SHORT COMMUNICATION

SARSIA

EGG MASSES OF THE SQUID *GONATUS FABRICII* (CEPHALOPODA, GONATIDAE) CAUGHT WITH PELAGIC TRAWL OFF NORTHERN NORWAY

HERMAN BJØRKE, KARSTEN HANSEN & ROLF C. SUNDT

BJØRKE, HERMAN, KARSTEN HANSEN & ROLF C. SUNDT 1997 08 15. Egg masses of the squid *Gonatus fabricii* (Cephalopoda, Gonatidae) caught with pelagic trawl off northern Norway. – *Sarsia* 82:149-152. Bergen. ISSN 0036-4827.

A description of egg masses from *Gonatus fabricii* (LICHTENSTEIN) caught with pelagic trawl in the Norwegian Sea is given. The eggs were kept together in a single layer between two mucous membranes, and the pieces collected appeared to be fragments of more extensive structures torn apart by wear from the sampling gear. No embryos were observed in the eggs, and none of the eggs showed any staining for five enzyme systems analyzed by isoelectric focusing. Either the eggs were caught shortly after spawning and fertilization, or the lack of embryonic tissue reflects the fact that most of the eggs were caught in water colder than 0 °C. The developmental rate at this temperature is expected to be very slow.

Herman Bjørke, Karsten Hansen & Rolf C. Sundt, Institute of Marine Research, P.O. Box 1870 Nordnes, N-5024 Bergen, Norway.

KEYWORDS: Cephalopoda; *Gonatus fabricii*; Norwegian Sea; egg masses; pelagic trawl.

Gonatus fabricii is the most abundant squid of the arctic and subarctic waters of the North Atlantic. This squid was studied intensively in the 1980's (review by KRISTENSEN 1983; KRISTENSEN 1984). Still, little is known about the spawning of this species. Spawned eggs have never been found, and KRISTENSEN (1984) suggested that spawning took place at bottom on the continental slope, while MANGOLD (1987) supposed that all oegopsid squids that have nidamental glands released egg masses in surface layers, and considered egg laying on the ocean floor or at great depth to be rather unlikely.

Off the Norwegian coast young specimens of *G. fabricii* are recorded in the upper 60 m in May, and they seem to disappear from this layer when reaching a DML (dorsal mantle length) of 5 cm. During the summer young specimens of *G. fabricii* are distributed all over the Norwegian Sea, and BJØRKE (1995) estimated the biomass of younger *G. fabricii* in the upper 30 m in the Norwegian Sea to constitute at least 1.5 mill. tonnes during the summer of 1994.

A cruise was conducted off Andenes in July 1996 trawling at depths greater than 1000 m (Table 1, Fig. 1). This is an area where diving sperm whales (*Physeter macrocephalus*) are commonly observed. The previous year two mature females and three mature males of *G. fabricii* were caught in this area with a similar trawl (BJØRKE & HANSEN 1996). The pelagic trawl has an opening of 30 m x 30 m and a mesh size of 20 mm in the cod end (VALDEMARSEN & MISUND 1995).

The egg masses were usually caught together with mature *G. fabricii,* towing depths are listed in Table 1. Eggs were kept together in a single layer between two brownish mucous membranes in a honeycomb pattern, and the pieces collected were of different sizes, some with eggs inside and some without (Fig 2). The honeycomb pattern of the eggs and the fact that only one of the mature female squids sampled was ruptured, suggests that these eggs had been laid naturally. The eggs were elliptical with a maximum diameter varying from 4.05 to 5.91 mm with an average of 5.24 mm, and a minimum diameter varying from 3.16 to 4.78 mm with an average of 4.17 mm. The eggs were translucent or light bluish. Eggs of similar size and colour were found the previous year in mature females from the same area (BJØRKE & HANSEN 1996).

