demonstrated that in the Indian Ocean southern Rorquals migrate over the entire breadth of the Ocean south of 30° S. North of 30° they migrate only at the eastern and the western side, apparently in order to avoid the waters with low biological productivity in the central part of the Ocean.

No special relationship was found between the distribution or the migratory routes of the whales and the course of the big Ocean currents with regard to the locomotory aspect. There was a special relationship only in those cases where the big currents show a great biological productivity, as for example the Gulf Stream and the currents in the northern part of the Indian Ocean.

#### 2. Migration, general remarks

With regard to Rorquals in the North and South Atlantic, the Indian Ocean and the Pacific Ocean, as well as with regard to Humpbacks in the Atlantic and in the Indian Ocean it could be demonstrated that during the summer a part of the population does not migrate into Arctic or Antarctic waters, but that it stays in tropical, subtropical or temperate waters. In Humpbacks the phenomenon is less pronounced than in Rorquals. In Rorquals the phenomenon is not caused by observations of Sei or Bryde Whales only, because catches of land stations and strandings show that Blue and Fin Whales are present during the summer in the waters involved as well. The percentage of the stock of Blue and Fin Whales staying behind in warm and temperate waters is not known, but the authors have the impression that it is not insignificant. The number of Rorquals staying behind during the summer appears to be larger in the North than in

the South Atlantic, probably because Fin Whales in the North Atlantic feed on fish.

The phenomenon of staying behind of a part of the population confirms the assumption that estimations of the Antarctic population of Blue, Fin or Humpback Whales never bear on the total stock of the species involved. The phenomenon may also cause that the number of periods or laminations in baleen plates or ear plugs, used in determining the age of Whalebone Whales, is not a reliable indication for the actual age of the animals. The actual age may be higher than the number of periods, because the staying behind in warm waters causes irregularities in their formation.

It could, however, be demonstrated, that in most areas the majority of the populations showed the generally accepted type of annual migration.

### 3. Migration, Rorquals

In the *North Atlantic* the principal northward migration of Rorquals takes place in April-July, the southward migration in September-November. In the *South Atlantic* the period of migration southward is September-December, that of the northward migration March-June.

The majority of the Rorqual population (which may be principally the Fin Whale population) lives in the North Atlantic during the northern winter between  $0^{\circ}$  and  $40^{\circ}$  N and during the northern summer between  $30^{\circ}$  N and the border of the pack ice. With regard to the South Atlantic these areas are: in the southern winter between  $20^{\circ}$  N and  $50^{\circ}$  S, in the southern summer between the equator and the pack ice, but mainly in Antarctic waters.

The northern and southern population apparently meet in the Caribbean, in waters off the North African west coast and probably also in the central part of the Ocean between  $0^{\circ}$  and  $20^{\circ}$  N.

In the *Indian Ocean* large concentrations of Rorquals have been encountered in the northern part of the Ocean during the southern summer, whereas the number of sightings during the southern winter is surprisingly small. During this season the majority of the Rorquals is concentrated in waters of Madagascar and off the Australian west coast. This suggests, that during the southern summer (northern winter) the northern part of the Ocean is populated by Rorquals coming from the northern part of the Pacific Ocean. Probably these whales enter the Indian Ocean by passing the waters of the Indonesian Archipelago and the straits between these waters and the Indian Ocean. This supposition is supported by the fact that in the northern part of the Indian Ocean

calves have been sighted in almost equal monthly numbers during the whole year, whereas in the Atlantic Ocean seasonal peaks in the number of sightings have been demonstrated. On the other hand, the possibility of a local stock in the northern part of the Indian Ocean may not be excluded.

Although a number of southern Rorquals certainly migrate into the northern part of the Ocean during the southern winter, the majority of the population probably live in this season between the equator (or  $10^{\circ}$  S) and  $30^{\circ}$  S. In the southern summer the majority of the population is found in Antarctic.

In the *North Pacific Ocean* the majority of the population is found during the northern summer between  $20^{\circ}$  N and the pack ice and in the northern winter between  $10^{\circ}$  N and  $30^{\circ}$  N. The *South Pacific* population apparently migrates northward during the southern winter up to about  $10^{\circ}$  N.

### 4. Migration, Humpbacks

Humpbacks appear to migrate principally in coastal waters with the exception of the crossing part of the Gulf Stream in the North Atlantic ( $30^{\circ}$  N to  $50^{\circ}$  N) where they are found during the northern winter over the entire breadth of the Ocean. In the northern part of the Indian Ocean they are spread over a large part of the Ocean as well.

In the *North Atlantic* the majority of the population is found during the northern summer between  $30^{\circ}$  N and  $50^{\circ}$  N, and during the northern winter between  $40^{\circ}$  N and  $10^{\circ}$  S (especially in the Caribbean and off the North African west coast). Probably all Humpbacks in the Caribbean belong to the northern stock, because the southern population appears to live during the southern winter between  $30^{\circ}$  S and  $20^{\circ}$  N at the African side of the Ocean, but between  $30^{\circ}$  S and the equator at the American side. During the southern summer they are found between  $30^{\circ}$  S and the pack ice (mostly in Antarctic waters). In former days the North Atlantic Humpback population probably lived further northward (in summer as well as in winter) than nowadays. This may be connected with changes in feeding conditions or with the general decrease of the stock.

Just as has been shown with regard to Rorquals, a part of the North Pacific Humpback population seems to migrate into the northern part of the *Indian Ocean* during the northern winter. The southern population of the Indian Ocean lives during the southern winter between the continent and  $30^{\circ}$  S. During the southern summer the animals are found between  $45^{\circ}$  S and the border of the pack ice.

The northern and southern stocks of the *Pacific*

Ocean meet in waters of the Indonesian Archipelago. At the eastern (American) side of the Ocean the northern population lives during the summer between  $30^{\circ}$  N and  $50^{\circ}$  N (or farther northward). During the winter they live between  $10^{\circ}$  N and  $30^{\circ}$  N. The southern stock appears to migrate as far to the North as  $10^{\circ}$  N.

#### 5. Calves

Sightings of calves of *Rorquals* (probably the majority of them being Fin Whales) in the Atlantic Ocean point to a peak in the number of births in December-January for the northern population and in May-June for the southern stock.

North Atlantic *Humpbacks* appear to be born principally in the southern part of the North Atlantic in April, whereas births of the southern stocks apparently occur in tropical waters with a peak in September.

### C. SPERM WHALES

#### 1. North Atlantic

Sperm Whales are always present in the North Atlantic between  $10^{\circ}$  S and  $30^{\circ}$  N, but on the African side the population appears to be much larger than on the American side. A great number of animals are sighted in the Gulf Stream during the summer. The northward migration starts in April, the animals return to the South in autumn. The majority of the females do not go farther to the North than  $40^{\circ}$  N (a minority probably up to  $50^{\circ}$  N). The males migrate into Arctic waters. During the northern winter the majority of the males and females apparently live between  $10^{\circ}$  S and  $30^{\circ}$  N (the American stock mostly in the Caribbean), but some males may stay behind in colder waters as far as  $60^{\circ}$  N.

#### 2. South Atlantic

Practically no sightings of Sperm Whales have been reported from the South American east coast, although these waters show a reasonable biological productivity and although a great number of *Rorquals* have been sighted there. In former days great numbers of Sperm Whales have been caught in these waters. During the summer the males migrate into Antarctic waters, the females migrate up to about  $40^{\circ}$  S. During the winter most of the animals live in tropical waters but some males and females are present up to  $40^{\circ}$  S.

#### 3. Indian Ocean

With regard to the Indian Ocean there is a very significant correlation between the distribution of Sperm

Whales and the biological productivity of the sea. In the northern part of the Ocean there are many more Sperm Whales sighted during the northern winter than during the northern summer.

The general seasonal movements described with regard to the Atlantic and Pacific Oceans could not be demonstrated in the Indian Ocean. Apparently the Sperm Whales in this region show very special migratory movements which may be correlated with special conditions, caused by the fact that the Monsoon-stream in the northern part flows in an opposite direction in the two halves of the year.

#### 4. Pacific Ocean

Sperm Whales are encountered in the Indonesian Archipelago the whole year round. In the South Pacific they are not evenly distributed but apparently they are restricted to certain areas. The normal seasonal migratory movements could be demonstrated with regard to the South Pacific.

### D. OTHER SPECIES

#### 1. Little Piked Whales

Fairly large numbers of this species were sighted throughout the whole year in tropical waters of all oceans. Large herds were also seen in the northern hemisphere. They show concentrations in areas with a high biological productivity of the sea. During the winter the majority of the animals apparently live in tropical and subtropical waters. During the spring and the autumn they show the usual migratory movements, just as *Rorquals* and *Humpbacks*. During the winter, however, some animals stay behind in northern waters, whereas during the summer there are some stragglers in warm waters.

The species has been observed in the northern part of the Indian Ocean during the northern winter. In the North Atlantic births take place in warm or temperate waters, probably from November to March.

#### 2. Californian Grey Whales

Sightings in the North Pacific were quite in accordance with the generally accepted opinion about the migration of this species.

#### 3. Right Whales

North Atlantic as well as Southern Right Whales have been reported. The majority of the animals do not migrate into waters between  $20^{\circ}$  N and  $20^{\circ}$  S, but there are indications that a few animals may also visit these tropical waters.



With regard to the North Atlantic no sightings have been reported from regions north of 50° N, whereas there was a large number of sightings between 20° N and 50° N during the northern summer.

In the Indian Ocean and in the Indian Archipelago two sightings were reported from waters between 10° N and 10° S. These observations, however, need further confirmation.

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Table 1. *Explanation of the symbols on the charts*

Atlantic and Indian Ocean		
● 1 dot	:	1- 10 animals sighted per 1000 hrs. steamed in daylight
2 dots	:	11- 20 "
3 "	:	21- 30 "
4 "	:	31- 40 "
5 "	:	41- 50 "
6 "	:	51- 60 "
7 "	:	61- 70 "
8 "	:	71- 80 "
9 "	:	81- 90 "
10 "	:	91-100 "
□ 6 squares	:	101-120 "
7 "	:	121-140 "
8 "	:	141-160 "
9 "	:	161-180 "
10 "	:	181-200 "
△ 5 triangles	:	201-250 "
6 "	:	251-300 "
7 "	:	301-350 "
8 "	:	351-400 "
9 "	:	401-450 "
10 "	:	451-500 "
⊗ 6 crosses	:	501-600 "
7 "	:	601-700 "
8 "	:	701-800 "
9 "	:	801-900 "
10 "	:	901-1000 "
Pacific Ocean		
● 1-10 dots	:	as in Atlantic and Indian Ocean
□ 1 square	:	101-150 animals sighted per 1000 hours steamed in daylight
2 squares	:	151-200 "
△ 1 triangle	:	201-300 "
2 triangles	:	301-400 "
3 triangles	:	401-500 "
⊗ 1 cross	:	501-750 "
2 crosses	:	751-1000 "
3 crosses	:	1001-1500 "

Table 2. *Number of sightings and number of animals sighted in the different regions*

Species and area	Number of animals per sighting is exactly known			Number of animals per sighting is estimated			Number of big herds
	Total number of sightings	Total number of animals	Average number of animals per sighting	Total number of sightings	Total number of animals	Average number of animals per sighting	
<b>Rorquals</b>							
Atlantic	784	1874	2,38	124	1519	12,25	4
Indian	438	903	2,05	66	715	10,83	2
Pacific	138	384	2,78	24	268	11,16	3
<b>Humpback Whale</b>							
Atlantic	142	341	2,40	17	161	9,47	1
Indian	131	377	2,87	11	123	11,18	1
Pacific	58	216	3,72	6	86	14,33	11
<b>Sperm Whale</b>							
Atlantic	281	767	2,73	41	431	10,51	1
Indian	227	485	2,13	20	243	12,15	3
Pacific	57	140	2,45	11	110	11	4
<b>Little piked Whale</b>							
Atlantic	54	199	3,68	21	362	17,24	1
Indian	24	43	1,79	6	116	19,33	—
Pacific	6	15	2,50	3	30	10,00	—
<b>Grey Whale</b>							
Pacific	11	37	3,36	2	20	10,00	—
<b>Right Whale</b>							
Atlantic	23	37	1,60	1	22	22,00	—
Indian	4	9	2,25	—	—	—	—
Pacific	2	5	2,50	—	—	—	1

Table 3. *Total catches of land stations from summer 1948 to summer 1958, according to*

	Blue Whale								
	Jan.	Febr.	March.	Apr.	May.	June.	July.	Aug.	Sept.
Norway Steinshamn	—	—	—	—	—	—	2	1	1
„ Skjelnan	—	—	—	—	—	1	2	—	—
„ Hestnes	—	—	—	—	—	1	2	2	—
„ Blomvåg	—	—	—	—	—	4	1	2	—
West Greenland	—	—	—	—	—	—	3	1	1
Iceland	—	—	—	—	3	19	37	53	34
New Foundland	—	—	—	—	—	49	74	1	2
Faroe Islands	—	—	—	—	—	7	4	12	3
Scotland	—	—	—	—	—	2	3	1	—
Portugal	—	—	—	—	1	—	—	—	—
Spain Algeciras	—	—	—	—	—	—	—	—	—
„ Camelinas	—	—	—	—	—	—	—	—	—
„ Vigo	—	—	—	—	—	—	—	—	—
Brazil	—	—	—	—	—	—	—	—	2
Peru	—	1	—	2	—	—	—	—	2
Chile Cia. Ind.	164	230	87	59	3	2	—	—	—
„ Cia. Chil. Pesca	7	20	18	9	5	1	3	—	—
Azores	—	—	—	—	—	—	—	—	—
Madeira	—	—	—	—	—	—	—	—	—
Gaboon	—	—	—	—	—	—	—	—	—
Morocco	4	—	—	—	—	—	—	—	—
Natal	—	—	—	—	18	41	24	7	4
Cape Province	—	—	—	5	7	11	4	5	4
Madagascar	—	—	—	5	—	1	—	—	—
Indian Ocean	—	—	—	—	—	—	—	—	—
California	—	—	—	—	—	1	—	—	8
North Pacific	—	—	—	—	4	67	—	—	69
Kamchatka	—	—	—	—	28	145	114	49	74
Kuril Islands	—	—	—	—	18	38	36	10	13
Bonin Islands	—	—	1	—	—	—	—	—	—
Japan	—	—	—	—	28	18	5	4	7
British Columbia	—	—	1	6	19	24	12	12	9
Australia Carnarvon	—	—	—	—	—	—	—	—	—
„ Point Cloates	—	—	—	—	—	—	—	—	—
„ Frenchman Bay	—	—	—	—	—	—	—	—	—
„ Byron Bay	—	—	—	—	—	—	—	—	—
„ Tangalooma	—	—	—	—	1	—	—	—	—
New Zealand	—	—	—	—	—	—	—	—	—
South Georgia	80	49	51	7	—	—	—	—	—

Fat = top catches

[illegible]



	Sei Whale									
	Jan.	Febr.	March.	Apr.	May.	June.	July.	Aug.	Sept.	
Norway Steinshamn	—	—	—	—	34	40	20	10	4	
„ Skjelnan	—	—	—	—	1	—	—	—	—	
„ Hestnes	—	—	—	—	21	13	6	1	—	
„ Blomvåg	—	—	—	—	—	8	6	—	1	
West Greenland	—	—	—	—	—	—	—	1	4	
Iceland	—	—	—	—	—	28	60	250	178	
New Foundland	—	—	—	—	—	2	—	10	27	
Faroe Islands	—	—	—	—	—	87	123	18	27	
Scotland	—	—	—	—	—	—	3	—	—	
Portugal	—	—	—	—	—	—	—	—	—	
Spain Algeciras	—	1	2	1	1	2	9	—	4	
„ Camelinás	—	—	—	—	—	—	—	—	—	
„ Vigo	—	—	—	—	—	—	—	—	—	
Brazil	—	—	—	—	—	27	208	287	380	
Peru	—	—	—	—	3	4	1	4	3	
Chile Cia. Ind.	1	2	8	5	1	4	—	1	1	
„ Cia. Chil. Pesca	1	—	—	9	12	—	—	—	—	
Azores	—	—	—	—	—	—	—	—	—	
Madeira	—	—	—	—	—	—	—	—	—	
Gaboon	—	—	—	—	—	19	140	144	266	
Morocco	10	1	6	10	9	4	3	1	18	
Natal	—	—	—	7	252	423	235	212	183	
Cape Province	—	—	—	—	74	158	244	248	678	
Madagascar	—	—	—	—	—	—	—	—	3	
Indian Ocean	—	—	—	—	—	—	—	—	—	
California	—	—	—	—	—	—	—	1	1	
North Pacific	—	—	—	—	3	122	219	33	—	
Kamtschatka	—	—	—	—	21	72	108	126	55	
Kuril Islands	—	—	—	—	21	50	146	309	254	
Bonin Islands	—	13	57	91	499	252	—	—	—	
Japan	—	—	—	—	141	238	468	277	435	
British Columbia	—	—	—	38	89	118	141	23	10	
Australia Carnarvon	—	—	—	—	—	—	—	—	—	
„ Point Cloates	—	—	—	—	—	—	—	—	—	
„ Frenchman Bay	—	—	—	—	—	—	—	—	—	
„ Byron Bay	—	—	—	—	—	—	—	—	—	
„ Tangalooma	—	—	—	—	—	—	—	—	—	
New Zealand	—	—	—	—	1	—	—	—	—	
South Georgia	839	2229	2233	401	—	—	—	—	—	

Tab *inued*)

[illegible]

Tab  
continued

	Sperm Whale												De
	Jan.	Febr.	March.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.		
Norway Steinshamn	—	—	—	—	15	24	23	8	18	7	—		
„ Skjelnan	—	—	—	—	56	53	76	148	75	26	—	Morocco	
„ Hestnes	—	—	—	—	3	10	8	13	—	—	—	Natal	
„ Blomvåg	—	—	—	—	3	6	1	—	—	—	—	Cape Pr	
West Greenland	—	—	—	—	4	37	11	19	7	5	—	Madaga	
Iceland	—	—	—	—	17	71	56	178	76	—	—	Indian C	
New Foundland	—	—	—	—	—	5	11	39	45	23	5	Califorr	
Faroe Islands	—	—	—	7	68	195	57	107	25	10	—	North F	
Scotland	—	—	—	—	—	1	—	—	—	—	—	Kamitch	
Portugal	—	—	3	1	3	2	7	—	1	3	1	Kuril Is	
Spain Algeciras	—	3	28	27	13	22	10	6	1	7	6	Donin I	
„ Camelinas	—	—	—	10	11	19	40	28	59	26	10	Japan	
„ Vigo	—	—	—	3	4	2	6	16	9	12	5	British C	
Brazil	—	—	—	—	—	—	2	—	3	3	—	Austral	
Peru	300	—	—	523	427	9	308	565	261	1341	1569	45	
Chile Cia. Ind.	616	606	628	431	387	346	295	277	188	271	189	8	
„ Cia. Chil. Pesca	169	144	83	166	81	56	15	—	—	33	89	9	
Azores	67	33	61	105	163	306	738	658	502	326	291	9	
Madeira	19	1	13	20	13	3	4	10	41	2	3	New Ze	
Gaboon	—	—	—	—	—	—	—	4	90	52	—	South C	

Table 4. Number of calves observed in the different months in the

	Rorquals					Whales				Humpback Whale				Spe
	Atl.		Ind.	Pac.	Tot.	Atl.	Ind.	Pac.	Tot.	Atl.	Ind.	Pac.	Tot.	In
	N <sup>1)</sup>	Z <sup>2)</sup>												
January	—	—	1	1	2	1	1	—	2	—	2	—		—
February	1	—	3	—	4	2	2	—	4	—	—	—		—
March	6	1	3	1	11	2	1	—	3	—	—	—		—
April	—	—	1	1	2	1	1	—	2	—	—	1		—
May	5	—	3	12	20	1	—	—	1	2	—	—		—
June	4	—	4	—	8	2	—	1	3	2	—	2		—
July	3	2	1	—	6	1	—	1	2	1	—	4		—
August	6	11	—	—	17	3	1	1	5	—	1	2		—
September	1	2	1	15	19	—	—	1	1	7	2	2		—
October	2	4	2	2	10	1	9	1	11	—	—	10		1
November	1	15	1	2	19	1	2	—	3	—	5	—		—
December	—	1	7	—	8	—	5	—	5	—	1	—		—
Total	29	36	27	34	126	15	22	5	42	12	11	21	34	

1) 10° N to 60° N

2) 10° N to 50° S

Table  
(continued)

