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The cetaceans *Phocoena phocoena* and *Tursiops truncatus*
in the Marsdiep area (Dutch Waddensea) in the years 1931-1973

Part II

by

J. Verwey

Intern verslag

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6. Appendices

Appendix I. Observations on the presence of Tursiops in the Marsdiep area (western Waddensea), chiefly in the years 1935-1938.

1932

On 7 February a Tursiops of 2,2 m length is found stranded on the beach south of the village of Huisduinen.

On 27 April a number of dolphins is jumping vertically out of the water between Huisduinen and the Meteorological Office (MO).

On 2 October a Tursiops of about 2,3 m length is found stranded between kilometre-poles 6 and 8 south of Huisduinen.

1933

On January 15 a number of dolphins are seen jumping vertically out of the water off Kaap Hoofd.

Six or more dolphins are seen jumping vertically out of the water off Kaap Hoofd on February 19 and 26. On February 26 one Lagenorhynchus albirostris is seen there.

1934

On 22 April a number of Tursiops are hunting a fish shoal (presumably herring) off Kaap Hoofd. Gulls diving for herring are above them. Among the Tursiops several pairs are present, consisting of a large dark coloured and a small lighter coloured animal, I suppose females with young.

1935

On January 2 a number of Tursiops are "fishing" against the ebbcurrent near the harbour entrance. On January 22 at least 4 Tursiops are wildly hunting along the seadike close to shore. On January 23 a number of Tursiops are to be seen along the dike, several of them swimming in pairs consisting of a large dark and a smaller light coloured animal.

On February 6 a number of dolphins in the Marsdiep are hunting fish (presumably herring) far from shore. On February 11 some 20 dolphins off

Kaap Hoofd are "fishing" at greater depth against the current (observation W.H. van Dobben).

No Tursiops were seen during bicycle rides along the Marsdiep dike on 21, 22, 27 and 28 March, small numbers were seen on 24, 25, 26, 28, 30 and 31 March. On 16 March some 6-10 Tursiops and 1-2 Lagenorhynchus albirostris were hunting for about one hour off the dike in all possible directions. Now and then vertical jumping took place, which was taken over by others. On 19 March some 6 Tursiops were present between Kaap Hoofd and Westplein during visits in the morning and afternoon. They were among others seen swimming alongshore in one transverse row. There was one small individual among them. On 20 March some 10 or more Tursiops were present in the Marsdiep. They were seen jumping vertically out of the water far from shore, gradually moving in to the harbour entrance, where jumping went on, hardly interrupted by the presence of ships. It should be added that the animals observed on 28-31 March were not seen jumping.

Enormous quantities of herrings are landed during the whole of this month. No Tursiops were seen during bicycle rides on 3, 7, 20, 22, 24, 25, 28, 29 and 30 April (on 30 April 2 rides). The reason for their absence during these rides may have been that they were hunting farther seaward, in the outer part of the area. Small numbers (up to about 10) were seen on 4, 5, 7, 11, 12, 20, 21 and 26 April.

Vertical jumping was seen on 4, 12, 20 and 26 April. Several pairs consisting of a dark and a light individual were seen on 19, 21 and 26 April. The light animal seen on 21 April is very light, its upperside is greyish. On April 26 I noted on about 6 animals: they swim chiefly in twos.

No Tursiops were seen on 1 (2 bicycle rides), 2, 4 (2 rides), 7, 9, 11 and 17 May. Tursiops were seen on 3, 5, 18, 19, 20 and 31 May. The animals of May 3 were a troop of 12-20 individuals, rather far away. Those of May 5 were spread over a rather large area; most of them prior to high tide were fishing off

Kaap Hoofd, close to

the dike; one of them went on fishing there during the ebb. Those of May 18 were spread over a large area between the MO and Kaap Hoofd. The same holds for the Tursiops of May 19 and 20, which are present in great numbers; on May 20 at least 30 were there. On May 30 or 31 G.J. van Oordt saw some Tursiops along the Marsdiep dike. Vertical jumping was seen on May 3, 5, 18 and especially on 19 May, when close to a jumping bottlenose a garpike (*Belone vulgaris*) jumped out of the water. A "pair" of two Tursiops swimming together were respectively large + dark and smaller + light.

J.J. ter Pelkwijk and others on July 14 observed some 3 bottlenose near the Zuiderzee-dike west of Kornwerderzand (not far from the Frisian coast). On July 22 one Tursiops is observed by J.J. ter Pelkwijk off the Marsdiep-dike.

A young Tursiopsis brought in at the Zoological Station on August 15. Not met a single Tursiops since the end of May. This note dates from September 12.

A young Tursiops is brought in at the Zoological Station on October 17. On November 24 the first 2 Tursiops since July 22 are observed. They are swimming together near the Marsdiep-dike.

No Tursiops were seen along the Marsdiep-dike on 17, 22 and 26 December. Tursiops were seen on 5, 15, 16 and 23 December. On 5 December 6 Tursiops were seen swimming to and fro off Kaap Hoofd. On 15 December at least 10 Tursiops were seen hunting off Kaap Hoofd, some 5 were seen east of the MO by W.H. van Dobben and P.J. Kipp. Among them one "pair" was seen, consisting of a large dark and a small light animal; the latter was strikingly small. No jumping was observed. On 16 December at least a dozen Tursiops were observed between Westplein and harbour entrance; one animal was seen jumping. On 23 December at least 8 Tursiops were seen between Westplein and harbour.

1936

No Tursiops were seen on January 1, 4, 5, 6, 12, 13, 15, 17 and 24 (on 24 two rides), small numbers were seen on 3 (at least 4 animals, "among which one adult with young"), on 9 (by van Dobben), may be on 10, on 11, 16 (near the harbour entrance), 19 (in the Schulpengat, south of Huisduinen, obs. van Dobben), on 20 (miss M. Jonker) and 22 January (near the harbour entrance).

No Tursiops were seen on February 6 (2 bicycle rides), 7, 11, 14, 21 (2 rides), 22, 23, 24 and 26. Tursiops were seen on 9, 12, 13, 16, 19, 20, 28 and 29. On 9 February one and 2 Tursiops were seen in the Schulpengat (van Dobben, with V.). At least 3 were seen between harbour and Westplein on February 12; "they blew small clouds of vapour like a horse in freezing weather". On 13 February at least 19, but possibly 25 were hunting between Westplein and harbour. Fishermen land much herring, especially caught near Wieringen. On February 16 at least 20 Tursiops are present off Kaap Hoofd, some 10 off the MO. They are especially active in the outer half of the Marsdiep, where they may be seen swimming quietly beside each other, or, rushing forward with great velocity, are hunting criss-cross in all directions; a single time they jump vertically out of the water. On 19 February several Tursiops are wildly chasing "herring" in the dike bend off the swimming-baths. On February 28 some 20 Tursiops are present east of Westplein, some 10 near the MO. A few times individuals were seen to jump vertically out of the water. Few only were seen on 20 and 29 February.

No Tursiops were seen on March 2 (harbour to Huisduinen), 4, 5, 6, 7, 8, 9 (2 rides), 10 (2 rides), 13, 15 (2 rides), 17, 19, 20, 21, 23 (2 rides), 24 and 27. Neither were Tursiops seen on 27 March during two ferry-crossings of Texelstroom from Den Helder to Oudeschild. Tursiops were seen on 1, 3, 4, 7, 18, 20, 22, 23, 25, 27, 28, 29 and 30 March.

There is much difference in numbers seen on one and the same day. On March 1 at least 21 Tursiops are counted between the MO and Huisduinen. On 3 March not a single Tursiops was seen (at low tide) between the harbour and Huisduinen, but later on the day 20-30 or more were seen there (Broekhuysen and V.). On 18 March about 15-20 Tursiops were seen far away in Texelstroom, at high tide. On 22 March at least 20 Tursiops are seen spread over Texelstroom between Oudeschild and "sanddike Mok"; it is near high tide then. On March 25 Broekhuysen observes some 12 Tursiops at low tide off Kaap Hoofd. On 27 March van Dobben meets with "some tens of Tursiops" not far from the harbour entrance at about low tide, although Broekhuysen did not see a single Tursiops during two ferry-crossings from Den Helder to Oudeschild and V. did not observe Tursiops between the harbour of Den Helder and Westplein. On 28 March van Dobben meets a number of Tursiops near the harbour entrance at low tide. On 30 March about 25 Tursiops are seen off the swimming-baths during the first part of the flood; they are also there at high tide and it looks as if they remained there the whole day. Few individuals were seen on 4, 7 and 20 March; also on 22 March (near the harbour entrance at low tide); on 23 March there were none during ebb, 6 during flood; on 29 March (at high tide) about half a dozen were present off Kaap Hoofd.

Pairs consisting of a large dark and a smaller light specimen were seen on March 1, 3 and 20. The large animals of such pairs appear to have a "black" upperside, the small animals look "grey". On March 3, when Broekhuysen and V. observe at least 20-30 Tursiops between the harbour of Den Helder and the village of Huisduinen the following note is made: Many of the animals look grey, not "black". The light coloured individuals that do not make part of a pair look like the grey partners of the pairs and since the latter are small and therefore must be young there may be many young animals in the schools. Yet, there were specimens among the grey animals, who looked quite large.

Jumping vertically out of the water was seen on different occasions: on 3, 7, 29 and 30 March. On 3 March I specially noted that vertical jumping was observed only few times, on 22 March I noted: they do not jump a single time. On 30 March it was evident that vertical jumping was transmitted from one individual to some others.

The observations on diving of Tursiops made on March 1, 1936, were fully mentioned in the chapter Diving and are therefore omitted here. On 29 and 30 March the "spouting" at emerging was seen several times.

Among the Tursiops observed on 3 March there was one specimen with a strikingly white patch on the forehead, above the snout; the side margins of the tail, too, appeared to be extra-white. Partial albinism?

All observations mentioned under 3 March were made by Broekhuysen and V. No Tursiops were seen during bicycle rides on 1, 13, 20, 24 (2 rides), 27, 28 (2 rides) and 29 April. Tursiops were seen on 1, 2, 9, 12, 13, 16, 17, 24, 25 and 26 March. On April 9 some tens of Tursiops are around us when hydrographical work is carried out in Molengat and Helsdeur, and off Kaap Hoofd. They are swimming in small tranverse rows of up to 6 animals. Several times vertical jumping out of the water took place. It was evident that the animals moved Northsea-wards during the ebb and that they returned during the flood. - A large number were to be seen off Kaap Hoofd on April 12. The water was rising. Later on the day they were to be seen near the MO and the harbour entrance. On 13 April some Tursiops were seen off the MO and near the harbour entrance during the beginning of flood. On 16 April a large number were seen along the dike by van Dobben and B.W. Tucker. On 17 April J.J. ter Pelkwijk saw a number of Tursiops near the harbour entrance. On April 24 a number of them were seen during flood; on April 25 many were present shortly before high tide. Later on the day some were to be seen at the harbour entrance. Also on April 26 many were present around high water. It is evident that more animals enter the Marsdiep during flood than during ebb. - Great quantities of herring

are landed; a good many have spawned, most of them are large.

No Tursiops were seen during bicycle rides on May 4 (2 rides), 6 (3 rides), 7 (3 rides), 10 (south of Huisduinen), 12, 13 (on 13 May 2 rides), 14 (2 rides) and 15 (2 rides). Tursiops were seen in moderate numbers on May 1, 5 (at low tide near Huisduinen), 24 and 25. On May 25 a dozen or more Tursiops were seen to enter the Marsdiep with strong flood, from swimming baths to harbour. - A male Tursiops of precisely 3 m length strands on 16 May on the Marsdiep dike off Westplein.

