

The Boreoatlantic gonate squid *Gonatus fabricii*: distribution and size off West Greenland in summer 1989 and in summer and autumn 1990

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Abstract

The Boreoatlantic gonate squid *Gonatus fabricii* is the most abundant squid in the offshore arctic and subarctic waters of the northern Atlantic. Adults are common in midwater while juveniles occur in surface waters close to the continents. As part of a research project focussing on the interactions among fish stocks off West Greenland we examined squid collections sampled with small pelagic nets in summer 1989 and in summer and autumn 1990 off Southwest Greenland. *G. fabricii* was by far the most abundant cephalopod species caught. We recorded a total of 698 juvenile specimens. During the summer cruise in 1989 the mantle lengths varied from 6 to 35 mm ($n=84$); in summer 1990 they ranged from 10 to 48 mm ($n=542$) with significantly larger body sizes in the southern part of the region. In autumn 1990 the mantle lengths ranged from 19 to 64 mm ($n=72$) with largest animals again at the southern sampling sites. The data suggest growth rates for juvenile *G. fabricii* off West Greenland of 4 to 5.5 mm per month between July and November 1990.

Keywords: Squid, geographical and seasonal, distributions, size distribution, quantitative distribution, West Greenland, *Gonatus fabricii*.

L'encornet atlantoboréal (Gonatus fabricii): distribution et taille à l'ouest du Groënland en été 1989 et en été et automne 1990.

Résumé

L'encornet atlantoboréal (*Gonatus fabricii*) est l'encornet pélagique le plus abondant des eaux arctiques et subarctiques de l'Atlantique. Les adultes se trouvent habituellement dans les couches de profondeur moyenne, et les juvéniles se trouvent en surface et proche de zone littorale. Parallèlement à une étude des stocks de poissons à l'ouest du Groënland, nous avons étudié les encornets pris avec des petits filets pélagiques en été 1989 et en été et automne 1990. *G. fabricii* fût le céphalopode le plus abondant, avec 698 juvéniles échantillonnés. En été 1989, les longueurs du manteau étaient de 6 à 35 mm ($n=84$); en été 1990, les longueurs étaient de 10 à 48 mm ($n=542$), et la taille du corps était significativement plus importante au sud de la région échantillonnée. En automne 1990, les longueurs du manteau étaient de 19 à 64 mm ($n=72$), et les animaux les plus grands se trouvaient encore dans le secteur sud. Les données suggèrent un taux de croissance d'entre 4 et 5,5 mm par mois pour les juvéniles de *G. fabricii* sur la côte sud-ouest de Groënland pour la période de juillet à novembre 1990.

Mots-clés : Encornet, distribution géographique, composition en taille, abondance, ouest du Groënland, *Gonatus fabricii*.

INTRODUCTION

The estimated total world catch of marine and freshwater molluscs was 7.9 million metric tonnes in 1989 (FAO, 1991). Teuthoidea, better known as squid, were the most important order among the molluscs with 2.1 million metric tonnes being landed in 1989, representing an increase of 14% compared to 1988. Squid fisheries in the South Atlantic are very intense (approximately 0.8 million metric tonnes in 1989) and concentrated on the Patagonian Shelf, while commercial catches from the North Atlantic are comparatively low with only 50 000 metric tonnes landed in 1989. With the depletion of several fish stocks in the North Atlantic increasing attention is now being paid to the so-called unconventional marine resources which include many squid species (Roper *et al.*, 1984).

Target species in the North Atlantic are the myopsid squid *Loligo forbesi* (Pierce *et al.*, 1992) and the ommastrephid squid *Illex illecebrosus* (Black *et al.*, 1987) and *Todarodes sagittatus* (Sundet, 1985; Shimko, 1989). Until today the subarctic gonate squid *Gonatus fabricii* has not been exploited, although spawning concentrations on the continental slope off western Norway and in the Barents Sea may be of commercial interest (Wiborg *et al.*, 1984; Sennikov *et al.*, 1989).

Gonatus fabricii is the most abundant squid of the arctic and subarctic waters of the North Atlantic and has been intensely studied by Nesis (1965) and Kristensen (1984). Its early life stages are found in large numbers in West Greenland waters, mostly as a bycatch in the shrimp fishery. *G. fabricii* occurs in

the stomachs of marine mammals, birds and fishes such as gadoids and the redfish *Sebastes marinus* (Nesis, 1965; Roper *et al.*, 1984). It is likely that this squid is an important component in the marine ecosystem off West Greenland with a considerable fishery potential. At present, however, only Inuit use it at Greenland as bait in the cod fishery and to a minor extent for human food (Roper *et al.*, 1984).