Nov.	Dec.		Sperm Whale											
			Jan.	Febr.	March.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
—	—	Morocco	28	38	41	88	32	17	3	3	3	1	2	12
—	—	Natal	303	133	176	378	1176	1091	760	754	568	147	102	230
—	—	Cape Province	—	—	—	71	376	470	275	234	269	247	7	—
—	—	Madagascar	—	—	—	—	—	1	—	6	5	—	—	—
—	—	Indian Ocean	—	—	—	—	—	—	—	—	46	6	—	—
5	—	California	4	1	11	12	16	14	12	11	11	7	4	—
—	—	North Pacific	—	—	—	—	426	178	—	200	—	—	—	—
—	—	Kamtschatka	—	—	—	211	792	1187	1338	1692	1510	796	51	—
1	—	Kuril Islands	—	—	—	151	950	1179	1708	2157	2598	2261	339	—
6	—	Bonin Islands	—	49	100	66	64	15	—	—	—	—	—	—
10	—	Japan	—	—	—	556	489	559	457	993	917	498	377	—
5	—	British Columbia	—	—	8	103	308	228	301	344	221	—	—	—
—	—	Australia Carnarvon	—	—	—	—	—	—	—	—	—	—	—	—
1569	4%	" Point Cloates	—	—	—	—	—	—	—	—	—	—	—	—
189	8%	" Frenchman Bay	—	—	—	—	—	—	—	—	—	1	5	1
89	9%	" Byron Bay	—	—	—	—	—	—	—	—	—	—	—	—
291	9%	" Tangalooma	—	—	—	—	—	—	—	—	—	—	—	—
3	4%	New Zealand	—	—	—	—	—	—	—	—	—	—	—	—
—	—	South Georgia	165	221	637	188	—	—	—	—	—	47	72	106

different months in the different regions

back Whale				Sperm Whale				Little Piked Whale				Grey Whale				Right Whale			
d.	Pac.	Tot.		Atl.	Ind.	Pac.	Tot.	Atl.	Ind.	Pac.	Tot.	Atl.	Ind.	Pac.	Tot.	Atl.	Ind.	Pac.	Tot.
2	—	—	14	—	—	—	14	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	2	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	3	5	1	9	11	—	—	—	11	—	—	—	—	—	—	—	—
—	—	—	1	2	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	2	—	—	2	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	2	1	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	4	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	2	—	—	2	1	—	—	—	1	—	—	1	—	—	—	—	1
—	—	—	2	—	—	2	1	—	—	—	1	—	—	—	—	—	—	—	—
10	—	—	7	19	3	29	4	—	—	—	4	—	—	—	—	—	—	—	—
—	—	—	2	5	1	8	1	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	2	2	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—
1	21	4	39	34	5	78	18	—	—	18	—	—	1	1	1	—	—	—	1

Table 5. *Observations of Whales made by Captain W. F. J. MÖRZER BRUINS*

Date	Number	Position
ATLANTIC OCEAN		
Fin Whale		
4- 4-1956	2-4	40°N to 50°N - 40°W to 50°W
28-11-1956	2	20°S to 30°S - 10°E to 20°E
29- 8-1957	3-4	30°N to 40°N - 0 to 10°W
Sei Whale		
10- 5-1957	1	40°N to 50°N - 0 to 10°W
19-10-1957	50 + newborn	30°N to 40°N - 0 to 10°W
1- 6-1959	5	40°N to 50°N - 0 to 10°W
Sperm Whale		
8-11-1954	2	30°N to 40°N - 30°W to 40°W
3- 4-1956	1♂ and 1♀	30°N to 40°N - 40°W to 50°W
11- 3-1957	2	0 to 10°N - 10°W to 20°W
Right Whale		
May 1954	12	40°N to 50°N - 50°W to 60°W
MEDITERRANEAN		
Fin Whale		
11- 6-1955	2 + 2 + 1	40°N to 50°N - 0 to 10°E
16- 6-1955	2-3 + 2 + 1	40°N to 50°N - 0 to 10°E
Sei Whale		
25- 6-1953	1	30°N to 40°N - 0 to 10°E
Sperm Whale		
28- 3-1956	1♂	30°N to 40°N - 0 to 10°E
22- 8-1957	1♂ + 3♀♀	30°N to 40°N - 10°E to 20°E
INDIAN OCEAN		
Blue Whale		
23- 9-1953	30-50	10°N to 20°N - 60°E to 70°E
24- 9-1953	1	20°N to 30°N - 50°E to 60°E
23-10-1954	?	10°N to 20°N - 50°E to 60°E
28-10-1957	3	10°N to 20°N - 50°E to 60°E
31-10-1957	1	0 to 10°N - 60°E to 70°E
Sei Whale		
17- 3-1955	1	10°N to 20°N - 70°E to 80°E
1- 6-1955	2	10°N to 20°N - 40°E to 50°E
	(20-30 + 1 c.)	
12-12-1955	1+3-4	10°N to 20°N - 50°E to 60°E
10- 3-1956	4	0 to 10°N - 70°E to 80°E
24- 5-1957	1+1	10°N to 20°N - 50°E to 60°E
2-11-1957	2	0 to 10°N - 70°E to 80°E
3-11-1957	2	0 to 10°N - 70°E to 80°E
29- 3-1958	1	10°N to 20°N - 50°E to 60°E
15- 5-1958	1	0 to 10°N - 80°E to 90°E
11- 5-1959	1	0 to 10°N - 70°E to 80°E
11- 5-1959	1	0 to 10°N - 80°E to 90°E
15- 5-1959	3+1	10°N to 20°N - 50°E to 60°E
17- 5-1959	1	10°N to 20°N - 40°E to 50°E

Table 5. (Continued)

Date	Number	Position
<b>Humpback Whale</b>		
21- 9-1953	1	0 to 10°N - 70°E to 80°E
26- 9-1953	±50	10°N to 20°N - 40°E to 50°E
<b>Sperm Whale</b>		
19- 8-1953	1	10°N to 20°N - 80°E to 90°E
21- 8-1953	1	10°N to 20°N - 80°E to 90°E
26- 9-1953	1	10°N to 20°N - 40°E to 50°E
23- 2-1954	1	20°N to 30°N - 60°E to 70°E
4- 3-1954	2+4+6	0 to 10°N - 80°E to 90°E
9- 8-1954	1	0 to 10°N - 70°E to 80°E
9- 8-1954	1	0 to 10°N - 80°E to 90°E
20-10-1954	4	10°N to 20°N - 50°E to 60°E
22- 1-1955	1	10°N to 20°N - 50°E to 60°E
21- 2-1957	1	0 to 10°S - 70°E to 80°E
1- 3-1957	2	30°S to 40°S - 30°E to 40°E
22- 5-1957	2	10°N to 20°N - 40°E to 50°E
24- 5-1957	1	10°N to 20°N - 50°E to 60°E
30-10-1957	1	0 to 10°N - 50°E to 60°E
5-11-1957	5-6	0 to 10°N - 90°E to 100°E
28- 3-1958	6+15	10°N to 20°N - 50°E to 60°E
17- 2-1959	1	10°N to 20°N - 40°E to 50°E
22- 2-1959	1-2	0 to 10°N - 70°E to 80°E
12- 5-1959	1	0 to 10°N - 70°E to 80°E
15- 5-1959	10±1 calf	10°N to 20°N - 50°E to 60°E
17- 5-1959	1	10°N to 20°N - 40°E to 50°E
<b>PACIFIC OCEAN</b>		
<b>Fin Whale</b>		
24- 6-1957	1	20°N to 30°N - 150°E to 160°E
<b>Sei Whale</b>		
4- 1-1956	1	0 to 10°S - 130°E to 140°E
2- 2-1956	1	0 to 10°S - 120°E to 130°E
<b>Humpback Whale</b>		
12- 7-1958	±30	30°N to 40°N - 120°W to 130°W
13- 7-1958	6+6	30°N to 40°N - 120°W to 130°W
18- 7-1958	4-6	30°N to 40°N - 120°W to 130°W
<b>Sperm Whale</b>		
9- 1-1956	1	0 to 10°S - 130°E to 140°E
2- 2-1956	1	0 to 10°S - 130°E to 140°E
24- 6-1958	2	20°N to 30°N - 140°E to 150°E
26- 6-1958	2	20°N to 30°N - 150°E to 160°E
27- 6-1958	1	20°N to 30°N - 160°E to 170°E
28- 6-1958	1	20°N to 30°N - 170°E to 180°E

Table 6. *Total number of hours steamed by daylight in the Atlantic Ocean per 10° square and per month. Squares without any shipping are not indicated*

Square	Month											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
50- 60 N	—	—	—	—	—	—	—	—	—	—	—	—
50- 60 W	—	—	—	—	—	—	37	65	28	—	—	—
40- 50 W	—	—	—	—	—	—	26	47	19	—	—	—
30- 40 W	—	—	24	82	140	185	85	173	78	44	18	15
20- 30 W	—	—	51	175	298	396	157	325	114	93	37	32
10- 20 W	—	—	56	192	326	432	173	357	151	102	41	35
0- 10 W	—	—	6	21	37	49	20	40	17	12	5	4
40- 50 N	—	—	—	—	—	—	—	—	—	—	—	—
70- 80 W	102	112	117	220	315	361	331	392	264	197	160	120
60- 70 W	291	320	367	741	1100	1305	1023	1318	828	628	495	376
50- 60 W	310	361	400	829	1553	1374	1102	1900	917	681	515	395
40- 50 W	275	356	378	826	1148	1217	1012	1364	895	634	439	340
30- 40 W	228	317	288	591	777	709	750	999	691	483	291	254
20- 30 W	723	655	745	1154	1479	2020	1883	1910	1252	1020	561	669
10- 20 W	1198	1137	1246	1790	2223	2886	2656	2604	1746	1541	1023	1066
0- 10 W	2317	3030	2727	3207	4510	4165	4144	3840	3096	3387	2058	2130
30- 40 N	—	—	—	—	—	—	—	—	—	—	—	—
70- 80 W	296	363	318	309	302	288	303	272	276	157	187	228
60- 70 W	431	541	420	313	289	255	245	334	232	125	216	319
50- 60 W	148	155	123	158	299	378	322	359	217	155	118	91
40- 50 W	358	256	266	273	575	906	704	1133	385	354	291	256
30- 40 W	843	623	677	817	1055	1916	1653	1422	920	794	596	722
20- 30 W	440	359	323	430	636	1037	897	846	559	410	451	376
10- 20 W	1581	1814	1674	2120	2263	2061	2044	2118	1652	1825	1757	1565
0- 10 W	372	384	379	505	776	468	745	815	516	512	357	354
20- 30 N	—	—	—	—	—	—	—	—	—	—	—	—
70- 80 W	281	164	261	350	510	725	614	473	397	339	255	171
60- 70 W	657	580	542	424	567	833	638	649	384	342	385	472
50- 60 W	501	340	371	478	514	955	831	733	495	435	286	432
40- 50 W	462	321	362	460	382	809	747	600	432	395	207	435
30- 40 W	10	7	4	16	4	9	13	12	15	4	10	10
20- 30 W	10	31	11	—	12	—	12	—	23	22	—	10
10- 20 W	1077	1236	1101	1363	1204	916	988	1001	896	1150	1215	1075
10- 20 N	—	—	—	—	—	—	—	—	—	—	—	—
70- 80 W	78	131	83	70	110	146	108	176	101	99	134	108
60- 70 W	863	807	798	654	554	1005	914	942	573	564	521	791
50- 60 W	308	253	284	253	230	468	439	451	260	279	203	297
40- 50 W	—	—	—	—	—	23	23	44	—	21	20	—
20- 30 W	471	505	390	449	505	384	359	516	369	523	403	430
10- 20 W	523	644	562	735	556	422	521	326	506	558	731	602
0- 10 N	—	—	—	—	—	—	—	—	—	—	—	—
70- 80 W	2	4	2	—	4	4	2	8	2	4	—	4
50- 60 W	153	227	224	141	92	128	133	208	111	86	223	153
40- 50 W	225	309	310	191	137	180	193	316	177	140	300	226
30- 40 W	18	55	48	22	33	41	47	710	14	58	56	22
20- 30 W	541	532	403	493	541	437	402	615	369	606	470	473
10- 20 W	513	620	541	648	484	386	489	345	434	550	758	588
0- 10 W	126	129	94	208	196	164	177	123	202	195	205	166



Table 6. (Continued)

Square	Month											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
0- 10 Z	—	—	—	—	—	—	—	—	—	—	—	—
30- 40 W	776	861	729	638	690	539	531	833	552	690	782	733
20- 30 W	99	114	96	90	62	74	65	95	59	58	113	86
0- 10 W	189	196	214	159	108	70	120	93	67	140	264	190
0- 10 O	89	88	44	173	173	154	154	117	195	181	161	134
10- 20 O	44	44	22	87	86	70	70	44	98	83	73	67
10- 20 Z	—	—	—	—	—	—	—	—	—	—	—	—
30- 40 W	1022	1329	701	1051	1033	506	784	1259	520	969	1193	1068
20- 30 W	44	65	52	40	10	29	29	40	21	—	77	44
10- 20 W	98	143	116	90	21	63	64	89	46	—	171	99
0- 10 W	148	151	160	117	78	47	83	61	50	104	201	149
0- 10 O	395	404	426	312	206	125	222	163	133	277	536	398
10- 20 O	16	15	7	28	28	20	20	10	32	26	23	23
20- 30 Z	—	—	—	—	—	—	—	—	—	—	—	—
40- 50 W	1047	1230	709	820	767	457	584	1021	555	834	880	750
30- 40 W	199	264	151	159	158	96	136	242	167	214	184	151
20- 30 W	59	57	36	17	48	31	32	66	87	96	40	20
10- 20 W	69	71	48	26	68	38	38	74	91	96	58	30
0- 10 W	127	171	133	94	225	76	76	116	82	42	196	111
0- 10 O	279	311	296	214	113	101	148	139	98	145	407	283
10- 20 O	310	312	321	230	148	88	158	118	98	217	421	315
30- 40 Z	—	—	—	—	—	—	—	—	—	—	—	—
60- 70 W	4	—	—	—	—	2	—	3	—	—	—	7
50- 60 W	800	658	531	398	412	398	384	565	444	557	603	642
40- 50 W	85	77	108	45	75	119	165	69	104	49	130	186
30- 40 W	—	—	45	—	38	72	111	—	43	—	52	106
20- 30 W	—	—	52	—	43	82	127	—	49	—	59	121
10- 20 W	—	—	58	—	49	92	143	—	55	—	66	136
0- 10 W	35	33	69	9	64	93	94	36	95	54	79	125
0- 10 O	84	89	109	34	90	117	161	80	142	97	134	156
10- 20 O	383	404	408	251	195	199	276	193	210	255	558	449

Table 7. *Total number of hours steamed by daylight in the Indian Ocean per 10° square and per month. Squares without any shipping are not indicated.*

Square	Month											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
30- 40 N	—	—	—	—	—	—	—	—	—	—	—	—
130-140 O	151	148	207	267	286	276	309	199	218	184	226	107
20- 30 N	—	—	—	—	—	—	—	—	—	—	—	—
30- 40 O	909	1003	901	1240	1723	1777	1588	1806	1368	1392	930	950
50- 60 O	567	634	504	645	766	800	805	703	593	620	629	625
60- 70 O	124	143	62	137	154	157	132	180	132	122	238	127
70- 80 O	7	7	—	—	8	17	12	12	4	11	23	10
80- 90 O	20	37	24	33	37	23	16	39	32	13	19	31
110-120 O	221	203	260	331	340	326	367	240	269	241	301	144
120-130 O	294	301	405	494	507	504	571	374	427	370	434	297
130-140 O	64	102	130	126	127	157	182	119	149	124	96	134
10- 20 N	—	—	—	—	—	—	—	—	—	—	—	—
30- 40 O	82	89	74	100	139	149	128	148	113	120	83	85
40- 50 O	1141	1227	1041	1385	1938	2059	1762	2112	1585	1647	1145	1198
50- 60 O	990	993	927	1154	1470	1572	1452	1514	1240	1210	907	1097
60- 70 O	204	112	122	243	213	190	214	179	281	127	227	163
70- 80 O	231	152	100	238	300	244	147	221	216	177	288	173
80- 90 O	80	184	161	157	202	124	68	227	113	65	97	157
90-100 O	36	49	89	94	57	66	77	68	90	59	29	84
100-110 O	102	78	86	104	97	93	134	107	89	86	115	54
110-120 O	269	244	275	316	321	324	370	247	292	273	316	196
0- 10 N	—	—	—	—	—	—	—	—	—	—	—	—
40- 50 O	148	150	90	110	125	88	111	157	134	122	107	160
50- 60 O	298	292	204	210	306	247	190	273	217	193	277	281
60- 70 O	556	519	474	523	821	811	580	925	601	632	516	539
70- 80 O	655	562	552	676	926	911	703	1072	755	775	614	670
80- 90 O	596	538	559	706	819	752	644	944	636	712	589	619
90-100 O	691	596	641	809	900	868	792	1050	760	852	694	728
100-110 O	468	406	447	502	535	528	613	564	502	492	512	394
0- 10 Z	—	—	—	—	—	—	—	—	—	—	—	—
40- 50 O	408	333	270	253	320	212	235	286	338	267	315	404
50- 60 O	71	—	12	12	23	—	—	—	12	—	36	12
60- 70 O	2	11	6	2	12	13	3	12	6	8	9	4
70- 80 O	108	217	112	130	20	251	109	234	132	190	249	131
80- 90 O	89	107	78	87	75	124	72	142	113	152	191	93
90-100 O	99	115	114	96	16	—	—	—	16	32	132	116
100-110 O	121	141	140	118	19	—	—	—	20	40	162	143
110-120 O	107	82	39	89	114	111	185	110	184	193	79	180
120-130 O	64	64	21	83	84	82	144	62	148	150	43	130
130-140 O	64	64	29	83	84	82	144	62	148	150	43	130
10- 20 Z	—	—	—	—	—	—	—	—	—	—	—	—
30- 40 O	152	106	101	79	105	65	74	84	113	73	114	144
40- 50 O	347	246	223	187	256	158	91	186	288	235	275	306
50- 60 O	95	101	88	87	33	52	35	45	44	73	139	104
60- 70 O	244	257	226	222	85	135	91	116	114	187	356	266
70- 80 O	166	184	170	151	40	42	28	36	49	87	230	190
80- 90 O	139	268	172	151	161	146	42	147	82	127	268	184
90-100 O	35	95	48	44	76	73	21	104	67	85	121	51
110-120 O	163	68	67	22	103	102	144	169	130	161	139	190
140-150 O	94	95	29	163	116	112	198	84	261	274	62	249

Table 7. (Continued)

Square	Month											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
20- 30 Z	—	—	—	—	—	—	—	—	—	—	—	—
30- 40 O	740	609	532	454	419	316	292	365	520	499	733	754
40- 50 O	248	262	229	212	69	53	67	86	94	166	356	277
50- 60 O	173	184	160	148	49	38	47	61	66	116	249	194
90-100 O	12	70	22	23	69	69	20	71	32	47	61	25
100-110 O	21	117	38	42	115	118	33	140	75	103	126	42
110-120 O	175	93	75	25	122	115	144	188	140	183	167	208
140-150 O	14	14	4	16	15	15	27	12	30	33	10	29
150-160 O	120	93	65	121	141	115	189	88	212	248	91	177
30- 40 Z	—	—	—	—	—	—	—	—	—	—	—	—
10- 20 O	146	109	118	90	65	21	36	48	60	65	168	118
20- 30 O	597	435	509	390	301	107	166	217	282	331	720	517
30- 40 O	151	88	136	108	91	27	40	60	79	133	184	143
40- 50 O	36	—	32	29	26	—	—	14	15	66	36	37
50- 60 O	36	—	32	29	26	—	—	14	15	66	36	37
60- 70 O	36	—	32	29	26	—	—	14	15	66	36	37
70- 80 O	36	—	32	29	26	—	—	14	15	66	36	37
80- 90 O	40	—	35	31	29	—	—	15	16	73	39	40
90-100 O	40	—	35	31	29	—	—	15	16	73	39	40
100-110 O	36	—	32	29	26	—	—	15	17	69	38	37
110-120 O	283	143	170	117	225	176	157	241	205	312	300	308
120-130 O	265	68	154	100	164	119	138	146	160	227	217	276
130-140 O	291	73	180	117	190	134	153	158	177	255	242	312
140-150 O	207	66	155	116	165	105	108	110	134	203	200	238
150-160 O	181	85	144	153	168	116	124	101	151	217	185	242
160-170 O	20	68	—	35	63	40	47	15	98	110	39	68
170-180 O	—	12	—	4	19	12	18	—	31	35	—	26