No Tursiops were seen during bicycle rides on June 3, 4, 7, 10, 11, 12, 13, 14, 16, 17 and 19. Not a single Tursiops is seen during hydrographical work on board ship in Schulpengat, Marsdiep and Molengat on June 18.

Also during the week 19-26 June no Tursiops were observed during 3 rides along the dike. - On June 5 one Tursiops is seen to swim Northsea-wards near Huisduinen. At least 10 Tursiops were active in the neighbourhood of the ship during hydrographical work on June 26. That day one individual showed vertical jumping again and again. Others were "marching" beside each other in transverse columns.

No Tursiops were seen during bicycle rides from the harbour to Kaap Hoofd and Huisduinen on July 2 and 3.

No Tursiops were met during hydrographical work in Helsdeur and Schulpengat on 23 and 24 September. A troop of 5 Tursiops were seen during hydrographical work in Molengat and Marsdiep on 25 September.

No Tursiops were seen during bicycle rides on October 22 (2 rides), 23 (2 rides), 28, 29 and 30. On October 25 a single Tursiops was observed quietly swimming off Kaap Hoofd; no jumping was seen. On October 27 some Tursiops were seen between Westplein and harbour in a boiling and foaming sea. On October 28 several Tursiops were seen, quietly swimming near the watersurface, between Westplein and harbour.

No Tursiops were seen on November 6, 7, 8, 9, 10, 13, 15, 16, 17, 18, 19, 27 and 29.

No Tursiops were seen on December 8, 9, 11, 13 and 20.

1937

G.P.H. van Heusden observes a few times 1-2 Tursiops between 1 and 10 January.

No Tursiops were seen during several bicycle rides on 8-12 and 15-19 February, none either on February 13, 24 (2 rides) and 27 (2 rides).

One single Tursiops was seen between 15 and 19, on 22, 26 and 28 February.

No Tursiops were seen on March 1, between March 22 and 24, and on March 26 and 31. Tursiops were seen on March 14, 15, 16, about 23, on 26, 27, 28, 29, 30 and 31.

On March 14 J.J. ter Pelkwijk and D. Kreger see (around the time of high water) 15-20 Tursiops, one of which has a white tail. This animal is also seen next day and it is again observed on 30 March, showing that the same animal may stay in the area at least for some time. Diving times of this individual have been described in the chapter on Diving and therefore are omitted here. On March 16 at least 15-20 Tursiops are present (at high tide) between Westplein and harbour. They are spread over a large area. On March 27 a number of Tursiops is present in the evening. They "play", swim beside each other, one of them shows two vertical jumps. On March 28 a troop of Tursiops is hunting between Huisduinen and MO. They rush along criss cross in all directions, producing a bow wave while doing so. The "diving" of gulls above the water proves that now and then fish (presumably herring) jump out of the water in their flight for the dolphins. On 29 March a good many Tursiops (more than a dozen) are spread over a large area between MO and Huisduinen. Some of them jump high out of the water. Single Tursiops are seen on 14, on about 23, on 26, 27 and 31 March (on 26 there were 3 or more).

No Tursiops are seen on April 25 between Westplein and harbour. It is low tide and the sea is rough. No Tursiops either on April 26 and 30

(two bicycle rides that day). About a dozen are seen between Westplein and harbour on April 1. On April 8 J.A. Nijkamp observes 15-20 Tursiops not far from the harbour entrance; several of them jump vertically out of the water. Some Tursiops are seen on 12 April between Kaap Hoofd and MO. On 27 April J.J. ter Pelkwijk observes some individuals along the dike. On 29 April 2 Tursiops are seen near the harbour entrance. Van Dobben that day observes a troop of 6.

No Tursiops are seen on May 12, 14 and 20. On 10 May (at high tide) 2-3 Tursiops are hunting off Kaap Hoofd. On May 13 one Tursiops is seen between Westplein and harbour; a strong flood current is running.

Hydrographical work on board ship is carried out on Texelstroom on 7 June. Some Tursiops are then seen near the lightbuoy of Burgzand.

[No observations on cetaceans were carried out near Den Helder during the months of July, August and September, 1937. On 17 September some 6 Tursiops were seen, swimming upstream against the ebb in the Nieuwe Waterweg off the Berghaven of Hook of Holland. On 22 September some Tursiops were seen swimming near the south pier of Hook of Holland. Both observations were made by Niko Tinbergen and V.]

No Tursiops were seen on October 28, one was seen near Huisduinen on 17 October, two were seen between Westplein and harbour on 30 October (the latter two were seen at about high tide).

No Tursiops were seen on November 7, 8, 11 and 12 (that day 2 rides); no Tursiops were seen in the evening of 23 November. In the morning of 23 November two pairs were to be seen between Westplein and harbour; the two animals of both pairs constantly keep quite close together.

No Tursiops were seen between Westplein and harbour on 28, 29, 30 and 31 December; one Tursiops was seen there on December 26.

1938

No Tursiops were seen on 5, 6, 7, 10, 11, 16, 18, 19, 22, 23, 26, 27 and 30 January, when the ordinary dike stretches were inspected.

No Tursiops were seen on February 4, 5, 7, 9, 11, 13, 23, 24, 25, 27 and 28. Again, the ordinary dike stretches were inspected. Only on February 19 a small number of Tursiops were seen (by Niko Tinbergen and V.).

No Tursiops were seen on March 1, 2, 3 (two bicycle rides that day), 6, 14, 15, 22 and 25. Tursiops were seen on 13, 20, 24, 25 and 27 March. On 13 March W.H. van Dobben and miss M.M.M. Broekema see half a dozen Tursiops in the Marsdiep. On 20 March some tens of Tursiops are seen, spread in the Marsdiep from Kaap Hoofd to MO and farther east. They are principally hunting close under the watersurface; now and then they can be seen rushing on there. Because they are hunting so close to the surface there is little difference between the direction of the deeper and the shallow dives. I see no vertical jumping. On 24 March half a dozen Tursiops are seen in the Marsdiep swimming from west to east. After having reached the "bay" of the swimming baths they start diving and swimming (that means hunting) in different directions. On 25 March some 20 Tursiops were seen, spread over quite an area between Westplein and harbour. One animal is seen on the 27th.

No Tursiops is seen on April 25.

[There now is a gap in the observations from the end (rather from the beginning) of April till the beginning of November.]

Observations were made on 7 and 20 November only. On 7 November a number of Tursiops were seen in the Marsdiep. On 20 November one Tursiops is hunting; it shows a deep dive of 150 seconds.

No Tursiops are seen on 18, 25, 27, 28, 29 and 30 December. On December 18 the Marsdiep is one extensive plain of floating ice, on December 27 the whole area is filled with open water again.

1939

No Tursiops are seen on 15, 18, 19, 22 and 23 January.

No Tursiops are seen on 11 and 12 February.

No Tursiops are seen south of the village of Huisduinen on 5 March, no Tursiops is seen along the Marsdiepdike on 12 March, neither are Tursiops seen on a great number of days after that date, until March 29. One single individual is seen on 11 March.

[There were no observations made in the months of April and May; there is a gap in the written data between the end of May and the end of August.]

Two Tursiops are seen on November 5 between the lighthouse of Huisduinen and MO.

1940

(Severe cold now follows from November till the end of February (1940). Although I visit the dike now and then no Tursiops or Phococna are seen). No Tursiops were seen on 17 March while crossing Texelstroom from Den Helder to Oudeschild and back. On April 3 the following note is given: I now and then rode along the dike last weeks, but did not see Tursiops, not in the favourable dike bends either. No further observations were made till the beginning of the war on May 10, and in the years thereafter.

Summarizing the data given in Appendix I the chief conclusions are that in 1933 a troop of Tursiops was present in the area in January and February, what was also the case in 1935. In March, 1935, they were present in fair numbers at least from the middle of the month on; a good many were present in May (not many in April). In December, 1935, several were there again. In 1936 small numbers were present in January, many at least from medio-February on and also in March and April. In May numbers apparently had decreased. In 1937 very few were present in January and February, many from medio-March on and may be through April; few data are there for May. Few were present in the autumn of 1937. No animals were seen in January and February, 1938, except a small number on one day. They were present in fair numbers in March. In the autumn

of 1938 a number were present on a day in November. In the spring of 1939 for the first time no Tursiops were seen in March, except one on March 11. It appears quite abnormal that no Tursiops were seen in the period 12-29 March. It is a pity that few observations were collected in January and February and no observations were collected in April and May that year, but I am inclined to assume that the absence of the animals in the second half of March makes it highly probable that few Tursiops entered the Marsdiep area in the spring of 1939. This possibility is strengthened because it is repeated in March 1940.

Some observations from the years after the war are given on page 86 in the chapter on Decrease.

Appendix II^a. Observations on the presence of Phocoena in the Marsdiep-area (western Waddensea), chiefly in the years 1935-1938.

1934

During 7 visits to the Marsdiep dike in December, 1934, the following numbers of Phocoena were seen: some, quite a number (among them several young), quite a number (among them large, medium sized and small animals), 2, some, 7 (among them several young), 8-9 (most of them young). - Moreover, miss M. Jonker counted during 16 bicycle rides on 8 different days 103 Phocoena, 55 of them "small" 1).

- On December 29, 1934, miss M. Jonker observes about 20 Phocoena hunting in very shallow water near Huisduinen. The water is so shallow that their dorsal fins project above the surface. Apparently, they sought the place for food.

1935

- During 5 bicycle rides along the Marsdiep dike in January the following numbers of Phocoena were seen: some, about 10 (large and small), about 6, and 2-3. None were seen at 6 other rides. The following note of January 24 is of interest: It is uncertain in how far the large number of cetaceans

1)

The possibility cannot be excluded that among the Phocoena observed by miss Jonker, when they were seen at a distance, bottlenose dolphins may have occurred. The chance is small, however, since miss Jonker was constantly concerned with the size of the porpoises because she was interested in the relation between the numbers of young and old animals. Newborn Phocoena are 70 to 80 cm in length, in their first winter they are about 1 m long, newborn Tursiops are about 130 to 150 cm in length. The size-difference is therefore sizable. Large Phocoena, of about 180 cm length, are larger, however, than young Tursiops.

present consists of Phocoena or Tursiops; young Phocoena (easy to identify) were not seen at all of late. Miss M. Jonker counts during 15 bicycle rides on 11 different days 56 Phocoena, 15 of them small. Compared with December numbers have decreased.

- During 12 bicycle rides in February the numbers seen were: 1, some, 1 (young), 2 (young), 2 (rather small), and 7 times none. - Moreover, miss M. Jonker during 5 bicycle rides on 2 days observes one (small) Phocoena. Compared with January numbers have again decreased.- One Phocoena is reported stranded.

- No Phocoena is observed during an unnoted number of visits to the dike in March.

- During 18 visits to the dike in April only one (small) Phocoena is seen. - A female of about 120 cm length is found stranded.

- During 13 visits to the Marsdiep-dike in May only twice seen one (small) Phocoena (probably the same animal on both days).

- At least 7 visits in June: not a few Phocoena seen, they have clearly increased; among them 3-4 females with newly born young (3 of these in the harbour).

- During one visit to the Marsdiep-dike in August a small number of Phocoena is seen.

- Note on September 12: Phocoena was regularly seen these last months. On September 19 several are seen near Kaap Hoofd.

- During two visits to the dike in October some 10 Phocoen were seen, large as well as small animals.

- Quite a number of Phocoena present in November. At some 9 or more visits to the dike some 35 Phocoena were seen. Three visits of 8-10 Phocoena each: small as well as large specimens.

- During 8 visits in December some 17 Phocoena were seen. Once 8, several times a single one or none. Several of them are small.