In the present study we provide new information on spatial distribution and body size of *Gonatus fabricii* off West Greenland. Additionally, seasonal comparisons of the length distributions within one year permit some growth estimations of this potentially economically important squid.

MATERIAL AND METHODS

Cephalopods were sampled along oceanographic transects off West Greenland during cruises of RV "Poseidon" (6 July-4 August 1989; 12 July-2 August 1990) and FRV "Walther Herwig" (20 October-28 November 1990) (fig. 1). During the first Poseidon cruise in summer 1989 zooplankton and micronekton were sampled with a MOCNESS (Multiple Opening/Closing Net and Environmental Sensing System; Wiebe *et al.*, 1976) which has a mouth opening of 1 m² and a mesh size of 300 µm. The standard oblique haul consecutively sampled eight different depth layers between 200 m and the surface. The towing speed was 3 knots. Since squids appeared in low numbers, only their total density was calculated for the whole water column sampled during each

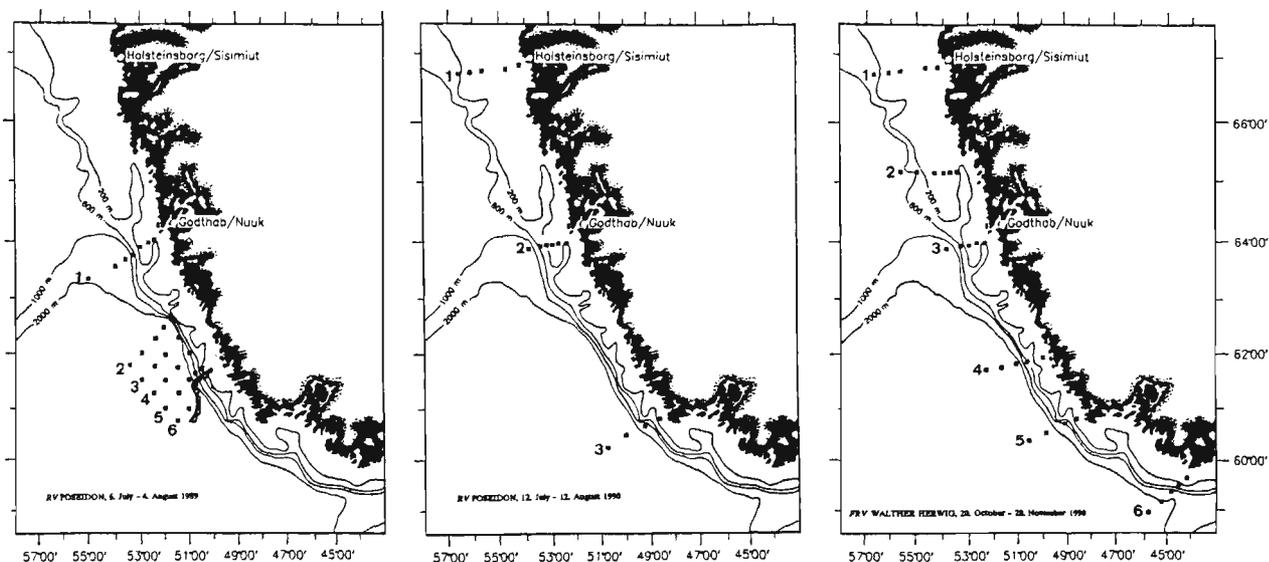


Figure 1. — Sampling sites. ■ MOCNESS stations (summer 1989) or IKMT stations (summer and autumn 1990).

MOCNESS haul; *i. e.* squid samples were pooled over depth for each haul.

In summer and autumn 1990 the early life stages of fish and squid were sampled with an IKMT (Isaacs Kidd midwater trawl; Isaacs and Kidd, 1953). The net opening was 10 m² and the mesh size in the codend was 4.5 mm in summer 1990, and 5.0 mm in autumn 1990. The standard oblique haul sampled down to 175 m in summer 1990, and 200 m in autumn 1990. The towing depth of the IKMT was recorded with an acoustic net sonde; a flowmeter was attached in the centre of the net opening. Total micronekton samples were stored in a 4% buffered formalin/freshwater solution. Ashore squid were sorted from the samples and dorsal mantle length (ML, in mm) was measured for each specimen. Density of squid was calculated as number per unit volume ($n/1000\text{ m}^3$).