Very few records exist of naturally spawned eggs or

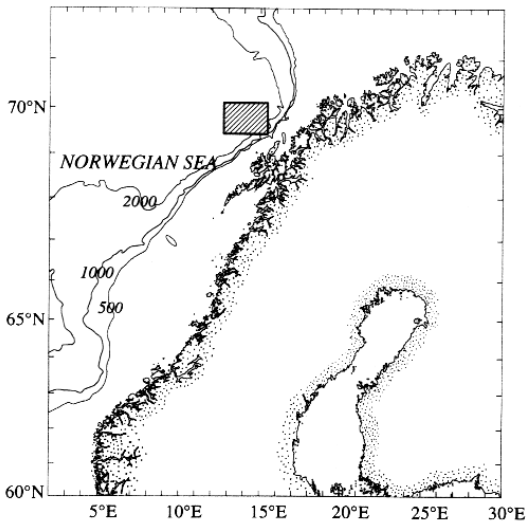

Figure 1. The eastern Norwegian Sea. Depths in meters. Hatched rectangle shows the sampling area.

egg masses from oceanic cephalopods (Okutani & al. 1995, Young & al. 1985, Clarke 1966). Young & al. (1985) refers to descriptions of egg masses of very similar appearance: large, gelatinous, cylindrical masses generally 60-90 cm long by 10-21 cm in diameter, containing rows of eggs which encircled the mass in a helix near its periphery. Muus (1959) describes egg masses from some oegopsid cephalopods as ribbon-like structures. The pieces sampled thus seem to be fragments of more extensive structures torn apart by wear from the sampling gear (Fig. 2). Okutani & al. (1995) refers to underwater photographs of a female gonatid cephalopod carrying egg masses on the arms. A similar behaviour with *G. fabricii* cannot be disregarded. On only one station were egg masses found without any mature female present (Table 1). Two of the present authors have examined more than one thousand trawl hauls sampled in the upper 60 m in the same area and downstream during summer through several years, but similar egg masses have never been observed.

Of the oceanic species recorded in the Norwegian Sea or adjacent waters (Muus 1959, Clarke 1966 and Høisæter 1986) only *Todarodes sagittatus* has been observed in abundant numbers in this area. However, in spite of extensive investigations on this species, only a few maturing females with smaller eggs have been recorded (Wiborg & Beck 1983, Wiborg & Gjøsæter 1981). It is thus likely that the recorded egg masses are produced by *G. fabricii*. Table 1 shows the approximate number of eggs found in each haul. Most of the egg masses were

Table 1. Pelagic trawling in July 1996. Positions and bottom depths from the point where hauls started. Where available, temperature and salinity are given in the towing depths. For station 271, 272 and 274 the conditions at 1000 m. are given. * Female with spermatophores present. Number of eggs estimated.

Station	Date	Position	Towing depth (m)	Bottom depth (m)	Duration (hrs.)	Nos. mature specim.	Nos. eggs	t (°C)	S (‰)
268	17 July	69° 28' N, 15° 39' E	1000	1170	1.5	2*	0	-0.10	34.87
			900		1.5			0.43	34.87
269	17 July	69° 27' N, 15° 42' E	800	1910	1.5	0	0		
			700		1.5				
270	18 July	69° 27' N, 15° 40' E	600	1070	1.5	0	0		
					1.5				
271	18 July	69° 32' N, 15° 44' E	1100	1160	4.5	3*	300	-0.53	34.87
272	18 July	69° 44' N, 15° 41' E	1100	2100	3.0	1*	0	-0.67	34.87
273	19 July	69° 46' N, 14° 33' E	1100	1200	3.0	2*	100		
274	19 July	69° 28' N, 14° 58' E	1100	2200	3.0	7*	2100	-0.54	34.87
275	19 July	69° 27' N, 14° 48' E	1100	2110	3.0	0	0	-0.63	34.89
276	20 July	70° 05' N, 12° 37' E	1100	2660	3.0	5*	300	-0.55	34.89
277	20 July	69° 05' N, 15° 43' E	1100	1260	3.0	1*	50	-0.68	34.89
278	20 July	69° 32' N, 15° 42' E	1100	1340	3.0	1*	0		
279	21 July	69° 31' N, 15° 41' E	1100	1450	3.0	9*	1200		
280	21 July	69° 32' N, 15° 41' E	1100	1320	3.0	1	300		
281	21 July	69° 32' N, 15° 42' E	900	1320	1.0	1*	50	-0.46	34.89
			800		1.0			-0.06	34.89
			700		1.0			0.84	34.90
282	21 July	69° 32' N, 15° 42' E	600	1260	1.5	0	50		
			400		1.5				