1936

- During 18 visits to the dike in January some 80 Phocoena were counted, at least 30 of which on January 5. There are great differences in numbers from week to week. None are seen on January 9-15, some 8-10 specimens are seen on January 1, 6, 16 and 24. On January 16 the animals (10 specimens) were concentrated in the neighbourhood of the harbour. There are 1-2 very small specimens among them. Also on January 5 both large and small animals were present.
- During 24 visits to the dike in February 13 Phocoena were observed. No animals were seen on February 6 (twice), 7, 11, 12, 13, 14, 16, 20 (thrice), 21 (twice), 24, 26 and 29; 3 animals were seen on February 9, 2 animals (one small) were seen on February 19, 2-3 on February 23, 4 on February 28. Compared with January the animals have decreased.
- During 38 visits to the dike in March a total of 27-29 Phocoena was observed. No animals were seen during 25 rides; 1-4 animals were seen on each of 13 other rides. No Phocoena were seen on 22 and 27 March at ferry-crossing Den Helder-Oudeschild and back. The animals are apparently not fewer (possibly somewhat higher) in numbers than in February.
- No Phocoena is observed during the 13 bicycle-rides made in April. The species is strikingly scarce. - A male of 120 cm length is caught in a herringkom. A second male, stranded on the dike, is heavily rotten.
- No Phocoena is seen during 15 out of 22 bicycle-rides in May. At each of the other 7 rides 1-3 animals (partly small) are seen. On May 10 one Phocoena is found stranded 4 km south of Huisduinen; a female of 151 cm length with a fullborn young of 81 cm length is found stranded on May 16 near Kaap Hoofd. - A newly born young is caught off Callantsoog, at a depth of 8,5 fathoms. - The animal is already somewhat tainted.
- No Phocoena is seen during 8 bicycle-rides along the dike in June, a total of 39 specimens is seen during 17 other rides. The busiest day

- is June 3, with about 15 animals between the harbour and Huisduinen. Among them is a female with very small young. During the other rides 1-5 animals are observed each time. On June 18 the Zoological Station's vessel is trawling around the Haaks grounds, 4-5 Phocoena are seen then.
- Several animals stranded that month: one young near Huisduinen with rest of umbilical cord attached; a second young (♀) stranded on seadike, length 85 cm, also with rest of umbilical cord attached.
 - 7 Phocoena are seen on July 2; during 3 other rides the number seen is 0-2. - On July 6 a male of 133 cm length is caught off de Koog, Texel, at a depth of 4-4.5 fathoms.
 - As in July (and August!) no comparable observations were obtained in September. The Station's vessel worked on 23, 24 and 25 September in Helsdeur, Schulpengat and Molengat, when altogether about 8 Phocoena were seen.
 - During 5 bicycle-rides in October no Phocoena is seen. On 25 October there are about 10 Phocoena off Kaap Hoofd. One animal jumped nearly out of the water. On 29 October 4 Phocoena were seen, keeping closely together. They surfaced together and dived together, repeating this. Finally one remains at the surface, while the 3 others disappear. On 30 October 2 Phocoena are seen.
 - In November no Phocoena were seen during 3 of the bicycle-rides; 24 were seen during 6 other rides. Of these, 8-9 animals are counted on November 7, apparently all separate animals. On November 6, however, there are distinctly 3 pairs, plus about 3 separate animals. Since the paired animals show a behaviour similar to that of the 4 animals observed on 29 October (keeping close together) it may well be asked whether this is the time of pair formation or copulation. Judging from the facts mentioned in Appendix 4 this seems very improbable, however. Copulation time would fall in July.
 - During 6 visits to the dike in December at least 25 Phocoena are

observed. There are 12 on December 20. They must be rather numerous, as ought to be in December.

1937

- Some Phocoena are seen by G.P.H. van Heusden during the period January 1-10.
- Only during two out of 16 visits to the dike in February Phocoena was not observed. During the other visits the species was regularly seen, up to 12 on 13 and 22 February and with a total of 50-55 for the 16 visits together. They are rather numerous.
- During 11-12 visits to the dike in March only one Phocoena (a large animal) was observed on March 31. Not a single Phocoena was observed at the other of these 12 visits. A strong decrease must have taken place since February.
- Not a single Phocoena was seen during 7 visits to the dike in April. March and April together have now furnished one Phocoena during altogether 18-19 visits.
- No Phocoena is observed during 3 out of 9 visits in May. During the other 6 visits altogether 19 animals were seen, with a maximum of 6 on May 23. Since April there is a distinct increase. - On May 8 a living female, bearing a young, is brought in at the Station and set free again after marking.
- During research in the Waddensea on August 29 2 Phocoena are seen at the meeting-point of Inschot and Blauwe Slenk.
- In October two bicycle-rides together furnish 3 Phocoena seen. One Phocoena is seen in Schulpengat, one in shallow water near Callantsoog.
- In November 7 bicycle-rides give 5, 14, 4 times one, and 3-4 Phocoena respectively, probably 23 in all. The 3-4 animals probably represent two pairs; if not, they consist of one pair and one animal apart. The two animals of the pair constantly remain close together.
- In December 5 bicycle-rides with altogether 4 Phocoena are seen

(thrice none). On December 27 Phocoena at night was many times heard respiring along the dike at the water's edge.

1938

- 13 visits in January, 5 of which without Phocoena. The 8 other visits give a total of 23-27 animals; on most days there are few only, but on January 16 there are 8-10.

- No Phocoena are seen during 10 visits in February; about 9 are seen on February 9. There is one pair and one animal apart on February 23. Altogether 12 Phocoena at 12 visits.

- No Phocoena were seen during 9 visits in March. There are 3 visits with one Phocoena each. Moreover, van Dobben and miss Broekema on March 14 believe to have seen some 40 animals (they had not counted these). Their counting next day furnishes 12 animals between harbour and Kaap Hoofd, 17 animals on the way back, according to them the number on March 14 may have been double that figure. Anyhow, there was a sudden invasion in a period when Phocoena ought to be scarce.

- On March 21 the Station received one female Phocoena (probably stranded).

- On April 25 one Phocoena is observed during the only visit made this month.

Between March 23 and April 2 two dead Phocoena (probably stranded) were brought in at the Station.

- No Phocoena is seen during the two visits paid to the dike in November.

- 7 visits were paid to the dike in December. On December 25 the Marsdiep is one extended plain of floating ice, on December 27 all the ice has disappeared. One small Phocoena was seen on December 18; at the other visits no Phocoena was seen.

1939

In January 6 visits to the dike with altogether 19-20 Phocoena, 13-14 of which were seen on January 15. "It was a long time ago I saw so many

and I suppose that they may have been in the North Sea farther out during the frost; - The part of the dike inspected was small (Kaap Hoofd to Meteorological Office). The number of animals from Harbour to Kaap Hoofd may well have been greater.

- Some 5 Phocoena were seen on February 11, one was seen on February 12. Other visits were not made in this month.

- The following note of March 29 is of interest: "For some weeks already I visited the dike (Westplein to Harbour) nearly daily, sometimes twice a day, without seeing Phocoena". Since I saw 2 Phocoena on March 5 some specimens on March 11 and no Phocoena on March 12 no specimens were seen during the whole of the second half of March.

- Several Phocoena were seen between the lighthouse of Huisduinen and the Meteorological Office on November 5.

Strong cold reigns from then on to the end of February, when no Phocoena (or Tursiops) were observed during a number of visits to the dike.

1940

- 1-2 Phocoena were seen from Texel-ferry on March 17.

- 3 Phocoena were seen along the dike on April 3, the first animals after that of March 17. In the intervening period I visited the dike now and then, without seeing Phocoena, even at the favourable places.

Appendix II^b. Data on the presence of Phocoena in the Marsdiep-area in the years 1945-1973. Included are some observations in the western part of the Waddensea and from the westcoast of Texel, strandings of animals along the Dutch westcoast from Camperduin to Terschelling, and catches of animals in fishermen's trawls in the North Sea around Den Helder.

1945

- 5 bicycle visits are paid to the dike between 24 and 31 December. At two visits no Phocoena is observed, the other visits together furnish at least 14 animals. There is one large animal accompanied by a small one that keeps to her scrupulously. This should be a late-born young of this year.

1946

- On January 1 two Phocoena swim inward (in the direction of the harbour) with the flood.

- No Phocoena is seen at 2 out of 4 visits to the dike in March; on the other two occasions 3 animals are seen.

- In April no Phocoena is seen at 2 visits; at a third visit (by I. Kristensen) 3-4 are seen. One is seen off de Koog (Texel), also by I. Kristensen.

- At 3 visits to the dike between 20 and 26 May 4 Phocoena are seen; no Phocoena is seen at a 4th visit these days.

A stranded specimen is found off De Koog, Texel.

- About 10 solitary Phocoena are seen from Texel ferry on June 15; next day 4 are seen (both observations by G.P. Baerends).

On June 21 a newborn female of 35 cm length (dorsal fin and tail flukes still folded) is caught in trawl 25 miles NW by N of Den Helder.

- One Phocoena is seen in harbour on 19 July (I. Kristensen). One female of 117 cm is found stranded on dike on July 7. A young male of 81 cm, very lean, is caught at outer margin of Texel Hole (15 fath.) on July 3. Dorsal fin and tail flukes have already stiffened.

One Phocoena is seen along dike on August 5, one specimen fishing there against the ebb on August 31. It keeps to a certain place close to the water's edge, surfaces only once each time and stays down for a longer time then. One and two Phocoena are seen from Texel ferry on August 5.

- One Phocoena is seen along dike on September 8. At least 7 are seen from Texel ferry on September 28. Among them are 2 small ones. A few times they keep stationary at the watersurface for a long time.

- In October 2 Phocoena are seen along dike (I. Kristensen).

- At low tide on November 7, 2 Phocoena are fishing near Kaap Hoofd.

For further observations on them see text, footnote on page 75-76. Fishing at low tide often takes place near Kaap Hoofd, fishing at high tide takes place somewhere farther in, often near the harbour entrance.

The animals must therefore now and then go up and down with ebb and flood.

1947

- 5° C frost on January 5. No Phocoena seen along dike that day.

The frost continues to the middle of the month. On January 19 2 Phocoena are seen. Frost sets in again on January 21, continuing to March. On March 4 it still freezes 12.5° C. The lowest temperatures observed at Den Helder were about -15° C. No Phocoena were seen on March 14, 15, 16 and 22. On March 23 at least 2 Phocoena (separate animals) were seen.

"They have certainly returned after the cold."

- Around April 16 J. de Veen saw 7 Phocoena on Texelstroom near Oudeschild; no Phocoena are seen from Texel ferry on April 20.

- No Phocoena are seen along dike on May 26. From Texel ferry 2 Phocoena are seen on May 25.

- No Phocoena were seen along dike on 8 and 14 June.

- No Phocoena were seen along dike on August 24, one Phocoena with young at the harbour-entrance is seen on August 27. Twice a Phocoena

was seen near Noorderhaaks on August 21, 2 Phocoena were seen on northern Texelstroom on August 27 (both observations from the Station's vessel). A male of 110 cm length is caught by trawl off Callantsoog, 4.5 fath., on August 25; a male of 146 cm length is caught by trawl off Terschelling, 18 fath., on August 6.

- A dying male (testis 12-12.5 cm) is found stranded on seadike on September 23. Altogether 8 Phocoena are seen in Waddensea from Texelstroom to Inschot on 3-4 September; no Phocoena is seen on Texelstroom on September 6 (observations from the Station's vessel).

- No Phocoena was seen along the dike on October 5. 2 Phocoena were seen on northern Texelstroom on October 3; no further animals en route from there to Terschelling and back to Den Helder on October 4.

