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NORWEGIAN INVESTIGATIONS OM *GONATUS FABRICII* (LICHTENSTEIN)

by

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ABSTRACT

By far the majority of the investigated *Gonatus fabricii* were caught as bycatch by pelagic trawls fishing in the upper 60 m. Sampling took place in April/May, June/July and August/September in the period 1978-1991.

The distribution of gonatus along the Norwegian coast south of 71°N is clearly connected with Atlantic water with salinities above 35°/°°. The highest concentrations are found in the area between Jan Mayen and Spitsbergen, i.e. in the Polar front area.

The biomass of young gonatus in the Norwegian Sea constituted at least 1.5 mill tonnes in July 1994.

Young gonatus begin to occur in the surface layers in May, and they seem to descend from the upper 60 m at a length of 50-60 mm. They might then live near the bottom or pelagically at depths of 200-600 m.

Age and growth based on counts of primary growth rings should be treated with caution.

At least in the eastern part of the Norwegian Sea prey items for gonatus are, in decreasing order of impoerance, amphipods, mainly *Parathemisto* spp., copepods, chaetognaths and euphausiids. Larger gonatus consume fry of *Sebastes* sp., *Maurolicus mülleri*, and small gonatus.

Based on catch statistics are four spawning areas for gonatus suggested: West of Spitsbergen, off Vesterålen, off Møre and between Iceland and Jan Mayen.

Hatching seems to take place throughout the year while the main spawning takes place from December to April.

The growth rate of the statoliths decreases strongly in gonatus with DML 70-250 mm.

The correlation between the rostral length of the gonatus beak and dorsal mantle length was calculated.

Gonatus are important as food for the bottlenose whale. It has been recorded in stomachs of hooded seals, salmon, blue ling and Greenland halibut.

INTRODUCTION

Gonatus fabricii (Lichtenstein, 1818) is the most abundant squid of the arctic and subarctic waters of the North Atlantic. This squid has been studied intensively in recent years and is the best known oceanic cold water squid (Kristensen 1983). In his work about the biology of *Gonatus fabricii* Kristensen (1983) concludes: "*Gonatus fabricii* hatch at a size of 0.3 cm PL (*Pen Length. Present authors note*). As juveniles of 0.3-4.0 cm the species live in the uppermost 80 m of the water column. At increasing size they live deeper, and as sub-adults and adults they live above the bottom from 200 m downwards, but migrate upwards at night. Growth is about 8 mm per month and they reach a size of about 10 cm PL the first year.

After the first winter period the gonads begin to develop and this continues until maturity is reached. For females in West Greenland, this seems to be at an age of about 2-3 years and at a size depending of the region.

After spawning the female apparently dies. Males mature at an age of about 2 years, and might be able to breed twice, i.e. at the age of 2 and 3 years. Three years is probably the maximum age, the animal then being about 30 cm PL. The spawning areas are on the continental slope, the eggs probably deposited on the bottom. At spawning the eggs are roughly spherical and have a diameter of about 5 mm.

All information, except on maturity and reproduction, is based on extensive and well-examined data. Information on reproduction was obtained from a few specimens, but these were rich in new information.

Although *Gonatus fabricii* is today one of the best known oegopsid cephalopods, work is still required in order to obtain knowledge of the spawning of the eggs and location of the large numbers of adults which are presumed to occur."

In addition to the work cited above (1983), Norwegian scientists have published work on investigations of *Gonatus fabricii* (hereafter gonatus) (Wiborg 1982; Wiborg *et al.*1982; Wiborg,*et al.* 1984a, b,) and with additional information of recent recordings of the species it is felt that these investigations can confirm existing knowledge and perhaps bring some new insight.

MATERIALS AND METHODS

By far the majority of the collected specimens of gonatus in the Norwegian studies were caught as bycatch by pelagic trawls fishing in the upper 60 m. The aim of the trawling has been to assess the abundance of young fish of economical importance (Anon 1994 , Sundby *et al.* 1989; Nedreaas and Smedstad 1987) and the sampling has been done in April/May, June/July and August/September along the Norwegian coast, in the Barents Sea and in the northeastern Norwegian Sea during the period 1978-1991 and in 1994. Most of the material used in this report is given in Table 1. Sennikov *et al.* (1989) presented the gonatus material collected from 1986 to 1988 during the 0-group survey in studying the trophic importance of gonatus. The material in Table 1 also include most of the material used by Wiborg 1979, 1980, 1982 and Wiborg,*et al.*1982, 1984a, b). During the spring and autumn cruises dorsal mantle length (hereafter DML) was sporadically measured.

DML have been measured on fresh material, most frequently on 50 specimens during the summer surveys. During the spring and autumn surveys DML were sporadic measured.

No growth rings have been counted on statoliths sampled after 1983.

RESULTS AND DISCUSSION

Distribution

The distribution of gonatus in April/May along the Norwegian coast south of 71°N is clearly connected

with Atlantic water with salinities above 35°/°° (Nedreaas and Smestad 1987), and Wiborg *et al.* (1982) states that the largest concentrations in June/July are usually found outside the 1000 m contour line (Fig. 1).

