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A SHORT REVIEW ON THE BIOLOGY AND FISHERY OF THE SQUID TODARODES SAGITTATUS.

by

J. H. Sundet

Institute of fisheries, University of Tromsø
P.O. Box 3083, N-9001 Tromsø, Norway

Abstract.

Increased importance of squid Todarodes sagittatus in Norwegian fishery in the recent years have lead to an intensified biological research on this species.

This squid invades Norwegian coastal waters in large amounts in late summer in and the main fishing period is from August to December. In 1983 the total catch was about 18.000.- of which about 4.000.- tons were used for human consumption and the rest as bait in long line fisheries, while more than 90 % of a total catch of ca. 8000 tonnes in 1984 went to human consumption.

Since the spawning area is believed to be i the western Atlantic the T. sagittatus makes extensive migrations like other squids do. Tagging experiments indicate, however, that migration is small between the different coastal areas .

The squid is about eight months old when arriving Norwegian waters and increased in weight from about 0.3 kg to more than 1.0 kg during its stay in this area. There are always more than 90 %

females in the catches during the period from August to December, while the sex ratio seem to be near unity among the squids caught at other parts of the year. There are several sexually mature males in all catches, but only one ripe female have been found. While staying in Norwegian coastal waters the squid feed on a large variety of species, the main diet apparently being small fishes especially Sheppy argentine (Maurolicus mulleri) and herring (Clupea harengus).

Resume.

L'importance croissante du calmar Todarodes sagittatus pour la pêche industrielle norvégienne ces dernières années a conduit à une intensification de la recherche biologique de cette espèce. Ce calmar envahit les eaux côtières norvégiennes en quantités importantes vers la fin de l'été, et la période principale de pêche s'étend d'août à décembre. En 1983, le tonnage total des prises s'est élevé à environ 18.000 tonnes, dont 4000 furent utilisées dans la consommation courante, le reste servant d'appâts pour les ligne de pêche.

Bien que la région de reproduction soit supposée se trouver dans la partie ouest de l'océan atlantique, T. sagittatus effectue de vastes déplacements ainsi que les autres espèces de calmars. Des expériences de marquages indiquent cependant que les déplacements sont peu importants entre les différentes régions côtières norvégiennes.

Le calmar est âgé d'à peu près huit mois quand il arrive dans les eaux norvégiennes et son poids passe d'environ 0.3 kg à plus de 1.0 kg durant la période qu'il passe dans cette région. Il y a toujours plus de 90 % de femelles dans les prises effectuées pendant la période d'août à décembre, alors que mâles et femelles semblent être en quantité égale dans les prises effectuées en dehors de cette période de l'année. Il y a beaucoup de mâles capables de se reproduire dans toutes les prises, mais une femelle dans ce cas seulement a été trouvée.

Le calmar se nourrit d'une quantité d'espèces différentes pendant qu'il habite les eaux côtières norvégiennes, et la nourriture principale semble être de petits poissons, notamment Maurolicus mulleri et Clupe harengus.

INTRODUCTION.

The squid Todarodes sagittatus has a wide western Atlantic distribution from South Africa to the Barents Sea and in the Mediterranean Sea (ARNOLD 1979). The presence of the squid in the different areas seem however to be changing with the seasons of the year. In late summer the squid migrates in to Norwegian waters in great numbers each year, usually to the coastal area between Bergen and the Murman coast (WIBORG 1972).

From 1972 to 1977 the yearly invasions of squid to the Norwegian coast was absent. Before that period the squid fishery in Norway was of very limited economical value; the yearly catches was between 0 and 10.000 tonnes in the period from 1957 to 1971 (figure 1). After the return of the squid in 1977 the amount of landed catches has increased to about 18.000 tonnes in 1983. The T. sagittatus was earlier used exclusively for bait, but in the recent 2 - 3 years an increasing part has been produced for human consumption.

Because of the relatively limited knowledge of the biology of T. sagittatus and the increasing role it has in the Norwegian fishery, the research on the squid as a marine fishing resource has been intensified.

MATERIALS AND METHODS.

Growth and biochemical investigations.

Squid samples have been collected from several locations in Troms area since October 1982. It has been attempted to get monthly samples but this have shown to be difficult especially in the Spring and summer.

Total body wet weight, digestive gland weight and dorsal mantle length was measured on all squids sampled. Statoliths and stomach content was taken from ten squids of each sample for further investigations in the laboratory. Parts of mantle and digestive gland was analyzed for lipid and protein content, and the statoliths prepared after the method of WIBORG et al (1982) before counting daily growth rings.

Tagging of squid.

