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SQUID, TODARODES SAGITTATUS (LAMARCK) IN NORWEGIAN  
COASTAL WATERS DURING THE AUTUMN 1977 AND SPRING 1978

by

Kristian Fredrik Wiborg  
Institute of Marine Research  
Box 1870, 5011 Bergen Norway

#### INTRODUCTION

Todarodes sagittatus is the only squid of commercial importance in Norway. During the years 1949 - 1971 it came to the Norwegian coast nearly every autumn, failing only in 1951, 1952, 1956 and 1961. The yield of the fishery varied considerably, from more than 10 000 tonnes to 0. The biology of T. sagittatus was studied in 1970 - 1972 (WIBORG 1972).

#### MATERIALS AND METHODS

Squid was collected from the commercial fishery and during research cruises from October 1977 till May 1978 (Table 1).

The squid were deep-frozen and thawed in the laboratory before examination. Mantle length was measured to the nearest cm below, while total weight and weight of liver were determined to the nearest 10 g below. The length of gonads was measured to the nearest cm, the weight to the nearest g. Sex, stage of maturity and egg size were determined macroscopically and under a microscope.

Stomach contents were determined under a stereoscopic microscope and stomach filling estimated in a six degree scale.

## RESULTS

### Size (Table 1, Fig. 1).

From October 1977 until March 1978 the mean mantle length increased from 28 cm to 39 cm. In Syltefjord near Cape Stad the squid were larger than in the other localities. The mean sizes corresponded very well with the growth curve drawn earlier (WIBORG 1972).

Males were, on average, 3-5 cm smaller than the females, e.g. at Seløy in October 24.9 cm and 27.9 cm for males and females respectively, and in Syltefjord in March, 34.1 cm and 39.1 cm. This is also in accordance with earlier investigations (WIBORG 1972).

### Weight (Table 1).

The mean total weight increased from about 400 g in October to 1.500 g in March, but the range of variation was considerable. In March the maximum weight was 2.320 g, but according to local fishermen, squid up to 2.900 g were caught in April - May.

The relationship of mantle weight to total weight was studied (Fig. 2) and earlier observations (WIBORG 1972) confirmed. At the same mantle length squid from Syltefjord were heavier than those from other localities. Better feeding conditions are suggested as a reason for this, as will be dealt with later on. There also seems to be indication of an increase in mean weight for the same mantle length from December to March, but the difference was not significant.

### Liver percentage (Table 2).

The liver is a cylinder- or spindle-shaped organ situated along the dorsal side of the mantle cavity. It has a fat content of approximately 50% (LAMBERTSEN, pers. comm.). The fat probably serves as a food reserve. In Todarodes pacificus the liver is about 10% of the total weight, with maximum fat content during October November (TAKAHASHI 1961).

Table 2 shows the liver percentages for different localities and months. The variations are considerable, at Husøy 4 - 15% in Syltefjord 7 - 22%. The average percentage was highest in Syltefjord, decreasing from 13 - 14% in December to about 10% in March.

#### Sex ratio and maturation

As found earlier, (WIBORG 1972), males were scarce (Table 1, Fig.1). At Seløy and Husøy the percentage decreased from 12 - 14% from October to November. In Syltefjord males only made up 2 - 5% of the population, and were sometimes completely lacking.

All squid were immature, the females mostly in stage I in the scale of MANGOLD-WIRZ (1963). In May a female caught in Syltefjord had nidamental glands 13 cm in length, an ovary weighing 54 g, and eggs in stage III (diameter 1.2 - 1.5 mm). In the Mediterranean, this stage is observed in March - July, while mature females (stage IV) do not appear until October (MANGOLD-WIRZ 1963).

#### Food

The frequency of various food organisms in the stomachs of T. sagittatus from different localities is shown in Table 2. Empty stomachs have been excluded. Earlier results (WIBORG 1972) were mostly confirmed.

Fish occurred most frequently, in 40 - 85% of the stomachs, except Syltefjord in January, where only 17% had fish.

At Seløy and Husøy Sebastes sp. were most frequent, but saithe (Pollachius virens) also occurred. Herring (Clupea harengus) and Maurolicus muelleri were also identified. In Syltefjord herring dominated together with sprat (Sprattus sprattus). Saithe was also important, possibly also small M. muelleri. At Vingen farther south, M. muelleri was most frequent, next came herring, cod (Gadus morhua) and saithe.

Judging from the size of otoliths, scales and vertebrae, the fish eaten were mostly 20 cm or below.

