DECAPODA AND DECAPOD LARVAE IN THE SURFACE PLANKTON FROM THE SOUTHERN NORTH SEA NEAR "TEXEL" LIGHTSHIP

by

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Introduction

From mid-January 1961 until the end of 1966 macroplankton was collected by the crew of "Texel" lightship (position: 53°01'30"N 04°22' E) and identified afterwards in the Nederlands Instituut voor Onderzoek der Zee, at that time still in Den Helder.

The nets, of Saran gauze with a 2 mm mesh and an opening of 1 m^2, were originally intended for catching elvers, for investigations reported upon by Creutzberg, 1961. The original aim of the present plankton project was to catch Scyphomedusae, but soon after it had been started all the available macroplankton was sorted out and, if possible, identified. This explains why the decapod larvae, dealt with in the present paper, came to be collected by nets, quite unfit for that purpose. When the meshes are open, most of the smaller larvae can pass through, but when they are blocked, e.g. by algae or, as happens to be the case in midsummer, by enormous quantities of echinoderm larvae, then great quantities of smaller organisms may suddenly turn up in the catches. Therefore the number of larvae caught does not give a reliable picture of the numbers actually present in the plankton.

The postlarval and the later stages of the Natantia have been identified by the second author (H.). The identification of the adult Reptantia has also been checked by him. The larvae of the Reptantia have been identified by the third author (S.). The identification is based on the keys and descriptions as given by Lebour (1928, 1943, 1944) and by MacDonald, Pike & Williamson (1957).

For the data on occurrence of *Pandalus* and various other species in the fishing area near Den Helder we are much indebted to Mr. P. Boer, who kept the records of the species, brought to the N.I.O.Z. by fishermen.

The abbreviation N.I.O.Z. is used here for Nederlands Instituut voor Onderzoek der Zee (Netherlands Institute for Sea Research).

List of species, collected at "Texel" Lightship

The indication x is given in the last column if only larvae have been observed.

Natantia		
Hippolytidae	*Hippolyte* sp. (mostly or exclusively *H. varians* Leach)	
	Thoralus cranchii (Leach)	
Processidae:	*Processa parva* Holthuis	
Pandalidae:	*Pandalus montagui* Leach	
Crangonidae:	*Pontophilus* sp. (mostly or exclusively *P. trispinosus* Hailstone)	
	Crangon crangon (L.)	
	Crangon allmanni Kinahan	
Reptantia		
Anomura		
Galatheidae:	*Galathea* sp.	x
Porcellanidae:	*Pisidia longicornis* (L.)	
Paguridae:	*Pagurus bernhardus* (L.)	x
Brachyura		
Corystidae:	*Corystes cassivelaunus* (Pennant)	x
Thiidae:	*Thia scutellata* (Fabricius)	x
Cancridae:	*Cancer pagurus* L.	x
Portunidae:	*Carcinus maenas* (L.)	x
	Portumnus latipes (Pennant)	x
	Macropipus pusillus (Leach)	
	Macropipus holsatus (Fabricius)	
Xanthidae:	*Pilumnus hirtellus* (L.)	x
Pinnotheridae:	*Pinnotheres pisum* (L.)	
Majidae:	*Inachus dorsettensis* (Pennant)	x
	Macropodia tenuirostris (Leach)	
	Macropodia rostrata (L.)	
	Hyas araneus (L.)	

Discussion of species

Natantia

Hippolyte varians Leach, 1814

As far as could be ascertained all *Hippolyte* specimens obtained at the lightship belonged to the species *Hippolyte varians* Leach, although the younger larval stages could not be identified with complete certainty. The following specimens, all being young postlarval stages, occurred:

in 1961/62 between 6 August and 7 January;
in 1962 on 15 July only;
in 1963 between 28 August and 30 November;

in 1964/65 between 5 November and 9 January;
in 1965/66 between 8 June and 4 January;
in 1966 between 24 May and 9 June.

The specimens were taken in water with a wide range of temperature. The lowest temperature was 5.3° and the highest 17.3° C. The salinity of the water in which *Hippolyte* was taken varied between 28.37 and 35.03‰.

The numbers of specimens taken are low, the largest catch consisting of only four specimens. Of the 34 samples containing *Hippolyte* 12 came from flood- and 22 from ebb-hauls, while 3 of the hauls were taken during the daytime, 7 hauls during part of the night and 24 at night. In all only fifty specimens were caught.

In additional hauls made from the research vessel "Ephyra", in the same area, the species occurred only occasionally. One postlarva was then collected at 23 metres depth on 4 July 1966 and 4 adults on 21 and 22 September 1966, one at 10 m, the other three at 23 m.

The species, which is found in the eastern Atlantic from the Norwegian coast south to southern Spain, is mainly a form from coastal waters, where it lives among seaweeds. Perhaps that is why it is not common in the lightship catches. Rees (1954), in his investigations on North Sea plankton, did not find it common either: in the period 1947-49 he obtained only 45 specimens. Hamond (1971) reported it from the Norfolk coast as being frequent on moderately rough ground.

Thoralus cranchii (Leach, 1817)

This species was only taken twice, one postlarva in the evening flood haul on 17 October 1962, temperature 14.4° C, salinity 34.92‰, and one postlarva in the flood haul in the night of 8/9 June 1965, temperature 11.1° C, salinity 33.66‰.

Thoralus cranchii seems to be rare in this area. Holthuis & Heerebout (1961) mentioned seven finds from the Dutch province of Zeeland. Rees (1954) dit not mention it at all. Off Yarmouth it largely coincides with the previous species, but it is much scarcer (Hamond, 1971). It is known to occur throughout the North Sea, and in the eastern Atlantic from southern Norway to the Gulf of Guinea and the Mediterranean.

Processa parva Holthuis, 1951

A common and comparatively numerous species, especially when it is taken into account that only the post-larval and later stages were counted, as they could be identified with certainty. It was found:
in 1961 between 20 July and 18 December;

in 1962 between 12 August and 28 November;
in 1963 it was not found at all;
in 1964 between 31 July and 22 December;
in 1965/66 between 12 August and 15 February;
in 1966 between 19 July and 28 December (end of the investigations).