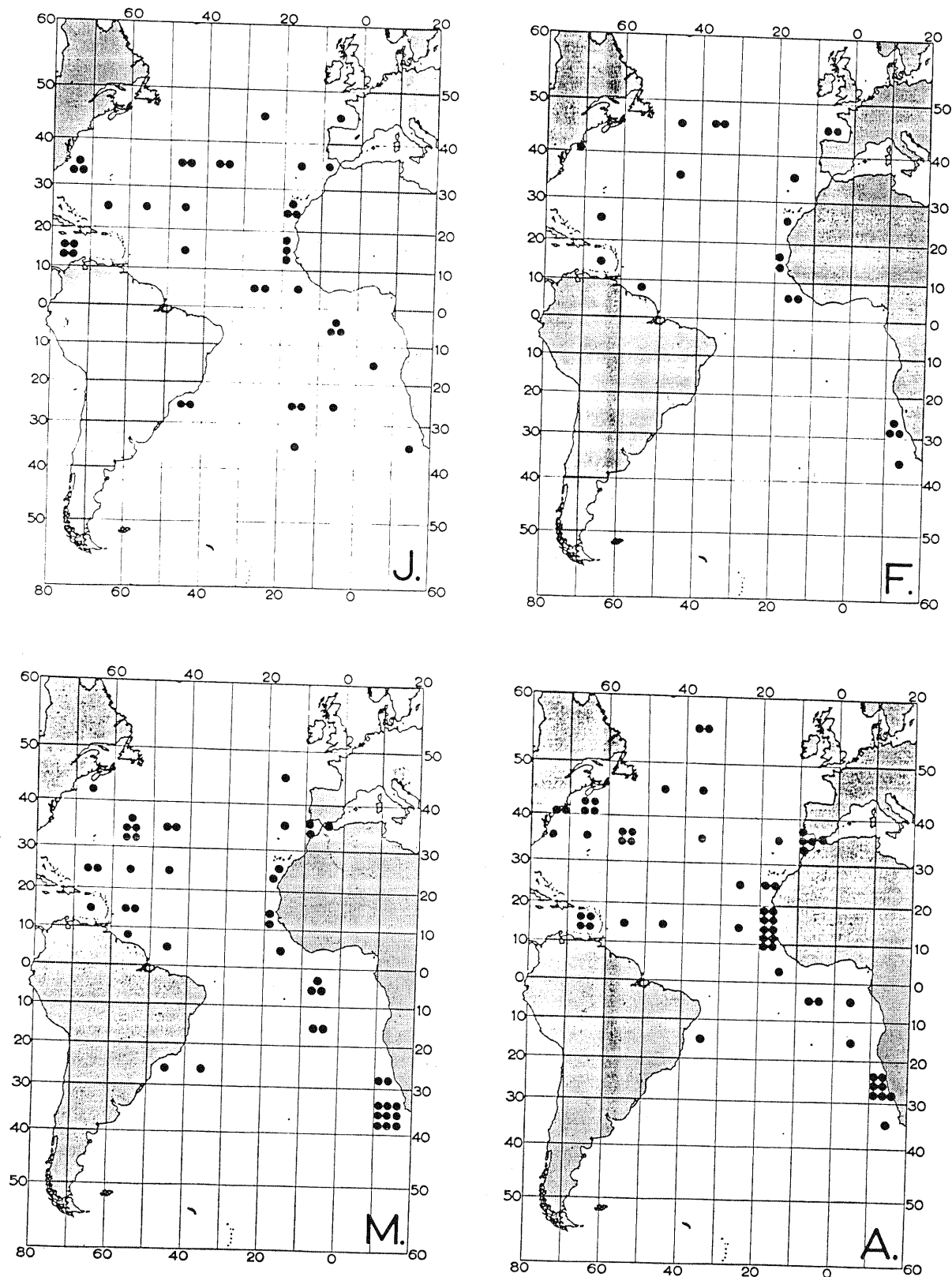
[illegible]

Table 8. (Continued)

Square	Month											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
100-110 W	1	3	16	2	2	—	—	2	2	2	3	—
90-100 W	13	26	16	13	13	—	—	13	13	13	26	—
80- 90 W	58	61	86	17	88	86	71	131	186	31	72	68
70- 80 W	21	14	35	—	—	43	36	57	85	7	28	35
0- 10 Z	—	—	—	—	—	—	—	—	—	—	—	—
140-150 O	—	—	—	—	—	—	—	—	—	—	—	—
130-140 W	7	13	—	7	6	—	—	6	7	7	13	—
120-130 W	19	37	—	18	18	—	—	18	18	18	37	—
110-120 W	15	31	—	15	15	—	—	15	15	15	31	—
100-110 W	19	37	—	18	18	—	—	18	18	18	37	—
10- 20 Z	—	—	—	—	—	—	—	—	—	—	—	—
150-160 W	5	11	—	5	5	—	—	5	5	5	11	—
140-150 W	19	38	—	18	17	—	—	17	18	19	38	—
130-140 W	12	24	—	11	11	—	—	11	11	12	24	—
20- 30 Z	—	—	—	—	—	—	—	—	—	—	—	—
160-170 W	7	14	—	6	6	—	—	6	6	7	15	—
150-160 W	24	45	—	20	19	—	—	20	21	23	47	—
30- 40 Z	—	—	—	—	—	—	—	—	—	—	—	—
170-180 W	25	48	—	20	19	—	—	20	21	24	48	—
160-170 W	15	29	—	12	11	—	—	12	13	14	29	—
40- 50 Z	—	—	—	—	—	—	—	—	—	—	—	—
170-180 O	23	51	—	24	22	8	7	17	32	38	49	11

## CHARTS

The charts show the monthly number of sightings in the different squares calculated per 1000 hours steamed in daylight. The month is indicated at the bottom of each chart (right). For explanation of symbols see table 1.

Chart 1. *Rorquals in the Atlantic Ocean*



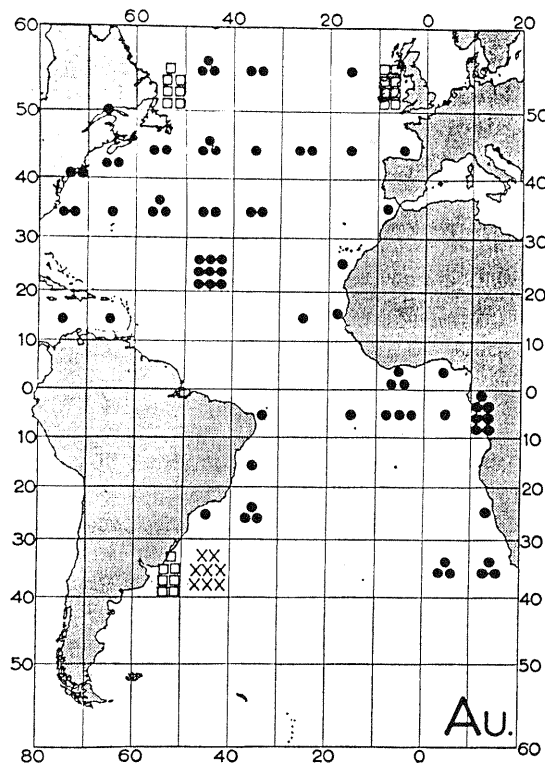
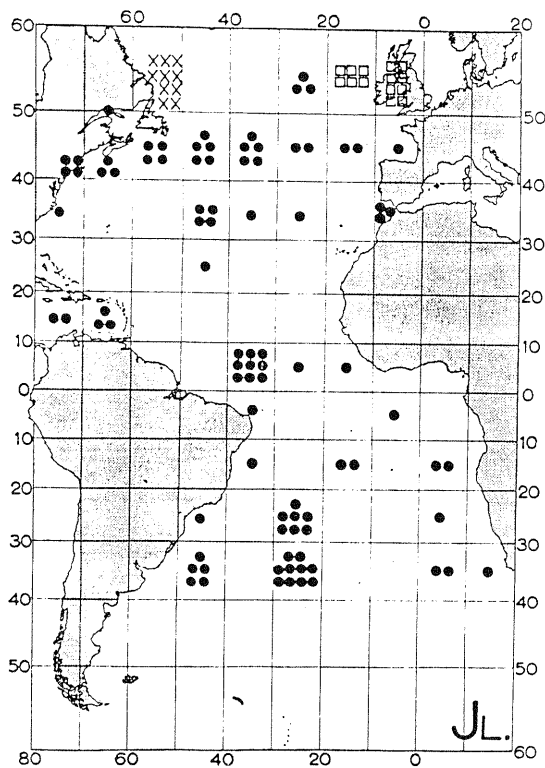
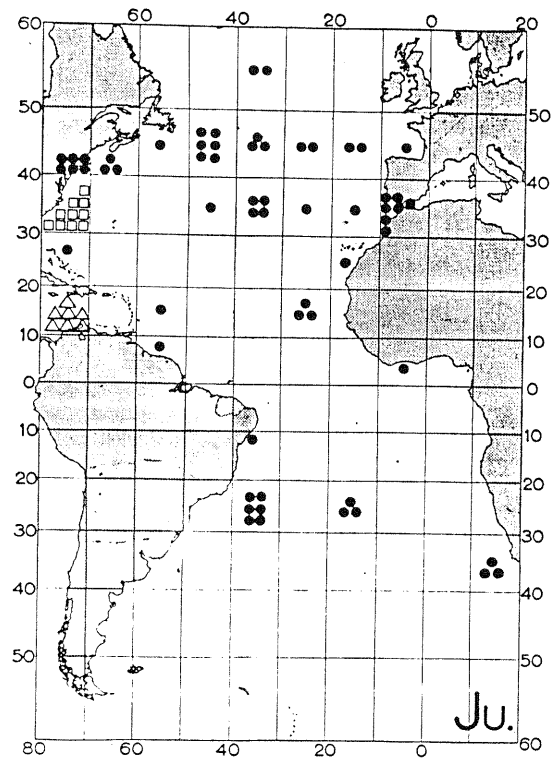
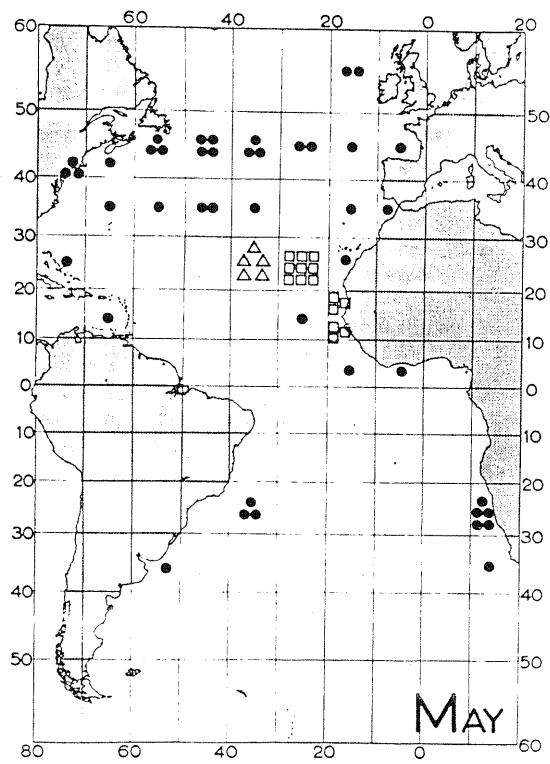


Chart 1. Rorquals in the Atlantic Ocean

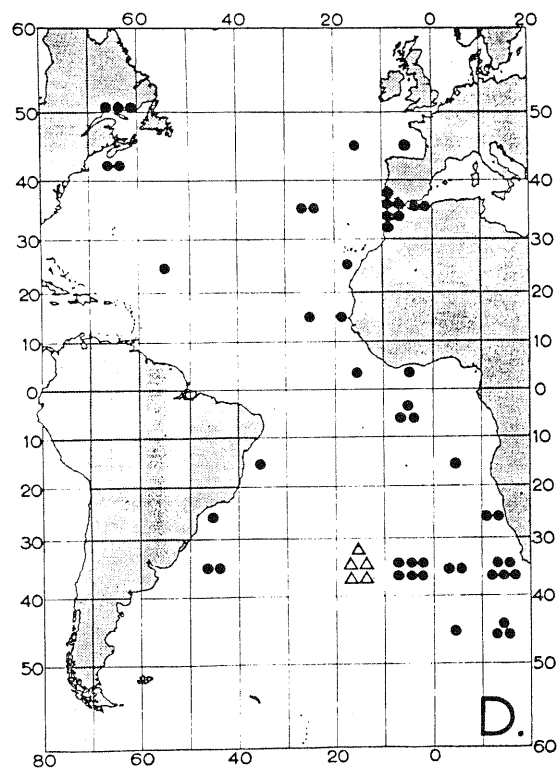
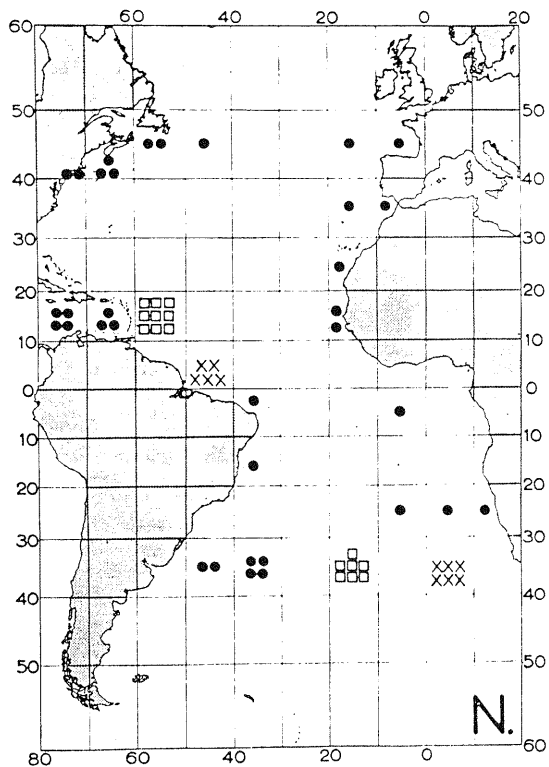
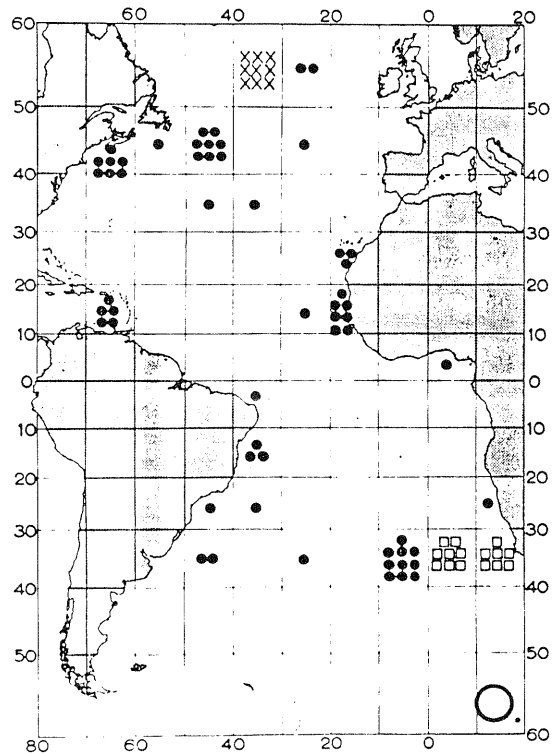
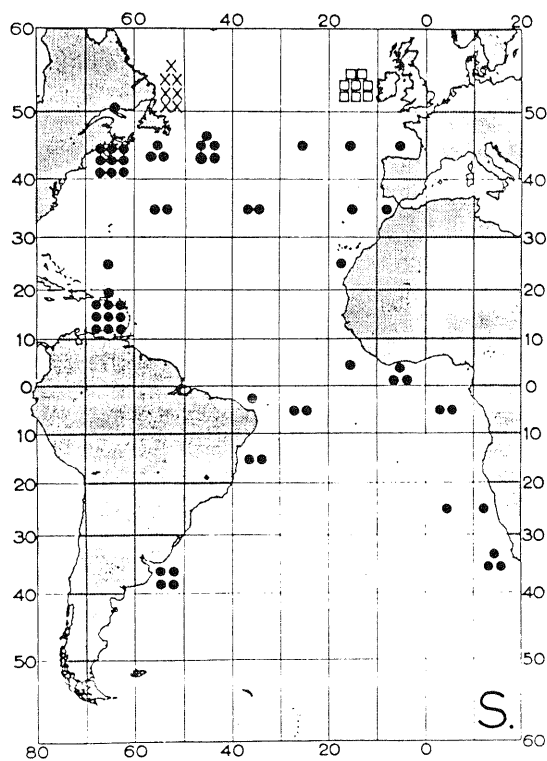