Squid ranged second, mostly T. sagittatus, but smaller species also occurred. At Seløy and Husøy squid was as important as fish, occurring in 37 - 48% of the stomachs, but further south in only 15 - 26%.

As T. sagittatus is evidently cannibalistic when other food is scarce, this may indicate better feeding conditions in the Syltefjord area.

Krill was very frequent at Seløy in October and at Vingen in December, otherwise scarce. Meganyctiphanes norvegica was identified.

Shrimp, Crangon almanni was very common in Syltefjord, especially in in January.

Themisto sp., Nereis pelagica and Pareuchaeta norvegica were occasionally very common in the squid stomachs.

Fullness of stomachs was estimated in six degrees:

0-empty, I-trace, II-little, III-moderately full, IV-full, V-distended (Table 3).

Squid is known to be very voracious and to digest very rapidly. In addition, the food organisms are usually very well quartered in the stomachs. Indices of fullness may therefore be of restricted value, depending on the time of fishing.

At Seløy most of the stomachs had some contents, few were empty. Those full or distended contained remains of herring, sprat or saithe. At Husøy most of the stomachs were empty in October. Also in November the stomachs were little filled. A few contained saithe. In Syltefjord about 50% of the squid in October had stomachs full or distended with herring, sprat or saithe.

In a few squid the stomach contents made up 10 - 17% of the total weight.

In December most of the stomachs were empty or nearly empty, but the degree of filling increased throughout January and March.

## PROSPECTS OF THE FISHERY FOR T. sagittatus IN NORWAY

As in earlier years, the occurrence of T. sagittatus in 1977 coincided with great quantities of salps off the west coast of Norway in August-September. The same occurred in previous years (WIBORG 1972) and was taken as an indication of the influx of water masses of Atlantic origin.

During the autumn of 1977 and spring of 1978 about 200 tonnes of T. sagittatus were fished in Norway. The catch was partly used for bait, partly for human consumption. The introduction of the squid on the Norwegian market has been successful, and there is an increasing demand. The problem is the irregular occurrence of T. sagittatus in Norwegian coastal waters, with periods of complete absence for up to six years. With the great quantities caught in some years, it is to be expected that the stock sometimes may be of a considerable size. However, there is still little or no information on the main habitat and spawning areas of the Atlantic stock of T. sagittatus. Spain is quoted to catch about 2.400 tonnes of the species per year (ANON: 1975). However, Spanish marine scientists (GUERRA and GANDARAS, pers. comm.) informed the author that the species fished is Todaropsis eblanae. Inquiries to fisheries scientists in Ireland, France and Portugal have not revealed any localities where the species is abundant.

Future investigations on the distribution and spawning areas of T. sagittatus should probably be concentrated in the areas along and off the Atlantic slope from the west of Scotland southwards to the Azores.

### SUMMARY

After 1971 Todarodes sagittatus did not visit the Norwegian coast until August 1977. The fishery yielded about 200 tonnes until May 1978. Single squid were still caught in the fjords in July. The mean mantle length increased from 28 cm in October to 39 cm in March. Maximum size observed in May was 46 cm.

The mean total weight increased from 400 g in October to 1.500 g in March. Maximum weight observed was 2.320 g, - reported - 2.900 g. The liver weight was, on average, 10 - 14% of the total weight, maximum 22%, decreasing during winter.

All squid were immature. Males constituted 12 - 14 % of the stock off northern Norway, decreasing to 7 - 9% in November. Farther south males were scarce, in some samples completely absent.

A female caught in May had eggs in stage III, usually found in March - July in the Mediterranean (MANGOLD-WIRZ 1963). Earlier observations on the diet of T. sagittatus were confirmed. Fish dominated, mostly herring and saithe, but squid was also common. *Crangon almanni* was a usual food organism on the west coast during winter.

The degree of filling of the stomachs was usually low, but near Cape Stad 30% of the stomachs were full or distended, the contents making up to 17% of the total weight. Information on the occurrence of *T. sagittatus* in other Atlantic areas is still scarce. None or very few are caught during the squid fisheries near Ireland and Spain.

It is suggested that future investigations should include the Atlantic slopes off Scotland and Ireland and the ocean farther southwest to the Azores.

Table 1. Material of T. sagittatus studied in the present investigation.