The squids were tagged with "spagetti-tags" anchored in the mantle at the posterior end of the dorsal side (Wiborg et al 1982).

Only females were tagged because males have a very delicate skin which tares off very easily when handled.

Tagging was carried out in two periods and at two different geographical areas; in one area 1350 squids were tagged and 650 in the other.

RESULTS AND DISCUSSION.

Biology

Age and population biology.

Table 1 shows that the squid spawn throughout the whole year, but the lot seem to spawn in December and January. There seem to be no connection between the numbers of growth rings in the statoliths and the mantle length. This may be due to a big difference in growth between the individual squids or that the growth rings are not "daily" growth rings and our assumption on age is wrong. When comparing monthly catches of squid from northern Norway and Western Atlantic one finds that the Todarodes population are separated in at least two cohorts. Of which one has its main spawning period in december - january, and the other spawns during summer (SUNDET & WIBORG in prep.).

The autumn fishery for squid in northern Norway are based on the winter spawning cohort which also seem to be by far the greatest part of the population.

Specimens from the summer spawning cohort are some times present in our areas during spring and early summer.

Table 1. Numbers of growthrings and proposed period of hatching for the squid T. sagittatus caught at different times the year.

| Sampling date | Number of squids | Growth rings x + SD | | Hatching period |
|---------------|------------------|------------------------|----|-----------------|
| 21.Oct. 1982 | 3 | 296 | 5 | December |
| 16.Dec. 1982 | 10 | 308 | 18 | February |
| 8.Mar. 1983 | 5 | 250 | 11 | July |
| 12.Apr. 1983 | 7 | 243 | 20 | September |
| 20.Jul. 1983 | 6 | 251 | 14 | December |
| 1.Aug. 1983 | 5 | 264 | 34 | December |
| 9.Sep. 1983 | 9 | 281 | 11 | January |
| 28.Oct. 1983 | 9 | 254 | 35 | February |

Biochemical content.

The content of protein and lipid in the mantle and the digestive gland seem to variate greatly from one animal to another, but there is not found any variations connected with size, sex or season of the year. In the digestive gland the content of protein are between 2 - 13 % of dry weight and the lipid content from 45 to 65 %. The same analysis of the mantle shows from 33 to 45% protein and between 8 and 10 % lipid.

The squid is a fast swimming and short living species and the needs for storage energy is therefore probably small. The reason for the great content of lipid in the digestive gland is more likely the need for boyancy, since the squid has no swim bladder.

Growth.

Equations for the length and weight relationship are calculated and presented in figure 2. The squid seem to have a relatively low growth rate up to about 25 cm mantle length. This is the size of the squid when it invades Norwegian waters and the nearly exponential growth rate afterwards indicate a high feeding rate when being in these areas. The growth curves also show that males becomes heavier than females at the same mantle length at sizes more than 25 cm mantle length. This has also been found by WIBORG and GJØSÆTER (1981) and by MURATA (1978) in Todarodes pacificus.

There was a great difference in total catch of squid in northern Norway in 1983 and 1984 (figure 1). The squid was also much more difficult to catch in 1984 than in 1983, and it did not migrate into the fjords and sounds as usual, but stayed in oceanic areas throughout the season.

The reason for this was probably that the squid stock were much less numerous in 1984 than in 1983.

As found in other squid species (e.g. Illex illecebrosus, DAWE 1984) one would therefore expect a slower growth rate in 1984 than in 1983. According to the growth equations this may be true for males, but not for females (figure 3 and 4).

Prey items.

T. sagittatus feed on different kinds of pelagic species while staying in Norwegian waters. The appearance of the different food items in the squid stomach seem to some extent to be dependent on the abundance of each prey species. Although, different kinds of small pelagic fishes is most dominant (table 2).

A single stomach usually contain several different species, both fish and invertebrates, with one dominating species. Some stomachs have also remains of squid, usually pieces of squid arms. Several authors (FIELDS 1965, CLARCE 1966, ENNIS and COLLINS 1979) have proposed that squids are cannibalistic, but our findings indicates that during jig-fishing, parts of the squids are tared off and probably eaten by other squids in the

vicinity.

Prey composition and stomach fullness seem to be different in 1984 and 1982/83. There was a significant higher proportion of fish in the diet in 1984, while the relative amount of cephalopoda and polyceates were considerably less in 1984 than in 1982/83 (table 2)(BREIBY 1985).

One has not tried to quantify stomach fullness in the samples in 1984, but it was generally very little content in the stomachs. Full or distended stomachs was found in only 10 of the 419 squids analysed in 1984, while 151 out of 614 was full or distended in 1982/83 (BREIBY 1985).