Chart 1. Rorquals in the Atlantic Ocean

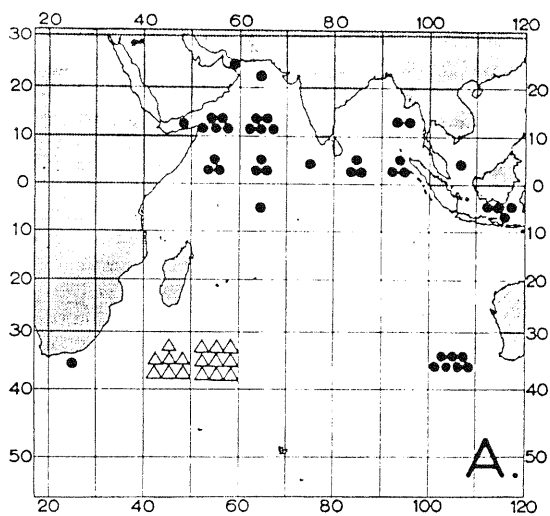
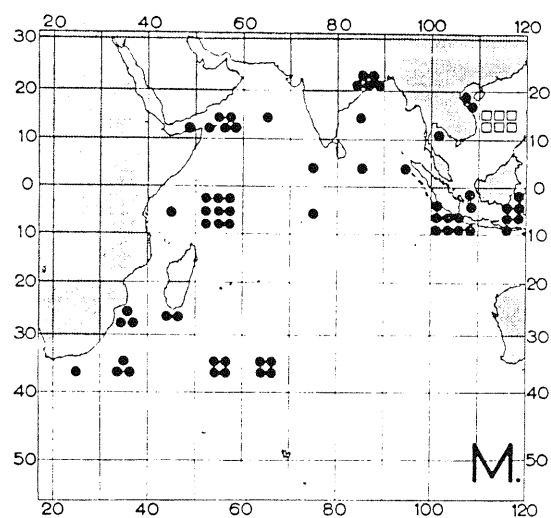
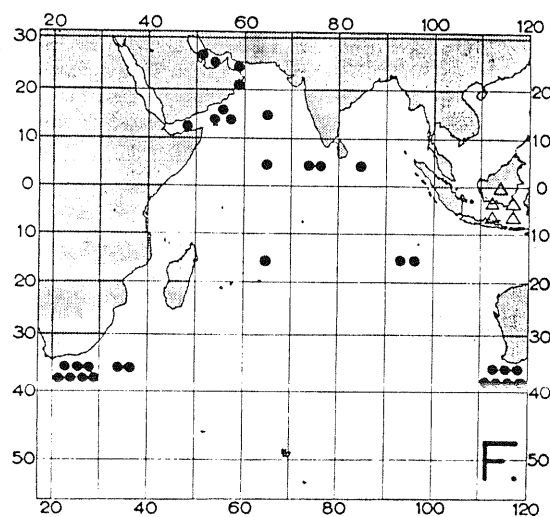
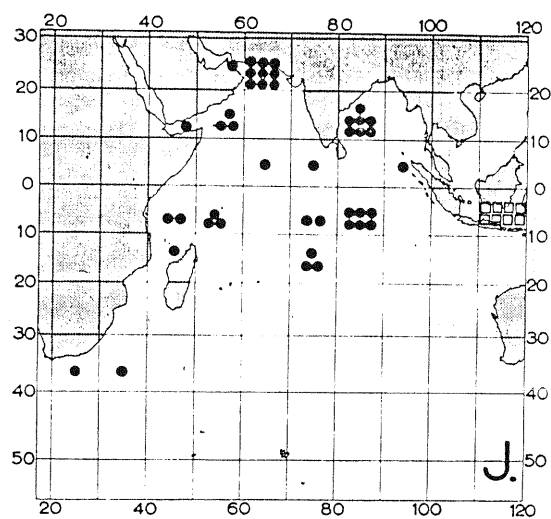
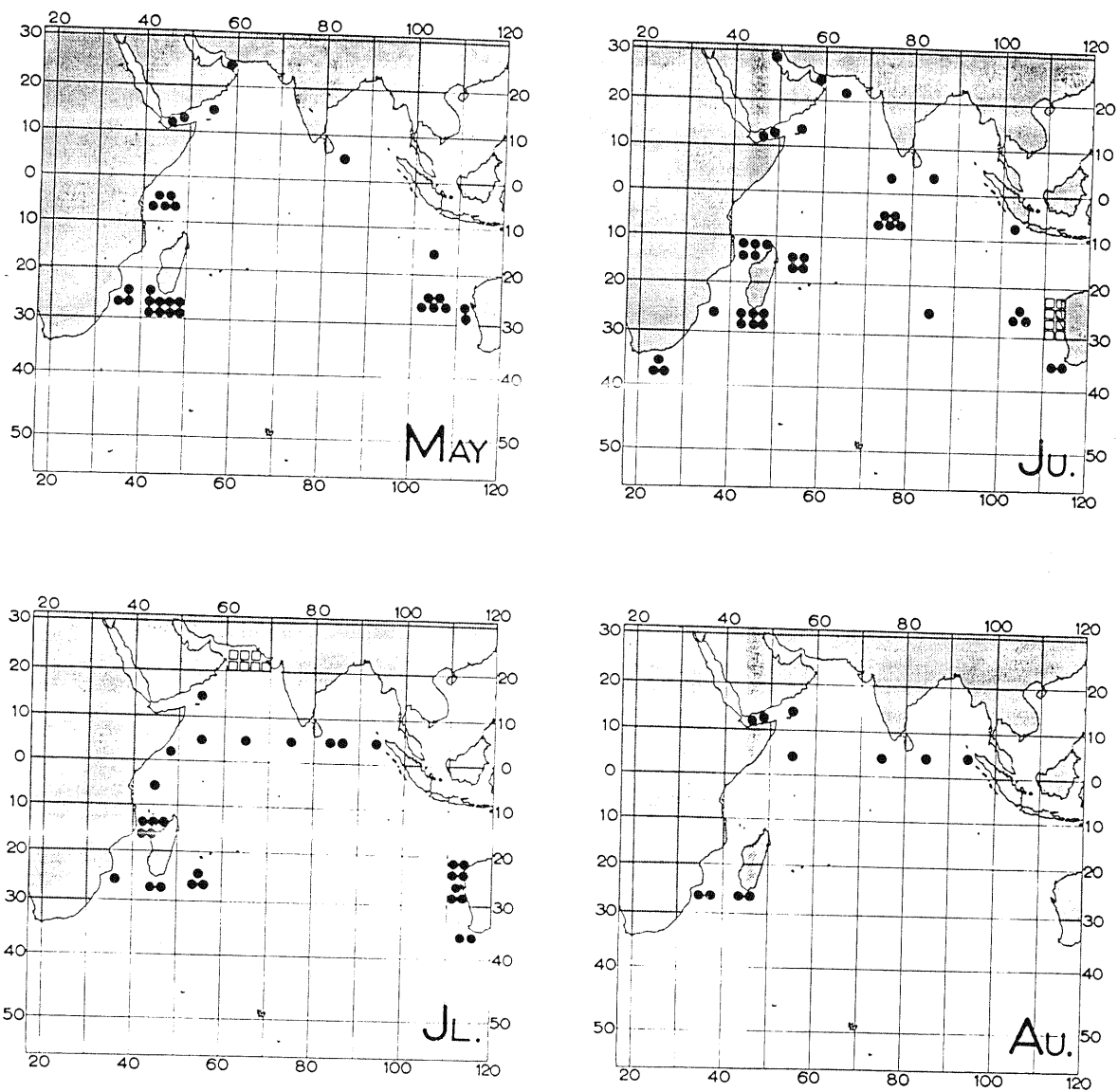
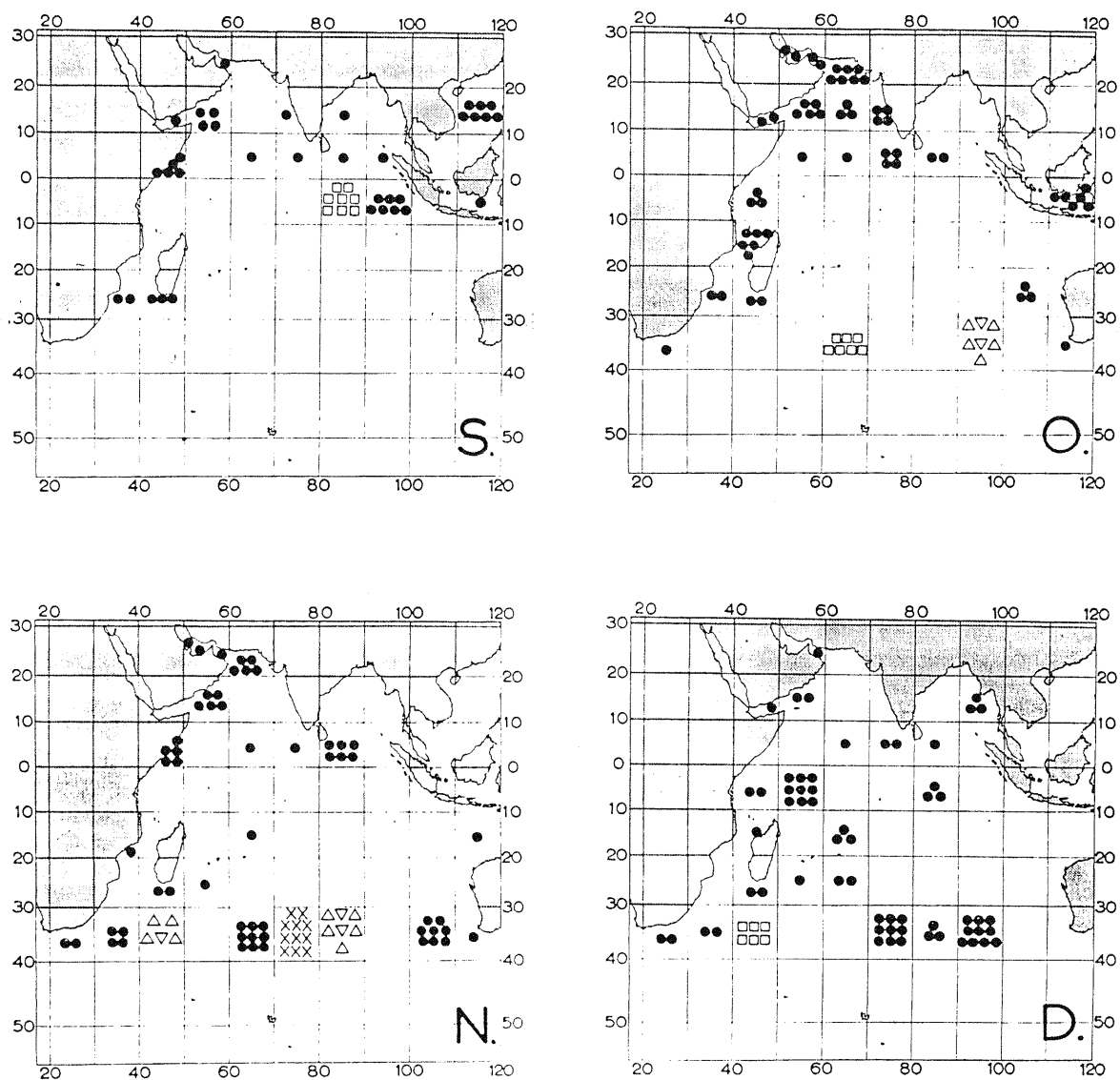