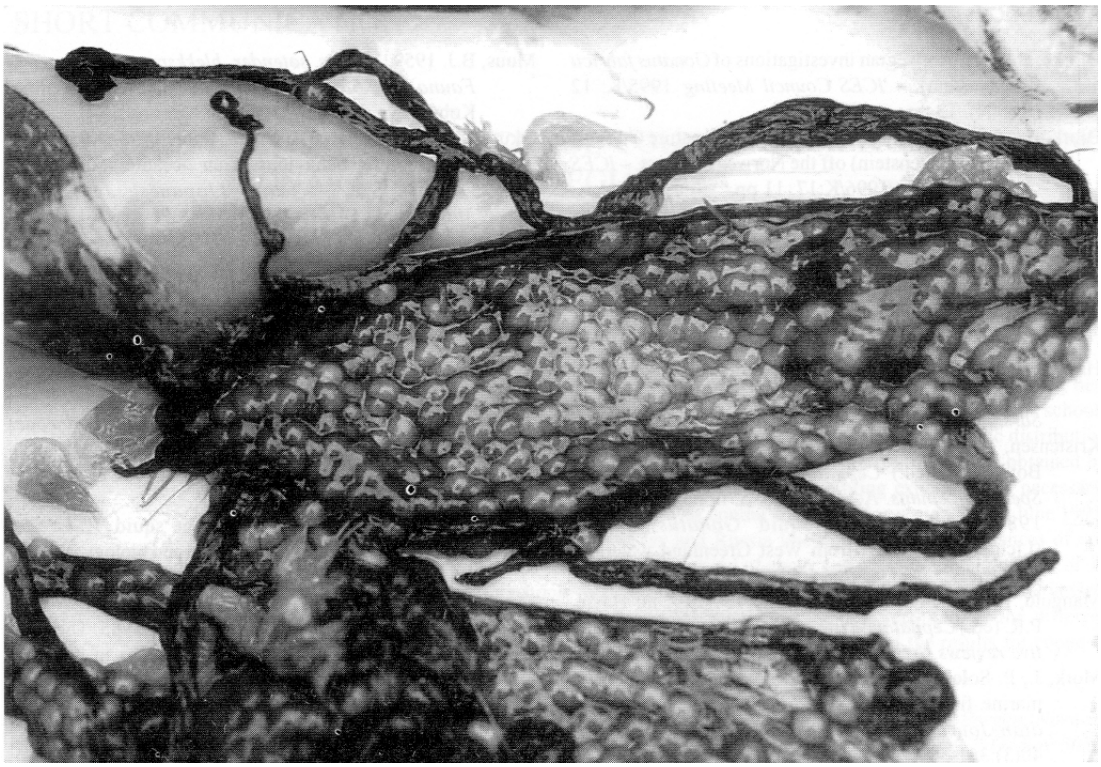

Figure 2. *Gonatus fabricii*. Egg masses, probably fragments of more extensive structures torn into smaller fragments by the sampling gear.

caught in temperatures below 0 °C. Thawed eggs were examined under a dissecting microscope. The freezing process may have affected the inner structures to some extent, but they were obviously in a very early stage of development. The eggs could have been caught shortly after spawning and fertilization but as embryonic development is expected to be very slow under the ambient temperature, this could not be confirmed.