Both trips took place via the Waddensea. - Sailing from Den Helder to Terschelling via the North Sea on October 7, 3 Phocoena were seen in the entrance to the Schulpengat, about 5, 2 and 4, all swimming in southern direction, were seen off buoy ET1. No further animals were seen under way to Terschelling. Returning from Terschelling via the Waddensea-route to Den Helder on October 8 not a single Phocoena was seen. - 4 Phocoena (1, 1 and 2) were seen in Scheurrak, Omdraai and Oude Vlie (Waddensea) on October 13. One animal in Oude Vlie on October 14, one seen there on the 15th. No Phocoena were seen during hydrographical work at the junction of Oude Vlie and Inschot, none during the trip from there back to Den Helder on October 16.

- No Phocoena was seen during trawling along the Zuidwal on November 12.

1948

2 Phocoena are seen off the harbour entrance on March 15 and 16 (observation J. Bennema).

- A young Phocoena of 67 cm length, still without teeth, is caught by trawl off Callantsoog, at a depth of 6 fathoms, on July 1.

- 2 Phocoena of 100 and 110 cm length were found stranded along the Hondsbosse Zeecewing (the sea dike between Petten and Camperduin) on September 19.

1949

4 Phocoena were seen in the North Sea off Callantsoog on May 4: 2 together, and 2 solitary individuals.

- A male Phocoena, 83 cm length, was caught in trawl in the outer part of Texel Hole, depth 17 fathoms, on June 10.

1950

- One Phocoena of 70 cm length was caught in trawl off Callantsoog, depth 8 fathoms, on June 1. - Another specimen, length 79 cm, was caught in trawl NE of Terschelling, depth 20 fathoms, on June 3.

- One male Phocoena, 120 cm length, was caught in trawl off Callantsoog, depth 12 fathoms, on September 21.

- One Phocoena (♀ ?) of 123 cm length was caught in trawl off Petten, depth 8 fathoms, on October 14.

1951

- One Phocoena (rather large specimen) was caught outside the Stones (Texel Hole), depth about 17 fathoms, on February 14.

1955

- A female Phocoena, bearing a young at the stage of birth, is caught south-east of Texel on July 6.

- A specimen of about 110 cm length is brought in at the Zoological Station and set free after marking on August 2.

1956

One specimen was caught in trawl in Westgat, 7 fathoms, on April 19.

- One Phocoena was caught in trawl in outer part Texel Hole, 16 fathoms, on June 15. - Another specimen, a young of 81 cm, is caught by trawl, not far from there, depth 12 fathoms, on June 19. One specimen, 76 cm

length, is caught by trawl north of Terschelling, depth about 30 m, on 20 June.

1957

- One dead Phocoena is brought in at the Station on May 30. It was caught in a herring-kom.
- One Phocoena is seen in the Molengat on June 18. One or two are seen near the Vangdam on June 28.

1958

- One Phocoena is brought in at the Station on April 14. It was found stranded on Kolenplaat, Waddensea, south of Den Helder.
- One Phocoena stranded south of Huisduinen on May 10.

1959

- A female Phocoena of about 100 cm length was caught in trawl in Westgat, about 7 m depth, on February 9.
- A male of 125 cm length was caught in trawl in the outer part of Texel Hole, depth about 30 m, on February 19.
- A male Phocoena of 105 cm length stranded on sea dike on March 3.
- A male Phocoena of 122 cm was found stranded on dike 't Horntje (South-Texel), on 5 June. A newborn male of 74 cm length was found stranded on the seadike on June 11. A male of 113 cm length was found stranded off Callantsoog on June 30.
- About 7 Phocoena are seen in the North Sea off Westerslag, Texel, on December 6 (observation G.J. de Haan).

1960

- One Phocoena is seen off the harbour entrance on January 15. - Quite a number would have been seen off Egmond that same day. - Dudok van Heel saw quite a number on Texelstroom medio-January. He spoke about 40-50 (Lutra 1, p. 11-12, 1960).
- A male of 42 cm length (this must be a misprint) was caught in trawl west of Black Bank (North Sea) on February 10.

- A male was caught in outer part Texel Hole, depth about 31 m, on March 15.
- A female of 160 cm length was found stranded or caught near the Vangdam, Den Helder, on May 9.
- A female of 81 cm length was found stranded between De Koog and Westerslag, Texel, on August 4 (G.J. de Haan). - A female of 128 cm length was caught in trawl near buoy ET4 in the North Sea off Texel, depth 27 m, on August 24.
- A female of 156 cm length (in bad condition: rotten) was found stranded near Falga, beach south of Huisduinen, on December 6.

1961

- A specimen was found stranded near the lighthouse of De Cocksdorp, North Texel, on April 29.
- A specimen was found stranded at the harbour entrance, Den Helder, on May 12. Another specimen, a male of 146 cm length, was found stranded south of Camperduin on May 29; the latter animal was in rotten condition.

1962

- A female of 159 cm length was caught in Texel Hole, depth about 30 m, on May 23.

1965

- A female of 120 cm length was found stranded on Terschelling on May 28.
 - A male of 106 cm length was found stranded on Eyerland, Texel, on June 3.
 - A female of 126 cm length was found stranded on NW-Texel on July 4.
- A male of 110 cm length was caught or found stranded in the Nieuwediep, Den Helder, on July 5. A female of 127 cm length was found stranded on West-Terschelling on July 18.
- One Phocoena was caught in the NE part of the Stones, Texel Hole, depth about 30 m, on November 6.

1966

- A male Phocoena of 108 cm length was caught in trawl near Amrum-bank-buoy

(Schleswig—Holstein) on 3 or 7 July.

1967

- A Phocoena of 148 cm length was caught in trawl in the Borkum Stones, depth 20 m, on December 21.

1970

- Two Phocoena of 124 and 131 cm length (♀ and ♂ respectively) were found stranded 5-6 km south of Huisduinen on November 14.

1972

- A female of 155 cm length was found stranded on Texel (km pole 12) on March 26.

- Around June 1972 P. Duiven, NIOZ, Texel, during a period of about 3 weeks saw a Phocoena daily present in the entrance to the harbour of Den Helder.

In the end of June or the beginning of July C. Swennen saw a young animal brought in at the Zoological Station.

- A female of 112 cm length was found stranded between Petten and Callantsoog on 24-31 August.

- A male of 134 cm length was found stranded near Petten on November 25.

1973

- A female of 119 cm length stranded on February 25 near Camperduin.

- A female of 157 cm stranded on July 12 near Camperduin.

- A specimen was caught in trawl 8 miles north of buoy P8, depth 43 m, in the North Sea, on 22 September.

- A female of 129 cm stranded on South-Texel on October 2. A male of 114 cm length stranded on the seadike of Den Helder on October 23.

- A Phocoena was caught in trawl off Petten, 8 fathoms depth, on 9 November. Another Phocoena, a female of 131 cm length, was caught by trawl on Doggersbank, 18 fathoms depth, on November 24.

- A female of 138 cm length stranded 3 km south of Huisduinen on

December 4. A male of 120 cm length stranded on the seadike, Den Helder, off Westplein, on December 15.

1974

- A specimen of about 170 cm length stranded off Julianadorp, south of Den Helder, on March 15 (P. de Wolff).

Appendix III. Food of Tursiops and Phocoena.

A few words may be said on the kind and quantity of food of bottlenose dolphin and porpoise.

I. Common porpoise

Dudok van Heel (1962, p. 443) gave the porpoises he caught in Denmark in the beginning 6 kg of young cod (*Gadus morrhua*) per day. They lost visibly weight on that diet and he changed over to the same quantity of herring, after which no more weight was lost. Since herring is fatter than cod this change may have been due to the higher caloric value of this fish. In this connection it is of interest to know that the Californian sea lions (*Calophus californianus*) at Harderwijk needed about 15 kg per day when they were fed whiting (*Gadus merlangus*), but half that weight when herring or mackerel were used for food.

The porpoise Dudok van Heel worked with in Holland in the beginning consumed up to 12 kg per day, a quantity that in the course of spring decreased to 8-10 kg, both values expressed in herring and mackerel. It is of course important to know the weight of the animal. In this connection Møhl-Hansen's work is valuable. Females of about 75 kg have a length of about 160 cm, the heaviest females weigh about 90 kg, their length is about 180 cm. Adult animals of one and the same weight may differ some 10% in length.

Sergeant (1969) summarizes daily food rations of some cetacean species expressed as percentage of body weight. He cites results of Andersen (1965) on 8 *Phocoena* studied in Strib, Denmark. The animals

weighed 30-71 kg. They were fed whiting (*Gadus merlangus*) and mackerel (*Scomber scombrus*). Porpoises of 30 and 32 kg consumed 4.1 kg of fish per day; this comes down to 13.2% of their weight. Two porpoises of 71 kg each consumed 4.2 and 5.1 kg per day, or 5.9 and 7.2% of their weight. The percentages for all porpoises were 5.3 - 13.7, with an average of 8.3. It is not stated what part mackerels, and whittings, formed of the different diets; they may well have caused these differences.

- Sergeant says that Andersen's results show that consumption per day was inversely proportional to body weight, but the figures hardly permit to say that. Animals of 30, 32, 55, 63, 68 and 71 kg gave daily consumptions of 4.1, 4.1, 4.8, 5.4, 4.5 and 4.6 kg. One can say that 6 animals of 30-71 kg consumed 4.1 - 5.4 kg per day (average 4.6); there is no indication that young animals of the weights cited eat more when they grow somewhat older, nor that they eat less.

The daily food consumption of the porpoise studied by van Heel was apparently much higher than that of Andersen's specimens.

From the fact that herring and mackerel have a higher caloric value than cod one should, of course, not conclude that young cod would not be an excellent food for porpoises too. Rae (1965 and 1973) has given data on the stomach contents of some 90 porpoises caught in Scottish waters, and a summary of the literature in question. The data are not quantitative. The number of porpoises with recognizable food remains was 64, of which 42 had eaten Clupeoids (10 of them herring, 3 sprat), 28 had eaten Gadoids (16 of them whiting, 3 cod, 1 haddock, 3 Norway pout (*G. osmarki*), 2 Saithe (*G. virens*), 1 hake (*Merluccius*), while two had eaten mackerel and 5 sandeel (*Ammodytes*). One had eaten a flatfish (*Pleuronectid*). Four had eaten decapod crustaceans (2 of them shrimps), one had eaten a cephalopod, there were 2 porpoises whose stomach

was 3/4 full of herring, stomachs of others contained rests (especially otoliths) of many small Gadoids. Rae comes to the conclusion that the porpoise feeds chiefly on Clupeoids and Gadoids, that it takes rather small fish (mostly less than 25 cm long, the largest perhaps up to 35 cm) and that it specially takes pelagic and few demersal fish. "This dependence on pelagic fish is of course understandable in an animal leading a pelagic existence such as the porpoise". I personally do not subscribe that opinion and would call the porpoise demersal rather than pelagic.