Fig. 2 shows the distribution of gonatus in July 1994 in the upper 30 m. The highest concentrations are found in the area between Jan Mayen and Spitsbergen. This is in the Polar front area, and this were among the feeding areas for herring (Blindheim 1989). Up to half of the weight of the food of herring in June in the Norwegian Sea can consist of squid identified as gonatus (Nesis 1965).

Wiborg *et al.* 1982 related the distribution of gonatus in the Norwegian Sea largely to the current system. The juveniles, living in the surface layers, are carried northwards in the eastern part, and concentrate in various eddies, e. g. between Jan Mayen and Vesterålen. With increasing size, gonatus goes deeper, and may settle along the slopes of the continental shelf. Some may follow the current farther north and northwestward, and again southwards, either in cooled Atlantic water, or perhaps joining the East Greenland current. Finally, they may reach the Jan Mayen or East Icelandic slopes.

Kristensen (1983) shows a distribution map for *Gonatus fabricii* (Fig. 3). Although the maps shows the approximate area occupied by the species based on information available then (Boyle 1983), the Norwegian material shows that the distribution area should include the area indicated on Fig. 1. Wiborg (1979, 1980, 1982) and Wiborg *et al.* (1982 1984a, b) refer to recordings of gonatus south to 61 °N and north to more than 80 °N.

Abundance

Table 1 shows the number of gonatus caught during the spring, summer and autumn surveys. The table shows that the number of gonatus caught was highest during the period 1985-1988 during the summer surveys.

The pelagic trawl used in the Norwegian Sea in July1994 had an opening of 30m*30m, and was fishing at surface. In a nearly similar trawl, Godø *et al.* (1994) found insignificant herding effect of the large meshes in front of the trawl on cod larvae smaller than 65 mm. Waldemarsen (IMR, *pers. comm.*) estimates an effective catching opening of $30m^2 \pm 10m^2$ on the trawl used to sample young cod. Using the same reasoning for gonatus, the integrated amount of young gonatus in Fig. 2 constituted 2.0, 1.5 and 3.0 mill. tonnes with an effective catching opening of $30m^2$, $40m^2$ and $20m^2$, respectively. This is a very low estimate since only 40 m^2 of an gear opening of ca. 900 m^2 is effectively fished. Usually a continuous layer of plankton and juvenile fish is observed in the upper 50-60 m during the summer and autumn surveys and this layer is fished (Sundby *et al.* 1989; Anon.1994). It is assumed that most of the young gonatus are found here. Krill biomass in the upper 600 m sampled during the same cruises constituted 50 mill. tonnes.

Vertical distribution

Specimens of gonatus are recorded in the surface layers in May (Nedreaas 1986; Nedreaas and Smestad 1987). During a cruise in April 1995 in the same area no gonatus were collected.

The abundance of gonatus in the upper 60 m seems to decrease at a length of about 50 mm (Fig. 4). This could indicate avoidance of the gear. Most probably, however, the sharp decline at about 50 mm indicates a shift to deeper waters. This is shown by Sennikov *et al.* 1989.

Larger gonatus (DML 80-200 mm) were taken in deep pelagic and bottom hauls at 200-400 m in August. Gonatus with DML 95-255 mm, were found to be the main stomach contents of blue ling and Greenland halibut fished in April-June on the continental slope between 63°N and 64°38 ´N, at depths from 460 to 600 m (Wiborg *et al.* 1984b).

There is no clear indication of diel migration in the present material, but most of the samples were collected during conditions of nearly 24 h daylight.

It thus seems that gonatus begin to descend from the upper 60 m at a length of 50 mm, but some may decend

at lengths from 60-80 mm, as suggested by Wiborg *et al.* (1984b). They might then live near the bottom or pelagically at depths of 200-600 m.

Age and growth

Wiborg *et al.* (1982; 1984b) estimated age and growth from counts of primary growth rings in the statoliths sampled in 1980-1981 and in 1982-1983. From the 1982-1983 material they they found linear relations between DML and number og growth rings of gonatus smaller than 80 mm, but with varying slopes of the regression lines. The correlation coefficients varied from 0.47 to 0.67. This growth rate of the 1982-1983 material was in reasonable accordance with the 1980-1981 material where they found a growth rate of 6-8 mm a month. This is in good agreement with Kristensens findings from Greenland (Kristensen 1977). The investigations in 1982-83 indicated an increase of the growth rate at DML of 60-80 mm, and this was related to a change in living habits. For the larger gonatus the number of growth rings are maximum about 300, which does not fit very well into the picture. If the readings are correct, *Gonatus fabricii* must increase its growth rate considerably with the change of an epipelagic life to a deep-pelagic or bottom life.

Wiborg *et al.* (1984) proposed that growth rings in the statoliths of gonatus were formed daily, but left open the question when the formation started.

Lipinski and Durholtz (1994) concluded that it appears that squid statoliths cannot yet be regarded as accurate an ageing tool as fish otoliths. Therefor, the results above (Wiborg *et al.* 1982 and 1984b) should be treated with caution, as the authors suggest.

Food

The stomach contents of gonatus from pelagic trawl hauls were studied (Wiborg 1980, 1982). Various organisms, mostly crustaceans, were identified. The average frequencies of the most important groups were: Amphipoda 62.8%, Copepoda 33.6%, Chaetoghnata 21.9%, Euphausiacea 7.7%. Larger gonatus had also taken fry of *Sebastes* sp., *Maurolicus mülleri,* and small gonatus.

