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RECORDINGS OF MATURE *GONATUS FABRICII* (LICHTENSTEIN) OFF THE NORWEGIAN COAST.

by

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ABSTRACT

Two mature female and three mature males were sampled by trawling with a pelagic trawl at depths of more than 800 m off northern Norway. A third female were sampled with bottom trawl at 970 m off mid Norway.

The females had a flabby, swollen appearance and degenerated tentacles and from 5 to 12 mature eggs on the ovary. The mature eggs had a largest diameter varying from 4 to 6 mm. The females were all larger than the mature males and the smallest had a DML of 260 mm. The females seems to mature at lengths between 200 and 250 mm.

The mature males had spermatophores, 7 to 9 mm long, in the spermatophoric sac and in the penis, showing that they had not copulated. The smallest male had a DML of 190 mm. The males seems to mature at smaller length than the females.

Assuming the same growth rate as observed at West Greenland, *Gonatus fabricii* seems to mature at an age of 2 to 2.5 years. Other recordings of larger mature males could indicate a second mating at an age of three years.

The recordings of mature females at bottom indicate spawning at bottom.

Recordings of mature females from summer to end of November indicate that spawning takes at least place during this period.

The recordings of mature females at bottom indicate spawning at bottom.

Recordings of mature females with emty spermatophores more than 500 m above bottom arise questions of a second mating or pelagic spawning.

Keywords: Norwegian Sea, squid, *Gonatus fabricii*, egg size, spawning period, length at maturity.

INTRODUCTION

Gonatus fabricii (Lichtenstein, 1818) is the most abundant squid of the arctic and subarctic waters of the North Atlantic. This squid was studied intensively in the 1980s and is the best known oceanic cold water squid. 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."

Kristensen (1981 and 1984) have recorded one mature female (20.9 cm PL) from the Norwegian Sea caught at a depth of 2700 m and two mature males (21.9 cm and 29.3 cm PL from West Greenland. This is the first and only descriptions of mature specimens of *Gonatus fabricii* . The relation: Pen length/Dorsal Mantle Length (DML) is found to be 9/10 (Wiborg 1982) . The corresponding DML for the female would thus be 22 cm, and for the males 24.3 and 32.5 cm respectively.

Sennikov, Muchin and Bliznichenko (1989) reports capture of a spawning male in May 1984 of length 32.0 cm (DML) at 68°31´N, 08°30´E (off Vesterålen) at a depth of 300 m over depths of more than 2000 m. In addition they reports findings of a spawning male (22.0 cm) and two spawning females (31.0 cm and 38.5 cm) on the southern shelf of Jan Mayen in October 1986 at depths of 160-215 m. No further description is given.

Thus, only one mature female and two mature males of *Gonatus fabricii* are more closely described, although Young (1973) m described a spent female belonging to the genus *Gonatus* which could not be referred to any particular species. Recordings of three mature males and three mature females in the present work gives additional information about the biology of *Gonatus fabricii.*

MATERIAL AND METHODS

The area off Andenes (Fig. 1) is a popular place for whale watching (whale safari) during summer, and the most common whale observed is the sperm whale (*Physeter macrocephalus*). It is usually observed over depths of 800-1500 m, but is also observed over depths of 300-400 m (Hanne Strauger, Hvalsafari, Andenes, Norway, *pers. comm*). In this area two trawl hauls were made at greater depths in 1995 (Fig. 1). The pelagic trawl used was an Åkra trawl with an opening of 30m x 30 m (Valdemarsen and Misund 1995). One haul was made 10 May over a depth of more than 2000 m. It was trawled one hour in each of the depths 1200 m, 1000 m and 700 m. The other haul was made 1 August by trawling for two hours at 827 m depth and half an hour at 270 m depth over a depth of 1350 m. The trawling depth was monitored by acoustic methods.

During a bottom trawl haul made 26 November 1995 at 970 m a third mature female was recorded.

All the specimens were frozen immediately after they were caught.

The maturity stages were classified according to Lipinski (1979).