In an attempt to confirm the species of the eggs biochemically, five proteins from the eggs where analyzed by means of isoelectric focusing (IEF), a method used for identification of fish eggs (Mork & al. 1983). For comparison, samples of muscle and hepatopancreas from adult female *G. fabricii* were run alongside the eggs. Samples of the eggs and tissue were immediately frozen separately and transported to the laboratory were they were stored at -20 °C for up to two months before being analyzed. Samples of muscle, hepatopancreas and eggs for IEF were prepared by sonicating tissue in equal amounts of distilled water. Pieces of filter-paper (10 x 1.5 mm) were soaked in the cell lysates and applied to the gels. IEF was performed using Ampholine™ PAGplate precast polyacrylamide gels (LKB-Produkter AB) in the pH range 3.5-9.5, following the instructions in the LKB leaflet no. 1804. The application position was approximately 10 mm from the anode. The following enzymes were stained according to Harris & Hopkinson (1976): Lactate dehydrogenase (LDH, E.C. 1.1.1.27.); Malic enzyme (ME, E.C. 1.1.1.40.); Isocitric dehydrogenase (IDH, E.C. 1.1.1.42.); Phosphoglucomutase (PGM, E.C. 2.7.5.1.); Glucose phosphate isomerase (GPI, E.C. 5.3.1.9.). None of the enzymes tested showed any staining from egg samples but strong zymograms with good resolution were obtained from the 'standard' muscle or hepatopancreas from adult squid samples. The high resolution of the adult tissue zymograms indicates that the storing conditions could not have affected the enzyme systems to a great extent. The lack of detectable enzymatic activity is expected to be caused by the very limited embryonic tissue in the eggs.

REFERENCES

Bjørke, H. 1995. Norwegian investigations of *Gonatus fabricii* (Lichtenstein). – *ICES Council Meeting* 1995/K: 12 (Ref. N). 13 pp.

Bjørke, H. & K. Hansen 1996. Recordings of mature *Gonatus fabricii* (Lichtenstein) off the Norwegian coast. – *ICES Council Meeting*/1996/K:17. 11 pp.

Clarke, M. R. 1966. Review of the systematics and ecology of oceanic squids. – *Advances in Marine Biology* 4:91-327.

Harris, H. & D.A. Hopkinson 1976. *Handbook of enzyme-electrophoresis in human genetics.* – North Holland, Amsterdam. Pag. var.

Høisæter, T. 1986. An annotated check-list of marine molluscs of the Norwegian coast and adjacent waters. – *Sarsia* 71:27-145.

Kristensen, T.K. 1983. *Gonatus fabricii* . – Pp. 159-173 in: Boyle, P.R. (ed.) *Cephalopod life cycles. Volume 1. Species Accounts*. Academic Press. London.

— 1984. Biology of the squid *Gonatus fabricii* (Lichtenstein, 1818) from West Greenland waters. – *Meddelelser om Grønland, Bioscience* 13:3-12.

Mangold, K. 1987. Reproduction. – Pp 157-219. in: Boyle, P.R. (ed.) *Cephalopod life cycles. Volume II. Comparative reviews.* Academic Press, London.

Mork, J., P. Solemdal & G. Sundnes 1983. Identification of marine fish eggs: A biochemical approach. – *Canadian Journal of Fisheries and Aquatic Sciences* 40(3):361-369.

Muus, B.J. 1959. *Skallus, søtender, blekksprutter. Danmarks Fauna. Bd. 65* . – Dansk Naturhistorisk Forening. København. 239 pp.

Okutani, T., I. Nakamura, & S. Katsunori 1995. An unusual egg-brooding behaviour of an oceanic squid in the Okhotsk Sea. – *Venus (Japanese Journal of Malacology)* 54:237-239.

Valdemarsen, J.W. & O.A. Misund 1995. Trawl designs and techniques used by Norwegian research vessels to sample fish in the pelagic zone. – Pp. 135-144 in: Hylen, A. (ed.) *Precision and relevance of pre-recruit studies for fishery management related to fish stocks in the Barents Sea*. Proceedings of the sixth Russian-Norwegian Symposium. Bergen 14-17 June 1994.

Wiborg, K.F. and I.M. Beck 1983. The squid *Todarodes sagittatus* (Lamarck). Distribution and biology in northern waters August 1982-June 1983. – *ICES Council Meeting* 1983/K:7.15 pp.

Wiborg, K.F. & J. Gjøsæter 1981. The squid *Todarodes sagittatus* (Lamarck). Distribution and biology in northern waters, April 1980 - April 1981. – *ICES Council Meeting* 1981/K:14. 18 pp.

Young, R.E., R.F. Harman & K. M. Mangold 1985. The common occurrence of oegopsid squid eggs in near-surface oceanic waters. – *Pacific Science* 39:359-366.

Accepted 29 January 1997