The peak of occurrence in 1961 was found around 12 and 13 September; in 1962 it fell early in November; in 1964 the numbers were always low so that no peak was discernible; in 1965 the peak occurred September/October; in 1966 there was a peak at the end of August.

Peak numbers mean some 60 to 70 specimens in one haul, the average haul lasting some 4 to 5 hours. In 1965 the largest catches contained some 30 specimens, postlarval stages. The usual number per catch was 1 to 10 identified specimens. As stated above the actual numbers may have been much higher.

The temperature of the water in which *Processa* was taken varied between 6.5 and 17.9° C, according to the season. The salinity lay between 28.37 and 35.31‰, but most samples had a salinity between 34 and 35‰.

Of the 140 hauls in which the species was found, 72 were made by flood and 68 by ebb, while 14 were made during the day and the rest partly or completely in the dark hours.

The absence of *Processa parva* in 1963 may be due to the abnormally low temperatures in the beginning of that year, when the temperature of the surface water around the lightship fell to below 0° C.

In January, April, July and September 1966 hauls were made near "Texel" lightship from the research vessel "Ephyra" of the N.I.O.Z. In January a few specimens of *Processa parva* were found in hauls just over the bottom. In September it was rather numerous at depths of 10 and 23 metres, especially at the latter depth.

Larvae of other *Processa* species were not found.

In the paper by Rees (1954) the present species is mentioned as *Processa aequimana* Paulson. Although Rees found it the most numerous of the *Processa* species collected with the continuous plankton sampler, its numbers were much lower than in our present lightship hauls (7 in 1947, 29 in 1948, 14 in 1949). Rees' specimens occurred from June to November, the greatest number being obtained in August (Rees, 1954: 166). For 1950 and 1951 the numbers were 8 and 15 respectively (Rees, 1959).

In the paper by Nouvel & Holthuis (1957), most of the Dutch records of *Processa parva* are those of specimens taken from fish stomachs, especially of rays. To these finds are now added a substantial number of records from the open sea off the Dutch coast.

The range of the species extends from the North Sea southward to West Africa (Gabon) and the eastern Mediterranean (Turkey).

Pandalus montagui Leach, 1814

Not a common species in our catches. One postlarva was caught in the night of 1-2 July 1965 and fourteen more were caught in May 1966; of these ten came from one haul on 24 May and the other four from three hauls during the following day.

The temperatures at which the specimens were caught varied between 11.1 and 14.8° C, the salinities between 33.60 and 34.63‰. Out of a total of over 5000 hauls, made during the entire project, only 5 yielded postlarvae of this species. Of these 5 hauls 3 were made during flood and 2 during ebb; 1 was made by daylight and the rest either partly or completely at night.

In the summer the adults are found in coastal waters. According to Holthuis (1950) the species occurs all along the Dutch coast and ovigerous females are recorded here in February and March. The larvae hatch in deeper water, farther away from the coast. Rees (1954), in reporting on the results of continuous plankton records for decapod larvae in the North Sea, also mentioned the larvae of *P. montagui* as being uncommon. Hamond (1971) called it "an exclusively offshore species".

During every shrimping season fishermen used to bring specimens of *Pandalus montagui* to the N.I.O.Z. These specimens were caught in the area between Den Helder and the open sea and off Texel between November and June, but mainly in March and April. Ovigerous females were received as early as January, but never after about the middle of April. No definite conclusions can be drawn from these data since these specimens of *Pandalus* are only brought in (a) during the shrimping season, (b) when shrimps fetch a big enough price in the market to make shrimping profitable and (c) by those fishermen who are sufficiently knowledgeable to distinguish these shrimps and sufficiently interested to bring them to the Institute. Still, the evidence provided corraborates the data given by Mistakidis (1957) who found that the greater part of the local population of *Pandalus montagui* of the Thames estuary left the estuarine area in November to hatch its eggs in the open sea. The same might be true for the (much scarcer) population of *P. montagui* off the Dutch coast.

Mistakidis found that in the Wash area (east coast of England) the migration of *Pandalus montagui* is less evident. Here the deeper waters are nearer to the coast than in the Thames estuary. As has been pointed out previously for mysids (1971), wherever animals migrate in the winter

from shallower coastal waters to deeper offshore waters the migration will be more evident the longer the distance is that has to be covered to reach the deep waters.

Pandalus montagui is a boreal species, its range in the eastern Atlantic reaches from the Arctic Sea to the southern North Sea.

Pontophilus trispinosus Hailstone, 1835

The majority of the specimens of *Pontophilus* collected belongs to the postlarval stages of the species *Pontophilus trispinosus*. Some specimens of *Pontophilus bispinosus* (Hailstone, 1835) may have occurred in the samples. Therefore we prefer to use the name *Pontophilus* sp., with the explicit statement that most of them belonged to the species *P. trispinosus*.

In 1961/62 *Pontophilus* sp. occurred between 19 July and 7 January with a peak (hauls of 20 to 30 specimens) on 20-21 September and again on 19 and 20 October. In 1962 it occurred from 17 October to 4 December, with a peak (30 to 50 specimens per haul) from 1 to 5 November. After that it did not turn up before 1965, when 1 specimen was caught on 1 September and another one on 4 November. If, as might be the case with e.g. *Processa parva,* this was due to the severe cold spell early in 1963, its effects lasted longer here than with some other species. In 1966 *Pontophilus* was again absent. It is true that the fishing programme was much restricted in that year, but this did not seriously affect the numbers obtained of the other species.

In the N.I.O.Z. lists are kept of the stomach contents of fishes taken in the area near Den Helder. These lists comprise both *P. bispinosus* and *P. trispinosus*. The records always date from the winter months, since most of them are from rays, which are only fished for in the winter. Besides there are some other records of *P. trispinosus,* caught separately, also in the winter.

According to Rees (1954), postlarvae of *Pontophilus trispinosus* were found to be uncommon in the catches of the continuous plankton recorder, but larvae of *P. bispinosus* were of wide-spread occurrence.

In the 1966 "Ephyra" hauls larvae of *Pontophilus trispinosus* were found at the surface only in September. In the other three cruises as well as in September the species was found in hauls at a depth of 10 m and just over the bottom. Therefore its absence in the surface hauls of 1966 at the lightship is only accidental and does not reflect the true situation.