Samples taken at random in 1982 and 1983 showed the same food organisms as were found earlier (Wiborg *et al.* 1984). Amphipods, mainly *Parathemisto* sp. dominated, followed by copepods, chaetognaths, euphausiids and *Phasiphaea* sp. Sennikov *et al.* (1989) found the same ranking for gonatus sampled in June-August.

Spawning area

Fig. 1 shows the distribution of gonatus smaller than 10 mm from the spring, summer and autumn material. The smallest specimens are distributed from 66°N to nearly 74°N and from 5°E to 20°E, and in a more southernly area than the larger ones. All gonatus smaller than 10 mm were sampled during the summer surveys.
If the gonatus hatch at a length of 3 mm and have a growth rate of 8 mm/month as suggested by Kristensen (1977, 1980), all the gonatus smaller than 10 mm is less than one month old. Judging from Fig. 1 spawning seems to take place along the continental shelf off Norway. The recordings are abundant between 69°N and 72°N. This is an area for observing sperm whale (*Physeter macrocephalus* L.) and squid beaks have been recorded stomachs of whales caught in 1971(Benjaminsen, IMR *pers. com).* These are not at present identified. Squid is amounting to 80% of the entire food bolus of sperm whales (Berzin 1972), and gonatus is a one of the main food items (Nesis 1965).

Sennikov *et al.* (1989), reports findings of a spawning male of length 320 mm at 68°31´N, 08°30´E (off Vesterålen) at depths of 300 m, in May, in addition to a spawning male (220 mm) and two females (310 mm and 385 mm) on the southern shelf of Jan Mayen in October at depths of 160-215 m.

Benjaminsen and Christensen (1979) found gonatus to be the main food item for bottlenose whale (*Hyperoodon ampullatus*). Based on this and of other similar recordings, Wiborg (1979) suggested that areas with high abundance of bottlenose whale could be spawning grounds for gonatus. A map showing areas where bottlenose whale were caught by Norwegian whalers during the period 1938-1972 suggests four main areas: West of Spitsbergen, off Vesterålen, off Møre and between Iceland and Jan Mayen (Fig. 5).

Hatching period.

Wiborg *et al.* (1982) concluded that hatching took place during most of the year, with a maximum in February-April.

From the 1982-1983 material they found that spawning took place from October to June and the main spawning from December to April. They found different spawning periods depending of sampling period and area. (Wiborg *et al.*1984).

Table 1 show the minimum, maximum and average length of gonatus in the present material. Assuming a hatching length of 3 mm and a growth rate of 8mm/month as suggested by Wiborg *et al.*(1982) and by Kristensen (1980) the earliest and latest hatching can be calculated. The table shows that gonatus with minimum length of 10 mm are recorded during the spring, summer and autumn surveys indicating hatching at least less than a month before the survey, i. e. from April to August. Assuming a constant growth rate as indicated by Kristensen (1980), the oldest gonatus hatched at the end of July the previous year. All months are represented in Table 1. Hence hatching seems to take place throughout the year. Fig. 4 indicate that the descent of gonatus seems to start at a length of 50 mm. The length frequencies of gonatus sampled at spring indicate that the majority of gonatus hatched that year are represented. The mean length of these indicate hatching in January-February.

Statolith length/mantle length.

Wiborg (1979), Wiborg et al. (1982) (1984a) studied the the relationship total statolith length/dorsal mantle length. They found that the growth rate of the statoliths decreased strongly in gonatus with DML 70-250 mm. This indicate together with the observation of increased growth rate of the mantle at a length of 60-80 mm, the transition from an epipelagic life to a deep pelagic or bottom life. The following equations were found:

DML 10-250 mm:	$TLS = 0.131\ DML^{0.47}$, n=201, $r^2 = 0.93$
DML 10- 96 mm:	$TLS = 0.104\ DML^{0.53}$, n=163, $r^2 = 0.93$
DML 70- 296 mm:	$TLS = 0.382\ DML^{0.26}$, n= 38, $r^2 = 0.74$

Rostral length/dorsal mantle length

Larger gonatus with mantle length 60-280 mm have been found in stomach content of beaked whales and hooded seals and the correlation between the rostral length of the gonatus beak and dorsal mantle length was calculated (Wiborg *et al.* 1982). The following equation for the linear regression was found:

DML (mm)=41.3 RL (mm)-38.6
r=0.96

Predators

It is well known that the bottlenose whale eats gonatus (Hjort and Ruud 1929). The stomach content of 46 bottlenose whales examined off Iceland and of 108 examined off Labrador showed that 91 and 94 percent respectively had eaten *Gonatus fabricii*. Gonatus was the only food item for 87 and 45 percent, respectively (Benjaminsen and Christensen 1979). In stomachs of hooded seals (*Cysophora cristata*) caught near Jan Mayen has Gonatus been recorded (Wiborg 1979). Gonatus is important as food for salmon (Wiborg *et al.* 1982). Larger gonatus were found in stomachs of blue ling and Greenland halibut, caught on the continental slope off western Norway in April-June 1981-1983 (Wiborg *et al.* 1984).