RESULTS AND DISCUSSION

Table 1 shows the data collected. It is seen that the two mature females were 303 mm and 335 mm long (DML) and both were caught in August. The third one caught in November was 260 mm long. All three had a flabby, swollen appearance, and none of them had tentacles (Fig. 2). The tentacles were clearly degenerated and not cut during the handling. All arms, except the fourth pair, had two suckers on the edge of the arm and two hooks in the middle. The fourth pair had four pair of buds. The ovaries had from 5 to 12 larger oval eggs (Fig 3) with a largest diameter from 4 to 6 mm in length. On the buccalmembrane were about 70 spermatophores. These were about 2.5 mm long and were all empty. Kristensen (1981) described the length of the nidamental glands to be nearly one third of the pen length. From Table 1 it can be calculated that the length of the nidamental glands is only 1/5 of the pen length. This might indicate a different stage of maturity than the one described by Kristensen (*op. cit.*).This might also explain presence of suckers and hooks on the arms on the present females. Kristensen (*op. cit.*) also describe the few large eggs as orange with a greatest diameter of 4.7 mm. Those eggs were fixed in formalin, while the eggs in the present material were frozen and then thawed, and the large ones were translucent or light bluish. After having been fixed in formalin the present eggs were also reddish or brownish in colour. Disregarding this, the observations are in correspondence with Kristensens (*op. cit.*).

The smallest mature female ever recorded in the Norwegian Sea was 243 mm in length (Kristensen 1981). An immature female with a DML of 192 mm in the present material indicate that maturation in females takes place between these lengths. It thus seems that females in the Norwegian Sea mature at lengths between 190 mm and 250 mm corresponding to an age between two and two and a half year.

Based on growth rate and length at sampling, Bjørke (1995) concluded that hatching seemed to take place throughout the year while the main hatching seem to occur in January-February. Mature females are recorded from summer until the end of November (Table 2). This indicate spawning at least during this period of the year.

The mature males were 189 mm, 200 mm and 240 mm long (DML) and were thus smaller than the females. They did not have the flabby, swollen appearance of the mature females and the tentacles were not degenerated. All tentacles were lost except one, but short stubs were present; indicating loss during handling. All had spermatophores, about 7 to 9 mm long, in the spermatophoric sac and in the beginning of the penis. The length of the spermatophores is in correspondence with Kristensens (1984). According to Kristensen (*op. cit.*) and Lipinski (1979) this could indicate that copulation had not happened. The weight of the testis of the largest male were surprisingly low (Table 1). Kristensen (1984) observed the same at West Greenland, and, taking into account the growth rate, suggested that this indicated the second reproduction of this male at an age of three years. The length of the present males do not indicate this, although the mature males showed no signs of degeneration. However, Sennikov *et al.* (1989) recorded a mature male with DML of 320 mm, and , assuming a growth rate of 10 cm/year, this could indicate a second copulation at an age of three year.

The smallest mature male had a mantle length of 189 mm, and this is the smallest mature male ever recorded (Table 2). With a growth rate of about 10 cm/year., he age of this male should be nearly two years.

Two of the mature females in the present material were caught over 1300 m depth during trawling at depths of 820 to 270 m and one in a bottom trawl at 970 m depth. The rest of the recorded females, four (Table 2), were sampled at the bottom at 2500-2700 m, at 970 m and at 160-215 m. Kristensen (1981) supposed that spawning took place at the bottom. The recordings by Sennikov *et al* . (1989) and the present recording supports this.

Of the 6 recordings of mature females of *Gonatus fabricii* in literature and in the present work, 4 of them were sampled at the bottom indicating that spawning takes place here. However, does sampling of females more than 500 m above the bottom with empty spermatophores in the buccal area and both mature and immature eggs in the ovary (Table 2) indicate a second mating? Or does it indicate pelagic spawning?

None of the specimens given in Table 1 had gut content.

CONCLUSIONS

The females of *Gonatus fabricii* seems to mature at lengths between 200 and 250 mm.

The males seems to mature at smaller length than the females.

Gonatus fabricii seems to mature at an age of 2 to 2.5 years. Other recordings of larger mature males could indicate a second mating for males at an age of three years.

