

Northwest Atlantic



Fisheries Organization

Serial No. N532

NAFO SCR Doc. 82/VI/43

SCIENTIFIC COUNCIL MEETING - JUNE 1982

Preliminary Data on Predation of Fishes on Squid (*Illex illecebrosus*)
on the Scotian Shelf (NAFO Div. 4VWX)

by

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Introduction

Squid, *Illex illecebrosus*, is an important predator of fishes (Ennis and Collins, 1979). Cannibalism is also a great source of food for squid (Amaratunga, 1980). But squid constitutes equally a prey for other species, particularly finfishes and cetaceans (Mercer, 1974).

During the course of a French research survey on board the *R/V Thalassa* on Scotian Shelf in the summer of 1981 (Dupouy and Minet, 1982), an attempt was made for estimating the importance of squid consumption by main finfish species encountered, i.e. silver hake, haddock, pollock and cod. Data are provided on occurrence of squid in the stomachs of these species, with reference to size and weight of ingested squid, and an estimate of natural mortality of squid resulting of this predation is made.

Material and Methods

A total of 100 tows of 30 minutes duration were made with a standard Lofoten bottom trawl during the course of this survey, during 28 August-22 September 1981. Tows were randomly made in strata ranging from 50 to 200 fathoms (see Dupouy and Minet, 1981). The catch of each tow was sorted by species and weighted. For main species of fishes, measurements by sex and examination of stomach contents with *Illex* were noted. When possible, squid ingested were measured to half-centimeter below.

Results

Main species encountered on Scotian Shelf were composed of Silver hake (*Merluccius bilinearis*), Haddock (*Melanogrammus aeglefinus*), Redfish (*Sebastes mantella*), Pollock (*Pollachius virens*), and cod (*Gadus morhua*). They represented a total of 18,000 kg against 2672 kg (i.e. 11,000 individuals) for squid *Illex*.

Because redfish is principally restricted to Subdiv. 4Vs where squid was very scarce, this species was not retained for this study.

Percentage of occurrence (number of tows where species were caught against total number of tows) is presented in Table 1. The most abundant in number and weight was the silver hake, followed by the haddock, these two species representing about 40% of the total catch.

However, most of the stomach contents with squid were from cod and pollock (Table 2). This can result from the larger size of individuals of these two species compared to haddock and silver hake but also from differences in feeding behaviour. For a given species, the probability of occurrence of squid in stomachs increases with the length of predator as shown for cod (Fig. 1), pollock (Fig. 2), haddock (Fig. 3) and silver hake (Fig. 6). For these four species, no squid were ingested by individuals smaller than 35 cm and most squid occurred in stomachs of predators larger than 50 cm. This is very consistent with data of Minet and Perodov (1978) for predation of cod on cephalopods in NAFO Subareas 2, 3 and 4. Thus, this can explain the very low occurrence of *Illex* in the stomachs of silver hake, because very few individuals reach 40 cm in length, except for some females (see Fig. 6).

Moreover, the number of squid in stomachs increased with the length of predator. For example, a female cod of 105 cm was digesting at the same time 5 squid ranging from 15 to 19 cm, representing about 500 grams of food. So the mean number of squid, when present, per stomach was calculated for each species (Table 2). An estimate of the total number of squid ingested by the four predator species analyzed in this paper is also obtained by multiplying the values of the first three columns of Table 2. For a total of about 47,000 individual fish caught, only 513 squid and squid remains were present (i.e. about 1% of the number of fishes). Length distributions of squid ingested are presented and compared to the squid distribution obtained for the survey (Table 3). Mean sizes of squid ingested by cod and pollock are close to the general distribution, but, for haddock and silver hake, the squid taken as prey are of smaller size.

An estimate of the duration of elimination of squid in the stomachs of predators was calculated by using the equation of Tseitlin (1980):

$$T(\text{hours}) = T_0 W^s Y_m^{0.62 t}$$

where T_0 and s are constants of 57.9 and 0.18 respectively for cold water species.

W is the mean weight of fishes eating squid for a given species.