Table 2. Occurrence of the different food category in 419 stomachs of T. sagittatus.

| Food category | Number of stomachs | Percent of total |
|---------------|--------------------|------------------|
| Pisces | 172 | 41.1 |
| Crustacea | 98 | 23.4 |
| Polychaeta | 34 | 8.1 |
| Cephalopoda | 22 | 5.2 |
| Other | 45 | 10.7 |
| Empty | 48 | 11.5 |
| Total | 419 | 100 |

The dominating prey species among fishes in the 1982/83 catches was the sheppy argentine, herring and capelin (BREIBY 1985). The eaten fishes are usually less than 12 - 13 cm in total length which probably is due to the capability of the squid for catching bigger fishes. Squid hunting in schools of herring is observed being able to catch and hold specimens as big as 25 cm for only a short time. Although, the herring is injured by the squid, it is able swim away (own observ.).

Tagging experiments.

There have been done two different tagging experiments of which one was carried out in open waters and the other in a closed fjord (see Figure 5). In the first experiment 1350 squids were tagged during 24 hours on September 9th, 1983, and in the other 650 squids were tagged 27 and 28 of October. Two tagged squids were recaptured from the open sea tagging, both were quite a distance away from the tagging area, while 12 tagged squids were caught from the experiment in the fjord and all were taken in the same area as they were released.

These experiments indicates that when the squid have invaded the fjord areas it seem to be stationary with little or no migrations into other areas. In the open sea experiment the squid was on its way in to the fjords and therefore it shows great distance migrations.

Fishery.

The fisheries after squid in Norway takes place in the Autumn from August to December and is mainly carried out from small vessels - usually 20 - 30 feet and with only one crew. Jigging machines with Japanese produced hooks are the ordinary equipment for squid fisheries. Being equipped with 3 - 4 jigging machines a vessel may be able to catch up to 2 tons of squid during 24 hours in the best season. In 1984 as much as 1800 vessels were participating in this fishery.

Traditionally squids were fished for bait or food for animals. The increasing part of the landed squid that goes to human food have especially been facilitated due to a new method for "de-skinning" the squid.

It has been done experiments trying to attract the squid with light during night, as done in other squid fisheries (OSAKO and MURATA 1983). There are, however, different opinions about the effect of using light during fishing. There was no accumulation of squid using light in an experiment trying to catch the squid with a purse net (WIBORG unpubl.).

Our inability to forecast any size of the yearly squid invasion is a problem in managing this fishing resource in Norway. Since the squid several years have been absent in the Norwegian coastal

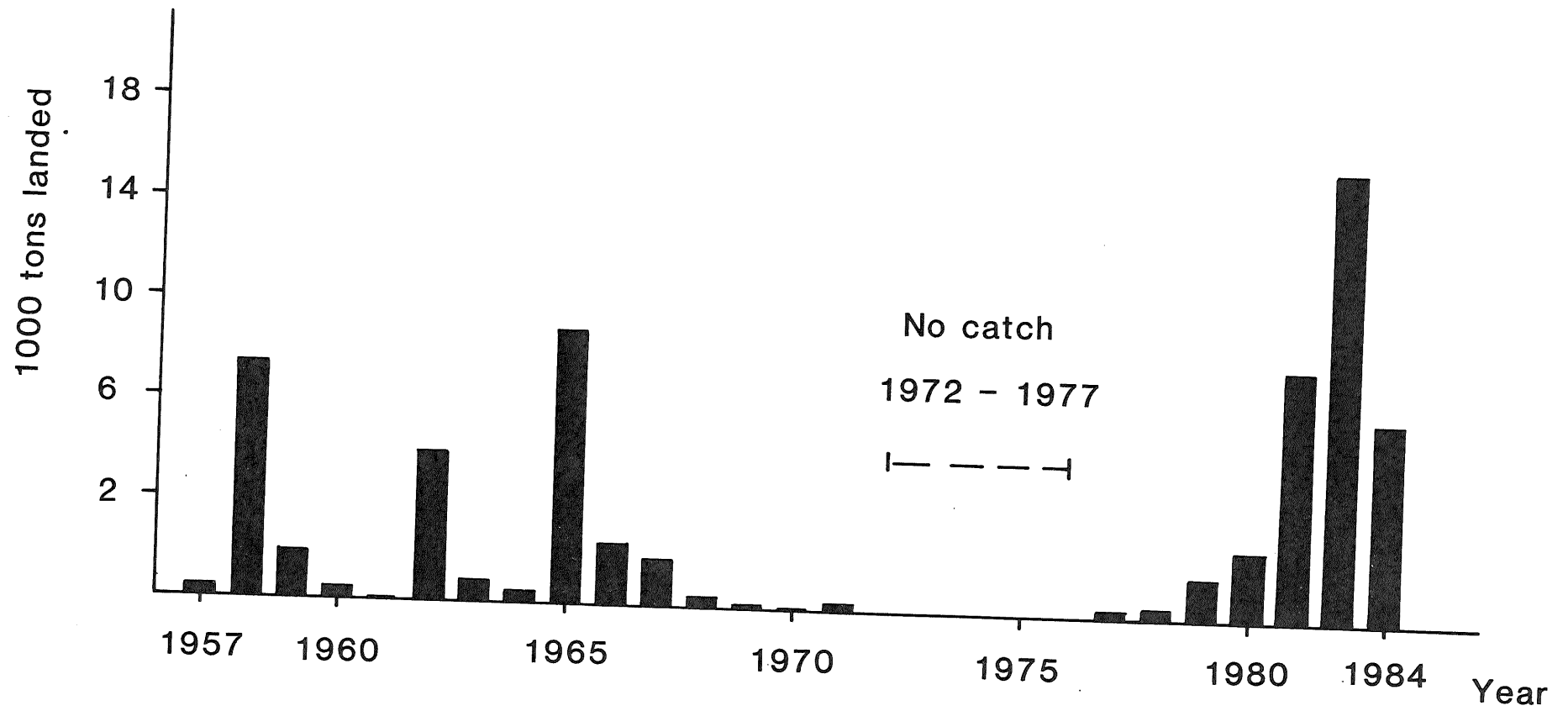
waters it is very difficult for the fishermen to prepare for the season.