Juvenile occationally drifting ashore on beaches along the coast of Finmark, North Norway during the autumn, are collected for bait (Wiborg *et al.* 1982).

CONCLUSION

The distribution of gonatus in April/May along the Norwegian coast south of 71°N is clearly assosiated with Atlantic water having salinities above 35°/°°. The highest concentrations are found in the area between Jan Mayen and Spitsbergen, i.e. in the Polar front area.

The biomass of young gonatus in the Norwegian Sea constituted at least 1.5 mill. tonnes in July 1994.

Young gonatus begin to occur in the surface layers in May. and they seems to descend from the upper 60 m at a length of 50-60 mm. They might then live near the bottom or pelagically at depths of 200-600 m.

Age and growth based on counts of primary growth rings should be treated with caution.

At least in the eastern part of the Norwegian Sea the ranking of food items for gonatus is amphipods, mainly *Parathemisto* spp., copepods, chaetognaths and euphausiids. Larger gonatus had also taken fry of *Sebastes* sp., *Maurolicus mülleri*, and small gonatus.

Based on catch statistics are four spawning areas for gonatus suggested: West of Spitsbergen, off Vesterålen, off Møre and between Iceland and Jan Mayen.

Hatching seems to take place throughout the year while the main spawning takes place from December to April.

The growth rate of the statoliths decreases strongly in gonatus with DML 70-250 mm.

The correlation between the rostral length of the gonatus beak and dorsal mantle length was calculated. The following equation was found:

$$DML\ (mm) = 41.3\ RL\ (mm) - 38.6$$
$$r = 0.96$$

Gonatus are important as food for the bottlenose whale. It has been recorded in stomachs of hooded seals, salmon, blue ling and Greenland halibut.

REFERENCES

Anon. 1994. Preliminary report of the international 0-group fish survey in the Barents Sea and adjacent waters in August-September 1993. ICES CM 1994, /G:3

Benjaminsen, T. and Christensen, I. 1979. The natural history of the bottlenose whale, *Hyperoodon ampullatus* (Foster). P. 143-146 in: Winn, Howard E.,Olla, B. L. eds. *Behavior of marine animals.* Plenum Publishing Corporation, New York.

Berzin, A. A. 1972. *The sperm whale.* Israel Program for Scientific Translations, Jerusalem, 394 pp.

Blindheim, J. 1989. Ecological features of the Norwegian Sea. P. 366-401 in: Rey, Louis and Alexander, V. eds.*Proceedings of the sixth conference of the comite' arctique international 13-15 May 1985,* Fairbanks, Alaska, 13-15 May, 1985. Brill, E. J., Leiden, Leiden, New York, København, Köln.

Boyle, P. R. 1983. Introduction. P. 1-8 in: Boyle, P. R. (ed.) *Cephalopod life cycles. Volume I. Species accounts.* Academic Press, London, 475 pp.

Godø, O. R., Valdemarsen, J. W. and Engås, A. 1993. Comparison of efficiency of standard and experimental juvenile gadoid sampling trawls. *ICES mar. Sci. Symp., 196*:196-201.

Hjort, J. and Ruud, J. T. 1929. Whaling and fishing in the North Atlantic. *Rapp. P.-v. Reun. Cons. int. Explor. Mer, 56*:1-123.

Kristensen, T. K. 1977. Hatching, growth and distribution of juvenile Gonatus fabricii (Mollusca: Cephalopoda) in Greenland waters. *Astarte, 10*:21-28.

Kristensen, T. K. 1980. Periodical rings in cephalopod statoliths. *Dana, 1*:39-51.

Kristensen, T. K. 1983. Gonatus fabricii. P. 159-173 in: Boyle, P. R. (ed.) *Cephalopod life cycles. Volume I. Species accounts.* Academic Press, London, 475 pp.

Lipinski, M. R. and Durholtz, M. D. 1994. Problems associated with ageing squid from their statoliths - towards a more structured approach. *Antarctic Science, 6*:215-222.

Nedreaas, K. 1986. Abundance and distribution of postlarvae in the 0-group saithe survey in the North-East Arctic in 1985. ICES CM 1986/ G:87

Nedreaas, K. and Smestad, O. 1987. Abundance and distribution of postlarvae in the 0-group saithe survey in the Northeast Arctic in 1986 and 1987. ICES CM 1987/G:87

Nesis, K. N. 1965. Distribution and feeding of young squids Gonatus fabricii (Licht.) in the Labrador Sea and the Norwegian Sea. *Oceanologi*(Translation of the Russian Okeanologiya by Scripta Technia Inc. for The American Geographical Union), *5*:102-108.

Sundby, S., Bjørke, H., Soldal, V. A. and Olsen, S. 1989. Mortality rates during the early life stages and year-class strength of the northeast Arctic cod (*Gadus morhua* L.). *Rapp. P.-v. Reun. Cons. int. Explor. Mer, 191*:351-358.

Wiborg, K. F. 1979. *Gonatus fabricii* (Lichtenstein), en mulig fiskeriressurs i Norskehavet. (*Gonatus fabricii* (Lichtenstein), a possible fishery resource in the Norwegian Sea). *Fisken Hav., 1979* (1):33-46. (In Norwegian, with English summary).