Y_m is the ratio between squid weight ingested against W .

t is an exponential function of temperature (the mean bottom temperature during the survey was 7.4°C, so t calculated is 2.76. Results are expressed in the following table:

Species	Cod	Pollock	Haddock	Silver hake
Mean size of predators(cm)	73.4	82.9	52.5	43.1
Mean weight of predators(g)	3400	4500	1250	670
Mean weight of squid ingested(g)	290	400	100	60
t in hours	150	162	128	115
t in days	6.3	6.7	5.3	4.8

So the mean time needed for digesting the squid ingested is close to 6 days. Consequently, the total number of squid (513) present in the stomachs of the four species caught represented their predation on the squid population for about one week. If we assume that the availability to the trawl was not very different for squid than the predators studied during this survey, the ratio of total number of squid ingested (513 individuals) against the total number of squid caught (11,513 individuals) represented the mortality rate for a 6 day period (i.e. instantaneous mortality rate of about 0.22 per month). This rate, if considered as the only factor of natural mortality, should correspond to a removal of about 58% of the squid population during its stay on the Scotian Shelf from end of spring to beginning of autumn (4-month period). Cod represented 33% of predation in number, silver hake 26%, haddock 25% and pollock the remaining 16%.

However, these results are preliminary ones, because the distribution of squid related to the four other species can change from month to month, thus affecting their relative proportion and size in the standing crop. Moreover, abundance of squid is subject to great variations from year to year and percentage of squid ingested can vary accordingly.

References

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TABLE 1. Occurrence and characteristics of the four species sampled as predator of squid.

Species	% of tows with the species	Total weight (kg)	Total number	No. measured	Mean size cm	No. stomach examined	No. of stomach with squid
Cod	45	1133	494	494	53.8	494	93
Pollock	29	1283	271	271	71.4	271	37
Haddock	26	5190	12637	7411	32.4	2839	31
Silver hake	63	5480	33564	7467	27.7	1480	6

TABLE 2. Estimation of total number of squid in the stomachs of species examined as predator.

Species	Total number in the catch	% of stomach with squid	mean number of squid in stomach	total number of squid ingested
Cod	494	19	1.82	171
Pollock	271	14	2.11	80
Haddock	12637	1	1.0	128
Silver hake	22564	0.4	1.0	134
Total	47114	0.85	1.1	513

TABLE 3. Comparison between the squid length distribution for the survey and length of squid ingested.

ML	Survey	Cod	Pollock	Haddock	Silver Hake	Total
5	2	-	-	-	-	-
6	87	-	-	-	-	-
7	173	-	-	-	-	-
8	180	-	-	-	-	-
9	73	-	1	-	1	2
10	25	1	-	-	-	1
11	26	-	-	1	-	1
12	16	-	-	-	-	-
13	24	-	-	-	-	-
14	30	1	-	-	-	1
15	26	2	-	-	-	2
16	10	5	-	-	-	5
17	24	9	1	-	-	10
18	38	9	-	-	-	9
19	99	18	2	1	-	21
20	361	14	5	1	-	20
21	1066	12	7	-	1	20
22	1259	12	3	1	-	16
23	921	5	1	-	-	6
24	437	1	1	-	-	2
25	290	-	-	-	-	-
26	163	-	-	-	-	-
27	83	-	-	-	-	-
28	30	-	-	-	-	-
29	6	1	-	-	-	1
30	-	-	2	-	-	2
Total	5449	90	23	4	2	-
Mean length (cm)	20.89	19.50	20.17	18.00	14.5	19.67