Physical oceanographic data were obtained at biological sampling stations from CTD recordings with a ME multi-sonde.

RESULTS

Forty-seven of 67 micronekton stations during the three cruises yielded squid. All specimens were juvenile or sub-adult *Gonatus fabricii* ($n=698$), with the exception of one animal that was identified as the cranchiid species *Teuthowenia megalops* (ML=52 mm). It was captured during the autumn 1990 cruise at one of the most southern stations (50°17'N, 44°52'W) within the top 200 m. Water temperature was approximately 5°C.

During the summer cruise in 1989 (*fig. 1*) the total number of juvenile *Gonatus fabricii* was 84. They were distributed throughout the sampling area with slightly higher concentrations at the Fyllas Bank off Godthab (transect 1; *fig. 1*). The lengths varied from 6 to 35 mm (*fig. 2*).

The summer cruise in 1990 yielded the largest squid samples. Altogether 542 specimens were caught on three transects off West Greenland (*fig. 1*). The length distribution ranged from 10 to 48 mm (*fig. 2*). Mean lengths of the two northern transects were very similar with $\bar{x}=18.7$ mm (std=5.4) off Holsteinsborg (transect 1), and $\bar{x}=18.8$ mm (std=5.1) at Fyllas Bank (transect 2; *fig. 3*). The southern transect off Kap Desolation (transect 3), however, revealed a significantly larger mean mantle length with $\bar{x}=22.9$ mm (std=5.2; Mann-Whitney U-test, $p<0.05$). Densities varied between 0.05/1000 m³ and 2.88/1000 m³ (*fig. 4*). The animals were most abundant at the nearshore stations of the Fyllas Bank (transect 2) at water temperatures between 0 and 3°C.

During the autumn cruise in 1990 a comparatively low number of *Gonatus fabricii* was caught: $n=72$ specimens at 11 of 29 IKMT stations. The lengths

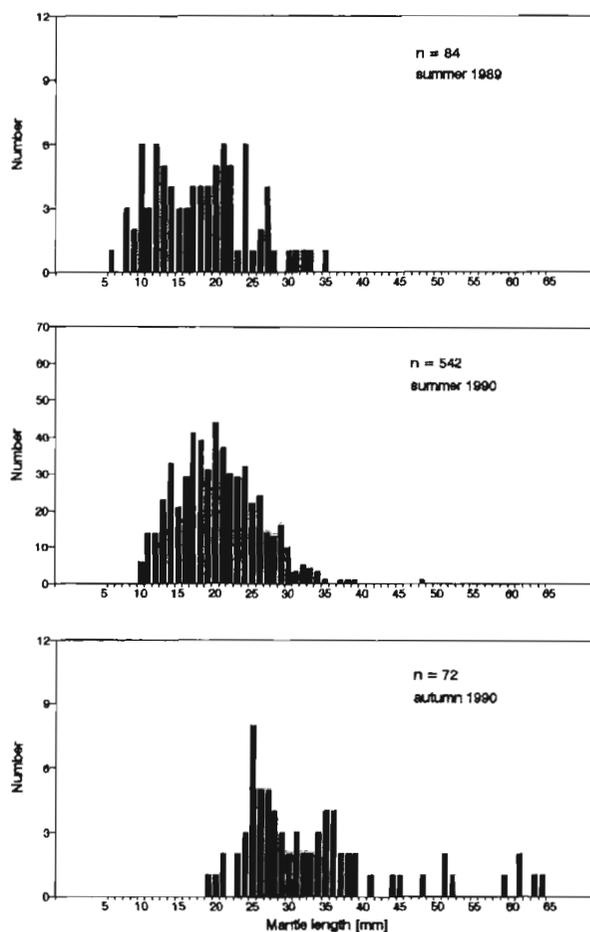


Figure 2. — *Gonatus fabricii*. Length distribution off West Greenland in summer 1989, summer 1990, and autumn 1990 (n =total number of specimens).