Wiborg, K. F. 1980. Undersøkelser av *Gonatus fabricii* (Lichtenstein) i Norskehavet og det vestlige Barentshavet i juni-september 1979. (*Gonatus fabriici* (Lichtenstein). Investigations in the Norwegian Sea and the western Barents Sea, June-September 1979). *Fisken Hav., 1979* (1): 13-27. (In Norwegian, with English summary).

Wiborg, K. F. 1982. Undersøkelser av *Gonatus fabricii* (Lichtenstein) i Norskehavet og det vestlige Barentshavet i februar-september 1980 og juli-september 1981. (*Gonatus fabricii* (Lichtenstein). Investigations in the Norwegian Sea and the western Barents Sea, February-September 1980 and July-September 1981). *Fisken Hav.., 1982* (2): 13-25. (In Norwegian, with English summary).

Wiborg, K. F., Gjøsæter, J. and Beck, I. M. 1982. The squid *Gonatus fabriici* (Lichtenstein). Investigations in the Norwegian Sea and western Barents Sea 1978-1981.ICES CM 1982/K:31.

Wiborg, K. F., Gjøsæter, J. and Beck, I. M. 1984a. *Gonatus fabriici* (Lichtenstein). Undersøkelser i Norskehavet og det vestlige Barentshavet, i juni-september 1982 og 1983. (*Gonatus fabriici* (Lichtenstein). Investigations in the Norwegian and western Barents Seas, June-September 1982 and 1983). *Fisken Hav., 1984* (2):1-11. (In Norwegian, with English summary).

Wiborg, K. F., Beck, I. M. and Gjøsæter, J. 1984b. The squid *Gonatus fabricii* (Lichtenstein). Investigations in the Norwegian Sea and western Barents Sea 1982-1983. ICES CM 1984/K:19.

Table 1. *Gonatus fabricii.* Catch per trawl hour. Length measurements=number of stations/number of stations with gonatus/number of stations with length measurements/number of gonatus measured. Mean, maximum and minimum length, earliest, latest and maximum hatching based on growth rate.

Year	*Catch*	Length measurements	*Mean length mm*	*Min. length mm*	*Max. length mm*	*Earliest hatching*	*Latest hatching*	*Maximum hatching*
April/May								
1985	21538	146/99/2/164	31.33	14	48	Mid Nov. 1984	Mid Mar.	Mid Jan.
1986	29496	223/81/2/101	25.58	10	40	Mid Des. 1985	Early April	Early Feb.
1987	10264	262/105/?/0						
1988	22146	236/?/3/9	48.33	40	55	End May	Early April	
1989	25260	252/58/21/638	31.92	11	55	Mid Oct. 1988	Early April	Mid Jan.
1990	1896	240/44/44/274	33.97	11	60	End Sept.1989	Early April	Early Jan.
1991	2454	229/36/35/432	28.88	13	59	Early Oct. 1990	End Mar.	End Jan.
June/July								
1978	3899	60/40/5/225	26.13	12	40	Mid Feb.	End May	
1979	19263	82/62/61/2162	27.26	6	70	Mid Oct. 1977	Mid. June	
1980	18614	84/44/44/2665	34.04	9	84	End Aug. 1978	Early June	
1981	4423	101/39/39/1231	22.99	6	70	Mid Oct. 1979	Mid June	
1982	2314	155/31/30/386	28.03	10	60	End Nov. 1980	Early June	
1983	5287	99/40/39/671	33.81	11	61	End Nov. 1981	Early June	
1984	8674	145/69/13/52	25.87	10	45	End Jan.	Early June	
1985	32471	128/65/15/79	28.24	15	45	End Jan.	Mid May	
1986	35758	196/92/66/1237	38.89	12	72	Mid Oct. 1985	End May	
1987	19287	218/129/129/3181	37.33	7	82	Early Sept. 1986	Mid June	
1988	28234	242/119/119/3577	37.58	6	85	End Aug. 1987	Mid June	
1989	8908	242/93/93/2109	36.66	8	78	Mid Sept.1988	Mid June	
1990	1968	105/45/45/666	40.17	14	75	Early Oct. 1989	Mid May	
1991	3498	162/80/80/1120	32.72	7	81	Early Sept. 1990	Mid June	
Aug./Sept.								
1983	126	274/?/3/9	46.17	27	67	Early Jan.	Early June	
1984	1988	256/?/1/1						
1985	5146	301/?/26/302	47.45	22	112	Mid Aug. 1984	Mid June	
1986	3218	332/?/23/314	44.88	17	87	Mid Nov. 1985	Early July	
1987	39348	269/?/48/2283	38.33	14	170	End July 1986	Mid July	
1988	10966	283/104/95/2176	35.94	10	111	Mid Aug. 1987	Early Aug.	
1989	2654	430/82/71/771	32.85	11	115	Early. July 1988	Early May	
1990	1384	399/60/45/657	36.88	10	119	Mid July 1989	Early Aug.	
1991	1212	419/54/66/402	38.6	17	103	Mid Sept. 1990	Early July	