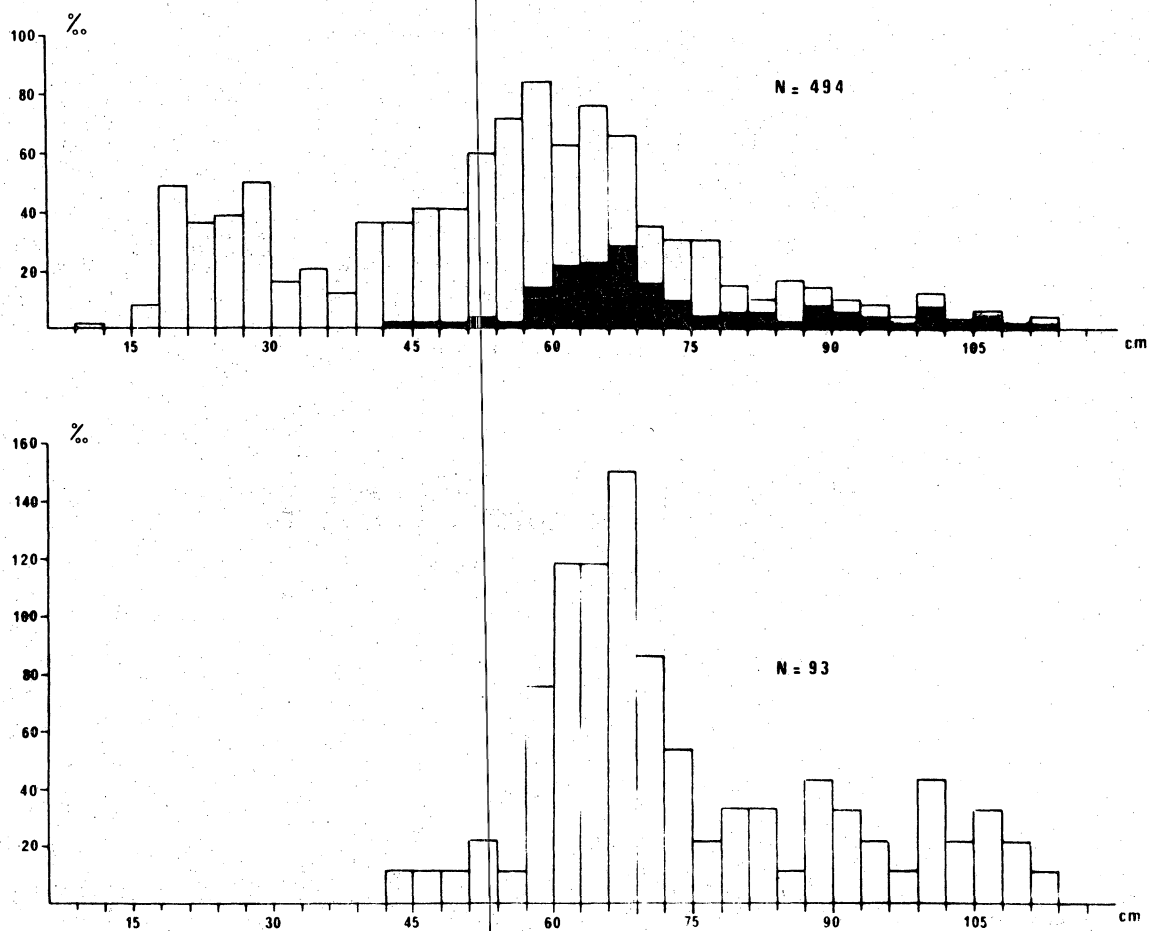


Fig. 1. Length distribution of total catch of cod (top of figure) compared with length distribution of cod with squid in stomach (bottom of figure and shaded area on top).