Pontophilus trispinosus is known from the North Sea southwards to the Azores and the Mediterranean, while *P. bispinosus* has about the same range, but is found as far north as the Lofoten.

Crangon crangon (Linnaeus, 1758) and **Crangon allmanni** Kinahan, 1857

For the occurrence of immature and adult *Crangon crangon* of a size of 7 mm and over we refer to a paper to be published by Van der Baan on migration of *Crangon crangon*. Specimens of *Crangon allmanni* of that size were only found in the "Ephyra" bottom hauls, one haul on 28 April 1966, two at a depth of 23 m on 4 and 5 July 1966 and one haul at 23 m on 21 September 1966.

In the surface plankton near the lightship no adult or postlarval specimens of *Crangon allmanni* were found. No attempt was made to identify the *Crangon* larvae further than the genus, on account of the great quantities in which they often occurred and which made it even impossible to sort them out of the plankton sample in a satisfactory way.

Crangon larvae occurred in the surface plankton every year, from about April to November, with the highest numbers in the summer. Rees (1954) found many *Crangon* larvae in the samples collected by the continuous plankton recorder at a depth of 10 m off the Dutch coast in January 1948. Bottom hauls taken from the "Ephyra" suggest that the larvae may be far more numerous deeper down in the sea than at the surface. From the data at our disposition nothing definite can be stated.

Crangon crangon occurs along the entire west coast of Europe and southward into the Mediterranean and the Black Sea. It has been reported from the Arctic and the Baltic. *Crangon allmanni* is known from S. W. Norway to the Bay of Biscay.

Reptantia

The occurrence of the larvae of more or less common species has been plotted in diagrams, divided in quantities of less than 10 specimens per haul, 10-100 specimens, 100-1000 specimens and over a thousand specimens (fig. 1). It has already been stated in the introduction that the type of net used was mainly intended for organisms other than larvae and that the numbers cannot be compared with catches obtained by other fishing methods. We think, however, that the general trend of occurrence, represented in this way, is sufficiently reliable. Since practically nothing is known about the distribution of decapod larvae off the Dutch coast, even the present scanty information seems worth publishing, if only to stimulate a more thorough research on the subject.

Galathea sp.

One larva, not identifiable beyond the genus was found in a night haul

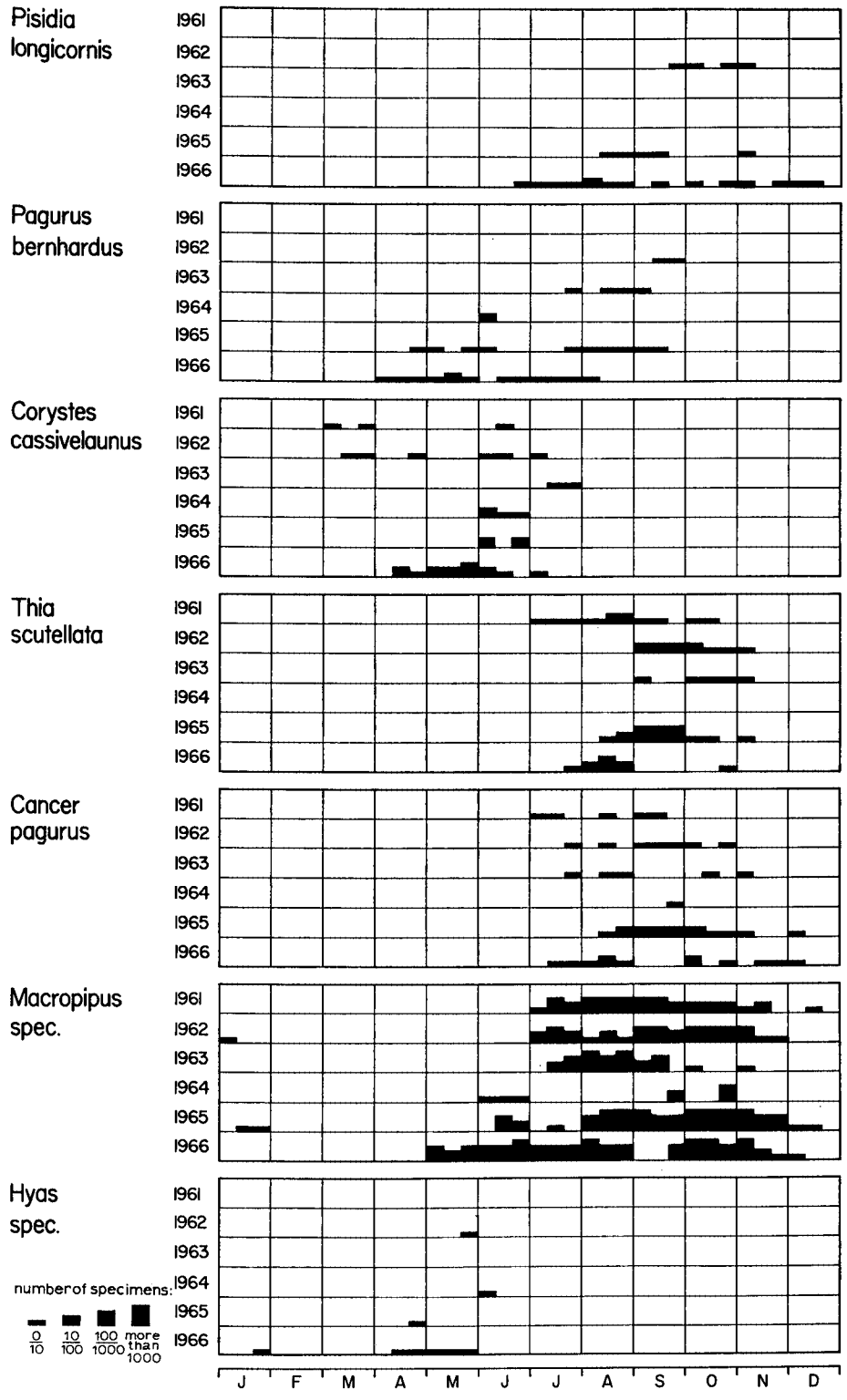

Fig. 1. Occurrence of Reptantia larvae near "Texel" lightship.

on 12 to 13 December 1965, temperature 7.4° C, salinity 35.12‰. Rees (1954, 1959) mentioned four species of *Galathea,* all in more northernly positions than our location.