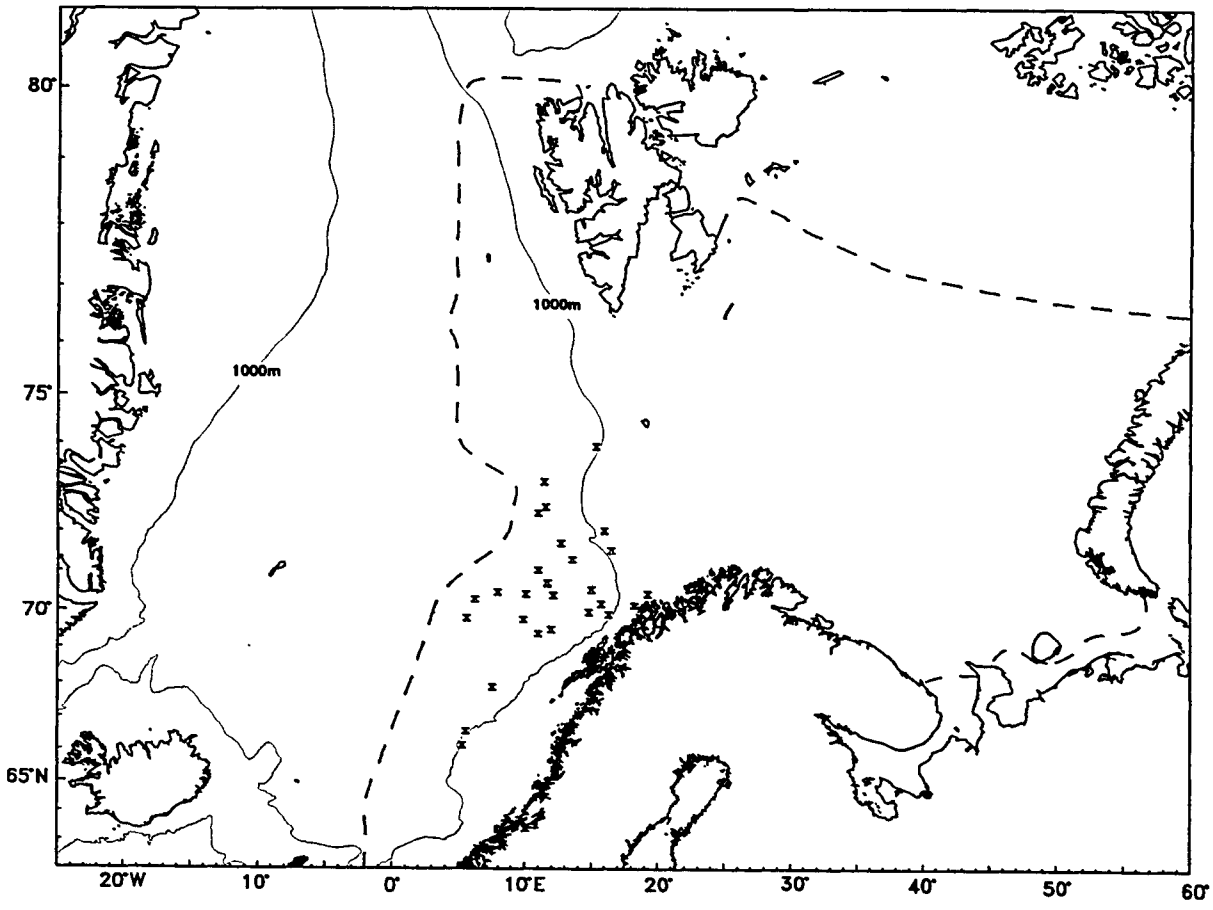

Fig. 1. Distribution of *Gonatus fabricii* smaller than 10 mm from the material presented in Table 1. Dashed line indicate investigated area. 1000 m contour line is indicated.