Year	Month	Date	Area	Position			Number			Mantle length, cm			Weight, g		
							♂	♀	% ♂	Variation	Mean	SD	Variation	Mean	SD
1977	October	1	Seløy	66	11.5	N 12 58 E	19	132	14.3	23-32	27.7	1.7	230-650	426.0	82.8
	November	2	"	"	"		7	92	7.1	23-35	30.8	2.0	260-830	540.8	127.7
	October	25	Husøy	69	29	N 17 29.5 E	12	88	12.0	25-35	30.3	1.7	320-840	554.0	94.7
	November	15	"	"	"		9	91	9.0	28-35	32.1	1.5	400-850	649.7	101.1
	October	29	Syltefjord	61	56	N 05 36.5 E	4	79	4.8	30-37	35.0	1.8	590-1360	1000.1	174.8
	December	6	"	"	"		2	93	2.2	34-41	37.5	1.3	830-1510	1172.3	141.6
	December	14	" 1)	"	"		0	60	0	31-41	37.3	1.7	690-1700	1176.9	167.8
	December	10-11	Suladypet 1)	64	04	N 08 12 E	1	9	(10)	31-35	32.7	1.9	530-850	646.9	103.3
	December	14	Vingen 1)	61	49.8	N 05 19 E	0	29	0	33-40	35.4	1.5	700-1270	894.1	128.0
1978	February	1	" 2)	"	"		0	4	0	34-39	37.5	-	830-1190	1060	
	January	16	Syltefjord	61	56	N 05 36.5 E	1	66	(1.5)	32-45	39.1	2.2	750-1920	1368.0	243.4
	March	15	"	"	"		4	37	(10.4)	32-44	39.0	2.9	930-2320	1446.6	327.9
	May	10	"	"	"		0	5	0	40-46	42.6	2.7	-	-	-

1) R/V "Havdrøn"

2) R/V "Peder Rønnestad"

Table 2. Weight of liver in percentage total weight of T. sagittatus in 1977 - 1978.

Locality	Date	Num- ber	Mean %	SD	Percentage of liver																		
					4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Husøy	25.X	80	9.8	2.2	1.3	1.3	1.3	8.8	17.5	21.3	12.5	16.3	8.8	3.8	5.0	2.5	-	-	-	-	-	-	-
"	15.XI	99	9.1	2.2	-	2.0	10.0	15.2	15.2	16.2	13.2	15.2	7.0	3.0	3.0	-	-	-	-	-	-	-	-
Syltefjord	29.X	79	14.9	2.4	-	-	-	-	-	2.5	1.3	2.5	7.6	12.7	18.5	19.0	13.9	12.7	5.1	3.8	-	1.3	1.3
"	6.XII	87	14.2	2.5	-	-	-	-	-	1.2	6.9	5.8	11.5	12.6	17.2	14.9	11.5	10.3	4.6	1.2	-	2.3	-
"	14.XII	59	13.1	2.4	-	-	-	1.7	1.7	8.5	5.1	3.4	13.5	22.0	17.0	6.8	15.3	3.4	1.7	-	-	-	-
Suladypet	10.XII	10	11.2	2.4	-	-	-	10	10	-	10	20	20	20	-	10	-	-	-	-	-	-	-
Vingen	14.XII	29	9.0	1.8	3.4	-	3.4	10.3	17.2	27.6	17.2	17.2	-	3.4	-	-	-	-	-	-	-	-	-
Syltefjord	16.I	60	11.6	2.4	-	-	-	1.7	11.7	6.7	11.7	21.7	11.7	15.0	3.3	10.0	3.3	3.3	-	-	-	-	-
"	15.III	37	10.2	3.3	2.7	2.7	5.4	2.7	24.3	8.1	8.1	10.8	10.8	8.1	8.1	-	5.4	2.7	-	-	-	-	-



Table 3. Frequency percentage of food organisms in the stomachs of T. sagittatus.

Locality	Date	Fish	Squid	Krill	Shrimps	Amphi-	Poly- chaetes	Par- euchaeta	Indeter- mined
Seløy	1. X	41.5	37.2	43.5	16.2	16.2	4.9	30.6	-
"	2. XI	45.9	43.8	8.3	3.2	25.0	2.1	2.1	-
Husøy	25. X	44.3	44.3	7.7	7.7	17.3	1.9	3.8	-
"	15. XI	46.1	48.0	2.0	4.0	6.0	4.0	-	6.0
Syltefjord	29. X	75.0	21.4	3.6	-	10.7	-	-	-
"	6. XII	46.5	18.5	5.6	40.8	5.6	3.7	-	9.3
"	14. XII	57.0	25.7	5.7	31.4	-	-	-	-
"	16. I	17.3	15.5	-	62.0	-	-	-	22.4
"	15. III	85.3	18.3	-	38.2	-	-	-	-
Vingen	14. XII	67.0	20.8	33.3	4.2	-	41.5	-	-

Table 4. Percentage of T. sagittatus stomachs with various degrees of filling in different localities 1977 - 1978.