Chart 2. Rorquals in the Indian Ocean

Chart 2. *Rorquals in the Indian Ocean*

Chart 2. *Rorquals in the Indian Ocean*

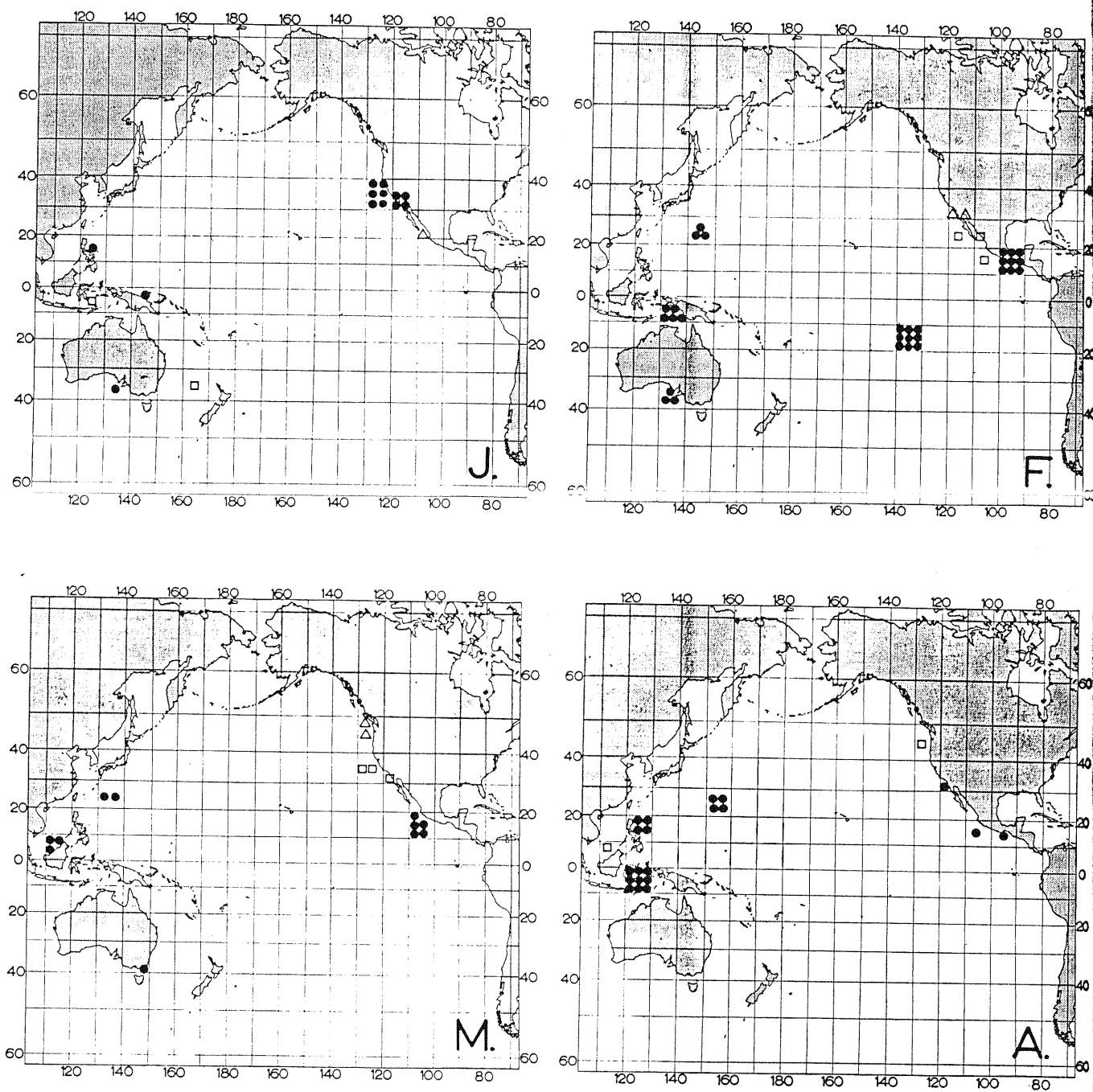


Chart 3. Rorquals in the Pacific Ocean

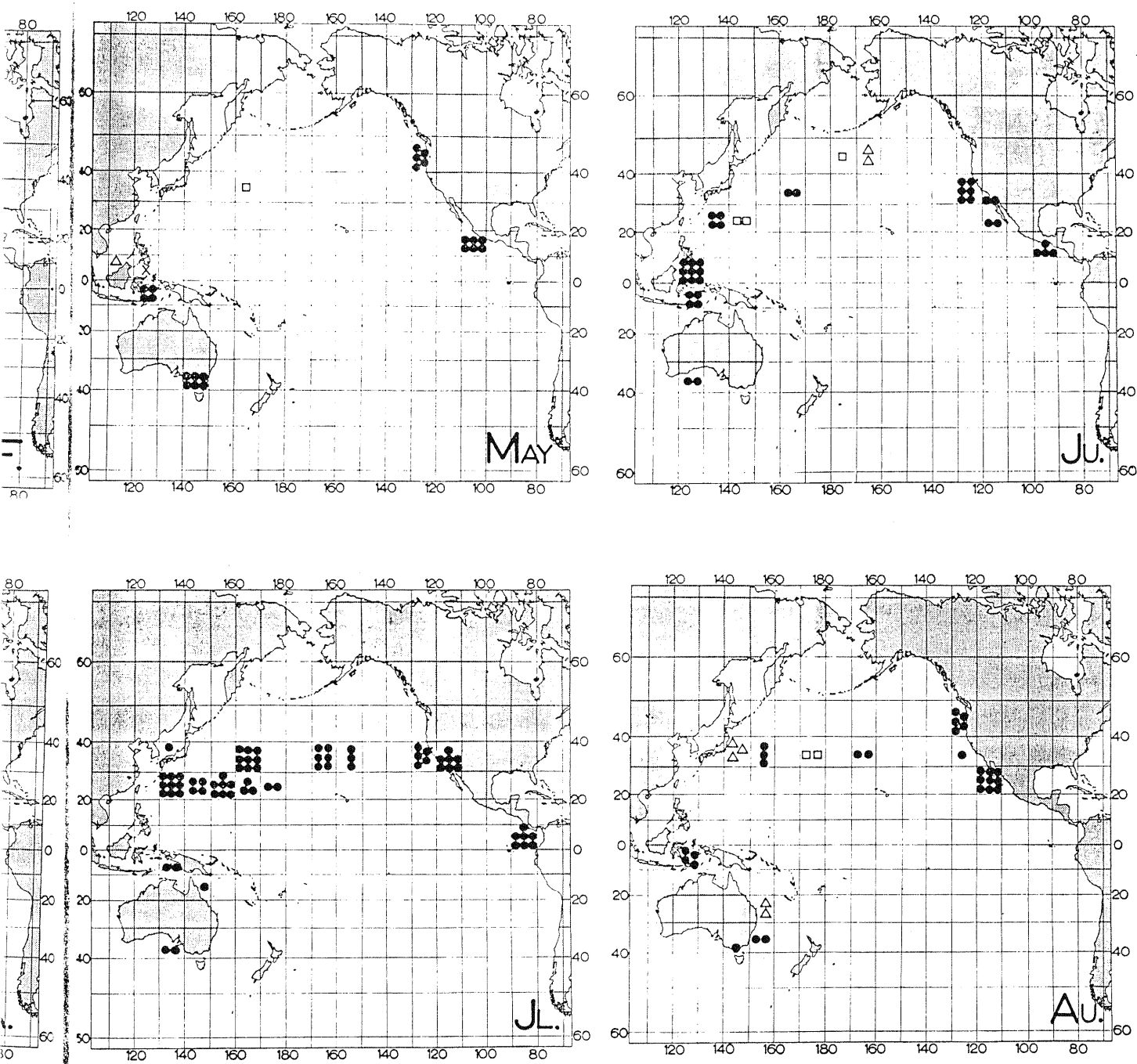


Chart 3. Rorquals in the Pacific Ocean

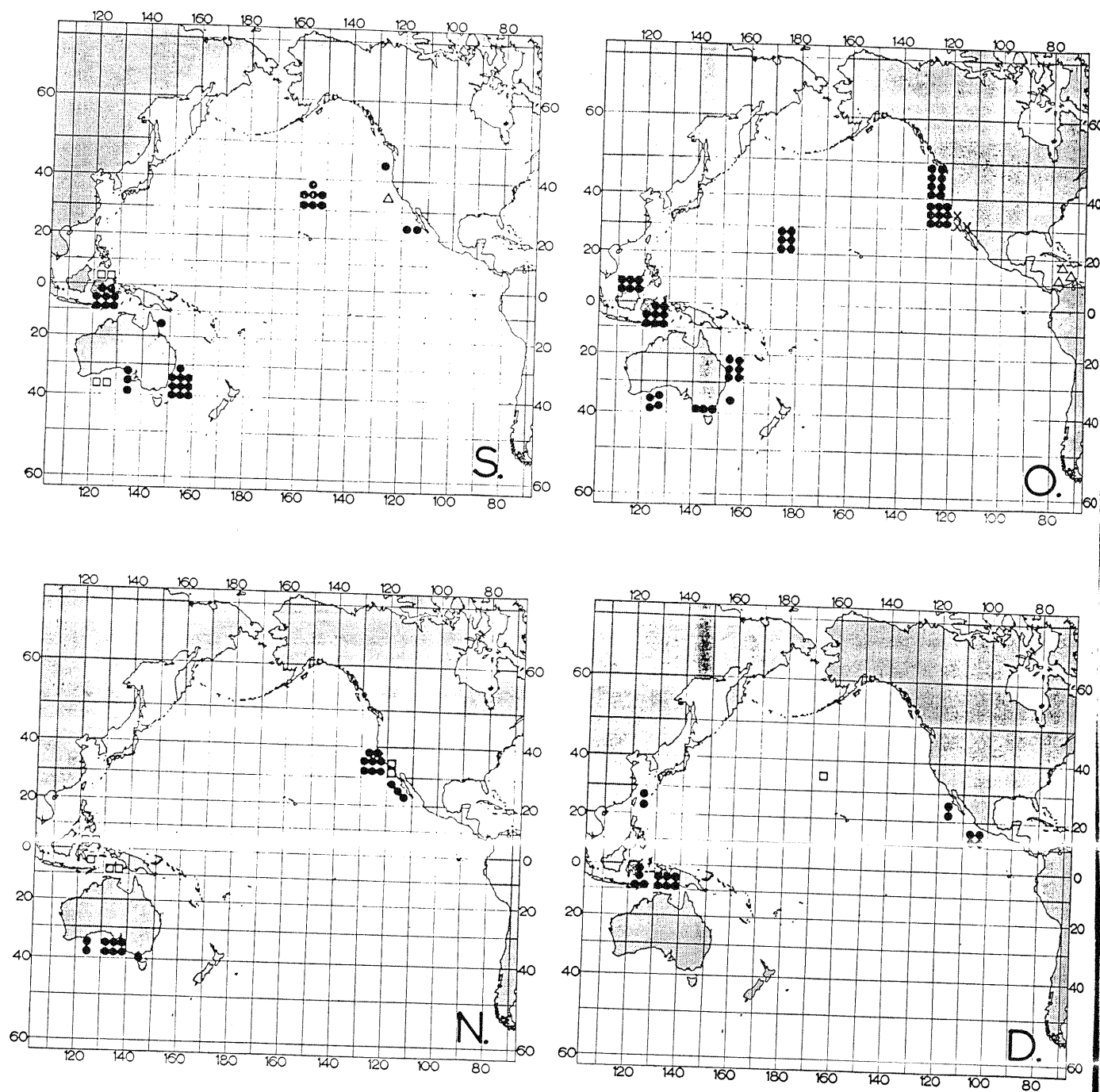


Chart 3. Rorquals in the Pacific Ocean



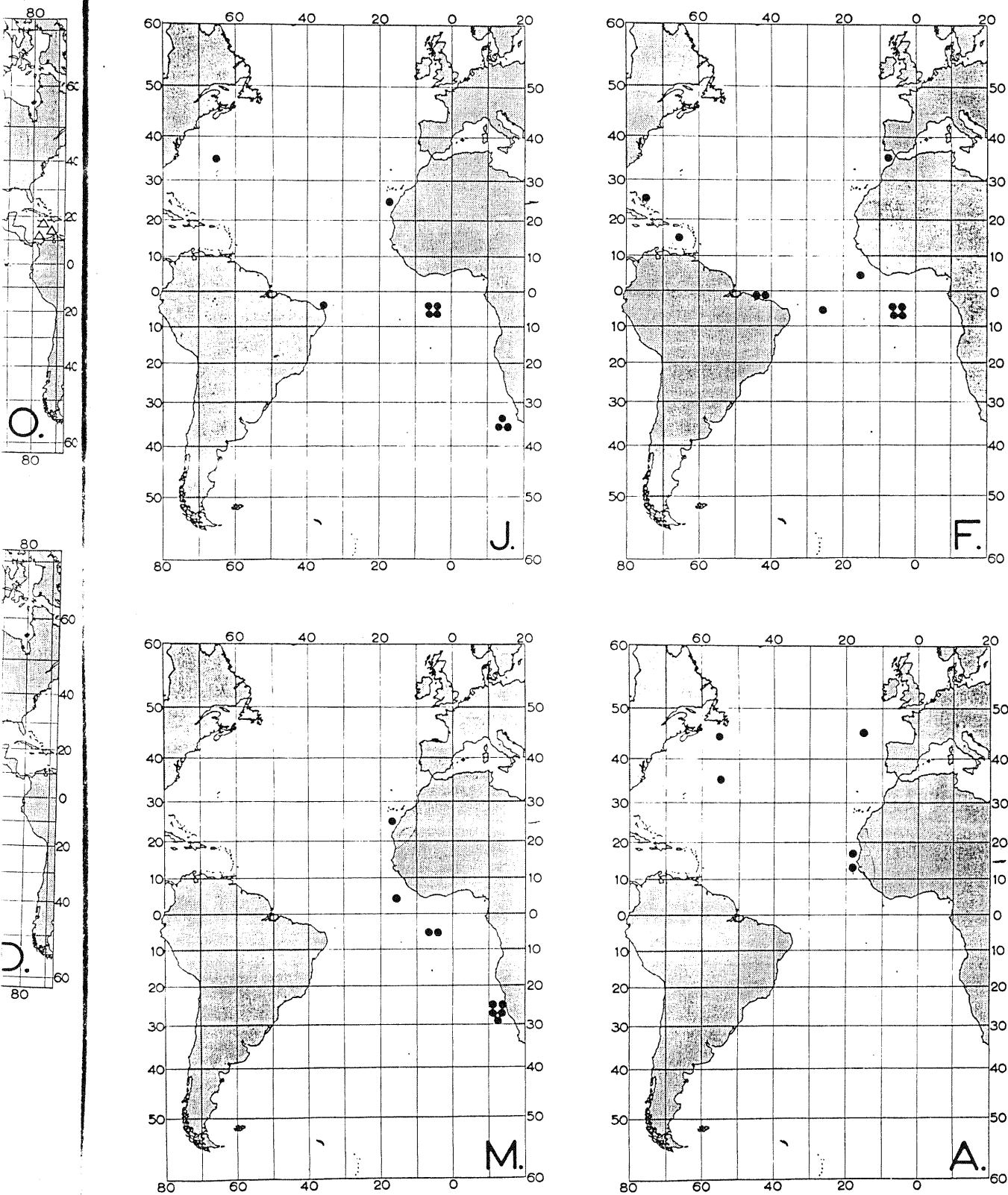


Chart 4. Humpbacks in the Atlantic Ocean

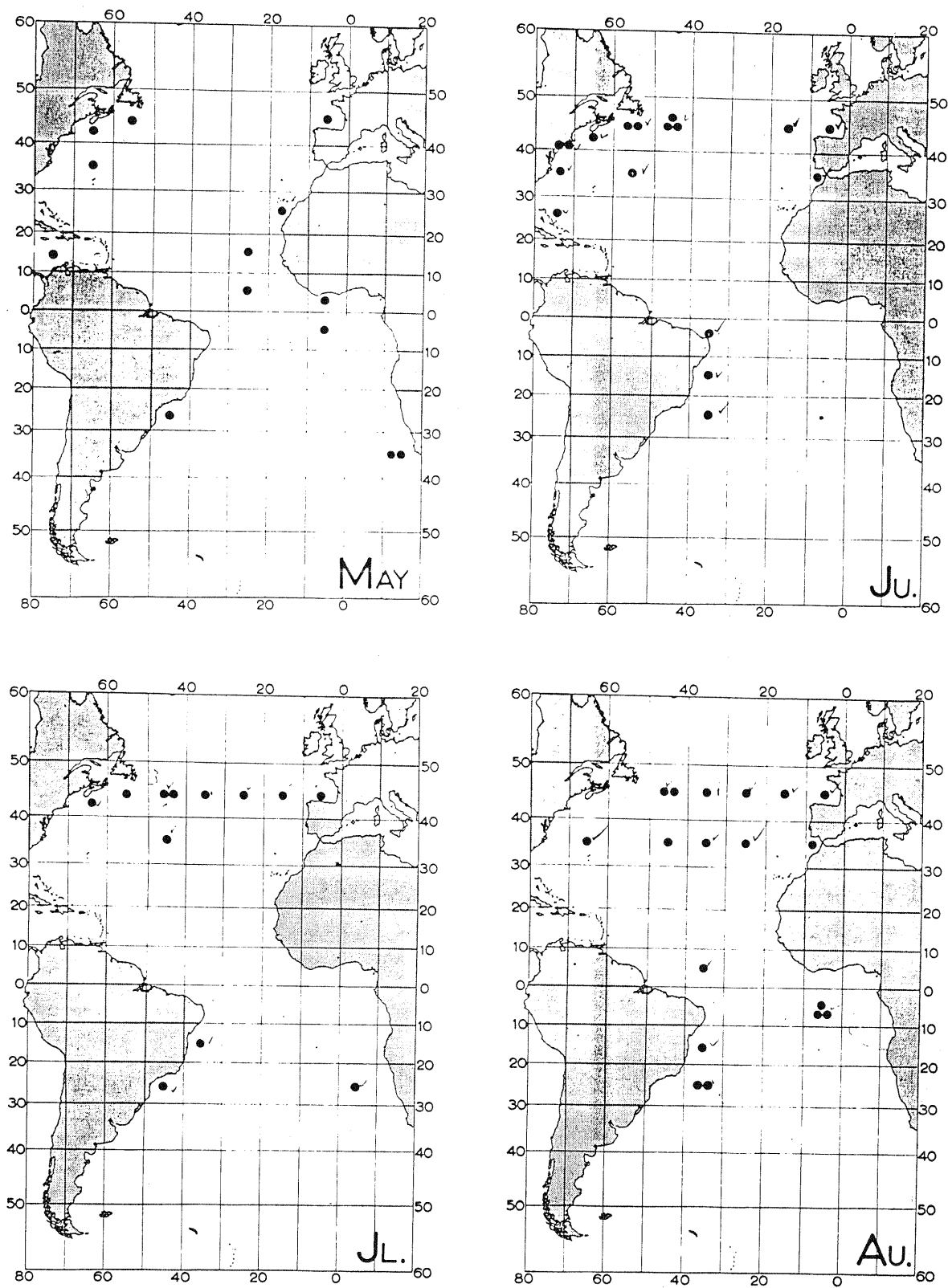


Chart 4. Humpbacks in the Atlantic Ocean

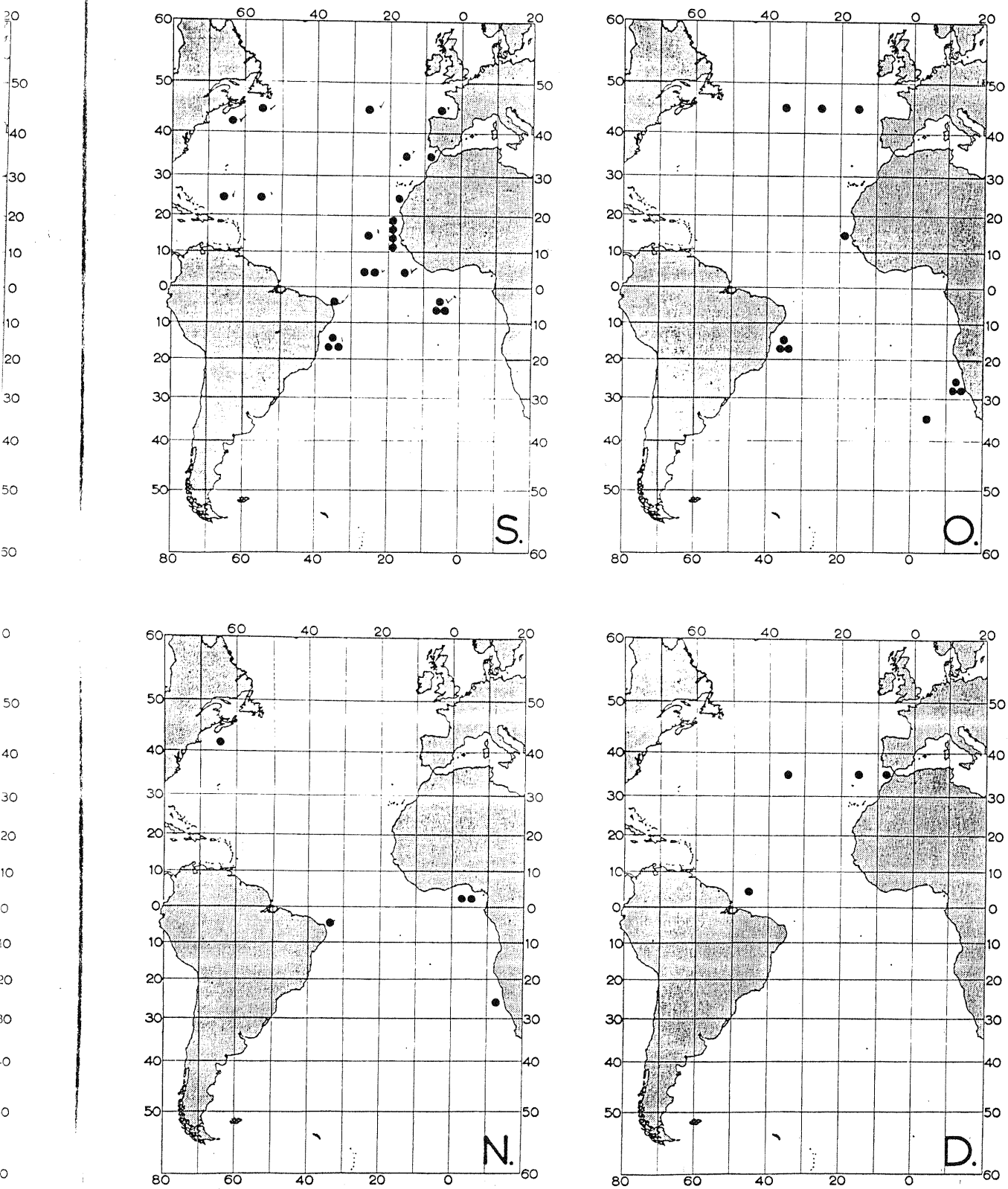
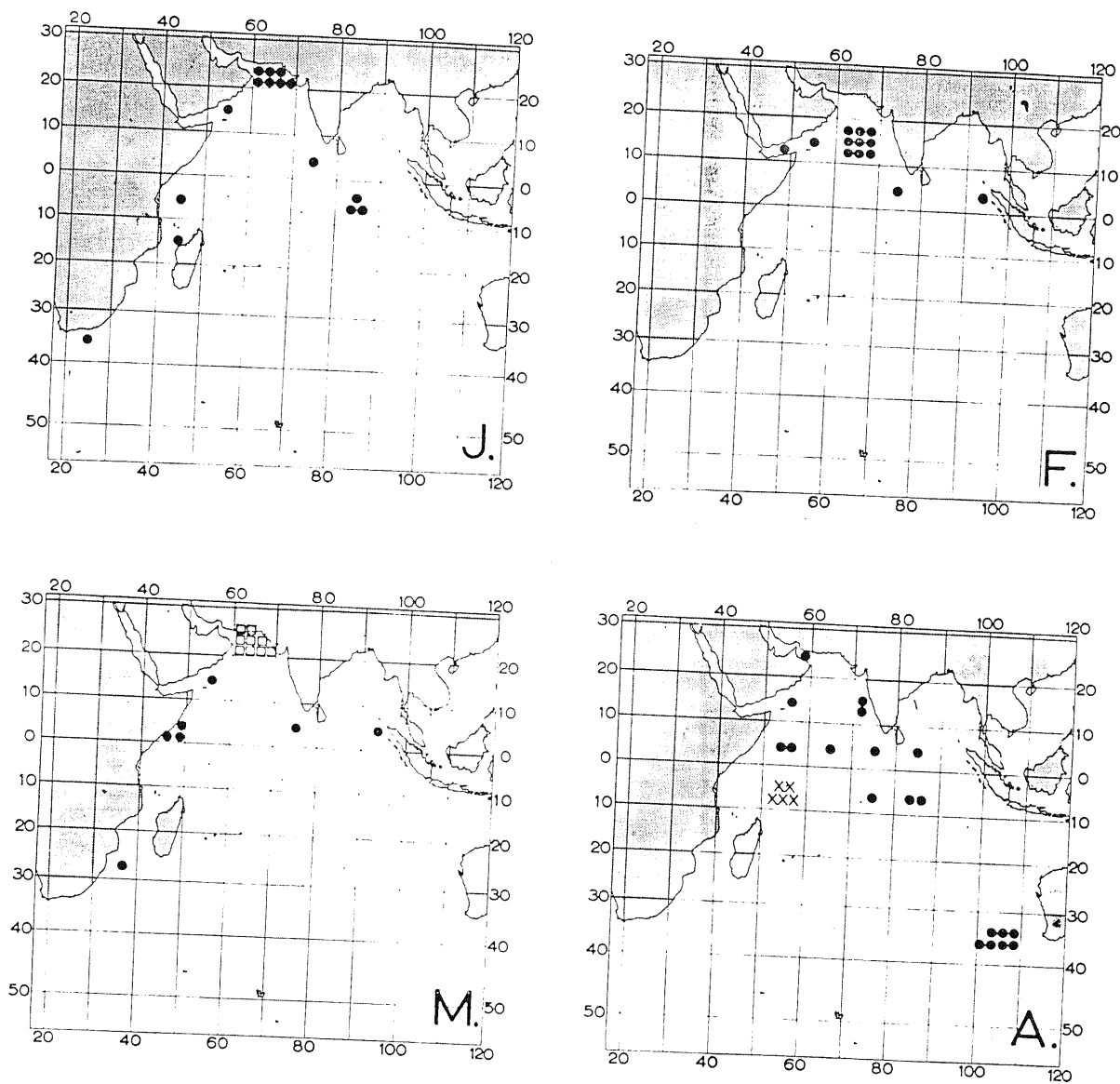
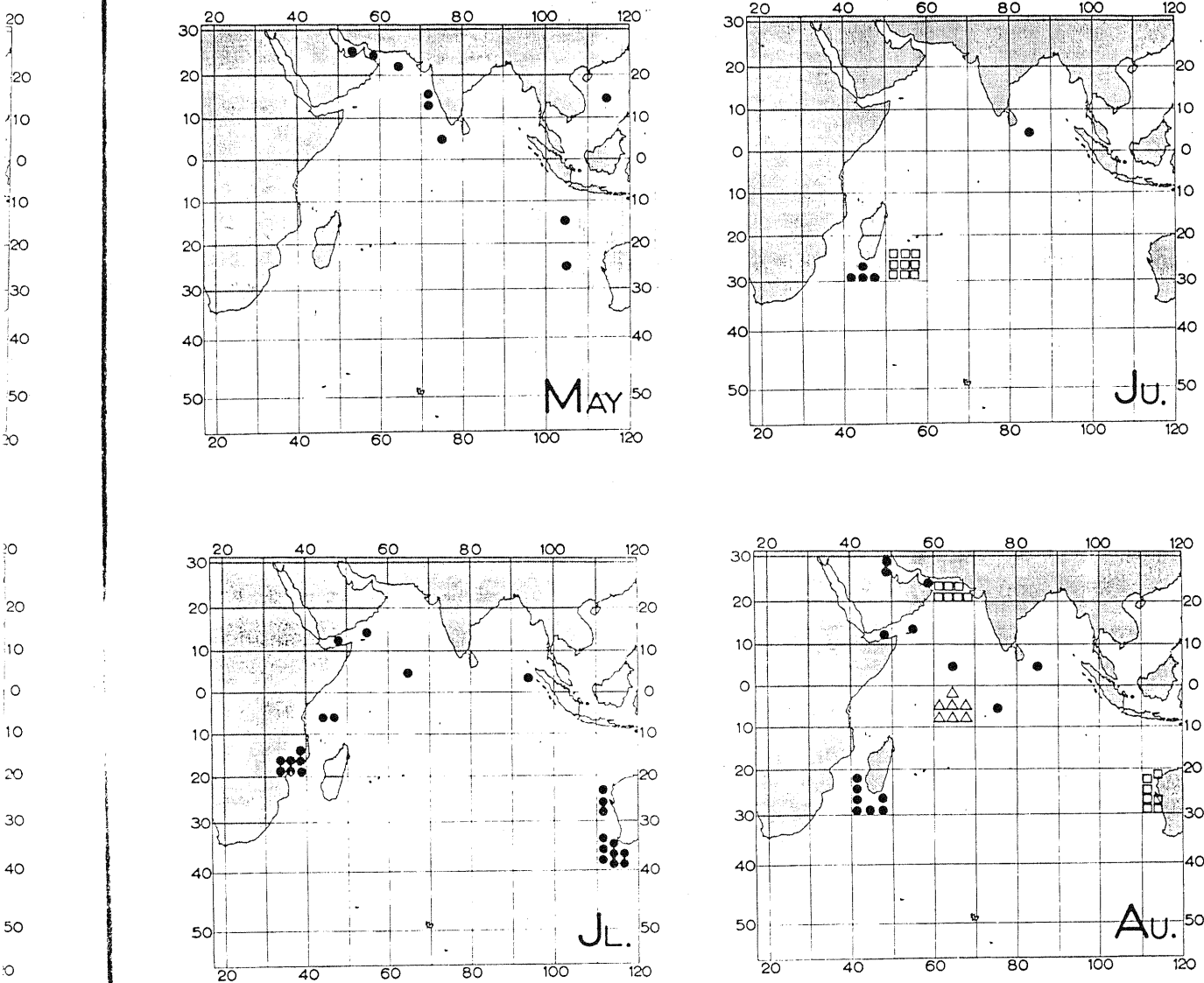
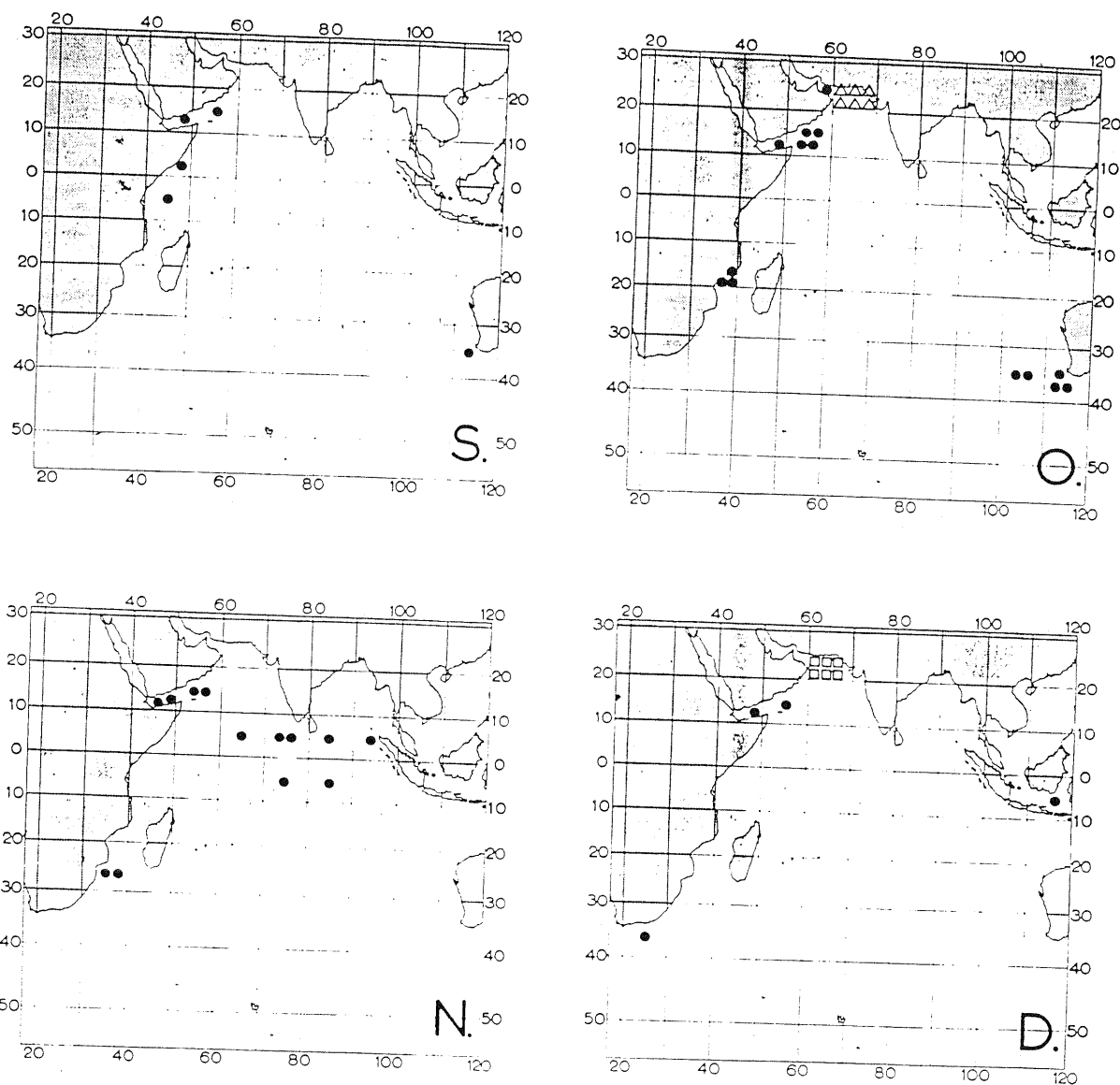
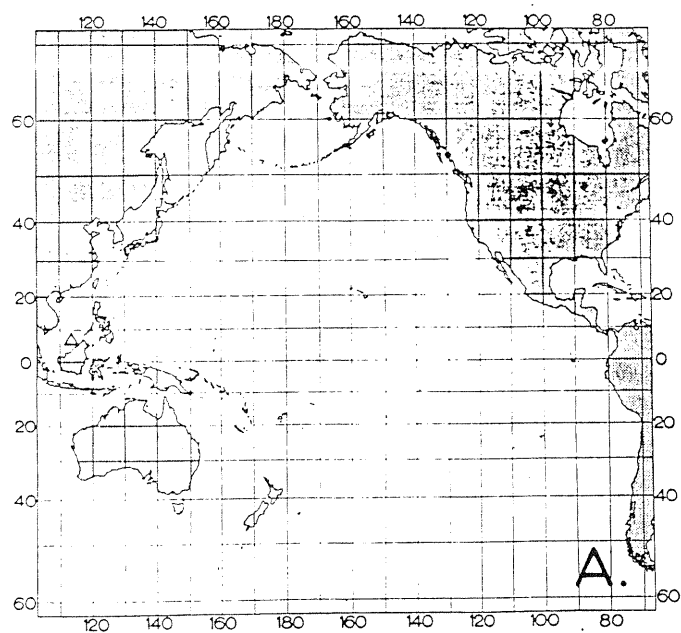
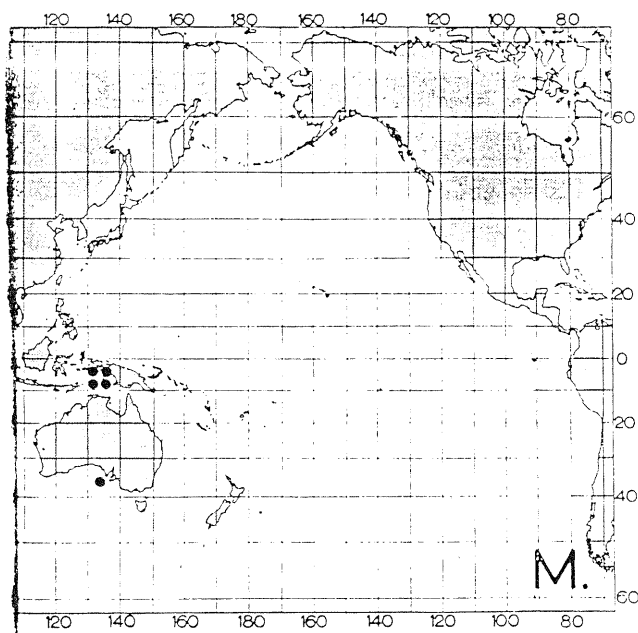
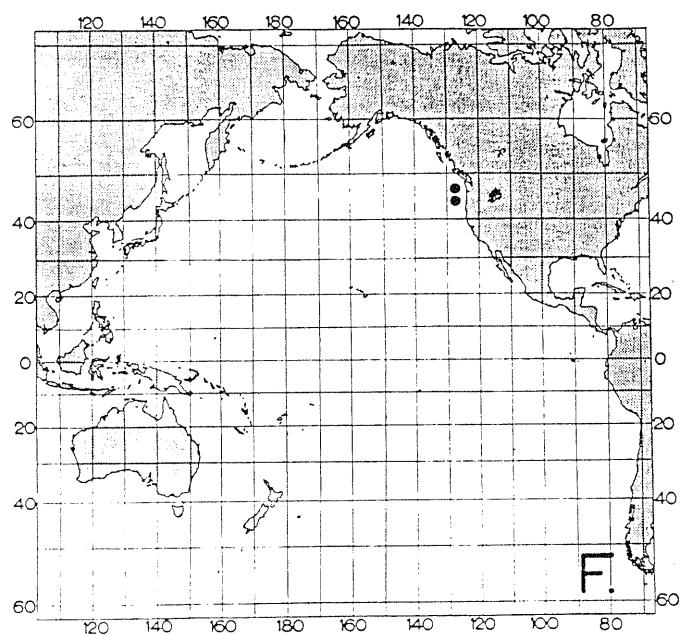
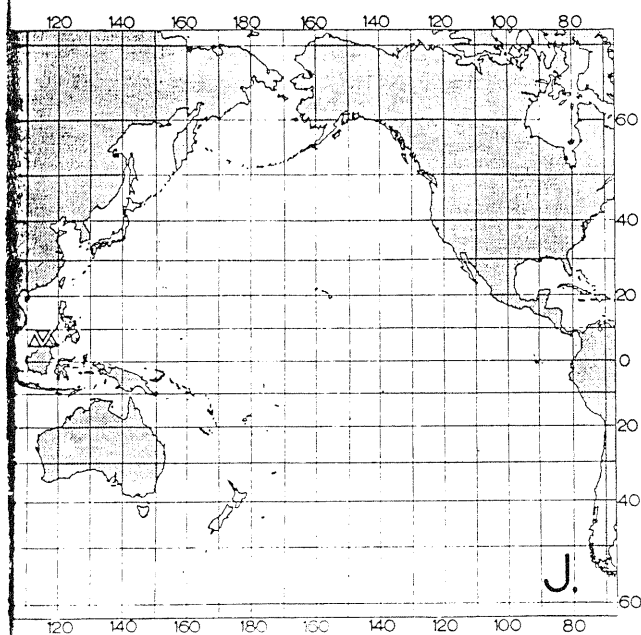