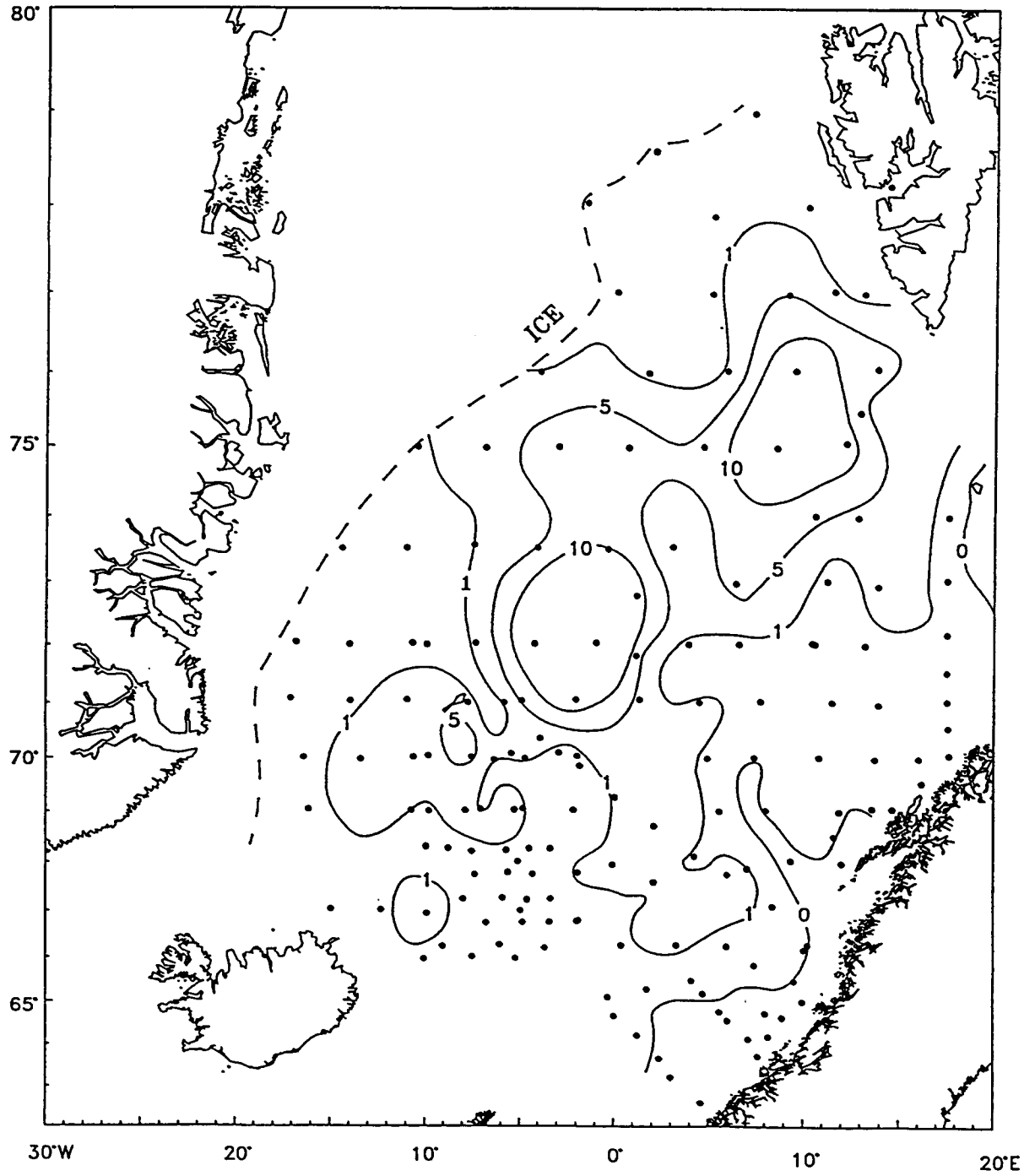

Fig. 2. Abundance of *Gonatus fabricii* in July 1994. Catch of gonatus in kilogrammes per 30 min. trawl haul in the surface layers.

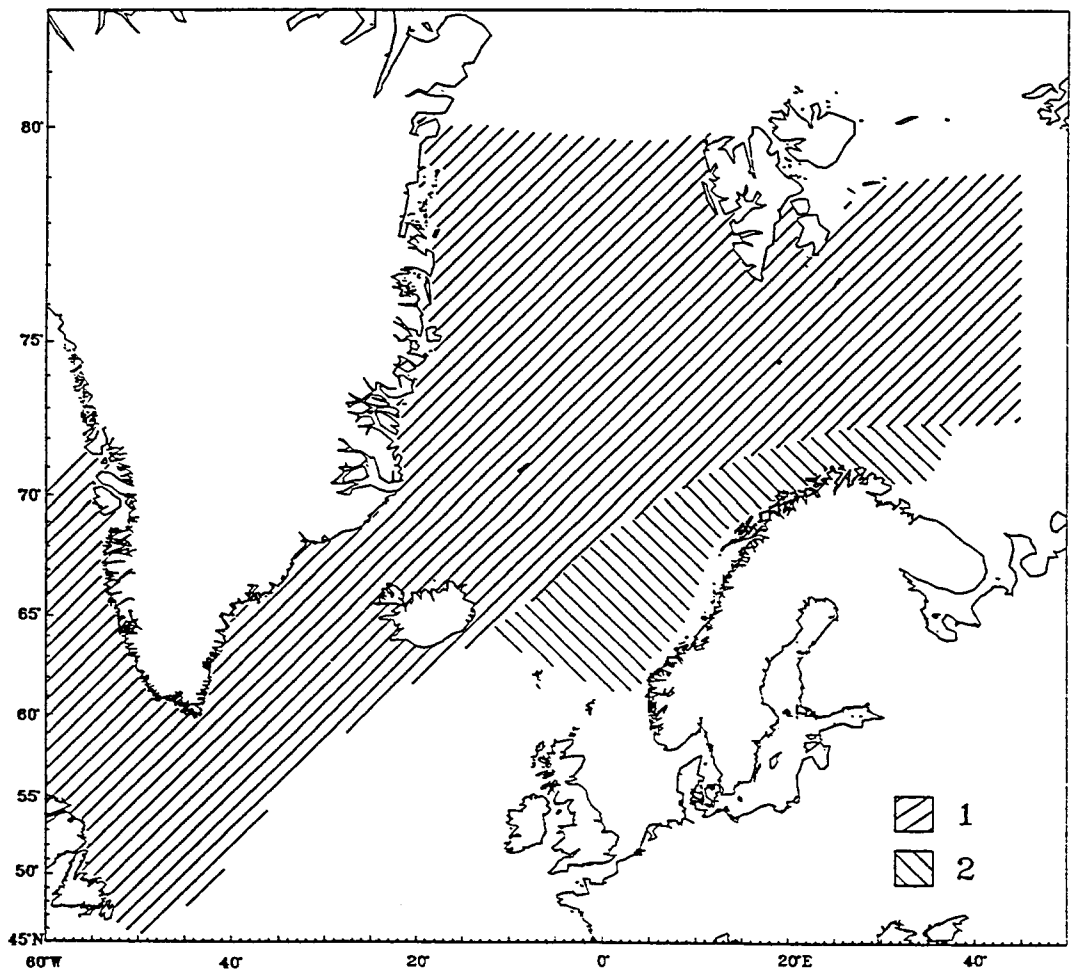

Fig. 3. Distribution of *Gonatus fabricii* in the North Atlantic. 1. Distribution shown by Kristensen (1983). 2. Additional distribution area found during Norwegian investigations.