ranged from 19 to 64 mm suggesting that, if they were from the same cohort, they had grown considerably compared with the length distribution from the summer collection (*fig. 2*). All animals were caught on the three most northern transects (*fig. 1*) with the exception of 4 specimens which were sampled off Kap Desolation (transect 5) and off Kap Farvel (transect 6). The length distributions at the various transects (*fig. 5*) illustrate that the biggest animals were sampled at the Fyllas Bank (transect 3). Mean lengths of the specimens were $\bar{x}=32.0$ mm (std=5.6) at transect 1, $\bar{x}=27.6$ mm (std=4.3) at transect 2, and $\bar{x}=36.8$ mm (std=13.3) at transect 3. Mean lengths differed significantly (Mann-Whitney U-test, $p<0.05$) between transects 1 and 2 and transects 2 and 3. Densities were considerably lower than during the summer cruise, with values ranging between 0.04/1000 m³ and 0.41/1000 m³ (*fig. 6*). Again, the animals were most abundant at the nearshore stations of transect 3 (Fyllas Bank; T=1 to 5°C), whereas at the northern transects, the nearshore stations with cold water masses (<1°C), they were mostly absent.

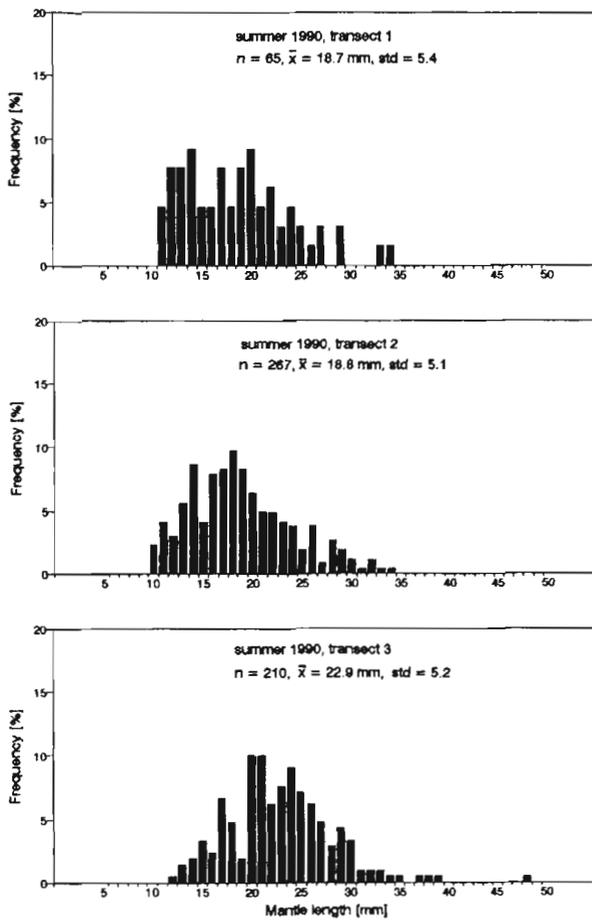


Figure 3. — *Gonatus fabricii*. Length distribution at various locations off West Greenland in summer 1990 (n =total number of specimens, \bar{x} =mean length, std =standard deviation).

DISCUSSION AND CONCLUSION

The most comprehensive work on *Gonatus fabricii* off West Greenland has been published by Kristensen (1984), who examined 7000 juvenile and 300 adult specimens. Although Kristensen's work is the most extensive study on *G. fabricii* to date, especially with respect to annual variability, it was restricted to the latitudinal range of 63°–68°N and only one month (July). The present study extends further south (to ca. 59°N) and includes also seasonal comparisons within one year. The mean size of *G. fabricii* was not as uniform as Kristensen (1984) reported from his collections which is not surprising, because his study was seasonally much more restricted (each July during the years from 1950 to 1966).

In summer 1990 the mean length of *Gonatus fabricii* was significantly larger (Mann-Whitney U-test,