Rae also cites Scott (1903), who found the stomach contents of a porpoise caught in a salmon net near Aberdeen to contain 280 otoliths, at least 240 of which were almost certainly those of whiting (*G. merlangus*), the majority of which were about 20 cm in length; 12 other otoliths appeared to belong to the young of some other Gadid. The remainder, some 22 otoliths, somewhat resembled the otoliths of sandeel (*Ammodytes*). -Harmer (1927) says that the stomach of one of the porpoises he mentions in his list of stranded specimens (1925-5) contained numerous bones of whiting, and not less than 400 otoliths, 336 of which were of whiting. -Fraser (1936) makes mention of a porpoise with a common sole (*Solea vulgaris*), wedged in its throat (apparently the cause of his death).¹⁾ -Harmer says that porpoise 1926-11 from his list had been feeding on large herring; in this connection he refers to Stephen (1926). -It should be added that Møhl-Hansen (1954) investigated the stomach contents of 300 *Phocoena* from Gøteborg Fjord but did not give the results in his paper. -According to Rae (1964) the fullest published account of

1)

Dr H. Engel, then director of the Zoological Museum, Amsterdam, found a sole wedged into the connection between throat and left nose hole of a bottlenose dolphin, stranded on the island of Texel in April 1951 (cited from Logbook Zoological Station).

the food of the common porpoise is by Lindroth (1960), who examined the stomach contents of 50 porpoises from the Baltic in 1960-'61. Thirty-eight of the stomachs contained recognizable food. Cod was found in 13, herring in 21, sprat in 24, transparent goby (*Aphya pellucida* in 7 and sandeel (*Ammodytes spec.*) in 2 stomachs. The herring ranged from 11 to 27 cm in length and the cod from 2 to 38 cm. Of all the measurements tabulated by Lindroth relatively few codling exceeded 30 cm in length. It is remarkable that an animal of the size of a porpoise feeds on small fish like *Aphya pellucida*. - According to Rae (1964) Sergeant & Fisher (1957) found herring to be the principal food of the porpoise in certain bays in Eastern Canada, although saithe (*G. virens*), hake (*Urophycis tenuis*) and the squid *Loligo pealii* were also taken.

Summarizing these data there can be little doubt that whiting and other Gadoids form an important part of the food of the common porpoise, but that herring and other Clupeoids do also belong to its common natural food. Dudok van Heel remembers me of the fact that the vernacular name of the porpoise in Holland is haringkat (herring cat). The whiting being a rather slow fish it may well be that whiting is much taken by the porpoise because of its slowness and that the herring may be taken with somewhat more trouble, because it swims faster. Other behaviour of fish may also play a role; taste or form may be important too.

Dudok van Heel says his porpoise refused eel-pout (*Zoarces viviparus*) and flounder (*Pleuronectes flesus*). Andersen & Dziedzic (1964) say that their porpoise, who swam together with codfish of edible size for two months, never touched these. Beside herring and whiting (their ordinary food) they did take dead eel (*Anguilla anguilla*), sprat

(*Clupea sprattus*), mackerel (*Scomber scombrus*), sandeel (*Ammodytes*), pollack and poor cod (*Gadus pollachius* and *G. minutus*), eel-pout (*Zoarecs viviparus*) and horse mackerel (*Trachurus trachurus*). The only fish that was given the porpoise alive was the eel (*Anguilla*). It was readily taken. - I suggested on page 52 that the porpoise visited shallow water in winter because of the presence of flounder. C. Swennen suggested to me that the porpoise in question may have aimed at catching mullet (*Mugil*).

II. Bottlenose dolphin

Dudok van Heel tells me that an adult Tursiops in captivity at temperatures of 16-20° C needs about 5-7 kg of herring or mackerel per day, a pregnant or lactating female at 16-20° C needs about 10-15 kg. Animals feeding on the less fat, less nutrient Gadidae will require more kgs, however. Sergeant mentions data from Ridgway (personal communication), who gave a consumption of 7.3 kg per day for a bottlenose dolphin of 177 kg. Its food consisted of mixed fresh mackerel (*Pneumatophorus*) and smelt (*Osmerus mordax*). Brian Beck (also personal communication to Sergeant) gave a consumption of 13.6 kg per day for a female bottlenose of 159 kg. Its food consisted of herring and smelt. The animal soon reached satiety and ceased to feed. The average daily intake levelled off to 6.8 kg per day after 11 days. Sergeant adds that the daily food consumption in both cases was 4.2% of the body weight. - Tayler & Saayman (1972) say that a female bottlenose dolphin had an average daily food consumption of 11.4 kg. In the case of a pregnant or lactating cow the consumption was maximally 20.5 kg. The females weighed 150-200 kg. A bull Tursiops of about 300 kg had an average daily consumption of about 13.6 kg, a maximum of 31 kg. Saayman, Bower & Tayler (1972) say that the daily food consumption in captive adult bottlenose dolphins of

some 200-300 kg weight is approximately 5% of their body weight.

When the values for the food consumption of Andersen's porpoises (4-6 kg per day for animals of 50 kg or 9.2%) are compared with those for the bottlenose dolphins, the values for the porpoises are high, but they refer to young animals. Nothing can be said for certain on the difference between porpoise and bottlenose. The activity and inferior body surface to volume ratio of the porpoise may be higher than for the so much heavier bottlenose.

It is probable that the chief food of the bottlenose in the Marsdiep-area was herring. Van Heel tells me that a very important food of Tursiops in Florida is *Caranx*, and that *Caranx* there is preferred to other fish. Although *Caranx trachurus* was numerous in the Waddensea after the war (1940-'45) it cannot have been important for Tursiops there, because prior to the war *Caranx* was very little common, not to say rare. It for the first time entered the Waddensea in important numbers in 1943 or '44. Although the herring therefore will have been the most important food for Tursiops this does not mean that herring was the sole food. Van Deinse (1955) mentioned a bottlenose dolphin stranded on August 8, 1954, on the Boschplaat (island Terschelling), whose stomach contained 6 entire haddock (*Gadus aeglefinus*). Another bottlenose, from 23 September 1926 (the locality is not given), had in its stomach 15 haddock of 57-90 cm long (van Deinse, 1957). Since 90 cm is a great length for haddock from the southern North Sea it may be wise to let the possibility open that the fishes were (partly) cod (*Gadus morrhua*).- Again another bottlenose, which stranded in June 1958 near Oosterend on the island of Texel, had in its stomach a spiked dogfish (*Acanthias vulgaris*) of 104 cm long, a John Dory (*Zeus faber*) and 3 soles (*Solea vulgaris*) (van Deinse, 1959). On 27 March, 1936,

Brockhuysen investigated the stomach of a bottlenose of 274 cm length, stranded on 24 March on the westcoast of Texel. He found 2 fairly large otoliths of *Gadus*.

It looks as if for bottlenose and porpoise in Holland *Gadus* species form an important part of their diet. This is the more remarkable since *Tursiops* at Harderwijk according to van Heel absolutely refuse *Gadidae*. Maybe they like herring and mackerel so much. For *Tursiops* herring may be quite important, for *Phocoena*, at least in the Marsdiep-area, whiting may be more important than herring.

Tursiops truncatus is a species of very wide distribution. It goes without saying that it cannot use the same species of fish everywhere. In this connection the importance of *Caranx* in Florida was already mentioned. Gunter (1942) brought some other instances together. He cites Kleinenberg (1938), who found that in the Black Sea the anchovy (*Engraulis encrasicolus*) and a species of cod (*Gadus euxinus*) were in the overwhelming majority; 87% of the fishes belonged to these species. The anchovy was only used as food when it was very numerous. Townsend (1914) and Kellogg (1940) say that at Hatteras, North Carolina, the bottlenose dolphins are known to feed chiefly on the squeteague (*Cynoscion regalis*). For the coast of Texas Gunter enumerates a number of fishes used as food by bottlenose dolphins. Nearly every fish is taken including a hammerhead shark (*Sphyrna zygaena*) hauled in on a handline and a spotted eagle-ray (*Stoasodon marinari*). In the latter case the dolphin leapt from the water and captured the ray in mid-air after it had left the water, "doubtless in an effort to escape." The fish used most of all there (for over 83%) is the striped mullet (*Mugil cephalus*). The mullet was followed by the Gizzard shad (*Dorosoma*

copedianum), which was much less numerous, however. "It has been estimated that Mugil is one of the leading four fishes of the Gulf Coast. In connection with what was said about the preying of Tursiops on large fish schools these data form good instances: Tursiops takes what it can get in large numbers.

An interesting detail concerning the food of the bottlenose dolphin is the following. Gunter (1942) cites McBride 1940, who relates the instance of a young dolphin that sickened and died, apparently from eating eel-grass stolen from manatees. He said the animal seemed to be jealous of the manatees. I think the interpretation may be right. The bottlenose is so fond of imitating others that one can expect such a behaviour.

Appendix IV. Reproduction and growth.

Since during the work now and then observations were made which had to do with reproduction of the two species involved a short summary is given here of some facts of interest.

I. The bottlenose dolphin

Valuable observations on reproduction in bottlenose dolphins have been made by McBride & Hebb (1948), McBride & Kritzler (1951), Tavolga & Essapian (1957), Harrison, Boice & Brownell (1969), Sergeant, Caldwell & Caldwell (1973) and others. The development of marine studios, oceanaria, dolfinaria, etc. has greatly contributed to better knowledge, and so has age-determination from dentin. Several young bottlenose dolphins have been born in captivity and made possible detailed description of parturition.

McBride & Kritzler (1951) still believed that the female bottlenose becomes mature in her 4th year and that she would get her first infant when 5 years old. Also Harrison, Boice & Brownell (1969) say that there are indications that females reach sexual maturity at 5, males reach maturity at 6-7 years. An animal that was kept in captivity for 21 years became mature when 7 years old, but annual growth rings in dentin indicate (Sergeant, Caldwell & Caldwell, 1973) that female bottlenose dolphins may mature when 12, males when 13 years old. Sergeant c.s. assume that life in captivity, with better food, would cause increased growth and earlier maturation. There are apparently strong differences in maturation: maturing bulls were from 7 to 15 years old, bulls were mature from 12 years on.

Dominant male *Tursiops truncatus* bulls become aggressive to other males in the spring sexual season (Sergeant c.s., 1973). Since, apparently, more young are born in the spring than in other seasons and gestation takes about one year copulations would especially occur in the spring.¹⁾ McBride & Kritzler (1951) say that the height of sexual activity in the captive dolphins occurs in April, but this refers to Florida. Pregnancy may be initiated while the mother is still nursing her previous offspring.

Detailed descriptions of the birth of young has been given by McBride & Kritzler (1951) and Tavolga & Essapian (1957). The length of the young animal at birth according to Harrison, Boice & Brownell (1969) is 98-126 cm. It is interesting that another female than the parent as a rule partakes in the care and protection of the young. Although the dorsal fin and flukes of the young stiffen and straighten shortly after birth or during the first two weeks of natal development their softness seems in no manner to impair the ability of the infant to swim as rapidly as the mother. Only one infant is born, the interval between births when two young were born by the same parent was two years (McBride & Kritzler, 1951). The young seems to surface for respiration twice as many times as the adult.

Respiration is vocal from the moment of birth; the high pitched whistling which is used for ordinary communication is very much in evidence. The infant and its mother seem to be in constant connection as shown by the bubbles escaping from their blowholes when whistling is heard.

1) Tayler & Saayman (1972) mention gestation periods of less than a year: 342 and 351 days.

Young dolphins are sexually very precocious. Attempts at copulation with older animals of both sexes may be seen at each age, from six weeks after birth on. Masturbation is frequent, especially in females of any age. Anomalous sexual behaviour is very common in confined animals and it is open to question whether or not the sexual precociousness exhibited by the young dolphin is merely a manifestation of their tendency to imitate anything they see the older animals do. Interest in solid food comes very late: in one female when she was 11 months old. Playing with food is the beginning. At an age of 12 months she ate her first fishes. 18 months after birth she ceased nursing altogether. But another young (male) dolphin began eating pieces of Loligo, when it was 5 months old. He played with fish-food when 8 months old.