The future investigations on squid in Norway will therefore be intensified; particularly on the forecasting and estimation of stock size area.

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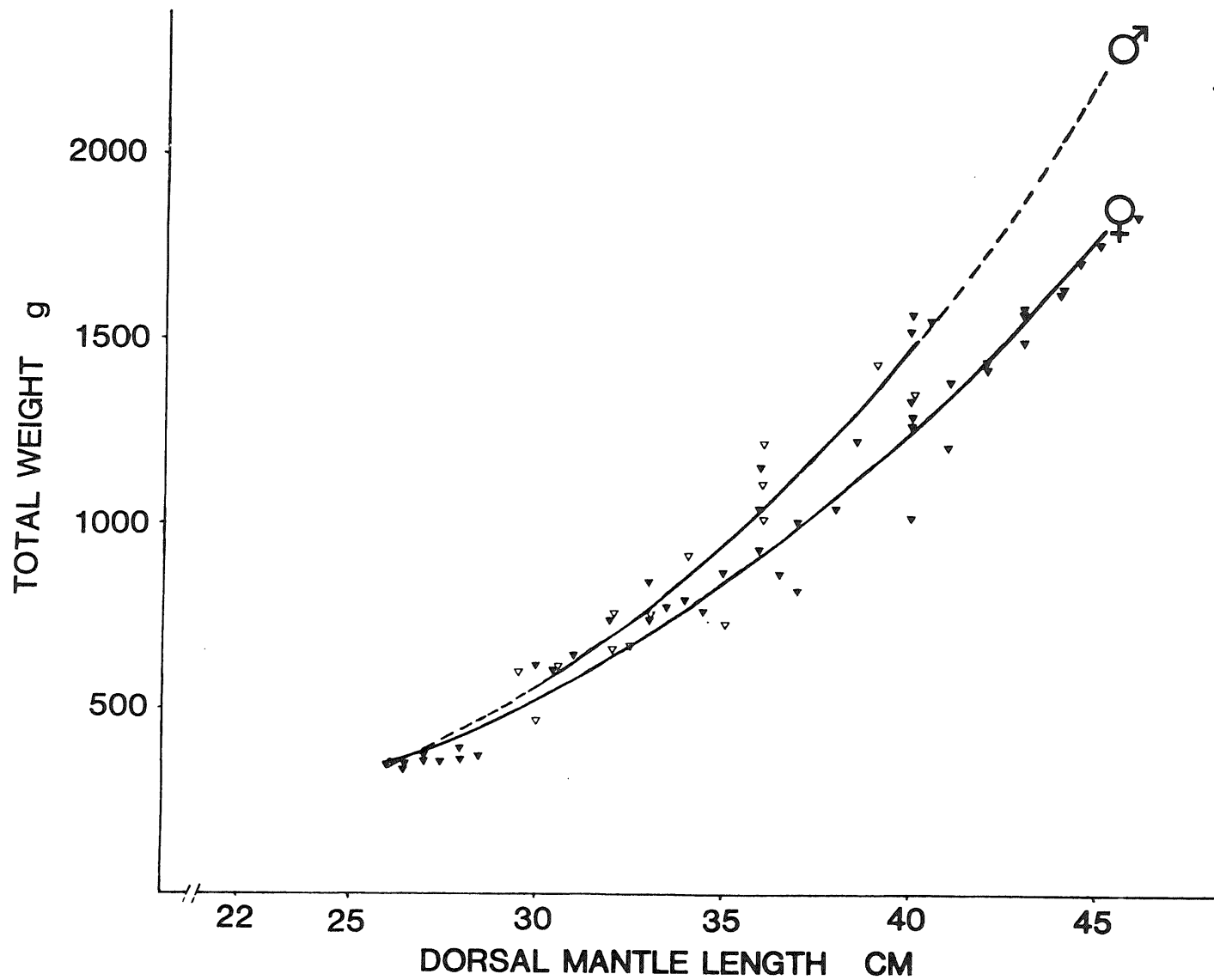
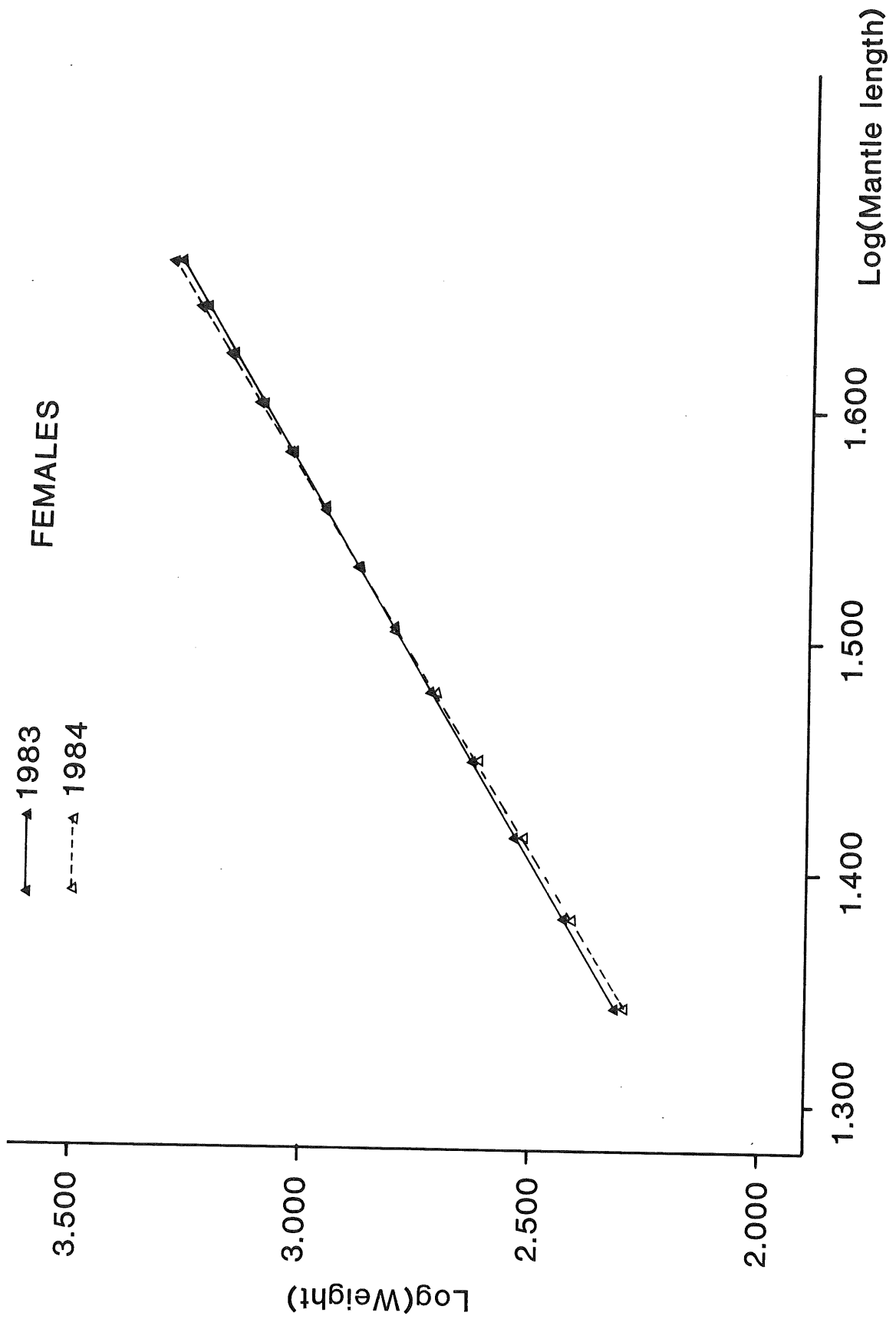
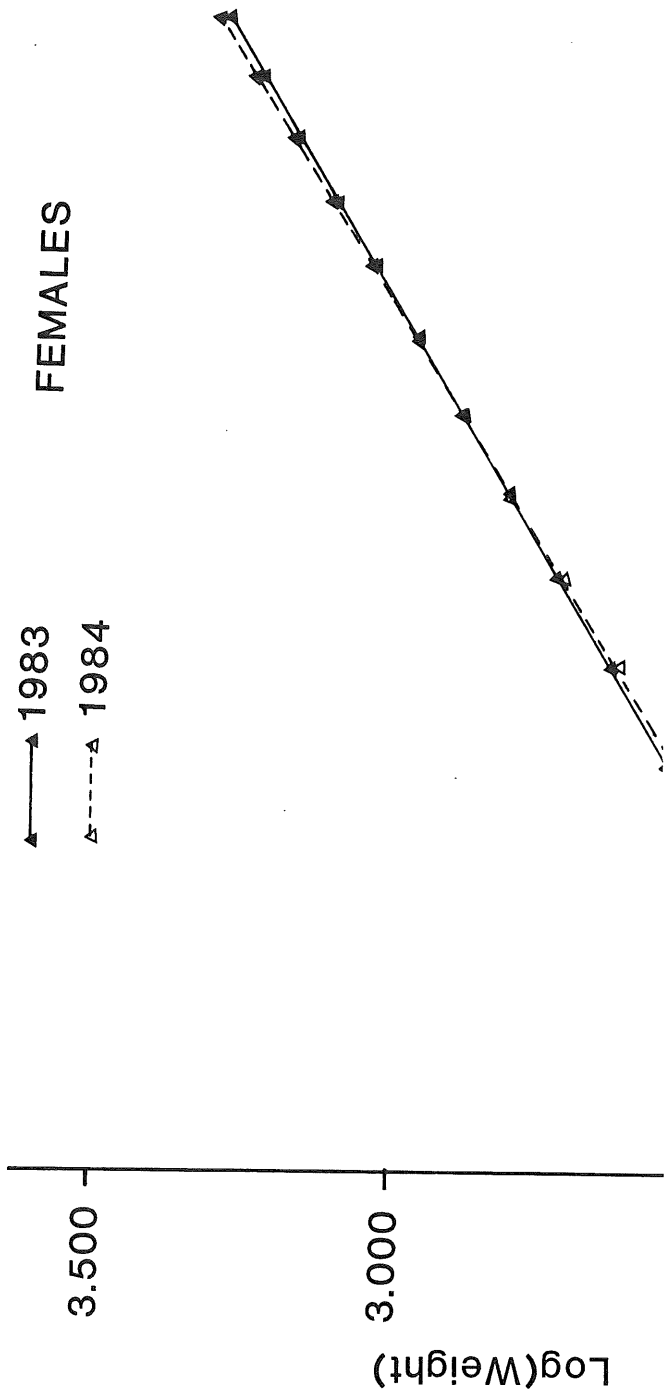