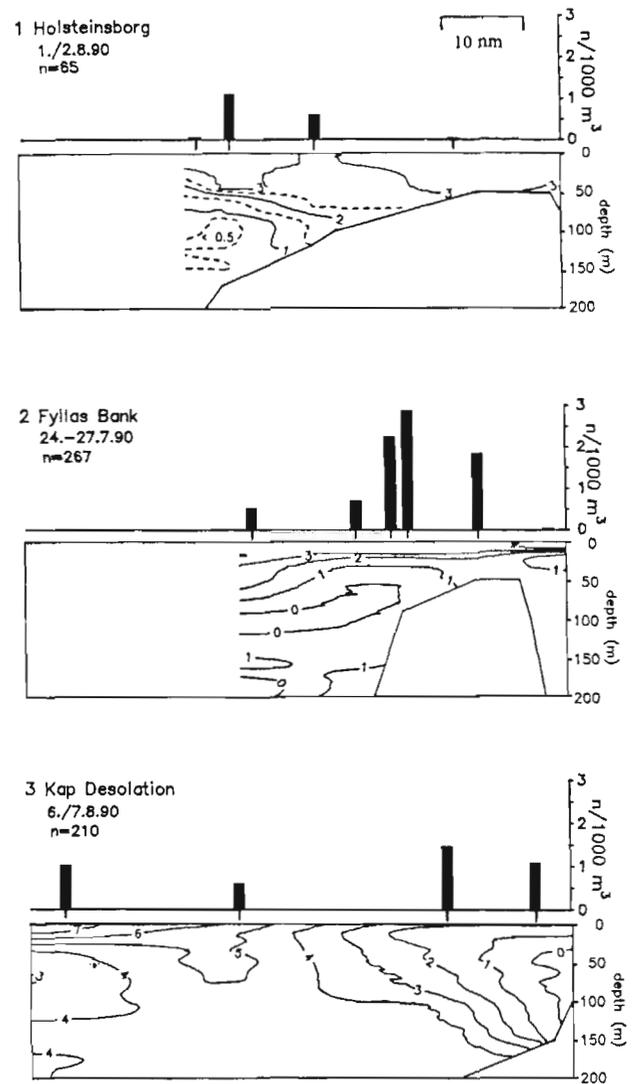


Figure 4. — *Gonatus fabricii*. Abundance (top) and vertical temperature profile (°C) (bottom) along station transects off West Greenland during summer 1990.

$p < 0.05$) at transect 3 off Kap Desolation than at the more northern transects off Holsteinsborg and at Fyllas Bank which indicates that different populations had probably been sampled. A similar pattern can be derived from the autumn collection where specimens from transect 3 (Fyllas Bank) were considerably larger than those from the more northern region (transect 2; Mann-Whitney U-test, $p < 0.05$). It cannot be excluded, however, that these differences are due to a variety of within-population effects, such as size-dependent or age-dependent migration or the distribution of size-specific prey types.

Assuming that populations along the transects are resident, juvenile growth for *Gonatus fabricii* can be estimated from the difference in mean length between the autumn and summer samples. This calculation

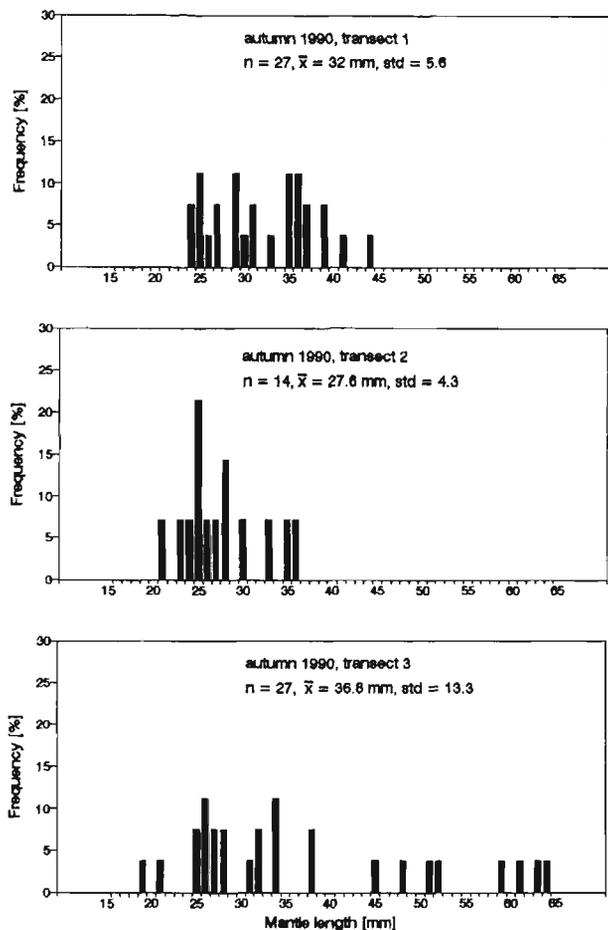


Figure 5. — *Gonatus fabricii*. Length distribution at various locations off West Greenland in autumn 1990 (n = total number of specimens, \bar{x} = mean length, std = standard deviation).