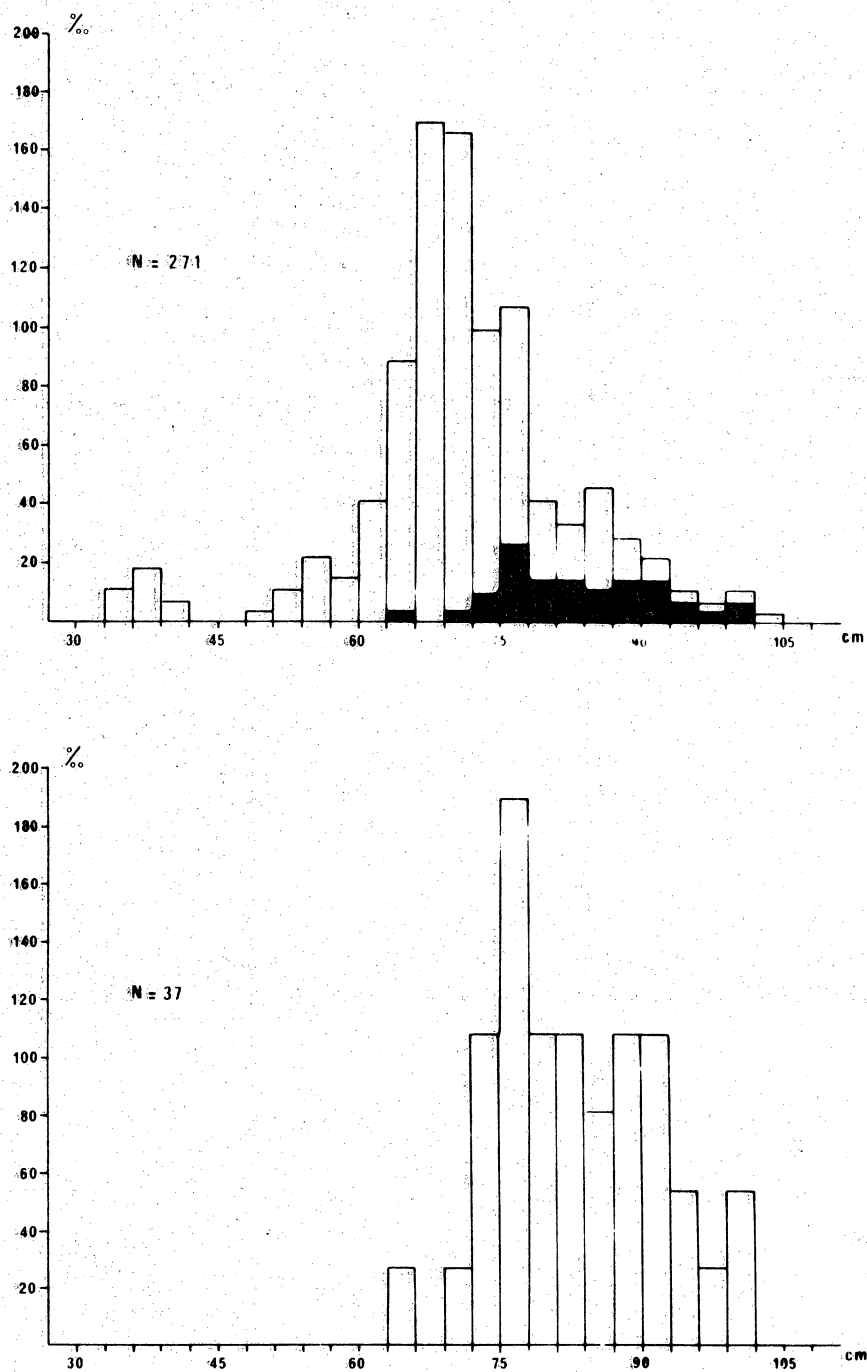


Fig. 2. Length distribution of total catch of pollock (top of figure) compared with length distribution of pollock with squid in stomach (bottom of figure and shaded area on top).