Locality	Date	0	I	II	III	IV	V
Seløy	1. X	1.6	26.6	57.8	9.4	1.6	3.2
"	2. XI	2.1	34.4	44.8	12.5	5.2	1.0
Husøy	25. X	35.8	33.3	21.0	9.9	-	-
"	15. XI	1.6	27.0	58.7	9.5	-	-
Syltefjord	6. XII	39.3	30.3	14.6	12.3	3.4	-
"	14. XII	38.4	35.0	23.4	3.3	-	-
"	16. I	20.0	44.6	23.1	6.2	4.4	-
"	15. III	12.2	9.8	39.2	19.5	9.8	9.7

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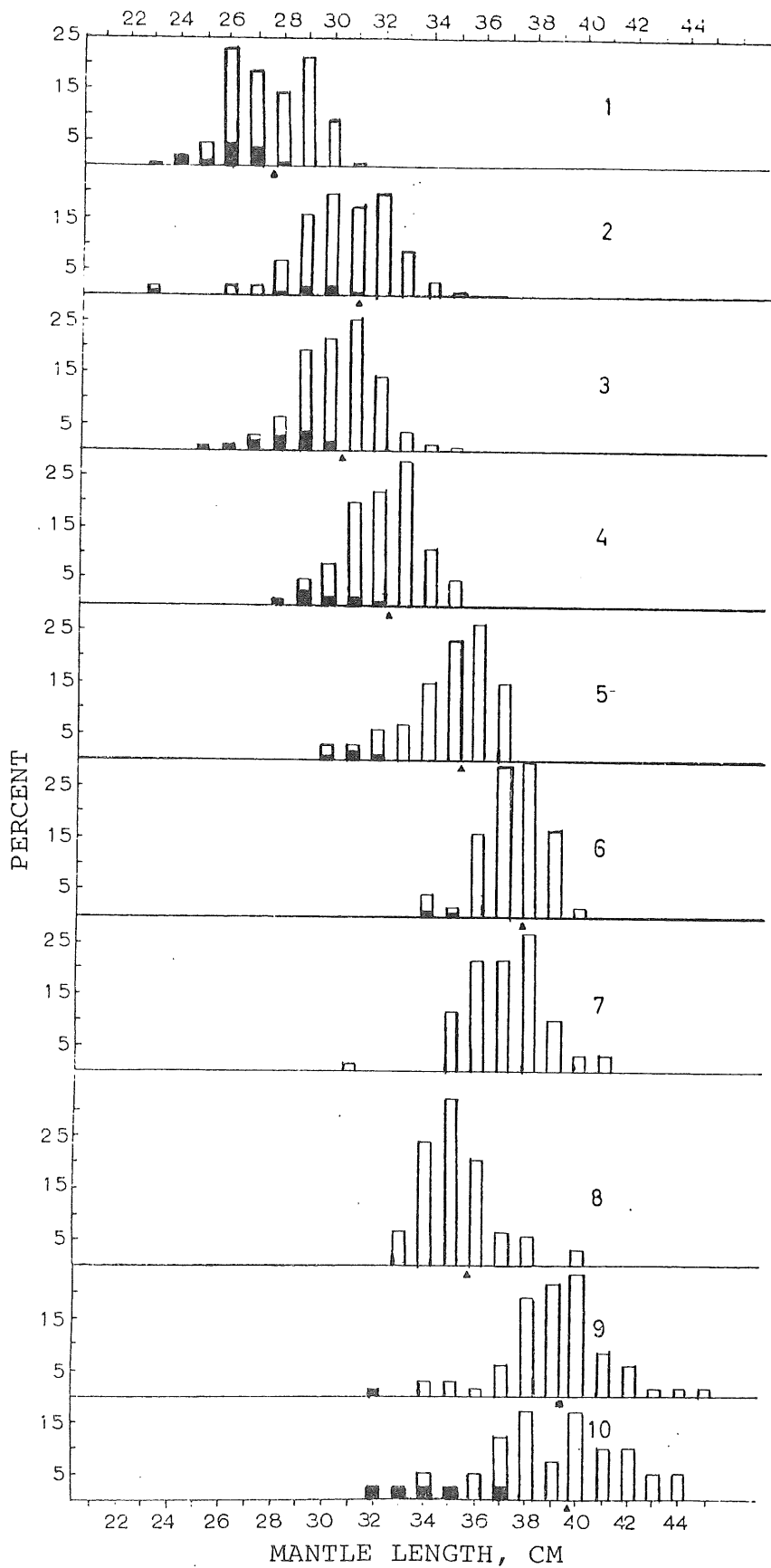