II. The porpoise

Circumstantial data on the porpoise were obtained by Møhl-Hansen (1954). He got his animals from Gøborg Fjord, Little Belt, Denmark, where porpoises from the Baltic passed on their way during northward migration between medio November and medio February. All in all, Møhl-Hansen examined some 700 animals and 119 foetuses. About 630 of them were measured and sexed and some 400 of these were weighed and their foetuses measured and weighed.

The great value of his data lay in the determination of weight and size of the pregnant and non-pregnant females. He found that they became pregnant at a weight of about 50 kg and a length of about 145 cm. Since nearly all females above this size were pregnant Møhl-Hansen concluded that the animals give birth to one young each year.

It is of much interest to know at what age pregnancy begins.

Because his animals were caught from November to February he missed the copulation-period (presumably in summer) and the time of birth of the young (May to July), but he could follow the growth of the animals and foetuses in winter. The smallest November-foetuses were about 140 mm long and they had a weight of about 50 gram. In the beginning of February their length was about 400 mm, their weight about 1700 gram. It is known from other data that the young are chiefly born in June-July at a length of 700-900 mm. These newly born young reached Gamborg Fjord in November and their growth came to the fore from frequency curves of their weights in December and January. They showed a peak weight of 35-40 kg and a length of 120-135 cm. This was the average size of the yearlings in their first winter. The males had a somewhat smaller size than the females.

From the fact that the animals had a length of 120-135 cm around the end of the year (at an age of about 6 months) and that they were pregnant from a length of about 145 cm on in the summer of the year after the year of birth Møhl-Hansen concluded that somewhat more than a year elapsed between birth and first maturity (first copulation). In other words, *Phocoena* according to Møhl-Hansen becomes pregnant when good one year (about 13-14 months) old.

In this connection the paper of Fisher & Harrison (1970) is of interest. It deals principally with animals from the Canadian coast, collected between May and October.

Fisher & Harrison are specially interested in the state of the male gonads, and they find that the males are mature from a size of about 133 cm length on, the females from a length of about 145 cm on, as was also found by Møhl-Hansen. The authors reason that the

animals are about 100-110 cm long at the end of the year of their birth (they are 120-135 cm according to Møhl-Hansen) and that they measure 120 cm when a year old. As a result they decide to a slower growth than Møhl-Hansen did and suppose that Phocoena does not mature before its 3rd or 4th year. They further believe (contrary to Møhl-Hansen) that Phocoena does not reproduce annually.

The youngest fetuses described by Fisher & Harrison are from the beginning of August, and copulations therefore probably take place from July on. Fisher & Harrison say that histological evidence of spermatogenesis, together with sperm in the epididymis, was confined to July-specimens and that the diameter of testis-tubules in the period May-November reaches a peak in the second half of July, and falls sharply along with testis size by mid-August. This would mean that the time of copulation would especially fall in the second half of July. There are, however, few direct data on copulation, and little attention has been given to the possibility of geographical differences.

There are a good many data on the time of birth of young porpoise. Those of Fisher & Harrison and most others show that in Canada as well as in Europe the chief period of birth is June-July. Møhl-Hansen concludes (chiefly from earlier data) that normal birth time "may be fixed" at the last half of May and the first half of June, but he added that there is apparently much variation. My own data for Den Helder show that animals are born from the middle of May on; young are born up to and inclusive July, I did not meet with young born in August. For Passamaquoddy Bay Fisher & Harrison cite Levitt, who says that young are born from June on, that the peak of calving falls around the end of June and the beginning of July, but that

young may even be born in September. Such a late season of reproduction may well agree with such a northern locality. Apparently the young at birth are greater in Canada than in Holland. According to Fisher & Harrison their size at birth is 80-90 cm, whereas in Holland their size at birth is rather 70-80. As to birth of young too little attention has been given to geographical differences.

Since the "normal" time of copulation would be the second half of July, and June or the second half of June is probably the chief time of parturition, pregnancy would last about 11 months. Møhl-Hansen comes to the same conclusion¹⁾. He further concludes that the young are nursed for at least 8 months. He found milk in the mammae up to the end of the period in which *Phocoena* was caught: February. He adds that the young did not use milk only during that period.

There seems something in favour of the viewpoint that *Phocoena* is born somewhat later in Canada than in the southern North Sea, that the young at birth are somewhat greater in Canada and that their growth in Canada may be somewhat slower. It would therefore be understandable if in Canada they would mature somewhat later, as Fisher & Harrison supposed. If their supposition as to later maturation would be right, we may assume that the differences between Canadian and North Sea animals may be ascribed to climatic causes.

1)

When studying the literature I noted that according to Altman & Diltner *Phocoena* has a gestation period of 300-330 days. I did not find back the reference lateron.

7. References

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8. Summary

In this paper observations are summarized, dealing with the occurrence, movements and part of the life-history of the cetaceans *Tursiops truncatus* (the bottlenosed dolphin) and *Phocoena phocoena* (the harbour porpoise or common porpoise). The observations were made in the neighbourhood of Den Helder, Holland, chiefly in the years 1933-1938 and later. The value of the paper lies in the relatively great number of in itself little important facts.

The behaviour of the two species studied is, as far as possible, compared with that of other cetacean species, whereby social behaviour (group formation and other behaviour traits), (vertical and horizontal) jumping, respiration and diving, floating at the water surface, eventual basking, and sleeping, are specially dealt with. The data show how scarce details on several of these behaviour traits are.

The data on the movements of *Tursiops* and *Phocoena* in the course of the year show that observations on annual periodicity in the appearance of the living animals give a picture quite different from that on numbers of animals stranded. In so far *Tursiops* is concerned, there may be a low mortality near Den Helder in spring, when numbers of living *Tursiops* are high; as to *Phocoena* annual periodicity is probably chiefly due to movements towards the coast in spring and movements away from coastal areas in autumn and winter, whereas stranded animals show a maximum in summer, when the animals are chiefly to be found in warm coastal water. - In this part of the paper migrations of cetaceans generally are also shortly dealt with.

The annual periodicity in the presence of Tursiops near Den Helder was in the years involved apparently bound to the periodicity in the occurrence of the Zuiderzee-herring. There was quite probably no connection between the periodicity in the occurrence of Phocoena and that of the Zuiderzee-herring. Apparently, there was a distinct connection between the spring and other seasonal movements of Phocoena and the water temperature or the periodicity of light.

There are indications that Phocoena in the estuarine areas it inhabits may move up and down with the tides, so that they may be found farthest "inland" during high water.

It is probable that the strong decrease of the Tursiops-population in the Marsdiep-area in 1939 took place as a result of the disappearance of the Zuiderzee-herring after the closure of the Zuiderzee. A decrease in the numbers of Tursiops probably brought about by chlorinated organic compounds or other poisons started in 1965 or somewhat later. - Phocoena did not show a decrease as a result of the disappearance of the Zuiderzee-herring in 1939. It did show a general decrease in western Europe around 1946; the cause of this decrease is uncertain. Phocoena showed a strong decrease along the Dutch coast in 1960 or possibly earlier. As in Tursiops it was probably due to poisoning of the coastal waters by chlorinated hydrocarbon compounds, biphenyls or heavy metals, but the decrease of Phocoena probably started somewhat earlier than that of Tursiops.

It is suggested that the increase in the size, motorcraft and numbers of fishing vessels may have contributed to a higher death rate of Phocoena after the war.

Appendices I, II^a and II^b give a full description of all observations on Tursiops and Phocoena which were made.

Details on the food of Tursiops and Phocoena, taken from the literature, are given in Appendix III. Good quantitative data are scarce. It follows from the qualitative data that Tursiops uses many species of fish as food; along the Dutch coast especially herring and Gadus-species are important as prey. The same may be said of Phocoena, but it takes smaller preys.

Appendix IV contains some notes on reproduction and growth of Tursiops and Phocoena. Even now there is no complete certainty as to the age at which Phocoena starts reproduction and on the question whether Phocoena gives birth to a young every year. Reproduction in Tursiops is better known. Apparently, it shows much individual variation. - Differences in time of reproduction, growth and maturity of Phocoena from Canada and the North Sea may be due to climate.

Localities and depth (Maps Figs 1 and 4)

A few words may be added on the area of occurrence of *Phocoena* as studied in this paper.

The localities in which *Phocoena* was observed or accidentally caught by fishermen in and outside the Marsdiep area are mentioned here and there in the text of this paper, especially in Appendices II^a and II^b. They may be found by consulting the names of fairways, channels or localities mentioned on the maps, Fig. 1 and Fig. 4. Since part of the localities mentioned in the text are not given on the maps the following data are added.

Consulting map Fig. 1, the town of Den Helder is situated along the shore between Huisduinen and Nieuwediep, the reader will easily find *Phocoena* in Texelstroom and along the route of Texel ferry between Den Helder harbour and Oudeschild (Texel), in Marsdiep, Helsdeur, Molengat, Westgat and Schulpengat. - The localities Zuidwal, Vangdam (diverting dam) and Kolenplaat are to be found within the Waddensea in the immediate vicinity of Den Helder harbour. Generally speaking, the depth within this area is not more than some 25 metres.

A favourite area for the animals in the western Waddensea in summer is found along Texelstroom northward, Scheurrak, Omdraai, Oude Vlic, Inschot and Blauwe Slenk, mentioned in Fig. 4. Generally speaking, the depth within this area is not more than 20 m or less.

Animals observed (most of them caught) off Camp, Petten, Callantsoog, on the Haaks Gronden, near Noorderhaaks buoy (west of the western entrance to Molengat), in the area of Texel Hole (Diepe Gat), off Westerslag and De Koog (west coast of Texel), off Eyerland or the lighthouse of Texel (north of Texel) and in the North Sea off Terschelling in principle

inhabit the open sea at some distance from shore along the Dutch west coast between Camp (Camperduin), 10 km south of Callantsoog, and the island of Ameland, the fourth Waddensea island from the west. The depth within this area may have a maximum of 30 m.

Finally, not a few animals came from deeper water far from shore between Doggerbank and the Danish west coast: Doggerbank, Blackbank, the neighbourhood of buoys Pitt 8, Elbe-Texel 1, Elbe-Texel 4, Borkum stones and Amrumbank buoy. The depth within this area may be 40 m and more. Since the nets used by the fishermen were always bottom trawls (this holds for all catches cited) it may be probable that the animals, when caught, were seeking their prey near the bottom. The possibility exists, however, that they may also have entered the net during hauling, somewhere between bottom and surface.