Chart 4. Humpbacks in the Atlantic Ocean

Chart 5. *Humpbacks in the Indian Ocean*

Chart 5. *Humpbacks in the Indian Ocean*

Chart 5. *Humpbacks in the Indian Ocean*

Chart 6. *Humpbacks in the Pacific Ocean*

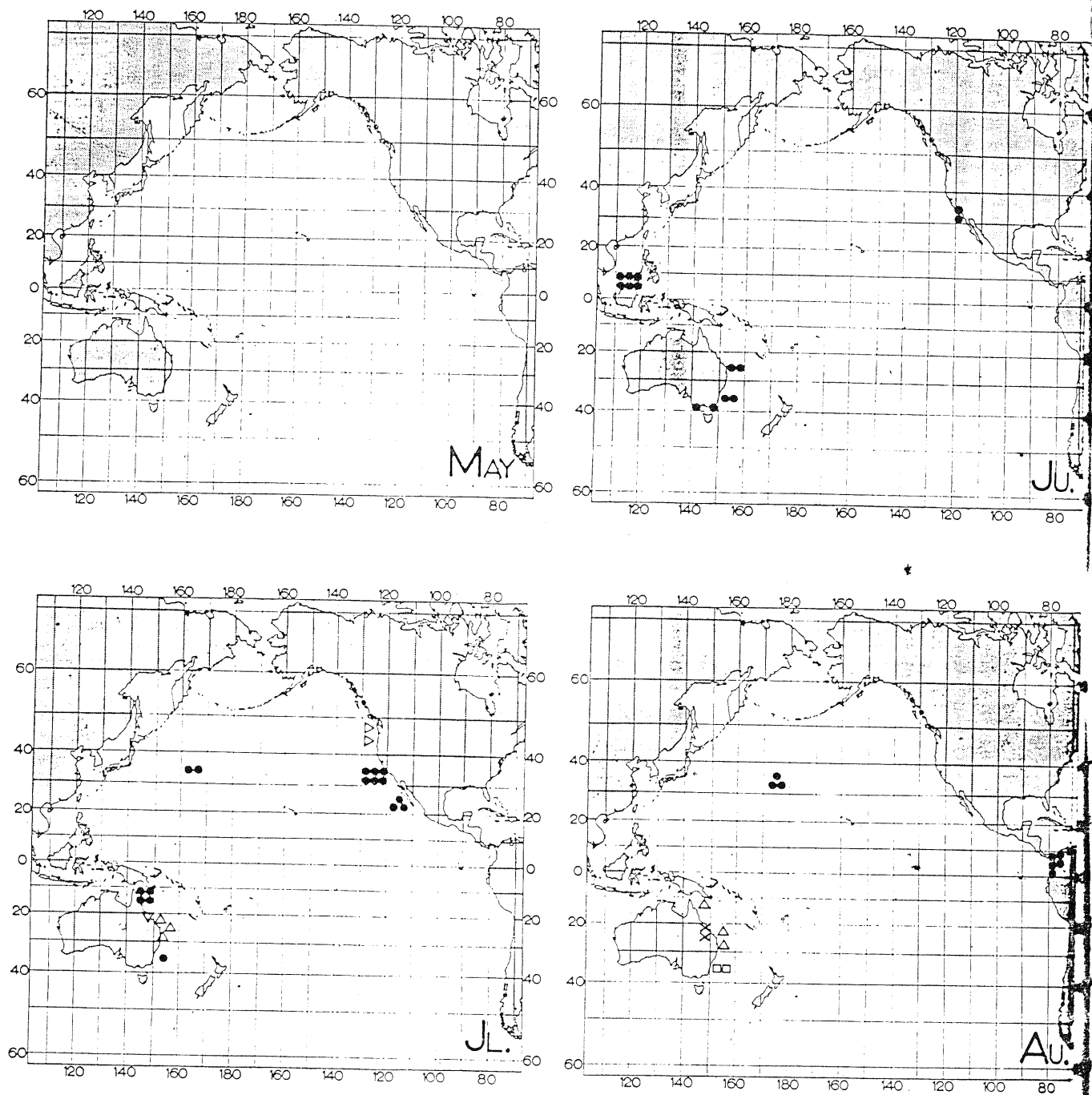


Chart 6. Humpbacks in the Pacific Ocean



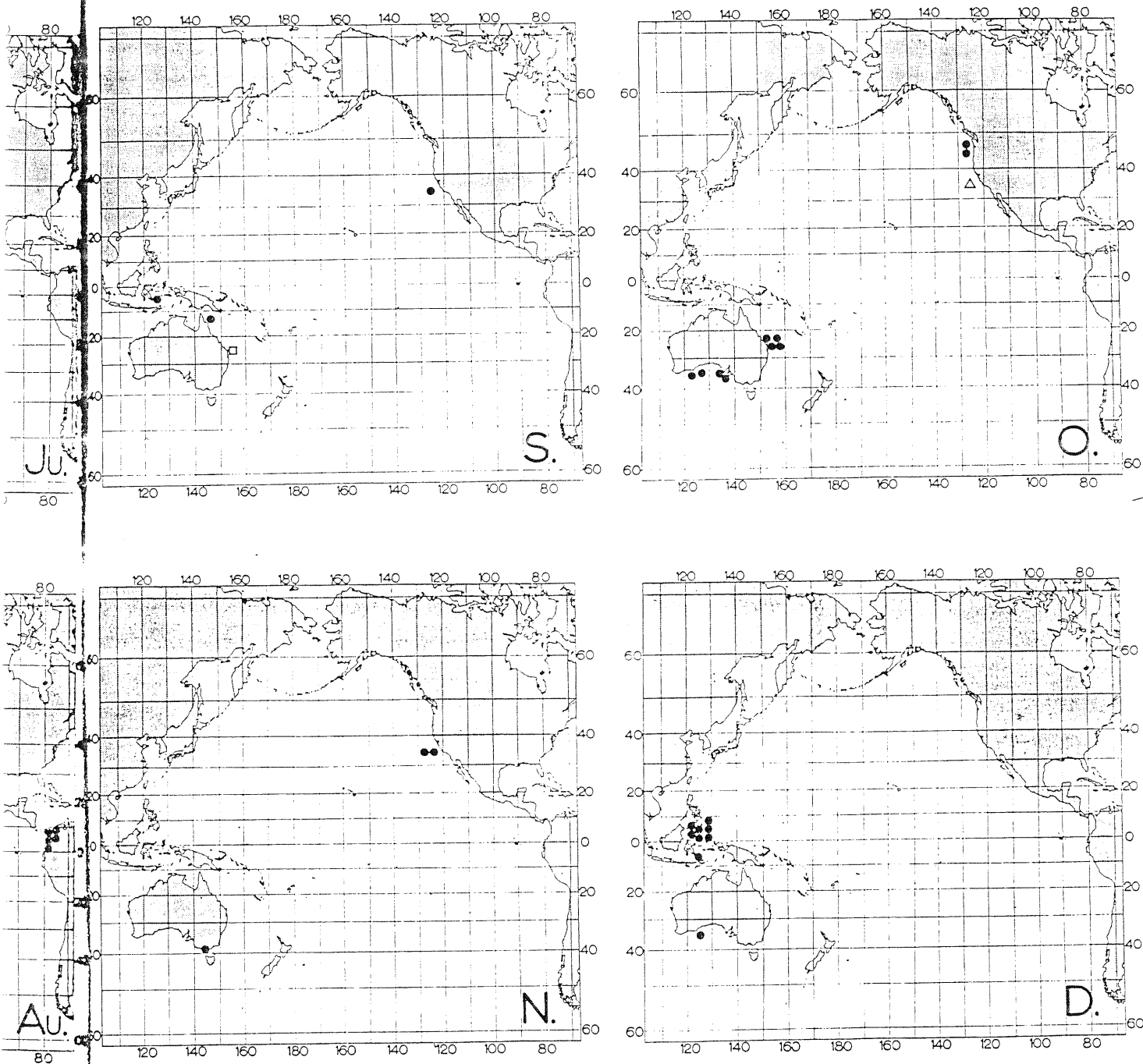


Chart 6. Humpbacks in the Pacific Ocean

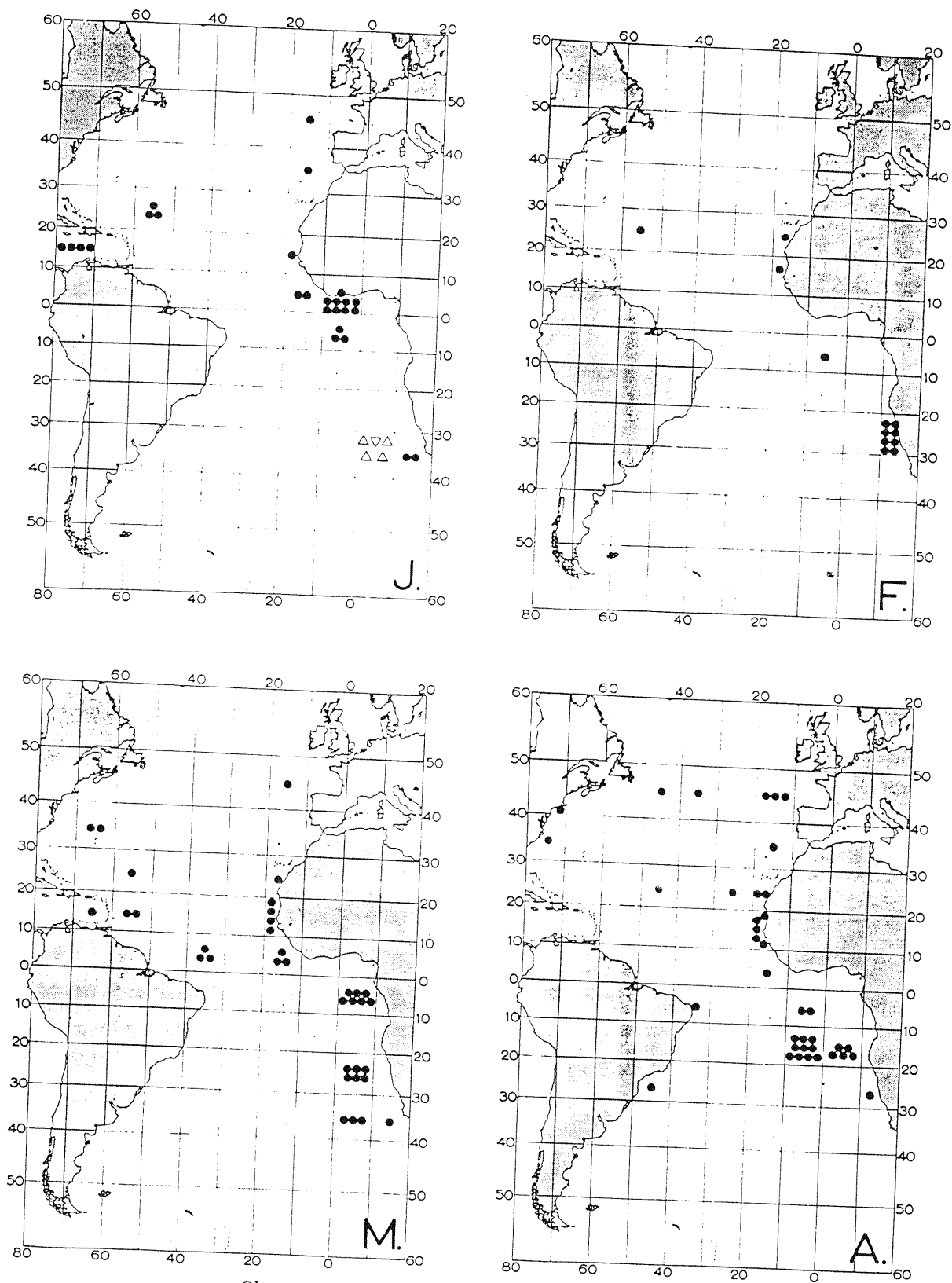


Chart 7. Sperm Whales in the Atlantic Ocean

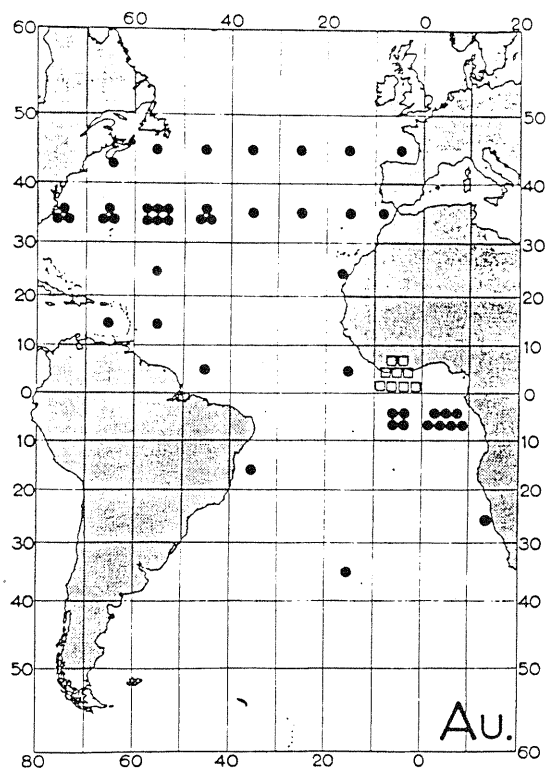
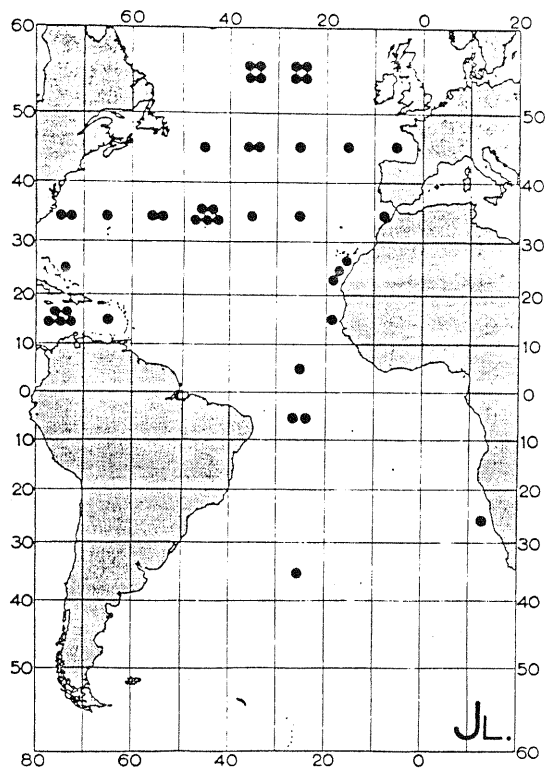
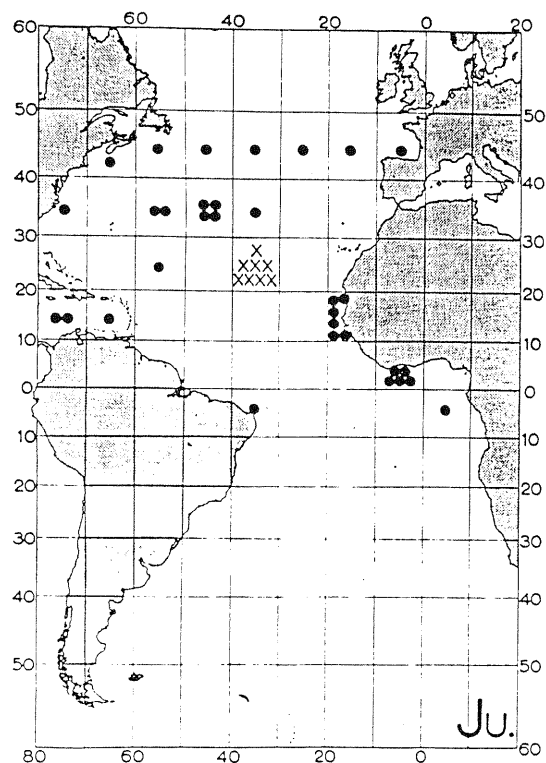
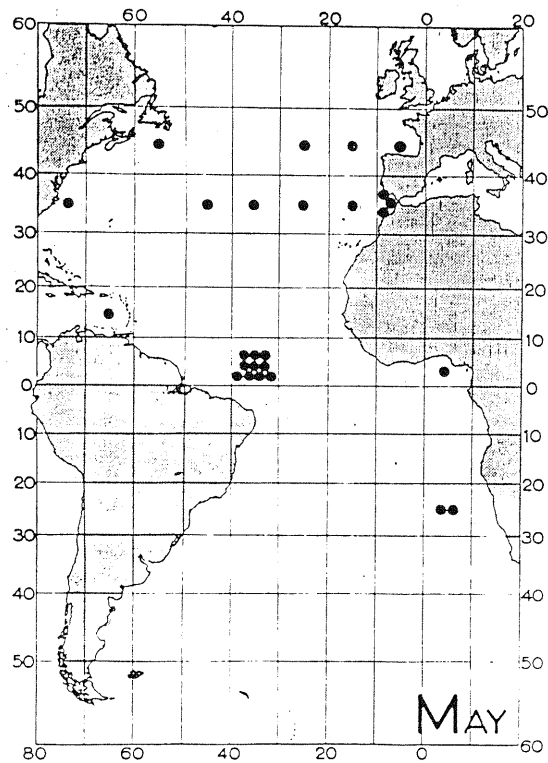