Fig. 1. Mantle length of *T. sagittatus* October 1977 - March 1978. 1) Seløy October 1-3, 2) Seløy November 2, 3) Husøy October 25, 4) Husøy November 15, 5-7) Syltefjord October 29, December 6, December 14, 8) Vingen December 14, 9) 10) Syltefjord January 16, March 15. Black columns: males, white: females.

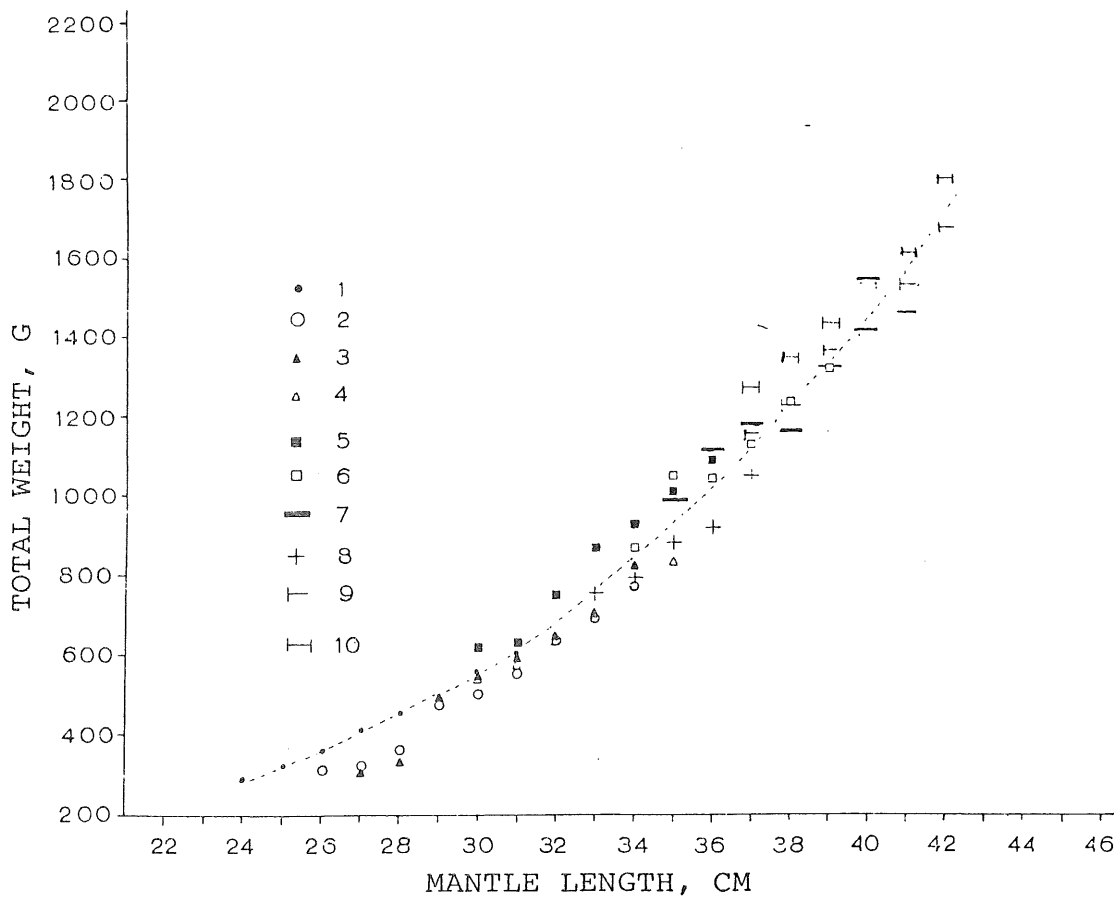


Fig. 2. Relationship: mantle length to total weight in T. sagittatus. Localities and dates as in Fig. 1.