Pisidia longicornis (Linnaeus, 1767)

Small numbers of megalopa larvae were found in 1962, 1965 and 1966. In a depth haul from the "Ephyra" one zoea was caught on 22 September 1966. To these finds must be added one crab on 8 July 1961 and a young crab in a haul in 6/7 November 1962.

Rees (1954, 1959) found the larvae almost completely restricted to British coastal waters, with a maximum in August. Lebour (1947) also found them commonest in the summer. Our data suggest that the possibility of catching *Pisidia* larvae is greatest in the late summer and autumn (fig. 1), which tallies with the statement by Hamond (1971) that in 1965 larvae were unusually abundant in (bottom) plankton off Norfolk in August, September and October. According to Wolff & Sandee (1971) the species is fairly common in the Delta area. *Pisidia longicornis* inhabits the eastern Atlantic from Norway to Angola, and is also found in the Mediterranean.

Pagurus bernhardus (Linnaeus, 1758)

In the catches made from "Texel" lightship between 1962 and 1966 the larvae of *Pagurus* became more and more numerous and occurred over longer periods (fig. 1). Rees (1959) observed in his second publication on decapod larvae in the North Sea, dealing with the period 1950-1951, that *Pagurus* larvae were much less numerous than in the period 1947-1949 (Rees, 1954). Evidently the numbers of *Pagurus* larvae in the North Sea fluctuate greatly from one year to another. Rees found them most common at the Doggers Bank. He found two main hatching periods, one in April/ May and another one in the winter months (Rees, 1954: 172). Thorson (1946) found the larval season to extend from late March to late October, and Jackson (1913) indicated as such the period from April to the end of September. Our data, especially those for the most productive years, agree best with Jackson's finds (fig. 1).

Pagurus bernhardus is known from Norway and Iceland south to the Atlantic coast of Spain and Portugal.

Corystes cassivelaunus (Pennant, 1777)

The larvae of this species became more numerous in the course of the years 1961 to 1966, especially so in 1965 and 1966 (fig. 1). Rees found the main concentrations at the western side of the North Sea, particularly off

the Humber, with a peak from April to the end of June. There are also differences in the catch from one year to another, and their period of occurrence shifted (Rees, 1954).

Corystes cassivelaunus is a rather common species in the southern North Sea and is frequently found in Dutch waters. Its range extends from southern Norway into the Mediterranean.

Thia scutellata (Fabricius, 1793)

The occurrence of the larvae in the surface plankton is given in fig. 1. In 1963 they were less numerous than usual — it had been an extremely cold winter — and in 1964 they were not found at all. This may be partly due to the fact that in the summer of 1964 the smallest animals in the plankton samples were often in a very poor state of preservation, owing to large quantities of algae or half decayed echinoderm larvae, which interfered with the sampling. Anyhow, there cannot have been many *Thia* larvae in that year.

It is sometimes assumed that, off the Dutch coast, the occurrence of a species fluctuates from one year — or rather a series of years — to another. There are several possible causes for this supposed phenomenon, such as changes in temperature or a greater or lesser influx of Channel water, and in the latter case we may think of the direct transport of larvae as well as of better conditions for reproduction. However, as far as we know, no experiments to this effect have been carried out, and neither has any scheme of sampling ever been undertaken with the aim to check this hypothesis. Practically all data at our disposal are incidental finds, or the by-product of sampling cruises intended for other animal groups, and therefore not a good basis for definite conclusions.

Still, there emerges a fluctuating pattern of distribution. Interesting in this respect is a project with a Van Veen grab carried out in 1964-1967 off the Dutch coast, mainly to collect living molluscs (Eisma, 1966), during which several specimens of *Thia scutellata* were obtained. The area covered by the cruises undertaken under this project is shown in fig. 2. The greater part of this sampling operation coincides in time with our macroplankton investigations.

In 1964 Eisma (N.I.O.Z.) sampled from Hoek van Holland to the island of Ameland and did not find any *Thia scutellata,* although the sand collected in the sampler was searched very thoroughly and any object, not only molluscs, was collected.

In 1965 transverses off the English coast were made. One specimen was found on the Brown Bank.

In July 1966, in collaboration with the Delta Institute, the area off the province of Zeeland was studied. This yielded 10 specimens of *Thia scutellata,* carapace size: 6, 7, 7.6, 9, 11, 13, 14, 15 and 16 mm respectively. In 1967 the sampling area extended from Hoek van Holland to the island of Terschelling. Three specimens were obtained, one off Goeree, the others farther away from the Dutch coast.

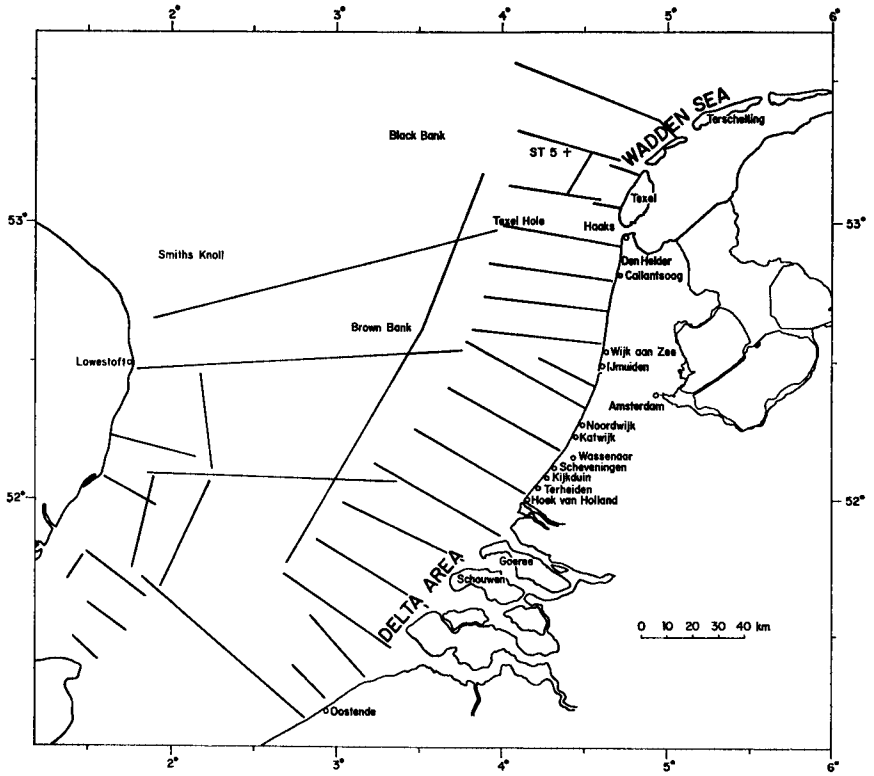

Fig. 2. Map showing the localities mentioned in table 1, and the area covered by the cruises mentioned on pp. 84-87.