Recordings of mature females from summer to end of November indicate that spawning takes at least place during this period.

The recordings of mature females at bottom indicate spawning at bottom.

Recordings of mature females with emty spermatophores more than 500 m above bottom arise questions of a second mating or pelagic spawning.

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Table 1. Data on *Gonatus fabricii* from the present material. ND = Nidamental gland

Length DML (mm)	Total weight (g)	Gonad weight (g)	Penis length (mm)	Stage	Year	Month	Date	ND1 Length (mm)	NG2 Length (mm)
Males									
122	47,4	0,05	19	2	1995	5	10		
200	88,3	0,15	71	5	1995	5	10		
189	170,1		83	5	1995	5	10		
240	226	0,038	95	5	1995	5	10		
Females									
192	90,6	0,275		2	1995	5	10	13	
260	566,4			5	1995	11	26	55	60
302	486,8	6,58		5	1995	8	1	62	60
335	615	6,295		5	1995	8	1	55	54
165	70			2	1995	8	1		

Table 2. Recordings of mature males and females of *Gonatus fabricii.*

Length (mm)	Reference	Posision	Month	Catching depth	Bottom depth
Males					
320	Sennikov et al. (1989)	68°31´N, 08°30´E	May	100 m	2800m
220	Sennikov et al. (1989)	70°30´-70°40´N 08°30´W-09°20´W	October	160-215m	160-215m
219	Kristensen (1983,1984)	Disco Bay (West Greenland)	November	200-400m	200-400m
293	Kristensen (1983,1984)		July	200-400m	200-400m
200		69°45´N, 15°41´E	May	820-270m	1350m
240		69°45´N, 15°41´E	May	820-270m	1350m
189		69°45´N, 15°41´E	May	820-270m	1350m
Females					
310	Sennikov et al. (1989)	70°30´-70°40´N	October	160-215m	160-215m
385	Sennikov et al. (1989)	08°30´W-09°20´W	October	160-215m	160-215m
232	Kristensen (1981,1983)	64°26´N-64°19´N 01°36´E-01°44´E	Summer	2500-2700m	2500-2700m
335		69°32´N-05°23´E	August	270-820	1350m
302		69°32´N-05°23´E	August	270-820	1350m
260		64°26´N-05°23`E	End of November	970m	970m