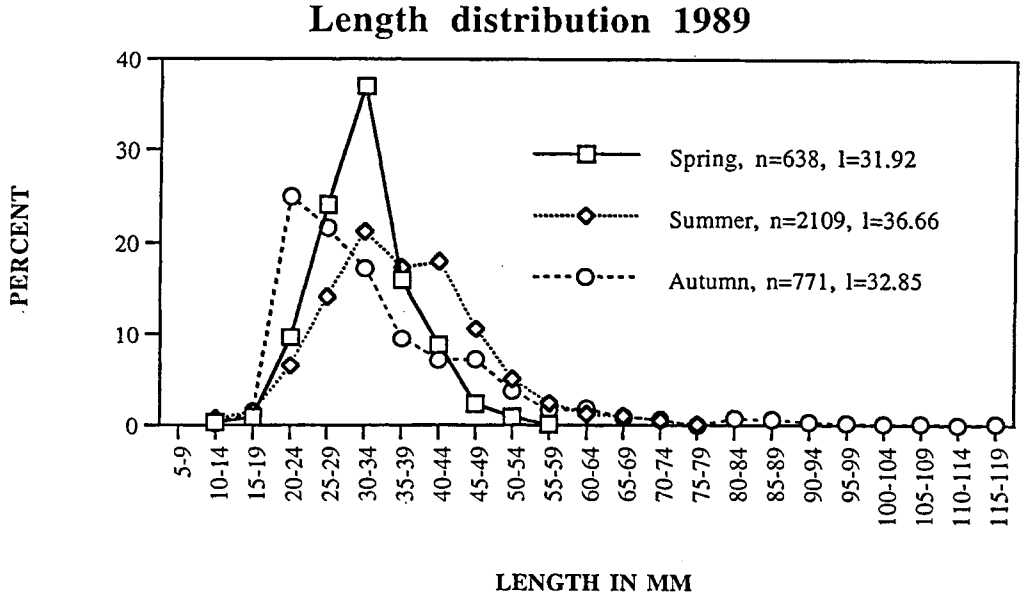

Fig. 4. Length distribution of *Gonatus fabricii* in 1989 in the upper 60 m.

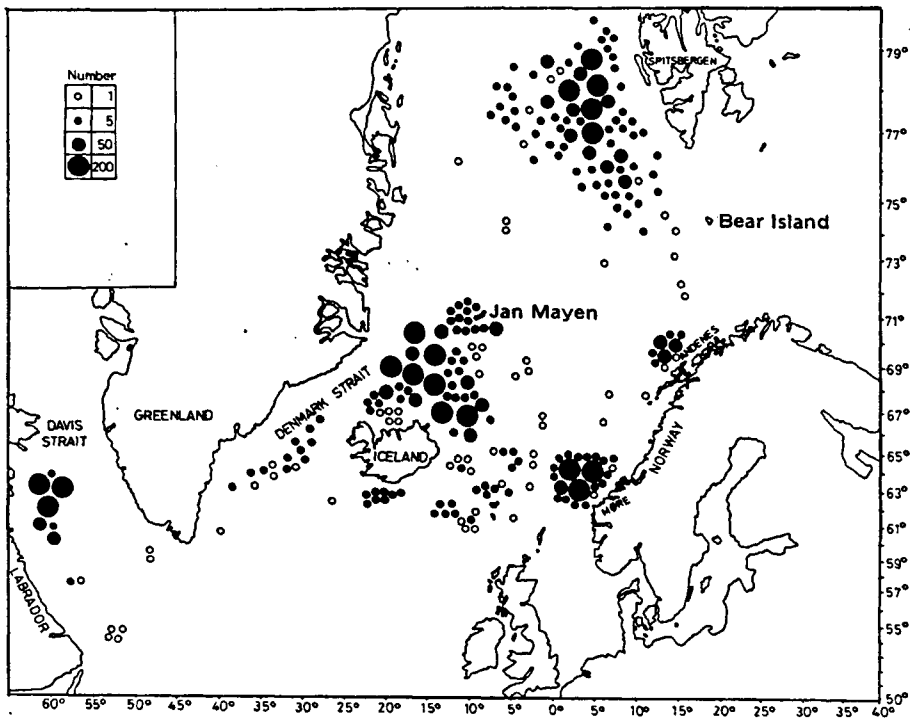

Fig. 5. Localities of bottlenosewhales (*Hyperoodon ampullatus*) caught by Norwegian whalers in the period 1938-1972. From Benjaminsen and Christensen 1979.