It seems likely that in the northern part of the sea off the provinces North Holland and Zeeland *Thia scutellata* was too scarce to be found easily by sampling with a Van Veen grab. Of course we cannot say with certainty that it was lacking altogether in the area during the period of Eisma's cruises; for one thing we do not know whether the Van Veen grab is the most suitable gear to obtain this species. Before 1964, as late as in 1962, *Thia scutellata* was collected from time to time by fishermen from Den Helder, operating in the North Sea just off North Holland (see table 1).

Table 1. Finds of *Thia scutellata* (Fabr.) in Dutch waters

1877		51°58'N 3°38'E, Schouwenbank, 13 fathoms	1	spec.	Hoek, 1887: 94
1904	27/9	53°12'N 3°41'E	?	spec.	Tesch 1909
1905	9/8	52°54'N 2°36'E	?	„	„
1907	1907	52°04'N 2°41'E	?	„	„
	19/7	52°36'N 2°45'E	?	„	„
		(in *Gadus merlangus L.*)			
1928	/3	Scheveningen	1	„	C.S.
1936	16/2	North of Scheveningen	1	„	„
1938	6/3	Wijk aan Zee	1	„	„
1939	1/4	Hoek van Holland, North pier	1	„	„
	/2	Wijk aan Zee	1	„	D.L.N. 43: 124
1940	31/1	Kijkduin-Terheijde	23	„	C.S.
	10/3	Scheveningen-Groene Huis	6	„	R.M.N.H.
	31/1	Between beach markers 108 and 111 (S. of Scheveningen)	8	„	„
	1/4	Kijkduin-Terheide	15	„	C.S.
	7/4	South of Kijkduin	246	„	„
	7/4	South of Kijkduin	18	„	„
	31/3-8/4	Kijkduin-Terheijde	30	„	R.M.N.H.
	8/4	Kijkduin-Terheijde	11	„	C.S.
	28/4	Katwijk-Wassenaar, dredge	1	„	„
1941	5/4	Terheijde-Kijkduin	7	„	R.M.N.H.
1942	29/3	North of Scheveningen	1	„	C.S.
1946	13/6	Texel Hole, in *Galeorhinus galeus* (L.)	1	„	N.I.O.Z.
1947	3/3	Texel Hole, in *Pleuronectes platessa* L.	1	„	„
	winter	Texel	2	„	C.S.
	11/4	Beach marker 99 (Scheveningen N.), carapace washed ashore	1	„	„
1952	1/8	ST 5, 18 fathoms, in *Raia clavata* L.	1	„	N.I.O.Z.
	9/11	Hoek van Holland	1	„	C.S.
1953	1/2	Scheveningen, after a gale	100	„	„
	2/2	Katwijk	1	„	R.M.N.H.
	6/2	Wassenaarse Slag	20	„	„
	6/2-8/2	North of Scheveningen	many	„	„
	7/2	Between beach markers 86 and 87 (Katwijk)	19	„	„
	8/2	Between beach markers 81 and 82 (Noordwijk)	13	„	„
	14-15/2	North of Scheveningen	50	„	„
	17/2	Katwijk-Noordwijk, carapaces	30	„	„
	19/2	North of Scheveningen	6	„	„
1954	10/3	Katwijk	1	„	„
	12/3	South of Scheveningen, 6 carapaces, 1 animal	7	„	C.S.
1955	22/5	Scheveningen-Hoek van Holland, fished	1	„	B. Entrop 1956
	23/5	Scheveningen-Hoek van Holland, fished	1	„	„
1956	29/2	Scheveningen-Hoek van Holland, caught after a breeze 30♀♀, 9♂♂	39	„	„
1956	8/3	Noordwijk, 12 fathoms 7♀♀, 3♂♂	10	„	B. Entrop 1956
1959	19/1	Terschelling, beach marker 19	1	„	C.S.
1960	/1	South of Scheveningen	2	„	R.M.N.H.
	23/2	Callantsoog, 50 feet	12	„	N.I.O.Z.
	23/2	Haaks, 9 fathoms	8	„	„
1961	/5	Brouwershavense Gat (N. of Schouwen)	1	„	R.M.N.H.
1962	20/3	Molengat, 5 fathoms (S. W. of Texel)	4	„	„

	24/3	off Texel, 6 fathoms	2	„	„
1963	14/1	50 miles W of Scheveningen	1	„	Delta
	1/3	25 miles W of Schouwen	1	„	„
	25/3	50 miles off Goeree	1	„	„
	8/4	22 miles W of Schouwen	1	„	„
1965	4/9	8 miles W of Brown Bank, 32 m	1	„	N.I.O.Z.
1966	1-2/7	off Zeeland	10	„	Delta
1967	/3	22 miles off Goeree	1	„	N.I.O.Z.
	7/9	5 miles North of Brown Bank	1	„	„
	4-8/9	7 miles East of Smith's Knoll	1	„	„
	17/11	Black Bank, 80-85 feet, in stomach of *Raia montagui* Fowler	1	„	„
1969	7/2	53°50'N 3°20'E, 20-24 fathoms, in stomach of *Raia montagui* Fowler	1	„	„
1970	25/3	½ mile N.W. outer buoy Molengat, 15 m depth	1	„	„
		1 mile N.W. outer buoy Westgat, 15 m depth	1	„	„
		In August 1970 it was very common in the ET route off Texel at depths of 20 and 24 m, up to 5 spec. per m^2. (N.I.O.Z.)			