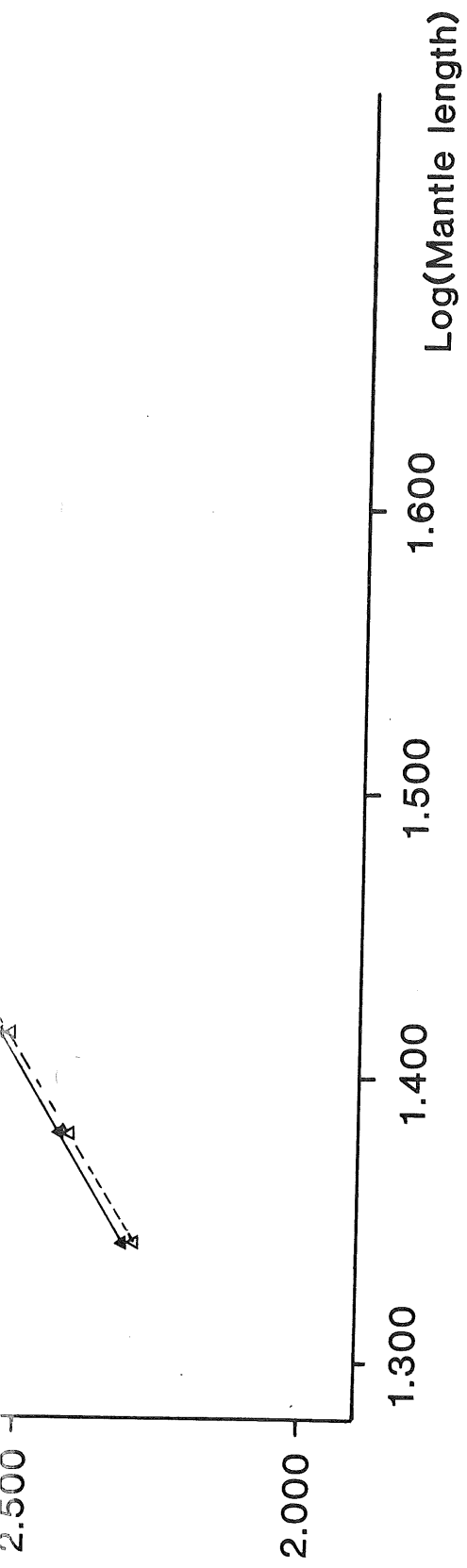
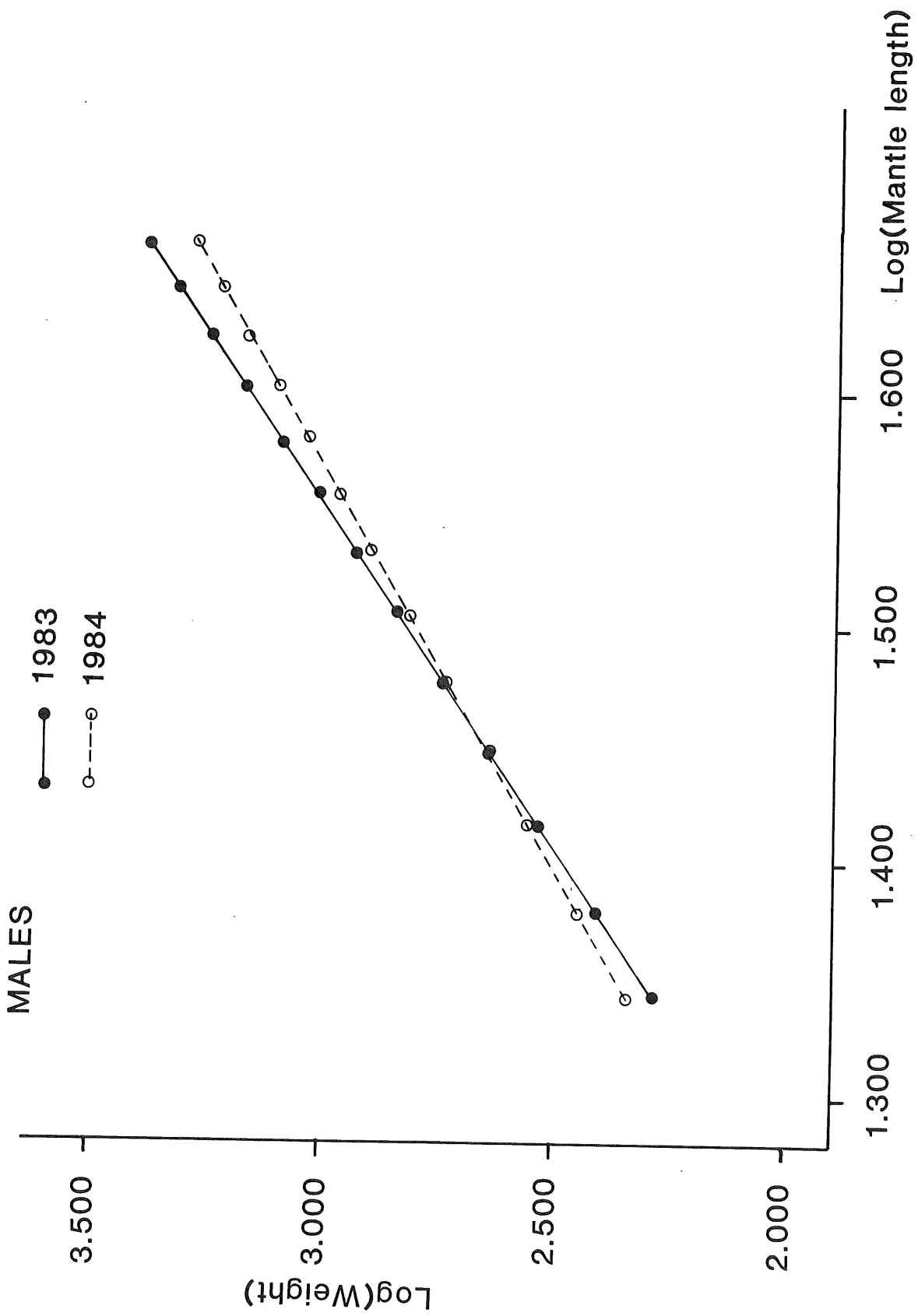