suggests growth rates of 4.0 mm per month off Holsteinsborg (transect 1), and 5.5 mm per month at Fyllas Bank (transect 2 in summer 1990, transect 3 in autumn 1990). Both estimations are considerably lower than the 8.0 mm per month which Kristensen (1977) suggests for juvenile growth of *G. fabricii*, but are subject to bias if the populations are migratory. However, any kind of traditional length-frequency analysis for assessment of squid age and growth should be viewed with great caution due to the intriguing growth pattern of squid, related to fast growth and short life cycle (Jereb *et al.*, 1991). Modern techniques to determine age and growth in squid are using growth increments in hard parts of the squid body which occur in the radula, gladius and statolith (Rodhouse and Hatfield, 1990). These methods clearly have better value in squid fisheries investigations than length-frequency analyses. For the present study, however, we believe that it was appropriate to use a

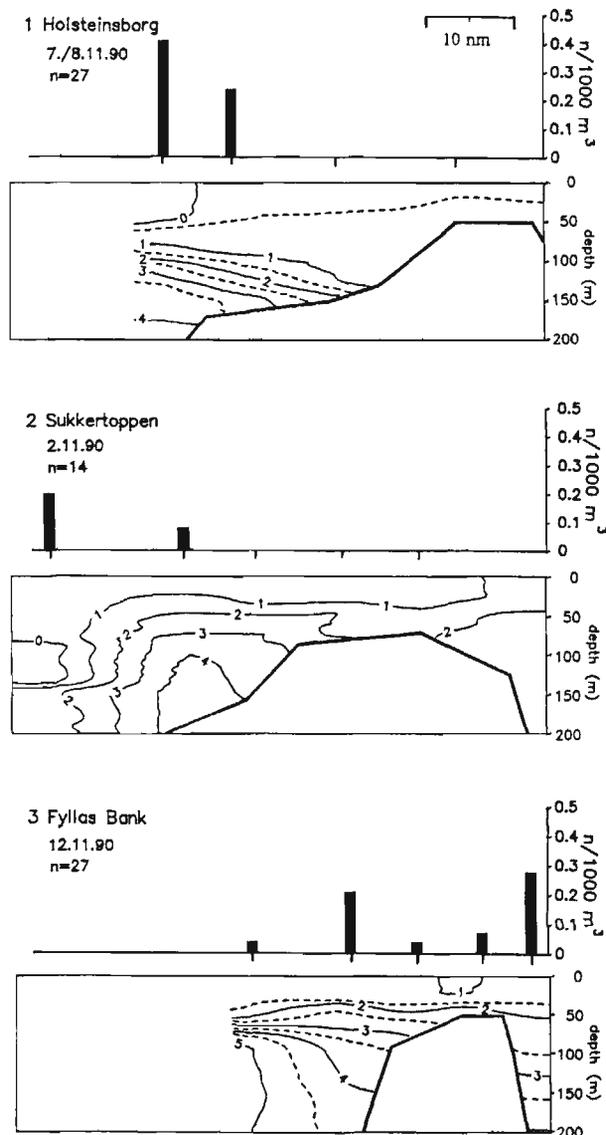


Figure 6. — *Gonatus fabricii*. Abundance (top) and vertical temperature profile (°C) (bottom) along station transects off West Greenland during autumn 1990.

conservative growth assessment by comparing length-frequency data due to the lack of any reliable growth estimations for *G. fabricii*.

The present data provide new information on geographical distribution, body size, and juvenile growth of *Gonatus fabricii*. However, as squid are capable of avoiding traditional sampling gear, so abundance and length frequencies might be underestimated from our samples. Avoidance and patchiness are well-documented shortcomings in analyzing distribution patterns and density of cephalopods (Wormuth and Roper, 1983). Moreover, larval drift and active migration of juvenile specimens cannot be excluded. They are characteristic phenomena in other North Atlantic

squid species such as *Todarodes sagittatus* where they substantially affect investigations on biology and distribution (Shimko, 1989).