C.S. means: Central File of Records (by members of a seashore naturalists' club).
D.L.N.: De Levende Natuur.
R.M.N.H.: Rijks Museum Natuurlijke Historie.
Delta: Records from the Delta Institute, Yerseke.
The N.I.O.Z. finds are derived from a research of stomach contents of fishes, or they are incidental finds and observatons during cruises.

In the spring of 1970 another N.I.O.Z. sampling scheme, covering the area between the Haaks Grounds and the Eyerlandse Gat (N.E. of Texel) revealed the occurrence of *Thia scutellata* at depths below 15 m in densities of sometimes as many as 5 per square meter. The samples were collected with the same Van Veen grab as used by Eisma; it was operated in depths as far down as 25 m at the utmost (Beukema, personal communication), Wolff & Sandee (1971) found it at depths below 25 m. They connect the occurrence of the species with the presence of Channel water of high salinity and low turbidity.

All the data concerning the occurrence of *Thia scutellata*, known at the N.I.O.Z., have been collected in table 1. They comprise animals collected by fishermen, specimens washed ashore on the beach and collected by a very active group of young marine naturalists, specimens present in the Rijksmuseum van Natuurlijke Historie, Leiden, specimens mentioned in various periodicals, and finally those specimens collected by the N.I.O.Z., including those from the stomach contents of fishes.

It appears from these data that, with one exeption (9/11, 1952) specimens washed ashore have only been found in the winter and early spring. The hypothesis that (as far as the rather shallow North Sea off the Dutch

coast is concerned) *Thia scutellata* suffers a severe mortality in extremely cold winters or after extremely heavy gales and that it consolidates its population over a period of mild winters, expanding from survivors in the deeper water, might well repay a closer investigation, but it is not proved by the above data (see *Macropipus puber*).

As megalopae occurred regularly in surface waters it may be doubted, at least as far as *Thia* is concerned, whether the conclusion of Atkins (1954) about the dispostion of the pereiopods as an indicator for the duration of the pelagic stage is correct.

Thia scutellata has been reported from Sweden (Gullmarfjord), the North Sea coast of Germany and the Netherlands, the Atlantic coast of Ireland, Great Britain and France, from some places on the western coast of Africa and from the Mediterranean.

Cancer pagurus Linnaeus, 1758

It appears from fig. 1 that the caught numbers of the larvae of *Cancer pagurus* increased during the period of the investigations (1961-1966), notwithstanding the fact that the fishing schedule was reduced twice, once at the end of 1962 and again for 1966. It is remarkable that hardly any zoeae were found, although their size would be sufficient to be included in the catch of a net of 2 mm mesh. Wolff & Sandee (1971) found that off the province of Zeeland the adults were mainly concentrated at the entrances of the estuaries, so perhaps the younger stages are more numerous in coastal waters.

According to Rees (1954) larvae of this species are common in the North Sea, except for the Southern Bight.

Cancer pagurus is a common species in the southern North Sea, including Dutch waters. Its range extends from N.W. Norway southwards into the Mediterranean.

Carcinus maenas (Linnaeus, 1758)

Larvae of this species were only occasionally found. The species seems to be restricted to inshore waters, also in the larval stages. Two megalopae were found, one on 3 September 1965, and one on 1 October of the same year.

Carcinus maenas is a very common species along the Dutch shores. It is found in shallow water and in the tidal area of the entire North Sea coast and in the estuarine areas. In the eastern Atlantic its range extends from N.W. Norway to N.W. Africa. It is also found in N.E. America and in a few other places, where it was introduced.

Portumnus latipes (Pennant, 1777)

Of this formerly so common crab only one megalopa was found: on 21 October 1965. In 1967 and 1968 Wolff commented on the possible disappearance of this crab from Dutch coastal waters. He gave as the last find of the species in Dutch waters the one recorded by the N.I.O.Z., viz: one on 19 February 1962 near the Noorderhaaks. The record of a species found in September 1965, which he also mentioned, is erroneous, due to a confusion in the N.I.O.Z. records, it pertains to *Macropipus pusillus* (c.f. Wolff, 1967, 1968).

Wolff (1967, 1968, 1971) suggested that the specimens found on the Dutch coast may be migrants from the Channel or elsewhere, which cannot maintain a permanent extension of their northern boundary. It seems more likely, since the North Sea forms the northern limit of the range of the species, that the present disappearance is just due to a normal fluctuation in the size of the area occupied by the species. Its former occurrence in Dutch coastal waters had all the characteristics of a settled population and not of a number of immigrant stragglers.

Portumnus latipes is known from the Mediterranean, the Black Sea and the Atlantic coast of Europe, where its range extends as far north as the Dutch and German North Sea coast and along the British Isles as far as Scotland.

Macropipus diverse species

For identification of the larvae of this genus Lebour (1928) used mainly colour characteristics. Since our animals were preserved, first in formalin on the lightship, and afterwards in alcohol, the colour had disappeared in all but the freshest specimens. Rees (1954) found that the reproduction periods of three species overlap. Still, we feel quite sure that the great majority of our larvae belong to the species *Macropipus holsatus,* because (a) in our area that is by far the most numerous species, (b) a gradual transition through all the stages from zoea to adult crab could be observed in the plankton samples.

Five species of *Macropipus* are regularly or occasionally brought in at the N.I.O.Z. by fishermen who catch them in the area near Den Helder. The numbers below are taken from the N.I.O.Z. records and show the adults of these species, brought in during the years of our plankton research at "Texel" lightship, 1961-1966.

		1961	1962	1963	1964	1965	1966
Macropipus holsatus (Fabricius, 1798)		many thousands					
„	*puber* (Linnaeus, 1758)	18	12	—	—	—	—
„	*depurator* (Linnaeus, 1758)	—	—	12	77	2	—
„	*marmoreus* (Leach, 1816)	—	1	—	—	—	—
„	*pusillus* (Leach, 1816)	—	—	—	—	—	—

In the plankton hauls too some thousands adults of *Macropipus* were caught, all belonging to the species *Macropipus holsatus,* except for one *Macropipus pusillus,* which was caught in a night haul on 7/8 September 1965, temperature 15.9° C, salinity 35.03‰. In the same year five post-larval specimens of *Macropipus pusillus* were caught in the plankton: on 14, 20 and 24 August and on 10 and 29 September respectively; 1965 evidently being an exceptional year for this species.