Chart 7. Sperm Whales in the Atlantic Ocean

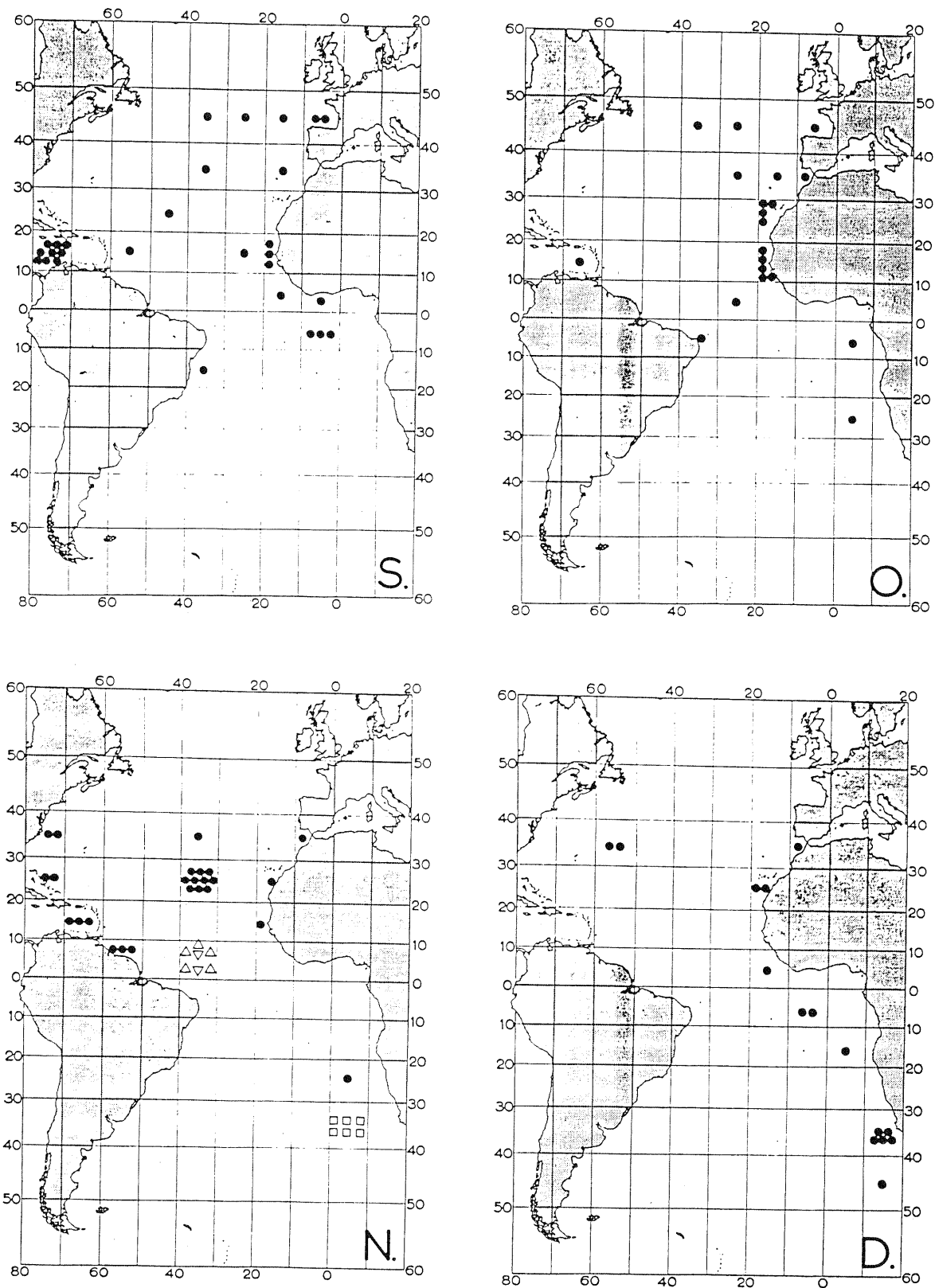


Chart 7. Sperm Whales in the Atlantic Ocean

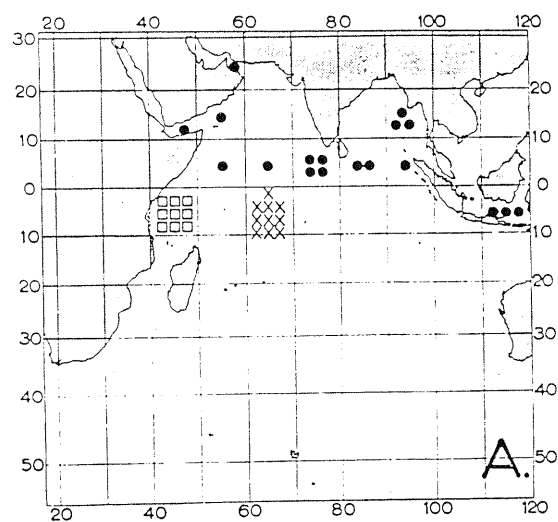
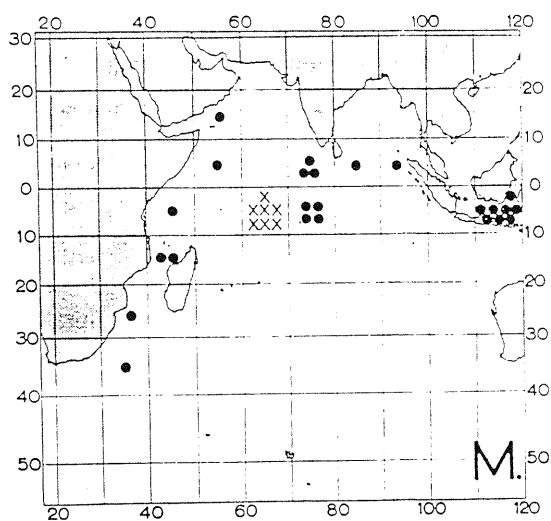
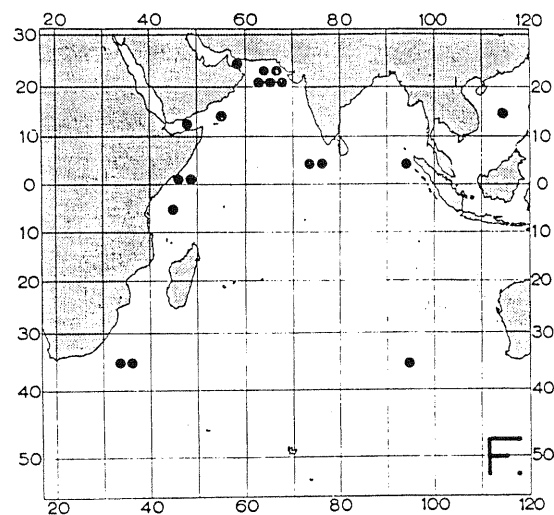
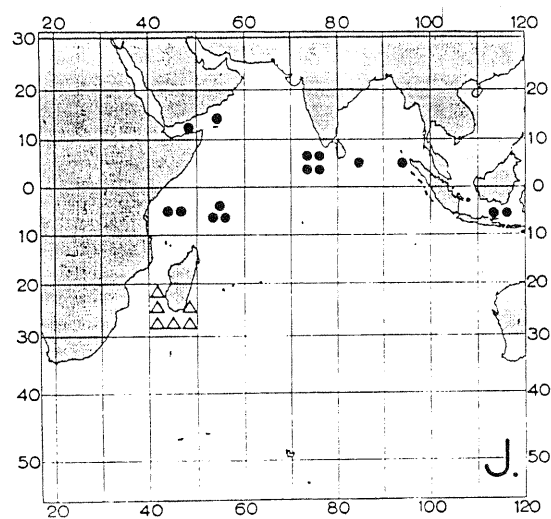
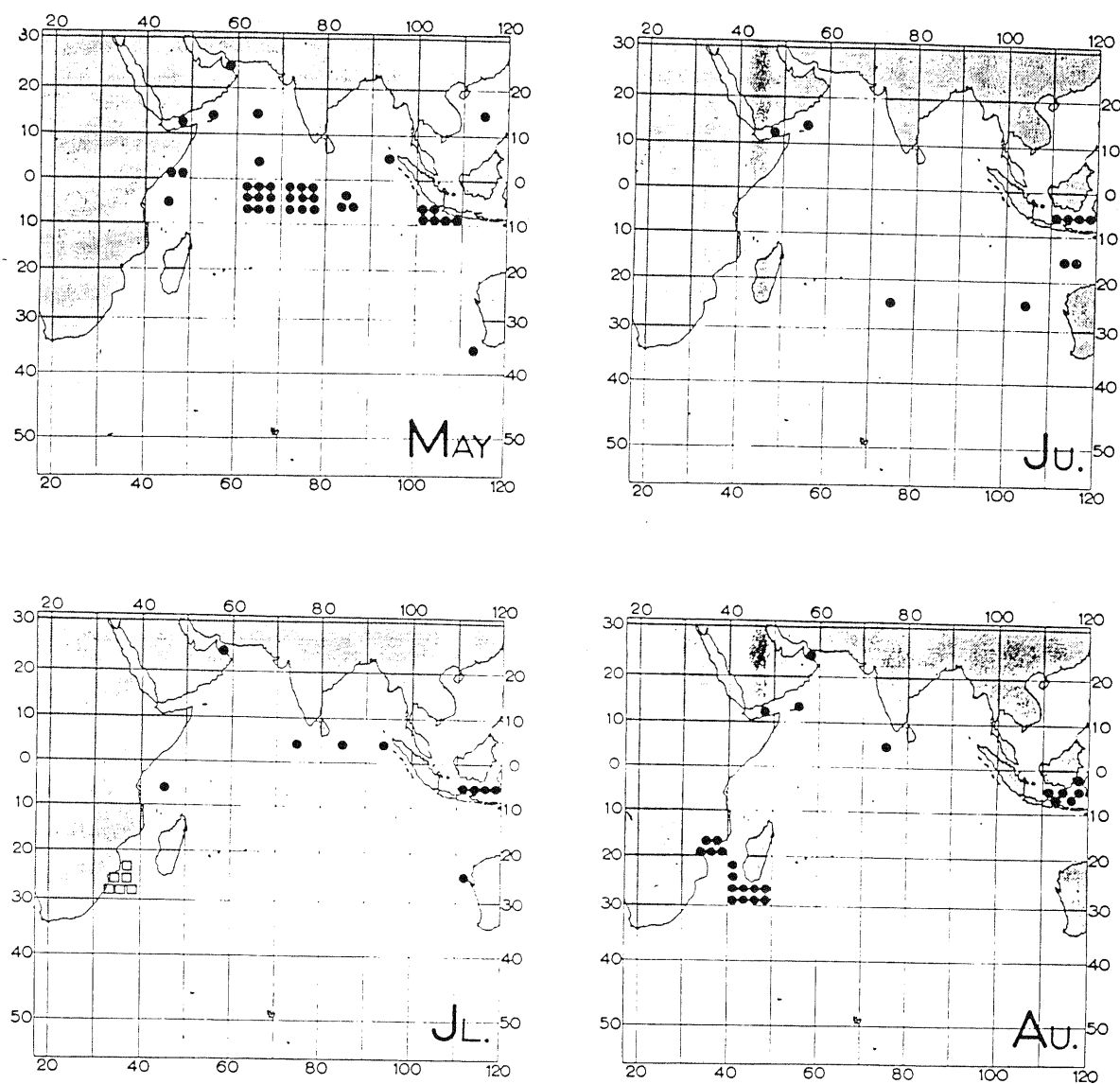


Chart 8. Sperm Whales in the Indian Ocean

Chart 8. *Sperm Whales in the Indian Ocean*

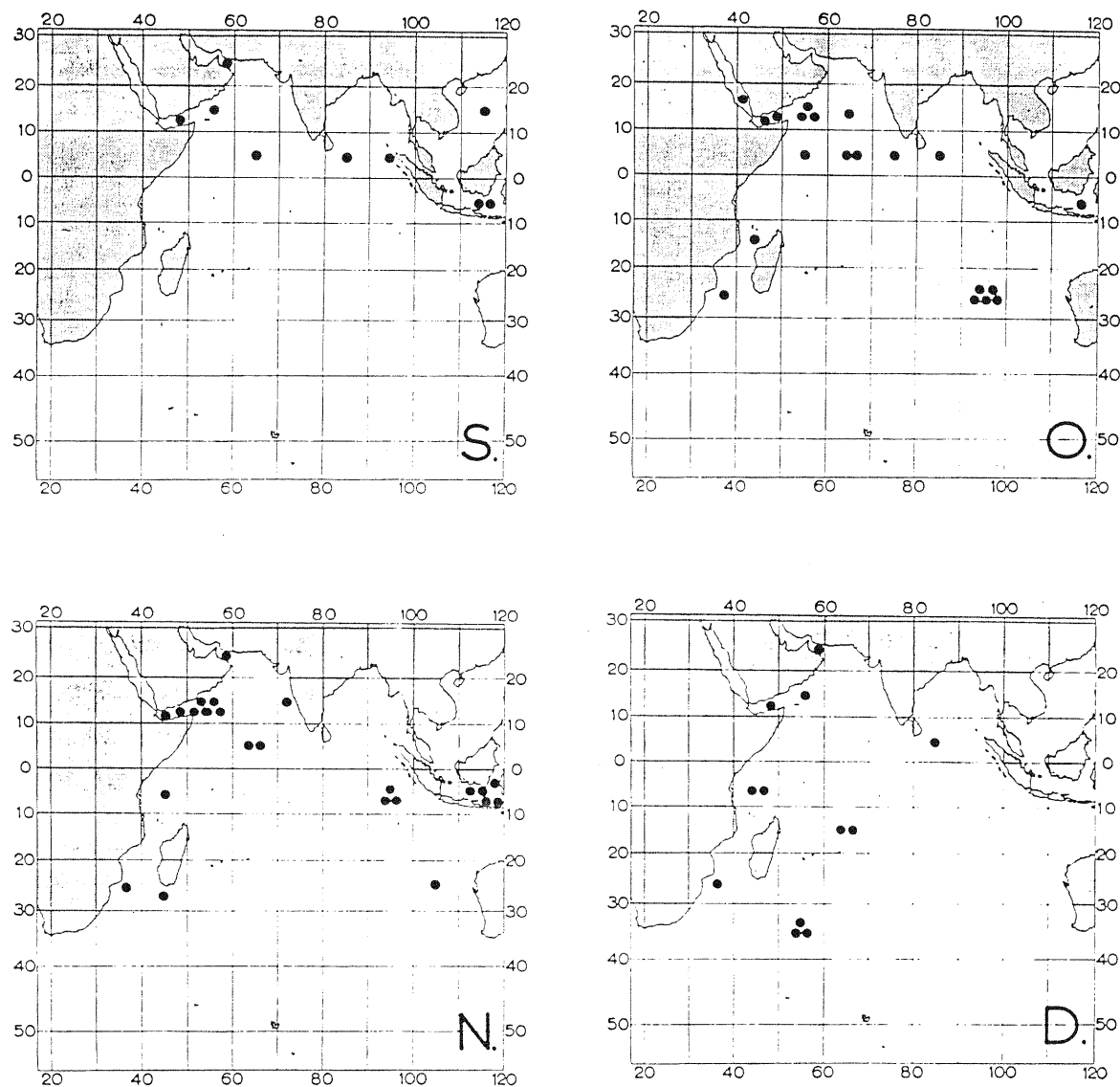
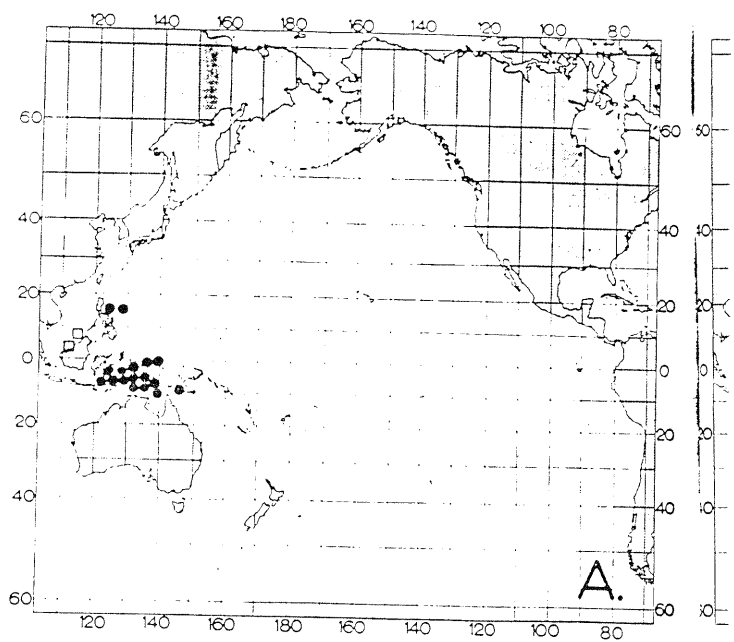
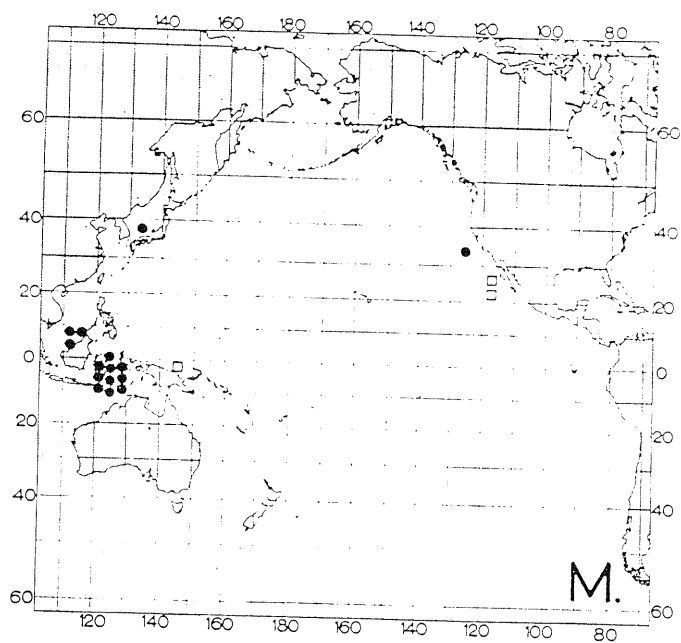
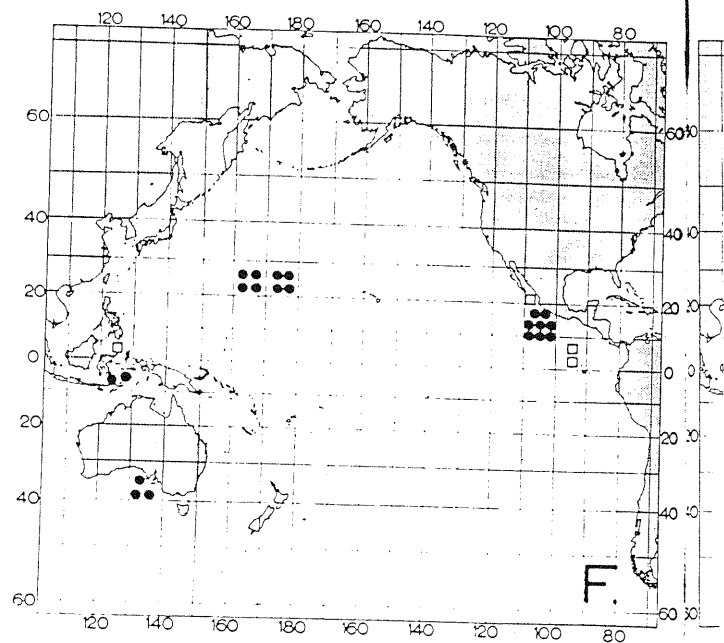
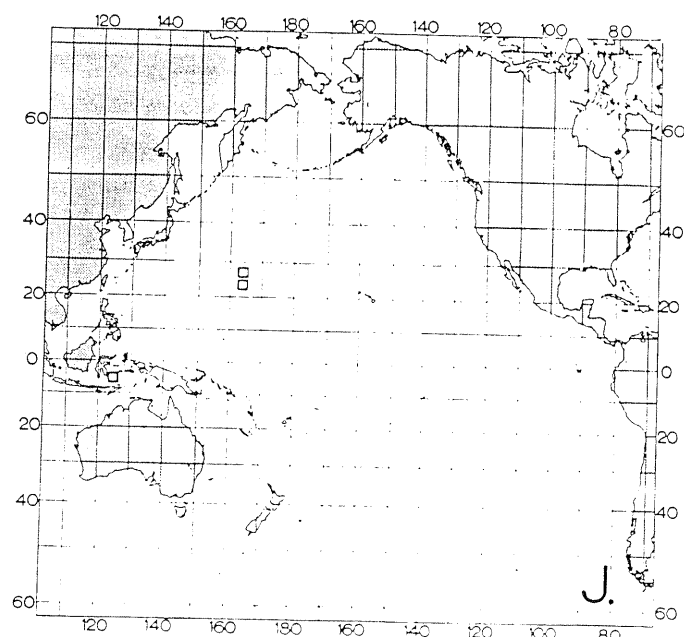