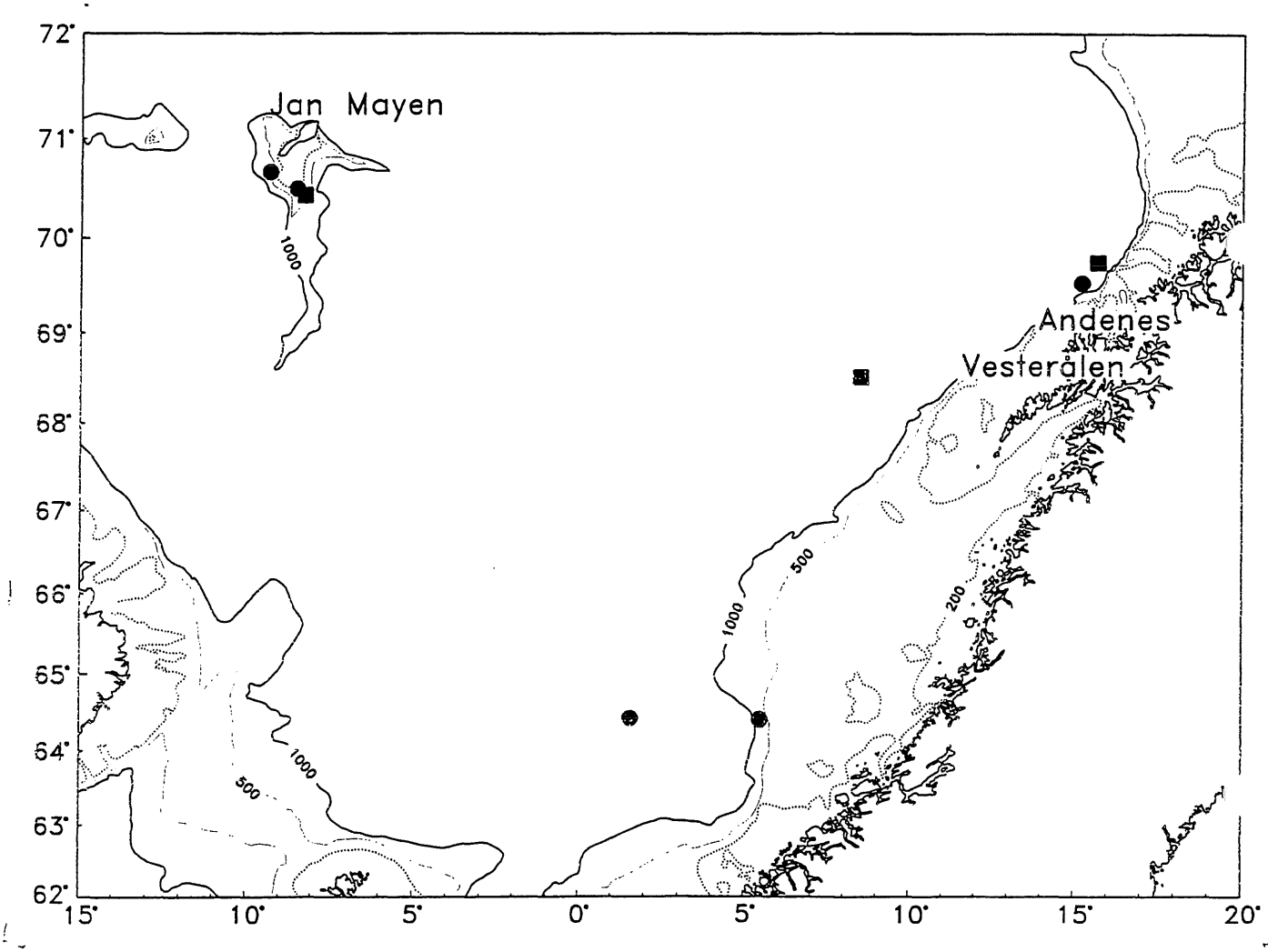

Fig. 1. Recordings of mature females (circles) and males (squares). In addition to this two males were recorded in Disco Bay, West Greenland.