Although juvenile *Gonatus fabricii* are frequently caught in shrimp trawls, it has not been possible to estimate quantitatively the adult densities and little information is available on their biology (Kristensen, 1984). Adults live at the bottom on the continental slopes, only rarely ascending to the surface, whereas paralarvae and juveniles live in the epipelagic zone.

On the basis of large catches of sub-adult specimens by midwater trawls in the Norwegian Sea, Wiborg *et al.* (1984) suggest that spawning concentrations of *G. fabricii* may be of commercial interest. However, such concentrations have not yet been found off West Greenland.

The studies on *Gonatus fabricii* clearly demonstrate that more basic research should be directed towards locating spawning concentrations of squid which may be capable of supporting a commercial fishery.

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REFERENCES

- Black G. A. P., T. W. Rowell, E. G. Dawe, 1987. Atlas of the biology and distribution of the squids *Illex illecebrosus* and *Loligo pealei* in the Northwest Atlantic. *Can. Spec. Publ. Fish. Aquat. Sci.*, **100**, 1-62.
- FAO, 1991. FAO yearbook. Fishery statistics, catches and landings 1989, vol. 68. *FAO Stat. Ser.*, **98**, 1-516.
- Isaacs J. O., L. W. Kidd, 1953. Isaacs-Kidd midwater trawl. In: Final Report Scripps Inst. Oceanogr. Ref. 53-3, 18 p.
- Jereb P., S. Ragonese, S. v. Boletzky, 1991. Squid age determination using statoliths. Proc. Int. Workshop Istituto di Tecnologia della Pesca e del Pescato (ITPP-CNR), Mazara del Vallo, Italy, 9-14 Oct. 1989. N.T.R.-I.T.P.P. *Spec. Publ.*, **1**, 1-128.
- Kristensen T. K., 1977. Hatching, growth, and distribution of juvenile *Gonatus fabricii* (Mollusca: Cephalopoda) in Greenland waters. *Asterte*, **10**, 21-28.
- Kristensen T. K., 1984. Biology of the squid *Gonatus fabricii* (Lichtenstein, 1818) from West Greenland waters. *Meddr. Grönland, Biosci.*, **13**, 1-20.
- Nesis K. N., 1965. Distribution and feeding of young squids *Gonatus fabricii* (Licht.) in the Labrador Sea and the Norwegian Sea. *Oceanology*, **5**, 102-108.
- Pierce G. J., P. R. Boyle, L. C. Hastic, F. G. Howard, 1992. The Scottish fishery for *Loligo forbesi*: current trends. *Int. Counc. Explor. Sea*, C.M. 1992/K:6, 27 p.
- Rodhouse P. R., E. M. C. Hatfield, 1990. Age determination in Squid using statolith growth increments. *Fish. Res.*, **8**, 323-334.
- Roper C. F. E., M. J. Swecney, C. E. Nauen, 1984. FAO species catalogue, vol. 3. Cephalopods of the world. An annotated and illustrated catalogue of species of interest to fisheries. *FAO Fish. Synop.*, **125**, 1-277.
- Sennikov A. M., S. G. Mukhin, T. E. Bliznichenko, 1989. Distribution and trophic importance of juvenile squid (*Gonatus fabricii* Lichtenstein) in the Norwegian and Barents Seas. *Int. Counc. Explor. Sea*, C.M. 1989/K:15, 18 p.
- Shimko B. P., 1989. Biology and peculiarities of the squid *Todarodes sagittatus* (Lamarck) distribution at early life stages. *Int. Counc. Explor. Sea*, C.M. 1989/K:17, 12 p.
- Sundet J. H., 1985. A short review on the biology and fishery of the squid *Todarodes sagittatus*. *Int. Counc. Explor. Sea*, C.M. 1985/K:44, 10 p.
- Wiborg K. F., J. Gjøsæter, I. M. Beck, 1984. The squid *Gonatus fabricii* (Lichtenstein) investigations in the Norwegian Sea and western Barents Sea 1982-1983. *Int. Counc. Explor. Sea*, C.M. 1984/K:19, 14 p.
- Wiebe P. H., K. H. Burt, S. H. Boyd, A. W. Morton, 1976. A multiple opening/closing net and environmental sensing system for sampling zooplankton. *J. Mar. Res.*, **34**, 313-326.
- Wormuth J. H., C. F. E. Roper, 1983. Quantitative sampling of oceanic cephalopods by nets: problems and recommendations. *Biol. Oceanogr.*, **2**, 357-377.