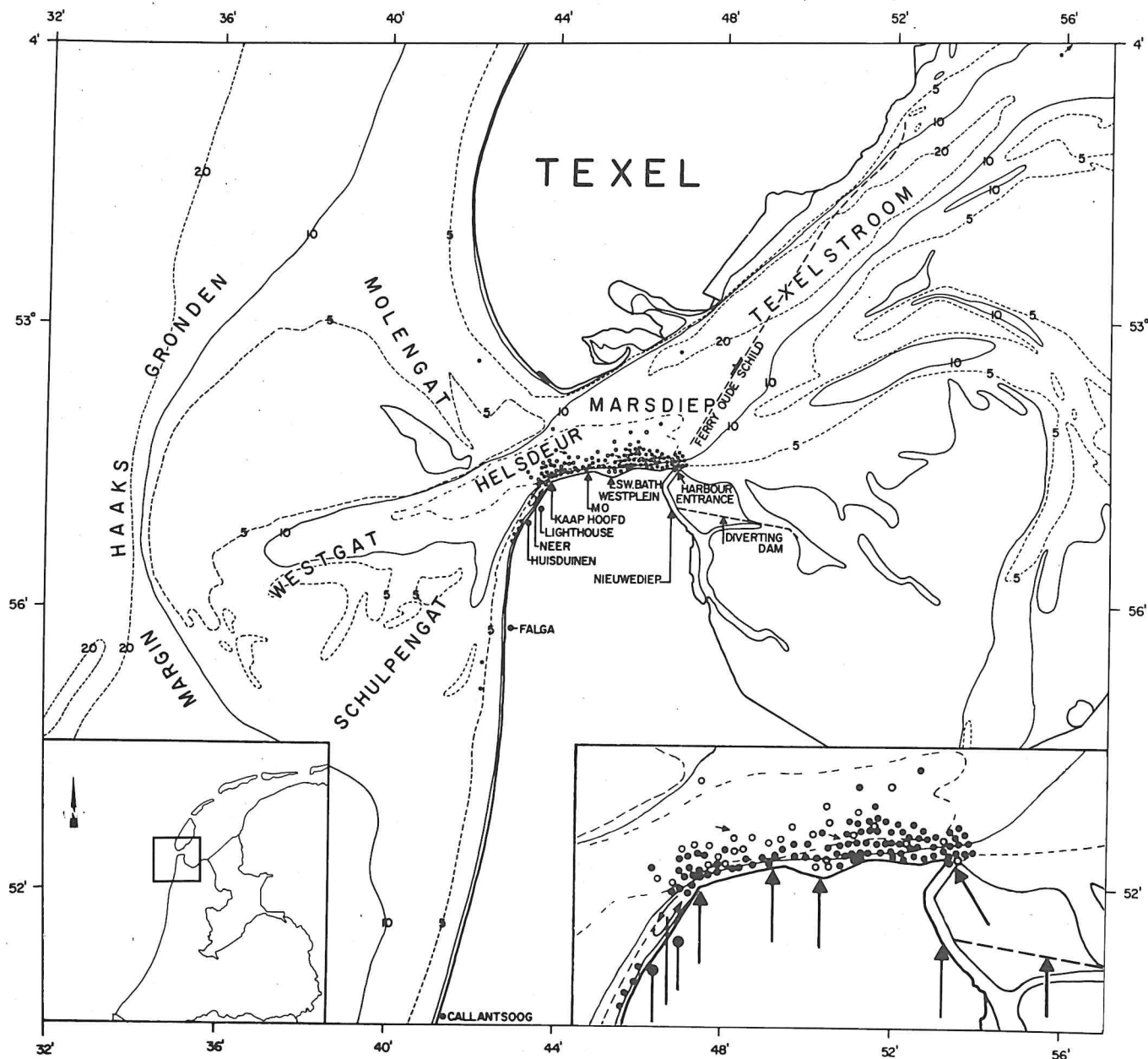


Fig. 1. Map Marsdiep with harbour entrance, swimming bath, meteorological observatory MO, Kaap Hoofd, lighthouse and village of Huisduinen, etc. Open circles denote places where troops of at least 10 (up to 30) Tursiops were seen, black circles denote places where small troops of Tursiops were seen. Circles do not give the exact localities of observation, they were placed at about the right place, but free from one another, so that their relative density may be judged (see detail). Depths in metres. From Huisduinen southward the coast consists of dunes, from Huisduinen north- and eastward there is a (heavy) dike.

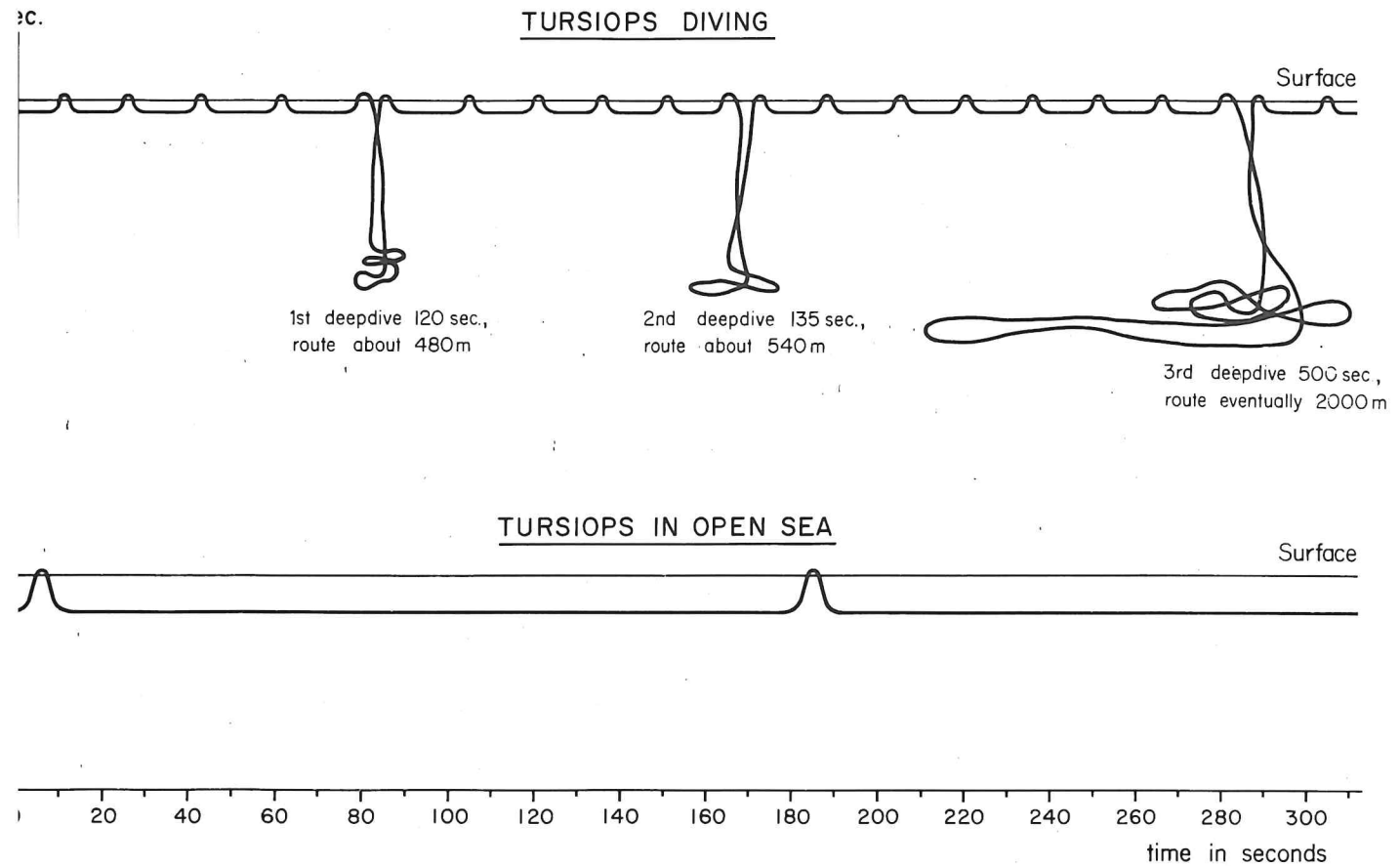


Fig. 2. Above : Diving of feeding Tursiops on March 1, 1936, see text. It has been assumed that the animal swims with a velocity of maximally 7 and on the average some 4 m per second. If the latter velocity would be maintained at its search for fish during the "deep" dives, which take respectively 120, 135 and more than 500 seconds the route under water should have about the length indicated. It may well be, however, that, while searching for fish under water, the animal may slow down at least part of the time.

Below are given surfacings of (probably non-feeding) Tursiops in open sea according to Kükenthal (Parker, 1932).

Seconds are given for the duration of vertical and horizontal movements.

One second is considered to represent 4 m.

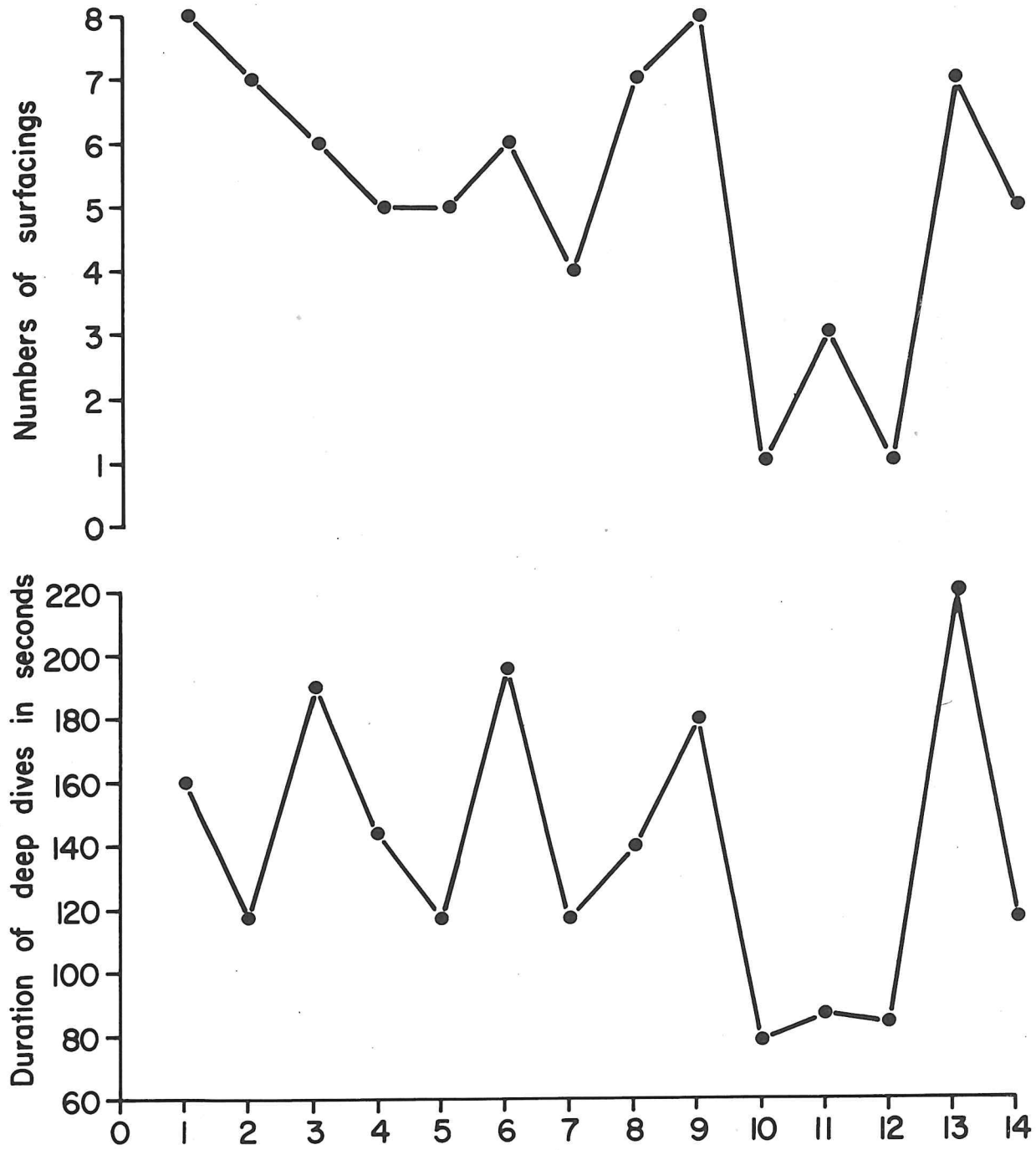


Fig. 3. Number of shallow dives and duration of deep dives of Tursiops on March 14, 1937.