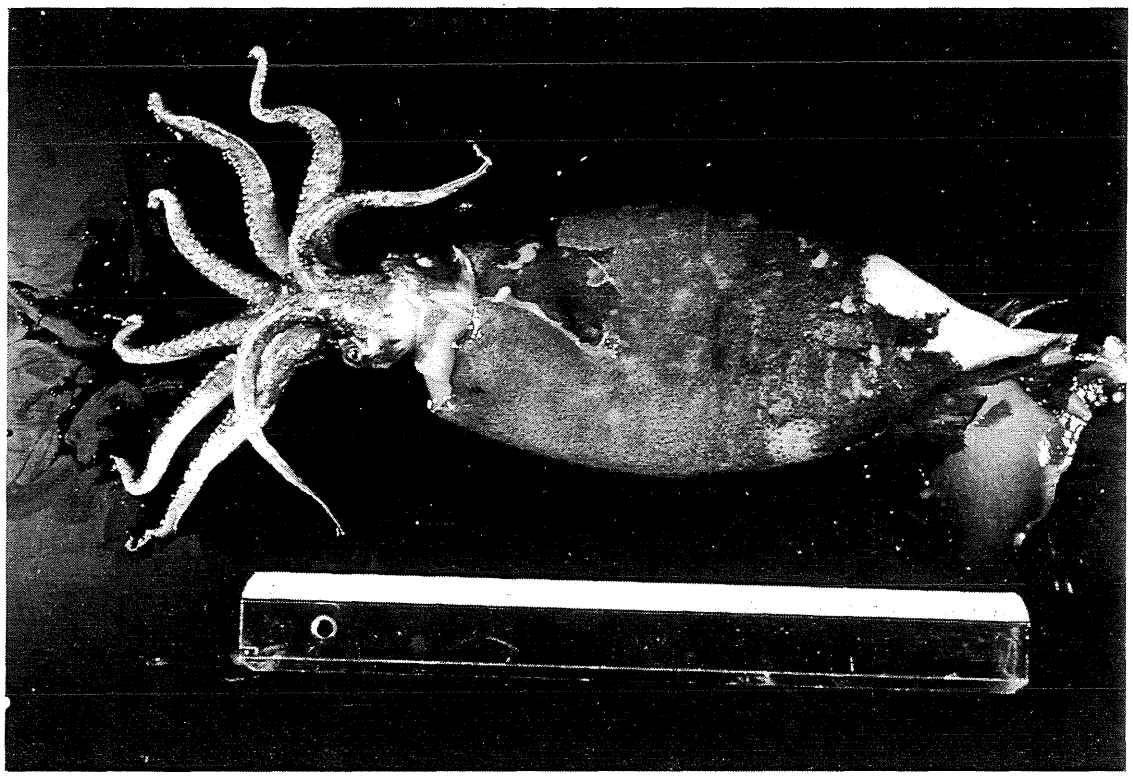

Fig. 2. Mature female 335 mm long (DML).

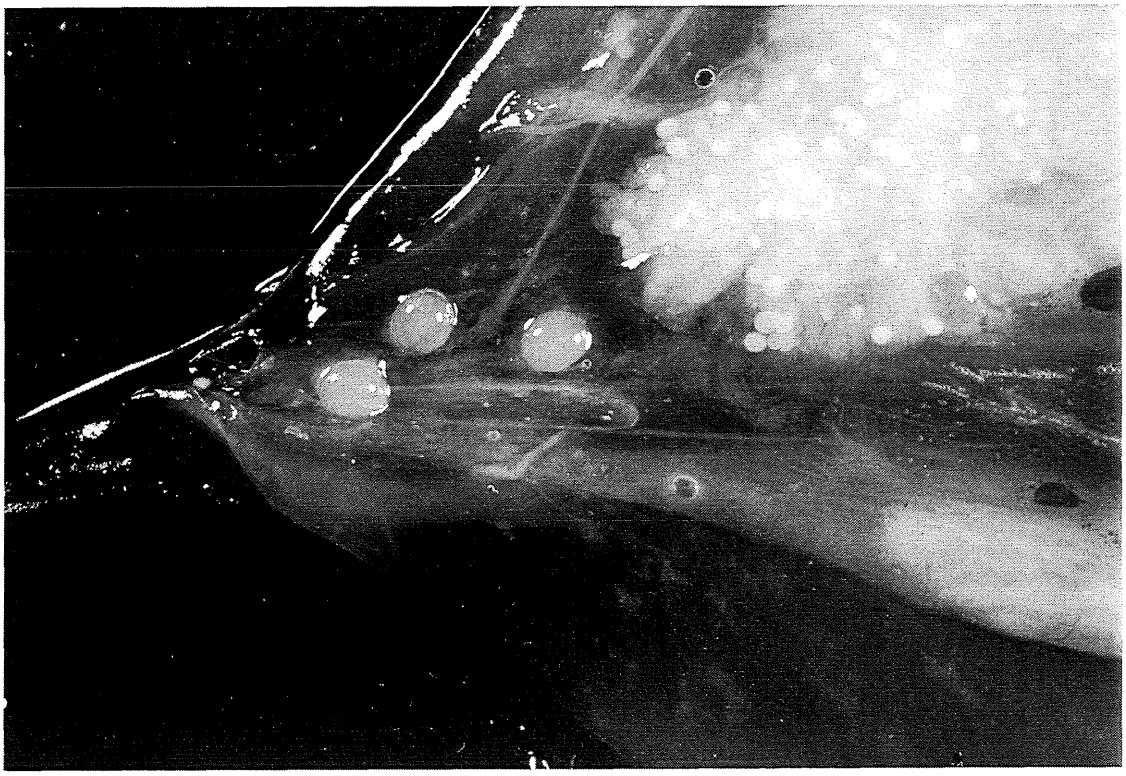

Fig. 3. Ovary from mature female 335 mm long (DML), showing mature and immature eggs.