Figure 2. Relationship between dorsal mantle length and total body weight in squid *Todarodes sagittatus*, open triangles = males and closed triangles = females. Growth equations for males : $W = 0.0049L^{3.423}$ and females : $W = 0.01762L^{3.031}$.









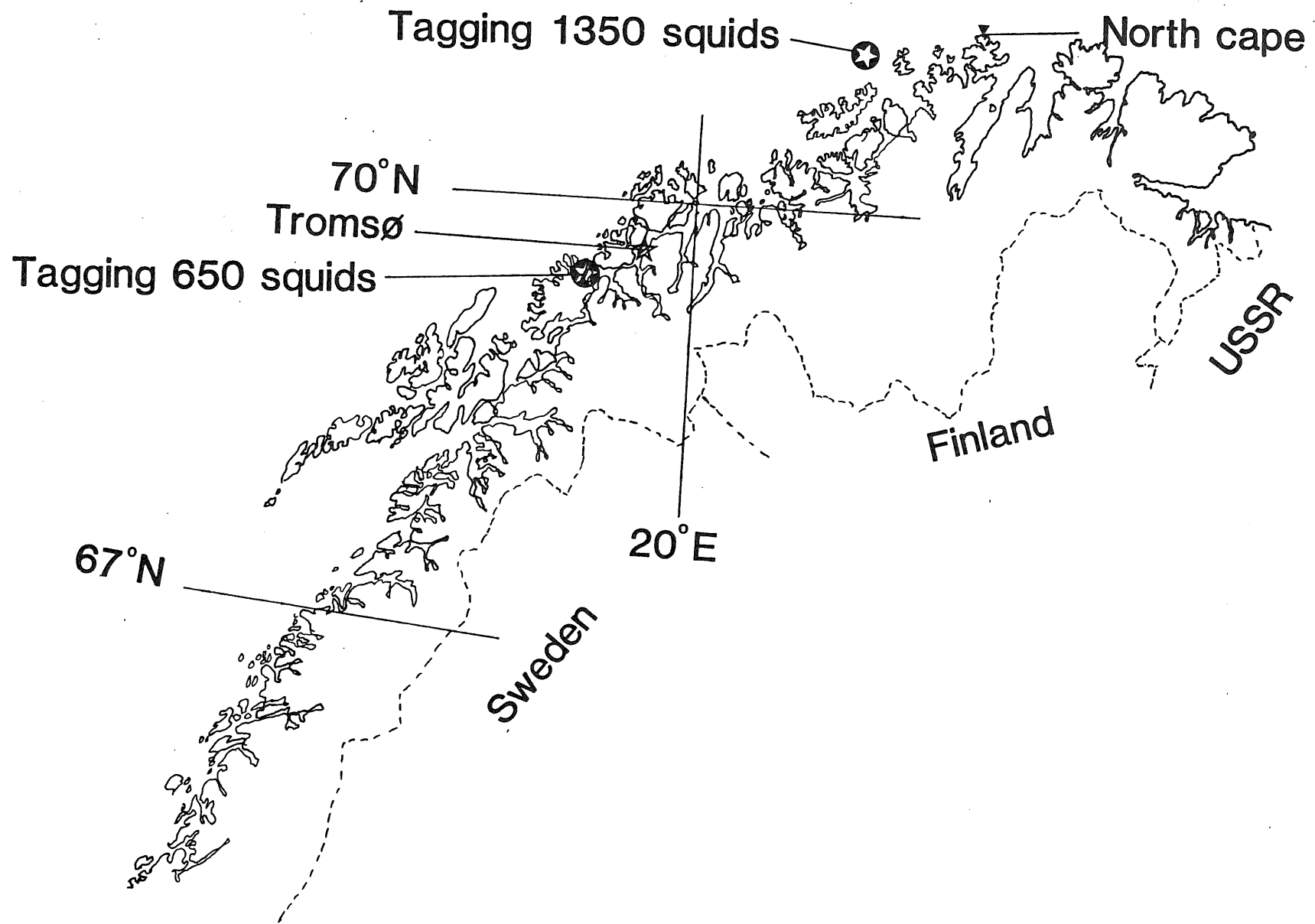


Figure 5. Tagging of squid *Todarodes sagittatus* in two different areas in northern Norway.