Macropipus pusillus has been found at several occasions in the southern North Sea; however, it is rare in Dutch waters. Its range extends from W. Norway into the Mediterranean and to the Canary Islands.

A *Macropipus* species which was not found in the lightship samples, neither as an adult nor in any of the larval stages, is *Macropipus puber.* This species is brought in by fishermen in very fluctuating numbers, which probably are not only caused by a variation in the occurrence of the species on the fishing grounds but also by incidental circumstances due to changes in fishing methods and commercial interest of the fishermen (Van der Baan, 1972). We may assume that *M. puber* is always present off the Dutch coast, with occasional peak years, but that, perhaps due to low numbers, the larvae have been overlooked in the years in which our investigations were carried out. During the first two years of the project *M. puber* was still brought in by fishermen, as appears from the above table. Hamond (1971) mentioned the species as being less uncommon for the Norfolk coast from June to September 1960, though it should still be regarded a rare species. Wolff (1966, 1971) also found that between 1963 and 1968 *Macropipus puber* was practically absent off the Dutch coast. Fishermen from Den Helder caught only one specimen in 1967, 8 in 1968 and 153 in 1969. Its absence from the North Sea in some years may be due to normal fluctuation in the extent of its range. Wolff (1966), again, assumed a recolonization from the Channel. The following notes on *Macropipus puber* may perhaps illustrate the difficulties in the interpretation of records, obtained not by purposeful research but by more or less incidental observations. In January and February 1971 *M. puber* was found dead or moribund on the beach in several places along the Dutch coast. This would

agree with either the hypothesis that it might be a "southern" species, suffering a high mortality in the winter months, or that it is not able to stand the lowered salinity of coastal waters in the winter. Since we needed some specimens of this species for experiments at the N.I.O.Z. we informed the fishermen of Den Helder that a special premium would be given for the species. After that it was brought in regularly in fair numbers by a fisherman, who fished usually off the North Sea coast near Callantsoog and Petten (province of Noord-Holland). In the normal course of events it would probably never have been detected. A distribution report based on this fisherman's catches would show an unusually high concentration off Callantsoog, this representing the fishing grounds of that particular fisherman, instead of the distribution of the species. This state of affairs continued until commercial fishing for other species became quite profitable, fish being plentiful as well as fetching a good price in the market. Then our supply of *Macropipus puber* was stopped because the fishermen could not be bothered to examine occasional crabs when commercial fishing kept them continually busy. Later on it was again brought in for a few months; then the fisherman went over to cod-fishing and the supply stopped again.

The moral of this story is to remind us that a theory based on data collected incidentally can only lead to a hypothesis for which further proof must be sought by relevant field study and if possible, laboratory experiments.

Macropipus puber has been found along practically the entire North Sea coast of the Netherlands. Its range extends from S. W. Norway to N.W. Africa. Its occurrence in the Mediterranean is doubtful.

Macropipus marmoreus, another species which figures only in the lists of species brought in by fishermen, has been taken at several occasions in Dutch waters. It is known to occur from the Azores and the Portuguese coast north to the Dutch and German North Sea coasts and the coast of Scotland.

Macropipus depurator was brought in by Den Helder fishermen during 1963, 1964 and 1965. Wolff (1971) stated that it is not found in the region regularly explored by the Delta-Institute.

The species is found rather regularly in the southern North Sea, but it is rare in Dutch coastal waters. In inhabits the area from the west coast of Norway south to N.W. Africa and the Mediterranean. It usually lives in deeper water than the other species.

The occurrence in surface waters near "Texel" lightship of larvae of *Macropipus* sp. (mainly or entirely *M. holsatus*) is represented in fig. 1.

The occurrence of the crabs with a carapace width of over 2 mm, is given in fig. 3 (average catch per half month, or number of crabs caught

per half month divided by the time the net was in action). Their occurrence may vary greatly from one year to another, but it always has a peak in the autumn, which peak simply represents the new generation.

All those crabs were also sexed and measured by the first author, but unfortunately the numbers do not permit any conclusions, based on statistical evidence.

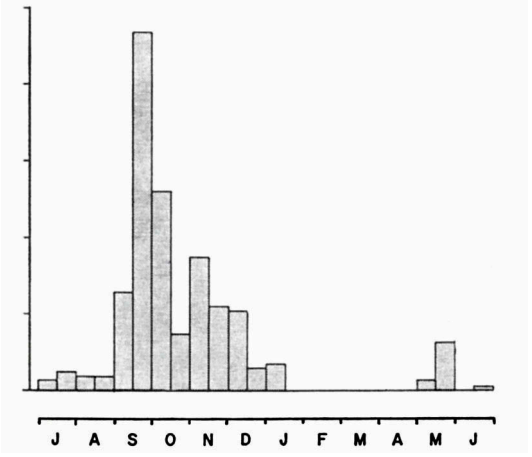

Fig. 3. The occurrence of *Macropipus holsatus* (Fabricius) (cb. over 2 mm) near "Texel" lightship, in 1961-1966. Relative catch per time unit in each half month.

All we can say is that the smallest size group, cb (carapace width) 2-10 mm, is found from about July till the end of November; that the next group (cb 11-20 mm) occurred from about August to the end of December; and that crabs with cb 21-30 mm occur from August and especially September until January, then they turn up again after an interval of one to three months. Of those spring crabs the majority are females, some of the largest being ovigerous. The size class with cb 31-40 mm also occurs from August and September until January and again in the spring. There are many ovigerous females in this class. Crabs with cb over 40 mm are rare in the plankton catches. They are found especially in the spring and early summer.

It appears that *Macropipus holsatus* in the crab stage may be caught in the surface water near "Texel" lightvessel in any month of the year, although between January and March it is very often absent. The greatest numbers are caught around October in the smaller size groups. Crabs with a carapace of over 4 cm across are rarely caught. A full year, from one summer till the next, seems to cover just one generation of crabs, so that we must assume that either the crabs die after reproduction or move to deeper waters. Ovigerous females are found between April and August.

The variability in carapace-pattern, observed by Hamond (1971) was also found in our specimens.

Macropipus holsatus is the most common swimming crab of the Dutch shores, and is frequently washed ashore on the North Sea coast of Holland. Its range extends from N. Norway and Iceland to the Atlantic coast of the Iberian peninsula and the Canary Islands.