Chart 8. Sperm Whales in the Indian Ocean

Chart 9. *Sperm Whales in the Pacific Ocean*



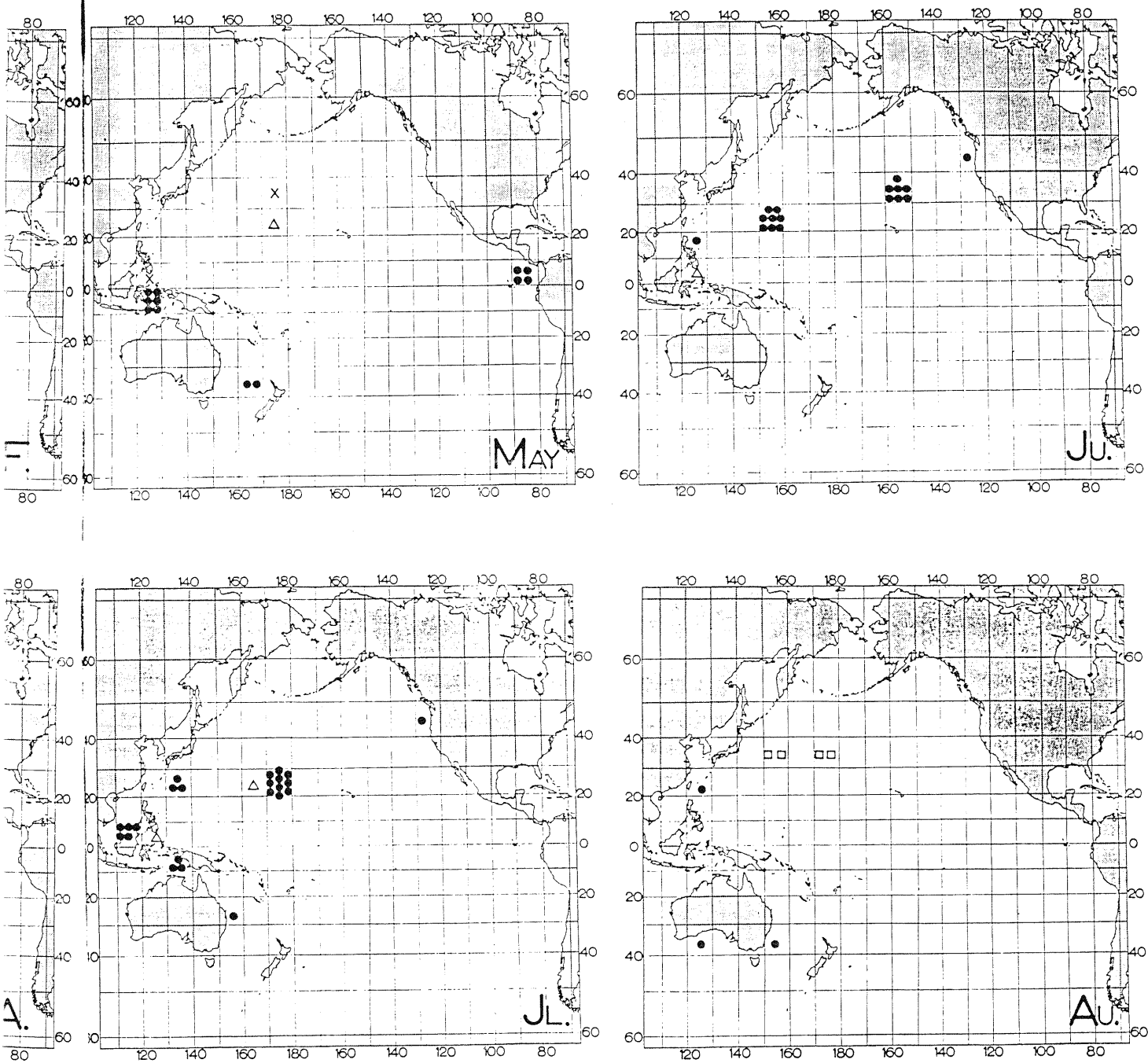


Chart 9. Sperm Whales in the Pacific Ocean

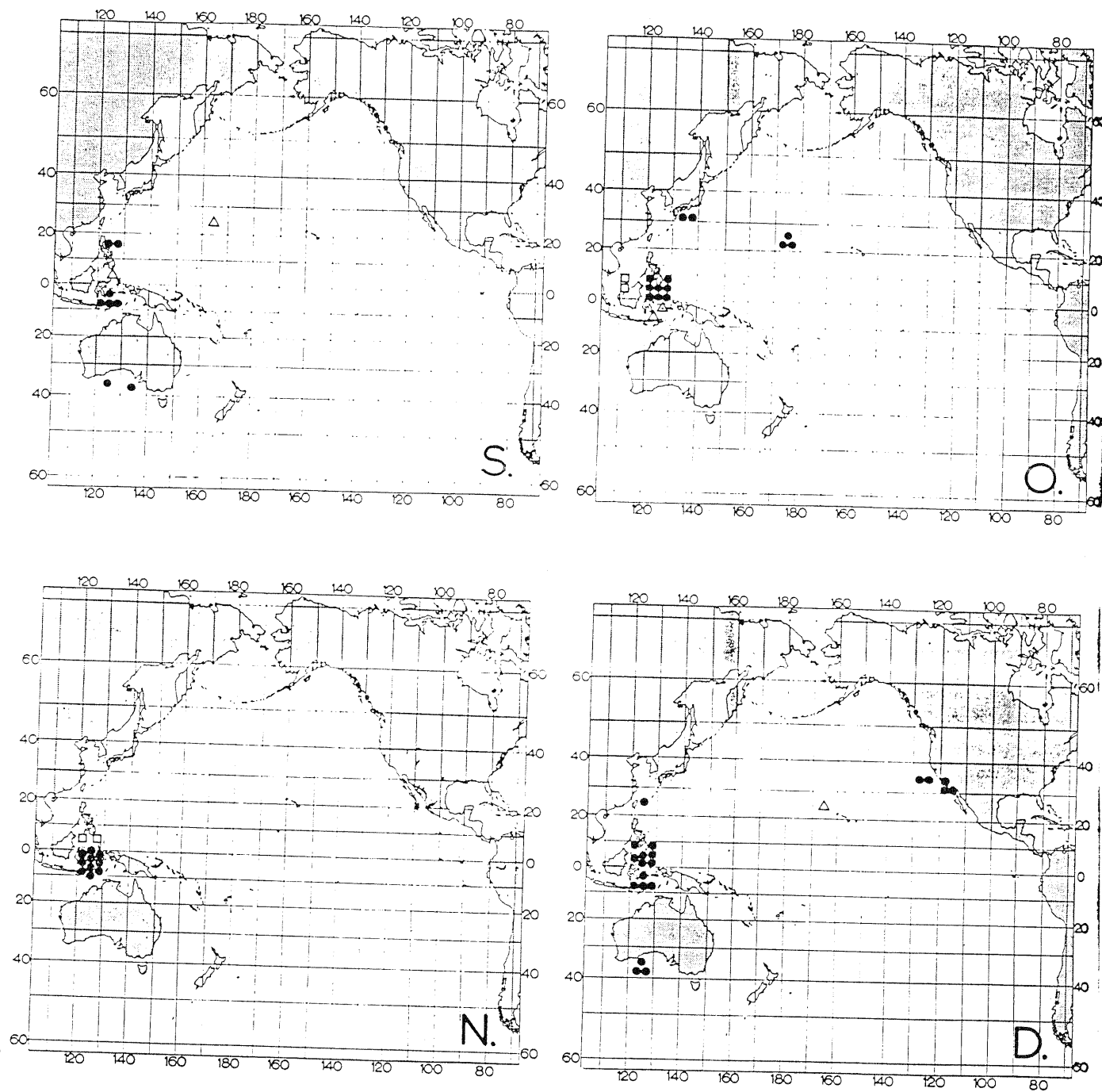
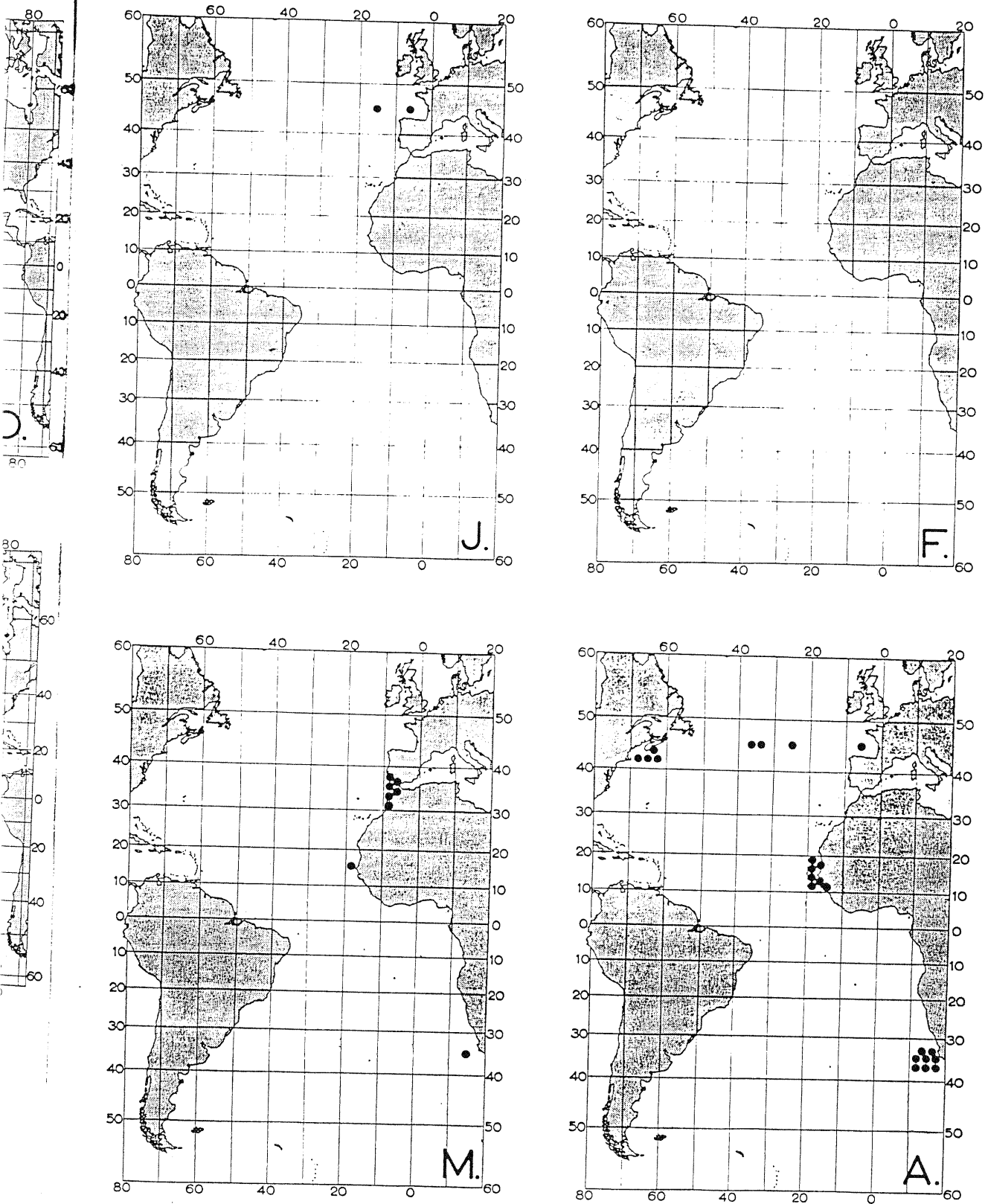


Chart 9. Sperm Whales in the Pacific Ocean

Chart 10. *Little Piked Whales in the Atlantic Ocean.*

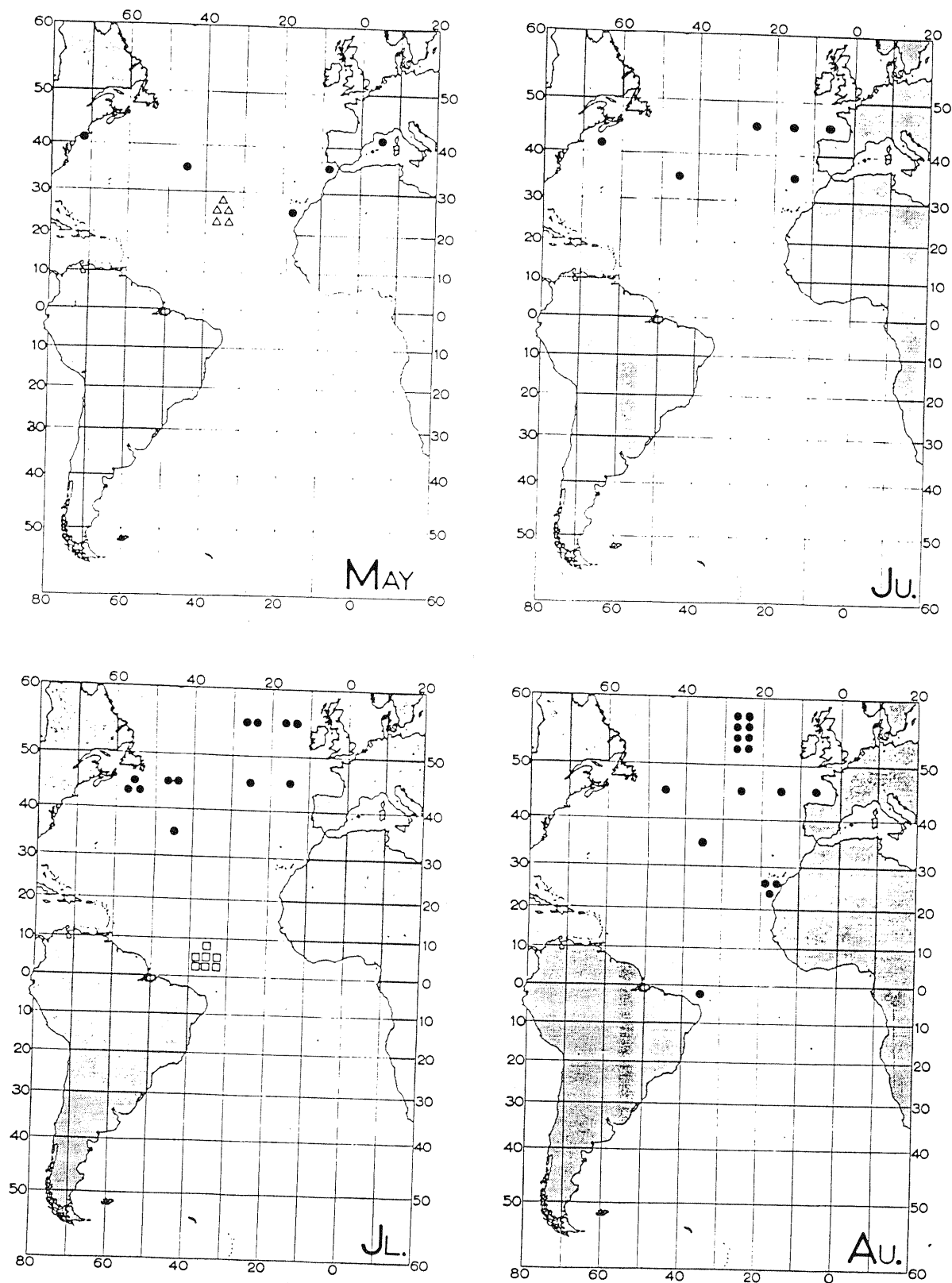


Chart 10. Little Piked Whales in the Atlantic Ocean.

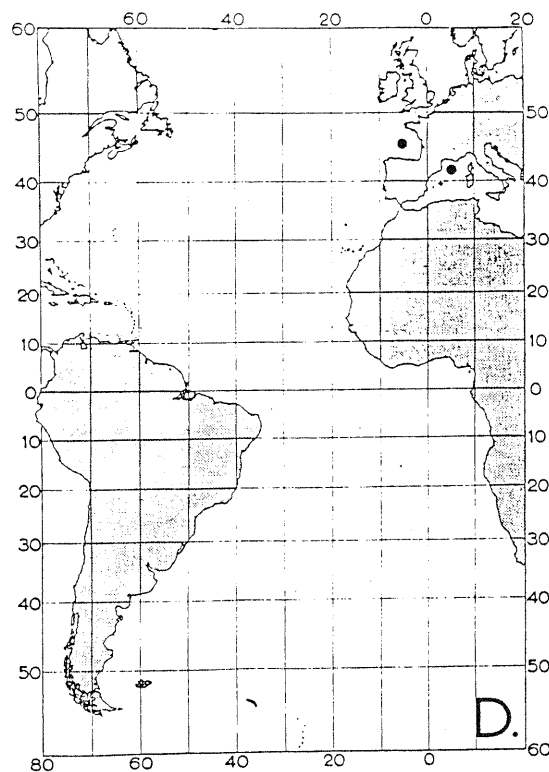
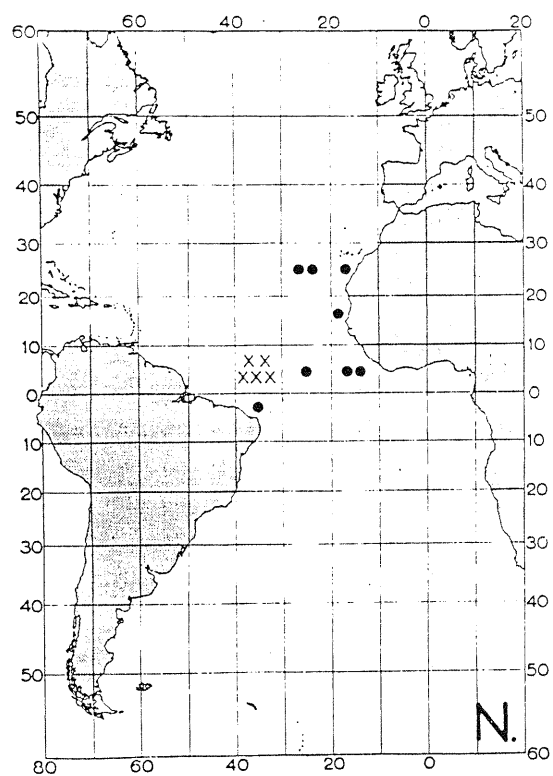
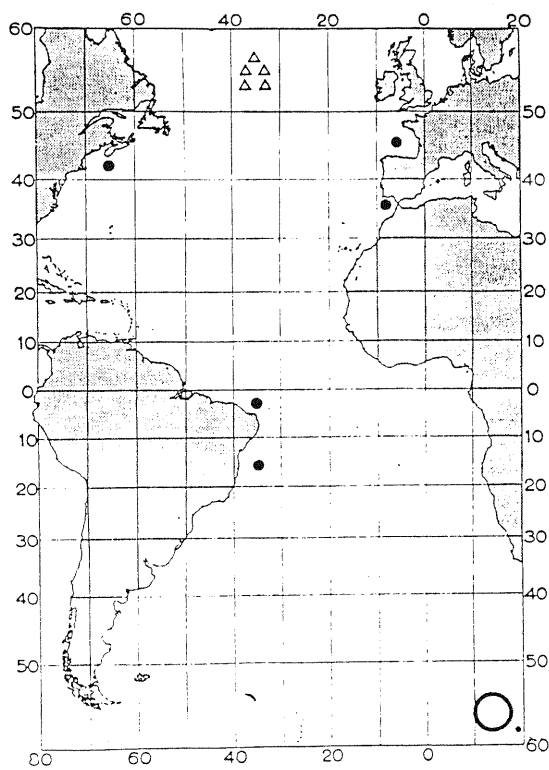
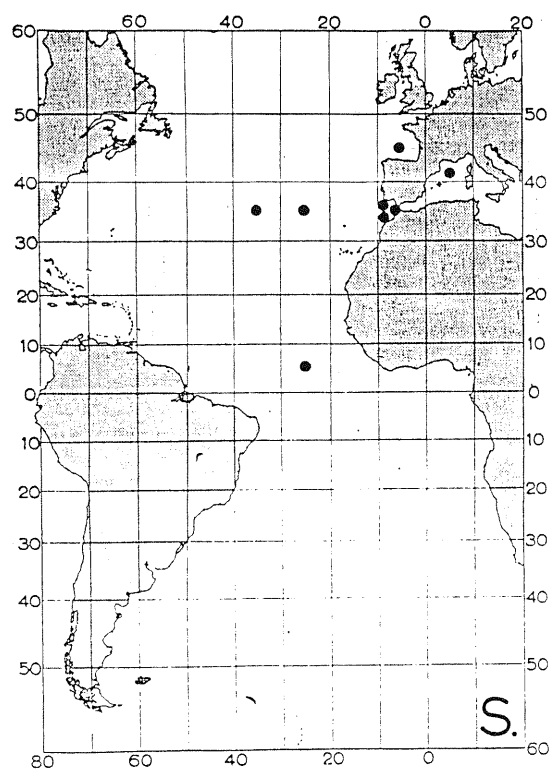


Chart 10. Little Piked Whales in the Atlantic Ocean.