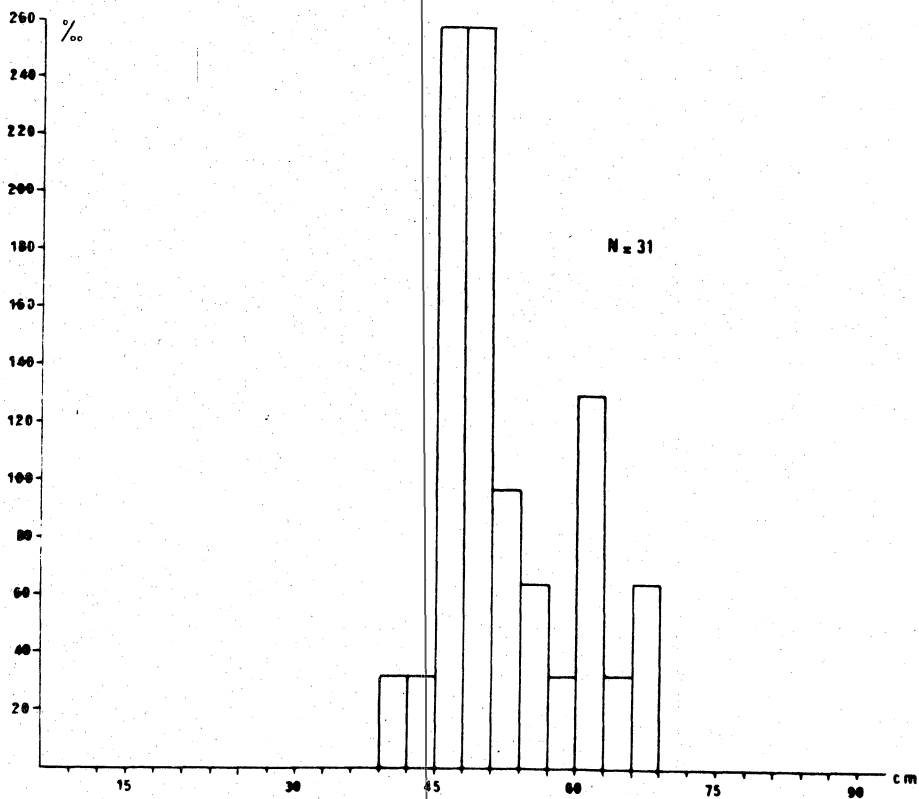
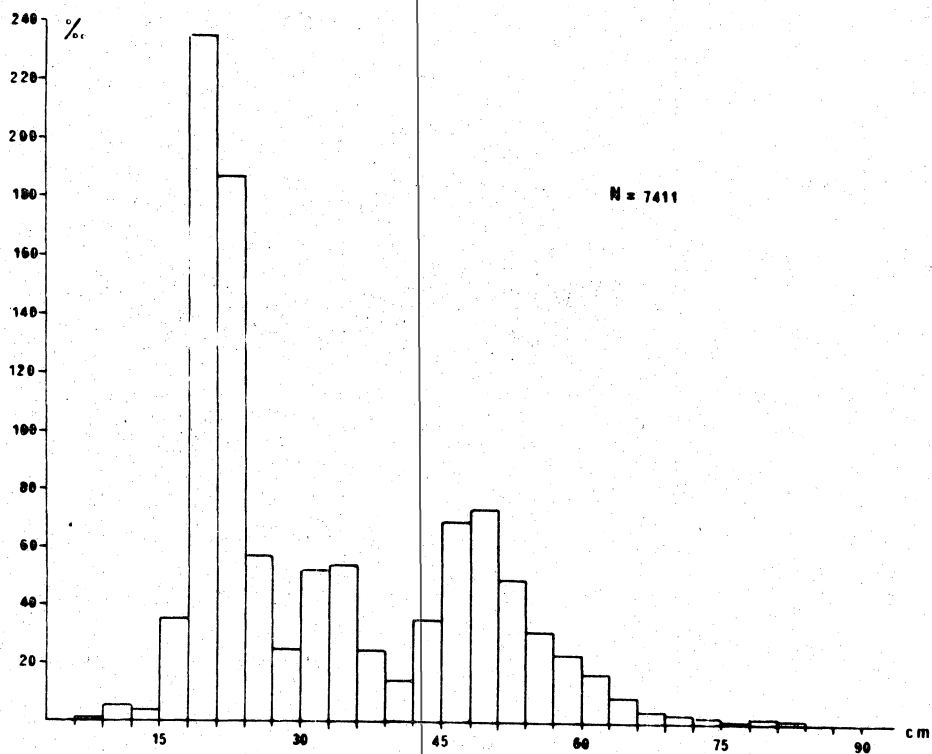


Fig. 3. Length distribution of total catch of haddock (tip of figure) compared with length distribution of haddock with squid in stomach (bottom of figure and shaded area on top).