Pilumnus hirtellus (Linnaeus, 1761)

Larvae of this species were not found before 1965, when one megalopa was caught on 4 November. In 1966 more larvae were found:

1 July	1 megalopa
4 October	23 megalopae
12 October	1 megalopa
14 October	a few megalopae
21 October	abt 30? megalopae
22 October	1 megalopa
2 November	1 megalopa
5 November	1 megalopa
8 November	1 megalopa
9 November	1 megalopa

From 1946 to 1949 Rees (1954) only found 19 larvae of the species off the Humber and on the line Rotterdam-Hull (Southern Bight).

Pilumnus hirtellus is not uncommon in the southern North Sea. On the Dutch coast it is often found on floating objects washed ashore. Hamond (1971) mentioned it as being common on the Norfolk coast. Wolff & Sandee (1971) stated that it is "rather rare" in the Delta area. The range of the species extends from S. W. Norway south into the Mediterranean.

Pinnotheres pisum (Linnaeus, 1758)

Free-swimming adult males of this species occurred regularly in the surface plankton from midsummer until winter.

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1961	—	2	—	3	5	1	11
1962	1	—	11	2	—	—	14
1963	—	—	—	—	—	—	—
1964	—	1	5	—	—	—	6
1965	—	1	13	2	—	—	16
1966	—	9	17	3	2	1	37

It appears that in 1966 the species was quite abundant as the numbers surpassed those of the previous years, although the fishing schedule was much reduced.

Pinnotheres pisum is a common species in the southern North Sea. Its range extends from S. Norway and W. Sweden to N.W. Africa and the Mediterranean.

Inachus dorsettensis (Pennant, 1777)

Only two megalopae of this species were caught, one on 8 and one on 21 November 1966.

Inachus dorsettensis is quite rare in Dutch waters, although there are several records from the extreme southern North Sea. The species is known from Norway south to West Africa and the entire Mediterranean.

Macropodia tenuirostris Leach, 1814 and **Macropodia rostrata** (Linnaeus, 1761)

Of the larvae of the genus *Macropodia* only megalopae and postlarval stages have been obtained. Their occurrence was as follows:

In 1964:	21	September	1 megalopa
In 1965:	2	September	1 postlarval stage
	22	September	1 megalopa, 1 postlarval stage
	24	September	1 megalopa
	21	October	2 megalopae, 1 postlarval stage
	8	November	2 megalopae
In 1966:	30	July	1 megalopa
	29	August	1 megalopa
	30	August	1 megalopa
	8	November	1 megalopa

Adult crabs were also found in the plankton, but unfortunately they were not always given due attention, as at first it was assumed that they might live in the weeds etc. accumulating on the hull of lightship.

Three finds of *Macropodia tenuirostris* are recorded, all from August and September 1961, and 31 adult crab stages of *Macropodia rostrata*: 18 in the autumn of 1961, between 31 August and 18 December, 3 more in September 1965 and the remaining 10 specimens between 16 September and 8 December 1966. They were mostly young specimens and it is curious that they all should turn up in the autumn. According to Wolff & Sandee (1971) this is another species of high salinity water.

Macropodia tenuirostris is known from a few scattered records from the southern North Sea. Its range extends from the Faeroes and the British Isles to N.W. Spain. *Macropodia rostrata* is not uncommon in Dutch waters. Its range extends from the west coast of Norway south to West Africa and the Mediterranean.

Hyas araneus (Linnaeus, 1758)

For the same reason as with *Macropodia* species the finds of adult *Hyas araneus* were not given due attention. The larvae were rare in the plankton (fig. 1), although a few were found in every year except 1961. They were most numerous in the spring of 1966. Rees (1954) also found a maximum in the spring.

Conclusions and summary

It must again be stressed that the results of the present macroplankton investigations carried out from mid-January 1961 till the end of 1966 at "Texel" lightship, can only give incomplete information on the occurrence of decapods and decapod larvae, since neither the type of net nor the fishing method was designed for this purpose. It is only because so little is known on this subject that the results which must be considered with certain reservations, are published.

The distribution and occurrence of decapods and decapod larvae might well repay a closer investigation, in connection with abiotic conditions, especially temperature, and prevailing currents.

Of 23 species adults or larvae or both were obtained in surface waters. They are discussed in this paper, in some cases with additional information from other Dutch sources.

Processa parva, which so far had been mainly recorded from stomach contents, occurred regularly in postlarval and possibly also in larval stages, from late summer until winter.

Free-swimming males of *Pinnotheres pisum* were often found in the autumn.

In the case of certain crab species, their occurrence in consecutive years may be widely divergent. During a period of successive years they may become increasingly more numerous, after which they may be absent again for a number of years. The cause of this fluctuation is not known, although several possibilities can be imagined, such as fluctuation of temperature, or influx of Channel water and the absence thereof. A closer study of the limiting factors of the distribution of these species is needed. This is discussed in some detail for the case of *Thia scutellata,* with additional information on Dutch records.

Samenvatting

Tijdens een macroplanktonderzoek bij het lichtschip „Texel", waarbij werd verzameld van half januari 1961 t/m december 1966, werd een groot aantal decapodenlarven gevangen, die zoveel mogelijk werden geteld of geschat en op naam gebracht. Aan de gebruikte vangstmethode, die niet op larven was berekend, kleven vele onvol-

komenheden, zodat de gegevens onvolledig zijn, maar vanwege de grote lacune in onze kennis betreffende de verspreiding van Decapodenlarven in de zee voor de Nederlandse kust meenden wij onze resultaten toch te moeten publiceren.

Nadere aandacht is besteed aan *Processa parva,* die algemeen bleek voor te komen — tot dusverre slechts bekend uit de inhoud van vismagen — en aan z.g. zuidelijke soorten als *Macropipus puber* en *Thia scutellata.* Van de laatste wordt hier een opsomming gegeven van alle bekende Nederlandse vondsten, zowel op het strand als in de zee. Hierbij wordt er nog eens op gewezen hoezeer de aantallen, gebaseerd op toevallige vangsten van vissers, door bijkomstige omstandigheden kunnen worden vertekend zodat een verklaring van de sterk wisselende aantallen van jaar op jaar nog niet te geven valt.

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