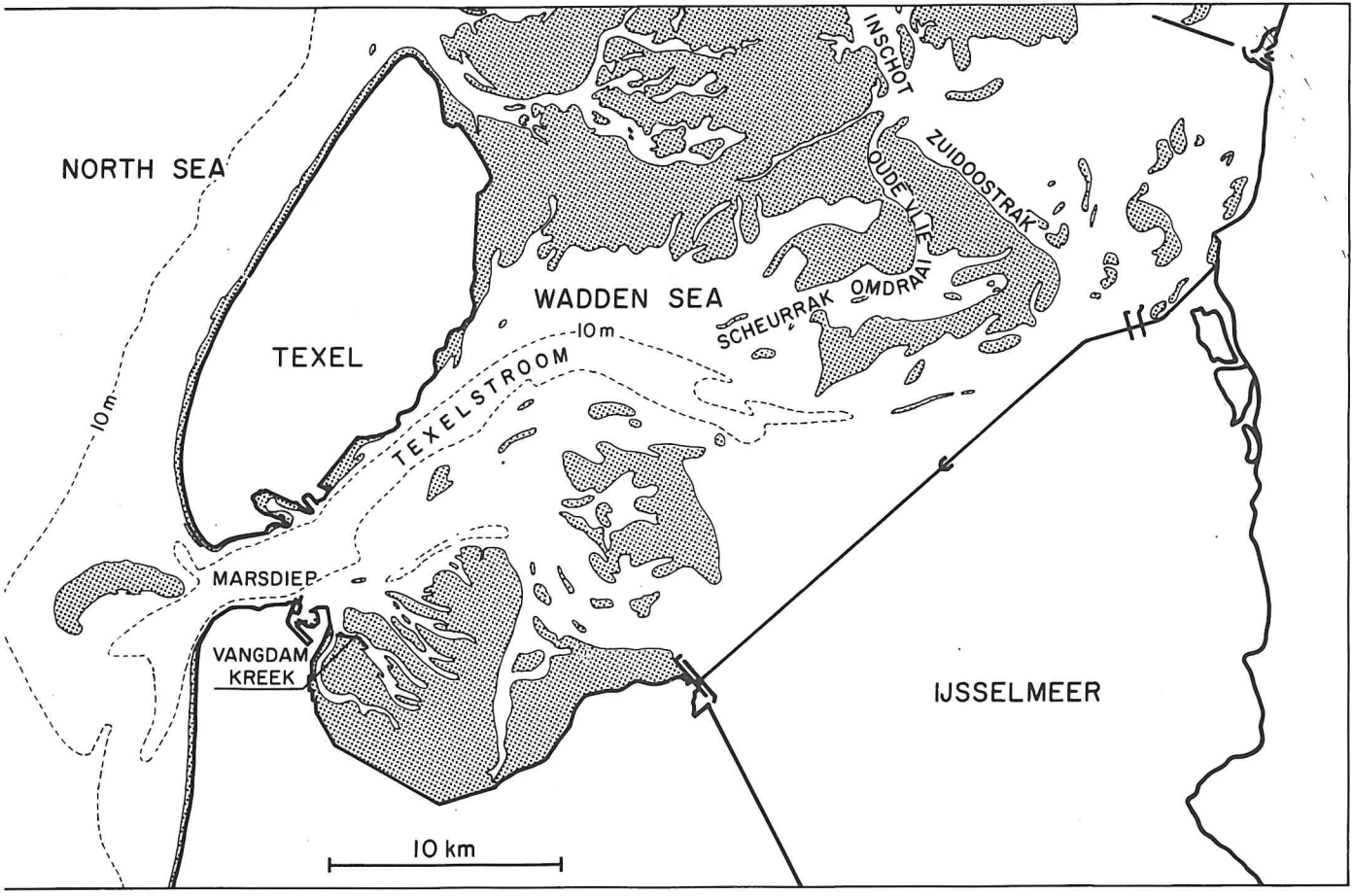


Fig. 4. Map of Wadden sea

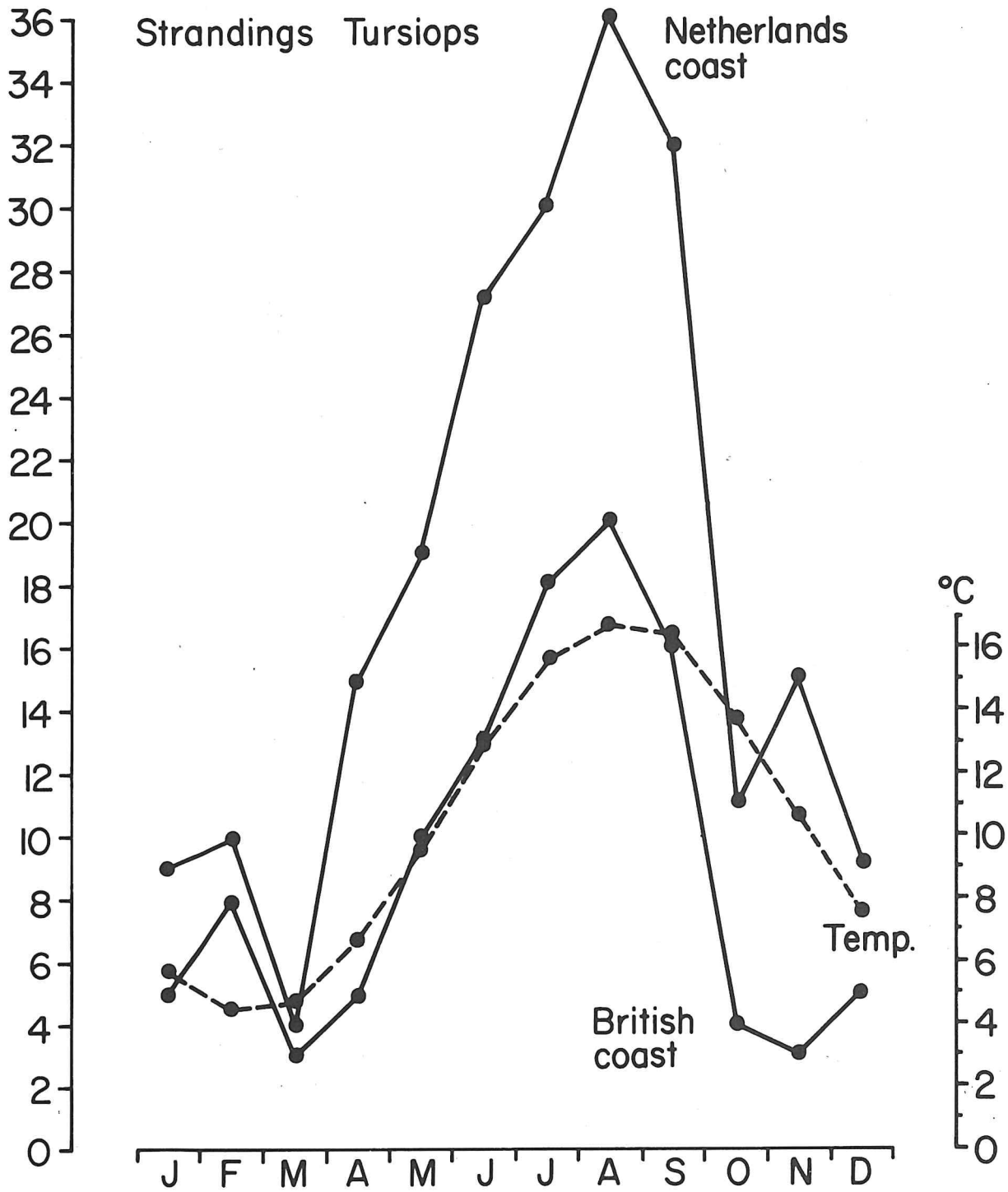


Fig. 5. Monthly totals of British and Dutch stranded Tursiops. Surface water temperature light vessel Haaks near Den Helder, 1890-1909 : monthly averages.

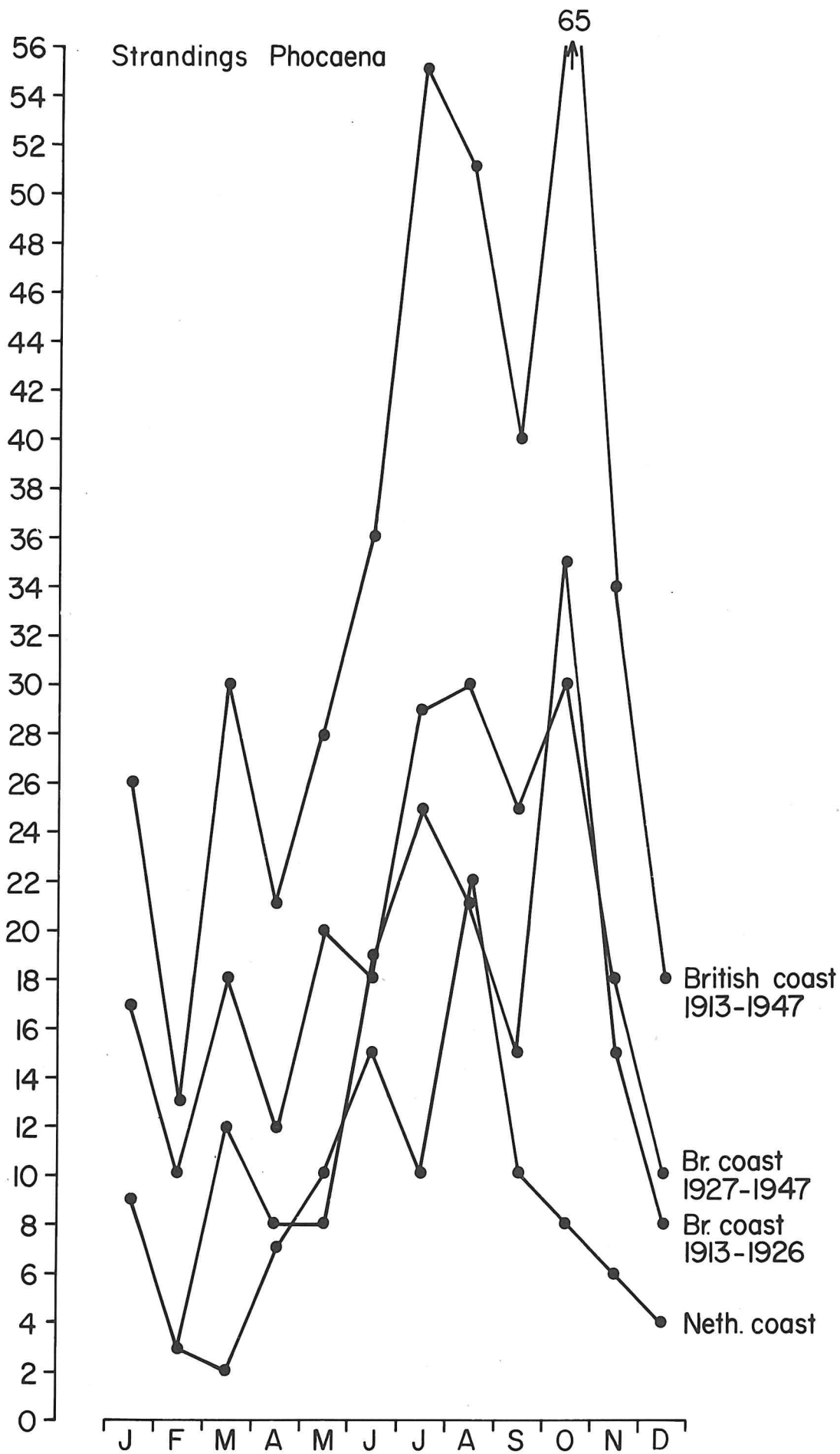


Fig. 6. Monthly totals of British and Dutch stranded *Phocaena*. The British strandings for the years 1913-1926 have been kept separate from those of the years 1927-1947 and from the totals.