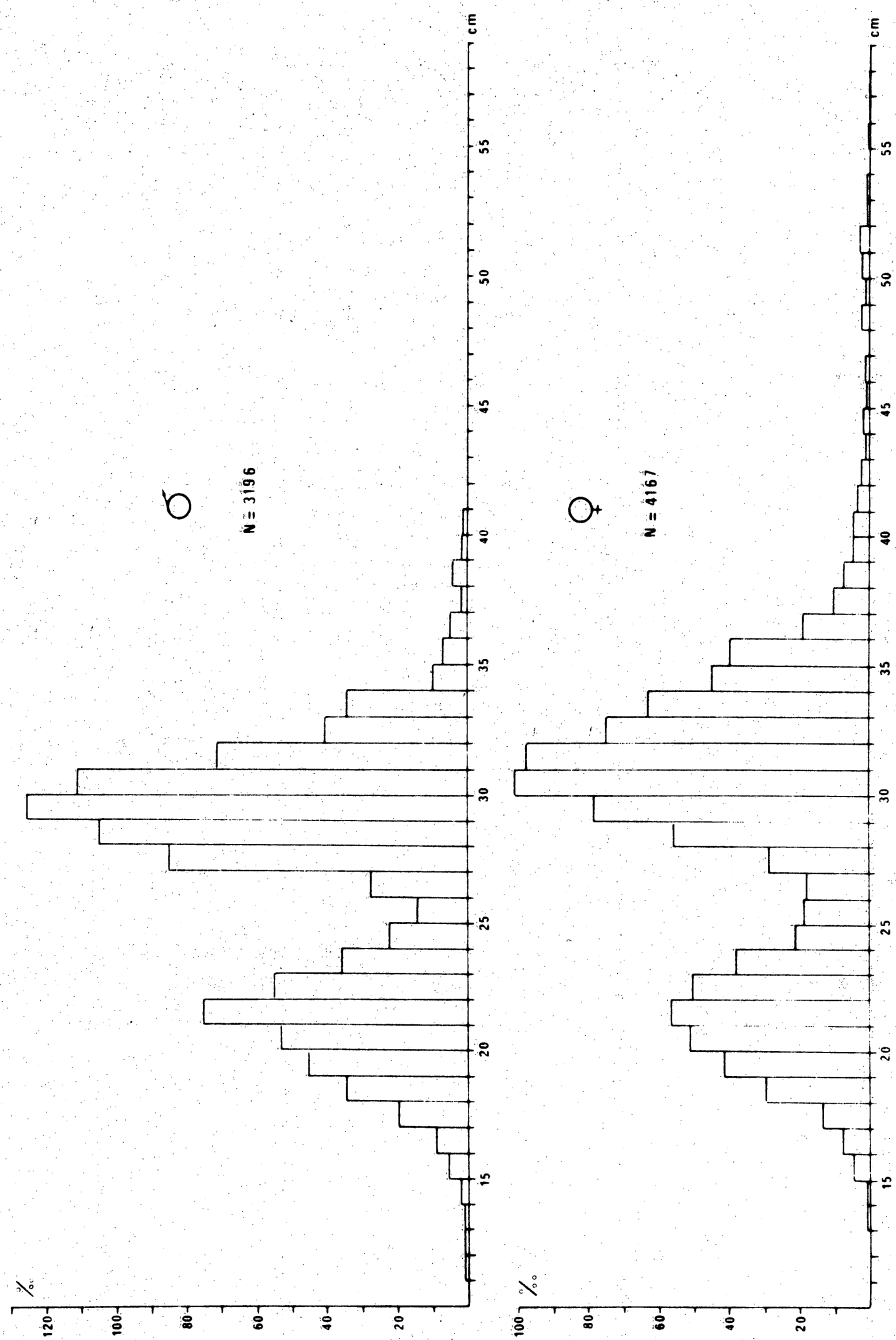


Fig. 4. Length distribution for male and female silver hake. Arrows represent individuals with squid in stomach.